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Half a Century of Seed Years in Major Tree Species of Poland

By W. KANTOROWICZ

Forest Research Institute, Ul. Bitwy Warszawskiej 1920r/3, PL-00-973 Warszawa, Poland

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Summary

Data on fruiting estimates for the six main forest species of Poland: Scots pine (*Pinus sylvestris* L.), Norway spruce (*Picea abies* (L.) KARST.), white fir (*Abies alba* MILL.), European larch (*Larix decidua* MILL.), oak (jointly *Quercus robur* L. and *Q. petraea* LIEBL.), beech (*Fagus sylvatica* L.), that is being regularly collected by the Polish Forest Service through an annual questionnaire sent out to all Forest Districts has been compiled onto a single drawing showing the magnitude and temporal positioning of seed years. A short discussion is given of the nature of recurrence of seed and cone crops in various parts of Poland.

Key words: cone crops, seed crops, seed years, mast, fructification, records.

Introduction

Information about seed years in forest tree species is important not only for the current management of forest nurseries but also for the long term tree improvement programs. Since seed quality is much better during seed years their frequency will affect the area of needed seed orchards and the rate of breeding programs. Thus it is useful from time to time to look back at what records say about crop years. Such long term data is seldom to be found in scientific literature. For half a century the Forest Research Institute (IBL) has been compiling annually the reports from Forest Districts about seed crops. The Forest Districts are required to report on the expected magnitude of the crop, the possibilities of seed collection and seed needs. When making the report in the following year they are also required (since 1962) to verify the data supplied the previous year on the basis of collection experience. On the basis of these reports the Forest Service makes decisions about accumulation of seed reserves for non-crop years or about withholding collections, in spite of good crops, if reserves are sufficient. The Forest Research Institute is an intermediary between the Forest Districts and the General Directorate of State Forests, performing the function of compiler and evaluator of the incoming data. As usual, the veracity of the reports differs from Forest District to Forest District and from year to year. The Forest Research Institute has to use its judgement based on many reports before supplying a country wide evaluation. Each year a communique is issued giving a summary of the pertinent data for the previous year (IBL 1951 to 1999). This work has been continuing for half a century, with various people being involved in the process both of sending the reports and evaluating them. This paper is a joint report for our six main forest tree species for the period 1951 to 1999. Both the end of the century and plans to restructure the mode of reporting justify a backward look at what has already been observed.

Methods

Each year Forest Districts obtain from the General Directorate of State Forests a questionnaire that has to be filled in with information on seed availability for the following species: Scots pine (*Pinus sylvestris* L.), Norway spruce (*Picea abies* (L.) KARST.), white fir (*Abies alba* MILL.), European larch (*Larix decidua* MILL.), oak (jointly *Quercus robur* L. and *Q. petraea* LIEBL.), beech (*Fagus sylvatica* L.). The questionnaire asks for the following data:

1. Verified information for the previous year concerning:

a) crop magnitude as judged in the autumn, based on the fruiting of trees (since 1962);

b) degree of utilisation of the crop;

c) weight of cones or seed collected;

2. Prognosis for the current year:

a) expected magnitude of the crop;

b) expected collection in weight of cones or seed;

c) seed demand (based on working plan requirements for outplantings).

Table 1. – Classification of crop intensity according to the adopted criteria.

Crop Intensity	Corresponding % of cropping trees	Notes helpful in determining crop intensity
no crop	0	No trees with cones or seed worth collecting
poor crop	10	Only single trees fruit on forest edges
mean crop	30	Numerous edge trees and some inside stands fructify
good crop	100	Substantial % of trees in the stand fructify

Crop magnitude is based on the number of seeding trees and its intensity, relative to what is considered a financially justified collection. The classification of crop intensity as defined in the adopted practice is given in *table 1.*

Till 1961 the data corresponds to prognosis information only. Since 1962 the practice was introduced of verifying the prognosis in the following year, and the data given from 1962 onwards is based on this verified data (except for 1999).

The data which arrived from Forest Districts was from the very beginning verified in individual cases when there were some doubts. For example the prognosis was good, utilisation of crop complete and collection small. The extent of this individual verification was substantially reduced after 1985 since it was observed that with improved storage facilities after good mast years collection and utilisation of current crops did not necessarily reflect the actual fruiting of the year. The self verification by estimating fruiting of the previous year proved sufficient.

The data supplied from the Forest Districts was summarised by Regional Forest Directorates (Regionalna Dyrekcja Lasów Państwowych – RDLP), of which there are 17, and published as an annual report (IBL 1951 to 1999). The author was a co-author of these reports for the last several years. Since the boundaries of the RDLPs have been changed several times the data has been interpolated for the current boundaries (*Fig. 1*). On the average there are currently 26 Forest Districts per RDLP.

