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Distribution of soil types, vegetation and tree species diversity in Eastern Ghats of Srikakulam District, Andhra Pradesh, India

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The present investigation was carried out on distribution of soil types, vegetation and tree species diversity in Eastern Ghats of Srikakulam District, Andhra Pradesh, India. The inventory of tree species was done in 40 different forest areas of Srikakulam district. All the sample plots are tropical and moist thorny forest and dry thorny scrub forests of Srikakulam district. The soils of the study area are compressed red soils, loamy soils, sandy loams, with varying proportions of sand and clay and it constitute 96% of the total area; red sandy soil is the common type. Tree species richness varied according to the disturbance gradient in the different stands, a total of 4744 individuals, belonging to 129 species, 96 genera among 46 families from 40 line transects were recorded in the study area. Species richness ranging from 47 to 9 in a transect was recorded in the present study. Highest species richness of sizes 47 for 65-N/14 (SW-3, 65N-14 NW-3) was seen at Haddubanghi and lowest diversity 9 was seen at Korasanda 74-B/1(SE-1).

Key words: Soil types, vegetation, tree species diversity, Srikakulam district.

INTRODUCTION

Biodiversity is used in describing the diversity of life on earth, it includes all life forms and the ecosystem of which they are part. In the developing countries, biodiversity provides the assurance of food, many raw materials such as fibre for clothing, materials for shelter, fertilizers, fuel and medicines as well as sources of work energy in the form of animal traction. In addition, biodiversity maintains balance for planetary and human survival (Jafferries, 1997). Species diversity in the tropics varies dramatically from place to place, as compared to other tropical forest types, (Holdridge 1967). Dry deciduous forests are

among the most exploited and endangered ecosystems of the biosphere (Murphy and Lugo, 1986; Gentry, 1992). Studies from forest survey of India showed that an average of 54% of forest is effected by fire and 72% of forest area is subjected to grazing annually, 3.73 million hectares of forest area are burnt resulting in economic losses of approximately 440 crores (MOE,1999). Dry deciduous forests are among the most exploited and endangered ecosystems of the biosphere (Janzen, 1988; Gentry, 1992). The world wide destruction of the natural environment by population explosion, urbanization,

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industrialization and habitat fragmentation has led to a tremendous loss of biological diversity over the past few decades. Over exploitation is to severely reduce the population sizes below the critical level and consequently the survival of the species. Phyto-sociological investigation of vegetation serves as a pre-requisite for investigating the details of the primary productivity of an ecosystem. Tree species diversity, distribution and population structure of tropical forests of Eastern Ghats are poorly understood. We analyzed the structure of tropical deciduous forests in Srikakulam district of Eastern Ghats, Andhra Pradesh, India.

MATERIALS AND METHODS

Phytosociological studies carried out during July 2008 to June 2011 covered all spectrum of vegetation. The entire stretches of Eastern Ghats of Srikakulam district are divided into 6.25 x 6.25 km grid, based on the toposheets obtained. This expertise method of classification is obtained from UAS-ATREE team Bangalore (Jagadish et al., 2003). Each grid is from a sampling unit. The inventory of tree species was done in 40 different forest areas in Srikakulam district. In each forest area consider as one belt transect, one belt transect (Plot) of 5 x 1000 m in each of the 6.25 x 6.25 km (grid) is a sampling protocol with 0.01% of sampling intensity based on random sampling method. All the plots samples are from tropical dry deciduous forests, moist deciduous forests and scrub deciduous forests of Srikakulam district. In order to revisit these plots for seasonal sampling, latitude, longitude, altitude values were recorded by using a GPS (Garmen India) and other Geo-climatic features were identified and represented in Tables 1 and 2. The specimens were identified with the help of flora of Andhra Pradesh 3 Volumes (Pullaiah et al., 1997) and local floras like Flora of Srikakulam district (Rao R.S. and Hara Sreeramulu, 1986), studies on the vegetation and flora of Vizianagaram district (Venkaiah, 1980) and (Srinivasa et al., 2012) phytosociological studies on tree diversity of Srikakulam districts of Andhra Pradesh, India.

