Proceedings 10th MEDECOS Conference, April 25 – May 1, 2004, Rhodes, Greece, Arianoutsou & Papanastasis (eds)

Demographic monitoring of four endemic plant taxa in the fire prone-environments of Central Greece: early results

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Keywords: *Fritillaria*, *Campanula*, *Stachys*, *Silene*, population structure, size classes, life stages

ABSTRACT: Several authors have indicated the important role of fire in the evolution of the Mediterranean ecosystems of the world. A significant part of Greece is typical Mediterranean. Of the total 1300 endemic plant taxa in Greece, about 25% occur mainly in the fire prone Mediterranean environments. Data concerning the occurrence and the life attributes of the plant taxa endemic in the Mediterranean habitats of Greece were collected through a literature inventory. Analysis of these data revealed five distinct profiles have identified of these taxa. From these five profiles five taxa have been selected for detailed study each, one corresponding to one profile. In this work the results of four of them namely *Fritillaria obliqua* Ker-Gawl. ssp. *obliqua*, *Campanula celsii* A. DC. ssp. *celsii*, *Stachys swainsonii* Bentham ssp. *melangavica*, *Silene spinescens* Sm. are presented. Their populations have been located in the field and data concerning their life attributes have been collected. Size classes have been distinguished relevant to the life stages of each taxon. First year's results show that each one of the studied taxa has a completely different population structure from the other. In *Fritillaria obliqua* ssp. *obliqua* a small number of seedlings is established and very few flowers and fruits are formed. For *Campanula celsii* ssp. *celsii* seedlings represent a large fraction of the population and although few individuals form flowers and fruits, flower and fruit production is quite high. *Stachys swainsonii* ssp. *swainsonii* population has a large number of mature plants and seedlings while small plants represent a small fraction of the population. In *Silene spinescens* the majority of the plants are large plants while seedlings and small plants represent a small fraction of the population.

1 INTRODUCTION

Fire is one of the major ecological factors that shaped the Mediterranean ecosystems of the world in the course of their evolution (Naveh 1975, Rundel 1981, Specht 1981, Kruger 1983, Arianoutsou 1998). Greece, a significant part of which is typical Mediterranean, has a particularly rich and diverse endemic flora. The total number of Greek endemics comprises approximately 1300 taxa (Georghiou and Delipetrou 2000), 50% of which occurs mainly in the Mediterranean environments of Greece. By excluding the habitats not prone to fire (e.g. maritime cliffs, coastal sand dunes, and small islets), a smaller fraction of 308 taxa is derived, appearing exclusively in the fire-prone ecosystems of Greece (Kokkoris and Arianoutsou 2000). In order to delineate the profile of this group of plants, a database was organized. In this database a number of attributes were used to describe the relevant taxa mainly through bibliographic data. Based on the frequency distribution of all attributes, five distinct profiles have emerged. One taxon for each profile was selected for further study, as a representative of each one of the five sub-groups. In this paper data on four of the five different representatives will be presented.

Demographic studies of plants indicate that each population possesses unique attributes that ultimately determine local abundance and/or persistence through time (Harper 1977). These studies give insight into the birth and death rates of plant species at particular life-history stages, and have been used widely in the past to model the dynamics of natural populations (e.g. Harper 1977, Solbrig et al. 1988, Silvertown et al. 1993, Meyer and Schmid 1999). The main objective of this work is to study the demography and population structure of the selected taxa.

2 MATERIALS AND METHODS

2.1 *The study taxa and the field sites*

Fritillaria obliqua Ker-Gawl. ssp. *obliqua* (Liliaceae).
It is a perennial bulbosous geophyte with soft and long leaves with few flowering stems. It occurrs in Attiki and Evvoia in scrub or maquis, on rocky hillsides often with *Juniperus phoenicea* or *Quercus coccifera*, on limestone (Phitos et al. 1995). The field site is located in Kinosoura Peninsula in Attiki. It is listed as vulnerable in the Red Data Book of Rare and Threatened Plants of Greece.

Campanula celsii A. DC. ssp. *celsii* (Campanulaceae).
It is a perennial hemicryptophyte and chasmophyte, forming rosettes with long flowering stems. It occurs in Attiki and Sifnos island (Runemark and Phitos 1996) on calcareous rocks. The field site is located in the natural habitats of Diomedes Botanical Garden in Athens metropolitan area.

Stachys swainsonii Bentham ssp. *melangavica* (Labiatae).
It is a perennial chamaephyte and chasmophyte. It occurs in crevices of limestone rocks in thin *Pinus halepensis* forests. The field site is located in Iraio area near Loutraki (Persson 1981). It is listed as Rare in WCMC.