Fig. 1. – Division of Poland into Regional State Forest Directions (RDLP).

Figure 2 shows the natural ranges of all the 6 species in Poland based on our Forest Encyclopaedia (MOLENDA, 1980).

The data on fructification, based on the percentagés as defined in *table 1*, has been averaged per RDLP and plotted by year and RDLP separately for the 6 tree species, with the size of the circles corresponding to the average percentage (*Fig. 3*). This is a method first used by CHALUPKA and GIERTYCH (1973) for the demonstration of Norway spruce crop years in Europe. Where no circle is shown there was no data, due the species not growing in the Regional Directorate in question. This concerns primarily beech in the Bialystok RDLP – 7 and white fir in most of northern Poland. However since all these tree species

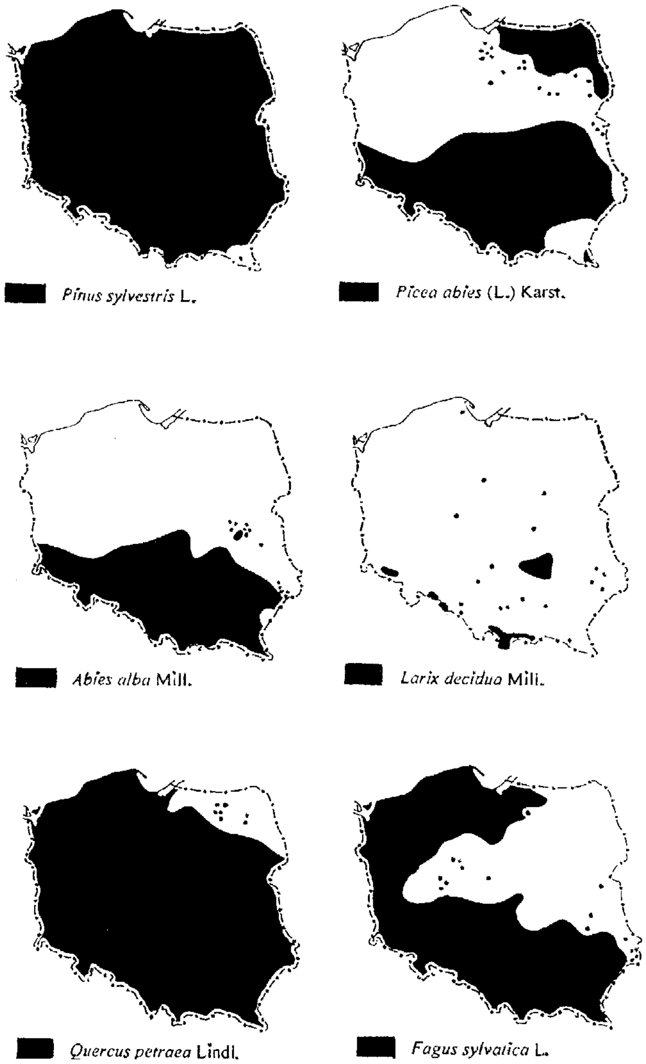

Fig. 2. – Natural ranges of the main forest tree species in Poland, based on the *Small Forest Encyclopaedia* (MOLENDA, 1990).

