Study and comparison of four forest structures on Mt. Chortiatis (northern Greece)

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Abstract

The purpose of this work is to study and analyze the forest structure in order to get a better understanding of an ecosystem. The chosen ecosystem for this work has been Mt. Chortiatis, near Thessaloniki, in northern Greece. The study area is in a slope of the mountain, between six hundreds and nine hundred meters of altitude. The climate for the area can be characterized as Mediterranean. We are going to compare four structures, a *Castanea sativa*, a *Fagus sylvatica*, a *Carpinus orientalis* and a *Pinus nigra* forest. For the study of the forest structure we have use a plot-less method, the Point-Centered Quarter Method, which is faster than the methods that use a plot. We have measure the distances from a point to the nearest tree in 4 squares, and the basal area to get the densities and covers of the species. *Castanea sativa* has been the species with the lowest density because the distances where the highest. On the other hand, *Carpinus orientalis* has the highest density. Looking at basal area, *Castanea sativa* has got the highest results, but *Pinus nigra* has got the highest absolute cover.

Lan honen helburua baso estruktura ikastea izan da, ekosistema hobeto ulertzeko. Lanerako aukeratu den ekosistema, Chortiatis mendia izan da, Thessalonika alboan dagoena, Greziaren iparraldean. Ikerketa area, mendiaren hego aurpegian kokatuta dago, seiehun eta bederatziehun metro bitartean. Zonaldean klima mediterraneoa da nagusi. Lau estruktura desberdinak ikertu dira, *Castanea sativa*, *Fagus sylvatica*, *Carpinus orientalis* eta *Pinus nigra* basoak. Baso estruktura ikertzeko area gabeko metodo bat erabili da, Point-Centered Quarter Method, area erabiltzen duten metodoak baino azkarragoa dena. Puntu batetik distantziak neurtu ditugu hurbilen dagoen zuhaitzari 4 koadrantetan, eta zuhaitz bakoitzaren azalera basimetrikoak lortzeko espezien dentsitateak eta azalerak. *Castanea sativa*k izan du dentsitate baxuena distantziak handiagoak zirelako, eta beste aldean, *Carpinus orientalis*ek izan du altuenena. Azalera basimetrikoari begiratuz, *Castanea sativa*k izan du emaitza altuena, baina Pinus nigra izan du azalera absolutu handiena.

Introduction

Forests are habitats in which the trees are the dominant form of vegetation. They occur in many regions and climates around the globe. The species composition is differentiated among forest types, with some forests consisting of many hundreds of species of trees (e.g. tropical ones), while others consist of just a handful of species (e.g. temperate forests) (Busgen and Munch, 1929).

"Forest structure" usually refers to the way in which the attributes of trees are distributed within a forest ecosystem (Gadow et al., 2012). The production and dispersal of seeds and the associated processes of germination, seedling establishment and survival are important factors of plant population dynamics and structure (Harper, 1977). Tree growth and the interactions between trees depend, to a large degree, on the structure of the forest.

Structure and diversity are important features which characterize a forest ecosystem. The evaluation of forest structure thus informs us about the distribution of tree attributes, including the spatial distribution of tree species and their dimensions for example (Gadow et al., 2012).

The method that is going to be used for our purpose is the point-centered quarter method, which belongs to a family of methods usually designated as "distance measurement methods," was developed by (Cottam and Curtis, 1956). One use of the point-centered quarter method is to determine the relative importance of the various tree species in a community (Mitchell, 2007). The term "importance" can mean many things depending on the context. An obvious factor influencing the importance of a species to a community is the number of trees present of that species. However, the importance of some number of small trees is not the same as the importance of the same number of large trees. So the size of the trees also plays a role. Further, how the trees are distributed throughout the community also has an effect. A number of trees of the same species clumped together should have a different importance value than the same number of trees distributed more evenly throughout the community (Mitchell, 2007).

Measuring importance can aid understanding the succession stages of a forest habitat. At different stages, different species of trees will dominate. Importance values are one objective way of measuring this dominance. The two main factors to determine the importance value of a species are the density and the size. Knowing the importance of the different tree species will help a lot to understand the structure of the forest.

The four forest types studied here are *Fagus sylvatica, Castanea sativa, Carpinus orientalis* and *Pinus nigra* forests on the Mt. Chortiatis. Below some important morphological, as well as ecological characteristics of the four studied forest species are given.

*Fagus sylvatica'*s natural range extends from southern Sweden to central Italy, west to France, southern England, northern Portugal, central Spain, northern Greece and east to northwest Turkey (Von Wuehlisch, 2008). In the southern part of its range around the Mediterranean, it grows only in mountain forests, at 600–1,800 m (1,969–5,906 ft) altitude. It is a large tree, capable of reaching heights of up to 49 m tall and 3 m trunk diameter, though more typically is smaller and slimmer. Though not demanding of its soil type, the European beech has several significant requirements: a humid atmosphere (precipitation well distributed throughout the year and frequent fogs) and well-drained soil (it cannot handle excessive stagnant water). It prefers moderately fertile ground, calcified or slightly acidic, therefore it is found more often on the side of a hill than at the bottom of a clayey basin. It tolerates rigorous winter cold, but is sensitive to spring frost (Buschbom et all 2010),

The genus Castanea has been thought to have originated from Asia, in Tertiary period. Its westward migration resulted in the European chestnut *Castanea sativa* (Ketenoglu et all, 2010). Now it is widely dispersed throughout Europe and in some localities in temperate Asia (Conedera et all, 2004). It can reach up to 35 m tall, with a trunk up to about 2 m diameter. *Castanea sativa* has always been a very important tree for humans because the fruit, chestnut. It is a valuable resource for many Mediterranean mountainous areas, due to its edible fruits and good quality timber. That makes it one of the most important forest species in the Mediterranean forest basin (Constantinidis et al., 2007).

Carpinus orientalis is a hornbeam native from southeastern Europe to northern Iran. It is a small tree, rarely over 10 m tall and often shrubby. *Carpinus orientalis* is usually found in neutral soil, and respect to soil acidity has narrow ecological amplitude. It is adapted to high light intensity, but it has wide ecological amplitude for light (Karadzié et al., 1997).

Pinus nigra is a large coniferous evergreen tree that can appear in the Mediterranean forest from Spain to the Crimea, in Asia Minor and on Corsica/Cyprus, and in the high mountains of the Maghreb in North Africa (Piermattei et all, 2012). It has a medium to fast-growing rate, reaching until 20-25 meters tall at maturity. Its optimal distribution is between 800 and 1,500 ma.s.l. (Isajev et al. 2004). The crown has symmetrical canopy with a regular (or smooth) outline, and individuals have more or less identical crown forms. Usually adapted to basic soils, is a very tolerant species with respect to soil acidity. *Pinus nigra* is adapted to high light intensity, but it has wide ecological amplitude for light (Karadzié et al., 1997).

Material and Methods

1-Study area:

The experimental area was confined on a slope of Mt. Chortiatis, about 20 km northeastern from Thessaloniki, Greece. The centroid coordinates of Mt. Chortiatis are 40.605612 N, 23.117766 E and the elevation of the slope studied fluctuates between 600-900 m.

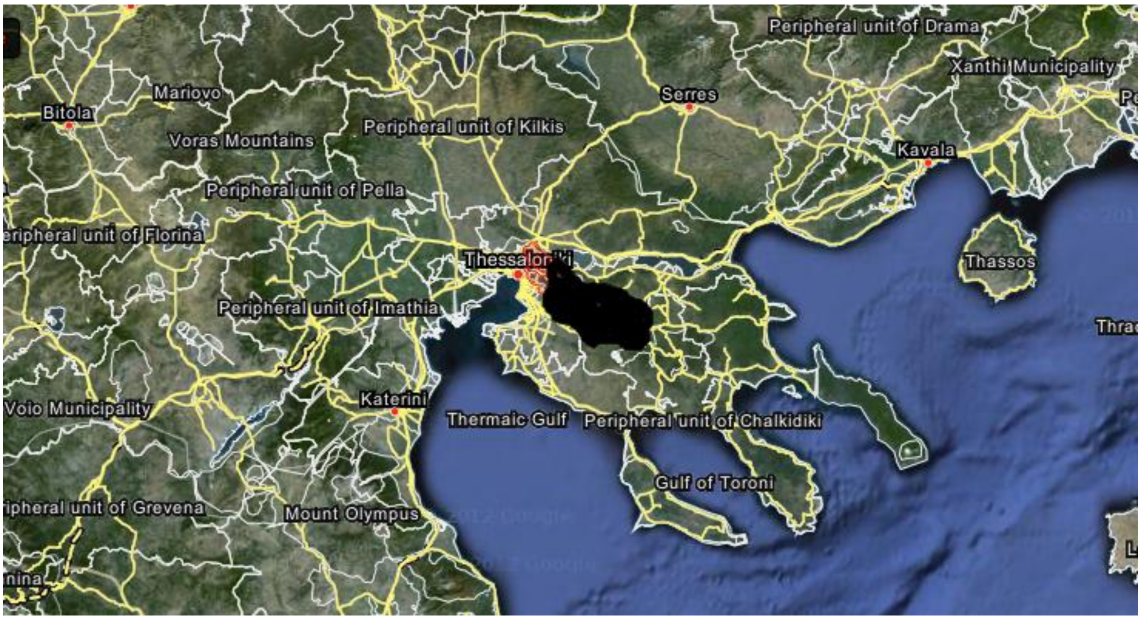

Figure 1. A map of northern Greece. The black spot indicates the location of Mt. Chortiatis.

