Fraxinus excelsior L. – Ash

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Present distribution in the Western Carpathians

Ash (*Fraxinus excelsior*) is a deciduous tree attaining a height of 40 m and being the only native member of the genus *Fraxinus* in the Polish part of the Western Carpathians. The taxon is found in nearly the entire area of this region (Zając & Zając 2001). Following Matuszkiewicz W. (2005), it is a characteristic species of the *Querco-Fagetea* Br.-Bl. et Vlieg. 1937 class. 1937. As a tree known to prefer humid areas with deeply developed soils, it occupies river valleys and generally lower locations in the Western Carpathians, particularly in communities of the *Alno-Ulmion* Br.-Bl. et R.Tx. 1943 alliance. However, it is also likely to occur in the mountains, both in the lower montane belt and in the dwarf pine belt, in hollows and channels with large amounts of accumulated detritus. At such sites, ash is found up to an altitude of 1600 m a.s.l., where it is recorded particularly in Central and Southern Europe (Dobrowolska et al. 2008). In Poland, the highest altitude at which *Fraxinus* was observed was 1000 m a.s.l. in Kuźnice, within the Tatra Mountains (Boratyńska 1995).

Ecology

The minimum annual amount of rainfall required by the tree is 600 mm (Orwa et al. 2009). Ash tolerates periodic flooding. However the presence of stagnant water, resulting in lack of soil oxygenation, is disadvantageous to the species. Additionally, it is sensitive to drought and a fall in the groundwater level is likely to be lethal for individual ash trees (Dobrowolska et al. 2008). The species is highly capable of colonizing new areas; however full-grown trees are usually scattered and, therefore, the taxon is infrequently dominant in forests (Faliński & Pawlaczyk 1995). Ash does not show high temperature requirements and tolerates a minimum annual temperature of even 4°C in montane and submontane areas (Marigo et al. 2000). Nevertheless, it is sensitive to harsh winters and slight frosts in the late spring (Savill 1991, Dobrowolska et al. 2008). Although young seedlings tolerate shading (Gordon 1964) growing and full-grown individuals of *Fraxinus excelsior* are already heliophilous and shading rapidly arrests their growth (Jaworski 1995). In the dynamic classification of trees, ash, as well as oak, elm, lime, hornbeam, and pine, are classified as post-pioneer species (Bugała 1995).

Intensive browsing of shoots, bark, flowers and fruits by herbivores, accompanied by strong grazing pressure, directly prevents the establishment and growth of ash seedlings (Bugała 1995). However, light grazing, where heavy cattle grazing is absent, may actually stimulate growth. Additionally, ash is able to reproduce vegetatively by suckers, which may compensate for intensive grazing (Marie-Pierre et al. 2006).

Expansion in Europe during the Late Glacial

Subfossil data concerning pollen of *Fraxinus excelsior* (Huntley & Birks 1983; Gliemeroth 1997, Brewer 2002, following Heuertz et al. 2004a) indicate the Balkans, the Eastern Alps and, presumably, Italy as the glacial refugia of the species. Evidence from the Iberian Peninsula and areas to the north of the Black Sea is scanty. Studies based on molecular genetics support the postglacial expansion of the taxon to Western and Central Europe from numerous glacial refugia, located most likely in the western part of the Balkan Peninsula and in north-eastern Europe. Refugia postulated to occur in the eastern areas of the Balkan Peninsula probably contributed only slightly to this postglacial recolonization by ash (Heuertz et al. 2004a, b). Nevertheless, Lang (1994), following Tobolski and Nalepka (2004), mentioned also the Carpathians as a refugial area of ash.

History of expansion in the Western Carpathians during the Holocene (Fig. 18)

10 000–9000 BP

Occurrence of ash pollen was recorded only in a small number of sites and in minor amounts (not exceeding 0.1%) at ca 9500 BP, therefore the presence of species *in situ* cannot be definitely stated. In the Preboreal chronozone, as the development of forest communities preceded, the number of sites with a record of ash pollen was increasing. In the Eastern Tatras, the eastern part of the Orawa-Nowy

Targ Basin and the Beskid Makowski range ash pollen was observed slightly more frequently, however in values still not confirming the occurrence of *Fraxinus* in these areas. Moreover, pollen material found in the Tatra Mountains may derive from long-distance transport.

9000–8000 BP

In this period, an increase in the proportion of ash is recorded in the Eastern Tatras and in the Orawa-Nowy Targ Basin. At ca 8000 BP, the frequency of the species locally exceeded 2%. It is normally assumed in Poland, that values of at least 0.5% provide evidence for the occurrence of *Fraxinus excelsior in situ* (Tobolski & Nalepka 2004). Such values were noted in the greater part of the Western Carpathians, excluding fragments of the Beskid Wyspowy range, the Jasło-Sanok Depression and the Beskid Niski range.

8000–7000 BP

This period was marked by an expansion of ash in the western part of the Beskid Niski range, where the species attained its first Holocene maximum (10%), influenced mainly by proportions recorded from the profile of Szymbark (Gil et al. 1974). A centre of occurrence of the taxon was recognised in the belt comprising the Beskid Niski range, the Beskid Wyspowy range and the Pogórze Ciężkowickie Foothills.

7000–6000 BP

After an initial decrease in the eastern part of the Western Carpathians, the frequency of ash returned to values recorded for 8000–7000 BP.

6000–5000 BP

Initially, ash spread in a north-eastern direction, towards the Pogórze Dynowskie Foothills; however the importance of the area including the maximum extent of species, in the eastern part of the Beskid Niski range, was reduced. The proportion of ash decreased also in the Beskid Makowski, Beskid Wyspowy and Beskid Żywiecki ranges.

