EUFORGEN

Lime

Tilia spp.

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These Technical Guidelines are intended to assist those who cherish the valuable lime genepool 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 in 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

Limes *(Tilia* spp.) are tall trees that can live for up to 500 years. *Tilia* flowers at the end of June until early July, and *T. cordata* flowers later than *T. platyphyllos*. Mast years are infrequent. *Tilia* sets flowers at the age of 30, and up to ten years earlier on solitary trees. In northern Europe, seed regeneration is sparse, which is assumed to be caused by low temperatures. *Tilia* species are outcrossing, and at least some of the individuals within a population are self-sterile. Seeds can be stored for a maximum of three - five years.

The trees favour good, loamy sites, but can also be found on sandy, infertile soils, and are drought resistant. Dormant shoots of *T. cordata* can

resist winter frost temperatures as low as -34°C. In most places throughout Europe, *T. cordata* grows in several types of mixed species forest and many insects and fungi are associated with *Tilia*. Within the common range of the two species, hybrids between *T. cordata* and *T. platyphyllos* have been observed. Hybridization and introgression take place rarely. Examples of hybridization include *Tilia* x *euchlora* – a hybrid between *T. cordata* and *T. dasystyla*, and *Tilia* x *flaccida* (between *T. platyphyllos* and an American species, *T. americana*). Leaf, flower and fruit morphology are used for identification of the species.

T. cordata and *T. platyphyllos* trees easily reproduce vegetatively through cuttings and root layers, and cuttings can even be propagated from old trees. Somatic embryogenesis has been carried out both for *T. platyphyllos* and *T. cordata*.

Distribution

The ecological range of the most important lime species in Europe, *T. cordata*, is very broad. *T. cordata* shares roughly the same distribution area as *Acer platanoides*. It is found in most altitudes, and up to 1500 m in the central Alps. In eastern Europe, it is found in pure stands, but normally exists in mixed stands.

Three additional species are also present in Europe: *Tilia platyphyllos*, *T. tomentosa* and *T. dasystyla*. The distribution range of *T. platyphyllos* is quite limited and is commonly found on sites containing *T. cordata*, and is rare in northern Europe. *T. tomentosa* and *T. dasystyla* occur in south-eastern Europe and around the Black Sea.

Threats to genetic diversity

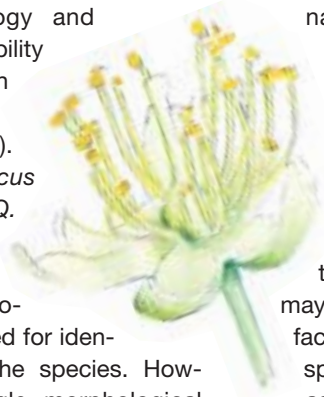
Climatic conditions and human impact have reduced the distribution of *Tilia* in Europe in the past 2000 years. The competitive ability of beech is also considered as a threat. In many lowland areas, *Tilia* may have disappeared when humans began farming these areas, limiting the species to marginal sites, and in northern Europe they are thought to have disappeared on many sites due to low seed fertility. However, other stands have evidently been established by humans.

Inbreeding caused by the extensive fragmentation and destruction of biotopes is expected to have an impact on both *T. cordata* and *T. platyphyllos.* Hybridization, introgression and widespread domestication of foreign species and provenances may also impact the existing genepool.

Tilia spp.