Silene spinescens Sm. (Caryophyllaceae).
It is a perennial chamaephyte with short, erect vegetative shoots and several flowering stems occurring in Sterea Ellada and Pelloponissos (Strid and Tan 1997). It grows on vertical calcareous rocks. The field site is located in the natural habitats of Diomedes Botanical Garden. It is protected by the Greek Law (P.D. 67/1981).

Field demography of all taxa was monitored between December 1999 and June 2002. In the present paper only first year's data will be presented. In each of the study sites permanent quadrats were randomly selected and established, according to the sampling design adopted for each taxon (Table 1). The quadrats were marked with stainless steel rods in the case of *Fritillaria obliqua* ssp. *obliqua* and with paint on the rocks in the case of the other three taxa. The number and size of quadrats was determined during the preliminary sampling at the beginning of the sampling period. In each quadrat all individuals were marked and their position was plotted on paper by using X-Y coordinates. Morphometric characteristics (height, diameter, number of leaves, flowers and fruits) were measured and flowering and fruiting phenology was recorded in all individuals for further analysis. In order to attribute each individual to the appropriate life stage one of this morphometric characteristics was chosen after processing the data. Each size class corresponded to a different life stage and finally the population structure of each taxon was obtained.

Table 1. Number and size of quadrats used for field demographic monitoring for each taxon

Studied taxa	Number of quadrats	Size of quadrats
Fritillaria obliqua ssp. *obliqua*	27	$25m^2$ (5m X 5m)
Stachys swainsonii ssp. *melangavica*	41	$1m^2$ (1m X 1m)
Silene spinescens	17	$1m^2$ (1m X 1m)
Campanula celsii ssp. *celsii*	37	$1m^2$ (1m X 1m)

3 RESULTS

During the first year of sampling (winter 1999 – summer 2000) as it is shown in Table 2, density value is relatively low for *Fritillaria obliqua* ssp. *obliqua* (0.618) while for the rest of the taxa it ranges between 2.47-7.27. Dispersion index values for all taxa show that they have a normal distribution. This type of distribution is quite rare under field conditions (Elliot 1971).

Table 2. Density and dispersion index (I_A) values for each taxon

Studied taxa	Density Nr. of plants / m^2 (S.D)	Dispersion Index I_A
Fritillaria obliqua ssp. *obliqua*	0.618 (0.685)	0.2134
Stachys swainsonii ssp. *melangavica*	5.488 (3.458)	0.0984
Silene spinescens	2.470 (1.068)	0.1048
Campanula celsii ssp. *celsii*	7.270 (4.445)	0.1005

As far as it concerns *Fritillaria obliqua* ssp. *obliqua* the morphometric characteristic used to organise the different size classes was the plant height and 5 different life stages were distinguished (seedlings, saplings, small plants, large plants, plants with reproductive structures) (Table 3). Seedlings were recorded in the field and they were 5.04% of the population (Fig. 1). Saplings had only leaves and no vegetative stems while the plants with reproductive structures were almost one third of the total population (31.41%). Flower and fruit production was low and few individuals produced as much as 2 flowers (Table 3).

Table 3. Morphometric characteristics of *Fritillaria obliqua* ssp. *obliqua*

Life stage	Nr. of leaves ± S.D	Height ± S.D (in cm)	Nr. of flowers/ flowering individual ± S.D	Nr. of fruits/ fruiting individual ± S.D
Saplings	1.62 ± 0.86	-	-	-
Small plants	4.95 ± 0.79	13.52 ± 3.79	-	-
Large plants	10.72 ± 3.85	24.80 ± 8.53	-	-
Plants with reproductive structures	11.89 ± 3.79	28.06 ± 8.53	1.084 ± 0.77	0.36 ± 0.60

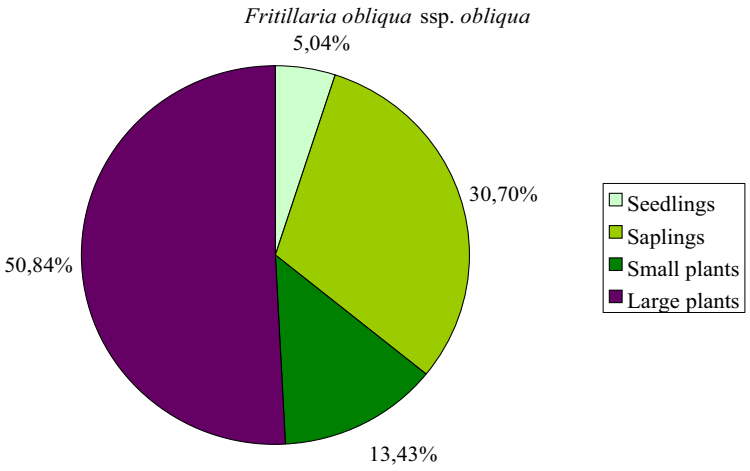

Figure 1. Population structure of *Fritillaria obliqua* ssp. *obliqua*

In *Campanula celsii* ssp. *celsii* the morphometric characteristic used to organise the different size classes was the rosette surface and 5 different life stages were distinguished (seedlings, saplings, small vegetative rosettes, large vegetative rosettes, plants with reproductive structures) (Table 4). Seedlings were recorded in the field and they were 42.01% of the population (Fig. 2). Saplings had only up to 10 leaves and their surface was approximately 5 cm^2 (Table 3), while the plants with reproductive structures were very few (about 2% of the total population). Although very few individuals produced flowers and fruits, flower and fruit production was massive when it was taking place (Table 4).

