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RESEARCH ARTICLE

HABITAT AND PHYTOSOCIOLOGICAL CHARACTERS OF THE ENDANGERED PLANT SPECIES, *EXACUM BICOLOR* ROXB.

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ABSTRACT

Study on the phytosociological characters like distribution, abundance, density etc of a species in its established habitats is a tool to determine the effect of environmental conditions on variations in population characteristics. Based on this concept, four leaf shape variants (ovate, linear- lanceolate, oblanceolate and ovate – elliptic) of the plant species, *Exacum bicolor* distributed in four different grasslands habitats *viz.,* Payyanur, Taliparamba, Paithal mala and Thirunelli at Kannur and Wayand districts of Kerala were selected in the present study. The populations of the study species showed distinct expression of ecological attributes across the four leaf shape variants in four habitats studied. The distribution level determined through the annual mean frequency percentage was higher (89.29 %) in the populations of ovate leaf shape variant in Taliparamba, where as it was lower (5.71 %) in the populations of linear – lanceolate leaf shape variant in Payyanur. Similarly, the annual abundance of the population was higher (5.08/ m^2) for ovate – elliptic leaf shape variant (Taliparmba) and lower (1.43/ m^2) for linear – lanceolate leaf shape variant (Thirunelli). The annual density obtained by the population was also higher for ovate leaf shape variant present in Taliparmba (4.10/ m^2) and lower for the population of linear – lanceolate leaf shape variant present in Thirunelli, (0.09/ m^2). From these ecological studies, it is understood that among the four leaf shape variants, generally ovate leaf shape variant has established well. In addition, the grassland community at Taliparamba is determined to have most suitable microclimate also for this variant than the other habitats studied.

Keywords: Exacum bicolor, phytosociological characters.

1. INTRODUCTION

Exacum bicolor (Family: Gentianaceae) is an endangered medicinal herb distributed in hillocks of northern Kerala between the altitude 50-200 m above MSL. Unique feature of this plant is limited dispersion with very few individuals in large stretch of grasslands. (10,11). In addition, in the districts of northern Kerala like Kannur, Wayanad, Calicut, Palakkad etc this species is represented by four ecological variants on basis of leaf shape such as ovate leaved, linear-lanceolate leaved, oblanceolate leaved and ovate-elliptic leaved.

E. bicolor have high ornamental value and in Kerala, it is in use of different ailments since many centuries. Whole part of the plant is used as a tonic, febrifuge and stomachic and antifungal agent (7, 13, 5, 2, 9). The plant also yields dye also (12). Being bitter in taste, local people take it as herbal remedy for diabetes, and skin disorders (8). In Kerala, the traditional practitioners prescribe decoction of the whole plant for the treatment of fever, eye and skin diseases and urinary disorders. Traditional healers of Pundra and Bilaspur regions of Chhattisgarh use this plant as blood purifier and for the treatment of malaria. Flowers of this plant were given great religious importance in old Valluvanadan region of Kerala. It is one of the choicest flowers to adorn Trikkakkarayappan, the earthern diety worshiped during Onam an important regional festival. Except few works on distribution status, no ecological studies have been carried out for this species. Hence, to know the status of the degree of distribution, density and abundance the present works has been done in all the four leaf variants.

2. MATERIALS AND METHODS

Phytosociological studies for the four leaf shape variants of the species, *Exacum bicolor* were carried out for a period of seven months from May, 2009 to November, 2009 at monthly intervals in all the four studied grasslands of Kerala *viz.,* Taliparamba (55m above MSL), Payyanur (15m above MSL), Paithal mala (1350m above MSL) of Kannur district and Thirunelli (900m above MSL) of Wayanad district. The minimum quadrat size of 1 x 1m was fixed by the species-area curve method, and each time, 20 quadrats were laid by randomized method. The minimum number of quadrats (i.e. 20) was determined as described by Greig - Smith (1). For this, the mean number of individuals of the first five, ten, fifteen, twenty, etc.,

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quadrats were calculated and plotted against the number of observations. It will be seen that the mean at first fluctuates, steadying as the required number of quadrats was reached.

