Souza GR, Krahl AH, Silva AG (2012) Population structure and spatial pattern of *Catasetum discolor* (Lindl.) Lindl. (Orchidaceae) in a sandy coastal plain southeastern Brazil Natureza on line 10 (3): 105-110.

Natureza on line
ISSN 1806–7409

Submetido em:20/06/2012 Revisado em:18/07/2012 Aceito em:31/07/2012

Population structure and spatial pattern of *Catasetum discolor* (Lindl.) Lindl. (Orchidaceae) in a sandy coastal plain southeastern Brazil

Estrutura populacional and padrão espacial de *Catasetum discolor* (Lindl.) Lindl. (Orchidaceae) em uma planície arenosa costeira do sudeste do Brasil.

Genyelle R Souza[1], Amauri H Krahl[2,*], Ary G Silva[1,3]

1. Universidade Vila Velha, Departamento de Ciências Biológicas, Rua Comissário José Dantas de Melo, 21, Boa Vista, CEP 29102-770, Vila Velha, Espírito Santo, Brasil. 2. Instituto Nacional de Pesquisas da Amazônia – INPA, Programa de Pós-Graduação em Botânica, Departamento de Botânica, Av. André Araújo, 2936 – Aleixo, Manaus – AM – 69.060-001. 3. Bolsista de Produtividade em Pesquisa FUNADESP.
*Corresponding author: amaurikrahl@hotmail.com

Abstract The objective of this study was to identify the population structure and spatial pattern of a population of *Catasetum discolor* (Lindl.) Lindl. in a a sandbank area, known as *restinga* in a coastal area of Southeastern Brazil. This area is covered by an open shrubby vegetation, where bushes are alternated with sandy soil exposed substrate. During field work, 10 quadrats with 10x10m were established, comprising 1000 m², and we recorded the number of individuals, and were measured height and the diameter in height soil. The allometric relationship between plant diameter and height was established after log-transformation of their measures, added with one. Population age structure was described by establishment of classes of height and diameter. The spatial distribution pattern was determined through the Morisita's dispersion index and Morisita's standardized index. The population structure demonstrated higher percentage of individuals in the classes of low heights and diameters, and we could found three age classes: juveniles, young adults, and older adult. The spatial distribution pattern was characterized as random aggregates. The results show that the population has a large number of juveniles, which may ensure the maintenance of the population.

Key words: restinga, Morisita, random aggregate, orchids.

Resumo O objetivo deste estudo foi identificar a estrutura populacional and a distribuição espacial de *Catasetum discolor* (Lindl.) Lindl. em uma área de Restinga da região Sudeste do Brasil, numa área de vegetação arbustiva aberta periodicamente inundável. Foram demarcadas 10 parcelas de 10x10m, totalizando 1000 m², onde se registrou o número de indivíduos, a altura and o diâmetro no nível do solo de cada exemplar. A relação alométrica entre os diâmetros and alturas dos indivíduos foi investigada após sua transformação logarítmica. A estrutura etária foi descrita através do estabelecimento de classes de altura and diâmetro. Foi determinado o padrão espacial por meio do índice de dispersão de Morisita and do índice de Morisita Padronizado. A estrutura populacional mostrou maior percentual de indivíduos em classes de menores alturas and diâmetro, onde foram destacadas três classes de idade: juvenis, adultos jovens and adultos velhos. O padrão de distribuição espacial foi caracterizado como agregado aleatório. Os resultados mostram que a população tem uma grande quantidade de indivíduos juvenis, o que pode garantir sua manutenção.

Palavras-chaves: restinga, Morisita, agregado aleatório, orquídeas.

Introduction

The vegetation from the *restinga* ecosystem has different physiognomic types located on sandy ridges or sandy coastal plains which are dated from the Pleistocene and Holocene eras (Martin *et al.* 1997). For the Espírito Santo State, Southeastern of Brazil, it was proposed 10 vegetation types arranged according to the influence of the groundwater, with physiognomies ranging of herbaceous until forest types. The separation these vegetation types is simple, due the topographical structure this environment, which can be periodically flooded or constantly flooded, in the lower sites, and without flood, in the higher parts (Pereira 2003).

