EVALUATION OF LEAF UNFOLDING OF BEECH (*FAGUS SYLVATICA*) IN THE CZECH REPUBLIC IN THE PERIOD 1961–1990

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European beech (Fagus sylvatica) is among the most important forest species, with an ability to grow on a grate variety of sites all over Europe. At present, a special interest of forest ecologists focuses on the change of the beginning or duration of phenological phases as a result of climate warming and on its possible consequences (e.g., Chmielewski and Rötzer, 2001). Phenological observations have a long tradition in the Czech Republic and CHMI manages phenological network. In this paper was evaluated the phenological phase leaf unfolding (BBCH 11) from subsequent phenological stations: Česká Třebová (290 m asl) and Liščí (370 m asl). Both stations are located in different climatic conditions in the frame of the Czech Republic. The aim of this work is to assess which meteorological parameters influence the phenological onset and to analyze the shifts of dates of phenophase onset during 1961–1990. The station located at higher altitude shows the shift of phenophase to earlier date on the other side station situated at a lower elevation expresses the shift of leaf unfolding to later date.

Keywords: phenology, Fagus sylvatica, leaf unfolding, BBCH 11, Czech Republic

INTRODUCTION

Many studies examining the impacts of global warming on terrestrial ecosystems reveal a consistent pattern of change, the response to warming by phenological change across the northern hemisphere seems to be especially well documented (e.g., IPCC, 2007; Parmesan & Yohe, 2003). Long-term phenological records in trees, including spring events such as leaf unfolding and autumnal events of leaf colouring, have shown that a rise in global temperature generally leads to earlier timing of spring events and poleward and upward shifts in plant ranges (e.g., IPCC 2007; Parmesan and Yohe 2003).

In addition, phenological responses vary geographically, due to the heterogeneous geographical variability of warming (e.g., Chmielewski and Rötzer 2001; Doi and Takahashi 2008). The last AR4 report (IPCC 2007) therefore suggests that we should now focus on detailed sub-regional studies, particularly in areas that represent transitional climate areas.

European beech (*Fagus sylvatica* L.) is an important and widespread forest tree species in Europe. Several recent studies have shown that it might retreat from vulnerable ecosystems, especially at the edge of its natural range (e.g., Geßler *et al*. 2007; Kramer *et al*. 2010).

Beech needs an adequate period of chilling (generally at temperatures below about 10 °C) for release of winter dormancy and, after this, exposure to warm temperatures (forcing temperatures) are needed to trigger budburst. In addition, beech requires a relatively long photoperiod (more than about 12 h of daylight) to resume growth in spring (e.g., Caffarra and Donnelly 2011).

It belongs to a group of woody plants that have been included in several phenological studies dealing with past and possible future effects of changing climate on this species in different areas (e.g., Caffarra and Donnelly 2011; Vitasse *et al*. 2011).

MATERIALS AND METHODS

Phenological observations have a long tradition in the Czech Republic (the first phenological notes have been already carried out in the 18th century) and the Czech Hydrometeorological Institute (CHMI later on) manages phenological network and as a whole, 45 plant species are observed, they are perennial herbs, grass or ground bushes growing widely. We used phenological data of leaf unfolding 10 % (LU 10 % - BBCH 11) of European beech (*Fagus sylvatica* L.) from the phenological stations Česká Třebová (49°54’ N, 16°27’ E, 290 m asl) and Liščí (51°02’ N, 14°21’ E, 370 m asl). Both stations are located in different climatic conditions in the frame of the Czech Republic. Data originated from the phenological archive PHENODATA of the Czech Hydrometeorological Institute. According to the Guidelines for Plant Phenological Observations, the day of LU 10 % was recorded as the first regular surfaces of leaves were becoming visible in 3–4 places on the observed tree. The period of observation was 1961–1990. Climatic data, mean air temperature, mean monthly precipitation total and mean monthly sunshine duration, for the same period 1961–1990, were obtained from climatological stations Ústí nad Orlicí (49°58'49"N, 016°25'20"E, 402 m asl) and Liberec (50°46'11"N, 015°01'26" E, 398 m asl).

The aim of this paper is to assess which meteorological parameters influence the phenological onset and to analyze the shifts of dates of phenophase onset during 1961–1990.

Data were processed in the framework of Microsoft Excel, additionally; we used correlation function analysis to identify main climatic parameters explaining year-to-year variations in phenological series. Synoptic situation occurrence was made according to “Brádka” calendar (www.chmi.cz).