Study area

The Srikakulam district lies on the east coast of India between 18°-20' and 19°-10'N and 83°-50' and 84°-50' E. The total geographical area is 2,254 sq km. This area is bounded by Orissa State on the North and West and Bay of Bengal on the East and North east on the south and west Visakhapatnam district. These area consist of 37 mandals of different types of soils like red soils, loamy soils, sandy loams, with varying proportions of sand and clay and they constitute 96% of the total area. Red sandy soils area the common type. The climate of the region is generally tropical. The temperature in the hill areas is cooler than in plains because hills receive heavier rainfall. The mean maximum temperature is 30-40°C in April-May and the mean minimum temperature is 17.4°C in December-January during the summer season till the on-set of the South-West monsoon the heat is oppressive and the day temperature may sometimes be about 43°C. The rainfall in the region is considerably more in the hilly areas as compared to the plains.

RESULTS AND DISCUSSION

A total of 129 tree species were recorded from 40 tran-

sects; the predominant species of this region are *Mangifera indica* which is the most important species followed by *Lannea coromandelica*, *Wrightia tinctoria*, *Dalbergia paniculata*, *Tamarindus indica*, *Diospyros sylvatica*, *Cleistanthus collinus*, *Xylia xylocarpa*, *Chloroxylon swietenia* and *Terminalia alata* were recorded. Density, frequency, relative density, relative frequency and relative abundance values were taken for the preparation of single link cluster analysis and results revealed that the majority of the species formed similar groups (Scale 0-25) except *M. indica* and *T.s indica* which forms the dissimilar groups in the study area (Figure 1). Latitude, longitude and altitude readings of the sampling areas and different soil types like sandy, black, red, loam and with different combinations were recorded and presented in Table 1. In the present investigation, the highest altitude was recorded in Laada followed by Polla, Kothakota, Samarillu, Sara, Sunnapugedda and lowest altitude was recorded in Sakipuram. Total study area was divided into 40 grids, the number of species that occurred in each grid was recorded; 47 species in Huddubanghi (65N-14,SW-3) followed by 45 species in near Chapara (74B-1 SE-4) and Sundarada (74B-2 NE-1), 43 species at Sobha (74B-1(SW-2), 42 species at Sunnapagedda (65N-10 NE-3), 41 species at Yetugada (65 N-13 NW-2) etc were recorded in the entire forest area (Table 2). Tree species richness varied according to disturbance gradient in different, a total of 4744 individuals, belonging to 129 species, 96 genera among 46 families from 40 line transects in the study area are recorded in Tables 1 and 2). Species richness ranges from 47 to 9 in a transect, as recorded in the present study. Species richness was more 47 for 65-N/14(SW-3, 65 N/14 NW-3) at Haddubanghi and has least species diversity 9 at Korasanda 74 B/1 (SE-1). Species area and species individual accumulation curve against equal-sized sampling area in different vegetation types showed that species heterogeneity was higher in vegetation types at mid elevations while their abundance was higher in vegetation types at higher elevations (Jayakumar and Nair, 2013). In tropical rain forests, the ranges of tree species count per hectare is about 20 to maximum of 223 (Parthasarathy and Sethi, 1997), 42-47 species ha⁻¹ (Kadavul and Parthasarathy, 1998). In the present investigations, maximum of 47 tree species per 1000 m (one transect) was recorded, these results agree with earlier observations of Parthasarathy and Sethi (1997) and Kadavul and Parthasarathy (1998). In the present study, species richness in study sites are also correlated with the taxonomical studies, most of the trees show random distribution and was low when compared with that of tropical forests of Indian Eastern Ghats and Western Ghats, that is, the number of species in Nallamalias, 69 (Sudhakar et al., 2008), Kolli hills, 25-56 (Chittibabu and Parthasarathy, 2000), Kalarayan hills, 42-47 (Kadavul and Parthasarathy, 1999a). Shervarayan hills, 33-50 (Kadavul and Parthasarathy, 1999 b). The sacred grooves of Kerala 14-23, (Chandra Sekhar and

Table 1. Latitude, longitude and altitude of the sampling areas and soil types of the study area.

