Oriental beech

Fagus orientalis

Gaye Kandemir[1] and Zeki Kaya[2]
[1] Forest Tree Seeds and Tree Breeding Research Directorate, Ankara, Turkey
[2] Department of Biological Sciences, Middle East Technical University, Ankara, Turkey

These Technical Guidelines are intended to assist those who cherish the valuable oriental beech gene pool and its inheritance, through conserving valuable seed sources or use in practical forestry. The focus is on conserving the genetic diversity of the species at the European scale. The recommendations provided in this module should be regarded as a commonly agreed basis to be complemented and further developed for local, national or regional conditions. The Guidelines are based on the available knowledge of the species and on widely accepted methods for the conservation of forest genetic resources.

Biology and ecology

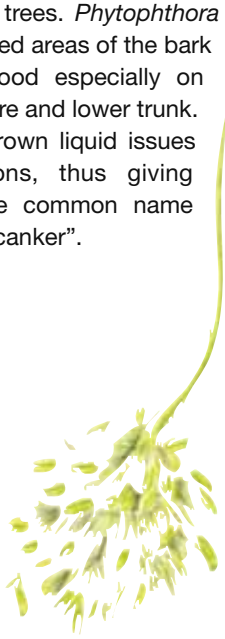
Oriental beech or eastern beech (*Fagus orientalis* Lipsky) belongs to the family *Fagaceae*. It is a deciduous broad-leaved tree which reaches height of 30-40 meters. In rare instances, trees up to 50 meters in height can be found. Stem diameter can reach about 1 m at breast height. Height growth of oriental beech at early ages is slow. The maximum growth rate is usually achieved at the age of 30-40 years, but under shelter, this could take longer, even 60 years. If oriental beech experiences fast growth during the early stages, then growth will end at about 100 years of age, whilst for stands growing more slowly over the early stages, the growth will continue until the age of 160-200 years.

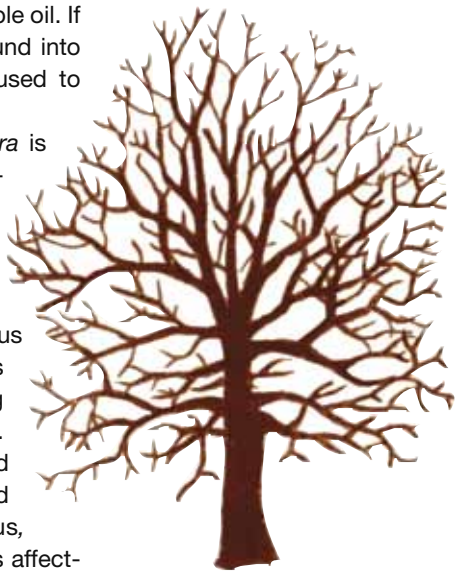
In general, oriental beech has a similar appearance to European beech (*Fagus sylvatica*). Both beech species are characterized by their smooth and silver-grey stem. The stem colour of oriental beech is a lighter grey than European beech. The leaves of oriental beech are egg-shaped without any lobes or peaks and have a short stalk. The leaves are alternate, simple and whole, or with a slightly crenate margin, 7-15 cm long and 5-9 cm wide, with 8-13 veins on each side of the leaf (compared with 5-8 veins in *F. sylvatica*). The buds are long and slender, 15-30 mm long and 2-3 mm thick, but thicker (4-5 mm) where the buds include flower buds.