There are few studies related to population structure and/or spatial distribution patterns of plant species in *restinga*, among them, a population of *Clusia criuva* Cambess (Beduschi and Castellani 2008). The great production of studies with this approach has been done for the Cerrado domain (Souza and Coimbra 2005, Souza and Silva 2006, Lima Ribeiro and Prado 2007). These studies provided

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basic information for conservation plans for the conservation of vegetation remnants, for recovering of degraded areas, as well as providing an understanding of how a population is regenerating or it is dispersed in its area of occurrence (Souza and Coimbra 2005).

The way a particular species is organized inside a tropical community can be seen from population data (Connell *et al.* 1984). The population structure is the result of the action of biotic and abiotic factors on its members, current or ancestors, thus affecting its spatial pattern, its age structure, and even its genetics, besides to establish temporal and spatial changes in number of plants in the population (Hutchings 1997).

Catasetum discolor (Lindl.) Lindl., commonly known as flower-monk or *sumaré*, belongs to the orchid family, It is a helophyte from the edge of shrubby bushes and from the areas between bushes in *restinga* (Fraga and Peixoto 2004). It may also be associated with temporary aquatic ecosystems, mainly distributed along the Brazilian coast and the Amazon region (Alves and Santana 2001).

Due to the association of this species to certain vegetation types from *restinga*, and of strength of anthropic impact that it has been suffering, mainly due to illegal sand extraction, real estate speculation, unplanned regional development, and deforestation, this paper aims to study the population structure and spatial distribution pattern of *C. discolor* in a coastal plain area in Southeastern of Brazil, in order to estimate the endanger risks for this species in that environment.

Methods

Study area

The study was carried out at the Environmental Protection Area of Setiba – APA Setiba, which was delimited in order to establish an impact buffer zone around the Paulo Cesar Vinha State Park – PEPCV. This located between the Northeastern municipality

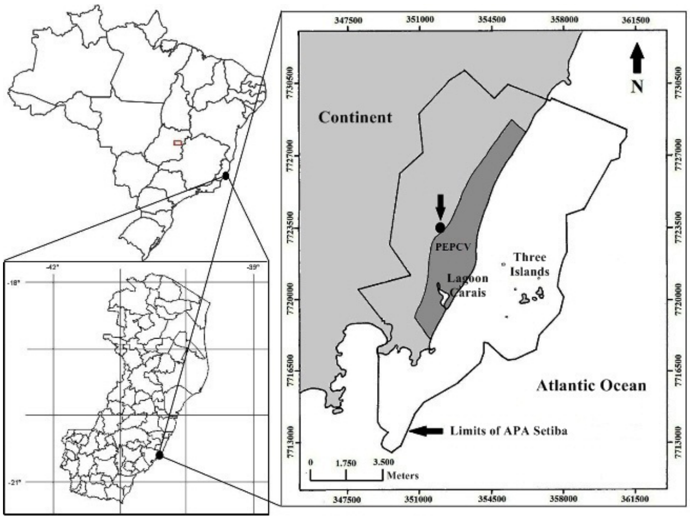

Figure 1 Environmental Protection Area of Setiba – APA-Setiba, and Paulo Cesar Vinha State Park - PEPCV.

of Guarapari and the extreme South of the municipality of Vila Velha (20°35'04''S-40°25'27''W), surrounding the PEPCV (Figure 1). It has a territorial area of 12,960 ha, and among them, 7,500 ha correspond to terrestrial area and 5,460 ha in the marine environment, constituting the largest Environmental Protection Area (APA) in the Espírito Santo State, Southeastern Brazil.