The number of individuals of all the four leaf shape variants of *E. bicolor* in each quadrat was recorded. From the observations, the quantitative characters such as frequency, density and abundance were calculated using the following formulae:

$$\text{Frequency} = \frac{\text{Number of quadrats in which the species present}}{\text{Total number of quadrats studied}} \times 100$$

$$\text{Density} = \frac{\text{Total number of individuals of the species in all quadrats}}{\text{Total number of quadrats studied}}$$

$$\text{Abundance} = \frac{\text{Total number of individuals of the species in all quadrats}}{\text{Number of quadrats of occurrence of the species}}$$

3. RESULTS AND DISCUSSION

The study on local distribution revealed that the four ecological variants of the study species, *Exacum bicolor* are site specific (Tables 1). The ovate, oblanceolate and ovate-elliptic leaf shape variants of *E. bicolor* are noted to be present in Payyanur and Taliparamba grasslands and linear-lanceolate leaf shape variant has distributed in Paithal mala and Thirunelli grasslands. In early study, (11) also reported the site specific distribution of variants of this species in northern Kerala. This may be explained due to the microclimatic preferences of the variants at soil level (10).

The ovate leaf variant registered its highest number of individuals, 115/20m^2 in Taliparamba during the month of August, 2009 . The lowest number (34/20m^2) for the same variant was found to be observed in Payyanur grassland during the month, May, 2009. The range of variation in the number of individuals over the period of study across the grasslands for the linear-lanceolate leaf variant was lying between 1 (in Thirunelli during May, June, October and November, 2009) and 95/20m^2 (in Paithal mala grassland during August, 2009). The oblanceolate leaf variant showed its higher number of individuals (119/20m^2) in Taliparamba grassland during August, 2009 and its lower number (36/20m^2) was present in Payyanur grassland during the month, May, 2009. The ovate-elliptic leaf shape variant showed its higher appearance (128 / 20m^2) in Taliparamba grassland during August, 2009 and lower appearance (49/20m^2) in Payyanur grassland during May, 2009 (Table 1).

The monthly variation in frequency percentage for ovate leaf shape variant was ranging between 55 (Payyanur grassland during May, 2009) and 100% (Payyanur grassland during August, 2009 and Taliparamba grassland during July, August, September and October, 2009). The linear-lanceolate leaf shape variant recorded higher frequency of occurrence (100%) in Paithal mala grassland during August, 2009 and the lower frequency (5%) of that variant was noted during the months, May, June, July, September, October and November, 2009 in Thirunelli. The range of frequency percentage for oblanceolate leaf shape variant was lying between 45 (Payyanur during the month of May, 2009) and 100 (Taliparamba and Payyanur during the month, August, 2009). The ovate-elliptic leaf shape variant showed its highest frequency as 100% in Payyanur grassland during August, 2009 and in Taliparamba during August and September, 2009. Its lower frequency percentage was noted as 55 during May, 2009 in Payyanur grassland and in Taliparamba grassland during November, 2009. The overall distribution of the four leaf shape variants on basis of annual mean value was varied according to grassland. The Taliparamba grassland was observed to have the ovate leaf variant with higher areas of distribution (89.29 %) (Table 2). On the other hand, the Paithal mala and Taliparamba grasslands hold respectively the linear – lanceolate leaf variant and oblanceolate leaf variant with more area of distribution. The Taliparamba grassland also encompassed the ovate- elliptic leaf variant with higher area of distribution. Odum (4) pointed out that the differences in macroclimatic conditions and certain microclimatic factors like the availability of soil moisture due to the angle of slope etc may influence the distribution of any species within the biome. Further, it is known from the present study that the ovate leaf variant of the study species recorded higher area of distribution than the other leaf variants studied. It may be explained due to the fitness of this variant in the natural herbaceous communities of northern Kerala in terms of germination and adaptability.