5000–4000 BP

At the beginning of this period ash attained its maximum percentage values in the Western Carpathians – proportion exceeding 10% in the Beskid Sądecki range. The observed pattern is very interesting as in isopollen maps for Poland the species did not demonstrate any rapid changes in its frequency at the transition between the Atlantic and Preboreal chronozones nor even showed a slight regression (Tobolski & Nalepka 2004). This conclusion was undoubtedly influenced by the exceptional pollen succession recorded in the profile from Jesionowa (site no. 261), where values for ash exceeded 30% of the total sum (Margielewski et al. 2011). The outline of isopolls in this part of the Western Carpathians results also from the fact, that Jesionowa (261) was the only site described from the Beskid Sądecki range. The small area of this peat bog suggests that it bears a record of only local changes in vegetation; therefore the apparent rapid increase in ash values may have been caused by local conditions at that site. In contrast, at the relatively nearby site of Szymbark (126), located in the Beskid Niski range, a slight decrease was observed in the abundance of this species. Nevertheless, in the profile from Puścizna Rękowiańska (111), actually a vast raised bog, the amount of this taxon showed a slight increase. From ca 4500 BP, the proportion of *Fraxinus excelsior* in the Beskid Sądecki range was decreasing while the species expanded its distribution to the east, apparently, however, omitting the Jasło-Sanok Depression.

4000–3000 BP

This period is typified by the regression of *Fraxinus excelsior* from nearly the entire area of Polish Western Carpathians. However, initially this pattern was not followed in the south-eastern part of the Beskid Niski range, from which the species only began to withdraw ca 3500 BP.

3000–2000 BP

This period was marked by a progressive decrease in the proportion of ash in forest communities. This process advanced from west to east, and consequently the Beskid Niski range and the Bieszczady Mountains became the areas of its greatest abundance within the Polish Western Carpathians.

2000–1000 BP

The distribution range of ash was still decreasing. At ca 2000 BP, the frequency of the species exceeded 0.5% only in the Bieszczady Mountains, the Beskid Niski range, the Pogórze Dynowskie Foothills and in the Jasło-Sanok Depression. For the period of ca 1500 BP, enclaves with a more abundant occurrence of ash were already perceived in the Beskid Niski range (particularly influenced by the record from the site Cergowa Góra Mt. (124), Szczepanek 2001a) and in the Bieszczady Mountains. However, these areas were also marked by a progressive decrease in the proportion of this taxon.

1000–0 BP

Ca 1000 BP, the frequency of ash exceeded 0.5%, i.e. the minimum value assumed to confirm the occurrence of this species, only in the vicinity of the site of the Cergowa Góra Mt. (124) in the Beskid Niski range. The data for ca 500 BP could not be plotted as isopollen maps because of the small number of sites bearing a record for this period. Among the sites, marked by percentage values of ash, mostly not exceeding 0.5%, Regetovká (61), with a pollen values attaining 1.9%, was an exception (Wacnik 1995). For the present (0 BP), the number of sites is still lower and in most of them the pollen values of *Fraxinus excelsior* do not exceed 0.5%; therefore its presence *in situ* cannot be stated. However, what is interesting is that

in maps of present-day ash distribution, its occurrence is recorded in nearly all 10×10 km squares covering the area of the Polish part of the Western Carpathians (Zając & Zając 2001). This indicates that even extremely low amounts of ash pollen, or even its absence in pollen spectra, do not provide evidence for the absence of the species in forest communities.

