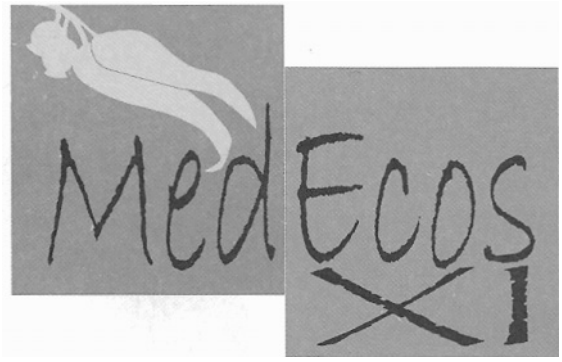

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Aspects of reproductive biology of the Greek fir (*Abies* cephalonica L.) in the Mt. Aenos National Park (Greece)

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Introduction

Abies cephalonica L. is a forest tree species endemic to the mountainous regions of central and southern Greece. The National Park of Mount Aenos at the island of Cephalonia (western Greece) was founded in 1962 to ensure the protection and conservation of this unique Abies cephalonica insular population, covering an area of 28.620 km^2. This area runs almost 11 km from NW to SE (38°09'04" N, 20°38'38" E) on a calcareous basement and reaches the height of 1628 m above sea level. The current study is part of a Ph.D Thesis concerning the evaluation of the conservation status of the Greek fir in the Aenos National Park and it reports on aspects of the species' reproductive biology. The main objectives are to determine the extent of interannual variation in cone and viable seed production and to investigate a possible reproductive strategy employed by the species. Previous research studies performed in the broader area of the Park have focused on botanical issues (e.g. Phitos and Damboldt 1985) and managing propositions, while the species has been studied from a genetic (Fady 1990 and 1991, Liu 1971) and silviculture point of view (Panetsos 1975). These works have indicated that although the species shows high levels of reststance to drought (compartng to other speces of the genus *Abies* in the Mediterranean basin) its current distribution on Mount Aenos nas been severely reduced (Forestry Department of Kefalonia 1996)

Materials and Methods

Twenty sampling permanent plots, of 100 m^2 each, were established at 11 different sites of the Park chosen in such a way so as to represent as much as possible of the landscape heterogeneity. The Abies population extends from 700 to 1620 m height, although a few scattered individuals occur at lower elevations. All mature trees occurring in the plots were mapped and measured. Every tree was monitored for its morphometric characteristics as well as for its cone and seed production on a three-year period. Cones were manually collected (with a use of a crane) at maturity stage from the top of the trees and separately put into hard-paper boxes. The cones were measured and then lefl to dry in well-ventilated rooms, where the exfoliation process was concluded and scales and seeds were separated from the central axis. Ail cone morphometric characteristics (length, diameter, cone-axe) were measured in the lab, while cones, seeds and scales weights were subsequently weighed using an analytical balance (180 g ± 0.1 mg).

Results

Flower buds usually open from late May to mid June. Female flowers are born mostly in the top half of the crown and on the outer ends of branches. Male flowers are born in the lower half of the crown. Seed production appears to begin when trees have reached the age of 25-30 years old (> 5 m long, > 9 cm diameter at breast height).

Cone and viable seed production varied significantly between years. However, the timing of dispersal remained almost the same regardless of the level of seed production. Cones are formed on trees in late spring, ripen in summer while seed dispersal takes place from mid October to early November.

The cones are erect, almost cylindrical, ending to a short-pointed apex of a yellowish green colour turning to brown at maturity. Their length is approximatelyl6.3 ± 0.4 cm, with a mean diameter of 4.6 ± 0.1 cm, while their mean weight varies between 65.3 ± 3.4 g in years of low cone productivity and 74 ± 3.7 g in the year of high cone productivity, as it is expressed by the number of cone bearing trees. The scales of the cones as well as the seeds on the same cone vary in size and weight, being smaller at the two edges and much bigger at in middle part of the cone where the sound seeds are located.

