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# Influence of the altitude in the diametric distribution of the *Quercus suber* in the Northwest of Tunisia.

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**Abstract.** The cork oak occupies a special place in the Mediterranean forest. In Tunisia, it is fairly represented in the Northwest (70000 ha), especially in the Ain Draham and Tabarka areas [3]. It is restricted to acid surrounding conditions with a mild climate and plays a very important ecological role, this way insuring the installation of a fairly diverse flora whole branched out enough floral and wildlife procession. It insures also a significant socio-economic role for the rural population which lived in this zone and adds to the national economy through the production and the export of cork. Going through a great made by people pressure, and a perfect worsening of the medium with the effect direct of the climatic change, the forests of oak cork are unable to grow again it naturally. So, and according to the variance analysis of the effect of height on the diametric structure of cork oak, one noted more than height decrease, more than the density of diameter's classes of cork oak is very significant and more there is chance to find young seedlings resulting from natural regeneration. These results show that the density of cork oak differs within the same height classes, this difference can be the result of the effect of factors environmental.

***Keywords:*** *Tunisia, cork oak, altitude, diameter classes.*

## 1. Introduction

The conservation of forests and forest plants in the Mediterranean bassin is a complex problem due to the mixed-up nature of the situations and the many made by people uses and pressures used by the different cultural things of the Mediterranean for millennia [13]. The cork oak forest occupies an important place in the Tunisian forest, representing 3% of the cork oak area of the western Mediterranean bassin and the Atlantic coast [10]. According to [5], the area of this species decreased from 40,000 ha in 40 years, ie 1.000 ha per year which represents 1% of decrease per year (between 1952 and 1992), Now, only 69.870 ha of this surface still remain including 49.142 ha on the level of Kroumirie, which represents 70 % of that recorded on a national scale [3]. [6] Showed that disturbance's factors cause extreme changes in the micro climate at the gap (significantly higher, lower humidity, etc.).

The ecological and socio-economic importance of the cork oak encourages increased efforts to repair and re-doilitate these cork oaks. The factors of evolution, represented here by the action of environmental factors such as altitude, degree of exposure for light and terrain inclination, are mainly expressed by climate and its effect on natural regeneration and the new shoots in general, as by the possible offences concerning in particular at sapling, and adult's of the species studied and by the action of made by people factors.



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This worsening is reflected in the reduction in the extent of natural regeneration, the fragility of ecosystems and the loss of biodiversity in general.
The aim of this paper is to study the influence of altitude on the diametric distribution of the cork oak in the Northwest of Tunisia.

# 2. Material and Methods

## 2.1 Study area

The study was carried out on 20394 ha in the Tabarka and Ain Draham forest belonging to the Kroumirie. The area is seen as a rugged land with slopes of 5 to 40 % and by many micros slopes. The average height of the study area is about 450 mÂ². It ranges from 100 m at the water to reach no more than 950 m at Ain Draham [7]. From a climatic point of view, the area is in the wet climate. Tabarka is located in hot winter whereas Ain Draham is located in moderate winter. Climatic analysis of the study area shows that the annual sum of rain is irregular and that the Ain Draham station receives on average rain sum of 989 mm of rain and more. Similarly, the average monthly rain is variable from one year to the next. At the level of the Kroumirie forest, temperature data are limited to the mean values m (minimum) and M (maximum) which are respectively -1 ° C and 47 ° C for Tabarka and 5 ° C and 43 ° C for Ain Draham [4]. These helpful climatic conditions, together with the nature of the soil and altitude and exposure factors (topographic factors), have an influence of the distribution and development of natural vegetation (Quercus suber, Quercus canariensis, Quercus Coccifera, Pinus pinaster, Olea europea, etc.) [7].

# 3. Method

## 3.1 Method

The massif of the study area presents an uneven relief, with more climatic ensembles depending on altitude and exposure. Sampling was conducted in three altitude ranges (A1: low, A2: medium and A3: high) as shown in Table 1.

**Table 1.** Distribution of sampling plots for the whole study area

| Altitude class | Number of plots | Percentage of altitude class |
|---|---|---|
| Low altitude (A1) [0-300 m] | 87 | 36,40 |
| Medium altitude (A2) [300-600] | 99 | 41,42 |
| High altitude (A3) [> 600 m] | 53 | 22,18 |
| Total | 239 | 100 |

For each altitude range, we chose a random sampling of the plots to be selected. We have selected plots covering the whole study area and where 239 circular plots of 500 m² are found. To present the diametric structure of the cork oak in Kroumirie, we have chosen five classes of diameters [4]: (C1): Ø <5 cm (seedling); (C2): 5 <Ø <10 cm (sapling); (C3): 10 <Ø <20 cm (low poles); (C4): 20 <Ø <30 cm (high poles); (C5): Ø> 30 cm (adult).

## 3.2 Statistical analysis

In order to have the effect of altitude on the diametric distribution of the cork oak in the Northwest of Tunisia, we used software such as "SAS" and "Excel" to calculate the variance. The comparison of the mean was carried out by the test (Student Newman Keuls).