Oriental beech is a monoecious species (having the female and male reproductive organs separated in different floral structures on the same plant). The male flowers hang as small catkins and the female flowers are erect inflorescences that appear at about the same time as the leaves begin to emerge in spring. Oriental beech is a wind-pollinated species. Fruit maturation occurs in October, 5-6 months after pollination. The endocarp is thick, smooth and a shiny dark brown colour, hairy

inside the husk. Its colour lightens as the beechnut dries. The seeds are small triangular nuts 15-20 mm long and 7-10 mm wide at the base; there are two nuts enclosed in a spiky cupule. The cupule differs from that of European beech in having flattened, slightly leaf-like appendages at the base (slender, soft spines in European beech). A good seed crop of oriental beech occurs about every 2-5 years. Fresh seeds, which are non-endospermic, contain about 25-30% water and cannot tolerate desiccation to a moisture level of less than 10-12% at room temperature. For spring sowing, seeds can be stored at 3˚C for 5-6 months. However, seeds can be stored for 1.5-2 years at -5˚C with 12-17% moisture content. Oriental beech seeds have a dormancy mechanism. Therefore, to induce germination, seeds need to be stratified for 9-14 weeks at 3˚C. Seeds are rich in edible oil. If seeds are dried and ground into a powder they can be used to make bread and cakes.

Phytophthora omnivora is the main defective fungus of beech seedlings. Starting from the germination period, especially at the appearance of the cotyledons, the fungus starts to affect seedlings by causing first browning and wilting, then death. Beech bark disease and bleeding canker, caused by *Phytophthora* fungus, are the principal diseases affecting beech trees. *Phytophthora* kills localized areas of the bark and sapwood especially on the root flare and lower trunk. Reddish-brown liquid issues from lesions, thus giving rise to the common name “bleeding canker”.





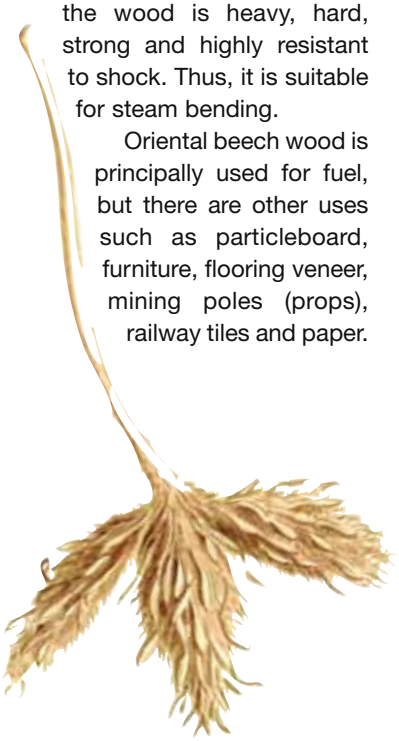
Distribution

Oriental beech is indigenous to the Balkans in the west, through Anatolia (Asia Minor), to the Caucasus, northern Iran and Crimea. In the central-east and east region of the Rhodope Mountains in Bulgaria and Greece, extensive hybridization zones are observed between oriental and European beeches. In Turkey, the species is distributed in Trachia and in the south of Marmara Sea and throughout the Black Sea Regions where it is possible to find oriental beech both as pure stands and mixed forests with conifers and other deciduous broadleaves. There are also isolated natural populations of the species north-east of the Mediterranean Sea on the Amanos Mountains (Turkey). These populations are known as the most southerly populations within the species’ distribution. In Iran, the distribution of the species is limited to the southern coast of the Caspian Sea and it occurs as mixed forest with *Carbines* in the northern slopes of the Elburz Mountains. Oriental beech also occurs naturally in the Caucasus Mountains in Georgia, Azerbaijan, and Armenia. Oriental beech is found between 200 m and 2200 m above sea level. The distribution patterns of the species in the south-eastern Balkans suggest that *F. orientalis* may occur on drier and warmer sites than *F. sylvatica*.

Importance and use

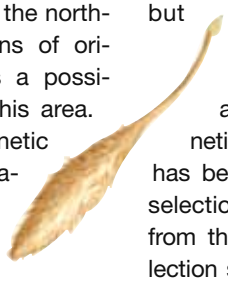
The wood colour of oriental beech ranges from reddish to white. Reddish-brown heartwood formation occurs when the trees reach 80-100 years of age. Beech wood is classified as a medium density wood (0.66 g/cm^3). As a hardwood species, the wood is heavy, hard, strong and highly resistant to shock. Thus, it is suitable for steam bending.