Measurements performed in three consecutive years revealed a high interannual variability in the cone production. Trees bearing cones in 2004 were only four out of 182 (0.0020/m^2) in all permanent plots monitored, they reached the number of five (0.0025/m^2) at the following year, while they were by far numerous in 2006, 99 individuals (0.049/m^2) (Figure Ia). The average number of cones per tree seems to vary significantly too, being 16 ± 3.4 in the year 2004, 19.4 ± 3.4 in 2005 and 51.6 ± 5.7 in 2006 (Figure Ib).

As for seed production, measurements performed in intact cones of the year 2005 indicated that each cone contains approximately 400 seeds. The number of sound seeds produced seems to vary also between years. Counting of seeds over a representative seedlot of 300 seeds selected from the central part of cones, produced in 2005 from 30 individuals. showed 2% sound seeds and 3% of insect damaged

seeds, while for 2006 a much higher percentage (40%) of sound seeds and a decrease of insect damage (0.3%) was revealed. The average weight of sound seeds was the same (0.8 ± 0.009g).

The average number of sound seeds offered as seed rain was 0.05/ m^2 at the year 2005 and increased to 98.801m^2 in the year of 2006.

Discussion

During the period of the study a different reproductive pattern was recorded for the three consecutive years, possibly indicating a masting behaviour of Abies cephalonica. Mast-fruiting or rnasting behaviour has been interpreted mainly as the synchronous intermittent production of large seed crops in perennial plants (Kelly and Sork 2002) as well as the cumulative result of the reproductive patterns of Individuals within a population (Koenig et al. 2003) in which there is a synchronization both in time and in size of crop. The annual variability of cone production in populations of Abies cephalonica has been previously reported from observations from other parts of Greece (Panetsos 1975. Dafis 1986), but little is known about the production of seeds and sound seeds of the species. Our data showed a significant concordance between yield of cone production and that of sound seed production. Similar trends have been reported by Houle (1999) for Abies balsarnea in an old growth temperate forest of north-eastern North America. Several hypotheses have been proposed with regard to the selective advantages of masting (Janzen 1971, Waller 1979. Smith et al. 1990, Lalonde and Roitberg 1992). Norton and Kelly (1988) and Kelly (1994) categorized these hypotheses into two types: (1) "resource matching." in which plants vary their reproductive effort in response to fluctuations in available resources; and (2) "economy of scale." in which larger reproductive effort is more efficient, favouring an occasional large effort rather than a regular, smaller one. However, there are still few studies with sufficient quantitative data to test these hypotheses for masting species. Our study needs further observations and analysis in order to fully justify this pattern as well as to classify Abies cephalonica in one of the above categories.

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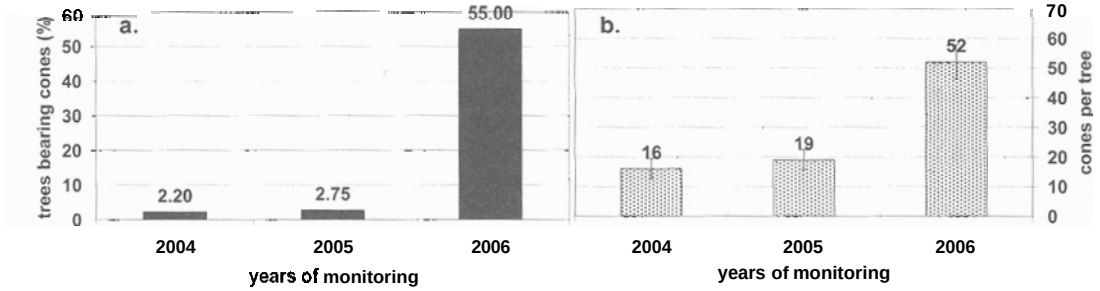

Figure 1. a. Percentage of mature trees bearing cones per sampling plot (100m²) and b. average number of cones per tree, during the years of study.