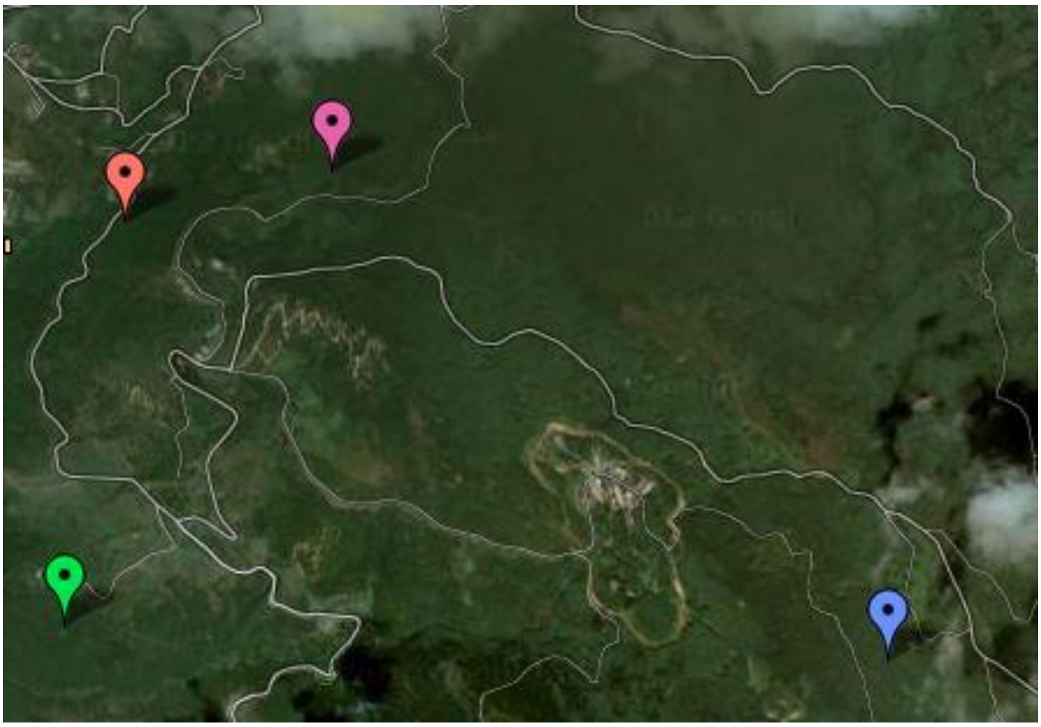

Figure 2. The slope studied on Mt. Chortiatis. The green placemark indicates *Pinus nigra* stand; coordinates 40.587755, 23.092562. The blue placemark indicates *Fagus sylvatica* stand; coordinates 40.587038, 23.124147. The pink placemark indicates *Castanea sativa* stand; coordinates 40.601018, 23.103126. The red placemark indicates *Carpinus orientalis* stand; coordinates 40.599128, 23.096388.

The climate can be characterized as Mediterranean, with a mean annual rainfall of 387.7 mm and mean monthly temperature in the range between 4.9–31.6^{o}C (Hellenic National Meteorological Service, 2013). The upper 35 cm of soil consists of slightly gravelly, silty clay loams that gradually changes to stony and bouldery silty clay loam up to 50 cm depth.

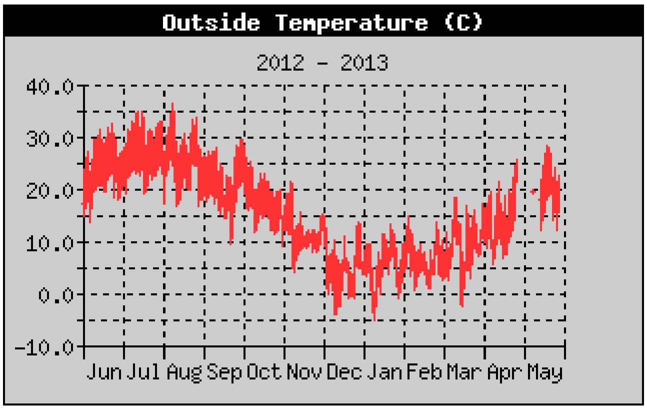

Figure 3. Annual temperature in Mt. Chortiatis. (http://www.hortiatis570.gr/weather ; access date: 1/06/2013)

As it is show in Figure 3, the hottest season is summer, especially months June, July and August with average temperatures higher than 25ºC. The temperatures decrease from August until January, which is the coldest month with a average temperature of 4,9ºC. After January the temperatures start rising again until July (Weather Station of Chortiati-Thessaloniki, 2013).

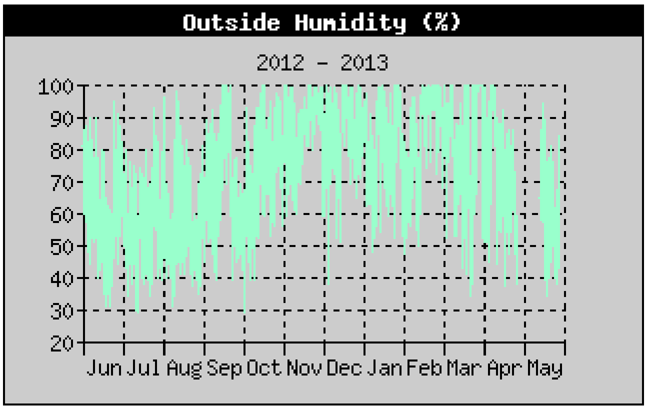

Figure 4. Annual humidity (%) in Mt. Chortiatis (http://www.hortiatis570.gr/weather ; access data: 1/06/2013)

As it is shown in Figure 4, the annual humidity is very high during the whole year. It goes under the 50% for few days, but usually it fluctuates around 60% in the warm season and 80% in the cold season (Weather Station of Chortiati-Thessaloniki, 2013).

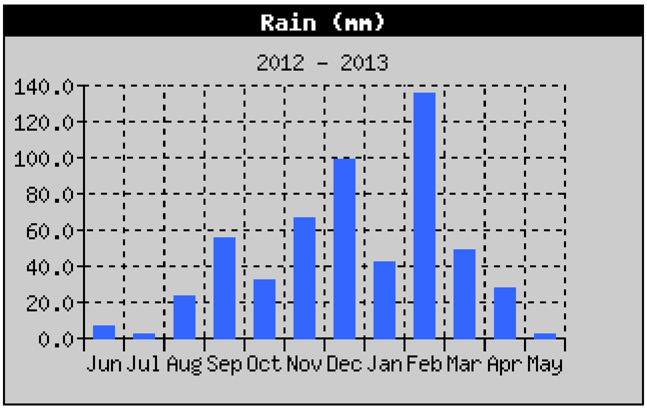

Figure 5. Annual rain (mm) in Mt. Chortiatis. (http://www.hortiatis570.gr/weather ; access date: 1/06/2013)

As it is shown in Figure 5 the annual rain varies a lot during the year. In summer it barely rains. It starts a little in August and then goes increasing until February, where it gets the highest amount (an average of almost 140 mm). In January there is has a significant decrease in rain, but that is explainable because the data that is shown is only the amount of rain, and in January, like is the coldest month, most of the rain is turn into snow, and it doesn't appear in the results (Weather Station of Chortiati-Thessaloniki, 2013).

2-Data sampling:

The method used for describing forest structure is the Point Centered Quarter Method (Cottam & Curtis, 1956). A wide variety of methods have been used to study forest structure parameters such as population density, basal area, and biomass. While these parameters are sometimes estimated using aerial surveys or photographs, most studies involve measurement of these characteristics for individual trees using a number of different field sampling methods. These methods fall into two broad categories: plot-based and plot-less (Mitchell, 2007).

Plot-based methods begin with one or more plots (quadrants, belts) of known area in which the characteristics of interest are measured for each plant. In contrast, plot-less methods involve measuring distances for a random sample of trees, typically along a transect, and recording the characteristics of interest for this sample (Mitchell, 2007).

The point-centered quarter method is one plot-less method. The advantage of using plot-less methods rather than standard plot-based techniques is that they tend to be more efficient. Plot-less methods are faster, require less equipment, and may require fewer workers. However, there is the opinion that plot-less methods have less accuracy compared to the plot–based methods. Nevertheless, point-centered quarter method is considered as one of the most accurate plot-less methods (Beasom & Haucke, 1975), and thus, any loss of accuracy can be considered as very small.

The material that has been used in this study in order to apply the point-centered quarter method were a GPS receiver (Global Positioning System), a laser distance meter, a meter, a compass, and plastic bags.

The sampling was made following a transect and leaving 50 meters between each sampling point. In each sampling point the exact coordinates and altitude have been measured. Using the compass, at each sampling point four quadrantal were divided. The first quadrantal was between north and east in the compass, the second between east and south, the third between south and west and the last one between west and north.

In each quadrantal, the tree nearest to the sampling point was located. Only individuals having diameter higher than 4 cm were considered. Then, the distance from the sampling point to the nearest tree was measured using the laser distance meter. These measurements were repeated in each of the four quarters. The height of all the four individuals per sampling point (nearest individuals) was measured using also the laser distance meter. In addition, the perimeter of the four trees was measured using the metre tape. The perimeter was measured at the breast height (more or less 1,3 m).

In Figure 6, an example of the way that the measurements are done in a sampling point is presented.

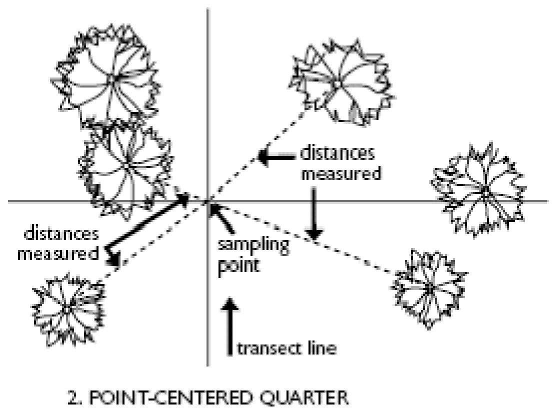

Figure 6. An example of a sampling point.

3-Data analysis:

To start, is necessary to use the measures that have been taken in the field, the perimeter and height of each tree and the distance to the sampling point.

First of all,the perimeter (P) of each tree must be used to take the radio(r). Just divide the perimeter by pi^2 (π).

Equation 1.

$$r = P/\pi^2$$

Once the radio is taken, the next step was the basal area (A) . In order to accomplish that, the radio^2 was multiply by π.

Equation 2.

$$A = \pi r^2$$

After the basal area, is possible to take the average basal area (A_a) for each tree. To do that, all the basal area (A) of the same specie must be taken and divided by the total number of trees (4n).

Equation 3.

$$A\text{a} = \frac{D}{4n}$$

The next step was to take the standard deviation for the basal area. χ_i are the individual x values for each basal area. Only values from the same species are used. $\bar{\chi}$ is the average basal area of the species. Once the average are taken, it is necessary to subtract the mean and square the result with each value (χ, distance). Then, the mean of those squared differences is work out. We add up all the values and then divided by the total number (less one, because is n−1). To finish the square root is taken.