Oriental beech wood is principally used for fuel, but there are other uses such as particleboard, furniture, flooring veneer, mining poles (props), railway tiles and paper.



Genetic knowledge

Molecular marker studies revealed that the differentiation of *F. orientalis* and *F. sylvatica* as separate species is a relatively recent event. The high number of chloroplast types in the northern Turkish populations of oriental beech indicates a possible glacial refuge in this area. The magnitude of genetic variation among populations of oriental beech is considerably higher than that of European beech. Also, adative trait related studies indicated that there is a discontinuous pattern of variation due to adaptation to certain local conditions, such as elevation, aspect, soil pH value and frequency of wet snowfalls. However, a continuous variation in other characters, as in the time of leaf flushing, was reported. The results of studies dealing with genetics of oriental beech reported the presence of higher genetic diversity in oriental beech than in European beech. This suggests that oriental species may be the ancestral species within the European beech complex.



Beech bears both male and female flowers on the same individual and is a wind pollinated tree species. This characteristic and reduced spreading of the seeds produce distinct family structures within natural stands. Thus, further genetic studies covering the whole range of oriental beech are needed and these characteristics should be taken into consideration during sampling of populations.

Oriental beech does not produce suckers like some other beech species. Mass propagation by means of vegetative propagation (cloning) is generally possible, but it is not practiced due to the high costs involved since cuttings are generally difficult to root. Genetic improvement of beech has been limited to seed stand selection and seed collection from them. A simple stand selection system is usually applied. The system relies on stand quality characters such as average growth increment, good health, good phenotypic appearance of most trees and a large number of seed trees for designation. The area of a seed stand should have a minimum core size of 10 ha. Most selected seed stands of oriental beech in Turkey, including core and buffer zone, are greater than 100 ha unless this is restricted by natural stand sizes. There are selected seed stands and gene conservation forests of oriental beech. However, currently none of the material from the seed stands has been tested. Also, no seed orchards exist.

Threats to genetic diversity

A considerable part of oriental beech forests, at least in Turkey, consist of trees originating from stem sprouts due to anthropogenic factors and improper silvicultural treatments in the past. This affects the quality of oriental beech timber and the genetic base of stands since regeneration with seedlings, the products of genetic recombination, will provide a larger genetic base needed for adaptation to existing or changing environmental conditions. Thus, regeneration of oriental beech forests in such places should be gradually replaced through seedlings rather than stem sprouting. Due to the rareness of mast seed years and presence of many diseases and predators of seeds and seedlings, more essential work on seed, seedling and plantation physiology and nursery are needed.

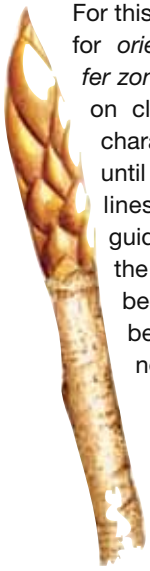
Beech grows in sites favourable for agriculture. Therefore, in the past, beech forests have been cleared for agriculture, probably causing some genetic resources to have been lost. Dense vegetation cover (like Rhododendron) and steep slopes cause problems for the natural regeneration of oriental beech. Although total beech forests cover about 1.7 million ha in Turkey, the difficulties for natural regeneration of oriental beech forests, low quality of wood for pulping and the paper industry, as well as land clearing and plantation of conifers (European black pine and Scots pine) have led to a fragmentation of the beech forests in the country.

To reduce the effects of threats on the genetic resources of oriental beech, seed stands and gene conservation forests have been established in many countries. For instance in Turkey, there are 28 seed stands, representing the natural range of the species and covering 3700 ha. There are also 23 gene conservation forests covering 3100 ha. Additionally, there are numerous national parks and nature conservation areas where oriental beech is naturally found as mixed and pure beech forests. These figures suggest that conservation activities for this species, at least in Turkey, are adequate to secure the genetic resources of oriental beech for future uses.

