DENDROBIOLOGY
2002, vol. 47, Supplement: 21–24

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The variability of dimensions of *Quercus robur* L. and *Quercus petraea* (Matt.) Liebl. acorns in Poland

Abstract: The paper includes results of measurements of the length and diameter of 12600 acorns of *Quercus robur* and 5099 acorns of *Q. petraea* collected in Poland in the mast-year 1993. Acorns of both species were compared. Significant differences in acorn length and diameter/length ratio were found. Acorns of *Q. robur* are somewhat larger, but both species have a large common area of variability. The scale of this variability has been determined. Geographical correlation of the size of *Q. robur* acorns was ascertained.

Additional key word: acorn size

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Introduction

Acorns are the largest among fruits of forest tree species in Poland. They need a large capacity of the store and higher sowing density standards, with reference to other genera. The variability of their size is important in case of the estimation of labor costs during their collection and in the case of construction of sowing machines. It may also influence the growth of seedlings in forest nurseries (Cieslar 1923, Ejtingen 1926, Popov 1949 and literature cited in this paper). The size of acorns depends on species and provenance (Cieslar 1923, Tyszkiewicz 1936, Popov 1949, Barzdajn 1993, 1994). Goetz (1931) wrote about the range of acorn variability in Poland, too. So far, research on the variability of the quantitative characters of acorns is not sufficient to solve practical problems.

Methods

Acorns were collected for the needs of a provenance trial and they were used also in this study. Samples were collected from selected oak seed stands as a material representing the population. The collection was carried out in the autumn of 1993 in 122 populations of *Quercus robur* and in 50 populations of *Q. petraea*. The presence of both species in the same stands was very frequent. In such cases the sample from the particular stand represents either one species or two samples were collected separately for each species. Location of the stands from which samples were collected (Fig. 1 and Fig. 2), is more precisely described in another paper (Barzdajn 2000). 100 acorns were taken at random from each sample. The measurements of the length and the largest diameter of acorns were conducted using the slide calliper, with accuracy of 0.1 mm. On the basis of these data , the diameter/length ratio was calculated as the third analyzed feature. In the case of *Q. robur* 12600 acorns were measured, and in the case of *Q. petraea*, 5099 acorns. Results were classified according to species and provenance. The geographical coordinates were correlated with the population mean values of each feature.

Results

Statistical descriptions for the species were carried out twice: 1) using the population means and 2) using all data for the species. In Table 1 the length of acorns