Equation 4.

$$s = \sqrt[2]{\frac{1}{n-1}\sum_{i=1}^{n}(\chi_i - \bar{\chi})}$$

Once the calculations with the basal area are finished, it is possible to start with the distances.The first thing that must be taken is the total of distance for every tree.

n= the number of sample points along the transect (10 in these case)
i= a particular transect point, where i = 1,…., n
j= a quarter at a transect point, where j = 1,…., 4
R_{ij}= the point-to-tree distance at point i in quarter j

Equation 5.

$$\sum_{i=1}^{5}\sum_{j=1}^{4} R_{ij}$$

Then, the average distance (D_a) for each tree must be taken. To do that, the distances (D, the one above) are divided by the total number of trees (4n).

Equation 6.

$$D_a = \frac{D}{4n}$$

After the average distance is taken, it is possible to take the standard deviation of the distances. It is the same process that the one used for the standard deviation for the basal area. In this case χ_i are the individual x values for each distance, and $\bar{\chi}$ is the average distance of the specie.

Equation 7.

$$s = \sqrt[2]{\frac{1}{n-1}\sum_{i=1}^{n}(\chi_i - \bar{\chi})}$$

Once the average distance and the standard deviation are taken, it is possible to start with the density. To get the absolute density of all trees this formula can be use:

Equation 8.

$$\bar{r} = \frac{\sum_{i=1}^{n}\sum_{j=i}^{4} R_{\text{ij}}}{4n}$$

Cottam, Curtis, and Hale (1953) showed empirically and Morisita (1954) demonstrated mathematically that r̄ is actually an estimate of $\sqrt{1/\lambda}$, the square root of the mean area occupied by a single tree. Consequently, an estimate of the density can be given by:

Equation 9.

$$Absolute\ density\ (\lambda) = \frac{1}{\bar{r}^2} = \frac{16n^2}{\left(\sum_{i=1}^{n}\sum_{j=1}^{4} R_{ij}\right)^2}$$

When the overall absolute density is taken it is possible to take the absolute densities of each species. To get the absolute density of K specie (λ_k) the absolute density (λ) must be multiply by the number of trees of K specie ($4n_k$) divided by the total number of trees ($4n$).

Equation 10.

$$\lambda_k = \lambda \times (4n_k/4n)$$

After that, the relative densities of each species can be taken. The relative density of K specie will be the absolute density of K specie (λ_k) divided by absolute density (λ) and multiply that by 100.

Equation 11.

$$Relative\ density\ (Species\ k) = \frac{\hat{\lambda}\kappa}{\hat{\lambda}} \times 100$$

Now that the densities are taken, it is possible to start taking the covers(C). The absolute cover of K specie (C_k) is the average basal area (A_a) of that specie multiply by absolute density of that specie, and then divided by 10000.

Equation 12.

$$C_k = (\lambda_k \times A_a)/10000$$

After the absolute cover is taken, the next step is to take the relative cover. The relative cover of K specie is the absolute cover of K specie divided by the addition of the absolute covers of all species.

Equation 13.

$$C_{rk} = C_k / \sum C_k$$

Results:

In Table 1 all the parameters (coordinates, orientation of each quarter, species, distance, height, perimeter, radio, diameter and area) measured in all the sampling points within *Fagus sylvatica* stands are presented. In the following tables (Tables 2, 3 and 4) the corresponding parameters for *Castanea sativa*, *Carpinus orientalis* and *Pinus nigra* stands, respectively, are presented.

Table 1. Parameters measured within *Fagus sylvatica* forest. The data content coordinates, orientation of each quarter, species, distance, height, perimeter, radio, diameter and area. Yellow color indicates the minimum values of distance per sampling point.

Random Point	Orientation	Species	Distance (m)	Height(m)	Perimeter (cm)	Radio (cm)	Diameter (cm)	Area (cm2)
Random Point 1	N-E	F. sylvatica	4,71	6,13	31	4,936305732	9,872611465	76,51273885
N 40º 35' 11,4''	E-S	F. sylvatica	3,99	10,48	101	16,08280255	32,1656051	812,1815287
S 023º 07' 29,9''	S-W	F. sylvatica	4,55	10,71	73 / 65,6	11,62420382	23,24840764	424,2834395
971M	W-N	F. sylvatica	5,1	10,12	48,5/68/78,6/78,)	12,51592357	25,03184713	491,8757962
		18,35	4,5875					451,2133758
Random Point 2	N-E	F. sylvatica	3,76	13,74	51/53/99	15,76433121	31,52866242	780,3343949
N 40º 35' 11,5''	E-S	F. sylvatica	3,99	13,92	149	23,72611465	47,4522293	1767,595541
S 023º 07' 29,8''	S-W	F. sylvatica	5,7	14,28	112	17,8343949	35,66878981	998,7261146
980M	W-N	F. sylvatica	3,67	10,34	66	10,50955414	21,01910828	346,8152866
		17,12	4,28					973,3678344
Random Point 3	N-E	F. sylvatica	4,42	13,28	87	13,85350318	27,70700637	602,6273885
N 40º 35' 11,3''	E-S	F. sylvatica	4,87	14,15	106,5	16,95859873	33,91719745	903,0453822
S 023º 07' 30,0''	S-W	F. sylvatica	2,83	11,12	64	10,1910828	20,38216561	326,1146497
986M	W-N	F. sylvatica	2,46	9,87	43	6,847133758	13,69426752	147,2133758
		14,58	3,645					494,750199
Random Point 4	N-E	F. sylvatica	2,15	13,65	67	10,66878981	21,33757962	357,4044586
N 40º 35' 13,3''	E-S	F. sylvatica	1,92	8,25	32/29	5,095541401	10,1910828	81,52866242
S 023º 07' 28,2''	S-W	F. sylvatica	1,45	11,43	55,5	8,837579618	17,67515924	245,2428344
1004M	W-N	F. sylvatica	2,34	10,12	44	7,006369427	14,01273885	154,1401274
		7,86	1,965					209,5790207
Random Point 5	N-E	F. sylvatica	2,35	6,92	25,5	4,060509554	8,121019108	51,77149682
N 40º 35' 13,6''	E-S	F. sylvatica	1,93	11,12	55/43	8,757961783	17,51592357	240,843949
S 023º 07' 27,9''	S-W	F. sylvatica	2,63	10,4	45,5	7,24522293	14,49044586	164,8288217
1011M	W-N	F. sylvatica	3,42	13,9	69/30/46	10,98726115	21,97452229	379,0605096
		10,33	2,5825					209,1261943
Random Point 6	N-E	F. sylvatica	2,15	7,85	26,5/31,4	5	10	78,5
N 40º 35' 14,4''	E-S	F. sylvatica	2,8	11,9	66,6	10,60509554	21,21019108	353,1496815
S 023º 07' 26,8''	S-W	F. sylvatica	3,62	14,12	47/88/50,4	14,01273885	28,02547771	616,5605096
1016M	W-N	F. sylvatica	5,46	15,6	122,6	19,52229299	39,04458599	1196,716561
		14,03	3,5075					561,2316879
Random Point 7	N-E	F. sylvatica	2	11,26	45/24,8	7,165605096	14,33121019	161,2261146
N 40º 35' 15,7''	E-S	F. sylvatica	1,93	8,12	29/25,6	4,617834395	9,23566879	66,95859873
S 023º 07' 26,3''	S-W	F. sylvatica	1,56	12,45	57,6/25,5	9,171974522	18,34394904	264,1528662
1007M	W-N	F. sylvatica	1,74	12,2	55/49/44,8/31,2	8,757961783	17,51592357	240,843949
		7,23	1,8075					183,2953822
Random Point 8	N-E	C. sativa	1,87	13,1	77/68,8	12,2611465	24,52229299	472,0541401
N 40º 35' 15,6''	E-S	F. sylvatica	3,72	10,85	61,8	9,840764331	19,68152866	304,0796178
S 023º 07' 26,2''	S-W	F. sylvatica	2,7	12,28	74/30,8	11,78343949	23,56687898	435,9872611
1012M	W-N	F. sylvatica	1,69	11,9	68,4	10,89171975	21,78343949	372,4968153
		9,98	2,495					370,8545648
Random Point 9	N-E	F. sylvatica	3,3	12,96	86,6	13,78980892	27,57961783	597,0987261
N 40º 35' 14,3''	E-S	I. aquifolium	2,44	4,82	37	5,891719745	11,78343949	108,9968153
S 023º 07' 27,3''	S-W	F. sylvatica	4,47	10,05	45,4/37,6	7,229299363	14,45859873	164,1050955
986M	W-N	F. sylvatica	3,17	9,36	42,8	6,815286624	13,63057325	145,8471338
		13,38	3,345					302,3503185
Random Point 1	N-E	F. sylvatica	2,56	11,45	71,2	11,33757962	22,67515924	403,6178344
N 40º 35' 13,9''	E-S	F. sylvatica	3,72	6,78	29,8	4,74522293	9,49044586	70,70382166
S 023º 07' 27,5''	S-W	F. sylvatica	2,32	11,15	68,6/34,8	10,92356688	21,84713376	374,6783439
1082M	W-N	F. sylvatica	4,15	8,35	28,8/41,6	6,624203822	13,24840764	137,7834395
		12,75	3,1875					246,6958599

Table 2. Parameters measured within *Castanea sativa* forest. The data content coordinates, orientation of each quarter, species, distance, height, perimeter, radio, diameter and area. Yellow color indicates the minimum values of distance per sampling point.