The bioclimatic classification of the studied area was made according the methodology proposed by Bagnouls and Gaussen (1957), by constructing ombrothermic diagrams in two situations. In one, the bioclimatic dry months were the one in which the ombric curve exceeds the thermal curve, in graphics in which the month rainfall precipitation (P) is plotted against a two times higher scale for mean month temperature values (T), that is, P = 2T (Figure 2A). In the other, under dry months were the ones in which the ombric curve exceeds the thermal curve, in graphics in which the month rainfall precipitation (P) is plotted against a three times higher scale for mean month temperature values (T), that is, P = 3T (Figure 2B). Mont mean temperatures and rainfall precipitation for the studied area were obtained through of database of World Climate Database (Hijmans *et al.* 2005), by the software Diva.Gis, release 7.1.7.

The sediment of the region is predominantly quartz sands originated by marine deposition dating from Holocene (Martin *et al.* 1997), where due to the strong influence of water table and the location between ridges sandy, form vegetation typical of flooded environments at certain times of the year and is then treated as open shrub periodically flooded (Pereira 2003).

Plant population structure

The study was carried out from March to November 2009, where, in the first half of August, 10 quadrats with 10 x 10 m were continuously settled, in a total sample area of 1000 m^2. This period was chosen primarily due to the large number of flowering individuals, what had made the identification of this species *in loco*. The criterion for inclusion of individuals in the plots was the rooting of the individual inside the quadrat. The individuals were photographed in the field, and four individuals in flower were collected and herbalized according to usual procedures (Mori *et al.* 1985), deposited in the herbarium of the Espirito Santo Federal University (VIES). We performed a brief analysis of these specimens, differentiating morphs male, female and hermaphrodite possible.

For the analysis of population structure we recorded the number of individuals of *C. discolor*, their height with a tape metric of 1m, and their stem diameter at ground height (DGH) with a pachymeter, in each plot. We also estimated absolute parameters of frequency, density, and dominance. By analyzing the vertical structure (height) and horizontal (diameter) of individuals were used in graphic column with values calculated for the studied population. For the allometric investigations, the values of height and diameter were transformed into logarithms and confronted through a scatterplot graphic.

For the analysis of spatial pattern in each plot was established axis with Cartesian coordinates. They were subdivided into

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microquadrats of 1 x 1 m. For the position of each individual in the microquadrat, we recorded the metric Cartesian coordinates and from this data was performed analysis with Morisita's dispersion index of and the Morisita's Standardized dispersion index.

Results

In the studied area, there was no bioclimatic dry month, since the ombric curve had not even equaled the thermal curve (Figure 2A) months with characteristic dry climate. However, a bioclimatic under-dry period happens in February and from May to September. For this period the average annual rainfall was approximately 1.411mm and the annual mean temperature was 24.5°C.

Population structure

The population of *C. discolor* is androdioecious, with male and hermaphrodite morphs. The hermaphrodite morph had hermphrodite flowers. The pistillate flowers (Figure 3A) had smaller size, more elongated fimbriae and are more robust when compared to the hermaphrodites (Figure 3B), where the frimbriae was reduced. There were plants with staminate and hermaphrodite flowers on the same inflorescence (Figure 3C). The blooms started in May and was ended in November, starting with the male morphs, and after half of the flowering cycle started if the presence of hermaphrodites. The presence of hermaphrodites morphs did not exclude the presence of male forms. There were no fruiting capsules. While male and hermaphrodite morphs were both found at the edges of shrubby bushes, only male morphs were found inside the bushes.