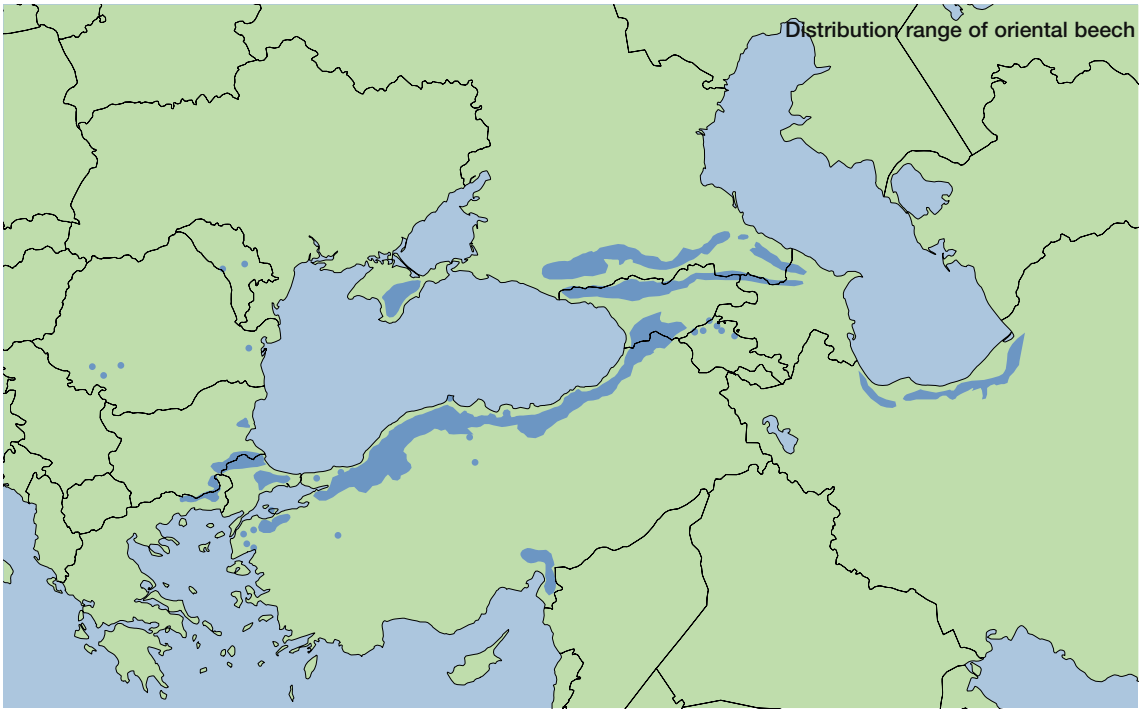
Guidelines for genetic conservation and use

Conservation of oriental beech genetic resources is carried out mainly by setting up seed stands and gene conservation forests as part of *in situ* programmes. Seed collected from these areas can be used for reforestation following the seed transfer zones. Furthermore, there are other conservation programmes such as national parks and nature conservation areas which harbour oriental beech stands that can be used as seed sources. There is no information concerning *ex situ* conservation of oriental beech genetic resources. In reforestation programmes the minimum requirement should be that the origin of the reproductive material is known and its adaptive characters should be appropriate for the ecological conditions at the regeneration site. For this purpose, the "Guidelines for *oriental beech seed transfer zones*", (Atalay, 1992) based on climate, soil and bedrock characteristics could be used until new seed transfer guidelines are prepared. These guidelines were prepared for the natural range of oriental beech in Turkey, but could be used as a reference by neighbouring countries.