Random Point	Orientation	Species	Distance (m)	Height (m)	Perimeter (cm)	Radio (cm)	Diameter (cm)	Area
Random Point 1	N-E	C. sativa	2,45	8,18	100,8 / 42,6	16,05095541	32,10191083	808,968153
N 40º 36'01,0''	E-S	C. sativa	6,8	8,52	121,4	19,33121019	38,66242038	1173,40446
S 023º 06' 09,2''	S-W	C. sativa	2,9	5,96	64,6	10,2866242	20,57324841	332,257962
813M	W-N	C. sativa	4,25	8,1	110,2	17,5477707	35,0955414	966,882166
		16,4	4,1					820,378185
Random Point 2	N-E	Q. coccifera	5,07	8,24	44,4	7,070063694	14,14012739	156,955414
N 40º 36'01,1''	E-S	C. sativa	6,23	8,05	103,6	16,49681529	32,99363057	854,535032
S 023º 06' 09,9''	S-W	C. Sativa	1,98	7,86	78,2/66/62,6	12,4522293	24,9044586	486,882166
801M	W-N	C. Sativa	5,59	7,21	58,8	9,363057325	18,72611465	275,273885
		18,87	4,7175					538,897028
Random Point 3	N-E	C. sativa	3,49	7,72	78,6	12,51592357	25,03184713	491,875796
N 40º 36'01,4''	E-S	C. sativa	3,86	7,58	73,8	11,75159236	23,50318471	433,633758
S 023º 06' 11,9''	S-W	C. sativa	1,6	7,2	37,6	5,987261146	11,97452229	112,56051
809M	W-N	C. sativa	2,38	6,95	69,6/60	11,08280255	22,1656051	385,681529
		11,33	2,8325					355,937898
Random Point 4	N-E	C. sativa	5,6	7,96	98,6	15,70063694	31,40127389	774,041401
N 40º 36'01,4''	E-S	C. sativa	5,08	7,8	87,2	13,88535032	27,77070064	605,401274
S 023º 06' 12,8''	S-W	C. sativa	1,93	6,46	56,8	9,044585987	18,08917197	256,866242
801M	W-N	C. sativa	2,66	6,78	66,4	10,57324841	21,14649682	351,031847
		15,27	3,8175					496,835191
Random Point 5	N-E	C. sativa	4,37	8,56	120/105,8/107,8	19,10828025	38,21656051	1146,49682
N 40º 36'01,4''	E-S	C. sativa	3,01	8,1	91,8	14,61783439	29,23566879	670,958599
S 023º 06' 12,4''	S-W	C. sativa	3,5	9,28	156/120,8	24,84076433	49,68152866	1937,57962
809M	W-N	C. sativa	6,49	7,52	71,2	11,33757962	22,67515924	403,617834
		17,37	4,3425					1039,66322
Random Point 6	N-E	C. sativa	6,54	9,56	158,8	25,2866242	50,57324841	2007,75796
N 40º 36'01,1''	E-S	C. sativa	7,37	10,28	183,8	29,26751592	58,53503185	2689,68471
S 023º 06' 14,6''	S-W	C. sativa	2,38	9,5	168,8	26,87898089	53,75796178	2268,58599
785M	W-N	C. sativa	9,424	9,16	135,6	21,59235669	43,18471338	1463,96178
		25,714	6,4285					2107,49761
Random Point 7	N-E	C. sativa	4,98	9,32	123,2/136,6	21,75159236	43,50318471	1485,63376
N 40º 35'57,4''	E-S	C.sativa	4,7	8,56	98,2/96/104,6	16,65605096	33,31210191	871,111465
S 023º 06' 16,3''	S-W	C. sativa	4,82	8,64	94,6	15,06369427	30,12738854	712,512739
821M	W-N	C. sativa	9,608	8,82	99,4/101,6	16,17834395	32,3566879	821,859873
		24,108	6,027					972,779459
Random Point 8	N-E	C. sativa	5,59	9,66	158	25,15923567	50,31847134	1987,57962
N 40º 35'57,9''	E-S	C. sativa	5,82	9,02	126	20,06369427	40,12738854	1264,01274
S 023º 06' 17,7''	S-W	C. sativa	2,68	9,6	154,2	24,55414013	49,10828025	1893,1242
818M	W-N	C. sativa	5,98	9,14	126,4	20,12738854	40,25477707	1272,05096
		20,07	5,0175					1604,19188
Random Point 9	N-E	C. sativa	5,45	8,86	105,6	16,81528662	33,63057325	887,847134
N 40º 35'58,3''	E-S	C. sativa	4,32	9,12	118	18,78980892	37,57961783	1108,59873
S 023º 06' 17,9''	S-W	C. sativa	3,28	8,66	98,4	15,66878981	31,33757962	770,904459
816M	W-N	C. sativa	6,78	8,94	107,4	17,10191083	34,20382166	918,372611
		19,83	4,9575					921,430732
Random Point 1(	N-E	C. sativa	4,89	9,65	132,6	21,11464968	42,22929936	1399,90127
N 40º 35' 58,6''	E-S	C. sativa	2,76	8,89	106,4	16,94267516	33,88535032	901,350318
S 023º 06' 18,1''	S-W	C. sativa	3,89	9,14	116,8	18,59872611	37,19745223	1086,16561
813M	W-N	C. sativa	6,97	9,46	127,8	20,35031847	40,70063694	1300,38535
		18,51	4,6275					1171,95064

Table 3. Parameters measured within *Carpinus orientalis* forest. The data content coordinates, orientation of each quarter, species, distance, height, perimeter, radio, diameter and area. Yellow color indicates minimum values of distance per sampling point.

Random Point	Orientation	Species	Distance (m)	Height (m)	Perimeter (cm)	Radio (cm)	Diameter (cm)	Area
Random Point 1	N-E	Q. coccifera	2,66	2,74	40	6,369426752	12,7388535	127,388535
N 40º 36' 00,1''	E-S	C. orientalis	1,71	4,66	21,6	3,439490446	6,878980892	37,1464968
S 023º 05' 46,5''	S-W	C. orientalis	2,05	4,38	21,4	3,407643312	6,815286624	36,4617834
661M	W-N	C. orientalis	1,79	3,06	22	3,503184713	7,006369427	38,5350318
		8,21	2,0525					37,381104
Random Point 2	N-E	C. orientalis	3,08	4,48	24/24/25/17	3,98089172	7,961783439	49,7611465
N 40º 35' 56,4''	E-S	C. orientalis	2,18	4,26	20/17/20	3,184713376	6,369426752	31,8471338
S 023º 05' 44,5''	S-W	C. orientalis	2,15	4,61	17	2,707006369	5,414012739	23,0095541
730M	W-N	J. oxycedrus	1,51	4,28	7/18/20/21	3,343949045	6,687898089	35,111465
		8,92	2,23					34,8726115
Random Point 3	N-E	I. aquifolium	1,49	2,5	20	3,184713376	6,369426752	31,8471338
N 40º 35' 55,5''	E-S	I. aquifolium	2,31	2,65	20,8	3,312101911	6,624203822	34,4458599
S 023º 05' 43,3''	S-W	C. orientalis	3,25	1,92	9/9/12,4	1,974522293	3,949044586	12,2420382
729M	W-N	C. orientalis	1,2	4,13	6/7/17/21/26	4,140127389	8,280254777	53,8216561
		8,25	2,0625					33,0318471
Random Point 4	N-E	J. oxycedrus	0,918	1,06	13,2	2,101910828	4,203821656	13,8726115
N 40º 35' 54,2''	E-S	I. aquifolium	1,668	1,74	16	2,547770701	5,095541401	20,3821656
S 023º 05' 42,1''	S-W	Q. coccifera	4,486	8,749	42,44	6,757961783	13,51592357	143,403949
736M	W-N	C. orientalis	1,564	4,46	24,6	3,917197452	7,834394904	48,1815287
		8,636	2,159					48,1815287
Random Point 5	N-E	C. orientalis	1,516	1,61	13,8	2,197452229	4,394904459	15,1624204
N 40º 35' 52,4''	E-S	J. oxycedrus	1,547	0,98	12,4	1,974522293	3,949044586	12,2420382
S 023º 05' 40,9''	S-W	I. aquifolium	1,57	2,17	14	2,229299363	4,458598726	15,6050955
730M	W-N	I. aquifolium	1,013	2,31	16,2	2,579617834	5,159235669	20,8949045
		5,646	1,4115					15,1624204
Random Point 6	N-E	C. orientalis	1,592	3,95	17,8/17,6	2,834394904	5,668789809	25,2261146
N 40º 36' 04,0''	E-S	C. orientalis	1,512	4,46	18,8	2,993630573	5,987261146	28,1401274
S 023º 05' 49,5''	S-W	C. orientalis	0,969	4,12	17,4/18,2	2,898089172	5,796178344	26,3726115
631M	W-N	C. orientalis	1,586	4,92	28,8	4,585987261	9,171974522	66,0382166
		5,659	1,41475					36,4442675
Random Point 7	N-E	C. orientalis	1,115	4,28	21	3,343949045	6,687898089	35,111465
N 40º 36' 04,1''	E-S	C. orientalis	0,678	3,82	16,6	2,643312102	5,286624204	21,9394904
S 023º 05' 49,6''	S-W	C. orientalis	1,863	3,66	16,4	2,611464968	5,222929936	21,4140127
705M	W-N	Q. coccifera	1,048	6,1	26,2	4,171974522	8,343949045	54,6528662
		4,704	1,176					26,1549894
Random Point 8	N-E	I. aquifolium	2,027	1,62	14,4	2,292993631	4,585987261	16,5095541
N 40º 36' 03,5''	E-S	C. orientalis	1,526	4,64	26,4/19,8/18	4,203821656	8,407643312	55,4904459
S 023º 05' 48,9''	S-W	C. orientalis	1,297	5,08	25,6/16,8	4,076433121	8,152866242	52,1783439
702M	W-N	C. orientalis	1,176	4,96	28	4,458598726	8,917197452	62,4203822
		6,026	1,5065					56,6963907
Random Point 9	N-E	C. orientalis	1,343	4,68	21,8	3,47133758	6,942675159	37,8375796
N 40º 36' 02,5''	E-S	C. orientalis	1,586	6,24	32/21,2	5,095541401	10,1910828	81,5286624
S 023º 05' 47,5''	S-W	C. orientalis	0,863	1,79	13,6	2,165605096	4,331210191	14,7261146
706M	W-N	C. orientalis	1,64	4,32	20,6	3,280254777	6,560509554	33,7866242
		5,432	1,358					41,9697452
Random Point 10	N-E	C. orientalis	1,78	4,56	21,6	3,439490446	6,878980892	37,1464968
N 40º 36' 01,8''	E-S	Q. coccifera	1,56	6,8	33,8	5,382165605	10,76433121	90,9585987
S 023º 05' 47,1''	S-W	J. communis	0,97	4,53	20,8	3,312101911	6,624203822	34,4458599
705M	W-N	C. orientalis	2,06	4,21	22,4	3,566878981	7,133757962	39,9490446
		6,37	1,5925					38,5477707

Table 4. Parameters measured within *Pinus nigra* forest. The data content coordinates, orientation of each quarter, species, distance, height, perimeter, radio, diameter and area. Yellow color indicates the minimum values of distance per sampling point.