Location	Latitude		Longitude		Altitude		Soil type
	Starting	Ending	Starting	Ending	Starting (mts)	Ending (mts)	
Akkarajupeta	18° 43' 223" N	18° 43' 672" N	83° 39' 523" E	83° 39' 848" E	74	186	Black
Bethalapuram	18° 58' 923" N	18° 59' 234" N	84° 3° 31" E	84° 3° 325" E	86	121	Red
Bharani kota	18° 17' 479" N	18° 17' 731" N	84° 47' 2°1" E	84° 47' 429" E	35	86	Red
Degalakotturu	18° 43' 422" N	18° 43' 631" N	84° 42' 7°2" E	84° 42' 873 "E	78	89	Red
Haddubangi	18° 45' 326" N	18° 45' 683" N	83° 42' 231" E	83° 42' 62" E	116	214	Red
Hannali	18° 53' 942 "N	18° 54' 1°3 "N	84° 28' 834" E	84° 28' 625 "E	35	86	Red
Haripuram	18° 35' 832" N	18° 35' 643" N	83° 47 '389 " E	83° 47' 526" E	58	110	Red
Hussanpuram	18° 4° 279 "N	18° 4° 636" N	83° 39' 8°3" E	83° 39' 917" E	78	96	Red
Irupeduguda	18° 42' 33° "N	18 ° 42' 656" N	83° 53' 175" E	83° 53' 268 "E	327	346	Black
Kalandinagaram	18° 56' 826 "N	18° 56 '798 "N	84° 26' 511" E	84° 25' 838" E	71	180	Black
Karakavalasa	18° 35' °2" N	18° 34' 733 "N	83° 54' 762" E	83° 54 ' 464" E	53	80	Black
Korasanda	18° 49' 782 "N	18° 49' 512" N	84 °1° 226" E	84° 1° 489" E	72	89	Red
Kothakota	18° 44' 154 "N	18° 44' 186" N	83°39' 27" E	83° 39 ' 776 "E	504	499	Red
Laada	18° 45' 233" N	18° 45' 372" N	83° 45' 434" E	83° 45' 543" E	667	739	Red
Labba	18° 43' 586 "N	18° 43' 759 "N	83° 52' 943" E	83° 52' 625" E	125	142	Red
Machannapeta	18° 32' 4°9 "N	18° 32' 725" N	83° 51' 969" E	83° 51' 834" E	101	199	Red
Manumakonda	18° 59' 423" N	18° 59' °15" N	83°46' 4°5" E	83 ° 45' 997"E	108	186	Red
Masinguda	18° 45'883" N	18 ° 45' 7°9 "N	83° 51' 75" E	83° 51' 791" E	125	169	Silt Red
Mukundapuram	18° 44' 152" N	18 ° 43' 756 "N	83° 51' 712" E	83° 51' 3°4" E	116	214	Red
