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Distribution, Ecology and Population Structure of *Euphorbia monchiquensis*, an Endemism in Southern Portugal

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Abstract. *Euphorbia monchiquensis* is, within the widespread and euryoecious *E. paniculata*-complex, an acidophilous subspecies, endemic in Southern Portugal. To evaluate the vulnerability of this taxon vis-a-vis disturbance and landuse changes, we studied the actual distribution, the population size, the ecological requirements and the coenological value of this taxon in the Serra de Monchique, a mountainous region in the Algarve Hinterland. Data sampling was between April and July 2001. The quite constant branching system of this half shrubby spurge allows to determine the age of the indivuduals from the plant architecture and therefore to study the demographic structure in a non-destructive way.

1618 individuals, clustered in 46 populations, have been registered in the Serra. 88% were in flower. *Euphorbia monchiquensis* is rare relative to its overall distribution. It shows a bimodal altitudinal and coenological pattern. The majority of the populations are concentrated in the most humid mid altitudes and on the luv-ward northwestern side of the Serra. A few populations occur in the dry lowlands, linked to riverine shrublets. The plant depends on a good water supply but does not need shadowing. Within its limited bioclimatic niche, the spurge has a certain capacity of recolonisation and is not extremely sensitive to disturbance. Humid forests of the *Euphorbio monchiquensis-Quercetum canariensis* are just one of the preferred sociological situations. The coenological spectrum includes pure cork oak forests, *Castanea sativa* coppices, *Eucalyptus*-afforestations, mantle communities (*Lonicero-Rubetum*, *Rubo-Nerietum*), *Origanion virentis* fringes, abandoned meadows and roadside verges. It was in this kind of secondary habitats with intermittent disturbance, that most of the juvenile plants could be stated.

Only very few plantlings were found. Most of the recorded populations are well balanced in their medium age classes, others are overaged. A correlation between habitat qualities, the reproductive effort and the regeneration efficiency could not be found. Four inflorescence--morphotypes can be distinguished. The inflorescence architecture becomes more complex with increasing age.

Euphorbia monchiquensis is not an extremely endangered, but a vulnerable species. It can be threatened by the process of *Eucalyptus* afforestation and by the spontaneous spread of *Acacia*

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dealbata. To give a reliable answer to the extinction risk, further aspects of its life cycle, seed bank characteristics, and reproductive behaviour have to be studied.
Key words: Serra de Monchique; reproduction; age-states; plant architecture; conservation biology; landuse

Distribuição Geográfica, Ecologia e Estrutura Populacional de *Euphorbia monchiquensis*, um Endemismo do Sul de Portugal

Sumário. A *Euphorbia monchiquensis*, incluída no bem disseminado e eurióico complexo de *E. paniculata*, é um táxone acidófilo, endémico do Sul de Portugal. Para avaliar a vulnerabilidade deste táxone em relação a perturbações e alterações no uso do solo, estudou-se a sua distribuição, dimensão da população, exigências ecológicas e valor cenológico na Serra de Monchique, uma região montanhosa do Algarve. A colheita de dados decorreu entre Abril e Julho de 2001. A distribuição bastante regular dos ramos deste arbusto permite determinar a idade dos indivíduos através da arquitectura da planta, e consequentemente o estudo da estrutura demográfica de um modo não destrutivo.

Na Serra registaram-se 1618 indivíduos, integrados em 46 populações. 88% estavam em floração. A *Euphorbia monchiquensis* é rara relativamente à distribuição geral. Apresenta um padrão bimodal em relação à altitude e cenologia. A maioria das populações concentra-se nas zonas mais húmidas de média altitude e no noroeste mais chuvoso da Serra. Algumas populações ocorrem nas baixas secas, ligadas a maciços arbustivos ripícolas. A planta necessita de boa disponibilidade hídrica mas não necessita de ensombramento. No seu limitado nicho bioclimático, este arbusto tem uma certa capacidade de recolonização e não é muito sensível a perturbações. As brenhas húmidas de *Euphorbio monchiquensis-Quercetum canariensis* são apenas uma das localizações preferidas. O espectro cenológico engloba montados de sobro, povoamentos de *Castanea sativa*, plantações de *Eucalyptus*, comunidades rasteiras (*Lonicero--Rubetum*, *Rubo-Nerietum*), franjas de *Origanum virentis*, prados abandonados e bordas das estradas. Foi neste tipo de habitats secundários, com perturbação esporádica, que muitas das plantas jovens se fixaram.

Foram encontradas muito poucas plântulas. A maioria das populações amostradas ronda a meia idade, outras são já velhas. Não conseguimos encontrar uma correlação entre a qualidade do habitat, o esforço reprodutivo e a eficiência da regeneração. Conseguimos distinguir quatro morfotipos de inflorescências. À medida que a idade avança, a arquitectura da inflorescência torna-se mais complexa.

A *Euphorbia monchiquensis* não é uma espécie em risco, mas é uma espécie vulnerável. Pode ser ameaçada pela plantação de eucaliptos e pelo alastrar espontâneo da *Acacia dealbata*. Para que se possa enfrentar com segurança o risco de extinção, teremos que estudar mais aspectos do seu ciclo de vida, características do banco de sementes e comportamento reprodutivo.
Palavras-chave: Serra de Monchique; reprodução; idade; arquitectura da planta; conservação; biologia; uso do solo

Distribution, Écologie et Structure de la Population de *Euphorbia monchiquensis*, une Espèce Endémique du Sud du Portugal

Résumé. *L'Euphorbia monchiquensis* est, parmi le bien disséminé et euryoecique complexe *E. paniculata*, un taxon acidophile, endémique du sud du Portugal. Afin d'évaluer la vulnérabilité de ce taxon vis-à-vis des perturbations et des altérations d'utilisation du sol, nous avons étudié l'actuelle distribution, la dimension de la population, les exigences écologiques ainsi que la valeur cénologique de ce taxon dans la Serra de Monchique, région montagneuse de l'arrière pays de l'Algarve. Les données ont étés recueillies entre avril et juillet 2001. La distribution assez régulière du branchage de cet arbuste permet de déterminer l'âge des individus par l'architecture de la plante, et ainsi étudier la structure démographique d'une manière non

destructive.

