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Study on Diversity, Density and Frequency of Mangrove Plants from South-Easten Ayeyarwady Delta of Myanmar

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Abstract:- A total of 26 species belonging to 22 genera and 15 families were recorded from the mangrove areas along the Thaung-ga-done creek, Pyapone Township, Ayeyawady Region. The recorded families included Acanthaceae, Meliaceae, Avicenniaceae, Leguminosae, Asclepidaceae, Sterculiaceae, Palmae and Sonneratiaceae. Among those, Avicenniaceae family represented the highest diversity and abundance in the study areas followed by Rhizophoraceae family and Acanthaceae family. Along the creek, *Avicennia offinalis, Acanthus ebractraus and Bruigyira cylindrica* species were dominated. However, *Derris trifoliata* and *Sesapenia* sp. were also represented as the abundance species among the mangrove associate species. Seven transect lines were laid along the creek. Simpson's index and Shannon Weiner index were used as tools for measuring the diversity and abundance of the plant species. Highest diversity value by Simpson's index was 0.82 in transect 3 and by Shannon Weiner index was 2.78 in transect 3.

Keywords:- Delta, Simpson's index, Shannon Weiner index.

I. INTRODUCTION

Studying on mangrove floristics, systematic and phytogeograghy, there is little information on mangrove forest structure. The comparative value of many of the available studies is not as great as it could be yielding results. Methods for studying mangrove structure reviews the development of structural measurements applicable in mangrove forest ecosystems.

Several field inventories have been made to study the mangrove distribution pattern, frequency and species abundance, which are used to determine the ecological status of the mangrove vegetation. It is common practice among ecologists to complete the description of a community by one or two numbers expressing the “diversity” or the “evenness” of the community. For this purpose a bewildering diversity of indices has been proposed and a small subset of those has become popular and is now widely used, often without much statistical consideration or theoretical justification. The theoretical developments on the use of diversity indices have been mostly discussed in the 60’s and 70’s. Although the subject continues to be debated to this day, by the 90’s their popularity in theoretical ecological work had declined. In contrast to this loss of interest from theoretical ecologists, diversity indices have become part of the standard methodology in many applied fields of ecology, such as pollution and other impact studies. They have entered environmental legislation and are again attracting attention at the turn of the century because of the surge of interest in biodiversity and the never ending quest for indicators of the status of the environment.

The basic idea of a diversity index is to obtain a quantitative estimate of biological variability that can be used to compare biological entities, composed of discrete components, in space or in time. In conformity with the “political” definition of biodiversity, these entities may be gene pools, species communities or landscapes, composed of genes, species and habitats respectively. In practice, diversity indices have been applied mostly to collections or communities of species or other taxonomic units. Two different aspects are generally accepted to contribute to the intuitive concept of diversity of a community: species richness and evenness (Peet, 1974). Species richness is a measure of the total number of species in the community. Evenness expresses how evenly the individuals in the community are distributed over the different species. Some indices, called heterogeneity indices by Peet (1974), incorporate both aspects, but Heip [7,8] made the point that in order to be useful an evenness index should be independent of a measure of species richness.

A diversity index should in principle fulfill the conditions that allow for a valid statistical treatment of the data. In modern ecological practice diversity indices are therefore nearly always used in conjunction with multivariate analyses.

The diversity of species in a particular area depends not only the number of species found, but also in their numbers. Ecologists call the number of species in an area its richness, and the relative abundance of species its evenness. They are both measures of diversity. Since any particular area can have all kinds of species living together, ecologists limit the taxonomy of interest when calculating species evenness.

II. MATERIALS AND METHODS

A. Study Areas

The study areas were situated at the mangrove areas along the Thaung-ga-don creek, Pyapon Township, Ayeyarwady Region. The creek is located between Htaung Gyi Tan and Ah Shey Hpyar villages. Belt transect line method was used for quantitative study of the areas. The study was conducted by 7 transect lines along the creek. Each transect line was assigned perpendicular to the bank which represented 17, 14, 14, 17, 9, 9 and 9 m long from seaward to landward respectively. Permanent plots (10m × 10m) were set along each transect. The location of the transect lines along the mangrove areas of the creek were shown in the Fig. 1.