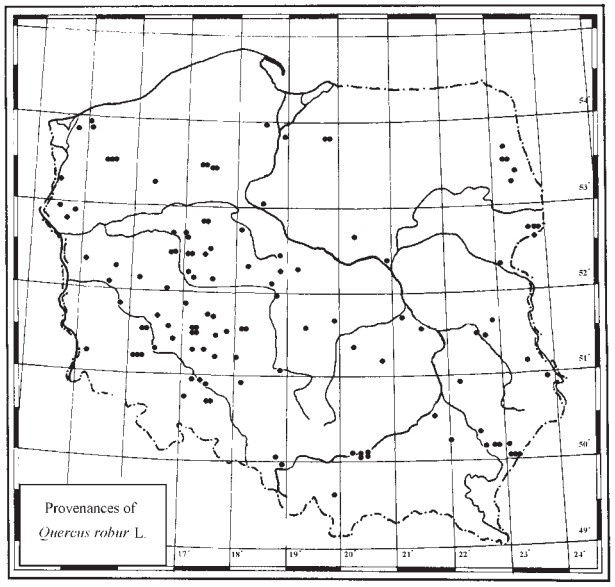

Fig. 1. Distribution of *Quercus robur* samples

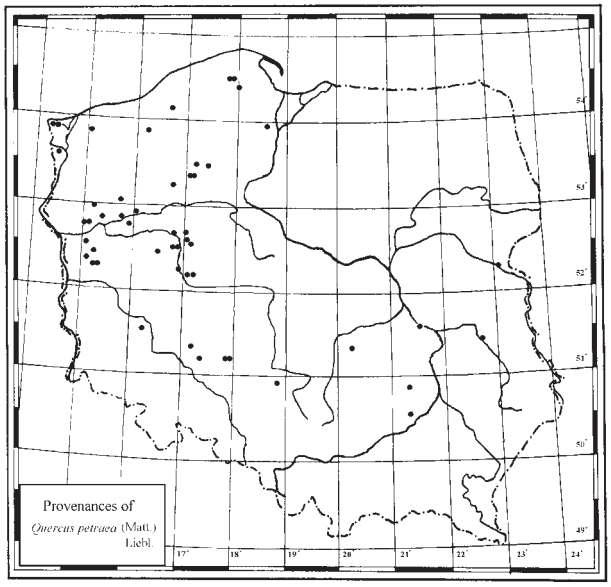

Fig. 2. Distribution of *Quercus petraea* samples

is presented. Acorns of *Q. petraea* were shorter. Species differ slightly from each other with regard to the range of variability. Within the range from 18.71 mm to 22.55 mm there are no mean values for the populations of *Q. robur*, and within the range from 28.43 mm to 32.9 mm no mean values for populations of *Q. petraea*. The range 22.55 mm – 28.43 mm is covered by means for both species. When analyzing the ungrouped values of length, the common range is much wider. Only acorns of *Q. petraea* were noted within the range of 13.50 mm – 14.50 mm, and only acorns of *Q. robur* were noted within the range of 35.50 mm – 39.50 mm. Thus, the common range is from 14.50 mm to 35.50 mm. This feature (length) is not suitable for distinguishing both oak species from each other. The diagram of the frequency distribution of their length (Fig. 3) confirms this assumption. The curves of the length distribution are clearly different for both species and they describe two different groups (in the statistical sense), but the common range is large.

The absolute differences in the diameter of acorns of both species are markedly lower. The differentiation, expressed by the coefficient of variability, is similar as in the case of the length of acorns (Tab. 2). The distribution of the characters in Fig. 4 confirms the conclusion from the table. The shape of acorns, determined by the diameter/length ratio, depends mostly on the length. The slenderness of *Q. petraea* acorns is somewhat lower comparing with acorns of *Q. robur* (Tab. 3). Nevertheless, a rounded shape of acorns has been noted for both oak species.

In case of *Q. petraea* the mean values of the investigated features do not show any dependence on the geographical location. The coefficients of their linear correlation with the coordinates (expressed in radians) are low (Tab. 4). The obtained significant correlation between latitude and longitude reflects the geographical distribution of the stands where acorns were collected. The acorn diameter correlates positively with their length. The diameter/length ratio correlates significantly only acorn the length. General

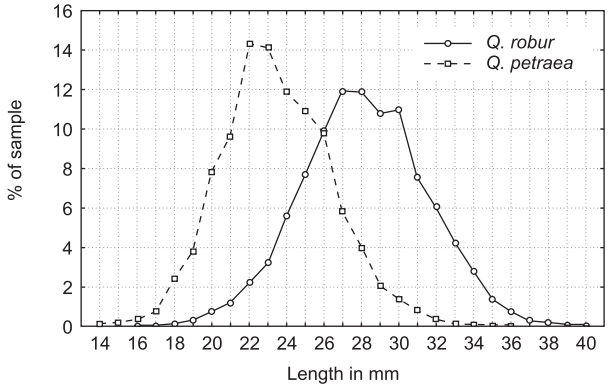

Fig. 3. Frequency distribution of acorn length for *Quercus robur* and *Q. petraea*

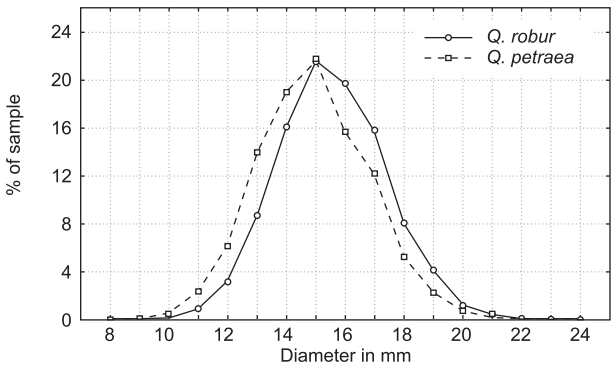

Fig. 4. Frequency distribution of acorn diameter for *Quercus robur* and *Q. petraea*

dependence obtained for *Q. robur* is similar, but more positive results were obtained (Tab. 5). In the case of this species the diameter of acorns correlates with the length, too, but it is proved that the shape of acorns depends to a higher degree on the length than on the diameter. These correlating characters must show slight independence. Both these dimensions negatively correlate with the latitude, which means that in