1618 individus, intégrés en 46 populations, ont été répertoriés dans la Serra. 88% étaient en fleurs. L'*Euphorbia monchiquensis* est rare considérant sa distribution générale. Elle représente un modèle bi-modal en relation avec l'altitude et la cénologie. La majorité des populations est concentrée dans les zones plus humides de mi-altitude et sur le flan nord-ouest plus pluvieux de la Serra. Quelques populations apparaissent en basse altitude sèche, liées à de massifs arbustes ripicoles. La plante dépend d'un bon approvisionnement en eau mais n'à pas besoin d'ombre. À l'intérieur de sa niche bioclimatique, l'arbuste a une certaine capacité à se re-coloniser et n'est pas extrêmement sensible aux perturbations. Les forêts humides de l'*Euphorbio monchiquensis-Quercetum canariensis* sont une des situations sociologiques préférées. Le spectre cénologique englobe les suberaies, les peuplements de *Castanea sativa*, les plantations d'*Eucalyptus*, les communautés rampantes (*Lonicero-Rubetum, Rubo-Nerietum*), les franges de *Origanion virentis*, les prés abandonnés et les bords de routes. C'est dans ce type de second habitat soumis à des perturbations intermittentes que se sont fixées de nombreuses jeunes plantes.

Seul un faible nombre de plantules a été trouvé. La majorité des populations étudiées se situe en âge moyen, les autres sont déjà âgées. Nous n'avons pas pu établir la corrélation entre la qualité de l'habitat, l'effort reproductif ni l'efficacité de régénérescence. Nous avons pu distinguer quatre morphotypes d'inflorescence. L'architecture de l'inflorescence devient plus complexe avec l'âge. L'*Euphorbia monchiquensis* n'est pas une espèce en risque mais est vulnérable. Elle peut être menacée par la plantation d'*Eucalyptus* et par la propagation spontanée de *l'Acacia dealbata*. Afin de contrer le risque d'extinction d'autres aspects de son cycle de vie, ainsi que les caractéristiques de la banque de semences et le comportement reproductif devront être étudiés.

Mots clés: Serra de Monchique ; reproduction ; âge ; architecture de la plante; conservation ; biologie ; utilisation du sol

Introduction

The Serra de Monchique, a mountainnous region in the Hinterland of the Algarve, is characterized by a remarkable degree of endemism and plant species richness (MALATO BÉLIZ 1982, RIVAS-MARTÍNEZ *et al.,* 1990). One of those endemic taxa is *Euphorbia monchiquensis*, a perennial spurge with lignified basal shoots.

Systematics and taxonomy

The populations in Southern Portugal have been separated from *Euphorbia welwitschii* respectively *E. paniculata* and raised to species level by FRANCO & P. SILVA (1968) under the name *Euphorbia monchiquensis*. In more recent taxonomic studies (VICENS *et al.*, 1996, BENEDÍ *et al.*, 1997), they are again treated as a subspecies within the *Euphorbia paniculata*-complex. *Euphorbia paniculata* ssp. *paniculata* is of southwest-iberian north-mauretanian distribution and ranges from the Extremadura in Spain and the Serra de Mamede in Portugal via the atlantic parts of Morocco and Algeria up to western Tunisia (see VICENTE *et al.* 1996, Figure 8). The Spanish populations in Aracena and in the Western Sierra Morena ("*Euphorbia monchiquensis*" sensu VALDES *et al.*, 1987) are related by some morphological characters to the Monchique populations, but are included by VICENS *et al.* (1996) and BENEDÍ *et al.* (1997) in the widespread *Euphorbia paniculata* s.str.. The other two subspecies are stenochorous and prefer specific

edaphic conditions. *E. paniculata* ssp. *welwitschii* is a basiphilous taxon, restricted to some coastal mountains in Central Portugal (Serra de Sintra, Serra de Arrabida). *E. paniculata* ssp. *monchiquensis* is acidophilous and endemic in Southern Portugal in the Algarve Hinterland and in Bajo Alentejo. We are following here the taxonomic concept of VICENS *et al.* (1996), but use the brief term *Euphorbia monchiquensis* for the taxon *E. paniculata* Desf. ssp. *monchiquensis* (Franco & P. Silva) Vicens, Molero, Blanché 1996 in the following text.

State of knowledge about distribution and habitat

From own preliminary field observations between 1996 and 2000, from the published data (the herbarium specimen have been exploited by FRANCO & P. SILVA 1968, VICENS *et al.*, 1996 and BENEDÍ *et al.*, 1997) and from personal communications (F.B. CALDAS, M.J. GONÇALES PINTO and colleagues of the Botanical Garden Lisbon, 1996), we can conclude, that *Euphorbia monchiquensis* prefers two types of habitats:

1. It is recorded from forests in mid altitude (400 to 600m a.s.l.) on acid soil and in humid to subhumid mesomediterranean bioclimatic conditions in mountainous areas of Southwestern Portugal (Serra de Monchique, Serra de Caldeirão and Serra de Espinhaço de Cão).

2. Lowland populations (50 to 100m a.s.l.) can be observed in the same areas of the Algarve and Bajo Alentejo province along permanent or periodical small rivers (Vale Paraíso, Rio Mira, Ribeira de Seixe, R. de Odelouca and R. de Aljezur), in a subhumid to semiarid thermomediterranean bioclimate.