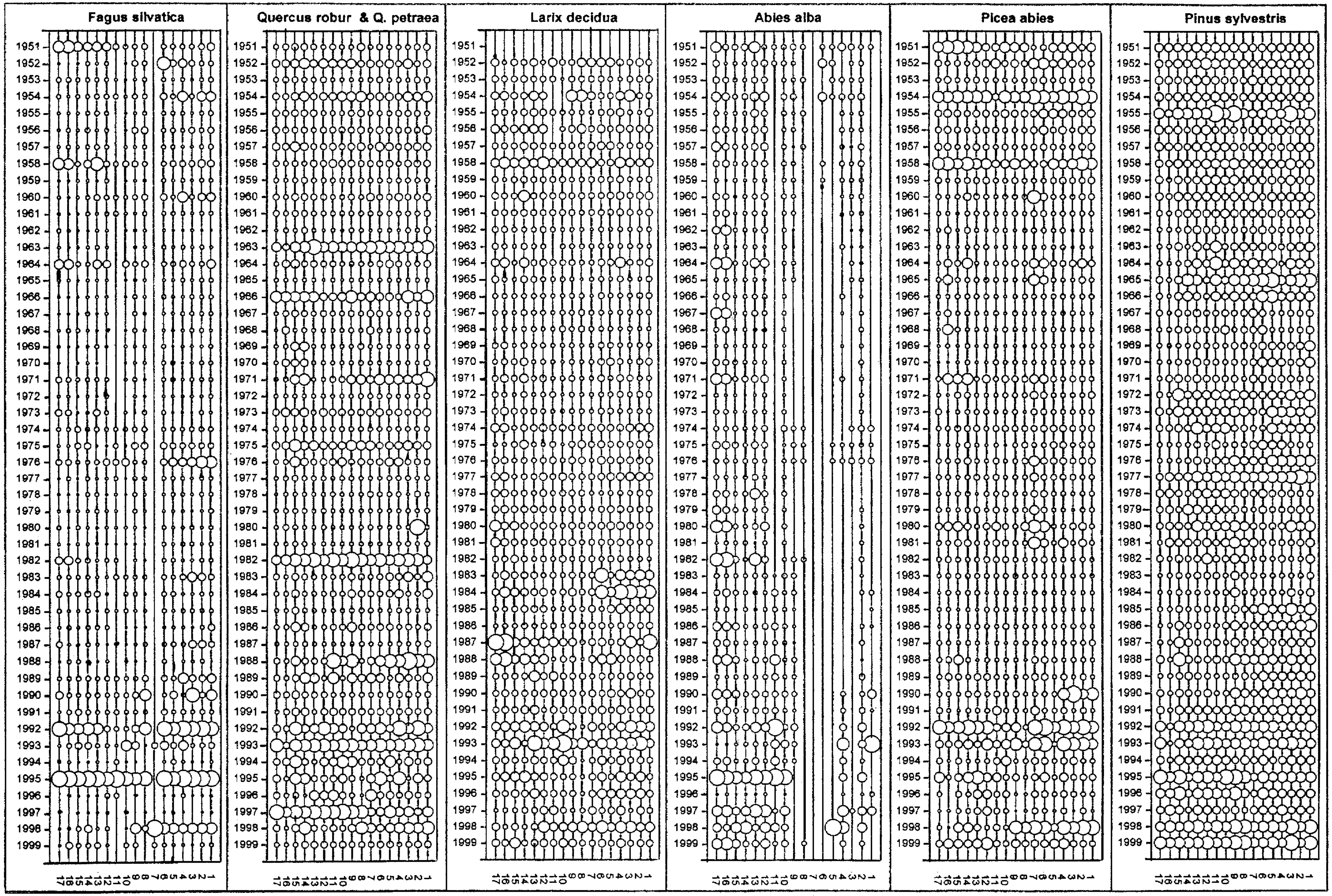

Fig. 3. – Estimate of seed cropping, indicated by circle size, in various years (from 1951 to 1999) for the main forest tree species of Poland and the 17 Regional State Forest Directories as defined in *figure 1.*

are to some extent planted throughout the country, there have been crop reports also from regions were the given species is non indigenous, particularly in crop years, thus there is also some data for the RDLPs where the species in question is non indigenous.

Results

Figure 3 presents information on the fructification of the six basic forest tree species of Poland, i.e. Scots pine, Norway spruce, white fir, European larch, oak (pedunculate and sessile oaks jointly) and beech for the years 1951 to 1999 and the 17 RDLPs. The latter are identified by numbers as defined in *figure 1.*

As can be seen fructification throughout the country is not always the same just as it was shown to be different in different parts of Europe for Norway spruce (CHAŁUPKA and GIERTYCH, 1973). This is evident not only in species occurring throughout the country (pine, oak) but also in those that grow both within and beyond their natural ranges such as spruce, fir or beech. Spruce from the north-eastern part of the country (RDLPs Olsztyn – 6 and Bialystok – 7) frequently fructifies abundantly in different years than spruce from the southern part of the range (RDLPs 12, 13, 14, 15, 16 and 17). White fir in the north-west (RDLPs Szczecin – 1), outside its natural range, fructifies quite irrespectively of the crop years in the south where it is native. Beech, native both in the north-west and in the south, fructifies abundantly at different times in the two regions.

However in spite of all these differences between regions, the main impression from the study of *figure 3* is the most common overall agreement of results for the different RDLPs. A good seed year for a species is usually good throughout the country, especially in the last decade. For each species the spacing between abundant crops is different and the mast years seldom coincide. This no doubt depends on weather conditions at the time of flower initiation, flowering and fruit seffing, which times are different for different species and the weather demands of the species for successful fructifications differ.