Nallarayiguda	18° 51' °73" N	18° 51' 24" N	83°5°192" E	83 ° 5° 614" E	196	69	Black
Nearchepara	18° 47' 782" N	18° 47' 435" N	84° 14' 2°1" E	84° 14' 535" E	55	63	Red
Pasukudi	18° 55' 628" N	18° 55' 182" N	83° 49' °9" E	83° 48' 922" E	89	71	Red
Peddakedari	18° 39' 47" N	18° 39' 642" N	84° 13' 221 " E	84° 13' 535" E	47	89	Red
Peddasankili	18 ° 42' 287" N	18 ° 42' 556" N	83 °55' 693 "E	83 ° 55' 949" E	61	109	Red
Polla	18° 45' 782 "N	18 ° 45' 323" N	83° 41' 198" E	83 ° 41' 71" E	503	487	Black
Rayala	18 ° 48' °58" N	18 ° 47' 823" N	83° 59' °92 "E	83 ° 59' 457" E	69	193	Red
S.Narsipatnam	18 ° 44' 689" N	18° 44 '987 " N	83° 36' 446" E	83° 36' 223" E	93	106	Black
Sakipuram	18° 45' 793" N	18° 45' 932" N	84° 2° 556" E	84° 2° 937 "E	31	49	Red
Samarillu	18 ° 43' 77° "N	18° 43'673" N	83 °45' °15" E	83 ° 45' 387" E	475	484	Loam
Sambam	18° 38' 7°3 "N	18° 38' 171" N	83° 5° 975" E	83 ° 51' 235" E	310	287	Silt black
Samparai guda	18 ° 45' 384" N	18° 45' 789 "N	83° 52' 262" E	83 ° 52' 638 "E	89	71	Red
Sara	18° 35' 6°6" N	18° 35' 577" N	83° 5° 645" E	83 ° 49' 785 "E	353	372	Red
Saribujili	18° 32' °12" N	18° 32' 619 "N	83° 54' °597 " E	83° 54' 444 "E	39	174	Red
Soba	18° 47' 436" N	18 ° 47' 6°8 "N	84° °1' 836" E	84 ° °1' 52" E	86	110	Red
Sundarada	18° 44' 567" N	18° 44' 998 "N	84° °8' 634 "E	84 ° °8' 935 "E	80	124	Red
Sunnapugedda	18° 45' 624" N	18° 46' 128" N	83° 42' 449" E	83° 42' 419" E	325	336	Black
Temburu	18° 37' 538" N	18° 37 '84° "N	84° °7' 678" E	84° °7' 937" E	59	98	Red
Timedisala	18° 43' 325" N	18° 43' 712" N	84° 18' 235" E	84° 18' 612" E	56	74	Red
Vampaliguda	18° 44' 979 "N	18° 45' 1°7" N	83° 51' 356" E	83° 51' 479 "E	105	186	Red
Yatuguda	18° 53' 658" N	18° 53 '655 " N	83° 47' 761" E	83° 47' 264 " E	151	331	Black