The abundance for ovate leaf shape variant was existing between 2.92 (Taliparamba during May, 2009) and 5.75 individuals/m^2 (Taliparamba during August, 2009). In the similar fashion, the abundance value for the linear-lanceolate leaf shape variant was also considerably varied between the months in each grassland. For the oblanceolate, the lowest abundance value was determined as 3.64 individuals/m^2 in Payyanur grassland during November, 2009 and the highest abundance value, 5.95 individuals/m^2 was determined in Taliparamba grassland during August, 2009. The minimum and maximum

abundance for ovate-elliptic leaf shape variant were 3.60 individuals/m^2 (Payyanur during October, 2009) and 6.40 individuals/m^2 (Taliparamba during August, 2009). The annual abundance of the population was higher (5.08/ m^2) for ovate – elliptic leaf shape variant (Taliparmba) and lower (1.43/ m^2) for linear – lanceolate leaf shape variant (Thirunelli) (Table 3). Among the four variants analyzed, the ovate-elliptic leaf variant was found to be greater in abundance. This may be accounted that generally the limited distribution with more number of individuals of this variant in the study areas.

Table 1. Number of individuals of four leaf shape variants of *Exacum bicolor* in the studied grasslands.

Variants and grasslands	Months						
	May	Jun	Jul	Agu	Sep	Oct	Nov
Ovate leaved							
Paithal mala	-	-	-	-	-	-	-
Payyanur	34 (11)	65 (16)	91 (19)	106 (20)	89 (19)	79 (19)	72 (13)
Taliparamba	38 (13)	71 (17)	96 (20)	115 (20)	93 (20)	84 (20)	77 (15)
Thirunelli	-	-	-	-	-	-	-
Linear- lanceolate leaved	30(12)	33(12)	48(15)	95 (20)	61 (13)	50 (10)	36 (9)
Paithal mala	-	-	-	-	-	-	-
Payyanur	-	-	-	-	-	-	-
Taliparamba	1(1)	1(1)	2(1)	4 (2)	2 (1)	1 (1)	1 (1)
Thirunelli							
Oblanceolate leaved	-	-	-	-	-	-	-
Paithal mala	36 (9)	56 (12)	72 (15)	103 (20)	76 (16)	65 (13)	40 (11)
Payyanur	42 (10)	66 (13)	83 (15)	119 (20)	85 (18)	79 (14)	48 (13)
Taliparamba	-	-	-	-	-	-	-
Thirunelli							
Ovate-elliptic leaved	-	-	-	-	-	-	-
Paithal mala	49(11)	63 (14)	85 (16)	115 (20)	90 (18)	54 (15)	50 (12)
Payyanur	53 (13)	68 (15)	96 (17)	128 (20)	105 (20)	65 (14)	55 (11)
Taliparamba	-	-	-	-		-	-
Thirunelli							

'-' mark in the columns indicates the absence of the ovate leaf shape variant.
Figures in parentheses are the number of quadrats in which the variant present, out of 20 quadrats (1 m^2 each) sampled.

Table 2. The frequency percentage of the four leaf shape variants of *Exacum bicolor* in the studied grasslands.