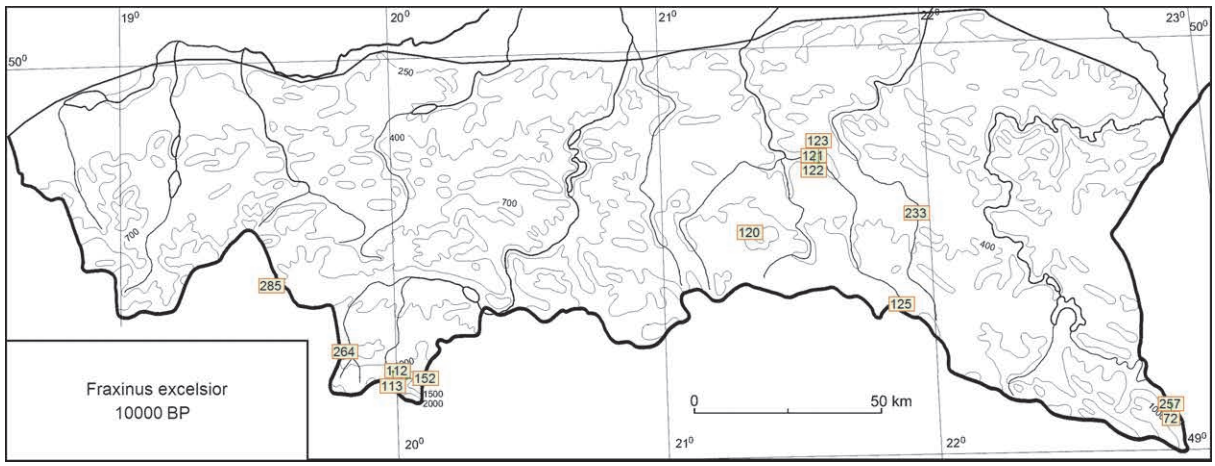
Conclusions

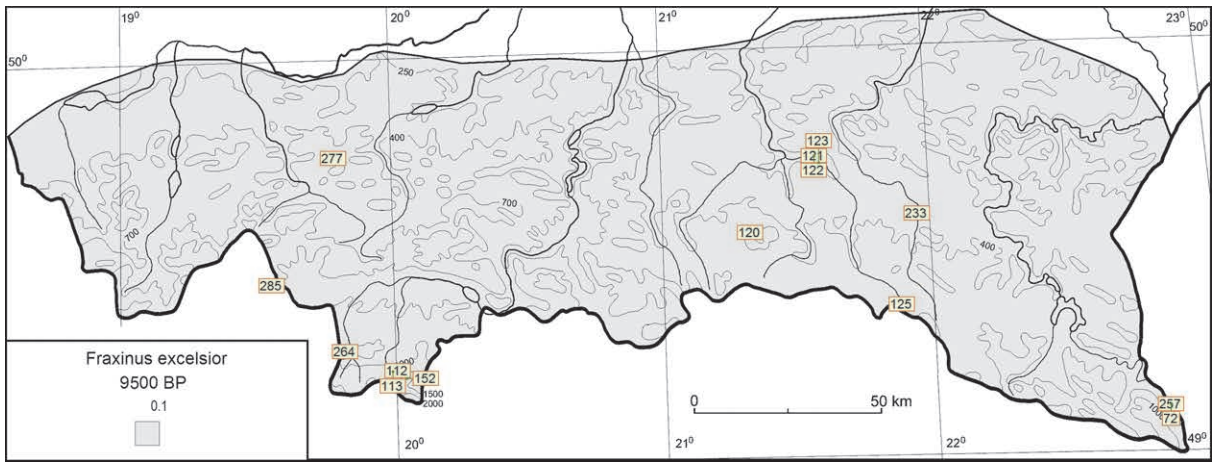
Isopollen maps plotted for *Fraxinus excelsior* in the Polish part of the Western Carpathians support the pattern previously presented in isopollen maps for Poland (Tobolski & Nalepka 2004). The taxon is typical of the mesocratic phase in the interglacial development of forest communities. However, when considering ash pollen values in the Preboreal and Boreal periods, it cannot be excluded that ash may have been a component of forest communities then.

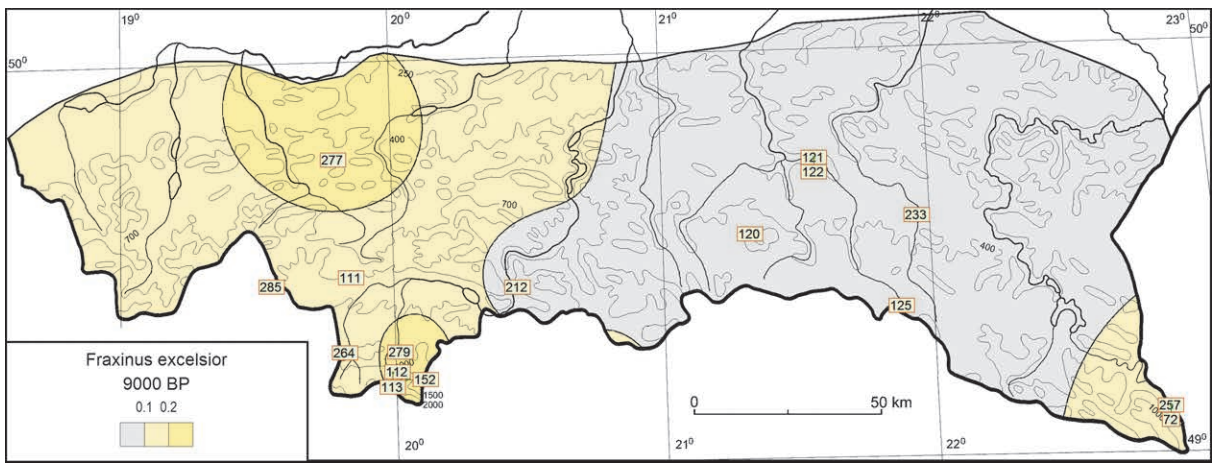
In the early Holocene the taxon gradually extended its range of occurrence from the western and south-eastern part of the area described. The second intensive migration wave of the species was likely to have occurred at the beginning of the Atlantic chronozone, when the expansion may have proceeded from the southern part of the Carpathians through the Dujawa, Beskidy Mountains and Tylicz Passes, along valleys of the Biała and Ropa rivers. The expansion of ash at the beginning of the Subboreal chronozone in the Beskid Sądecki range requires further investigation, as presently the data was collected only from one site, and the results of palynological analyses are likely to be affected by local events.

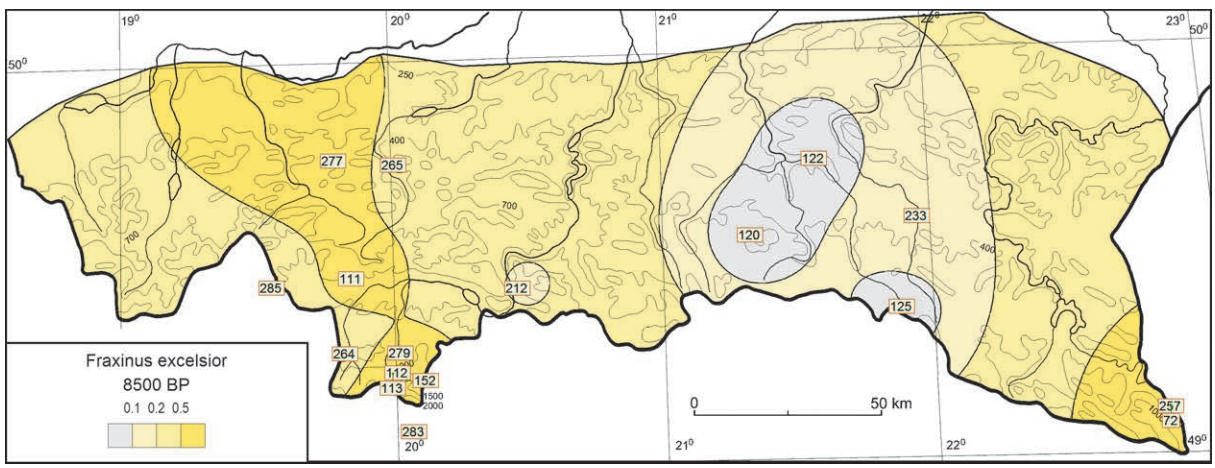
The Subboreal and Subatlantic chronozones were marked by a gradual decrease in the number of ash sites, presumably due to the expansion of spruce (*Picea abies*) and, in the later period, of fir (*Abies alba*), both of which may have prevented the regeneration of *Fraxinus* in fragments of forests extending along streams and rivers. Another, equally important reason of the disappearance of tree was most likely land management by human beings.