Random Point	Orientation	Species	Distance (m)	Height (m)	Perimeter (cm)	Radio (cm)	Diameter (cm)	Area
Random Point 1	N-E	P. nigra	0,91	10,21	47,2	7,515923567	15,03184713	177,375796
N 40º 35' 04,6"	E-S	P. nigra	2,61	19,38	117	18,63057325	37,2611465	1089,88854
S 023º 06' 23,7"	S-W	P. nigra	4,19	18,86	107,8	17,1656051	34,33121019	925,226115
912M	W-N	F. sylvatica	3,52	4,96	41,2	6,560509554	13,12101911	135,146497
		11,23	2,8075					730,830149
Random Point 2	N-E	P. nigra	2,82	10,08	46,2	7,356687898	14,7133758	169,93949
N 40º 35' 04,4"	E-S	P. nigra	3,17	15,1	73,4	11,68789809	23,37579618	428,94586
S 023º 06' 22,0"	S-W	P. nigra	2,99	17,92	100,2	15,95541401	31,91082803	799,366242
918M	W-N	P. nigra	1,97	17,35	96	15,2866242	30,57324841	733,757962
		10,95	2,7375					533,002389
Random Point 3	N-E	P. nigra	3,07	17,45	109,6	17,4522293	34,9044586	956,382166
N 40º 35' 03,2"	E-S	P. nigra	2,41	18,89	101,6	16,17834395	32,3566879	821,859873
S 023º 06' 20,8"	S-W	P. nigra	2,33	17,28	91,2	14,52229299	29,04458599	662,216561
901M	W-N	P. nigra	4,8	15,64	78	12,42038217	24,84076433	484,394904
		12,61	3,1525					731,213376
Random Point 4	N-E	P. nigra	1,6	19,08	119	18,94904459	37,89808917	1127,46815
N 40º 35' 01,2"	E-S	P. nigra	2,63	18,1	103,6	16,49681529	32,99363057	854,535032
S 023º 06' 21,0"	S-W	P. nigra	1,51	17,75	86,2	13,72611465	27,4522293	591,595541
909M	W-N	P. nigra	3,42	17,66	82	13,05732484	26,11464968	535,350318
		9,16	2,29					777,237261
Random Point 5	N-E	P. nigra	1,77	14,92	72,2	11,49681529	22,99363057	415,035032
N 40º 35' 00,9"	E-S	P. nigra	2,86	17,36	82,4	13,12101911	26,24203822	540,585987
S 023º 06' 19,6"	S-W	P. nigra	4,85	18,13	98	15,60509554	31,21019108	764,649682
916M	W-N	P. nigra	4,39	17,86	82,6	13,15286624	26,30573248	543,213376
		13,87	3,4675					565,871019
Random Point 6	N-E	P. nigra	2,89	13,48	65,6	10,44585987	20,89171975	342,624204
N 40º 34' 59,3"	E-S	P. nigra	3,42	17,27	86,8	13,82165605	27,6433121	599,859873
S 023º 06' 19,1"	S-W	P. nigra	2,87	18,24	102,6	16,33757962	32,67515924	838,117834
921M	W-N	P. nigra	4,12	16,89	80,2	12,77070064	25,54140127	512,105096
		13,3	3,325					573,176752
Random Point 7	N-E	P. nigra	2,23	18,14	96,8	15,41401274	30,82802548	746,038217
N 40º 34' 57,8"	E-S	P. nigra	2,58	20,78	119,8	19,07643312	38,15286624	1142,67834
S 023º 06' 18,6"	S-W	P. nigra	3,12	18,38	102,8	16,36942675	32,7388535	841,388535
923M	W-N	P. nigra	1,98	18,3	103,2	16,43312102	32,86624204	847,949045
		9,91	2,4775					894,513535
Random Point 8	N-E	P. nigra	1,92	9,78	42,8	6,815286624	13,63057325	145,847134
N 40º 34' 57,3"	E-S	P. nigra	3,46	13,24	68,2	10,85987261	21,71974522	370,321656
S 023º 06' 19,1"	S-W	P. nigra	3,88	15,92	77,6	12,3566879	24,7133758	479,43949
919M	W-N	P. nigra	1,78	15,48	75,1	11,95859873	23,91719745	449,045382
		11,04	2,76					361,163416
Random Point 9	N-E	P. nigra	2,28	15,86	78,2	12,4522293	24,9044586	486,882166
N 40º 34' 56,5"	E-S	P. nigra	3,43	17,33	91,8	14,61783439	29,23566879	670,958599
S 023º 06' 18,4"	S-W	P. nigra	1,25	17,48	89,2	14,20382166	28,40764331	633,490446
920M	W-N	P. nigra	4,15	16,91	82,2	13,08917197	26,17834395	537,964968
		11,11	2,7775					582,324045
Random Point 10	N-E	P. nigra	3,42	10,82	48,4	7,707006369	15,41401274	186,509554
N 40º 34' 54,9"	E-S	P. nigra	2,36	17,37	90	14,33121019	28,66242038	644,904459
S 023º 06' 17,8"	S-W	P. nigra	2,05	18,43	103,2	16,43312102	32,86624204	847,949045
925M	W-N	P. nigra	3,45	17,88	93,6	14,9044586	29,8089172	697,528662
		11,28	2,82					594,22293

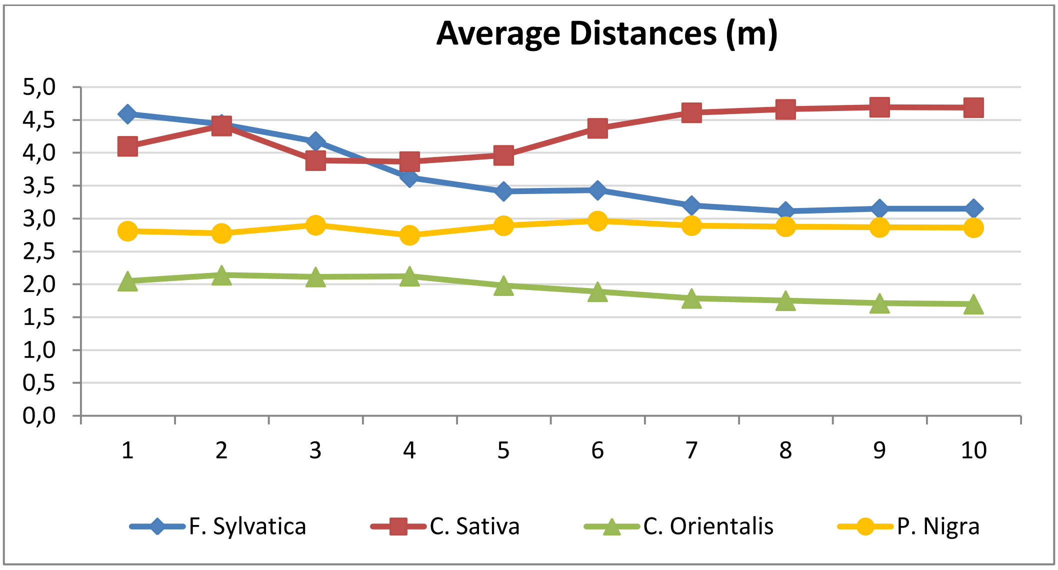

Figure 7. The average distance for the four species.

In the **Figure 7** it is shown the average of the distances within each sampling point for the four species. *Castanea sativa* has the highest average of distance. The next higher average is *Fagus sylvatica*, followed from very close by *Pinus nigra*. Finally, *Carpinus orientalis* has the lowest average, less than the half of *Castanea sativa*.

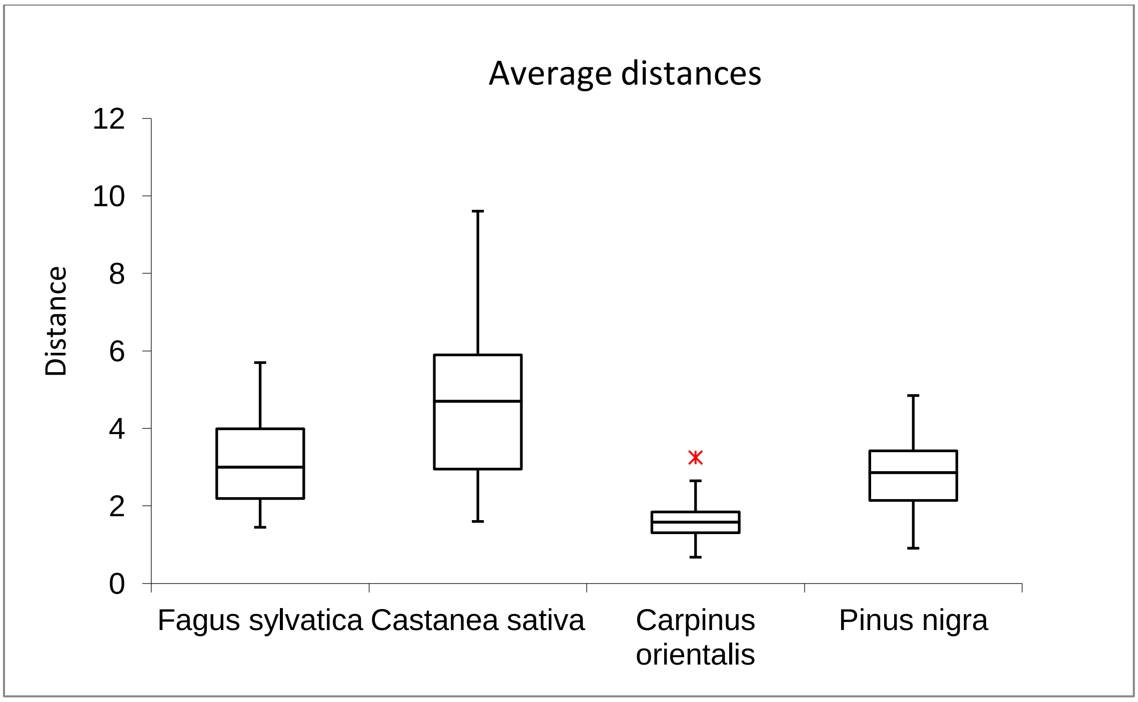

Figure 8. A box and whisker figure with the average distances of each species.