Table 4. Morphometric characteristics of *Campanula celsii* ssp. *celsii*

Life cycle stage	Nr of leaves ± S.D (in cm)	Diameter ± S.D (in cm)	Surface ± S.D (in cm^2)	Nr of flowers/ flowering plant ± S.D	Nr of fruits/ flowering plant ± S.D
Saplings	6.32 ± 3.43	2.11 ± 1.02	4.28 ± 3.99	-	-
Small vegetative rosettes	18.35 ± 10.62	5.37 ± 1.31	23.93 ±11.47	-	-
Large vegetative rosettes	68.27 ± 46.68	13.35 ± 5.23	161.14 ± 136.99	-	-
Plants with reproductive structures	92.00 ± 62.71	13.95 ± 5.96	175.10 ± 136.57	497.80 ± 569.82	458.20 ± 533.75

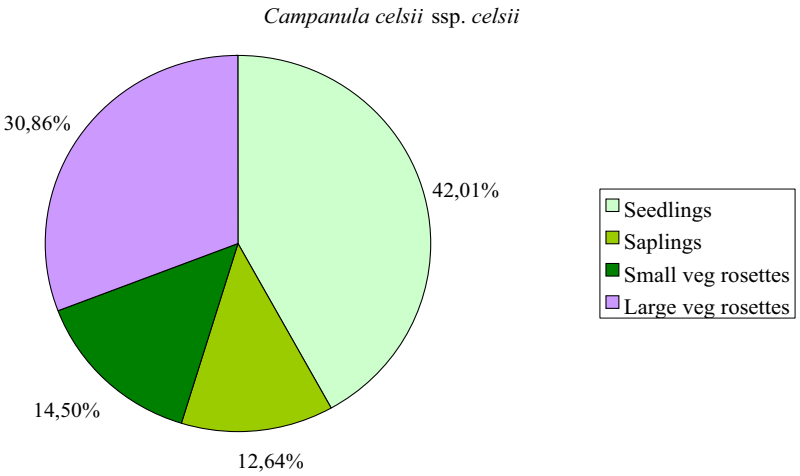

Figure 2. Population structure of *Campanula celsii* ssp. *Celsii*

In *Stachys swainsonii* ssp. *melangavica* the morphometric characteristic used to organise the different size classes was the plant height and 4 different life stages were distinguished (seedlings, small plants, large plants, plants with reproductive structures) (Table 5). Seedlings were recorded in the field and they were 33.11% of the population (Fig. 3). Large plants are 59.20% of the total population while 22.74% are the individuals with reproductive structures. Although flower and fruit production is not massive, it is important to note that flower to fruit ratio is quite high (Table 5).

Table 5. Morphometric characteristics of *Stachys swainsonii* ssp. *melangavica*

Life cycle stage	Height ± S.D (in cm)	Diameter ± S.D (in cm)	Surface ± S.D (in cm^2)	Nr of flowers/ flowering plant ± S.D	Nr. of fruits/ flowering plant ± S.D
Small plants	2.9 ± 2.2	-	-	-	-
Large plants	6.7 ± 4.7	16.4 ± 9.2	249.5 ± 275.4	-	-
Plants with reproductive structures	7.2 ± 4.7	20.3 ± 8.6	350.7 ± 295.7	40.0 ± 45.6	28.2 ± 35.8