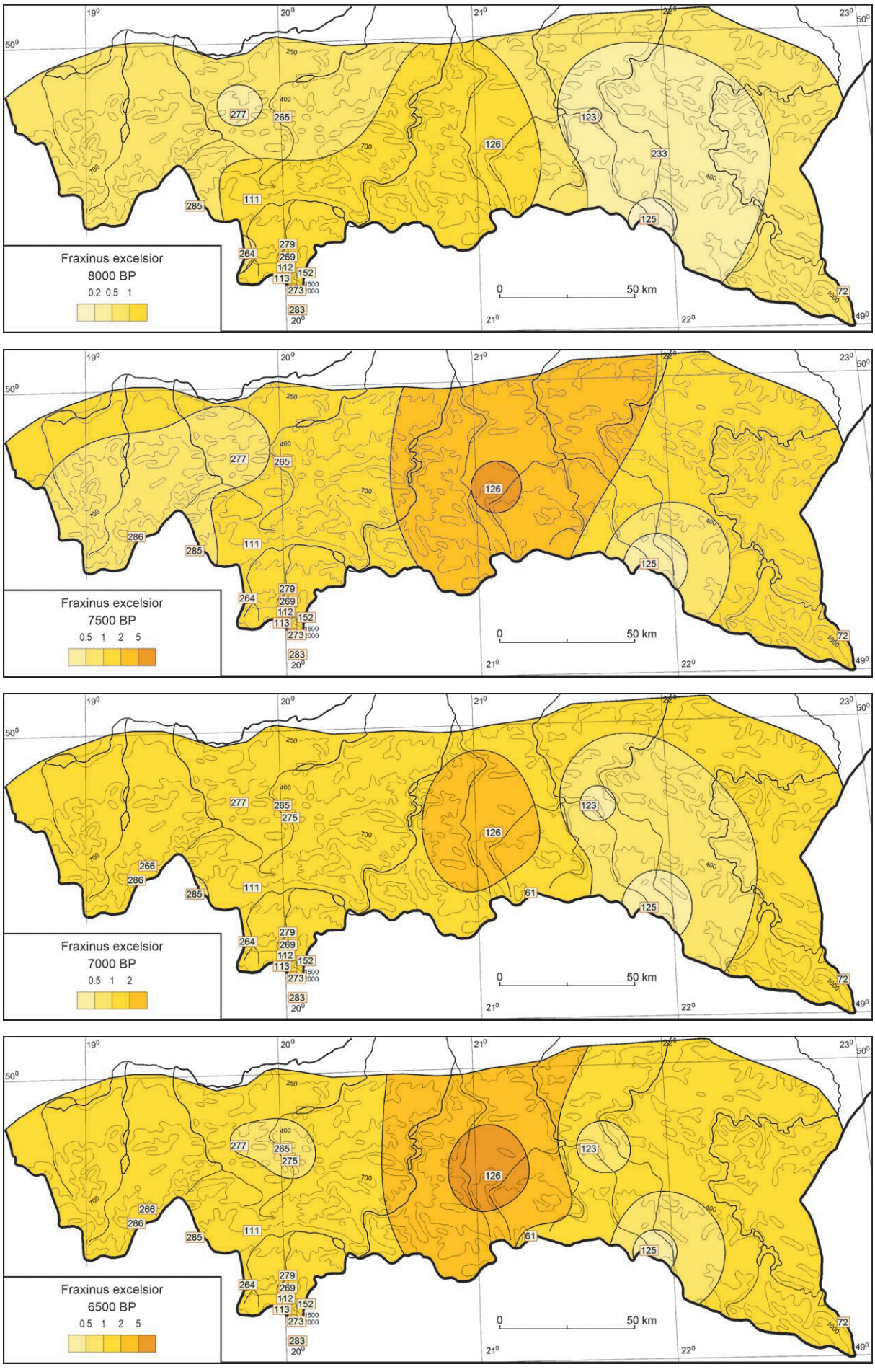
Fig. 18. *Fraxinus excelsior*: dot and isopollen maps for 10 000–0 BP