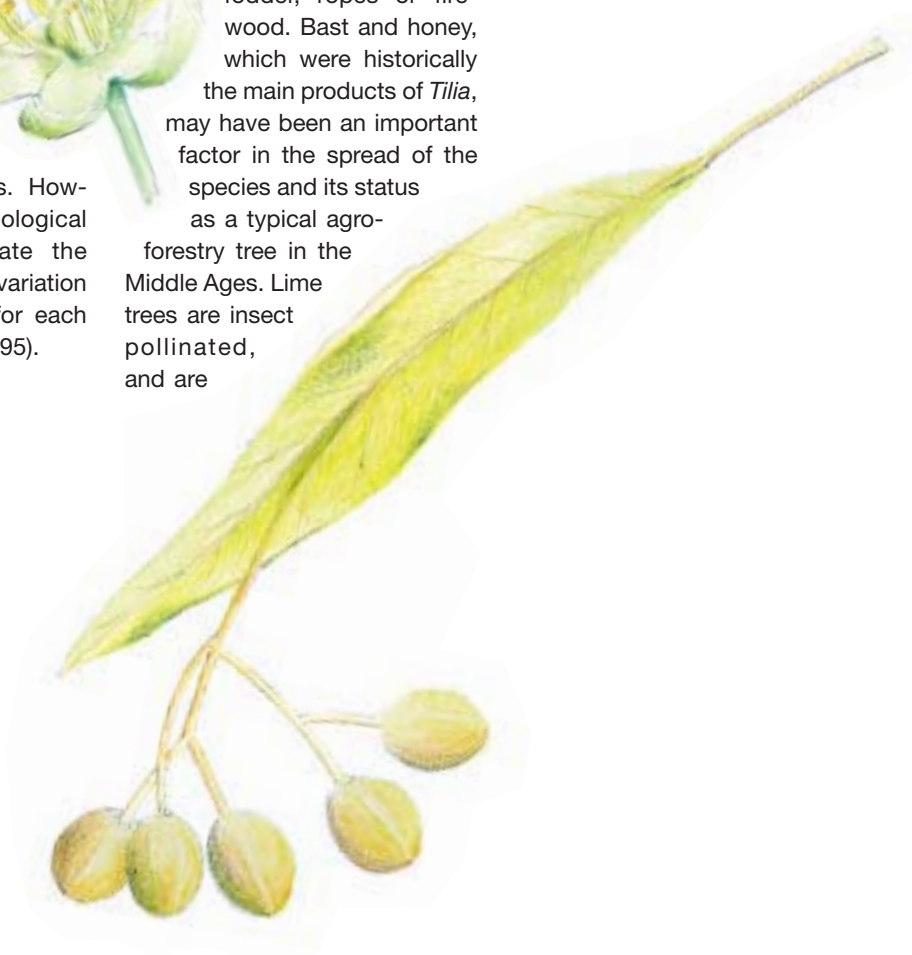
Genetic knowledge

Investigations of morphological characteristics of *T. cordata* have revealed little variation between populations (Pigott 1991). General genetic properties have been described by Giertych (*in* Bialobok 1991), but genetic knowledge is sparse. Reproductive biology and genetic variability have been reported by Fromm (2001). As for *Quercus robur* and *Q. petraea*, leaf, flower and fruit morphology can be used for identification of the species. However, no single morphological trait alone can separate the species due to large variation within the populations for each individual trait (Mauer 1995).



Importance and use

Owing to their aesthetic and cultural value as domesticated, urban and landscape trees, limes have become increasingly important in Europe in recent decades. The importance of *T. cordata* in Europe is well illustrated by the common use of its name for geographic localities. *Tilia* wood is used for carving, and almost all parts of the tree can be used for fodder, ropes or firewood. Bast and honey, which were historically the main products of *Tilia*, may have been an important factor in the spread of the species and its status as a typical agroforestry tree in the Middle Ages. Lime trees are insect pollinated, and are important for honeybees and honey production, especially in eastern Europe. *Tilia* spp. are also important for amenity use, shelterbelts and game plantings in the open landscape, in urban areas and recreational forestry.



