

Oak Tree Hybrids in the Bejan Forest

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The Bejan Forest, located near Deva in the Western Transylvania Region of Romania, has been well known since the last century as a unique ecological reserve supporting numerous hybrids of indigenous oaks. The literature cites the following oak hybrids in the Bejan Forest:

- *Q. xtabajdiana* Simonk. (*Q. frainetto* × *Q. polycarpa*)
- *Q. xtufae* Simonk. (*Q. frainetto* × *Q. petraea*)
- *Q. xdacica* Borb. (*Q. polycarpa* × *Q. pubescens*)
- *Q. xhaynaldiana* Simonk. (*Q. frainetto* × *Q. robur*)
- *Q. xkeneri* Simonk. (*Q. pubescens* × *Q. robur*)
- *Q. xbudensis* Borb. (*Q. pubescens* × *Q. virgiliana*)

In addition, some varieties of these hybrids are also mentioned:

- *Q. xdacica* var. *tiszae* Simonk. et fekete
- *Q. xhaynaldiana* var. *heuffelii* Simonk.
- *Q. xkeneri* var. *devensis* (Simonk.)

Our investigations, performed in 1988, 1989 and 1990, revealed a series of new hybrids and varieties not previously recorded in the Bejan Forest. This is not surprising, since no less than eight of the nine indigenous oak tree species of Romania occur in an area covering only 200 ha, providing many opportunities for interfertilization. The newly identified taxa are:

- Q. xrosacea* Beschst. (*Q. robur* × *Q. petraea*)
- Q. xrosacea* var. *petraeiformis* Beldie.
- Q. xrosacea* var. *feketei* Simonk.
- Q. xrosacea* var. *jahnii* Simonk.

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Q. xpseudodalechampii Crtz. (*Q. robur* × *Q. dalechampii*)

Q. xpseudodalechampii var. *cretzoui* Pascovschi

Q. xcsatoi Borb. (*Q. robur* × *Q. polycarpa*)

Q. xdiversifrons Borb. (*Q. petraea* × *Q. virgiliana*)

Q. xcazanensis Pascovschi (*Q. dalechampii* × *Q. virgiliana*)

The differences between these new hybrids have been established, in general, using the diagnostic criteria in *Flora Romaniei (Flora RSR)* and *Monografia Stejarilor din Romania*. For hybrids between the *Sessiliflorae* Series and *Q. virgiliana*, the diagnoses are original. For instance, in *Q. xdiversifrons*, leaves are intermediate between the two parent species, but closer to *Q. petraea* (not having alternate characters). The shape of cup scales also shows traits of *Q. petraea*, in addition to *Q. virgiliana*: short peduncles (0.5-0.8 cm) and no sessile cups.

Since oak species such as *Q. petraea*, *Q. dalechampii* and *Q. polycarpa* are in direct contact in the Forest, but the Forest itself is somewhat isolated, we believe the hybrids we have investigated are true hybrids and not subspecies or varieties, as sometimes has been proposed. This



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Q. xtufae (*Q. frainetto* × *Q. petraea*) in the Bejan Forest near Deva, Romania (tree #695-5).

conclusion is reinforced by the observation that there is a consistent morphological stability among these hybrids. Thus, the following hybrids have been provisionally described:

- *Q. petraea* × *Q. dalechampii*
- *Q. petraea* × *Q. polycarpa*
- *Q. dalechampii* × *Q. polycarpa*

The characteristics of the leaves of these hybrids are intermediate between those of the parent trees (leaf shape, lobation, form, etc.), or closely resemble one of them (coriaceousness and shininess), the same case being true with fruits (cups partially flat and partially globular). However, for all of these hybrids, diagnoses are provisional and should be supplemented by subsequent investigations of material derived from other trees.

A special place in the study of Bejan Forest is occupied by hybrids resulting from repeated backcrossing, and the double or multiple hybrids confirm the very remarkable ability to hybridize within mixed populations of local oak trees. This has produced the hybrids between *Q. petraea* and *Q. xrosacea*, between *Q. xtufae* and *Q. frainetto* (introgressive), and between *Q. petraea* and *Q. xpseudodalechampii* (multiple hybrids). There are, no doubt, other series of secondary hybrids in the Bejan Forest. Figure 1 is a diagrammatic representation of all known hybrids in the Forest.

Nevertheless, we have to mention that in our field research and in the material previously collected (leaves and fruits harvested by Augustin Stanciu, working under the auspices of Romsilva's Forest District Inspectorate for Hunedoara), we failed to find the following hybrids previously cited in the Bejan Forest:

Q. xtabajdiana Simonk.
(*Q. frainetto* × *Q. polycarpa*)

Q. xhaynaldiana Simonk. (*Q. frainetto* × *Q. robur*)

Q. xhaynaldiana var. *heuffelii* Simonk.

Q. xkeneri Simonk. (*Q. frainetto* × *Q. polycarpa*)

Q. xkeneri var. *devensis* Simonk.

Q. xdacica var. *tiszae* Simonk. et Fekete
(*Q. polycarpa* × *Q. pubescens*)

Q. xszechenyana Borb. (*Q. frainetto* × *Q. pubescens*), cited by A. Savulescu (unpublished).

Another problem resulting from the hybridization of oak trees in the Bejan Forest involves the combinations with genitors from the *Lanuginosae* Series (*Q. pubescens* and *Q. virgiliana*). Since these species possess a broad polymorphism, some uncertainty is introduced in the diagnoses of *Q. xdacica*, *Q. xszchnyana*, *Q. xcazanensis*, *Q. xkeneri* (*Q. pubescens* × *Q. petraea*), and *Q. xkanitziana*.