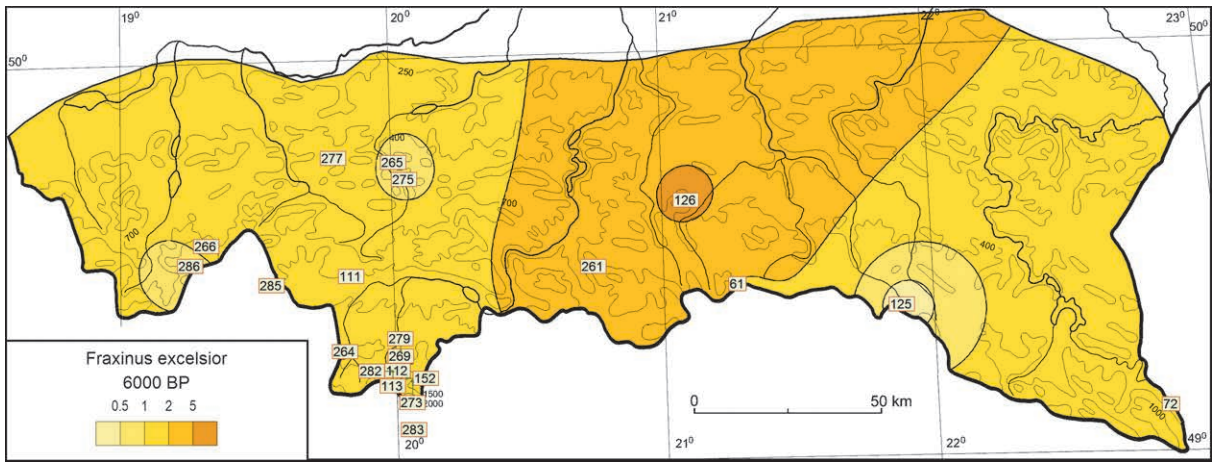

Fraxinus excelsior
10000 BP
0 50 km

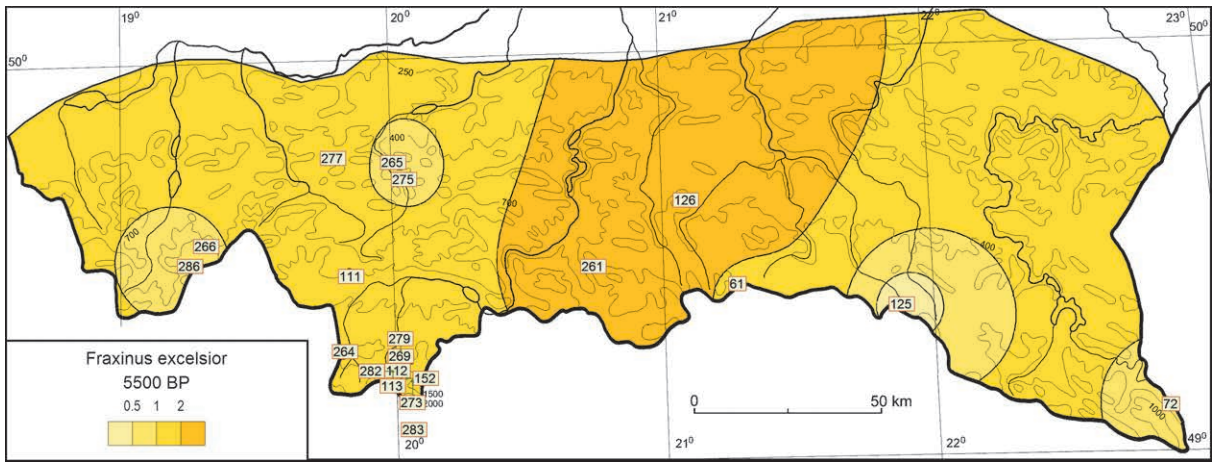

Fraxinus excelsior
9500 BP
0.1
0 50 km

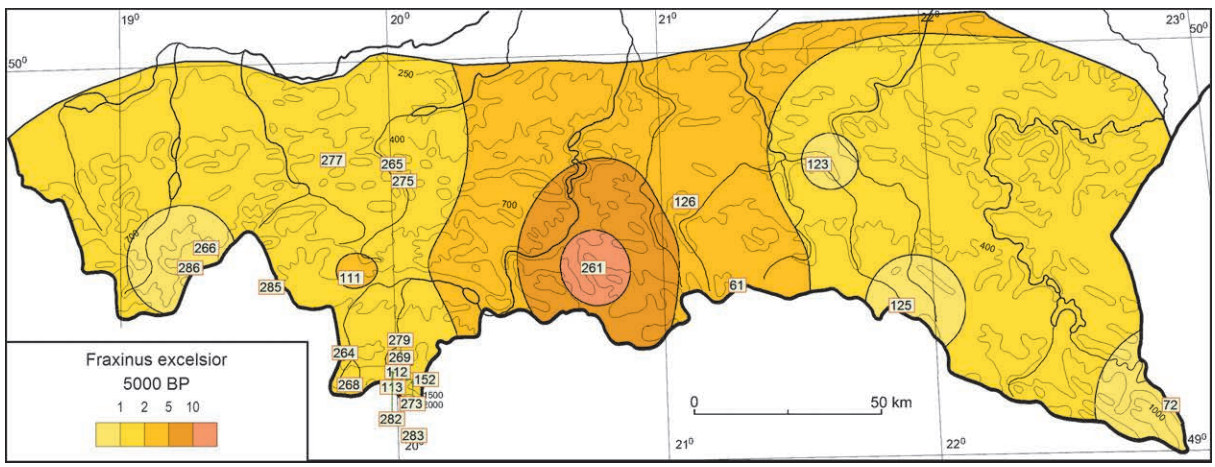

Fraxinus excelsior
9000 BP
0.1 0.2
0 50 km

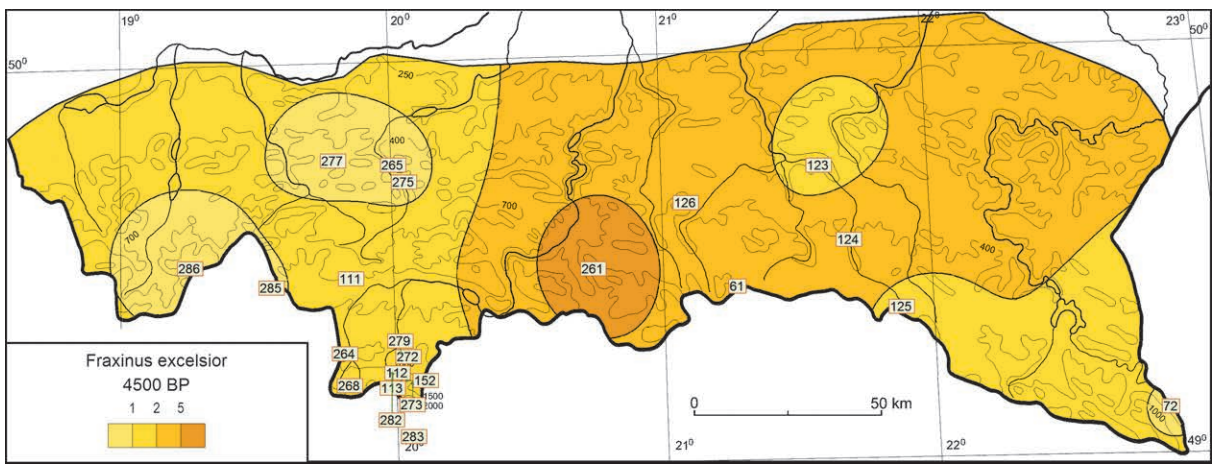

Fraxinus excelsior
8500 BP
0.1 0.2 0.5
0 50 km

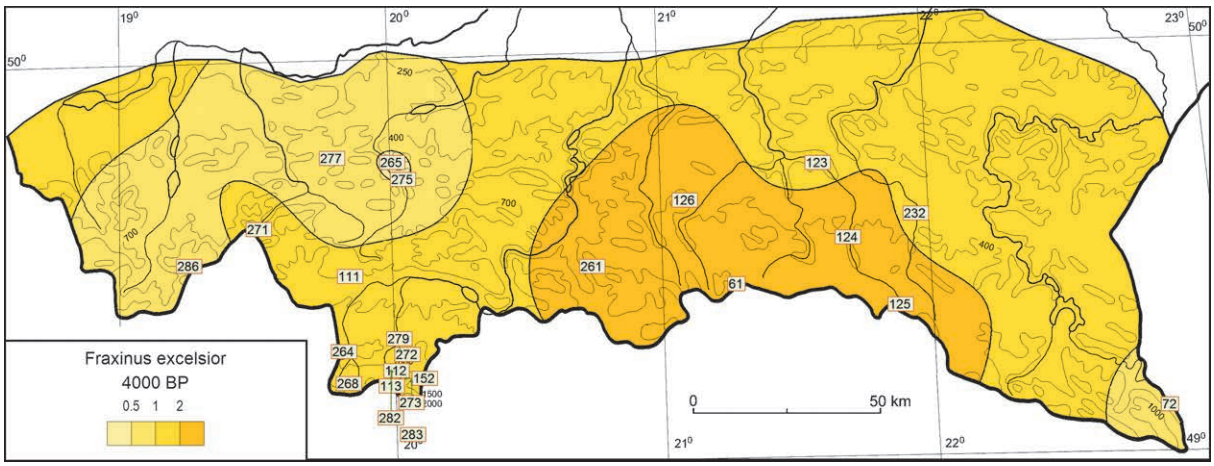

Fraxinus excelsior
8000 BP
0.2 0.5 1
Fraxinus excelsior
7500 BP
0.5 1 2 5
Fraxinus excelsior
7000 BP
0.5 1 2
Fraxinus excelsior
6500 BP
0.5 1 2 5
0 50 km
19°
20°
21°
22°
23°
50°
49°