Scots pine fructifies most regularly, the crop estimate rarely falling below 15%. Exceptionally good seed years can occur even in successive years, e.g. 1964, 1965 and 1966, 1972 and 1973, 1976 and 1977, 1992 and 1993, 1995 and 1996, 1998 and 1999 (unverified). However there can be longer periods with poorer crops. In the Krosno RDLP (no.17), where Scots pine is at the limit of its range and represents a low proportion of forest, a good crop year is reported only when it is very good in other parts of the country.

Norway spruce has good cone crops very rarely. There have been periods of even 8 years with no significant crop in any part of the country (1982 to 1989). The international review of crop years for the species made in 1973 (CHAŁUPKA and GIERTYCH, 1973) suggested that in Norway spruce there are never good cone crops in two consecutive years. This opinion is contradicted by the data presented here for the years 1992 and 1993, at least in some parts of the country, and for the north-eastern part of the country (regions 6 and 7) such consecutive crops were also observed for 1964 and 1965 and for 1980 and 1981.

White fir occurs naturally only in the southern part of the country (*Fig. 2*) and it is not planted much beyond that region. Thus most of the time foresters from the north do not bother to report on the fructification of their fir trees. When they do the information is quite different from the reports for the natural range. From RDLPs Kraków (16) and Krosno (17), where the species is most abundant, good seed years come more or less every three or four years. There was a longer no-crop period in the seventies. The year 1995 was an exceptionally good crop year throughout the south. It is noteworthy that it was also a very good crop year for beech, the two species often growing together in the mountains of the south.

European larch has a very limited natural range but it is planted throughout the forests of Poland. It is interesting to note that seed years often appear to come in two consecutive years. It would be interesting to investigate whether this phenomenon concerns the same trees or different trees in the same stand, some responding later to the same external stimuli of floral induction or seed formation. Usually there is a shortage of larch seed and foresters may tend to acknowledge crops as satisfactory more often than they would in other species.

In oak, while consecutive crop years do occasionally appear, the norm seems to be a fair spacing between crop years, even up to nine years. Usually when a crop occurs it is manifest throughout the country.

Beech is the most seldom cropping tree species. Really good crops throughout the country are very rare indeed. Most recently 1995 was such a year and 1992 was also rather good, but for the rest of the study period when good crops appeared this was true for only a part of the country. Blank years for more than a decade are not uncommon, in many regions. It is interesting that 1995 was also a good mast year for beech at several locations in England (HILTON and PACKHAM, 1997). The observation in the English study that two mast years never follow each other is supported by this study.

Each species appears to be fructifying independently of the others. Closest agreement appears to be between fir and beech. Observe the results not only for the exceptionally good crop year 1995 but also for 1998, 1992, 1982, 1964 and 1951. In some way the two species appear to be responding to the same external stimuli with increased fructification.

The overall impression is that there is an increase in frequency of seed crops in the past decade. To a lesser extent more frequent crops, at least of pine, spruce, larch and oak appear to be in the fifties. This could possibly be related to industrial pollution, which kept on increasing between 1960 and 1989, to drop drastically after the change of our political system, first as a consequence of drop in industrial output and later due to introduction of new more clean technologies. Another possible explanation could be a periodic fluctuation in the climatic patterns, e.g. global warming and global cooling cycles.

Forest tree breeders are generally aware of the differences in frequency of seed crops of various forest trees and adapt their programs accordingly. The presented compilation only confirms practical knowledge. However its usefulness stems not so much from this confirmation as from the opportunity it offers to look on the problem on a macro scale, over many years and regions. Control of seed cropping in seed orchards is an objective of long standing that has not been realised effectively anywhere. Hormonal or fertiliser treatments are of limited utility. Transfers of seed orchards to regions where more frequent crops were expected have been tried with some success but with new problems, contamination with pollen of a different ecotype and embryo adaptations to an alien environment. Modification of climate is a possibility not only for indoor orchards (e.g. in plathouses) but also outdoors (watering regimes, shading, supplemental illumination to extend photoperiod etc.) however we know very little about what kind of climatic change would promote more frequent crops. A comparison of the data presented here with various weather factors may provide some suggestions in this direction.

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Pattern and Magnitude of Genetic Diversity in *Pinus nigra* ARNOLD Subspecies *pallasiana* Populations from Kazdağı: Implications for *in situ* Conservation

By B. ÇENGEL[1)2)], E. VELIOĞLU[1)], A. A. TOLUN[2)] and Z. KAYA[2)3)]

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Summary

To determine the genetic structure of black pine (*Pinus nigra* ARNOLD subspecies *pallasiana*), populations sampled from Kazdağı (Eybekli, Asar, Katrandağ, Kalkım, Gürgendağ, Kapıdağ, Mıhlıdere). Isozymes from 16 enzyme systems were investigated from haploid female megagametophytes by starch gel electrophoresis.