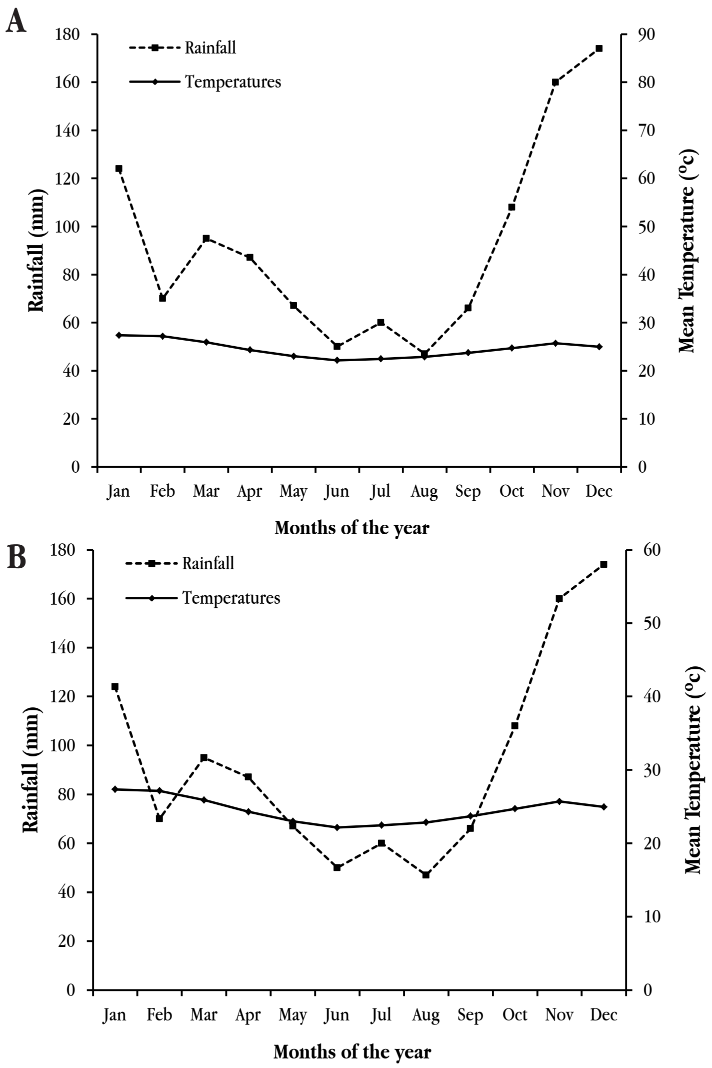

Figure 2 Ombrothermic diagrams for the Environmental Protection area of Setiba – APA-Setiba, based in data obtained from the World Climate Database. A. Diagram without a period with characteristics of dry bioclimate; B. Diagram of periods with characteristics of under-dry bioclimate.

Figure 3 Morphs of *Catasetum discolor* (Lindl.) Lindl. (Orchidaceae). A. Male; B. Hermaphrodite; C. Andromonoecious.

In the 10 sampled quadrats, 69 individuals were found, where the number of individuals per quadrat ranged from zero to 27. In 26 of 1000 microplots established were found individuals of C. discolor, comprising 2.6% frequency. The population density was 0.069 individuals/m² and the absolute dominance was approximately 1.244 m². The largest number of individuals was found in the smaller diameter classes (up to 2.01mm) (figure 4A) and at lower height classes (up to 19.98cm) (figure 4B).

From the allometric profile of the population, leading into account the ratio of diameter classes (log mm) and height (log^{-1} cm), three age classes were evident (Figure 5): the first one, with individuals of lower diameter and height; the second one with individuals with nedian