# 4. Results

### 4.1 Description of the current average global diametric structure of the cork oak in Tunisia

The plots of our study are divided into three classes of altitudes (low, medium and high altitude). The data collected of the whole of the plots and carried in table 2, show that the classes best represented of the cork oak are respectively the classes C1, C5 and C4 with high density. On the other hand, the classes C2 and C3 are less represented.

The reading of table two shows as well as the class C1, corresponding to the seedlings having diameters lower than five cm and representing the natural regeneration of the species, is present with high density (around 350 individuals / ha), in the plots pertaining to the first fringe of height [0-300 m].

Table 2. Density of each class of diameter (decreasing from C1 to C5) according to the altitude classes (decreasing from A1 to A3).

| | C1 | C2 | C3 | C4 | C5 | Total |
|---|---|---|---|---|---|---|
| A1 | 350 (45,39%) | 78 (10,11%) | 66 (8,56%) | 99 (12,84%) | 178 (23,08%) | 771 (100%) |
| A2 | 220 (42,63%) | 53 (10,27%) | 48 (9,30%) | 75 (14,53%) | 120 (23,25%) | 516 (100%) |
| A3 | 175 (42,99%) | 42 (10,31%) | 35 (8,59%) | 62 (15,23%) | 93 (22,85%) | 407 (100%) |
| Medium | 248 (44%) | 57 (10,20%) | 50 (8,80%) | 78 (13,94%) | 131 (23,10%) | 564 (100%) |

### 4.2 Effect of altitude on the various classes of diameter of the cork oak in Tunisia

#### *Class of seedling*

Figure one shows a very strong dominance, in terms of numbers, of young cork oak seedlings in the low altitude plots compared to those of medium and high altitudes. The analysis of the variance of the density of the individuals belonging to class C1 shows a very highly significant difference between the classes of altitudes; value of $P < 0.001$.

Figure one shows that the density of cork oak seedlings varies between a maximum of 350 individuals / ha for low altitude plots, 220 individuals / ha for medium altitude sites and a minimum of 175 individuals / ha for high altitude (> 600 m).

The importance of the rain distribution for seedling of cork oak is a deciding factor which increases the possibilities of their adaptation to the constraints of the medium.

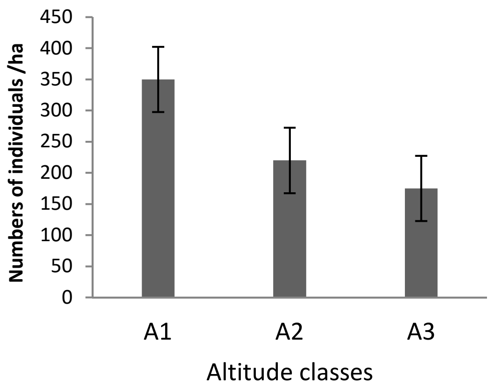


**Fig.1** Change in seedling class density as a function of altitude

### *Class of sapling*

Figure two shows the variation in the density of the sapling (C2) as a function of altitude. It is noted that plants with diameters between 5 and 10 cm are present with much higher numbers in the low-altitude plots (78 individuals / ha) than in the most high places (42 individuals / ha). There is a very highly significant interaction ($P < 0.001$) of the effect of altitude on density of trees of class of diameters D2.

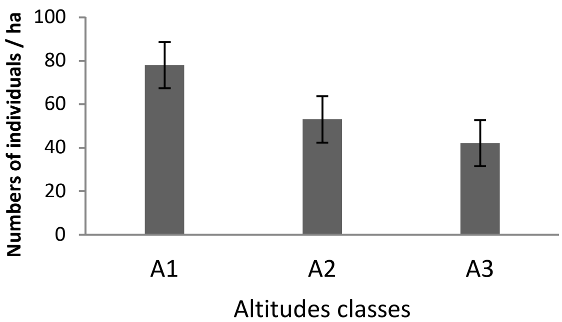


**Fig.2** Variation in the density of the sapling class as a function of altitude

### *Class of low poles*

The analysis of variance in the abundance of cork oak low poles, trees as a function of altitude shows a very highly significant relationship ($P < 0.001$) with a greater abundance in the plots Low altitudes. In the latter, low poles are fairly dense (66 individuals / ha), whereas in the high stations its numbers are much smaller (35 individuals / ha) (fig. 3).

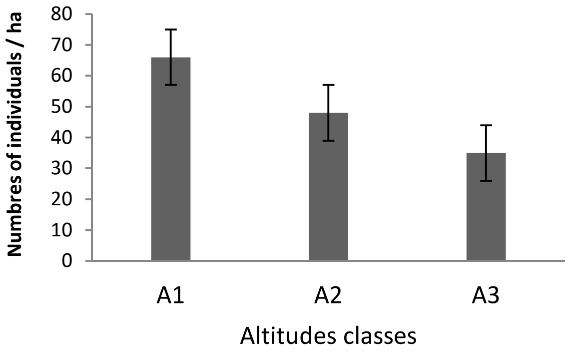


**Fig.3** Variation of the density of the blow pole class as a function of altitude

### *Class of high poles*

The relationship between the abundance of the high poles and the altitude has a correlation coefficient very highly significant at the threshold of $P < 0.001$.