B. Measuring the Diversity of the plants

Species diversity is expressed by two indices in the present study, namely, Shannon-Wiener index (H) and Simpson index (D). Species diversity is a combination of richness and evenness of species at a particular unit area. Species richness and species evenness are probably the most frequently used measured of the total biodiversity of a region. Diversity indices are better measure of the species diversity of a forest and more informative than species counts alone. Shannon-Wiener diversity index place more weight on the rare species while Simpson's diversity index emphasis on the common species. The following are the formula used for the diversity index.

Shannon-Wiener Index **Simpson Index**

$$H = -\sum_{i=1}^{s}[(p_i)(\log_2 p_i)] \qquad D = 1 - \sum_{i=1}^{s}(p_i)^2$$

H = Shannon-Weiner Index
D = Simpson Index
S = number of species in the community
p_i = proportion of individual of species "i" in the community

➢ *Species Evenness*

Species evenness is a diversity index, a measure of biodiversity which quantifies how equal the communities are numerically. The distribution of individual among the species is called species evenness or species equitability. Evenness is a maximum when all species have the same number of individuals. A greater number of species increases species diversity, and a more even equitable distribution among species will also increase species diversity measured by Shannon-Weiner function. Evenness was calculated by Shannon-Weiner function (1963), as follow:

$$E = \frac{H}{H_{max}} \qquad H_{max} = \log_2 S$$

E = evenness (range 0-1)
H = index of species diversity
H_{max} = species diversity under conditions of maximal equitability
S = number of species

C. Quantitative Structures of Plant Community

In the plant community, different species are represented by few or a large number of individuals aggregating in different vegetation units. It is essential to know the quantitative structure of the community, specially the numerical distribution and the space occupied by the individuals of different species. After extracting the essential data, following structures of the community could be determined:

➢ *Population Density*

The density of a species is the numerical representation of its individuals in a unit area or volume. The density of a species refers to the adequacy of its different requirements and the availability of space. Density is determined by the following formula:

$$Density\ (D) = \frac{\text{No.of individual of the species in all the sample plots}}{\text{Total no.of sample plots studied}}$$

For phytosociological purposes it is generally expressed as:

$$Relative\ Density\ (R.D) = \frac{\text{No.of individual of the species}}{\text{No.of individual of all the species}} \times 100$$

➢ *Frequency*

Individuals of a species are not evenly distributed within the community. While, some species are found to grow in clumps or in continuous mats, individual of different species indicate their adaptability to the local environment and also their success in reproduction. Thus, the frequency of a species is expressed as the percentage occurrence of its individuals in a number of observations. The *frequency* of different species growing in a community can be determined with the help of the formula:

$$Frequency\ (F) = \frac{\text{No.of sample plots in which the species occurs}}{\text{Total no.of plots sampled}}$$

For phytosociological purpose it is generally expressed as *Relative Frequency* and is determined with the following formula:

$$Relative\ Frequency\ (R.F) = \frac{\text{No.of occurrences the species}}{\text{No.of occurrences all the species}} \times 100$$

Frequency of occurrence of fungi can be tabulated using the following frequency groupings:

Very frequent ≥ 10% Infrequent = 1-5%
Frequent = 5 - l0% Rare ≥ 1%

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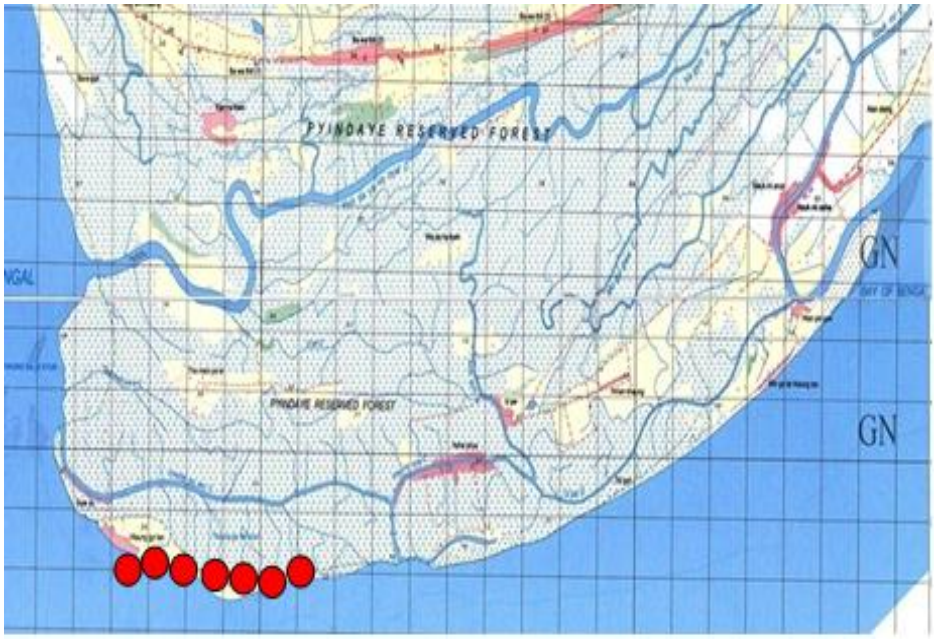