Syntaxonomic position

In the available phytosociological literature, notes about *Euphorbia monchiquensis* are scanty. In the monograph about the flora and vegetation of the Serra de Monchique by MALATO BÉLIZ (1982), *Euphorbia monchiquensis* is recorded by two relevés for closed and humid forests growing on the northern slopes of the Picota Mountain between Monchique and Alferce. MALATO BÉLIZ (1982) states that *Euphorbia monchiquensis* neither occurs in the "Soutos" (Sweet chestnut-forests) nor in the "Sobreiral" (cork oak forests of *Sanguisorbo-Quercetum suberis*), but exclusively in the "Bosque residual de *Quercus canariensis* Willd.". The author used the spurge as differential species of the *Rusco hypophylli-Quercetum canariensis euphorbietosum monchiquensis*. This community was typified by RIVAS--MARTÍNEZ *et al.* (1990) by selecting a relevé from MALATO BÉLIZ and by changing the rank into *Euphorbio monchiquensis-Quercetum canariensis* Malato Béliz ex Rivas-Martínez *et al.* 1990. The latter authors state *Euphorbia monchiquensis* also as a character species for the alliance *Quercion broteroi*. Within a bigger data set (155 relevés) from the Serra de Monchique, sampled by SENG & DEIL (1999) in oak forests, chestnut coppices and *Eucalyptus globulus*-plantations, *Euphorbia monchiquensis* was observed only once, in a *Castanea sativa*-facies of the *Euphorbio-Quercetum canariensis*. From the phytosociological observations one might conclude that *Euphorbia monchiquensis* is restricted to the most humid mid altitudes of the Serra and indicating there a good conservation

status of the last remnants of deciduous oak forests. In conclusion, it should be a species, which is sensitive to landuse changes, affecting those forests.

Landuse changes in the Serra de Monchique

During the last few decades, the landscape in Southern Portugal was affected by severe changes in landuse (KROHMER & DEIL, 1999). Some major trends are the afforestation of abandoned heathland with allochtone taxa like *Eucalyptus, Pinus* and *Acacia,* a decreesing grazing impact, the nearly total abandonment of traditional rotating cultivation practises and dry farming, a decreasing cork exploitation and the decline in the use of *Arbutus unedo*, which fruits used to be traditionally harvested (MABBERLEY & PLACITO, 1993). Do these trends have an impact on the humid woodland communities and on one of its keystone species, *Euphorbia monchiquensis*? - To answer this question we must have a closer look upon the ecological requirements and the coenological value of this species. Furthermore we must ask, if this obvious stenochorous and stenoic species is restricted to humid forests as its primary habitat, or if it is able to colonize secondary habitats. This will give some information about the vulnerability of the population.

Population size and age structure

Like in earlier studies about other rare plant species in the Serra de Monchique (MÜLLER & DEIL, 2001, 2002), a first goal of our study was to get precise informations about the regional distribution of the populations of *Euphorbia monchiquensis* in the Serra and to sample data about the number of individuals. Efficient conservation strategies for rare plant species, however, must also be based upon the knowledge of their demography (HOLDEREGGER, 1997). This is why a set of demographic parameters has been registered for a population viability analysis (PVA) sensu MENGES (1990). The relations between the different life and age stages (seedling, juvenils, sterile adults, fertile adults) for example will indicate the reproductive efficiency of a species in a given habitat or area. For rare and threatened plants however, such data must be collected in a non-destructive way. Beside the branching system of the vegetative parts of *Euphorbia monchiquensis* as an indicator for the age of the individual, the architecture of the inflorescence caught our interest. AL SAMMAN *et al.* (2001) studied *Euphorbia nicaeensis* in Southern France and claimed for possible relationships between the variability of the inflorescence architecture and the age respecttively the environmental conditions as differentiating factors. Could this also be the case for *Euphorbia monchiquensis*?

The study area

Field studies were carried out in the Serra de Monchique, a mountainous region of mid altitude in the Algarve Hinterland (District of Faro, Portugal) (Figure 1). The Serra is dominated by two mountain ridges running from Westsouthwest to Eastnortheast (Foia 902 m a.s.l. and Picota 773 m a.s.l.).

Climate

The Serra de Monchique has a Mediterranean precipitation regime (see climatic graph in Figure 1) with a certain

Atlantic character. Due to the proximity of the Atlantic Ocean and the elevation, the amount of rainfall is considerably higher than in the rest of the Algarve region, and fog is a common phenomenon in the summit regions. The central ridges Foia and Picota are responsible for a Luv-Lee effect with the northwestern slope being cooler and more humid than the southeastern one. The central part of the Serra, where most of the populations of *Euphorbia monchiquensis* occur, belongs to the humid to perhumid, mesomediterranean bioclimate (RIVAS-MARTÍNEZ *et al*., 1990)

Geology and soils

The central part of the Serra consists of a syenitic intrusion (Lakkolith), surrounded by paleozoic schists and graywakes. The weathering of the coarse-grained syenite results in cambisols with a sandy texture, a high water holding capacity and a good base saturation, whereas on the schists stony leptosols with low nutrient content and pH developed (KOPP *et al*., 1989).

Vegetation

The potential natural vegetation in the mesomediterranean belt is a dense oak forest with ombrophilous species in the ground floor (*Sanguisorbo-Quercetum suberis* in the humid parts and *Euphorbio monchiquensis-Quercetum canariensis* in the hyper-humid parts). The *Phillyreo-Arbutetum unedonis* as the first degradation step is widespread and still used in some remoted valleys to gain fruits from the strawberry tree for liquor production ("medronho"). Further degradation results in heathland communities (*Querco lusitanicae-Stauracanthetum boivinii*, *Erico australis-Cistetum populifolii*), which have expanded under human impact (grazing, fire, cutting) from a few original sites.

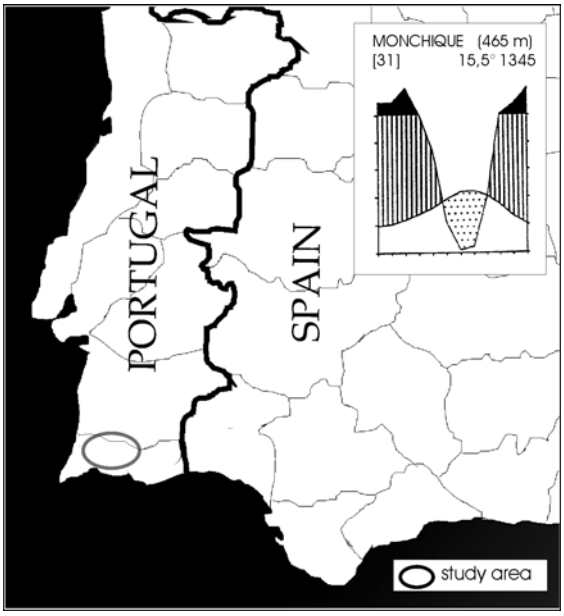

Figure 1 - Location of the study area and climatic graph for Monchique

In small openings of the *Sanguisorbo--Quercetum suberis* and the *Euphorbio--Quercetum canariensis* and along roadsides and footpaths crossing these forests, the mantel community *Lonicero periclymenum-Rubetum ulmifolii* and the herbaceous fringes from the *Origanion virentis* alliance can be observed, like *Senecio lopezii-Cheirolophetum sempervirentis* and *Stachyo lusitanicae-Origanetum virentis* sensu CAPELO *et al.* (2001).