Variants and grasslands	Months						
	May	Jun	Jul	Agu	Sep	Oct	Nov
Ovate leaved							
Paithal mala	-	-	-	-	-	-	-
Payyanur	55	80	95	100	95	95	65
Taliparamba	65	85	100	100	100	100	75
Thirunelli	-	-	-	-	-	-	-
Linear- lanceolate leaved	60	60	75	100	65	50	65
Paithal mala	-	-	-	-	-	-	-
Payyanur	-	-	-	-	-	-	-
Taliparamba	5	5	5	10	5	5	5
Thirunelli							
Oblanceolate leaved							
Paithal mala	-	-	-	-	-	-	-
Payyanur	45	60	75	100	80	65	65
Taliparamba	50	65	75	100	90	70	65
Thirunelli	-	-	-	-	-	-	-
Ovate-elliptic leaved							
Paithal mala	-	-	-	-	-	-	-
Payyanur	55	70	80	100	90	75	60
Taliparamba	65	75	85	100	100	70	55
Thirunelli	-	-	-	-		-	-

Annual mean frequency (%)	Ovate leaved Paithal mala (-), Payyanur (83.57), Taliparamba (89.29), Thirunelli (-) Linear- lanceolate leaved Paithal mala (65), Payyanur (-), Taliparamba (-), Thirunelli (5.71) Oblanceolate leaved Paithal mala (-), Payyanur (68.57), Taliparamba (73.57), Thirunelli (-) Ovate-elliptic leaved Paithal mala (-), Payyanur (75.71), Taliparamba (78.57), Thirunelli (-)

Table 3. Abundance of the four leaf shape variants of *Exacum bicolor* in the studied grasslands.

Variants and grasslands	Months						
	May	Jun	Jul	Agu	Sep	Oct	Nov
Ovate leaved							
Paithal mala	-	-	-	-	-	-	-
Payyanur	3.09	4.06	4.79	5.30	4.68	4.16	5.54
Taliparamba	2.92	4.18	4.80	5.75	4.65	4.20	5.13
Thirunelli	-	-	-	-	-	-	-
Linear- lanceolate leaved							
Paithal mala	2.50	2.75	3.20	4.75	4.69	5.00	4.00
Payyanur	-	-	-	-	-	-	-
Taliparamba	-	-	-	-	-	-	-
Thirunelli	1	1	2	2	2	1	1
Oblanceolate leaved							
Paithal mala	-	-	-	-	-	-	-
Payyanur	4.00	4.67	4.80	5.15	4.75	5.00	3.64
Taliparamba	4.20	5.08	5.53	5.95	4.72	5.64	3.69
Thirunelli	-	-	-	-	-	-	-
Ovate-elliptic leaved							
Paithal mala	-	-	-	-	-	-	-
Payyanur	4.45	4.50	5.31	5.75	5.00	3.60	4.17
Taliparamba	4.08	4.53	5.65	6.40	5.25	4.64	5.00
Thirunelli	-	-	-	-		-	-
Annual mean abundance (%)	Ovate leaved Paithal mala (-), Payyanur (4.52), Taliparamba (4.52), Thirunelli (-) Linear- lanceolate leaved Paithal mala (3.84), Payyanur (-), Taliparamba (-), Thirunelli (1.43) Oblanceolate leaved Paithal mala (-), Payyanur (4.57), Taliparamba (4.97), Thirunelli (-) Ovate-elliptic leaved Paithal mala (-), Payyanur (4.68), Taliparamba (5.08), Thirunelli (-)						

Table 4. Density of the four leaf shape variants of *Exacum bicolor* in the studied grasslands.

Variants and grasslands	Months						
	May	Jun	Jul	Agu	Sep	Oct	Nov
Ovate leaved							
Paithal mala	-	-	-	-	-	-	-
Payyanur	1.70	3.25	4.55	5.30	4.45	3.95	3.60
Taliparamba	1.90	3.55	4.80	5.75	4.65	4.20	3.85
Thirunelli	-	-	-	-	-	-	-
Linear- lanceolate leaved							
Paithal mala	1.50	1.65	2.40	4.75	3.05	2.05	1.80
Payyanur	-	-	-	-	-	-	-
Taliparamba	-	-	-	-	-	-	-
Thirunelli	0.05	0.05	0.10	0.20	0.10	0.05	0.05
Oblanceolate leaved							
Paithal mala	-	-	-	-	-	-	-
Payyanur	1.80	2.80	3.60	5.15	3.80	3.25	2.00
Taliparamba	2.10	3.30	4.15	5.95	4.25	3.95	2.40

