

Bud burst and flowering phenology in a mixed oak forest from Eastern Romania

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Abstract. Bud burst and flowering phenology have been observed in year 2008 in a natural white oak species complex situated in eastern Romania. A total of 300 mature individuals was mapped and identified based on leaf morphology. The community consists of four oak species: *Quercus pedunculiflora*, *Q. robur*, *Q. pubescens* and *Q. petraea*. A set of 28 individuals could not be unambiguously classified to one or another species. Data on bud burst showed a normal distribution and the differences among species were small. The "very late" flushing was recorded on 15th of April, three weeks later when compared to early flushing individuals. The time period between the bud burst and the complete development of leaves was nearly the same in all oak species, varying on average, between 18.4 and 20.6 days. The spatial distribution of phenological groups within the complex appears to be non-randomly, because in many parts of the study plot exist groups in which most of the trees belong to the same phenological category. Our results indicate an overlap in flowering time for all oak species which occur in the area. The data support the hypothesis that inter-specific gene flow is possible between closely related oak species.

Keywords. *Quercus*, bud burst, flowering, oak

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Introduction

Bud burst and flowering are complex processes controlled by both genetic and environmental factors (climate, physiography etc.) (Danciu & Parascan 2002). Phenological observations on tree species are useful for forest management practices (Marcu 1971) and an important indicator of variability and climate change (e.g. Menzel 2000, Chmielewski & Rötzer 2001, Richardson et al. 2006). Especially the flowering phenology can be an effective

reproductive barrier and influences the patterns of hybridization between closely related species (e.g. Bacilieri et al. 1996, Gerard et al. 2006). Data on phenology is also needed when searching for candidate genes in forest tree species (Vornam et al. 2009).

In Romania, in compared with other European countries (e.g. Germany, Great Britain, Czech Republic), phenological observations in forest tree populations were made discontinuously, systematic records being made in the last years in plots of the IPC Forests and

FENOFOR network (Teodosiu et al. 2005). Phenological data on oak species - pedunculate oak (*Quercus robur*) and sessile oak (*Q. petraea*) - were recorded for short time periods in several stands and arboreta across the country (Bălănică & Tomescu 1953, Tomescu et al. 1967, Teodosiu et al. 2005). However, no data about bud burst, flowering and leaf fall are reported for *Q. pedunculiflora* K. Koch., a lesser known oak taxon occurring in S-E Europe (Georgescu & Morariu 1948, Schwarz 1993).

A bimodal floral phenology distribution would be regarded as a complete prezygotic barrier between *Q. pedunculiflora* and *Q. robur* and it would support the hypothesis of the existence of two separate species. On the contrary, an unimodal distribution would rather suggest that the flower phenology does not constitute a reproductive barrier between them and the two taxa are part of the same species. The aim of this study was to examine the leaf unfolding and flowering phenology at a fine scale in a mixed forest with *Q. robur* and *Q. pedunculiflora*. The phenological observa-

tions, particularly on flowers, in these two oak taxa, are part of a large genetic and morphological investigation which aims to clarify the taxonomical status of *Q. pedunculiflora*. This species is considered either as separate species (Georgescu & Morariu 1948, Schwarz 1993) or as intraspecific unit of *Q. robur* (e.g. Petit et al. 2002, Broshtilov 2006).

Materials and methods

The studied tree species are monoecious, i.e. they produce on the same tree both male and female flowers. As most of the temperate tree species, they are wind-pollinated. *Q. robur* prefers nutrient-rich and wet soils whereas *Q. pedunculiflora* is more adapted to xeric conditions (Șofletea & Curtu 2007).

The study plot is located at Fundeanu forest (45°58'41"N, 27°41'26"E, altitude 230 m above sea level), Grivița Forest District, Galați Forest Directorate, in eastern Romania. A total of 300 adult oak individuals were sampled, numbered and mapped by using a high precision Leica SR 20 GPS unit (Figure 1).