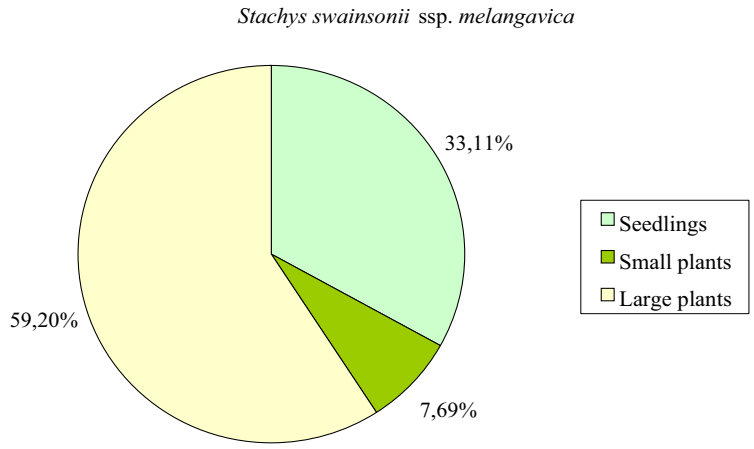

Figure 3. Population structure of *Stachys swainsonii* ssp. *Melangavica*

For *Silene spinescens* the morphometric characteristic used to organise the different size classes was the plant height and 4 different life stages were distinguished (seedlings, small plants, large plants,For *Silene spinescens* the morphometric characteristic used to organise the different size classes was the plant height and 4 different life stages were distinguished (seedlings, small plants, large plants, plants with reproductive structures) (Table 6). Seedlings were recorded in the field and they were 12.20% of the population (Fig. 4). Large plants are 80.49% of the total population while 63.41% are the individuals with reproductive structures. Noteworthy is the fact that flower production is relatively high but fruit production and flower to fruit ratio is quite low (Table 6). The data collected throughout the study period (December 1999 - June 2002) will be used for the construction of population projection matrices in order to investigate the population dynamics of all taxa under study.

4 DISCUSSION

Demographic monitoring of the studied taxa was based on field observations of survival, reproduction and growth of plants in natural conditions. In *Fritillaria obliqua* ssp. *obliqua* a small number of seedlings is established while a large number of individuals occur as saplings. The majority of the plants belong in the large plants size class which is formed by mature plants both flowering and non-flowering. It is important to indicate that each individual forms very few flowers and fruits. This fact has a major effect on seed rain and consequently on soil seed bank. Another important feature of

Table 6. Morphometric characteristics of *Silene spinescens*

Life cycle stage	Height ± S.D (in cm)	Diameter ± S.D (in cm)	Surface ± S.D (in cm^2)	Volume ± S.D (in cm^3)	Nr of flowers / flowering plant ± S.D	Nr of fruits / flowering plant ± S.D
Small plants	2.9 ± 0.4	-	-	-	-	-
Large plants	13.4 ± 6.4	22.8 ± 16.3	1823.6 ± 2401.7	11027.3 ± 22250.1	-	-
Plants with reproductive structures	13.8 ± 6.2	26.7 ± 16.4	2254.9 ± 2543.7	13396.2 ± 24026.3	43.9 ± 50.2	6.7 ± 19.0

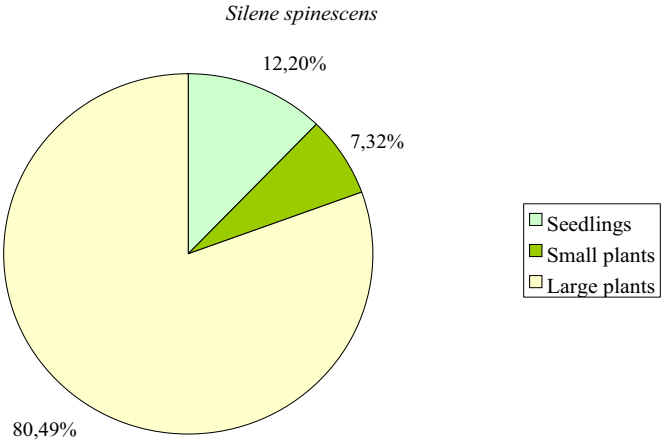

Figure 4. Population structure of *Silene spinescens*

herbaceous geophytes is that they exhibit subterranean dormancy. So, changes in the population size may or may not mean real changes in their survival and density (Lesica 1999, Yonezawa et al. 2000).

For *Campanula celsii* ssp. *celsii*, seedlings represent a large fraction of the population while saplings and small vegetative rosettes are almost equally represented in the population. Large vegetative rosettes are numerous but few mature individuals form flowers and fruits. However flower and fruit production is quite high. As a relatively short-lived monocarpic species, *C. celsii* ssp. *celsii* has a higher risk for population extinction than perennial or clonal plants (Fischer and Stöcklin 1997).

Stachys swainsonii ssp. *swainsonii* population has a large number of mature plants and seedlings while small plants represent a small fraction of the population. It is important to notice that under representation of small plants in the population may have serious effects in the population dynamics of this taxon. Flower and fruit production is not low and less than half of mature plants have reproductive structures.

In *Silene spinescens* the majority of the plants are large plants, which could have serious effects in the population dynamics of this taxon. Seedlings and small plants represent a small fraction of the population, which is a crucial factor for the persistence of the population. The majority of mature plants have reproductive structures but fruit production is low.

5 CONCLUSION

Each taxon studied presents a different population structure, which will ensure its persistence through time. This paper is part of an ongoing research under the framework of which more data are collected. It is expected that the analysis of all data will reveal a more complete picture of the population dynamics of these taxa.

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