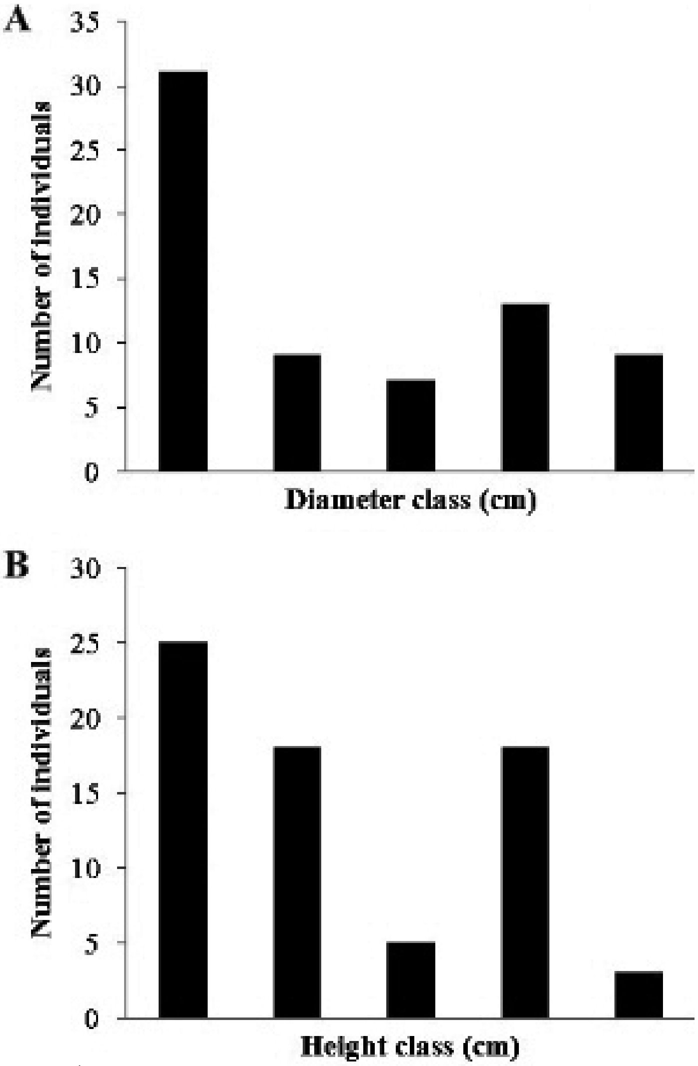

Figure 4 Distribution on class of: A. Diameter of stem (cm) at the height of soil and (B) height (cm) of a population *Catasetum discolor* (Lindl.) Lindl. (Orchidaceae) of Environmental Protection Area Setiba, Southeastern Brazil.

diameter and height; and, the third one of individuals with higher diameter and height.

Spatial distribution pattern

The values for the Morisita Index of Dispersion for quadrats 4, 5 and 10 were positive and greater than 0.5, indicating a trend of aggregate spatial pattern (Table 1). The other indexes, despite negative, represent values very small, near zero by approximation, characterizing a random spatial pattern. As in the four plots were not found no individual of this species, for the area it occupies a random aggregate spatial pattern.

Discussion

The sexual morphotypes in *C. discolor* and even in the whole genus *Catasetum* Rich. Ex Kunth, no matter if it happens in the same plant or inflorescence, were highlighted in a study by Dodson

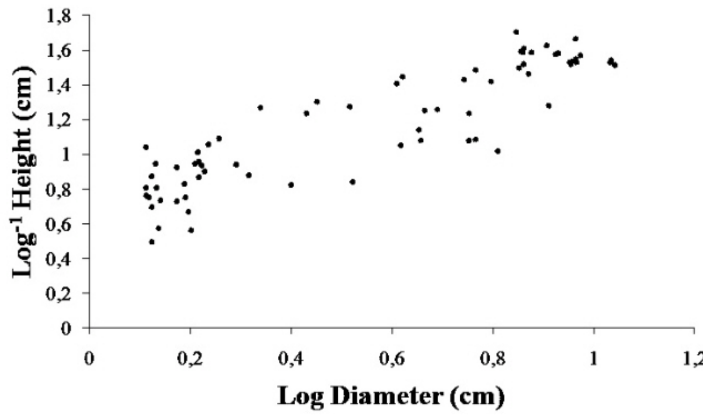

Figure 5 Allometric profile of *Catasetum discolor* (Lindl.) Lindl. (Orchidaceae) population at the Environmental Protection Area Setiba, Southeastern Brazil.

(1962), who explained that existence of male or female morphs is conditioned by the light incidence on the plant.