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Q. polycarpa × *Q. dalechampii* in the Bejan Forest near Deva, Romania (tree #695-13).

Genetic Prospects of Oak Hybrid Populations

From data collected in the field and from the literature, we have concluded that among the various indigenous oak tree species in the Bejan Forest, except for *Q. cerris*, there probably is full genetic compatibility for hybridization.

Therefore, we also expect to identify other hybrids in addition to those described in the literature, or those described previously by us. In fact, we can speak of a series of oak hybrids, within

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which various forms can be distinguished, some being closer to one or the other genitor.

The hybridization phenomenon in oak trees in the Bejan Forest is also complicated by the possibility of introgression and double or multiple hybridizations. This is the case already mentioned for the hybrid between *Q. xpseudodalechampii* and *Q. petraea*. However, it should not be concluded from these results that there are not limits to interfertilization in the Forest. Our data show that hybrids congregate around their genitors; thus, true interfertilization circles can be distinguished, circumscribed by the reduced distances that most pollen granules move. However, the actual dimensions of these interfertilization circles need further investigation.

In this sense, it would be helpful to determine the ecological component in the process of natural selection of hybrids of various orders. The study of hybrid oak populations in the Bejan Forest offers valuable data on establishing relationships between genes in descendants, as related to genitors, as well as in relation to the nature of genetic control over some characters. Thus, by extrapolating relationships between allele genes from intraspecific hybrids to interspecific ones, the following types of relationships can

be distinguished in oak trees:

Dominance: Manifest in typical or nearly typical characters of one of the two genitors in descendants. This is the case with the shape of the *Q. robur* oak leaf in the hybrid *Q. xrosacea*: with the base of the oak leaf in the same hybrid; with the hairiness of leaves and stems of most hybrids having *Q. pubescens* or *Q. virgiliana* as one parent; and with coriaceousness and shininess of the upper surface of leaves in hybrids with *Q. polycarpa* as a parent.

Semi-Dominance: Represented by intermediate characters between the genitors. Examples are *Q. xrosaea* var. *cretzoui* and *Q. xcsatoi*, with pedunculate, short acorns, characters intermediate between sessile-flowered and pedunculate oaks. Semi-dominance is also present in *Q. xdacica* and *Q. xdacica* var. *tizsae* as leaf and stem pubescence — up to disperse pubescent — although in other cases, pilosity remains a dominant character.

Co-Dominance: Having characters of both genitors in the same organ, such as hybrid leaves resembling those of one genitor, *Q. petraea*, in the upper distal part, and resembling the other genitor, *Q. dalechampii*, in the basal part; or as in the *Q. xcazanensis* hybrid, with *Q. virgiliana* scales in the upper part of the cup (flat, lanceolate) and *Q. dalechampii*

scales (tuberculate) in the lower part.

Alternate Co-Dominance: Revealed by the appearance, rather frequent in oak hybrids, of characters of both genitors in the same organ, but on different branches, as in *Q. xrosacea* var *jahnii*, *Q. xtufae*, etc.

Linkage

The genetic control of characters appears independent for characters such as

leaf shape and lobation, on one hand; and shape and lobation of leaf, versus glabrous character or pilosity of leaf surface, on the other hand. This means that the controlling genes of these characters are located either at large distances on the same chromosome, reducing the likelihood of linkage, or are located on different chromosomes.