The climax community in the thermomediterranean lowlands is an open woodland (*Myrto-Quercetum suberis*) (MALATO BÉLIZ, 1982; RIVAS-MARTÍNEZ *et al.*, 1990) (= *Teucrio baetici-Quercetum suberis* sensu CAPELO *et al.*, 2001). When opening the tree cover of the *Myrto--Quercetum* by cutting and grazing, heliophilous shrubs like *Cistus crispus* or *Helichrysum stoechas* can invade the forests (SENG & DEIL, 1999).

The azonal riverine vegetation is characterized by alder (*Scrophulario-Alnetum glutinosae*), if the water table is constantly high and the river permanent, and by oleander (*Rubo-Nerietum*), if the water table lowers in summer and the small streams are intermittent.

The forest vegetation of the Serra de Monchique was subjected to a variety of strong silvocultural impacts. In the 19th century, European chestnut (*Castanea sativa*) was cultivated as coppice stands in areas with good water supply. Today there are only a few *Castanea* stands left due to the infestations with *Phytophthora* in the beginnings of the 20th century. The last century is characterized by the "Eucalyptization" of the Serra de Monchique. This process is documented by MALATO BÉLIZ (1982) and KROHMER & DEIL (1999).

Phytogeography

The study area belongs to the western part (Monchiquense sector) of the Tingitano-Onubo-Algarviense province (GALÁN DE MERA & VICENTE ORELLANA, 1996). *Euphorbia monchiquensis* contributes to the Monchiquense endemism. Other outstanding elements can be found in heathland communities like *Centaurea crocata* and *C. fraylensis* (MÜLLER & DEIL, 2002).

Methods

Distribution, habitats and population size

Data sampling was between April and July 2001. We concentrated our field observations in the Serra de Monchique. The populations recorded from Bajo Alentejo have not been investigated. Individuals, growing in the same habitat and located less than 5 m apart from their neighbours were classified as a subpopulation. From the surface colonized by a given population and the counting of the individual numbers in some subplot areas, the total size of a given population and the density of the individuals could be approximatively calculated. As the studies were largely restricted to non-destructive observations in regard to the rarity of the species, every epigean shoot was treated as an individual without proving subterranean connections (such connections are improbable). We searched for *Euphorbia monchiquensis* in all kinds of habitats, from closed forests and semi-natural maquis up to man made habitats like roadside verges and borders of arable land. The localities of the observed individuals and populations were determined and documented by geographical

coordinates according to GPS-data.

For all the observed population, the following site descriptive parameters have been noted: altitude, aspect, substrate, habitat type (e.g. roadside verge, along a little stream) and vegetation type (plant community). Because *Euphorbia monchiquensis* was often stated in ecotones, some structural and floristic samplings along transects of several meters length were performed to get an insight in the contact series and to characterize the niche of the species.

Plant architecture and demographic structure

Like other perennial, half-shrubby Euphorbias (see for example *Euphorbia dendroides*, EICHBERGER, 2001), *E. monchiquensis* shows a very constant branching system (Figure 2). After the first year, the monopodial phase is replaced by a sympodial growth characteristic. The results are pleiochasia: The terminal bud produces an inflorescence, degenerates and is overtopped in the next season by lateral branches, sprouting from axillary buds. The number of overtoppings allows to determine the chronological age of the individual. This was proved by the analysis of the annual growth rings in the woody parts of *Euphorbia monchiquensis* (see Figure 2).

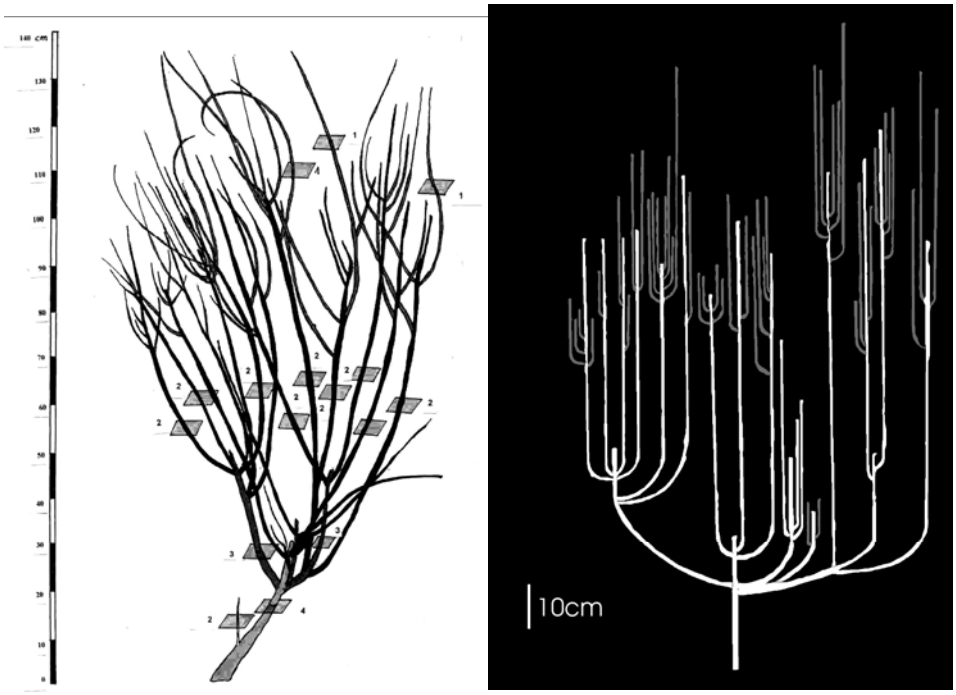

Figure 2 - Concrete and schematical architecture of an individual of *Euphorbia monchiquensis*. The branching system is clearly pleiochasic. Shoot age was verified by cross-sections at the indicated levels

Based upon the analysis of the vertical architecture and the data about plant height, diameter of the basal shoot, and the number of inflorescences, the age-states can be described in detail (for the concept of age-states see for example GATSUK, 1980 and URBANSKA, 1996). For *Euphorbia monchiquensis*, the age-states are closely related to the chronological age. By this approach it was possible to evaluate the demographic structure of the populations directly. The age of the individuals could be related to other vegetative and regenerative morphometric parameters.