Guidelines for genetic conservation and use

A network of conservation stands is needed to conserve the genetic variation of limes, which have evolved through adaptation to different ecological and environmental conditions. Conservation and breeding programmes in all countries where lime is found is required to ensure the conservation of the genepool. Specific strategies should include:

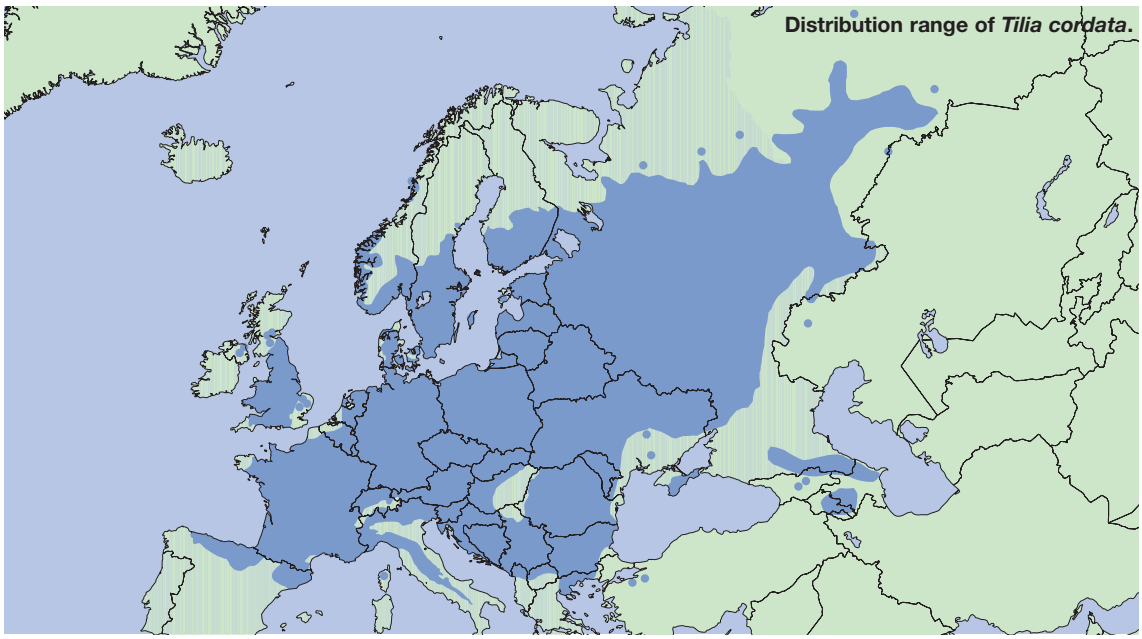
Sampling strategies: Inventories are needed to provide an overview of the status of genetic conservation in each individual country and at the European scale. For practical purposes, provenance regions can be identified on the basis of ecogeographic variation and can be modified to take into account either expected gene flow or general knowledge about genetic variation within the species.

Central core regions: Large genetic reserves within the central core regions of distribution are needed for effective gene conservation purposes and should be given high priority, as large genetic variation is expected to be present in the core distribution area. In general, *Tilia* occurs in mixed species forest and is associated with a number of different plant species. Existing protected areas will only partly serve as genetic conservation areas, as they are not selected at random nor do they cover the core regions of distribution.