For the class of diameter C4, the density varies from one altitude class to another. It reaches 99 individuals / ha for the low altitude plots, 75 and 62 individuals / ha, respectively, for medium and high stations (fig.4).

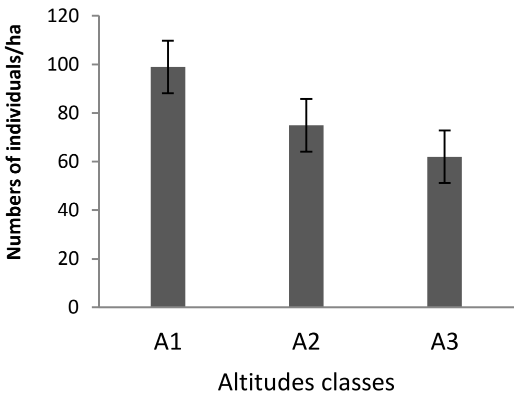


**Fig.4** Variation of the density of the high poles class according to the altitude

### *Class of the adult*

Generally, the largest numbers of adult individuals occur at low altitudes (178 individuals / ha) and are much higher than those observed in the vicinity of high sites (93 individuals /Ha) (fig. 5). There are very highly significant ($P < 0.001$) interactions between seed abundance and altitude.

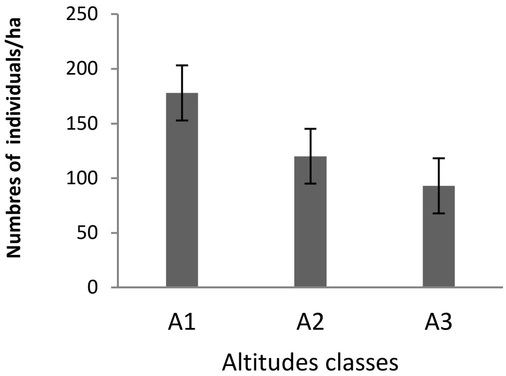


**Fig. 5** Variation of the density of the adult class as a function of altitude

### 4.3 Discussion

The low densities of the intermediate classes (sapling, low and high-pole plantation) are worrying and translate the problems met by the cork oak into Kroumirie to build up again itself naturally by seedling. The causes of this situation can be multiple, specific to the specie studied in certain environments such as altitude.

According to [4] and [6], the study of the diametric structure of the population of different oaks present at the Northwest of Tunisia makes it possible to figure out that it is far from being acceptable because it shows a clear break of the growth of young seedlings resulting from seedling, which leaves a rather worrying future for these oak groves.

The results of the statistical analysis of the effect of altitude on density and diameter distribution show that the zones of low altitudes (lower than 300 m) contain a high density of the young seedlings and seed-bearer the more significant than in the locations of high altitude. Altitude has a direct influence on rainfall and temperature, which, at the same time, directly affect the distribution of plants. In other words, the annual growth of this species is limited by low and cold temperatures during the winter and high temperatures combined with the increase in water deficit due to summer drought.

According to [5], seedlings are best established in low-lying stands that are best watered, but it is very likely that water is not the only factor responsible for this distribution and that predator's play a large role in this ratio.

It is a thermophilic species, grows temperate climate in mild winter, the mean value of the temperature is between 14 and 17 ° C, while the minimum must not fall below 9 ° C. During the summer, cork oak reduces leaf water loss while slowing down metabolism and growth. Loss of water is controlled through the closure of stomata, usually on the underside of the leaves, which control gas exchange with air [11]. Changes in temperature and water availability in the soil often cause increased stress due to drought, may also increase forest vulnerability and probably lead to changes in the productivity of forest communities [9]. Rain that plays a big part in water supply to trees is often the first factor highlighted in many research papers to explain this process. For many authors, the soil moisture deficiency is the result of a reduction in spring rain [9]. [2] Showed that the climate differs almost completely according to altitude and distance from the sea. Temperatures decrease when height increases. The number of frost days differs/changes between November and March depending on the altitude. In almost the same way, the once-a-year rainfall increases with the closeness of the sea. The summer water shortage, strongly marked in the low zone, reduces with altitude and distance from the sea. [1] Noted the action of wind on the relief and on plant growth.

## 5. Conclusion

In this work, we used the diametric structure as an indicator of the current state and evolution of cork oak stands in Kroumirie. The study of this structure shows the presence of a dominance of both strata (seedlings and mature trees), individuals belonging to intermediate strata are very rare and sometimes non-existent in some plots.

Factors of change are represented here by the effect of drought during the summer period and cold during the winter period, as well as climate and its effect on natural regeneration per seedling. The future of this ecosystem remains delicate and breakable and needs other propagation methods such as strain rejection.

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