Inflorescence morphotypes

The typology of the inflorescence morphology, elaborated by AL SAMMAN *et al.* (2001) for *Euphorbia nicaeensis*, was applied to 9 populations (558 individuals in total) of *E. monchiquensis* in mid altitudes, which were already flowering at their ultimate level at the end of our field campagne in June and July 2001. In the populations at higher altitudes, flowering and fruit riping started about three weeks later. The only population which was in the ripening stage in mid July, was located in the Odelouca-Valley. Within this population, 29 ripe inflorescences were investigated in detail). We looked for correlations between inflorescence morphotype and fruiting rate.

Results

Local distribution, population size and environmental conditions

In spring and early summer 2001, 1618 individuals of *Euphorbia monchiquensis* have been registered in the Serra. They were clustered in 17 populations respectively 46 subpopulations (for the difference see "Methods"). Some characters of the observed populations (number and density of individuals, colonized surface, flowering rate) as well as some abiotic conditions (altitude, aspect, inclination, substrate) are given in Table 1. The exact localities are also documented in this table.

Most of the populations of *Euphorbia monchiquensis* are located at the north-western slope of Picota and north-east of Foia (see Figure 3) in altitudes between 350 to 620 m a.s.l.. The populations 1 to 3 occur quite isolated in an altitude of 30 to 60 m a.s.l. in the valleys of Ribeira de Odelouca and Ribeira Sabrosa, running to the Southern Algarve coast. These lowland populations are located on schists, all other populations grow on cambisol over syenite. Most of the plants occured in flat areas, but inclination can rise up to 80°. Aspect is very variable, too. Even populations in southern exposure and in full sunlight have been observed. These plants however are mostly growing near to small water runnels.

Population size covers a wide range, from a few individuals (subpopulations 5, 24, 12, 39, 42) up to more than 200 individuals. The latter population (number 2) is scattered along a small riverside in the Odelouca Valley. In average, a subpopulation has 35 individuals (with a standard deviation of 38).

Table 1 - Characters of the studied populations

population	coordinates	part of the Serra de Monchique	altitude [m a.s.l.]	aspect	inclination	substrate	absolute number of individuals	area of the population [m²]	density of individuals [number per 100m²]	flowering rate [%]
1	N 37°11'44 W 8°45'38	Espinhaço de Cão	60	different	0°	Schists	**27**	1000	3	**100**
2	N 37°15'04 W8°29'24 to N 37°15'27 W 8°28'44	Odelouca	40 to 90	different	0° to 70°	Schists	**> 224**	2000	2	**88**
3	N 37°16'09 W 8°29'37	Odelouca	50	NNO	60°	Schists	**14**	480	3	**100**
4	N 37°20'08 W 8°34'01	NO of Foia	480	NO	30°	Syenite	**48**	140	34	**92**
5	N 37°19'46 W 8°34'09	NO of Foia	490	flat	0°	Syenite	**3**			**67**
6	N 37°19'52 W8°34'00	NO of Foia	520	NW	30°	Syenite	**42**	92	46	**33**
7	N 37°19'51 W 8°33'35	NO of Foia	550	flat	0°	Syenite	**10**	4	250	**100**
8	N 37°19'22 W 8°34'06	NO of Foia	620	flat	0°	Syenite	**145**	126	115	**1**
9	N 37°19'22 W 8°34'06	NO of Foia	610	flat	0°	Syenite	**12**	40	30	**25**
10	N 37°17'09 W 8°37'17	SW of Foia	400	N	60°	Syenite	**25**	105	24	**60**
11	N37°17'47 W 8°35'47	S of Foia	430	SO	40°	Syenite	**32**	600	5	**94**
12	N 37°18'30 W8°34'10	SO of Foia	550	flat	0°	Syenite	**5**	10	50	**100**
13	N 37°18'28 W8°34'23	SO of Foia	560	S	80°	Syenite	**31**	116	27	**100**
14	N 37°18'28 W8°34'23	SO of Foia	550	S	40°	Syenite	**6**	58	10	**100**
15	N 37°18'00 W 8°33'56	NW of Picota	350	flat	0°	Syenite	**34**	208	16	**100**
16	N 37°18'16 W 8°33'38	NW of Picota	360	SSW	10°	Syenite	**43**	4000	1	**91**
17	N 37°17'50 W 8°33'52	NW of Picota	380	W	30°	Syenite	**16**	100	16	**99**
18	N 37°18'19 W 8°34'55 to N 37°18'14 W 8°34'57	W of Picota	450 to 475	flat	0°	Syenite	**59**	40	148	**73**
19	N 37°18'19 W 8°34'55 to N 37°18'11 W 8°33'14	W of Picota	450 to 475	flat	0°	Syenite	**70**	3750	2	**91**

