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Size structure in populations of three woody species from Alentejo (Portugal)

Abstract

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The woody species *Securinega tinctoria* (L.) Rothm., *Nerium oleander* L. and *Dianthus lusitanus* Brot. are being monitored in order to evaluate the effects of the Alqueva reservoir (Guadiana River, Alentejo, Portugal).
Securinega tinctoria is a threatened narrow endemicspecies, *Nerium oleander* belongs to the riparian galleries and *Dianthus lusitanus* grows on rocky habitats. The three species are considered important for the maintenance of their habitat structure.
The Alqueva dam is under construction and the effects of its reservoir on the plant species are being evaluated and quantified by demographic, phenologic and reproductive biology studies. In these studies, it is necessary to define classes of individuals (cohorts) grouped by a common functional characteristic. Because the age determination in these individuals (i.e., the study of growth rings) may require destructive actions, biometric parameters related to floral production capacity or phenophase were studied using regression models. The most significant models and the parameters that better defined the groups of cohorts are presented.
The modelling of these relationships give the size structure of the populations in time zero. This allows for analysis of their evolution and the impact assessment of the dam's construction on the studied species in the next years.

Introduction

Nerium oleander L., *Securinega tinctoria* (L.) Rothm and *Dianthus lusitanus* Brot., are three woody species that can be found in Alentejo region (Portugal) of the Guadiana river. The two first are nanophanerophitics, xerothermics and phreatophitics belonging to mediterranean riparian communities. *N. oleander* is a circum-mediterranean species, that finds its northern limit in this Portuguese region and Extremadura (Spain). *S. tinctoria* is an endemic plant of the Iberian south-west. *D. lusitanus* is a chamaephyte with a rosette growth pattern present in acid rocky habitats. These populations will be perturbed by the Alqueva dam in an unknown way. To evaluate the effects in these species, in the context of a more extensive monitoring plan (Ballester & al. 2000), some works centred in the analysis of the populations structures and their evolution have been developed.

Population characterisation through size structure and the modelization of the relation between size and age, has been largely reported (Hett & Loucks 1976; Agren & Zackrisson

Table 1. Summary of the variables measured in *N. oleander* and *D. lusitanus*. "Y" is the dependent variable and " X " the independent variable.

		Abbreviation	Description	Unit
D. lusitanus	y	FLOW	Reproductive potential or reproductive effort	
	x	PER	Perimeter	cm
	x	H_BAS	Average height of the basal foliar axes	cm
	x	LONG	Average maximum length of the floral stems	cm
	x	NODE	Average number of nodes for floral axis	
	x	BIOV	Biovolume fitted to a geometric figure	m^3
	x	AREA	Basal area of the geometric figure	m^2
N. ololeander	y	FLOW	Reproductive potential or reproductive effort	
	x	HEIGHT	Shrub average height	cm
	x	BIOV	Biovolume fitted to a geometrical figure	m^3
	x	AREA	Basal area of the geometrical figure	m^2

Table 2. *N. oleander*: Linear Regression using a Negative Exponential Function and a Power Function. "y", reproductive potential; "x", biometric parameters. The significant function with the greatest R2 is underlined.

Variable X	**Negative Exponential Function**			***Power Function***		
	Model	R^2	p-level	**Model**	R^2	p-level
HEIGHT	Ln y=3,3756+0,01654 * HEIGHT	0.5111	p<0,000000	Ln y=-10,35+3,3267 * Ln HEIGHT	0,6955	p<0,000000
BIOV	Ln y = 5,8724 +0,08543 * BIOV	0.2076	p<0,000000	Ln y = 4,0059 + 1,7923 * Ln BIOV	0,5848	p<0,000000
AREA	Ln y = 5,2367 +0,10771 * AREA	0.3770	p<0,000000	<u>Ln y = 2,4584 + 2,0316 * Ln AREA</u>	<u>0,7298</u>	<u>p<0,000000</u>

Table 3. *D. lusitanus*: Linear Regression using a Negative Exponential Function and a Power Function. "y", reproductive potential; "x", biometric parameters. The significant function with the greatest R2 is underlined.