In other situations, characters tend to **contd. on pg. 10**

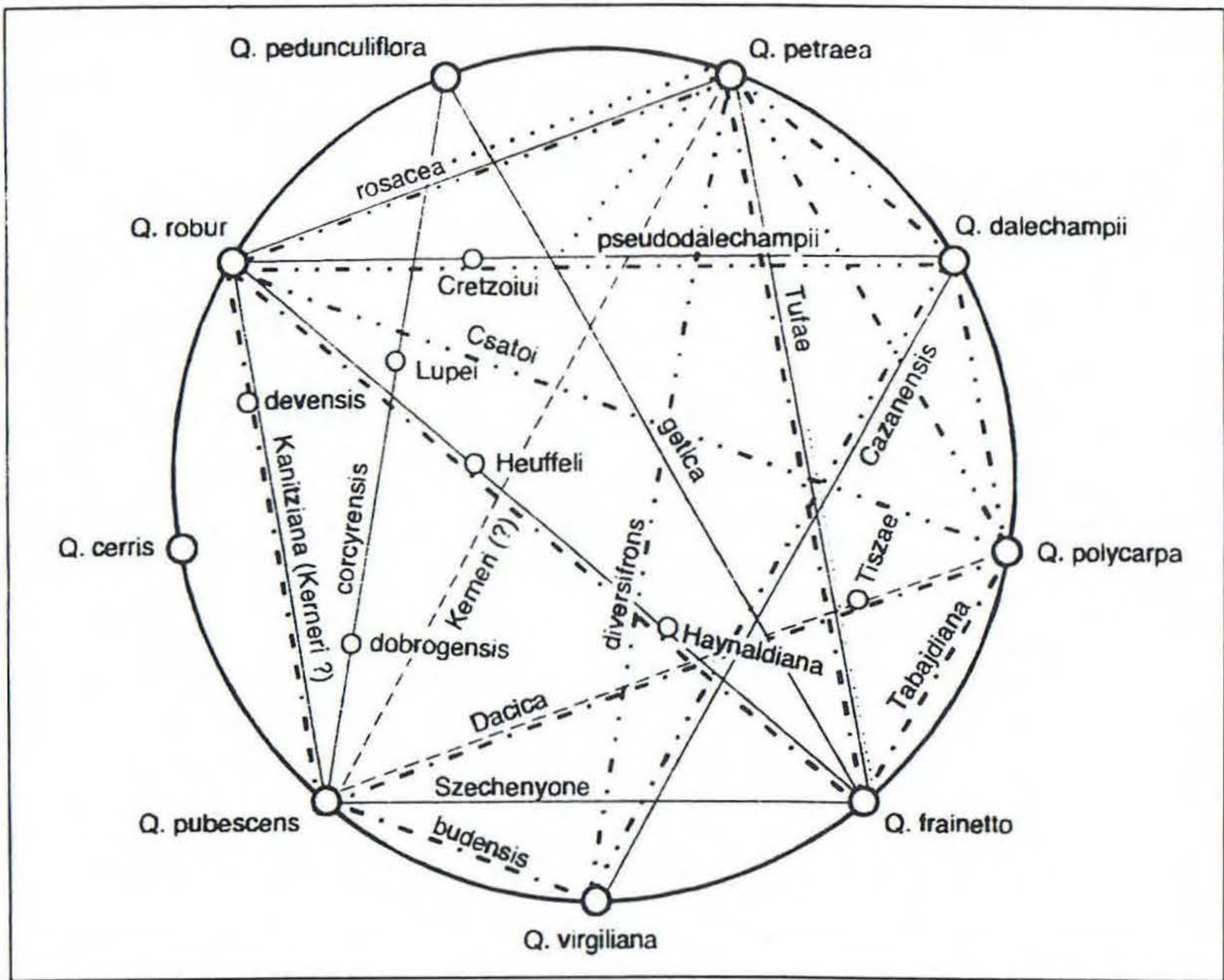


Fig. 1 - Diagram of Quercus genus hybrids (after C.C. Georgescu and I. Moraru) with data added from Flora României and our own investigations in the Bejan Forest)

- LEGEND:
- Hybrids in flora of our country mentioned in „Monografia stejarilor din România”.
 - - - - - Hybrids occurring in the Bejan Forest, after „Flora României”
 - New hybrids in the Bejan Forest (already described in literature)
 - New hybrids in the Romania's flora (for science?) identified in the Bejan Forest
 - Multiple hybrid and introgressive hybrids identified in the Bejan Forest

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be transmitted in association, such as leaf shape with lobation, lobation with length of petiole, coriacity and shininess with leaf pilosity and shape of scales of cups, etc. These characters could be controlled by linkage or even by supergenes.

However, linkage or crossing-over relations are hidden in hybrids by the presence of genes derived from both parents, so that in these instances, the use of some direct methods of investigation are required.

Conclusions

Oak hybridization in the Bejan Forest, which is almost devoid of genetic inter-specific constraints, is a remarkable phenomenon. Further studies are needed from taxonomic, ecological, physiological, and of course, genetic standpoints. The ecological circumstances allowing interfertilization of oaks in the Bejan Forest need particular attention. Nevertheless, due to the frequency of local introgression, one can conclude that the hybrids are fertile, at least partially.

Besides the phytogeographical influence of species interaction, phenological differences exist. They are related to timing of growth initiation, flowering, pollen production, and fertilization and could also affect hybridization. These should be investigated further.

Hybridization of oak trees in the Bejan

Forest, of course, is not just a recent phenomenon. It is possible that hybrids of various orders appeared at different times, with natural selection preserving the most balanced heterozygotes.

The hybrid populations in the Bejan Forest offer an opportunity to establish the relationships between the allele genes from descendants (dominance, semi-dominance, co-dominance, alternate co-dominance). However, this study of *Quercus* hybrids does not offer sufficient conclusive data on the linkage and crossing-over relationships, hidden in hybrids by the relationships between the allele genes derived from the two genitors. But the valuable germplasm existing in the Bejan Forest demands the establishment of special ecological and genetic preservation and conservation strategies. New investigations on local vegetation and biotypes should also be undertaken.

References Cited in this Synopsis

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(Note: 90 additional citations are listed in the original dissertation)