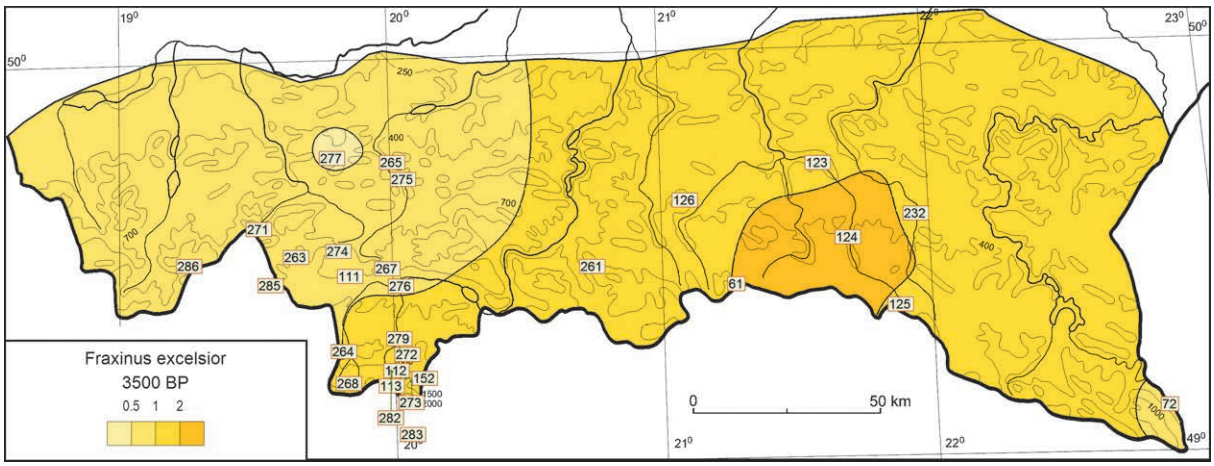

Fraxinus excelsior
6000 BP
0.5 1 2 5
0 50 km

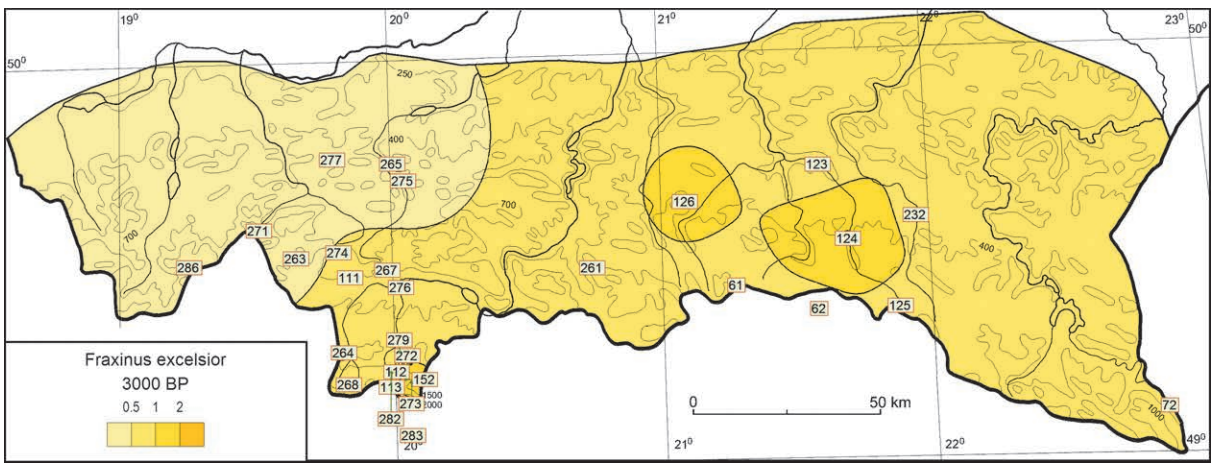

Fraxinus excelsior
5500 BP
0.5 1 2
0 50 km

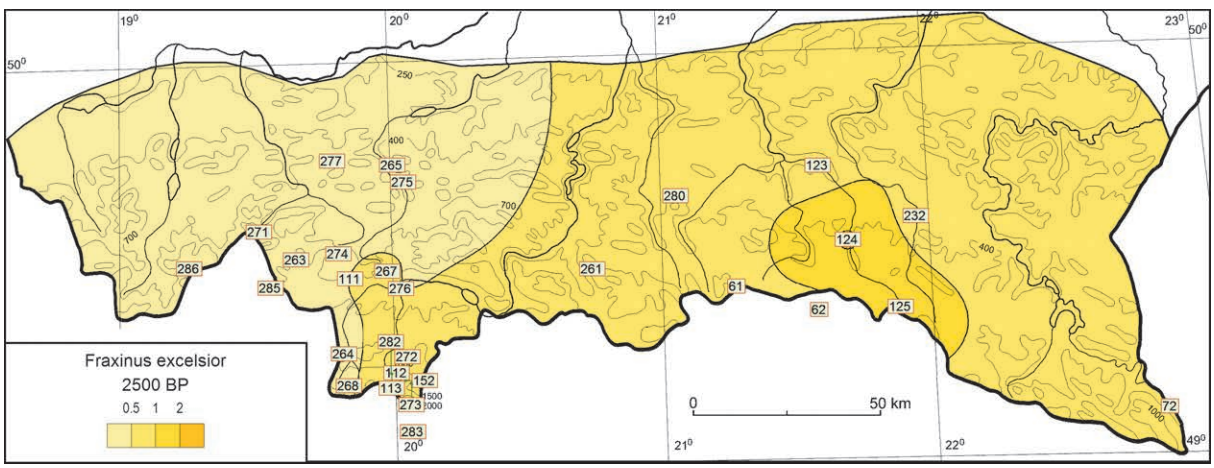

Fraxinus excelsior
5000 BP
1 2 5 10
0 50 km

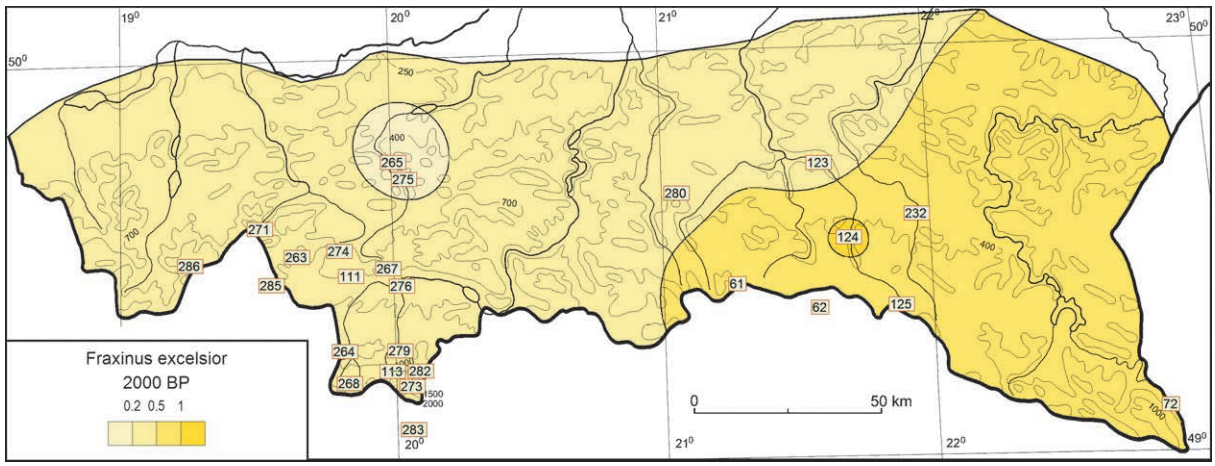

Fraxinus excelsior