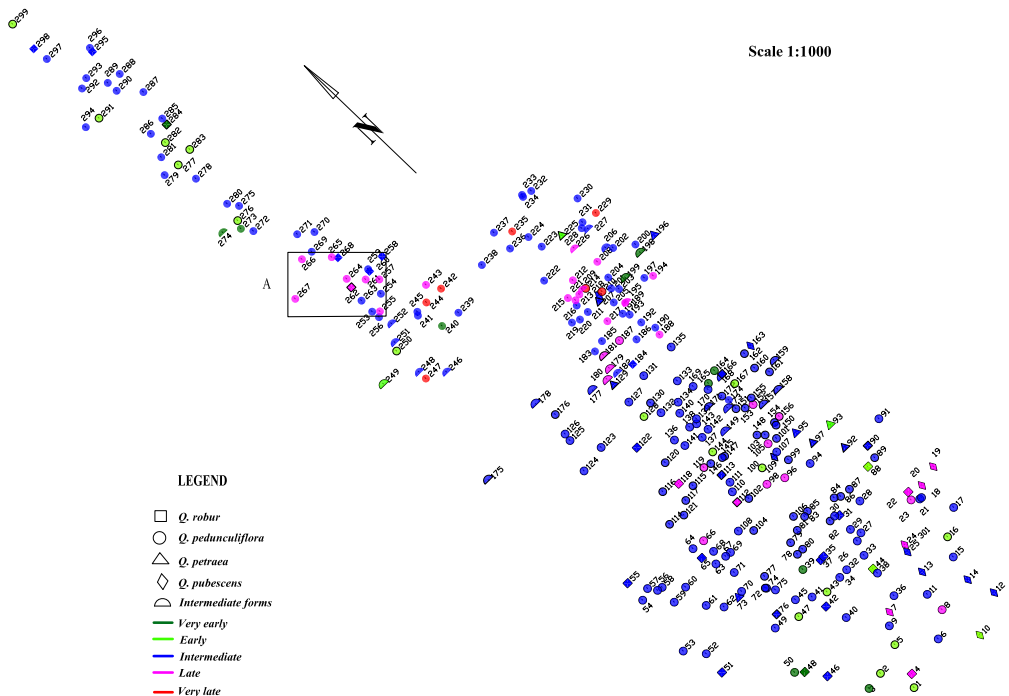


Figure 1 Map of the study site and distribution of oak tree on bud burst categories in year 2008

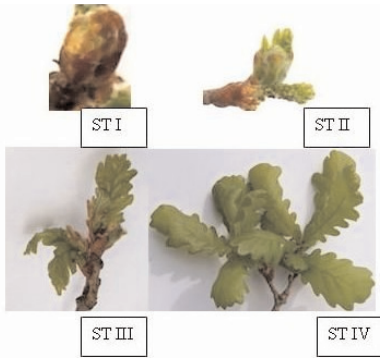


Figure 2 Different developmental stages for leaf unfolding

The raw data were processed with Leica Geo Office software, and the tree distribution map was drawn with AutoCAD software. All trees were classified as species or morphologically intermediate based on leaf morphological

characters (Georgescu & Morariu 1948, Dumitru - Tătăranu et al. 1960, Tutin et al. 1993, Stănescu et al. 1997). Within the study plot we identified 222 *Q. pedunculiflora* individuals, 28 *Q. robur* individuals, and 28 individuals which could not be unambiguously classified as *Q. robur* and *Q. pedunculiflora*. We named these individuals as morphological intermediates. Additionally 10 *Q. petraea* individuals and 12 *Q. pubescens* were also found (Figure 1).

Phenological observations of bud burst and flowering were made every two-three days in spring of 2008. The observations were made in upper part of the crown, whenever possible. For some trees, they were done in the middle part of the crown. The observations were made from the same direction (Preuhsler 1999). Based on the field observations, for bud burst, the trees were grouped in five classes: very early flushing, early flushing, normal, late

Table 1 Oak tree distribution on phenological classes for bud burst at Fundeanu

Morphological group	Number of individuals	Phenological class									
		Very early flushing		Early flushing		Intermediate		Late flushing		Very late flushing	
		No.	%	No.	%	No.	%	No.	%	No.	%
<i>Q. pedunculiflora</i>	222	7	3,2	17	7,6	165	74,3	26	11,7	7	3,2
<i>Q. robur</i>	28	2	7,1	2	7,1	19	67,9	5	17,9	-	-
Intermediates between <i>Q. robur</i> and <i>Q. pedunculiflora</i>	28	4	14,3	-	-	17	60,7	7	25	-	-
<i>Q. petraea</i>	10	-	-	2	20	8	80	-	-	-	-
<i>Q. pubescens</i>	12	-	-	1	8,3	6	50	4	33,4	1	8,3
TOTAL	300	13	4,3	22	7,3	215	71,7	42	14	8	2,7

Table 2 Mean length of the interval between bud burst and complete leaf development on phenological classes at Fundeanu

Cr. No.	Morphological group	Phenological class					General mean (days)
		Very early flushing	Early flushing	Intermediate	Late flushing	Very late flushing	
		Mean period (days)					
1	<i>Q. pedunculiflora</i>	29,4	25,3	18,4	16,7	14,9	19
2	<i>Quercus robur</i>	28,5	26	19,8	17,2	-	20,4
3	Intermediates between <i>Q. robur</i> and <i>Q. pedunculiflora</i>	28	-	18,1	16,8	-	19,2
4	<i>Q. petraea</i>	-	26,5	16,4	-	-	18,4
5	<i>Q. pubescens</i>	-	32	21	18,2	16	20,6