Table 1 – Continuation

population	coordinates	part of the Serra de Monchique	altitude [m a.s.l.]	aspect	inclination	substrate	absolute number of individuals	area of the population [m²]	density of individuals [number per 100m²]	flowering rate [%]
20	N 37°18'14 W8°33'26 to N 37°18'11 W 8°33'14	W of Picota	450 to 475	NW	20°	Syenite	**34**	150	23	**88**
21	N 37°18'19 W 8°34'55	W of Picota	450	NW	60°	Syenite	**12**	27	44	**100**
22	N 37°18'14 W 8°34'55 to N 37°18'10 W 8°33'08	W of Picota	480	flat	0°	Syenite	**66**	950	7	**88**
23	N 37°18'14 W 8°34'55	W of Picota	460	flat	0°	Syenite	**47**	63	75	**100**
24	N 37°18'33 W 8°33'22	W of Picota	410	SSW	10°	Syenite	**21**	90	23	**100**
25	N 37°18'27 W 8°33'16	W of Picota	430	SW	20°	Syenite	**82**	270	30	**83**
26	N 37°18'17 W 8°33'18	W of Picota	420	SW	70°	Syenite	**29**	30	97	**93**
27	N 37°18'14 W8°33'26	W of Picota	450	flat	0°	Syenite	**3**	20	15	**100**
28	N 37°18'48 W 8°32'41	NW of Picota	470	NW	10°	Syenite	**27**	50	54	**70**
29	N 37°18'48 W 8°32'41	NW of Picota	470 to 480	NW	10°	Syenite	**67**	3000	2	**64**
30	N 37°18'48 W 8°32'41	NW of Picota	470 to 480	flat	0°	Syenite	**9**	40	23	**67**
31	N 37°18'49 W 8°32'35	NW of Picota	490	flat	0°	Syenite	**10**	20	50	**0**
32	N 37°18'49 W 8°32'35	NW of Picota	500	flat	0°	Syenite	**26**	198	13	**54**
33	N 37°18'49 W 8°32'35	NW of Picota	490	flat	0°	Syenite	**15**	40	38	**73**
34	N 37°18'55 W 8°32'39	NW of Picota	370	flat	0°	Syenite	**42**	800	5	**93**
35	N 37°18'55 W 8°32'39	NW of Picota	380	flat	0°	Syenite	**20**	136	15	**70**
36	N 37°18'55 W 8°32'39	NW of Picota	360	NW	10°	Syenite	**8**	200	4	**100**
37	N 37°18'49 W 8°32'17	NW of Picota	520	NW	0° to 85°	Syenite	**27**	325	8	**65**
38	N 37°17'48 W 8°32'49 to N 37°17'51 W 8°32'48	SW of Picota	520 to 550	SSW	40°	Syenite	**35**	420	8	**100**

Table 1 - Continuation

population	coordinates	part of the Serra de Monchique	altitude [m a.s.l.]	aspect	inclination	substrate	absolute number of individuals	area of the population [m²]	density of individuals [number per 100m²]	flowering rate [%]
39	N 37°17'48 W 8°32'49	SW of Picota	520	SSW	40°	Syenite	**18**	30	60	**83**
40	N 37°19'24 W 8°33'36	NO of Foia	530	SO	0° to 80°	Syenite	**27**	54	50	**74**
41	N 37°19'24 W 8°33'36	NO of Foia	530	flat	0°	Syenite	**49**	60	82	**55**
42	N 37'1850 W 8°32'26	NW of Picota	540	flat	0°	Syenite	**1**			**100**
43	N 37°18'46 W 8°32'26	NW of Picota	540	W	10°	Syenite:	**26**	24	108	**12**
44	N 37°18'46 W 8°32'26	NW of Picota	540	W	10°	Syenite	**54**	300	18	**55**
45	N 37°18'42 W 8°32'15	NW of Picota	540	NNW	10°	Syenite	**6**	15	40	**100**
46	N 37°18'48 W 8°32'10	NW of Picota	550	NW	75°	Syenite	**11**	30	37	**99**

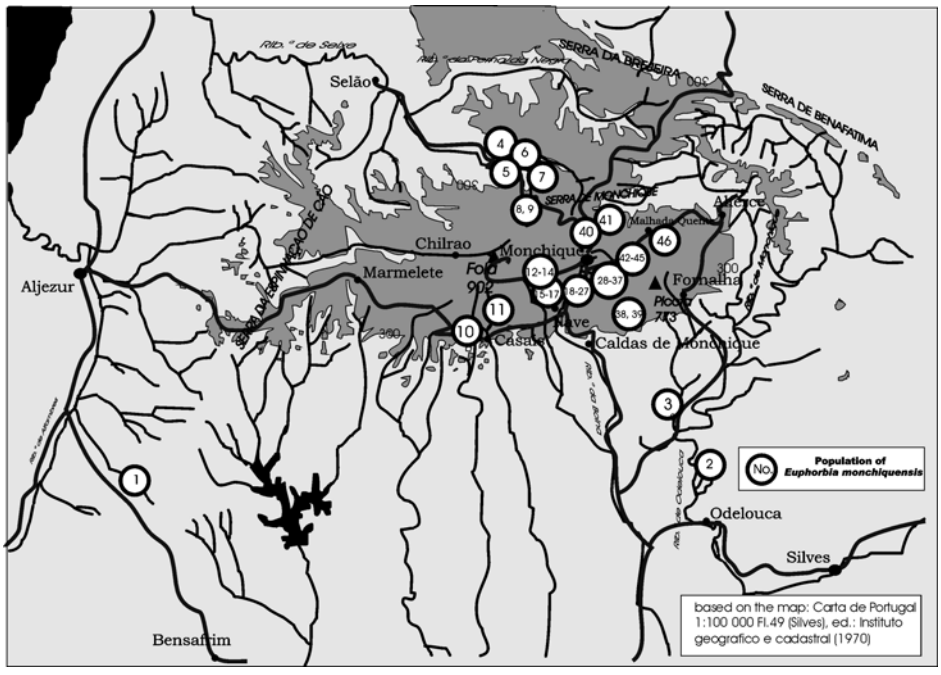

Figure 3 - Distribution of *Euphorbia monchiquensis* in the Serra de Monchique

Coenological character and ecological profile

One question we wanted to answer with our study was, whether *Euphorbia monchiquensis* is restricted to undisturbed humid forests of the *Euphorbio-Quercetum canariensis*-type. As we can see from the coenological spectrum (Figure 4), this is just one of the preferred sociological situations. 17% of the individuals occured in *Euphorbio-Quercetum canariensis*-stands with a natural floristic composition of the tree layer. 8% occured in stands with a tree layer, dominated by *Castanea sativa* and 2% in *Paeonia coriacea-Castanea sativa* coppice woodland (for the delimitation and characterization of the forests vegetation types see SENG & DEIL, 1999). Pure cork oak forests also shelter *Euphorbia monchiquensis* populations: 6% occured in *Sanguisorbo-Quercetum suberis*, 5% in *Myrto-Quercetosum suberis* (variant with *Cistus crispus* and *Helichrysum stoechas*), and 6% in *Eucalyptus*-forests as a substitutional unit of *Sanguisorbo-Quercetum*. In the alluvial forest community *Scrophulario scorodoniae-Alnetum glutinosae*, and its contact unit *Bidention*, the *Euphorbia* is rare (2 respectively 1%). In total, 46 % of the individuals were stated in forests and woodland. In all these forest types, the spurge is more common at the fringes of the stands or along small footpath, crossing these forests (see Figure 5). It is flowering earlier in these microsites and the inflorescence architecture is more complex. Species quite constantly associated with *Euphorbia monchiquensis* in the shrub layer are *Lonicera periclymenum* ssp. *hispanica* and *Rubus ulmifolius*.