Sankar, 1998), Thirumani Kuzhi sacred groove, 38 (Parthasarathy and Karthikeyan, 1997). The predominant forest areas of the study regions of Srikakulam district in Andhra Pradesh are tropical deciduous forests (Champion and Seth, 1968). Studies in this area reveal that the most abundant families were Rubiaceae and Mimosaceae (13), Moraceae (12), Euphorbiaceae (11),

Fabaceae (9), Verbenaceae (9), Rutaceae, Anacardiaceae, Combretaceae and Ebenaceae with 6 species, respectively. An obvious variation in representation of tree species and the proportion of dominant species in the forests can directly be attributed to rainfall distribution and favorable topographic conditions. The present study also support the above fact that Euphorbiaceae, Fabaceae

Table 2. Details of the study area.

Toposheet number	Grid number	Location	District	Forest Division	Forest range	Type of vegetation	Families number	Genera number	Species number
65N-10	NE-4	Akkarajupeta	Srikakulam	Srikakulam	Palakonda	DD	18	31	35
74 B-9	NW-1	Bethalapuram	Srikakulam	Srikakulam	Pathapatnam	SCRUB	21	29	34
74 B-5	NE-2	Bharanikota	Srikakulam	Srikakulam	Srikakulam	SCRUB	20	22	25
74 B-2	NE-3	Degalakotturu	Srikakulam	Srikakulam	Pathapatnam	SCRUB	11	12	12
65N-14	SW-3	Haddubangi	Srikakulam	Srikakulam	Pathapatnam	SCRUB	30	43	47
74 B-5	NE-4	Hannali	Srikakulam	Srikakulam	Srikakulam	SCRUB	20	22	25
65N-14	SW-1	Haripuram	Srikakulam	Srikakulam	Palakonda	SCRUB	23	30	33
65N-10	NE-2	Hussanpuram	Srikakulam	Srikakulam	Palakonda	SCRUB	17	21	22
65N-14	NE-1	Irupeduguda	Srikakulam	Srikakulam	Palakonda	D D	18	23	23
74B-5	NE-3	KalandiNagaram	Srikakulam	Srikakulam	Pathapatnam	DD	22	31	33
65N-14	SE-1	Karakavalasa	Srikakulam	Srikakulam	Pathapatnam	SCRUB	21	32	36
74B-1	SE-1	Korasanda	Srikakulam	Srikakulam	Pathapatnam	SCRUB	9	9	9
65N-10	NE-1	Kothakota	Srikakulam	Srikakulam	Palakonda	MD	23	34	38
65N-13	SW-2	Laada	Srikakulam	Srikakulam	Palakonda	DD	21	30	33
65N-14	NE-1	Labba	Srikakulam	Srikakulam	Palakonda	D D	20	26	26
65N-14	SW-4	Machanna peta	Srikakulam	Srikakulam	Palakonda	DD	24	33	37
65N-13	NW-1	Manumakonda	Srikakulam	Srikakulam	Palakonda	DD	11	13	14
65N-13	SW-4	Masinguda	Srikakulam	Srikakulam	Palakonda	DD	21	31	32
65N-14	NW-3	Mkundapuram	Srikakulam	Srikakulam	Pathapatnam	SCRUB	30	43	47
65N-13	SW-3	Nallarayiguda	Srikakulam	Srikakulam	Palakonda	SCRUB	20	27	33
74 B-1	SE-4	Near Chapara	Srikakulam	Srikakulam	Pathapatnam	DD	22	39	45
65N-13	NW-4	Pasukudi	Srikakulam	Srikakulam	Palakonda	SCRUB	21	27	30
74B-2	NE-4	Peddakedari	Srikakulam	Srikakulam	Pathapatnam	DD	22	33	38
65N-14	NE-3	Peddasankili	Srikakulam	Srikakulam	Palakonda	D D	18	23	23
65N-9	SE-4	Polla	Srikakulam	Srikakulam	Palakonda	D D	22	34	36
65N-13	SE-4	Rayala	Srikakulam	Srikakulam	Pathapatnam	SCRUB	21	26	28
65N-10	NW-3	S.Narsipatnam	Srikakulam	Srikakulam	Palakonda	SCRUB	15	16	18
74 B-5	SW-4	Sakipuram	Srikakulam	Srikakulam	Srikakulam	SCRUB	11	12	14
65N-14	NW-1	Samarillu	Srikakulam	Srikakulam	Palakonda	DD	24	36	39
65 N-14	NW-4	Sambam	Srikakulam	Srikakulam	Palakonda	DD	21	35	38
65N-13	SW-1	Samparai guda	Srikakulam	Srikakulam	Palakonda	SCRUB	21	27	30
65N-14	NE-2	Sara	Srikakulam	Srikakulam	Palakonda	DD	21	32	33
65N-14	SE-2	Saribujjili	Srikakulam	Srikakulam	Pathapatnam	SCRUB	11	13	14
74B-1	SW-2	Soba	Srikakulam	Srikakulam	Pathapatnam	DD	22	35	43
74B-2	NE-1	Sundarada	Srikakulam	Pathapatnam	Srikakulam	SCRUB	30	41	45
65N-10	NE-3	Sunnapugedda	Srikakulam	Srikakulam	Palakonda	DD	25	38	42
74B-2	NE-2	Temburu	Srikakulam	Srikakulam	Srikakulam	SCRUB	24	35	39
74B-6	NW-1	Timedisala	Srikakulam	Srikakulam	Pathapatnam	SCRUB	23	32	37
65N-14	NW-3	Vampaliguda	Srikakulam	Srikakulam	Palakonda	DD	22	32	32
65N-13	NW-2	Yetuguda	Srikakulam	Srikakulam	Palakonda	DD	23	37	41