4500 BP
1 2 5
0 50 km

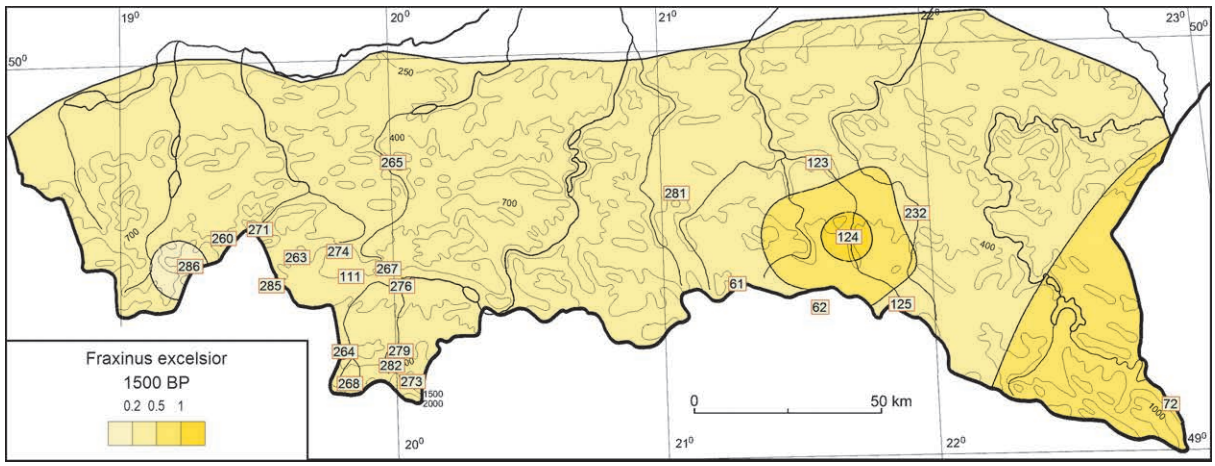

Fraxinus excelsior
4000 BP
0.5 1 2
0 50 km

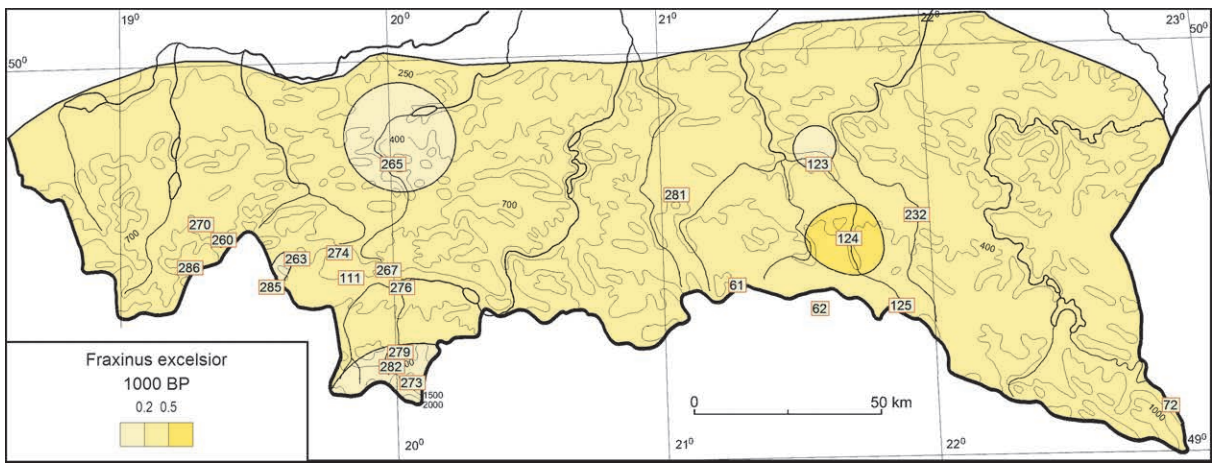

Fraxinus excelsior
3500 BP
0.5 1 2
0 50 km

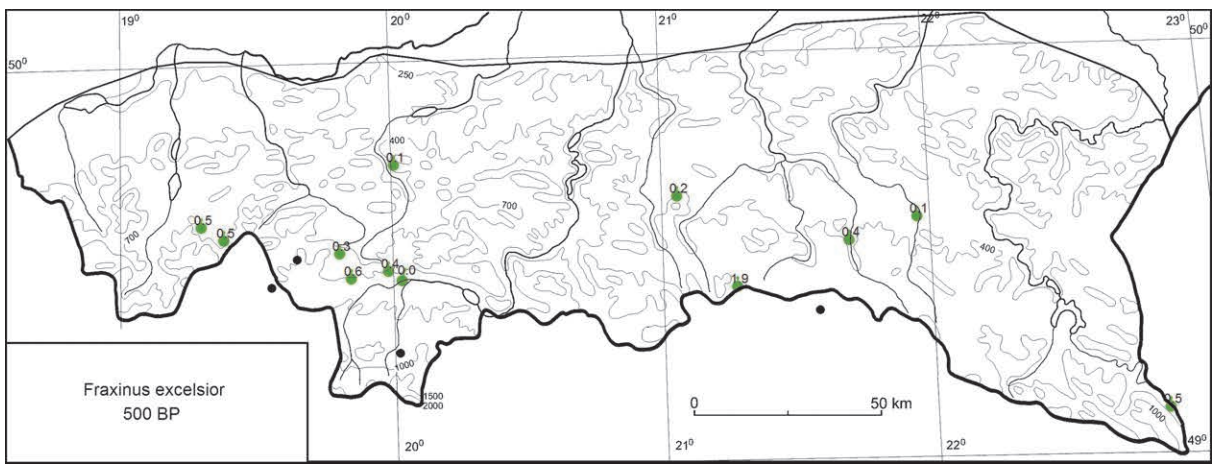

Fraxinus excelsior
3000 BP
0.5 1 2
0 50 km

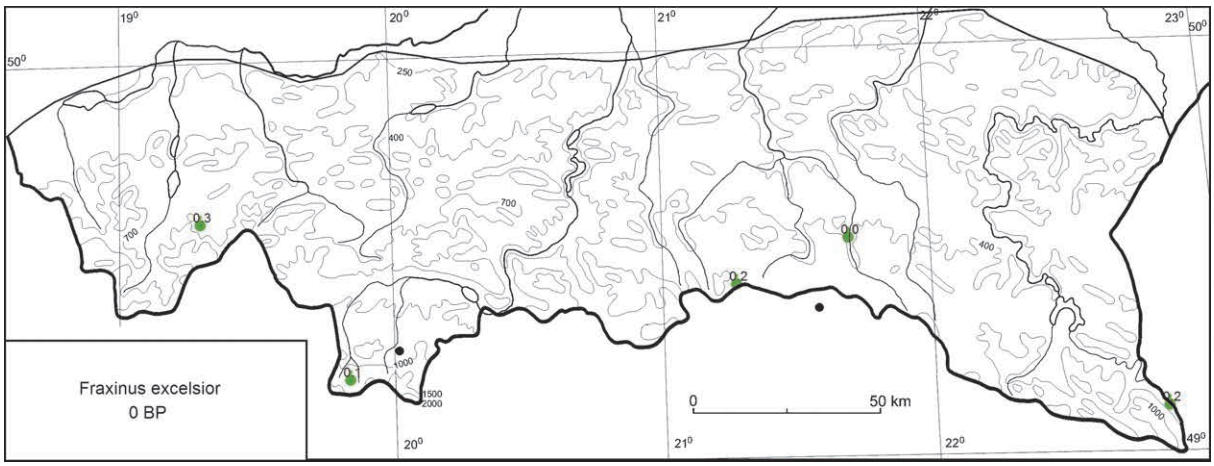

Fraxinus excelsior
2500 BP
0.5 1 2
0 50 km


Fraxinus excelsior
2000 BP
0.2 0.5 1
0 50 km


Fraxinus excelsior
1500 BP
0.2 0.5 1
0 50 km


Fraxinus excelsior
1000 BP
0.2 0.5
0 50 km


Fraxinus excelsior
500 BP
0 50 km


19°
20°
21°
22°
23°
50°
49°
250
400
700
1000
1500
2000
0.3
0.1
0.0
0.2
0.2
Fraxinus excelsior
0 BP
0
50 km