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PHENOLOGY OF HERBACEOUS VEGETATION IN BROADLEAVED FOREST OF KAMSA BOTANICAL–ZOOLOGICAL RESERVE

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The aim of this work was to determine seasonal dynamics of the herbaceous vegetation in the deciduous forests and their relations with climatic factors. The object of the work was Kamsa botanical-zoological reserve situated near Kaunas. Investigations were done during vegetation periods in 2009 and 2010. The dates of phenological appearance and projection cover we recorded. The spectra of vegetation and flowering were made. Vegetation of herbs started at the end of March (13th week). Intensive vegetative development started at the 15th week in 2009, and at the 14th week in 2010. The coldest year was in 2009. In this year vegetation and flowering of herbs started later than in other years. In 2009, 2010 dry period was the month of April and 2009 from the end of July till the beginning of August.

Key words: deciduous forest, efemeroids, phenology.

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INTRODUCTION

Recent climate change has been found to affect species' phenology in global and local scale (Parmesan & Yohe 2003, Root et al. 2003, Walther 2004).

The use of phenological data as indicator for climate variations is based on the relationship between climate parameters and phenological phases. The date of phenological events such as flowering could be explained by differences in temperatures from an arbitrary date to the date of the phenological event considered. However, phenophases are integrating climatological indices (Menzel 2002) responding to many meteorological and environmental factors (light, photoperiod, temperature, precipitation, humidity, wind, and others).

Nowadays it is widely accepted that the global and regional climate is changing, partly in response to human activities. The Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) provided an overview of the changes that have occurred (IPCC 2007). It was stated that since 1906 to 2006 temperature increased by 0.74 C^{o}.

Biological systems quickly respond in the timing of phenological stages to changes in the climate (Myneni et al. 1997, Ahas 1999, Chmielewski

& Roetzer 2001, Green et al. 2001, Penuelas & Filella 2001, Walther 2004).

Changes in the timing of phenological events are relevant for many natural processes thereby influencing biodiversity. As natural systems respond quickly to changes in climate, it is becoming more important to assess phenology in different ecosystems.

Seasonal variety of vegetation is one of the most important ecological adaptations, which is common in the middle latitude vegetation. This phenomenon is particularly clear in board-leaved forests. Spring efemeroids (short time vegetation plants) flower in the period starting from snow melting till leaves on trees foliate, when a lot of light reach the ground. During summer time efemeroids are replaced by species, which like warm conditions, are heliophobic and have long vegetation. During majority of vegetation season such plants dominate in forest herbaceous cover.

Plants adapt to live in certain environmental conditions. Plants are dependent on seasonal environmental conditions: temperature, moisture and the length of the day variation. Variation of climatic conditions (light, temperature, moisture) through the year influence the growth of plants and the periodicity of development. All plant species individually adapt to periodical variation of climate and develop in their own optimal time of a year.

Phenology of broad-leaved forest has been studied in Russia, Poland, Germany and USA (Gorishina 1969, Falinska 1986, Ellenberg 1979, Fred & Taylor 1974). There is still a lack of data on seasonal dynamics of broad-leaved forest vegetation under different climate regimes.

The objective of this study was to estimate seasonal dynamics of herbaceous vegetation of the broad-leaved forest ecosystem and evaluate its changes comparing the years of different climatic regimes.

MATERIAL AND METHODS

The study area is located in the middle of Lithuania in Kamsa botanical-zoological reserve (54° 53.898' N, 23° 50.091'E). The study area falls in the transitional deciduous coniferous mixed forest zone of Europe (Ahti et al. 1968). Climate conditions are sub oceanic. It is common mild winters and chilly summers, variable weather, long year seasons alternation periods. Annual mean temperature is 6.2 °C. The annual mean precipitation is 612 mm. Period with snow continues from 75 to 90 days. The majority of precipitation is during warm year period (Bukantis 1994).