and Rubiaceae are dominant families in almost all type of forests as reported by Sudhakar et al. (2008) and Kadavul and Parthasarathy (1999a). In moist deciduous forests, the species composition comprise a mixture of both moist and dry elements; indicating transitional zone. In this forest, *Anogeissus latifolia*, *Garuga pinnata*, *Haldinia cordifolia*, *Lagerstroemia parviflora*, *Lannea coromandelica*, *Mangifera indica*, *Protium serratum*,

Pterocarpus marsupium, *Syzygium cuminii*, *Terminalia alata* and *Xylia xylocarpa* are predominant species, some tree species like *Chloroxylon swietenia*, *Diospyros sylvatica*, *Schleichera oleosa*, etc. grow luxuriantly reaching more than 15-20 m in height. In dry deciduous forests, *Bombax ceiba*, *Bridelia retusa*, *Dalbergia paniculata*, *Gmelina arborea*, *Mitragyna parvifolia*, *Sterculia urens*, *Strychnos nux-vomica*, *Terminalia alata*,

Dendrogram using Single Linkage

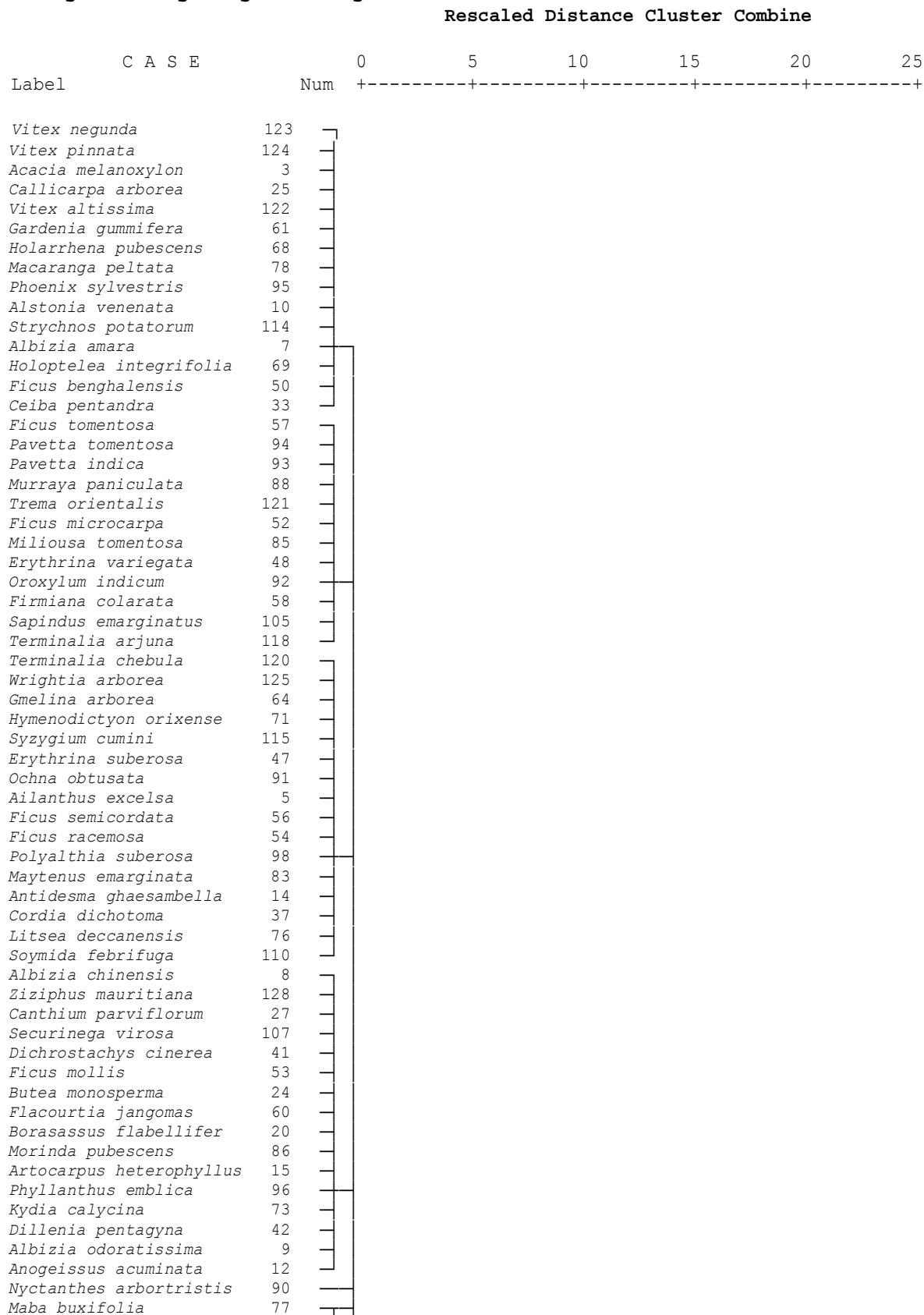


Figure 1. Hierarchical cluster analysis.