RESULTS

In the period 1961–1990, the average day of the year (DOY) of the LU 10 % varied from 30 April (DOY 120) to 2 May (DOY 122). Extreme values of LU 10 % were 12 April 1961 (DOY 102) and 11 May 1963 (DOY 131) at Česká Třebová station, and 17 April 1974 (DOY 107) and 13 May 1966 (DOY 133) at Liščí station. In 10 years‘period (1961–1970, 1971–1980 and 1981–1990) were average days of phenophase

onset were subsequent - Česká Třebová station: 28 April (DOY 118), 1 May (DOY 121) and 2 May (DOY 122); Liščí station: 1 May (DOY 121), 4 May (DOY 124) and 2 May (DOY 122). Statistical characteristics and deviations from normal value 1961–1990 are shown in Figure 1, 2. Extreme values of deviations varied from -18 days to +11 days.

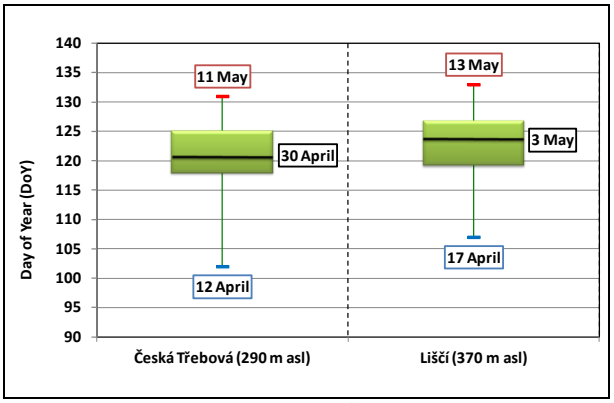

Figure 1. Statistical characteristics of LU 10 % (1961–1990)

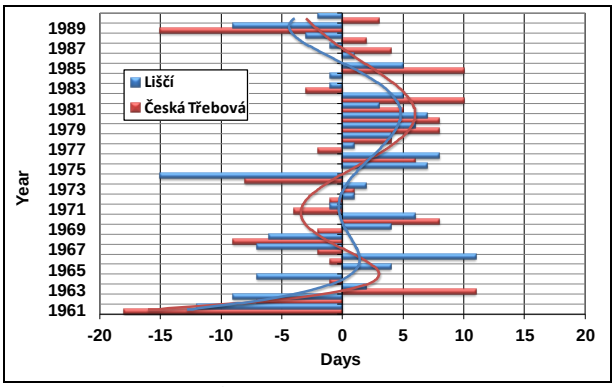

Figure 2. Deviations from normal value 1961–1990

Overview of synoptic situation occurrence is given in Table 1. Highlighted text means the same situation occurrence at both stations. Situations are various, alternating. The most often found synoptic situating was NEa (2x), Wcs (2x) and SWc3 (2x) at Česká Třebová station and SEc (3x) at Liščí station.

Table 1. Occurrence of synoptic situation on date of LU 10 %

	Česká Třebová	Liščí		Česká Třebová	Liščí
1961	Ap4	Ea	**1976**	Ap1	A
1962	Ea	Ea	**1977**	SWc2	Sa
1963	Wal	B	**1978**	SWa	C
1964	Wc	Vfz	**1979**	Ec	Ec
1965	*	Bp	**1980**	Wcs	Wcs
1966	NEa	Ea	**1981**	Bp	Bp
1967	NWa	NEc	**1982**	SWc3	SWc3
1968	SWa	C	**1983**	SWc1	SWc2
1969	SWc3	B	**1984**	NEc	SEc
1970	SEc	SEc	**1985**	C	SEc
1971	Wcs	Ec	**1986**	Ec	A
1972	Ap2	Ec	**1987**	B	Ap1
1973	SWc2	SWc2	**1988**	SEa	SEc
1974	Nc	Nc	**1989**	SEc	Bp
1975	A	C	**1990**	NEa	NWc

*Gap in dataset

Table 2. Correlation coefficients between LU 10 % and climatic variables

	Jan	Feb	Mar	Apr
Liščí				
Temperature	0.86	0.96	0.76	-1.0
Precipitation	0.04	-0.97	-0.96	-1.0
Sunshine	0.36	0.11	0.68	-0.94
Česká Třebová				
Temperature	0.96	0.72	0.99	-0.40
Precipitation	0.29	-0.99	-0.92	0.71
Sunshine	0.50	0.50	-0.50	0.50

Year-to-year variation of LU 10 % has significantly correlated with inter-annual variations in January, February and March by temperatures, and in February and March by precipitation totals (Table 2.) – negatively by precipitation and positive by temperatures. Correlation between sunshine duration and LU 10 % occurrence is weaker, mainly in January and February.

CONCLUSION

Leaf unfolding 10 % in European beech is similar at both stations and onsets are variable. The shift of phenophase onset to earlier date is more significant by station located in higher elevation. There is no dependence on synoptic situation occurrence and the closest correlation is between temperature and precipitation in January and March – findings are similar at both stations.

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