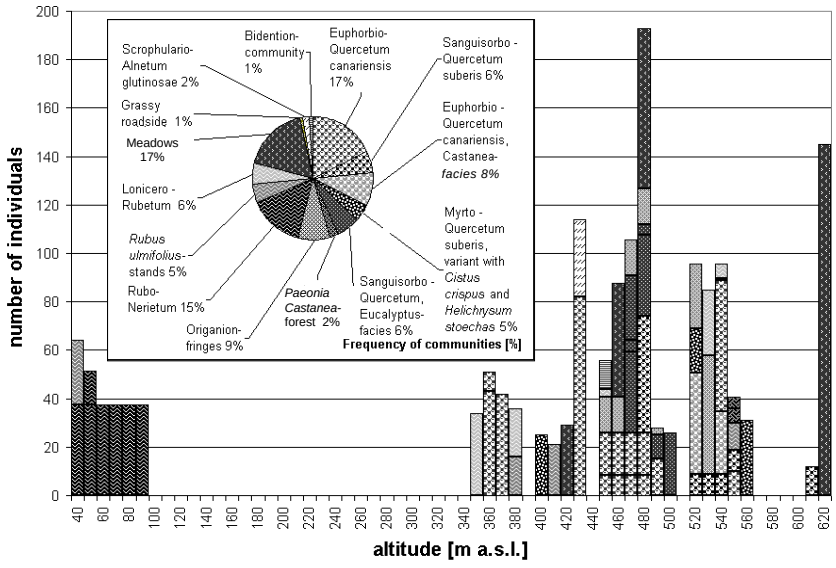

Figure 4 - The coenological spectrum of *Euphorbia monchiquensis* and its altitudinal range

Figure 5 - The mid-altitude forest niche of *Euphorbia monchiquensis*
Vertical structure of a mixed oak forest with *Eucalyptus*-facies and a *Lonicero-Rubetum*-mantle on the NW-slope of Picota at 470 m a.s.l. on Syenit (subpopulation 17B)

This kind of species combination can also be found outside the forests or as a mantle community in its periphery. In total, 26% of all *Euphorbia monchiquensis* populations are associated with *Rubus ulmifolius*, either in more or less monodominant closed *Rubus ulmifolius* thickets (5%) or as spiny mantles (*Lonicero-Rubetum*, 6%). In the thermomediterranean lowlands, the preferred habitat of the spurge are the edges of the riverine shrub community *Rubo-Nerietum* (15%). A typical catena there is illustrated by Figure 6.

27% of all observed *Euphorbia monchiquensis* individuals were stated in herbaceous vegetation, either in *Origanion virentis* fringes of *Quercus canariensis*- and *Q. suber*-forests in mid altitude (9%), often associated there with *Cheirolophus sempervirens*, or in abandoned meadows and along grassy roadside verges (18%). It was in this kind of secondary habitats with intermittend disturbance by man, where most of the juvenile plants could be stated.

The altitudinal distribution (and this is an expression of the bioclimatical ecological profile of the species) shows a clear preference for the most humid mid altitudes (Figure 4). In the semiarid and thermomediterranean bioclimate, the populations are obviously restricted to sites where *Euphorbia monchiquensis* has access to ground-water. The predominant occurence on syenite (see Tab. 1) is not an ecological preference for this kind of substrate, but more autocorrelated with altitude.

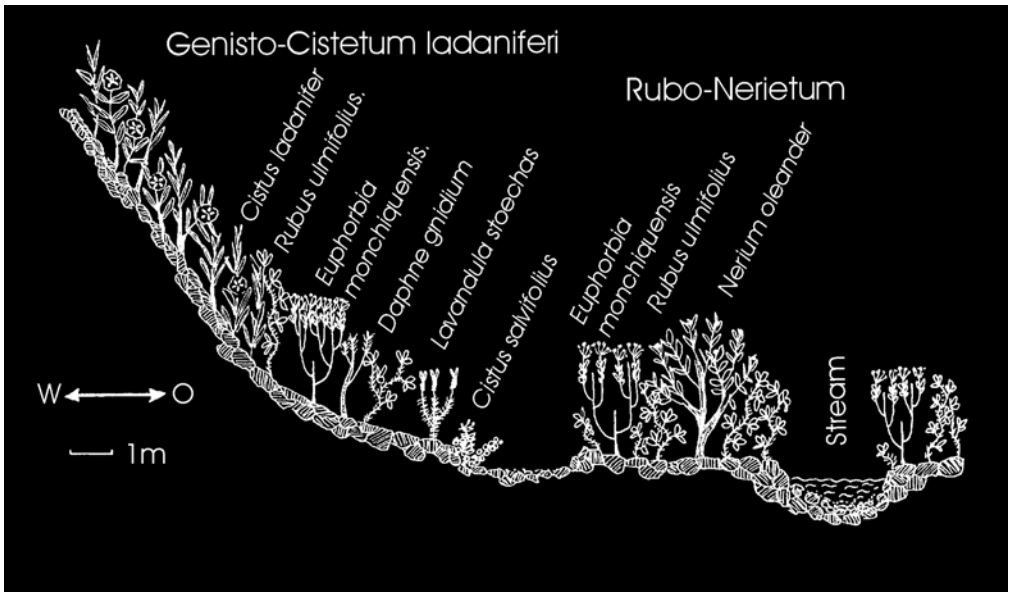

Figure 6 - The lowland riverside shrubland niche of *Euphorbia monchiquensis*
Catena in a side valley of Ribeira de Odelouca at 60 m a.s.l. on schists (population 2), ranging from the river bed via the alluvial shrub community *Rubo-Nerietum* to the heathland (*Genisto hirsutae-Cistetum ladaniferi*) on the slope