Fig. 1:- Map showing the study areas within South- eastern Ayeyarwady Delta, Pyapon Township, Ayeyarwady Region, Myanmar

III. RESULTS

A total of 26 species belonging to 15 families and 22 genera of mangroves and its associated plants were recorded in the present study. The species richness is commonly expressed as the number of species per unit area. Species evenness is expressed as measurement of how evenly distributed. Species evenness of each of transects were described in Fig. 3.10.

The number of individuals and their abundance in each sample plot within transect were shown in Table (3.1 – 3.8). The total number of plants and its associate were 15137 individuals the study areas. Among the recorded species, *Avicennia officinalis* representing 2042 individuals represented as the highest diverse species followed by *Rhizophora* in the study areas. *Derris trifoliata* and *Acantus ebractraus* also stand for the high diverse species among the mangrove associated species. The highest number of *Derris trifoliata* in the study area was numbering 6636 individuals and followed by *Acanthus ebractraus* with number totaling 2932.

There were four species such as *Amoora cucullata, Bruguiera sexangular, Rhizophora apiculata* and *Sonneratia apetala,* which are rarely found in the study areas. Only 7 species of *Amoora cucullata,* 3 species of *Bruguiera sexangular,* 2 species of *Rhizophora apiculata* and 7 species of *Sonneratia apetala* were observed in the study areas.

Species diversity of mangrove plants in the study areas were calculated by two methods; Simpson'index (D) and Shannon-Wiener Index (H). The measurements are presented in Table 9.

In the present study, the density of the mangrove species is also measured and the results were presented in Table3.9. In the present study, *Acanthus illicifolius* stand for the highest density representing 279.3 followed by *Avicennia officinalis* representing 117.3. Likewise, the density of the associate mangrove species is also measured. *Acanthus illicifolius* stand for the highest density representing 279.3 followed by *Derris* representing 117.3.

The relative density of the mangrove species is also measured and the results were presented in Table 3.9. *Acanthus illicifolius* was found to be maximum value of relative density representing 35.00 %. *Acanthus illicifolius* was found to be maximum value of relative density representing 35.00 %. The minimum relative density was represented by *Luminitzera racemosa* with 3.0 %.

Relative frequency mangrove species was also measured. *Derris trifoliata* stand for highest frequency in the study areas representing 43.84%. *Derris trifoliata* stand for highest frequency in the study areas representing 43.84% and *Acanthus ebractraus* 19.37 % and *Avicennia officinalis* 13.49 %. *Dalbegia spinosa, Excoecaria agallocha, Finlasonia maritime, Heritiera fomes, Nypa fruticans,* and *Sarcolobus globosus* were infrequently observed. Sixteen species were recorded in as less than 1% of species, being considered as "rare".

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No.	Species name	Plot-1	Plot-2	Plot-3	Plot-4	Plot-5	Plot-6	Plot-7	Plot-8	Plot-9	Plot-10	Plot-11	Plot-12	Plot-13	Plot-14	Plot-15	Plot-16	Plot-17	Total no. of species
1	*Acanthus ebractraus*	25	30	3	25	1		1							100	75	50	35	345
2	*Amoora cucullata*	1		3	3														7
3	*Avicennia marina*														2	2		6	10
4	*Avicennia officinalis*	7	5	1												1		9	23
5	*Bruguiera cylindrical*													1		1	3	15	20
6	*Caesalpinia bonduc*			1		1						70		35					107
7	*Ceriops tagal*												1				2		3
8	*Dalbegia spinosa*	1																	1
9	*Derris trifoliata*			100	75	100	75	50	75	50	75	75	100	35	70	35	35	35	985
10	*Excoecaria agallocha*	1																	1
11	*Finlasonia maritima*	1	10	1										7	35	35	35	70	194
12	*Heritiera fomes*	23		15	7	1		4	2	6	8	7	7			1			81
13	*Nypa fruticans*		2																2
14	*Phoenix paludosa*			1	2	1	1						1						6
15	*Sarcolobus globosus*	5		4	25		25					35	35						129
16	*Xylocarpus*	6												1	1	1			9