The investigations were performed in the 140-year-old forest, which is typical for Kamsha reserve. The trees of *Tilia cordata* Mill., *Acer platanoides* L., *Fraxinus excelsior* L., *Ulmus glabra* Huds., *Quercus robur* L. and shrubs of *Lonicera xylosteum* L., *Padus avium* Mill., *Euonymus verrucosus* Scop., *Corylus avellana* L. dominated in the site.

We recorded the dates of phenological appearance (flowering of herbaceous plants) and projection cover of herbaceous vegetation during vegetation periods in the years of 2009 and 2010. In 10 plots of 1x1 m size we registered phenological appearance and projection cover in percent of each species two times per week in spring time and one time per week in summer time. The spectra of vegetation and flowering were made (Fred, Taylor 1974). With the purpose to compare the changes of phenology under different climate conditions we used data on temperature and precipitation from Kaunas meteorological station, which is situated near the study location (about 2 km). We counted sums of active temperatures (>5ºC) for each year and compared with the dates of phenological appearance.

RESULTS

The changes of projection cover of herbaceous vegetation during vegetation period are shown

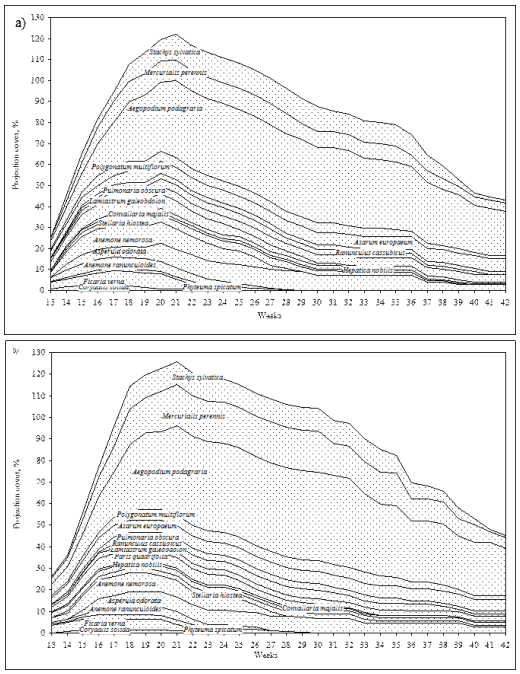

Fig. 1. Projection cover during vegetation period in a) 2009, b) 2010.

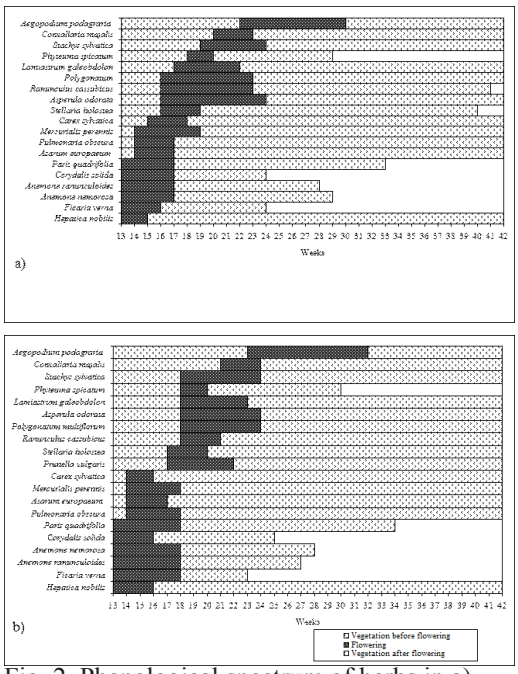

Fig. 2. Phenological spectrum of herbs in a) 2009, b) 2010.

in the figure 1. Vegetation of herbs started at the end of March (13th week). Intensive vegetative development started at the 15th week in 2009, and at the 14th week in 2010. Projection cover of efemeroids such as *Anemone nemorosa* L., *Anemone ranunculoides* L., *Corydalis solida* (L.) Clairv. and *Ficaria verna* Huds was the highest at the end of April and May and decreased intensively the beginning of July. Projection cover of herbs started decreasing at the beginning of August (30th week).