A system for the control of reproductive material should be applied and recommendations for proper use of different reproductive mate-



Fagus orientalis



rial should be developed. The Council Directive 1999/105/EC on the marketing of forest reproductive material provides basic definitions of current categories of reproductive material. In years with abundant seed of oriental beech, seed lots should be harvested and stored in sufficient amounts, even though it is expensive and difficult to maintain the viability of seeds in storage.

Seed stands alone may not fulfil the actual requirements for the conservation of genetic resources of oriental beech, especially those populations located in extreme habitats and refuge areas. Therefore, there may be a need for gene conservation forests to be set up from natural stands and managed according to proper silvicultural plans, to ensure the potential for successful natural regeneration. The objective is to maintain the potential for continuous future evolution of the population. It has been suggested that gene conservation forests should cover certain minimum areas in order to maintain sufficient amounts of genetic variability. An approximate estimate would be 100 ha including core and buffer zones. However, the area could be smaller to conserve locally adapted populations. Such forests may also contain other tree species if they are admixed with oriental beech.

The establishment of *ex situ* conservation plantations of oriental beech may be necessary in order to conserve the genetic variation of threatened populations that cannot be maintained at the original site, such as relic populations. The objective will be to establish a new population that maintains as much as possible of the original genetic variability and allows long-term adaptation to the local conditions at the planting site. It can be established by planting seedlings, but also by direct sowing. Stands of 10 ha are generally recommended for this purpose.

EUFORGEN

This series of Technical Guidelines and distribution maps were produced by members of the EUFORGEN Networks. The objective is to identify minimum requirements for long-term genetic conservation in Europe, in order to reduce the overall conservation cost and to improve quality standards in each country.

*Citation: Kandemir G. and Z. Kaya. 2009 EUFORGEN Technical Guidelines for genetic conservation and use of oriental beech (*Fagus orientalis*). Bioversity International, Rome, Italy. 6 pages.*

Drawings: Fagus orientalis*, Giovanna Bernetti © Bioversity, 2009.*

ISBN 978-92-9043-804-5

Selected bibliography

Atalay, İ. 1992. The ecology of beech (*Fagus orientalis* Lipsky) forests and their regioning in terms of seed transfer. Forest Tree Seeds and Tree Breeding Research Directorate, Ankara. 209 pp.

Papageorgiou, A. C., A. Vidalis, O. Gailing, I. Tsiripidis, S. Hatziskakis, S. Boutsios, S. Galatsidas, and R. Finkeldey 2008. Genetic variation of beech (*Fagus sylvatica* L.) in Rodopi (N.E. Greece). Eur. J. Forest Res. 127: 81-88.

Denk,T., G. Grimm, K. Stögerer, M. Langer, and V.Hemleben 2002. The evolutionary history of *Fagus* in western Eurasia: Evidence from genes, morphology and the fossil record. Plant Syst. Evol. 232: 213-236.

Gailing, O. and G. von Wuehlisch 2004. Nuclear markers (AFLPs) and chloroplast microsatellites differ between *Fagus sylvatica* an *F. orientalis*. Silvae Genetica 53(3): 105-110.

Gömöry, D., L. Paule and J. Vysny 2007. Patterns of allozyme variation in western Eurasian *Fagus*. Botanical society of the Linnean Society 154: 165-174.

Shanjani, P. S. and D. Gömöry 2004. Isozyme variability of *Fagus orientalis* Lipsky in beech populations. International Journal of Agriculture and Biology 6(1): 116-125.

Vettori, C., P. Donatella, L. Paule and R. Giannini 2004. Identification of the *Fagus sylvatica* L. and *Fagus orientalis* Lipsky species and intraspecific variability. Forest Genetics 11(3-4): 223-230.

Bioversity International

EUFORGEN Secretariat
c/o Bioversity International
Via dei Tre Denari, 472/a
00057 Maccarese (Fiumicino)
Rome, Italy
Tel. (+39)0661181
Fax: (+39)0661979661
euforgen@cgiar.org

More information

www.euforgen.org