Table 1:- Species composition in transect 1

No	Species name	Plot-1	Plot-2	Plot-3	Plot-4	Plot-5	Plot-6	Plot-7	Plot-8	Plot-9	Plot-10	Plot-11	Plot-12	Plot-13	Plot-14	Total no. of species
1	*Acanthus ebractraus*	1	35	20				1			1				4	62
2	*Avicennia marina*												2	5		7
3	*Avicennia officinalis*	112	82	50	5						2	15	1	3		270
4	*Bruguiera cylindrical*										1					1
5	*Caesalpinia bonduc*			3												3
6	*Ceriops tagal*										1			1	4	6
8	*Dalbegia spinosa*								1	1		1	1	15		19
7	*Derris trifoliata*			20	20	1	100	40	60	80				10		331
9	*Excoecaria agallocha*												2		3	5
10	*Finlasonia maritima*	22	40			1			2		35	20	40			160
11	*Heritiera fomes*					6	10	8	3	3	2				1	33
12	*Nypa fruticans*	4	1	80	70											155
13	*Phoenix paludosa*							1								1
14	*Rhizophora apiculata*	4														4
15	*Sarcolobus globosus*									20						20
16	*Sonneratia apetala*	2														2

Table 2:- Species composition in transect 2

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No.	Species name	Plot -1	Plot -2	Plot -3	Plot -4	Plot -5	Plot -6	Plot -7	Plot -8	Plot -9	Plot -10	Plot -11	Plot -12	Plot -13	Plot -14	Total no. of species
1	*Acanthus ebractraus*	75	75	25					35		35	70	35	35	35	420
2	*Avicennia marina*											1		1		2
3	*Avicennia officinalis*	314	102	80	50			1	1		1	3	10	11		573
4	*Bruguiera cylindrical*	1							1						1	3
5	*Ceriops tagal*									1	5				8	14
6	*Dalbegia spinosa*										20	70	35	70	70	265
7	*Derris trifoliata*		35			100	75	75	100	35			35	35	35	525
8	*Excoecaria agallocha*								2	5			3	10	13	33
9	*Finlasonia maritima*		35						35			35		35		140
10	*Heritiera fomes*					26	19	12	1	2	3	2		1	2	68
11	*Nypa fruticans*	2	2	50	50											104
12	*Rhizophora apiculata*	3														3
13	*Sarcolobus globosus*									20	70					90
	Species richness	5	5	3	2	2	2	3	7	5	6	6	5	8	7	2240

Table 3:- Species composition in transect 3

No.	Species name	Plot -1	Plot -2	Plot -3	Plot -4	Plot -5	Plot -6	Plot -7	Plot -8	Plot -9	Plot -10	Plot -11	Plot -12	Plot -13	Plot -14	Plot -15	Plot -16	Plot -17	Total no. of species
1	*Acanthus ebractraus*	12	10				1					1	1	35				70	130
2	*Avicennia marina*														2	3	22	3	30
3	*Avicennia officinalis*	150	150	1										2			20	2	325
4	*Brownlowia tersa*				35														35
5	*Bruguiera cylindrical*														1	1	3	20	25
6	*Caesalpinia bonduc*			10	15		25			1				35	1			35	122
7	*Ceriops tagal*				1										5	3	3	10	22
8	*Dalbegia spinosa*		1	1															2
9	*Derris trifoliata*	25	50	35	35	50	25	35	35	35	50	70	50	50	50	35	75	35	740
10	*Excoecaria agallocha*		1		3	2													6
11	*Finlasonia maritima*	10	15							1					2	35			63
12	*Heritiera fomes*		10		8	2	6	9	13	8	9	5	4						74
13	*Ipomoea alba*		25																25
14	*Phoenix paludosa*	3	2	2	1	3													11
15	*Sarcolobus globosus*	10	15	15	10	30	75	50	25										230
16	*Xylocarpus moluccensis*								1							4			5
	Species richness	6	10	6	8	5	5	3	4	4	2	3	3	4	6	6	5	7	1845