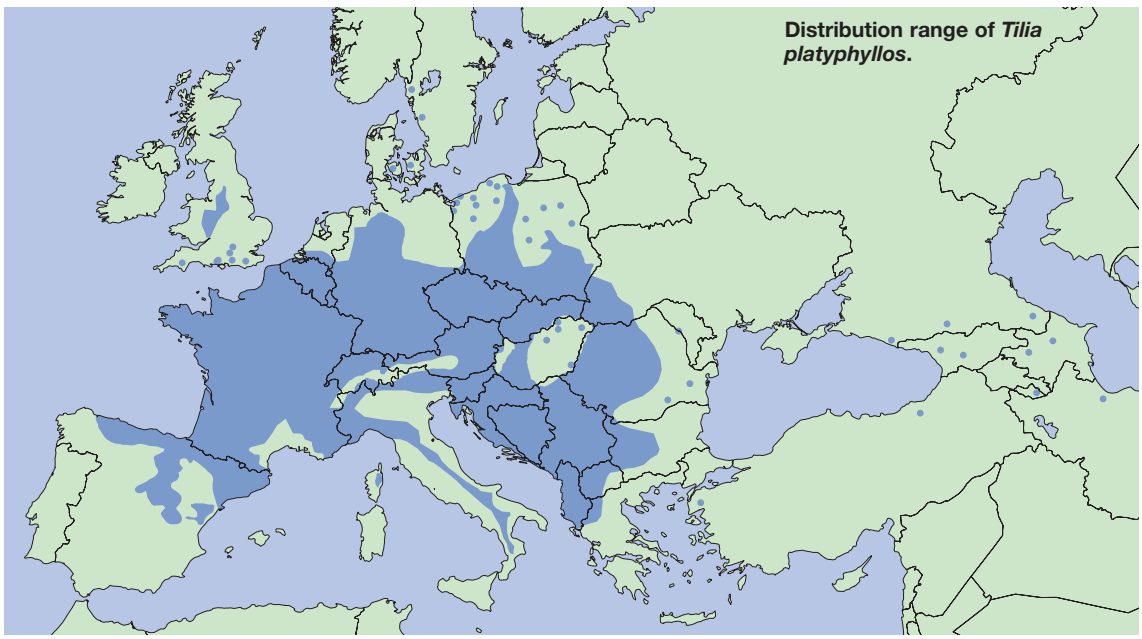
Marginal regions: In some regions, large gene reserves of *Tilia* are lacking, and these genetic resources may be extensively fragmented. They may also be subject to pollen contamination from new plantations originating from non-local seed sources. For these situations, *in situ* conservation may not be effective. In some of the marginal regions the regeneration of *Tilia* is lacking or inadequate. *Ex situ* conservation of *Tilia* genetic resources is therefore recommended in marginal regions. Preferably, these *ex situ* conservation stands should be established on the basis of reproductive material from within the local regions, in accordance with *in situ* silvicultural management principles. *In situ* conservation in marginal regions should include a larger number of populations.

Use and management of genetic resources: Breeding, improvement and management of genetic resources of *Tilia* should be combined with gene conservation to allow evolutionary forces to continue. Combining conservation and use is especially necessary for species of low economic interest ("use it or lose it"). At some locations the lime trees may be eradicated, if costly and extensive precautions are not taken. Alternatively, these resources could be used to promote the establishment of new populations from local seed collections.

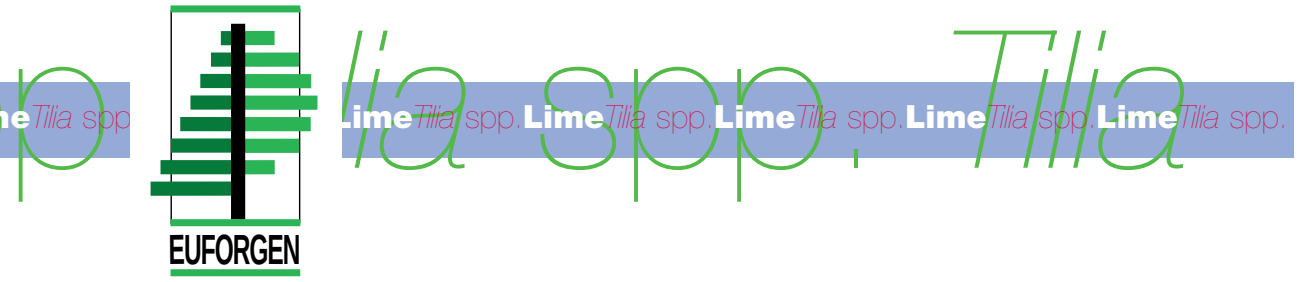
Tilia spp.



Distribution range of ***Tilia cordata***.



Distribution range of ***Tilia platyphyllos***.



These Technical Guidelines were produced by members of the EUFORGEN Noble Hardwoods Network. The objective of the Network is to identify minimum genetic conservation requirements in the long term in Europe, in order to reduce the overall conservation cost and to improve the quality of standards in each country.

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