RESEARCH ARTICLE

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

Jeeshna M. V.¹ and S. Paulsamy²
¹Department of Botany, Sree Narayana College, Kannur, Kerala, India.
²Department of Botany, Kongunadu Arts and Science College, Coimbatore, Tamil Nadu, India.

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, whereas 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/ m²) for ovate – elliptic leaf shape variant (Taliparamba) and lower (1.43/ m²) for linear – lanceolate leaf shape variant (Thirunelli). The annual density obtained by the population was also higher for ovate leaf shape variant present in Taliparamba (4.10/ m²) and lower for the population of linear – lanceolate leaf shape variant present in Thirunelli, (0.09/ m²). 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 Valluvananad region of Kerala. It is one of the choicest flowers to adorn Trikkakkarayappan, the earthen deity 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.
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, 115/20m² in Taliparamba during the month of August, 2009. The lowest number (34/20m²) 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 95/20m² (in Paithal mala grassland during August, 2009). The oblanceolate leaf variant showed its higher number of individuals (119/20m²) in Taliparamba grassland during August, 2009 and its lower number (36/20m²) was present in Payyanur grassland during the month, May, 2009. The ovate-elliptic leaf shape variant showed its higher appearance (128 /20m²) in Taliparamba grassland during August, 2009 and lower appearance (49/20m²) 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/m² (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/m² in Payyanur grassland during November, 2009 and the highest abundance value, 5.95 individuals/m² was determined in Taliparamba grassland during August, 2009. The minimum and maximum
abundance for ovate-elliptic leaf shape variant were 3.60 individuals/m² (Payyanur during October, 2009) and 6.40 individuals/m² (Taliparamba during August, 2009). The annual abundance of the population was higher (5.08/ m²) for ovate – elliptic leaf shape variant (Taliparamba) and lower (1.43/ m²) 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 | May | Jun | Jul | Agu | Sep | Oct | Nov |
|-------------------------|-----|-----|-----|-----|-----|-----|-----|
| Ovate leaved            |     |     |     |     |     |     |     |
| 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   |     |     |     |     |     |     |     |
| Payyanur                | 49 (11) | 63 (14) | 85 (16) | 115 (20) | 90 (18) | 54 (15) | 50 (12) |
| Taliparamba             | 53 (13) | 68 (15) | 96 (17) | 128 (20) | 105 (20) | 65 (14) | 55 (11) |
| 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 m² each) sampled.

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

| Variants and grasslands | May | Jun | Jul | Agu | Sep | Oct | Nov |
|-------------------------|-----|-----|-----|-----|-----|-----|-----|
| Ovate leaved            |     |     |     |     |     |     |     |
| 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   |     |     |     |     |     |     |     |
| Payyanur                | 55 | 70 | 80 | 100 | 90 | 75 | 60 |
| Taliparamba             | 65 | 75 | 85 | 100 | 100 | 70 | 55 |
| Thirunelli              |     |     |     |     |     |     |     |
| 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            | 4.00   | 4.67| 4.80| 5.15| 4.75| 5.00| 3.64|     |
| Payyanur                | 4.20   | 5.08| 5.53| 5.95| 4.72| 5.64| 3.69|     |
| Taliparamba             | -      | -   | -   | -   | -   | -   | -   | -   |
| Thirunelli              | 1.80   | 2.80| 3.60| 5.15| 3.80| 3.25| 2.00|     |
| Ovate-elliptic leaved   |        |     |     |     |     |     |     |     |
| Paithal mala            | 1.50   | 1.65| 2.40| 4.75| 3.05| 2.05| 1.80|     |
| Payyanur                | 1.90   | 3.55| 4.80| 5.75| 4.65| 4.20| 3.85|     |
| Taliparamba             | -      | -   | -   | -   | -   | -   | -   | -   |
| Thirunelli              | 0.05   | 0.05| 0.10| 0.20| 0.10| 0.05| 0.05|     |
| Annual mean abundance (%)|       |     |     |     |     |     |     |     |
| Ovate leaved            |        |     |     |     |     |     |     |     |
| Paithal mala            | 1.70   | 3.25| 4.55| 5.30| 4.45| 3.95| 3.60|     |
| Payyanur                | 1.90   | 3.55| 4.80| 5.75| 4.65| 4.20| 3.85|     |
| Taliparamba             | -      | -   | -   | -   | -   | -   | -   | -   |
| Thirunelli              | 0.05   | 0.05| 0.10| 0.20| 0.10| 0.05| 0.05|     |

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                | 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|     |
| 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                | -      | -   | -   | -   | -   | -   | -   | -   |
| Taliparamba             | -      | -   | -   | -   | -   | -   | -   | -   |
| Thirunelli              | -      | -   | -   | -   | -   | -   | -   | -   |

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

The linear lanceolate leaf shape variant present in Taliparamba (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 conducive 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.

REFERENCES

1. Greig - Smith, P. (1964). Quantitative Plant Ecology (2nd edn.). Butterworths, London.
2. Khare, C. P. (2007). Indian Medicinal Plants an illustrated dictionary. Springer Science, Business Media, LLC, New York. 256 pp.
3. Mishra, R. (1946). An ecological study of the vegetation of the Banaras Hindu University grounds. *J. Indian Bot. Soc.* 25: 39-59.
4. Odum, E.P. (1971). Fundamentals of Ecology. 3rd ed., W.B.Sanders Co., Philadelphia and London. 574+ pp.
5. Pullaiah, T. (2006). Encyclopaedia of World medicinal plant, Vo.II, Regency pub., West Patel Nagar, New Delhi, 929.
6. Rajvanshi, R. Kumar, V. Bachpari, W. Rajgopal, K. and Raj, S.F.H. (1987). Herbaceous under growth in some forest habitats in Nilgiris. Ind. For., 113(9): 599-608.
7. Rao, M.R. (1914). Flowering plants of Travancore, Bishen Singh Mahendra Pal Singh, Dehra Dun. 268-271.
8. Reddi, S.T.V. Naidu, B.V.A.R. and Prasanthi, S. (2005). In: Herbal remedies for diseases. I Alikhan, I. and Khanum, A. (eds), Ukay Publications, Hyderabad, pp. 67-134.
9. Shiddamallayya, N. Yesmeen, A. and Gopakumar, K. (2010). Medico – botanical survey of Kumar Parvatha Kukke Subramanya, Mangalore. Indian Journal of Traditional Knowledge 9 (1): 96 – 99.
10. Sreelatha, U. Baburaj, T.S. and Narayan Kutty, C. (2007 b). Exacum bicolor- A elegant wild flowering herbs. Underutilized and Underexploited horticultural crops. New India Publishing Agency, New Delhi. 151-157.
11. Sreelatha, U. Baburaj, T.S. Narayan Kutty, Nazeem, C.P.A. and Jyothi Bhaskar, (2007 a). Cultivation prospects of Exacum bicolor Roxb.- An endangered, ornamental and anti-diabetic herb. Natural Product Radiance. 6(5):402-404.
12. Srivastava, R.C. (1989). Drug plant resources of Central India (an inventory). Today and Tommarow's Printers and Publishers, New Delhi. 57.
13. The Wealth of India: (1952). A Dictionary of Indian Raw Materials and Industrial Products-Raw Materials Series, Publications and Information Directorate, CSIR, New Delhi, VoIII. 234 +pp..
14. Vijayakumar, K.K. (2006). Diversity and variability analysis of the medicinal shrub, Gaultheria fragrantissima Wallich in Nilgiri Biosphere Researve, the Western Ghats, India. Ph.D. thesis, Bharathiar University, Coimbatore, India. 95 p.