Table 4:- Species composition in transect 4

No	Species name	Plot-1	Plot-2	Plot-3	Plot-4	Plot-5	Plot-6	Plot-7	Plot-8	Plot-9	Total no. of species
1	*Acanthus ebractraus*	50	70	5	10	20	15	70	50	240	530
2	*Avicennia officinalis*	310	7			1					318
3	*Brownlowia tersa*	5									5
4	*Bruguiera sexangular*	1		1		1					3
5	*Caesalpinia bonduc*				2					5	7
6	*Ceriops tagal*						1	8			9
7	*Dalbegia spinosa*	5	5			10	3		1	15	39
8	*Derris scandens*	70								8	78
9	*Derris trifoliata*	150	180	240	300	170	20	50	30	50	1190
10	*Eupatorium odoratum*					50					50
11	*Excoecaria agallocha*			7	9		25	26	38	18	123
12	*Heritiera fomes*		2	13	7	3	1	13		27	66
13	*Hygrophila*					10					10

Table 5:- Species composition in transect 5

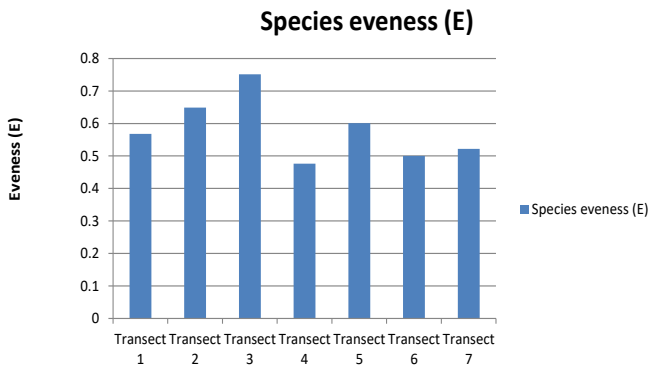

Fig. 2:- Species evenness of studied transect

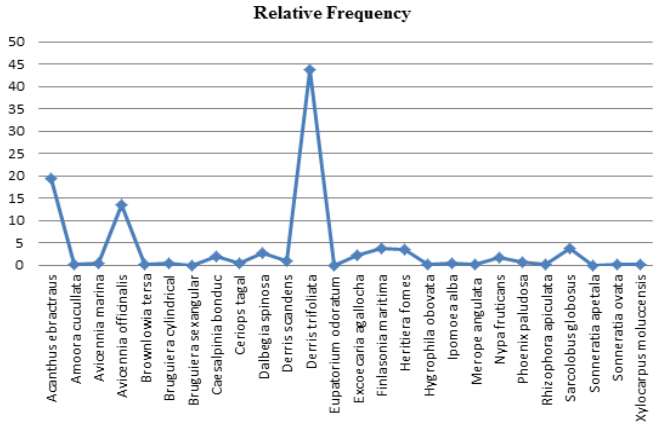

Fig. 4:- Relative frequency of mangrove species in study area

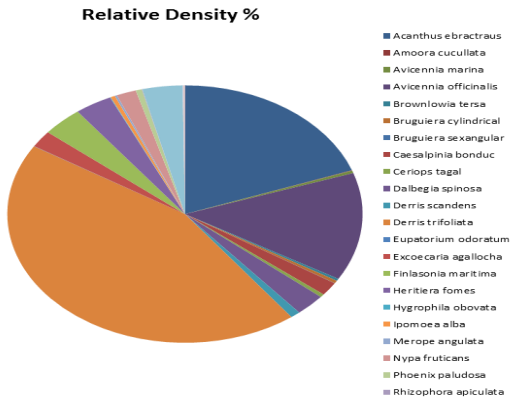

Fig. 3:- Relative density of mangrove species in study area

No	Species name	Plot-1	Plot-2	Plot-3	Plot-4	Plot-5	Plot-6	Plot-7	Plot-8	Plot-9	Total no. of species
1	*Acanthus ebractraus*	100	20	20	10	50	5	20	120	170	515
2	*Avicennia officinalis*	156	4			1	1				162
3	*Brownlowia tersa*	2									2
4	*Caesalpinia bonduc*							1	10	5	16
5	*Ceriops tagal*							1	3		4
6	*Dalbegia spinosa*	2	4			12					18
7	*Derris scandens*	10							5	15	30
8	*Derris trifoliata*	250	200	170	320	250	10	50	170	30	1450
9	*Excoecaria agallocha*			5	5	15	25	60	9	7	126
10	*Heritiera fomes*		5	20	12		1	3	9	15	65
11	*Ipomoea alba*	15	4								19
12	*Nypa fruticans*	2									2
13	*Phoenix paludosa*		1					1	10	2	14
Species richness		8	7	4	5	5	5	7	8	7	2423

Table 6:- Species composition in transect 6

No	Species name	Plot-1	Plot-2	Plot-3	Plot-4	Plot-5	Plot-6	Plot-7	Plot-8	Plot-9	Total no. of species
1	*Acanthus ebractraus*	150	30	5	50	180	15	50	250	200	930
2	*Avicennia officinalis*	365	1				5				371
3	*Bruguiera cylindrical*			1				1	1		3
4	*Caesalpinia bonduc*		2		8	10				10	30
5	*Ceriops tagal*								1		1
6	*Dalbegia spinosa*		2				6		30	30	68