Variable X	**Negative Exponential Function**			***Power Function***		
	Model	R^2	p-level	**Model**	R^2	p-level
PER	Ln y = 3,1666 +0,02457 * PER	0,5601	p<0,000000	Ln y = -,0455 + 1,2501 * Ln PER	0,6243	p<0,000000
LONG	Ln y = 2,9017 +0,05792 * LONG	0,1214	p<0,002695	Ln y=0,11301 +1,3232 * Ln LONG	0,1450	p<0,000967
H_BAS	Ln y=2,9047 +0,24769 * H_BAS	0,3084	p<0,000000	Ln y= 1,7258 + 1,4432 * Ln H_BAS	0,3047	p<0,000000
NODE	Ln y = 2,2409 +0,26717 * NODE	0,1392	p<0,001247	Ln y = -,5855 + 2,2854 * Ln NODE	0,1597	p<0,000504
BIOV	Ln y = 3,7896 +0,00008 * BIOV	0,3733	p<0,000000	<u>Ln y =0,23253+0,58805 *Ln BIOV</u>	<u>0,6768</u>	<u>p<0,000000</u>
AREA	Ln y = 3,4420 + 8,6912 * AREA	0,5126	p<0,000000	Ln y = 3,3573 + 10,736 * Ln AREA	0,5435	p<0,000000

1990; García & Antor 1995; Morris & Doak 1998; Patón & al. 1998; Marrero-Gómez & al. 1999). This characterisation allows to compile information about the changes that occur in the life cycles of plants. When age determination, through destructive actions (like the analysis of growth rings), or the complete following of the life cycle is not possible, the relationship between the reproductive potential and some biometrics parameters has been used (Herrera 1989; Hanzawa & Kalisz 1993; González-Benito & al. 1995).

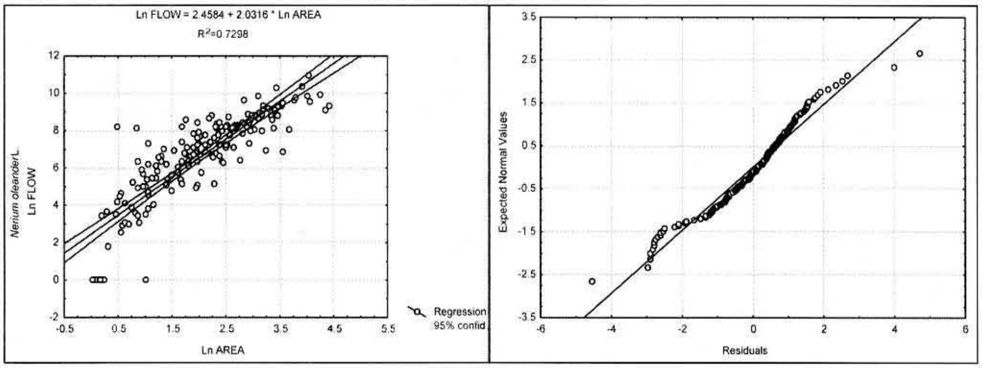

Fig. 1. *N. oleander*: Linear Regression Model and Residual Graphic.

The aim of this study is to determine the population structures of these three species, using easily measurable biometric parameters of the vegetative growth.

Methods and analytical techniques

Data for *N. oleander* and *D. lusitanus* were collected during 2000 and 2001 for *S. tinctoria*. Within the distribution area, some plots were selected at random for sample collection. For *N. oleander* and *D. lusitanus*, different size variables were measured in plants (Table 1) to determine which offered better information about population structure. In order to do this, the relationship between these parameters and the reproductive potential (total number of flowers, counting as flowers, flowers scats??, flower buds and fruits) was estimated. Two negative exponential functions that can explain this relation and define the best descriptors of the population structure, were found. These functions are the negative exponential ($y = y_0$ e -mx) and the power function ($y = y_0$ x-m). Both models required a linear regression analysis using a logarithmic transformation of the negative exponential function ($\ln y = \ln y_0 - mx$) and of the power function ($\ln y = \ln y_0 - \ln x$).

The best descriptors of the population structure were selected according to the highest coefficient of determination (R^2) of the linear model and its significance value.

A different methodology was applied for *S. tinctoria* due to its characteristics (a dioecious plant, extremely branched, with an enormous flower production and with difficulties to individualise each plant). It was tried to find cohorts of height in function of the pheno-phases. Height and phenologic state data was collected in 10 x 10 meter plots.