The flowering of herbaceous vegetation in broad leaved forest is shown in the figure 2. Most herbs flowered from the beginning of April to the beginning of June. *Hepatica nobilis* Mill., *Ficaria verna* Huds, *Anemone nemorosa* L., *Anemone ranunculoides*, *Corydalis solida* (L.) Clairv, Paris quadrifolia L. started flowering first. *Asperula odorata* L., *Stellaria holostea* L., *Polygonatum multiflorum* (L.) All., *Ranunculus cassubicus* L., started flowering later. *Aegopodium podagraria* L. flowered in the first part of Juni.

DISCUSSION

Phenology of plants depends on the temperature and precipitation of the year. The temperature has an influence to anatomical, morphological, physiological processes of plants also to growth and development of plants. The influence of temperature is many-sided and connected not only with certain temperature but also with its variation during the year or the day (Fitter& Fitter 2002, Menzel 2002, Chuine et al. 2003).

Flowering of herbaceous vegetation in broad leaved forests depends on the foliation of trees in the stand. The majority of plants flowered in spring when trees were without leaves and light conditions were good.

Mean temperatures per week are shown in the figure 3 and sums of active temperatures are shown in the figure 4. In the temperate zone the temperature is a limiting factor in spring time when vegetation and flowering of plants starts.

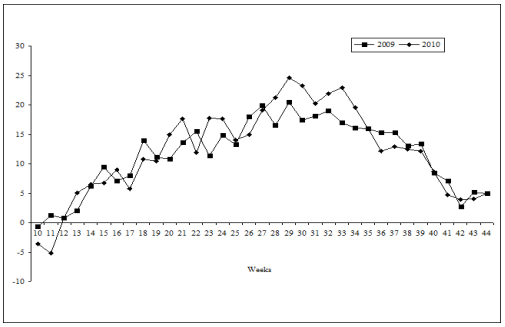

Fig. 3. Mean temperatures of week in 2009, 2010.

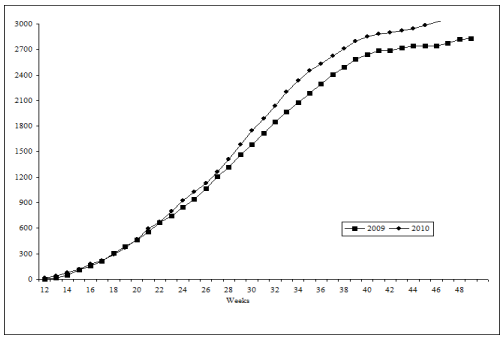

Fig. 4. Sum of temperatures > 5°C.

The coldest year was in 2009. In this year vegetation and flowering of herbs started later than in other years.

Equal precipitation distribution during the vegetation period is important for the development of plants. In 2009, 2010 dry period was the month of April and 2009 from the end of July till the beginning of August (Fig. 5). During dry period the projection cover of herbs decreased (especially of *Aegopodium podagraria* L.). In 2009, 2010 dry period started in September, so projection cover of herbs decreased in early autumn.

CONCLUSIONS

Vegetation of herbs started at the end of March (13th week). Intensive vegetative development started at the 15th week in 2009, and at the 14th week in 2010.

Most herbs flowered from the beginning of April

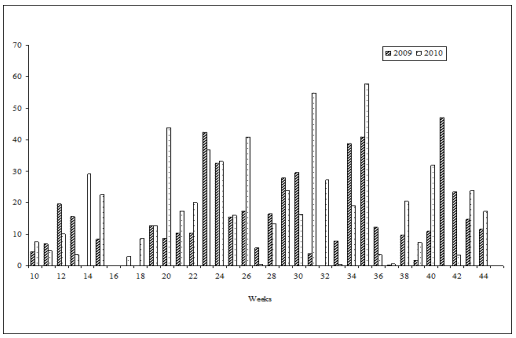

Fig. 5. Week precipitation in 2009, 2010.

to the beginning of June.

The coldest year was in 2009. In this year vegetation and flowering of herbs started later than in other years.

In 2009, 2010 dry period was the month of April and 2009 from the end of July till the beginning of August.

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