Table 1. Statistical description of acorn length in *Quercus robur* and *Quercus petraea*

Statistics	Population means		All acorns	
	Q. robur	*Q. petraea*	*Q. robur*	*Q. petraea*
Sample size	122	50	12600	5099
Mean (mm)	28.14	23.49	27.63	22.94
Semiinterval of confidence (mm) (=0.05)	0.39	0.52	0.06	0.08
Coefficient of variability (%)	7.75	7.83	11.42	12.78
Minimum (mm)	22.55	18.71	14.50	13.50
Maximum (mm)	32.92	28.43	39.50	35.50

Table 2. Statistical description of acorn diameters in *Quercus robur* and *Q. petraea*

Statistics	Population means		All acorns	
	Q. robur	*Q. petraea*	*Q. robur*	*Q. petraea*
Sample size	122	50	12600	5099
Mean (mm)	16.53	15.92	16.04	15.42
Semiinterval of confidence (mm) (=0.05)	0.21	0.34	0.03	0.05
Coefficient of variability (%)	7.00	7.50	11.42	12.14
Minimum (mm)	14.13	13.39	8.50	9.50
Maximum (mm)	19.91	18.63	28.50	22.50

Table 3. Statistical description of acorn diameter/length ratio in *Quercus robur* and *Quercus petraea*

Statistics	Population means		All acorns	
	Q. robur	*Q. petraea*	*Q. robur*	*Q. petraea*
Sample size	122	50	12599	5099
Mean (mm)	0.5890	0.6792	0.6000	0.6900
Semiinterval of confidence (mm) (=0.05)	0.0061	0.0108	0.0012	0.0021
Coefficient of variability (%)	5.76	5.59	11.60	11.18
Minimum (mm)	0.5005	0.5875	0.4000	0.4000
Maximum (mm)	0.7492	0.7735	0.9600	0.9600

Table 4. Correlation coefficients of features of *Quercus petraea* acorns representing 50 populations (provenances)

Feature	Diameter	D/L ratio	Latitude	Longitude
Length L	0.5939***	-0.6771***	-0.0211	-0.0359
Diameter D	×	0.1551	0.0920	-0.1005
D/L ratio	×	×	0.1840	-0.0234
Latitude	×	×	×	-0.4513***

* =0.05; *** =0.001

Table 5. Correlation coefficients of features of *Quercus robur* acorns representing 122 populations (provenances)

Feature	Diameter	D/L ratio	Latitude	Longitude
Length L	0.7093***	-0.5033***	-0.5705***	0.0006
Diameter D	×	0.2495*	-0.4714***	0.0513
D/L ratio	×	×	0.2343*	0.0575
Latitude	×	×	×	-0.2386*

* =0.05; *** =0.001

the south of Poland, populations of *Q. robur* are characterized by larger acorns than in the north. This finding is a new one and it should be commented on.