Thirunelli	-	-	-	-	-	-	-
Ovate-elliptic leaved							
Paithal mala	-	-	-	-	-	-	-
Payyanur	2.45	3.15	4.25	5.75	4.50	2.70	2.50
Taliparamba	2.65	3.40	4.80	6.40	5.25	3.25	2.75
Thirunelli	-	-	-	-		-	-

Annual mean density (%)

Ovate leaved
Paithal mala (-), Payyanur (3.84), Taliparamba (4.10), Thirunelli (-)
Linear- lanceolate leaved
Paithal mala (2.52), Payyanur (-), Taliparamba (-), Thirunelli (0.09)
Oblanceolate leaved
Paithal mala (-), Payyanur (3.20), Taliparamba (3.73), Thirunelli (-)
Ovate-elliptic leaved
Paithal mala (-), Payyanur (3.61), Taliparamba (4.07), Thirunelli (-)

For ovate leaf shape variant, the minimum and maximum densities were 1.70 individuals/m^2 (Payyanur during the month of May, 2009) and 5.75 individuals/m^2 (Taliparamba during August, 2009). The highest annual mean density for linear-lancceolate leaf shape variant (2.52 individuals/m^2) was determined in Paithal mala grassland. For oblanceolate leaf shape variant, the lowest density of 1.80 individuals/m^2 was determined in Payyanur grassland during May, 2009 and the highest density, 5.95 individuals/m^2 was determined in Taliparamba during August, 2009 for this variant. For ovate-elliptic leaf shape variant, the range of density was existing between 2.45 individuals/m^2 (Payyanur during May, 2009) and 6.40 individuals/m^2 (Taliparamba during August, 2009). The density is the most important quantitative character of any species in a community to know its structural and functional contribution to the ecosystem. In addition, the determination of density for a species or variant is more useful to know its microclimatic preferences in a common macroclimatic condition. In homogenous community, the density character is used to find out the dominant species also. The annual density obtained by the population was also higher for ovate leaf shape variant present in Taliparmba (4.10/ m^2) and lower for the population of linear – lanceolate leaf shape variant present in Thirunelli (0.09/ m^2) (Table 4).

In the present study, the density of all the four leaf variants of the study species, *E. bicolor* was increasing during rainy season. It is of common fact that in tropical and subtropical regions, the limiting factor, soil wetness increases the seed germination and stock sprouting rates and hence the density during rainy season for almost all species in a community (3). The enhancement of density for the studied four leaf shape variants was site specific *i.e* .ovate, oblanceolate and ovate-elliptic leaf variants attained higher densities in Taliparamba grassland. The linear- lanceolate leaf shape variant showed its higher density in the grassland of Paithal mala. It indicates the specific fitness of these variants to the above mentioned grasslands in respect of density. The pH, angle of slope in the respective grassland, content of micronutrients in soil and intensity of light available in the grasslands may be the possible factors for this fact (6). Vijayakumar (14) also reported the site specific preference of leaf variants of the medicinal plant, *Gaultheria fragrantissima* in the shola grasslands of Nilgiris. On basis of density, it is known that the Taliparamba grassland was found to have more favourable factors and condusive environment for the growth, reproduction and perpetuation of the study species *E. bicolor* particularly for the ovate leaf shape variant.

4. CONCLUSION

Based on the ecological attributes like frequency, abundance and density studied, it is understood that among the four variants, generally the ovate leaf shape variant of the species, *E. bicolor* has established well. In addition, the grassland community at Taliparamba is determined to have most suitable microclimate also for this variant than the other areas studied. Therefore, if any cultivation attempts will be made in future on demand, the Taliparamba habitat and other habitats similar to Taliparamba may be preferred partially for ovate leaf shape variant.

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