7	*Derris scandens*	10						1		15	26
8	*Derris trifoliata*	250	230	240	250	200	15	20	80	130	1415
9	*Excoecaria agallocha*	1		7				7	9		24
10	*Heritiera fomes*		2	13	20	8	10	27	9	36	125
11	*Ipomoea alba*	2	5								7
12	*Merope angulata*							15		15	30
13	*Nypa fruticans*	1									1
14	*Phoenix*							1	10		11

Table 7:- Species composition in transect 7

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No	Species name	Transect-1	Transect-2	Transect-3	Transect-4	Transect-5	Transect-6	Transect-7	Total no. of species
		15°43′28.7″N 95° 18′ 27″ E	15°43′28.7″N 95°18′26.7″E	15°43′19.8″ N 95°18′57.1″ E	15° 43′ 19.8″ N 95° 18′ 58.0″ E	15° 43′ 28.7″ N 95° 18′ 28.0″ E	15° 43′ 28.7″ N 95° 18′ 28.3″ E	15°43′ 28.7″ N ° 95°18′28.7″ E	
1	*Acanthus ebractraus*	345	62	420	130	530	515	930	2932
2	*Amoora cucullata*	7							7
3	*Avicennia marina*	10	7	2	30				49
4	*Avicennia officinalis*	23	270	573	325	318	162	371	2042
5	*Brownlowia tersa*				35	5	2		42
6	*Bruguiera cylindrical*	20	1	3	25			3	52
7	*Bruguiera sexangular*					3			3
8	*Caesalpinia bonduc*	107	3		122	7	16	30	285
9	*Ceriops tagal*	3	6	14	22	9	4	1	59
10	*Dalbegia spinosa*	1	19	265	2	39	18	68	412
11	*Derris scandens*					78	30	26	134
12	*Derris trifoliata*	985	331	525	740	1190	1450	1415	6636
13	*Eupatorium odoratum*					50			50
14	*Excoecaria agallocha*	1	5	33	6	123	126	24	318
15	*Finlasonia maritima*	194	160	140	63				557
16	*Heritiera fomes*	81	33	68	74	66	65	125	512
17	*Hygrophila obovata*					10			10
18	*Ipomoea alba*				25	9	19	7	60
19	*Merope angulata*							30	30
20	*Nypa fruticans*	2	155	104		5	2	1	269
21	*Phoenix paludosa*	6	1		11	48	14	11	91
22	*Rhizophora apiculata*		4	3					7
23	*Sarcolobus globosus*	129	20	90	230	80			549
24	*Sonneratia apetala*		2						2
25	*Sonneratia ovata*		10						10
26	*Xylocarpus moluccensis*	9	1		5			4	19
Species richness		16	18	13	16	17	13	15	15 13 7

Table 8:- Species composition in study area

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Transect	Shannon-Wiener Index (H)	Simpson Index (D)
1	2.27	0.69
2	2.71	0.80
3	2.78	0.82
4	2.77	0.78
5	2.48	0.72
6	1.85	0.54
7	2.04	0.43