Twenty-nine loci were resolved from the 16 enzyme systems assayed. The results indicated that the mean number of alleles per locus (*A*) and polymorphisms (*P*) did not vary significantly in the populations studied. The mean number of alleles per locus (*A*) was around 1.67 (range, 1.65 to 1.69). Polymorphisms varied between 51.7% in Kapıdağ and 58.6% in Mıhlıdere populations. Observed heterozygosity (H_{obs}) was the highest (0.186) in Asar and the lowest (0.122) in Gürgendağ populations. The expected heterozygosities (H_{exp}) ranged between 0.283 (in Asar) and 0.248 (in Katrandağ). There were large differences between H_{obs} and H_{exp}. Ninety-four percent of the total observed genetic variation was within populations. NEI's genetic distances also showed that variation among populations is relatively low suggesting that no population differentiation has occurred. From the estimated average genetic distances between populations, it is evident that the genetic distances between population pairs were low, ranging from 0.01 to 0.04. Genetically, most similar population pairs were Eybekli-Asar and Kalkım-Gürgendağ, and the least similar ones were Eybekli-Katrandağ, Eybekli-Kapıdağ, Eybekli-Mıhlıdere, and Mıhlıdere-Gürgendağ.

Based on the genetic diversity measurements and genetic distance between populations, Asar (or Eybekli), Mıhlıdere and Gürgendağ populations seem to be forming genetically distinct groups. These populations were, therefore, recommended as potential Gene Manegement Zones (GMZ) to conserve the genetic resources of Anatolian black pine in the Kazdağı Region in Turkey.

Key words: Pinus nigra subsp. *pallasiana*, genetic diversity, isoenzymes, genetic distance, *in situ* gene conservation, gene management zone.

Introduction

Anatolian black pine (*Pinus nigra* subsp. *pallasiana*) is one of the subspecies of European black pine, occurring naturally as a widespread mid-elevation species in Taurus, western Anatolian and northern Anatolian Mountains. The range in elevation varies from 250 m to 1550 m (*Figure 1A*). This subspecies covers a large area, more than 2 million hectares, in Turkey.

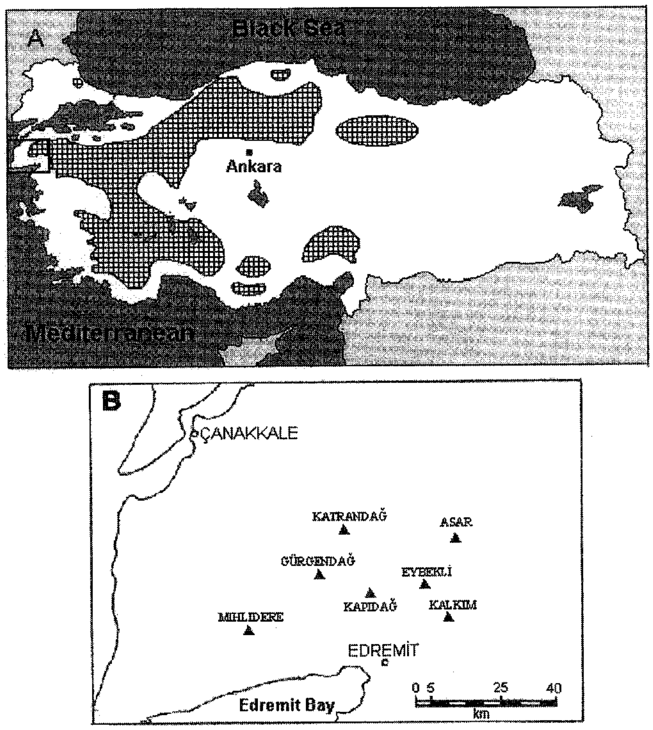

Figure 1. – The map showing the nautral distribution of *Pinus nigra* ARNOLD subsp. *pallasiana* in Turkey (A). Locations of the studied populations in the Kazdağı Region are indicated by ▲ (B).

[1)] Forest Trees and Seeds Improvement Research Directorate, 06560 Gazi, Ankara, Turkey

[2)] Department of Biological Sciences, Middle East Technical University, 06531 Ankara, Turkey

[3)] Corresponding autor:
Prof. ZEKI KAYA, Department of Biological Sciences, Middle East Technical University, 06531 Ankara, Turkey
Fax: 90+ (312) 2101289
Email: kayaz@metu.edu.tr