Disscusion

The variability of the size of acorns is usually measured by the mass of 1000 acorns. According to Tyszkiewicz (1949) it ranges between 1.5 kg – 5.0 kg the in case of *Q. petraea* and between 2.0 kg – 7.0 kg in the case of *Q. robur*. Probably, they were estimated for samples that were tested in seed testing stations and they refer to the fresh mass. In our studies conducted on 69 stand-samples of *Q. robur* collected in 1982, dry masses of samples were compared (Barzdajn 1994) and they varied from 1767 g (Krotoszyn provenance) to 4702 g (Chełm provenance). In both series of our study (in 1982 and 1993) large differences in acorn size were found between populations. These differences were not justified by climatic differences. This confirms the opinion of Tyszkiewicz (1949) and Krahl-Urban (1959), that the size of acorns may be influenced by the population and the seed year. In both series similar results were obtained in the case of *Q. robur* in spite of testing different populations. In 1982 the average length of acorns was (mean ± semiinterval of confidence) 28.01 ± 0.01 mm and the coefficient of variability was V=12.89%. In 1993 the values were as follows: 27.63 ± 0.06 mm and V=11.42%. For the diameter of acorns the mean values were: 17.00 ± 0.01 mm and V=12.52% (1982) and 16.04 ± 0.03 mm, V=14.42% (1993). The mean diameter/length ratio was 0.6134 ± 0.0019 and V=13.11% in 1982; and 0.6000 ± 0.0012 mm, V=11.60% in 1993. The coefficients of variability of all characters are similar and rather low. The opinion about the large variability of acorn size is based rather on the observed extreme values. In the case of *Q. robur* the minimal length of acorns was observed in 1993 and it was 14.5 mm and the maximal value was noted in 1982 and it was 40.8 mm. The extreme values of diameter were found in 1993 and they were: maximal 28.5 mm and minimal 8.5 mm. The diameter/length ratio may vary from 0.37 (1982) to 0.96 (1993). In the case of *Q. petraea* results can be presented only for the year 1993. The variability of the length of acorns of this species is slightly lower than in the case of *Q. robur* and the other features are more variable (Tables 1–3).

The observed negative correlation between acorn size and latitude (in Poland) is a new result. However, the following two hypotheses can be proposed:

1. In the colder climate characterized by a shorter growing season in the north of Poland, attaining of larger dimensions of acorns is not possible.
2. Return from the Pleistocene refugies was easier for the genotypes producing smaller acorns.

References

Barzdajn W. 1993. Preliminary results of an experiment with polish provenances of pedunculate oak (*Quercus robur* L.) and sessile oak (*Q. petraea* (Matt.) Liebl.). Ann. Sci. For. 50, Suppl. 1: 222–227.

Barzdajn W. 1994. [Size variability of acorns *Quercus robur* L. in Poland]. PTPN, Prace kom. rol. leś. 128: 5–13 (in Polish, Eng. summary).

Barzdajn W. 2000. Proweniencyjne doświadczenie z dębami (*Quercus robur* L. i *Q. petraea* [Matt.] Liebl.) z 1993 roku w nadleśnictwach Milicz i Oborniki Śląskie. [Provenance trial of oaks (*Quercus robur* L. and *Q. petraea* [Matt.] Liebl.) from 1993 in Milicz and Oborniki Śląskie Forest Districts]. Sylwan 144 (12): 57–67 (in Polish, Eng. summary).

Cieslar A. 1923. Untersuchungen über die wirtschaftliche Bedeutung der Herkunft des Saatgutes der Stieleiche. Zentralbl. Ges. Forstwes. 49: 97–149.

Ejtingen G. 1926. Der Wuchs der Eiche in Abhängigkeit von dem Gewicht der Eicheln. Forstwiss. Cbl. 48: 849–863.

Goetz J. 1931. Zmienność owoców dębu szypułkowego (*Quercus pedunculata* Ehrh.). [Variability of acorns of pedunculate oak (*Quercus pedunculata* Ehrh.)]. Rocz. Pol. Tow. Dendrol. 4: 3–12 (in Polish).

Krahl-Urban J. 1959. Die Eichen. Verlag Paul Parey, Hamburg u. Berlin.

Popov A.N. 1949. Dub i jego razvedenie v lesnykh massivakh i nasaždeniakh. Goslesbumizdat Moskva-Leningrad.

Tyszkiewicz S. 1936. Statystyka urodzaju, ocena wartości siewnej i normy wysiewu żołędzi. [Statistics of seed crop, sowing value and sowing density of acorns]. IBL, Ser. A. Nr 18.

Tyszkiewicz S. 1949. Nasiennictwo leśne [Forest seed science]. IBL Warszawa, Ser. D Nr 2. 1–357.