Table 5. The minimum, first and third quartiles, maximum and median values of distances (cm^2) for the four studied species.

	Fagus sylvatica	Castanea sativa	Carpinus orientalis	Pinus nigra
Min	1,45	1,6	0,678	0,91
Q_1	2,1925	2,955	1,3085	2,14
Median	3	4,7	1,586	2,86
Q_3	3,99	5,9	1,84475	3,425
Max	5,7	9,608	3,25	4,85

Castanea sativa has the highest average distance with a maximum of 9,608 m and a median of 4,7 m. The Q_1 is almost as big as the maximum of *Carpinus orientalis* and is bigger than the median of *Pinus nigra*. *Castanea sativa* has also the highest Q_3, 5,9 m. It is also the one with bigger dispersal, being 8 m of difference between the maximum and minimum. The next with highest distances is *Fagus sylvatica*. However, the maximum of *Fagus sylvatica* (5,7 m) is smaller than the Q_3 of *Castanea sativa*. The median is twice the *Carpinus orientalis* median. The most remarkable thing about the *Pinus nigra* is that there is a small difference between the median and the both Q_1 and Q_3 (**Table 5**).

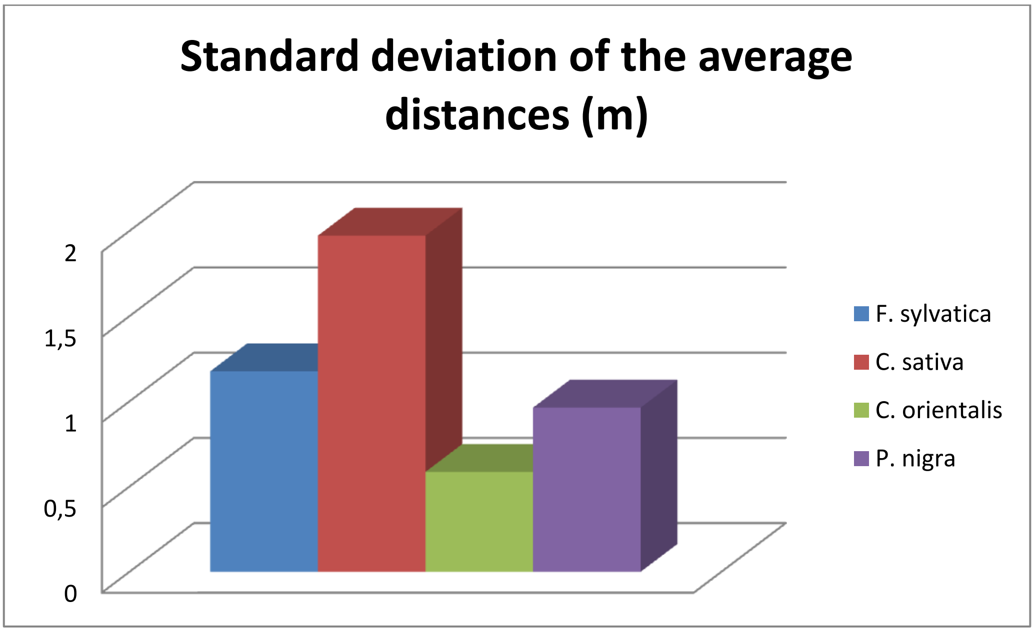

Figure 9. The standard deviation of the average distances (m) of the four species.

The highest standard deviation is the one of *C. sativa*. Then, with a bit more than the half goes the *F. silvatica*. The next standard deviation is the *P. nigra* with the half of *C. sativa* and the lowest is the *C. orientalis* with a little bit more than a quarter of *C. sativa* (**Table 6**).

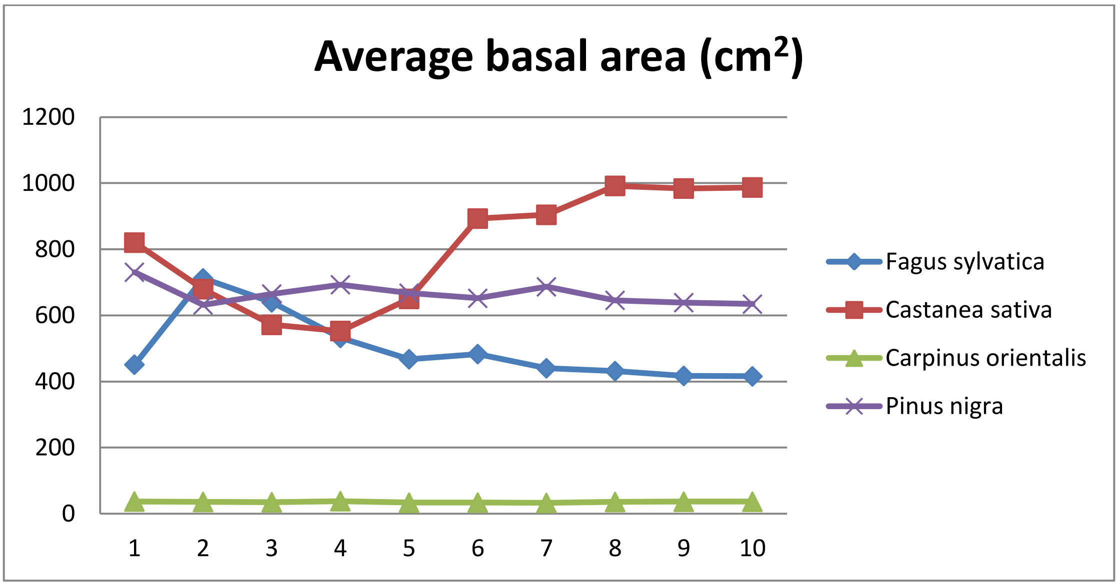

Figure 10. Average basal area (cm^2) for each species.

In **Figure 10** there is a comparison between the average basal areas of the four species. *Castanea sativa* has the highest average basal area, 1000 cm^2 aproximately. *Pinus nigra* has the second higher basal area, a little bit more than 600 cm^2 followed by the *Fagus sylvatica* with a little bit more than 400 cm^2. The smallest average basal area is for *Carpinus orientalis*, which never goes higher than 60 cm^2.

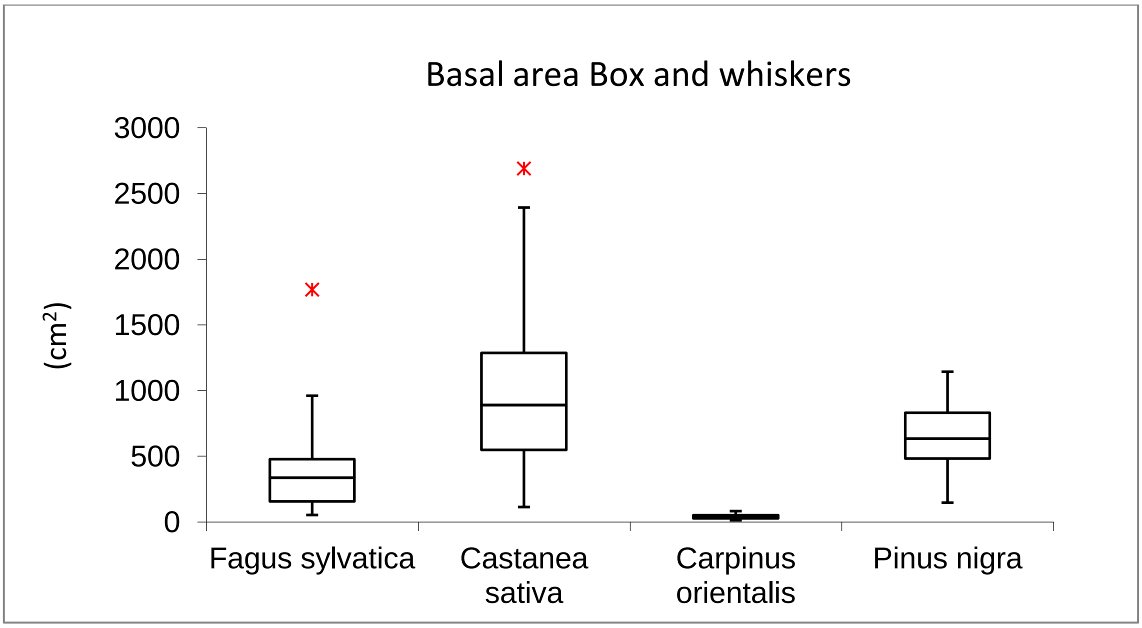

Figure 11. A box and whisker figure with the basal areas of each species.

Table 6. The minimum, first and third quartiles, maximum and median values of distances (cm^2) for the four studied species.

	Fagus sylvatica	Castanea sativa	Carpinus orientalis	Pinus nigra
Min	51,77	112,56	12,24	145,84
Q_1	155,91	548,635	25,5075	481,91
Median	336,235	887,84	36,8	633,49
Q_3	477,455	1286,215	49,365	829,9805
Max	1767,54	2689,68	81,52	1142,67

Is it very clear that the *Carpinus orientalis* has the lowest basal area. The highest basal area is lower than the minimum basal area of the *Castanea sativa* and *Pinus nigra*. The median is more or less ten times smaller than the median of Fagus sylvatica, which is the next smaller average. *Carpinus orientalis* has also the smallest dispersal. *Castanea sativa* has by far the highest results in everything, followed in almost all the cases by *Pinus nigra* and *Fagus sylvatica* respectively. *Pinus nigra* has a small difference between Q1 and Q3, which indicates a low dispersal. On the other hand *Fagus sylvatica* has a big difference between his results. For example the maximum distance is three times bigger than the Q_3, which implies a high dispersal.(**Table 6**).