Table 9:- Shannon-Wiener Index and Simpson Index of study area

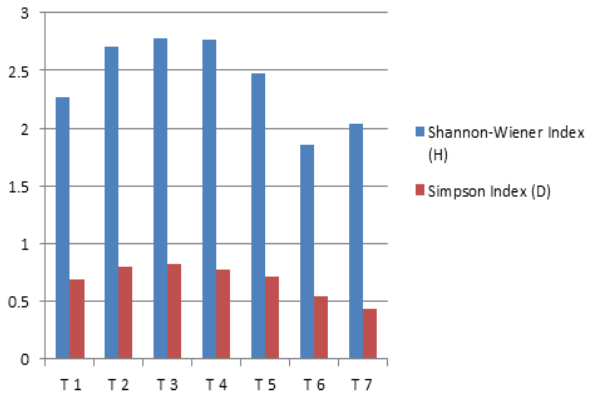

Fig. 5:- Shannon-Wiener index and Simpson index of study area

Transect	Species eveness (E)
1	0.57
2	0.65
3	0.75
4	0.48
5	0.60
6	0.50
7	0.52

Table 10:- Species evenness of studied transect

No	Species name	Density	Relative Density %
1	*Acanthus ebractraus*	32.94	19.37
2	*Amoora cucullata*	0.08	0.05
3	*Avicennia marina*	0.55	0.32
4	*Avicennia officinalis*	22.94	13.49
5	*Brownlowia tersa*	0.47	0.28
6	*Bruguiera cylindrical*	0.58	0.34
7	*Bruguiera sexangular*	0.03	0.02
8	*Caesalpinia bonduc*	3.20	1.70
9	*Ceriops tagal*	0.66	0.39
10	*Dalbegia spinosa*	4.63	2.72
11	*Derris scandens*	1.51	0.89
12	*Derris trifoliata*	74.56	43.84
13	*Eupatorium odoratum*	0.06	0.03
14	*Excoecaria agallocha*	3.57	2.10
15	*Finlasonia maritima*	6.26	3.68
16	*Heritiera fomes*	5.75	3.38
17	*Hygrophila obovata*	0.11	0.07
18	*Ipomoea alba*	0.67	0.40
19	*Merope angulata*	0.34	0.20
20	*Nypa fruticans*	3.02	1.78
21	*Phoenix paludosa*	1.02	0.56
22	*Rhizophora apiculata*	0.08	0.05

Table 11:- Density and Relative density of mangrove species in study area

No	Species name	Frequency	Relative Frequency	FG
1	*Acanthus ebractraus*	0.66	19.37	VF
2	*Amoora cucullata*	0.04	0.05	R
3	*Avicennia marina*	0.12	0.32	R
4	*Avicennia officinalis*	0.44	13.49	VF
5	*Brownlowia tersa*	0.03	0.28	R
6	*Bruguiera cylindrical*	0.17	0.34	R
7	*Bruguiera sexangular*	0.034	0.02	R
8	*Caesalpinia bonduc*	0.24	1.88	IF
9	*Ceriops tagal*	0.20	0.39	R
10	*Dalbegia spinosa*	0.29	2.72	IF
11	*Derris scandens*	0.09	0.89	R
12	*Derris trifoliata*	0.85	43.84	VF
13	*Eupatorium odoratum*	0.01	0.03	R
14	*Excoecaria agallocha*	0.32	2.1	IF
15	*Finlasonia maritima*	0.27	3.68	IF
16	*Heritiera fomes*	0.66	3.38	IF
17	*Hygrophila obovata*	0.01	0.07	R

Table 12:- Frequency and Relative frequency of mangrove species in study area

FG=Frequency Groupings; VF= Very Frequent; F=Frequency; R=Rare

IV. DISCUSSIONS

A total of 7 transect lines were laid to investigate the species composition, plant species diversity and quantitative structures of plant community. In this study area, the total number numbers of individual of all the species was 15137 and the species richness was 26.

Rao (1986) made comparative studies from mangrove area along the northern and western coasts and stated that the species composition and the agents causing maximum destruction differed with localities. Krishnamurthy *et al.* (1981) reported 110 species belonging to 60 genera and 35 families from Pitchavarum mangroves of Tamil Nadu. Vidyasagaran *et al.* (2011) investigated the floristic study at Kannur district, Kerala revealed that the occurrence of a total 12 species belonging to 7 families. Rhizophoraceae represented maximum genera of 4 species. In this study area, floristic diversity of mangroves constituted 26 species under 22 genera belonging to 15 families. Rhizophoraceae represented maximum genera of 3 species. Acanthaceae, Meliaceae, Avicenniaceae, Leguminosae, Asclepidaceae, Sterculiaceae, Palmae and Sonneratiaceae represented 2 genera.