Branching system, age-states and population structure

The reproductive period can start in the second year with specimen of still monopodial growth, about 40 cm in height, an inflorescence of morphotype S and lignified basal shoots (see Figure 7). In all kinds of habitats, individuals > 120 cm are in flower. During maturation, plants increase in height (80 to 180 cm, in rare cases up to 250 cm), diameter of the basal shoot (up to 25 mm), number of shoots and inflorescences. Lignification increases too. In the first five years elongation is pushed foreward. In later years, extension growth is reduced and replaced by an investigation of the biomass production in complex inflorescences. Aging plants reduce shoot and fruit production. Renewal by basal shoots is possible, but occurs rarely. Post-reproductive senescent plants have not been observed. The oldests observed individual had an age of 12 years.

Not a single seedling was observed during our field trip in spring 2001. The seeds ripe in summer and probably germ already in the autumn of the same year. Only very few plantlings (5 to 15 cm high with about 20 leaves, no lignification, no flowers) were found. Most of the recorded populations are well balanced in their medium age classes, expressed by the height classes and their shoot architecture. Others are overaged. A correlation between habitat qualities, the reproductive effort and the regeneration efficiency could not be found.

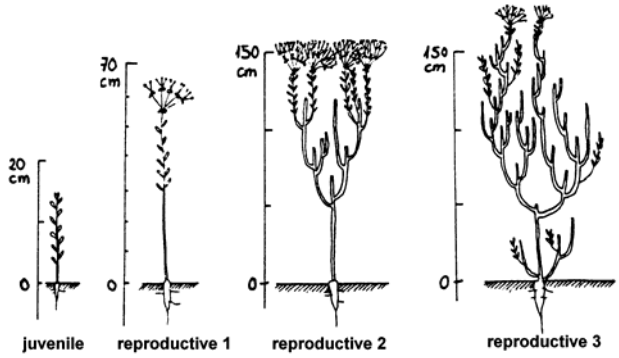

Figure 7 - Age-stages of *Euphorbia monchiquensis*

Inflorescence architecture, flowering and fruiting rate

All kind of inflorescence-morphotypes, distinguished by AL SAMMAN *et al.* (2001) within *Euphorbia nicaeensis*-populations in Southern France, could be confirmed for the *E. monchiquensis*-populations in Southern Portugal. In a very few cases, even a morphotyp with an additional plateau of cyathia (named morphotype XL) could be found. Within the 558 individuals from 9 populations, investigated for their inflorescence architecture, 88% have been in flower. Among these individuals in flower, morphotype I was dominating with 56%, followed by morphotype S (28%). The morphotypes L (3%) and XL (0.5) are rare. Morphotype L starts with four-year old individuals. Old plants only develop inflorescences of the morphotypes I and S.

Morphotype I was also the most frequent one amongst the fruiting inflorescences. The highest fruiting rate however could be stated for morphotype L (in absolute fruit numbers as well as in the percentage of fruiting cyathia). EICHBERGER (2001) stated in *Euphorbia dendroides*, that the second cyathium level is almost purely masculine and that hermaphroditic cyathia are restricted to the third level. This is not the case in *E. monchiquensis.* Hermaphroditic cyathia are produced at all levels, but are shed before ripening.

Flowering rate in most of the populations is quite high (see Table 1). In *Euphorbia monchiquensis,* the flowering of the terminal cyathia is synchronized, and not the beginning of flowering like in *Euphorbia nicaeensis*. In contradiction to the latter species, where AL SAMMAN *et al.* (2001) stated that inflorencence variability is more related to the ecological conditions than to the age of the individual, in *Euphorbia monchiquensis* the inflorescence architecture becomes more complex in the first years, declining again in very old individuals.

Discussion

Euphorbia monchiquensis is a rare species (see the criteria in RABINOWITZ *et al.*, 1986) relative to distribution, habitat specification and population size.

This stenochorous taxon has a bimodal altitudinal and coenological pattern. The majority of the populations are concentrated in the most humid mid altitudes and on the luv-ward side of the Serra. A few populations, occuring in the dry lowlands, are linked to habitats with a high groundwater table, which is compensating the lower precipitations there. From the macroclimatic point of view the species can be characterized as stenoecious. The plant seems to depend on a good water supply but does not need shadowing. In fact it can grow well in full sunshine. Moderate to high radiation even increases the flowering rate. Probably these conditions are best given at internal fringes of deciduous *Quercus*- and *Castanea*-forests. The regeneration seems to be favored by a modest opening of the crown cover and by a moderate disturbance frequency. Within its limited bioclimatic niche, which might be the main reason for the endemic occurance beside the myrmecochorous dispersal strategy, the spruce has a certain capacity of recolonisation. Like other endemic species of the Serra de Monchique such as *Centaurea crocata* and *C. fraylensis* (MÜLLER & DEIL, 2002), *Euphorbia monchiquensis* is not extremely sensitive to disturbance. It can support an exploitation of the forests or an replacement of the deciduous oaks by the European chestnut. A closed and dark canopy however (created by *Acacia dealbata*) or an extreme litter production (by *Eucalyptus globulus*) are difficult to overcome by the spurge.

From the overall distribution, from the number of populations in the Serra de Monchique and from the individual numbers counted there, *Euphorbia monchiquensis* is not an extremely endangered, but a vulnerable species. It can be threatened by the process of Eucalyptization in the Serra de Monchique and by the obvious spontaneous spread of *Acacia dealbata* there. To give a reliable answer to the extinction risque, further aspects of its life cycle, seed bank characteristics, and reproductive behaviour have to be studied. The preliminary observations about the inflorescence architecture, the population structure and the effects of age and environmental conditions can be a starting point for further investigation. Such studies are favoured by the possibility of estimating the individual chronological age of *Euphorbia monchiquensis* from its branching system to a certain extent. It has however more flexibility in its modular growth than *E. dendroides*. Even the latter species can shift from sympodial to monopodial growth characteristics, when shadowing is too strong (EICHBERGER, 2001).

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