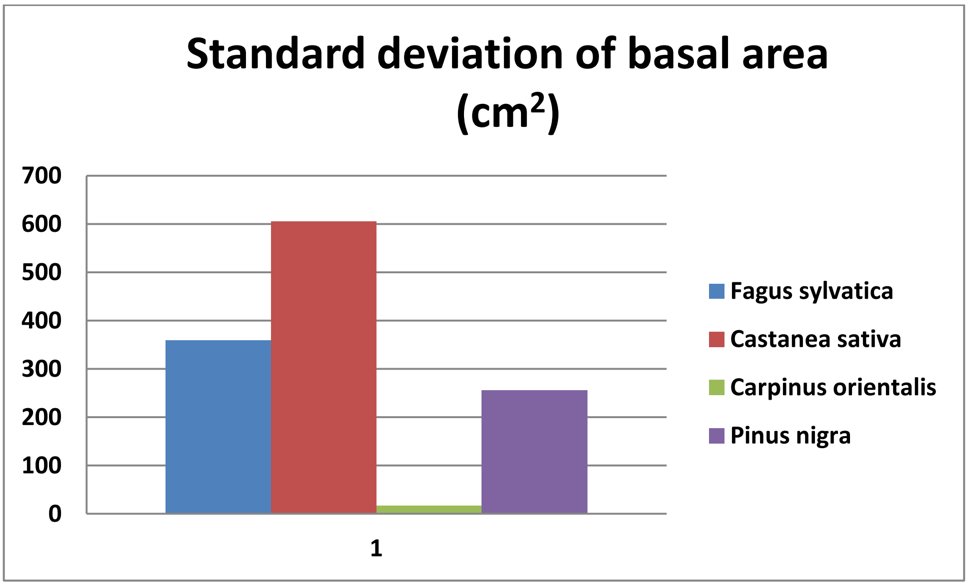

Figure 12. The standard deviation for the basal area.

Castanea sativa has the highest standard deviation for the basal area, around six hundreds (**Figure 12**). The second is *Fagus sylvatica* followed by *Pinus nigra*. The smallest, less than 20 cm^2 is *Carpinus orientalis*.

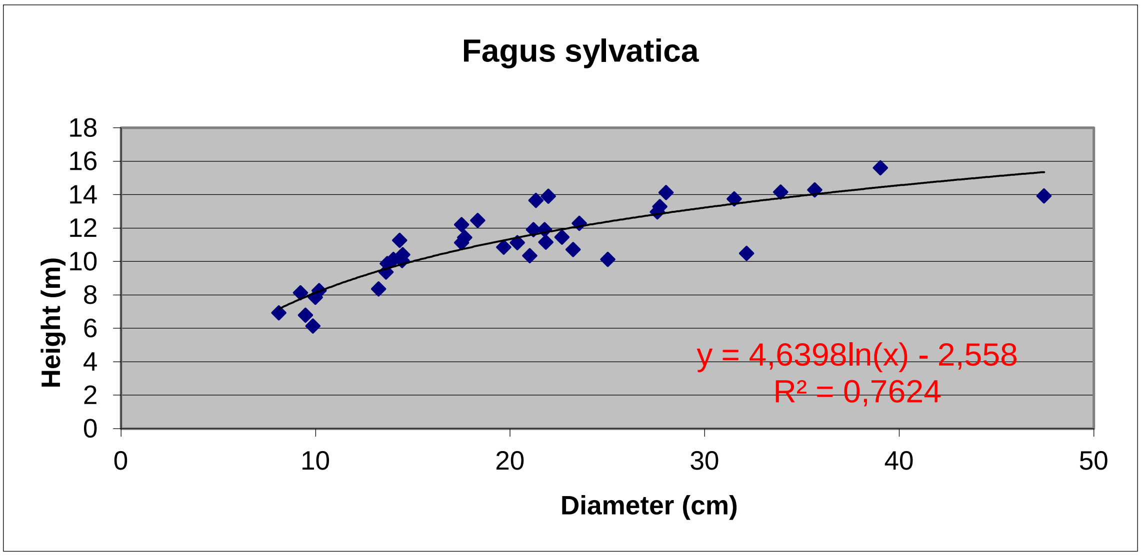

Figure 13. The relation between the diameter and height in *Fagus sylvatica*.

In **Figure 13** it is showed the relation between the diameter and the height of *Fagus sylvatica*. When the diameter is higher, the height also is higher in almost all the cases. Looking at the tendency line, the highest R^2 has been resulted using the logarithmic model.

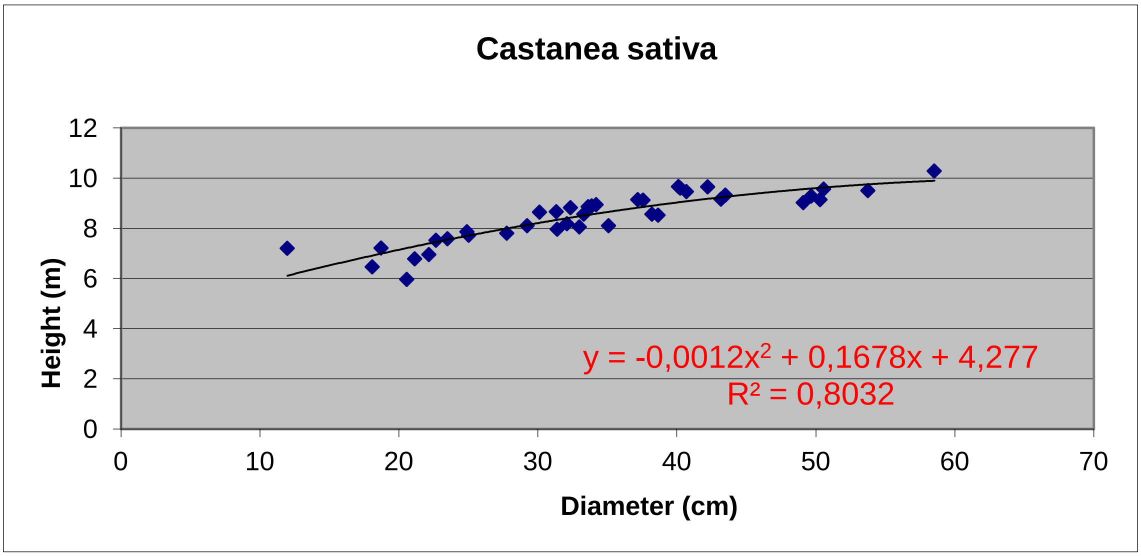

Figure 14. The relation between the diameter and height in *Castanea sativa*.

In **Figure 14** it is showed the relation between the diameter and the height of *Castanea sativa*. When the diameter is higher, the height also is higher in almost all the cases. Looking at the tendency line the highest R^2 has been taken using the polynomial model.

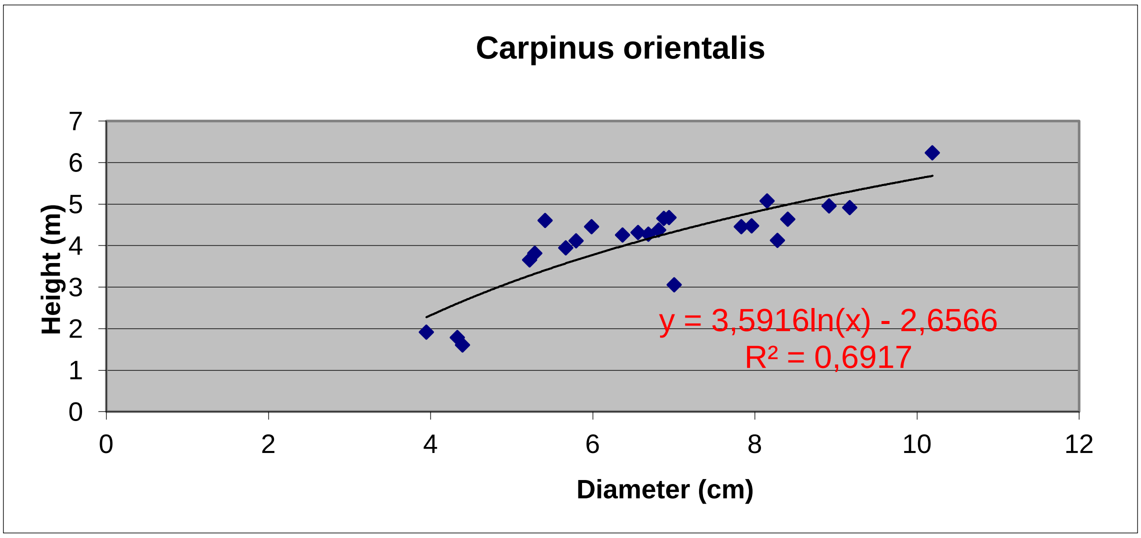

Figure 15. The relation between the diameter and height in *Carpinus orientalis*.

In **Figure 15** it is showed the relation between the diameter and the height of *Carpinus orientalis*. When the diameter is higher, the height also is higher in almost all the cases. Looking at the tendency line the highest R^2 has been taken using the logarithmic model. *Carpinus orientalis* has the lowest R^2 of all species.

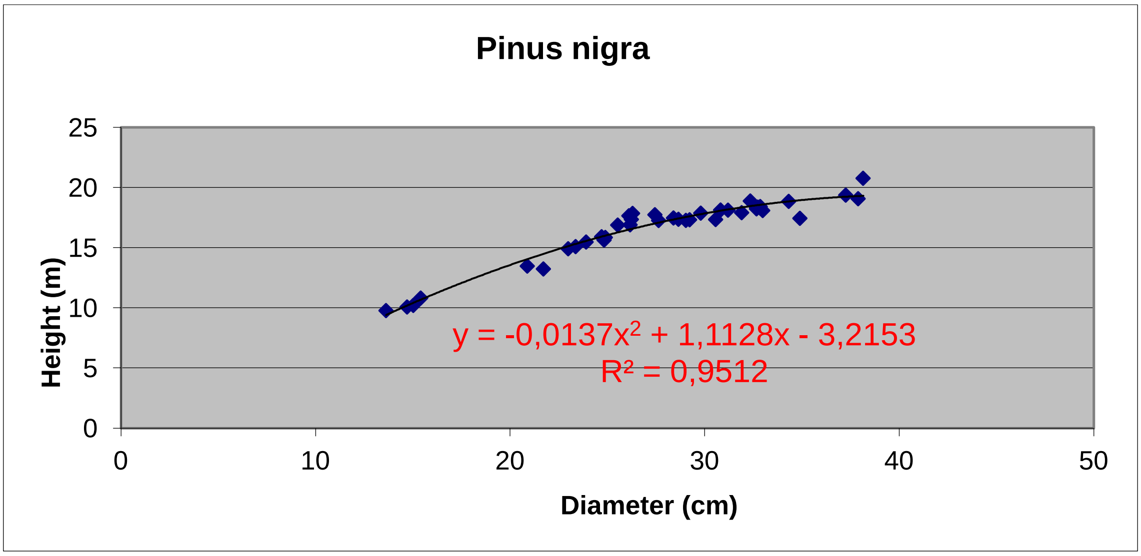

Figure 16. The relation between the diameter and height in *Pinus nigra*.