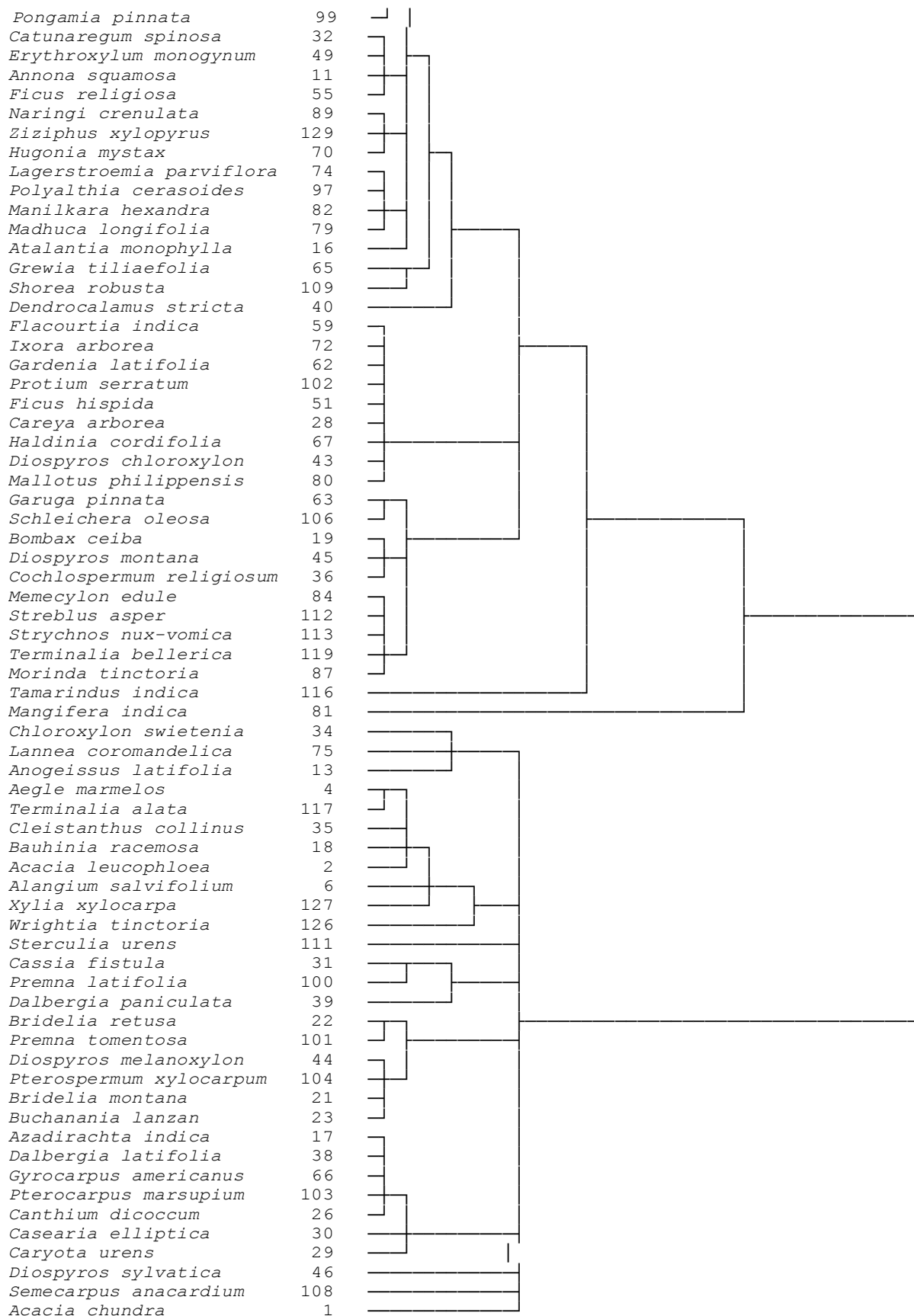


Figure 1 Contd.

Terminalia bellerica and *Xylia xylocarpa* are predominant tree species found in red sandy loam soils. Scrub deciduous forest is represented by *Diospyros melanoxylon*, *Diospyros chloroxylon*, *Strychnos potatorum*, *Zizyphus mauritiana*, *Wrightia tinctoria*, *Manilkara hexandra*, *Erythroxylum monogynum* species were reported because soils are characterized by red sandy types in study area. Studies revealed the presence of 4744 individuals in Srikakulam district when compared with Nallamalais, Seshachalam and Nigidi hills (1541-3ha⁻¹) (Sudhakara et al., 2008), Similipal Biosphere reserve (4819-8ha⁻¹) (Sudhakara et al., 2007), Boudh district, Orissa (2364-4 ha⁻¹) (Sahu et al., 2007), inland and coastal tropical dry evergreen forest of Peninsular India (4676-10 ha⁻¹) (Mani and Parthasarathy, 2006), the total individuals reported in the study area is less when compared with various sites in Eastern Ghats, revealing the degradation of forests due to cut stumps; ecological factors like forest fires are predominant hence we can conclude that some parts of the study area were under frequent fires, which is degradation to the vegetation.

Conclusion

The findings of the current study suggested that the species richness ranges from 47-9 in a transect. Species richness was more than 47 for 65N/14 (SW-3, 65N/14 NW-3) at Haddubanghi and has least species diversity of 9 at Korasanda 74B/1 (SE-1). Further research should focus on the diversity of the tree species from nearby Srikakulam forest area which will be beneficial to the ecological and taxonomical status of the plant species.

Conflict of Interests

The author(s) have not declared any conflict of interests.

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