The presence of few individuals in the higher height class, compared to the lower height one, may be the result of growth suppression, probably due to high mortality or low recruitment rates (Young and León 1989). There is equally a distortion of the standard inverted "J" (Scolforo 1998), possibly forming two "J", that may be related to recruitment peaks or disruption of reproduction and recruitment, due to some limiting factors. These factors can range from attack by herbivores, by pathogens, by competition among individuals (Swaine *et al.* 1987), up to interactions of plants with the physical environment (Marques and Joly 2000). An example of this distortion is the study of Oliveira *et al.* (1989), conducted in Cerrado, where they take this distortion as interference from the fire which was typical of certain seasons. For the area takes into account water stress ranging from prolonged droughts, up to the periodic flooding.

Table 1 Morisita's Dispersion Index and Morisita's Standardized Index for *Catasetum discolor* (Lindl.) Lindl. in different quadrats at the Environmental Protection Area of Setiba, Southeastern Brazil.

Quadrat	Average	Variance	Morisita	Morisita Standardized
1	-	-	-	-
2	-	-	-	-
3	0,0200	0,0198	0,0000	-0,0195
4	0,1900	0,8630	20,4678	0,5916
5	0,4000	0,4250	16,4835	0,5683
6	-	-	-	-
7	0,0300	0,2940	0,0000	-0,0390
8	-	-	-	-
9	0,0200	0,0198	0,0000	-0,0195
10	0,2700	2,5200	32,7635	0,6565

– No individuals in the quadrat

Primack and Rodrigues (2001) deal this division as juveniles, young adults and older adults, saying that the ideal proportions of these classes typically represents a stable population, pointing to an excellent regenerative potential and expansion.

The random aggregate spatial pattern found is differentiated by Harper (1977) who emphasizes that the aggregate spatial pattern is observed when in equal-sized plots, the presence of one individual influences the existence of another, while in the random spatial pattern, the presence of one individual, is not influenced by another. Their differentiation corroborates hypothesis elaborated by Janzen (1970) and Connell (1971), where most of the seeds produced by the plant would be deposited at shorter distances from their base, forming a group, but the peak recruitment of offspring occur at an average distance, changing the distribution spatial of aggregate to random. Thus, the aggregated spatial patters distribution decreases during the ontogenetic stages, being juvenile very close to the mother plant, and becoming largely spaced in his adult stage, establishing a random pattern, due to the death of large numbers of individuals during their growth. This random pattern may indicate that the population is more influenced by biotic factors due to suppression of growth by interspecific and intraspecific competition, herbivory, pathogens, rather than by abiotic factors such as availability of light, or water.

However, anemocoric species, as representatives of the orchid family, can take on large distances. Its seeds can be transported by wind due to its small size, being randomly dispersed. The establishment of seedlings in those sites would favor its deployment, due to the influence of abiotic factors (humidity, amount of sunlight, etc.) and biotic (herbivory, symbiosis with fungi) as quoted by Budke *et al.* (2004), thus complementing the ideas of Janzen (1970) and Connell (1971).

Thus, the population structure of *C. discolor* demonstrates has a higher number of individuals in the categories of smaller diameter and height, where one observes three age classes, which, following the standard inverted 'J', proves to be a stable population. Its spatial distribution, features a random aggregate spatial patters distribution, possibly related to the ontogenetic stage where is found.

Structural stability of terrestrial plant populations is noticeable when large numbers of individuals has smaller classes diameter and height, and few individuals of larger classes (Solbrig 1981), demonstrating that the population can recompose the deaths of adult individuals (Souza and Coimbra 2005). Spatially, terrestrial plants commonly show a distribution: aggregate, random or regular (Harper 1977). The aggregated distribution is common in species of Orchidaceae, as verified by Budke *et al*. (2004).

Acknowledgments

The authors thank to the Vila Velha University (UVV), for the facilities and support offered during this study, ando to FUNADESP for the Researcher Fellowship of Ary G Silva.

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