Simpson index of diversity for concentration of dominance (cd) represent the chance of two successively randomly chosen individuals belonging to same species (Simpson, 1949). Jose (2003) reported Simpson index of diversity for Kannur (0.854). Sureshkumar (1993) reported very less value for Simpson index of diversity (0.144) for mangroves in Puduvyppu, Kerala. Vidyasagaran *et al.* (2011) indicated that Simpson index of diversity of mangroves for whole Kannur was 0.821. San Tha Tun (2011) studied Simpson index of mangrove along the U –To tidal creek in Chaung Tha. The highest value for Simpson index of diversity was 0.69 in transect 3 and the lowest was 0.37 in transect 1. The present study indicated that similar value for Simpson index of diversity was 0.68 .

Sureshkumar (1993) reported this value for Shannon Weiner index changed from 3.8 to 4.3 in the mangroves of Puduvyppu, Kerala. Shannon Weiner index of 2.0 - 3.2 in Honkong (Steve, 1993), 1.4 in China (Licun Li, *et al*., 1993) 1.0 to 2.27 in Maharashtra (Kurlapkar and Bhosale, 1993) was reported by various workers. Shannon Weiner index of diversity (H max) in Kannur was ranged from 2.53 to 4.22 at different sites Vidyasagaran, *et al.* (2011). The present study indicated Shannon Weiner index of 1.85 - 2.78. This value was similar to that of in Maharashtra reported by various workers.

Structural analysis encompasses not only the study of vegetation and its internal "social" relationships, but also provides information on classifications of plant communities and their structure, composition, and successional relations. Phytosociological analysis of mangroves of Kannur (Vidyasagaran, *et al.*, 2011) revealed that the highest density for *Acanthus illicifolius* (279.3) followed by *Avicennia officinalis* (117.3). The relative density for *A. illicifolius* was found to be maximum (35.00). The minimum was represented by *Luminitzera racemosa*, which recorded lowest relative density of (3.0). In this result, the highest density for *Derris trifoliata (*74.56) and followed by *Acanthus ebractraus (*32.94). The highest value for relative density was *Derris trifoliate* (43.84) and the lowest for *Sonneratia apetala* 0.01.

Importance value index was estimated using the values of relative density and relative frequency. Vidyasagaran, *et al.* (2011) stated that relative frequency of *A. illicifolius* was high in Pappinisseri area only while in other areas relative frequency was highest for *A. officinalis* (18.06). San Tha Tun (2011) investigated that the relative frequency was highest for *Sonneratia alba* (40%), followed by *Avicennia marina* (26.67%) and the lowest for *Ceriops decandra* was (10.64%). In the present study, *Acanthus ebractraus* (19.37%), *Avicennia officinalis (*13.49%) and *Derris trifoliate (*43.84%) were very frequent. *Caesalpinia bonduc, Dalbegia spinosa, Excoecaria agallocha, Finlasonia maritime, Heritiera fomes, Nypa fruticans and Sarcolobus globosus (1-5 %) were infrequent. Amoora cucullata, Avicennia marina, Bruguiera cylindrical, Bruguiera sexangular, Ceriops tagal, Derris scandens, Eupatorium odoratum, Hygrophila obovata, Ipomoea alba, Merope angulata, Phoenix paludosa, Rhizophora apiculata, Sonneratia apetala, Sonneratia ovate and Xylocarpus moluccensis (≤ 1 %) were rare.*

V. CONCLUSION

In the study area, the community constituted 26 species of the mangrove plants and its associates belonging to 22 genera and 15 families. The family Rhizophoraceae are dominated and followed by the family Avicenniaceae and Papilionaceae. The community is signify with the *Avicennia-Rhizophora-Acanthus* association and also dominated with a variety of associated vines, shrubs, herbs and many other epiphytes.

Species diversity, density, evenness, richness and frequency of the plants were measured. *Avicennia* species was the highest diversity and *Acanthus* was the highest density in the study areas.

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