Results and discussion

Significant linear regressions were found to model reproductive effort as a function of size in *N. oleander* and *D. lusitanus*. The power function was the best model to explain these relationships in every case (higher significance coefficient of determination) (Tables 2, 3; Figs 1, 2). The best descriptors for the population structure were the figure area (AREA) for *N. oleander* and the biovolume (BIOV) for *D. lusitanus*. The frequency class

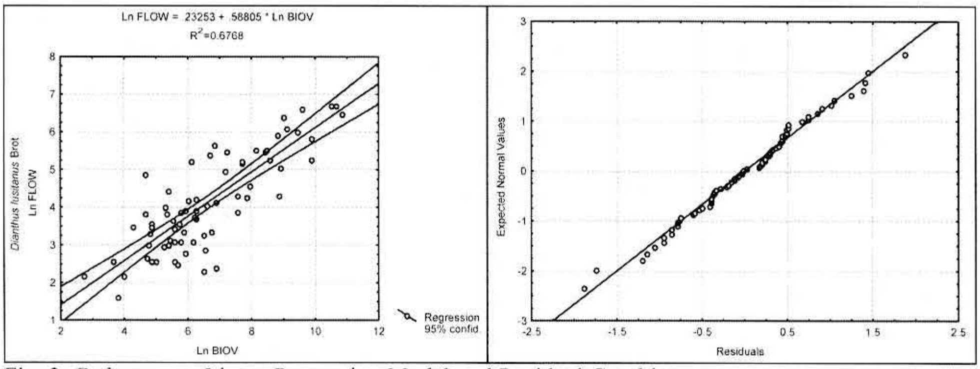

Fig. 2. *D. lusitanus*: Linear Regression Model and Residual Graphic.

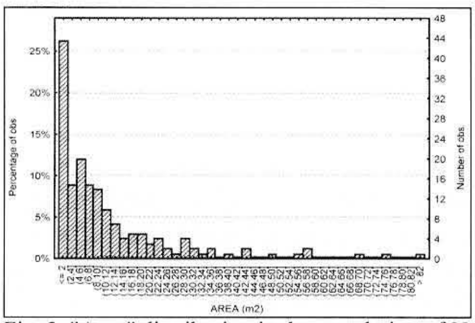

Fig. 3. "Area" distribution in the population of *N. oleander*.

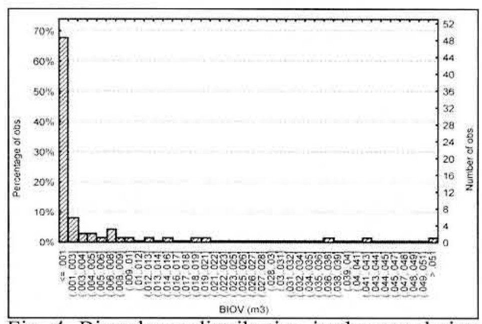

Fig. 4. Biovolume distribution in the population of *D. lusitanus*.

histograms in these two parameters present a typical reversed J-shaped distribution, with lots of small classes (AREA: 64,2% of the individuals in classes smaller than 10 m^2 in *N. oleander*; BIOV: 76,4% in classes below 0,003 m^3 in *D. lusitanus*) (Figs 3 and 4). This shows a stable situation between regeneration (with the incorporation of new individuals) and mortality. The existence of classes with a lower frequency than those of the subsequent ones can be a result of non-identified perturbations (probably grazing or floods from the river).

The great vegetative growth of *S. tinctoria* was verified in the field. In the river zones where sand extraction allows to see the basal zone of the plant, a great web of roots and stems was observed. In addition, the flowering changes, due to the great variation on the river flow from one year to another, allows to the underestimate the obtained data at this moment and to rethink the methodological approach of this species for the future.

Conclusions

- The significant relationship between the flower production and size justifies the use of these parameters for the structure description of *N. oleander* and *D. lusitanus*. The best model to explain the relation between the vegetative growth and the reproductive potential is the power function.

- The size structure for *N. oleander* and *D. lusitanus* corresponds to a situation of active regeneration, with stabilised populations. At present conditions these species don't need a special care, but it is necessary to consider future alterations by the Alqueva dam. In the next years the changes of the population dynamic due to dam fill-up will be monitored.
- Applied methodology for *N. oleander* and *D. lusitanus* is not viable for *S. tinctoria* due to problems inherent to the species. The methodology based on population characterisation based on phenological states, must also be reviewed and modified.

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