In **Figure 16** it is showed the relation between the diameter and the height of Pinus *nigra*. When the diameter is higher, the height also is higher in almost all the cases. Looking at the tendency line the highest R^2 has been taken using the polynomial model. *Pinus nigra* has the highest R^2 of all species.

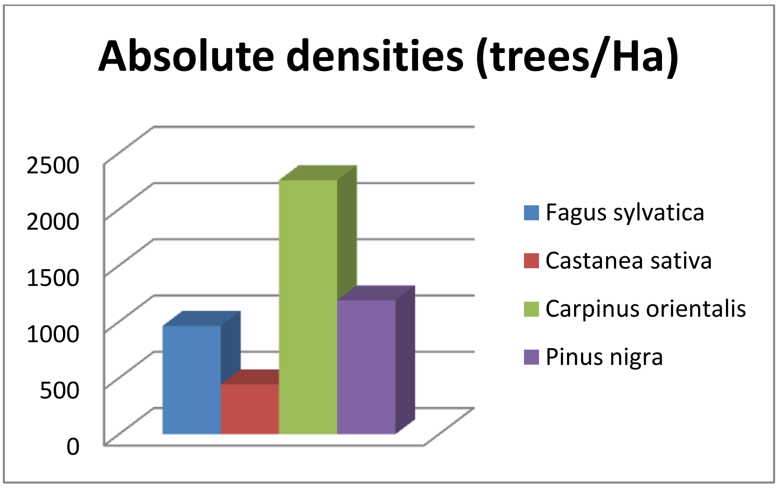

Figure 17. The absolute densities (trees/Ha) of the four species.

Carpinus orientalis has the highest absolute density (2258,89 tree/Ha). Then, with just the half goes the *Pinus nigra*. Just with a little bit less *Fagus sylvatica* and finally *Castanea sativa* with the lowest density, only 443,8659 tree/Ha (**Table 8**).

Table 7. Relative densities (in percentages) of the four species.

Species	Relative density (%)
F. sylvatica	95
C. sativa	97,5
C. orientalis	65
P. nigra	97,5

The relative density of 3 species (*Fagus sylvatica, Castanea sativa* and *Pinus nigra*) is more than 94%. The relative density of *Carpinus orientalis* is much lower, with just a 65% (**Table 7**).

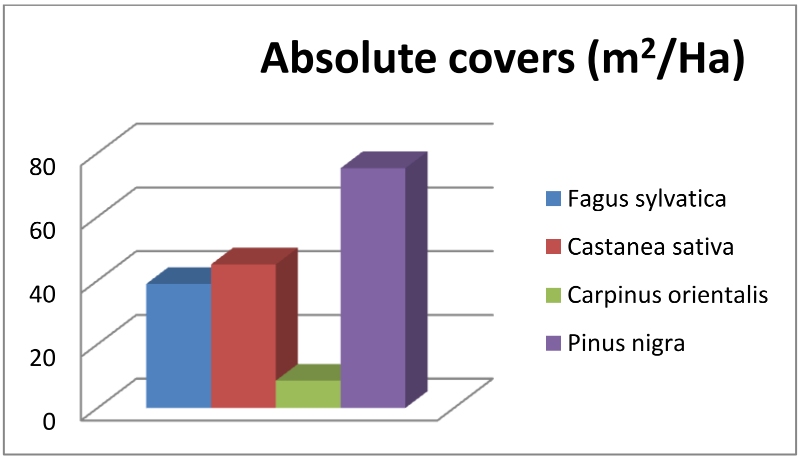

Figure 18. The absolute covers (m^2/Ha) of the four species.

The species with more absolute cover by far is the *Pinus nigra* with 75,241 m^2/Ha. The next one is the *Castanea sativa*, followed by *Fagus sylvatica* (which has more or less half the absolute cover of the *Pinus nigra*), and the one with less absolute cover is the *Carpinus orientalis* with just 8,672 m^2/Ha (**Table 10**).

Table 8. Relative covers (in percentages) of the four species.

Species	Relative cover (%)
F. sylvatica	96,353
C. sativa	99,605
C. orientalis	60,191
P. nigra	99,456

If we look at the relative covers, we see that in 3 cases (*Fagus sylvatica, Castanea sativa* and *Pinus nigra*) the relative cover is more than 95%, and in the case of the *Carpinus orientalis* is far below, with just a 60% (**Table 8**).

Discussion

The absolute density for *Castanea sativa* in the Hortiatis Mountain is 443,86 trees/Ha. Comparing to other works the result is remarkable lower. For example Colin-Belgrand et al. (1996), obtained an absolute density of 4707,33 trees/Ha. This study was made in Melle (Deux-Se'vres, France), in a forest planted by humans, as the forest of Mt. Chortiatis. The difference of the density occurs because of the difference of objectives at planting. In the *Castanea sativa* forest of Mt. Chortiatis the objective was to recollect the fruits of the tree. For this purpose they wanted to have trees with the maximum cover it was possible, so they planted leaving big spaces between each tree, and therefore the density is very low. They also cut any small tree that try to appear between the planted ones. On the other hand, in the forest of France, the objective was to take as much wood as possible, so they planted all the trees living the less space possible, which has resulted in a really high density.

In a similar study, Regina et al. (2001), got four absolute densities; 1895 trees/Ha, 5668 trees/Ha, 3970 trees/Ha and 2706 trees/Ha. All the densities are much higher than the one taken in Mt. Chortiatis (443,86 trees/Ha). In the same work they also study the basal area and cover. The cover for the *Castanea sativa* in Mt. Chortiatis is 45,04 m^2/Ha. In their study the results are 26 m^2/Ha, 28,1 m^2/Ha, 26 m^2/Ha, and 33,5 m^2/Ha. In all the cases their result has been lower than ours. Both comparisons support our theory, that the forest of *Castanea sativa* in Mt. Chortiatis was planted by humans to get the chestnut.

The absolute density for the *Pinus nigra* in the Mt. Chortiatis is 1190,74 trees/Ha. This result is remarkable higher than others. Del Cerro Barja et al. (2009), got the absolute density of *Pinus nigra* in six localities. The smallest result was 265 trees/Ha and the highest 555 trees/Ha, with an average of 394,33 trees/Ha. This study was made in Spain, in a Mediterranean climate similar to the one in the Mt. Chortiatis. We assume that this difference occur because the forest was abandon just after being planted for economical reasons, and was never pruned. As a planted forest, it is supposed that they planted the trees regularly, taking approach of all the space they could, so later they can cut the weakest trees (or the ill ones).

The absolute density for *Fagus sylvatica* in the Hortiatis Mountain is 963,37 trees/Ha. Similar density numbers have been found also in F. sylvatica forest in Italy, in a Mediterranean climate, very similar to the climate in Chortiatis. Specifically, Choa et al. (2009), have measured density of 1208 trees/Ha, which matches with our results. With the *Carpinus orientalis* our results were also similar compared to other works.

Castanea sativa has the highest average basal area (887,84 cm^2), followed by the *Pinus nigra* (633,49 cm^2). However, *Pinus nigra* has the highest absolute cover (75,241 m^2/Ha). The *Castanea sativa* absolute cover is only 45,046 m^2/Ha. It is expected that with bigger basal area, higher absolute cover will be found. In this case, the explanation is that the *Pinus nigra* forest has an extremely high density. Being the density so high, it overcomes the basal area. The high density of the *Pinus nigra* forest is explainable because of being a human planted forest. The results of the R^2 conducted to the same assumption. All were planted with the same bases, so all the trees have more chances of having similar height/diameter correlations.

It is remarkable that although the *Pinus nigra* has a bigger average of basal area than the *Fagus sylvatica*, the last one has a bigger standard deviation. The reason is that the *Fagus sylvatica* basal areas were much more dispersed than the *Pinus nigra* basal areas (they were very similar, in a more close range). We assume that this occurs because the *Pinus nigra* forest is not a natural forest, unlike the *Fagus sylvatica* forest. This means that most of the trees of the *Pinus nigra* forest were planted at the same time, so most of them will have the same age, and therefore, a more or less similar basal area too.

Looking at the relatives densities, it may look weird to see three results that are 95% or higher (*Pinus nigra*, *Castanea sativa* and *Fagus sylvatica*). In the case of the

Pinus nigra the answer to the extremely high relative cover is that is a planted forest. This means that they planted only *Pinus nigra*, so it is difficult for other species to invade the ecosystem. For the *Castanea sativa* it is the same. It is also a planted forest, and it were only planted *Castanea sativa* trees. The case of *Fagus sylvatica* is different. It is an extremely shade tolerant specie, so the natural process of the *Fagus sylvatica* is to cover every empty space. Apart from that, it is a very competitive specie, which usually tries to cover all by himself. This makes the life for other species difficult or impossible, so there are just a few individuals from other species.

With the relative covers the situation is exactly the same, there are three species with results higher than the 95% (*Pinus nigra*, *Castanea sativa* and *Fagus sylvatica*). The answer to these results is practically the same as for the relative densities.

Conclusion:

Carpinus orientalis has the highest absolute density (2258,89 tree/Ha), almost the double of the second species (*Pinus nigra*, 1190,74049m^2/Ha). However, it has the biggest tree diversity too (that's the reason of having the smallest relative density). Although the highest basal are was for *Castanea sativa (1014,85 cm^2)*, *Pinus nigra* has the highest absolute cover (75,241 m^2/Ha) due to his high density. On the other hand *Carpinus orientalis* get the lowest average basal area and absolute cover (with a significant difference, just 8,672 m^2/Ha). It has to be mentioned that the *Pinus nigra* forest and *Castanea sativa* forest where planted by humans and both have a different structure from what it is expected to find. The density of the *Castanea sativa* is lower (443,8659 m^2/Ha) than the one that was expected to be found. On the other hand *Pinus nigra* has a higher density (1190,74049 m^2/Ha) than the one that was expected to be found.

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