

ECOLOGY AND MORPHOLOGY OF THE FLOWERS OF *HEPATICA NOBILIS* SCHREB. (RANUNCULACEAE)

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Abstract. The study was conducted in the years 2009-2010 in the UMCS Botanical Garden in Lublin. The observations involved the flowering time and the seasonal and diurnal dynamics of flowering and pollen production in flowers of the liverleaf (*Hepatica nobilis* Schreb.) from the family Ranunculaceae. The liverleaf begins blooming in early March and the full bloom occurs at the end of March and beginning of April. All-day observations demonstrated that the flowers opened between 8 am and 3 pm, and pollen was released from the anthers between 10 am and 4 pm. The mean weight of pollen produced by 10 liverleaf flowers was estimated at 7.4 mg (1.85 mg/100 stamens). An impact of the weather on the flowering period as well as the seasonal and diurnal dynamics of flowering was observed. Among insect pollinators, the honeybee dominated with a density of 4 individuals per 1m² of a flowerbed that contained 74 open flowers on average.

Key words: *Hepatica nobilis*, flower, morphology, ecology, flowering rate

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Introduction

Species belonging to the Ranunculaceae family are an important element in the Polish flora (SZWEJKOWSKA & SZWEJKOWSKI 1993, 2003). Their flowers can be a valuable source of pollen and nectar for many pollinators such as honey bees, bumble bees, flies (SZKLANOWSKA 1995; DENISOW & ANTOŃ 2012).

The liverleaf (*Hepatica nobilis* Schreb.) is one of the most valuable native representatives of this family (JASIEWICZ 1985; SZAFER *et al.* 1986). It occurs in almost all Europe, East Asia, and North America (CHLEBOWSKI & MYNETT 1995; GIBBONS & BROUGH 1995; ERHARDT *et al.* 2008; SZWEJKOWSKA & SZWEJKOWSKI 1993, 2003). In Poland *H. nobilis* grows across the lowlands in fertile deciduous forest, i.e. beech, hornbeam, and luminous oak forests (GRABOWSKA & KUBALA 2006; SZAFER *et al.* 1986; JASIEWICZ 1985).

In the classification of plant communities, the species is characteristic for the class (Cl.) *Quercu-Fagetea* (MATUSZKIEWICZ 2007). In the past *H. nobilis* was used for medicinal purposes.

Currently, it is cultivated as an ornamental plant being highly valued for its early flowering time, impressive flowers and foliage, health, and longevity (MOWSZOWICZ 1987; SZEWCZYK-TARANIEK 2012). Purple-coloured flowers with a diameter of 15-30 mm appear in early spring before leaf development. They have numerous spirally arranged pistils and stamens (SZAFER & WOJTUSIAKOWA 1969; MOWSZOWICZ 1983; SZAFER *et al.* 1986; AMANN 1997). They are representatives of pollen-bearing plants (LIPIŃSKI 2010).

The aim of the study was to assess the flowering period in the environment of Lublin and the diurnal and seasonal dynamics of flowering and to estimate the flowering abundance and decorative values of *H. nobilis*.

Material and methods

The observations were carried out in 2009 and 2010 in the UMCS Botanical Garden in Lublin. Specimens of the liverleaf (*H. nobilis*) growing on a steep south-eastern slope were investigated. The diurnal flowering dynamics

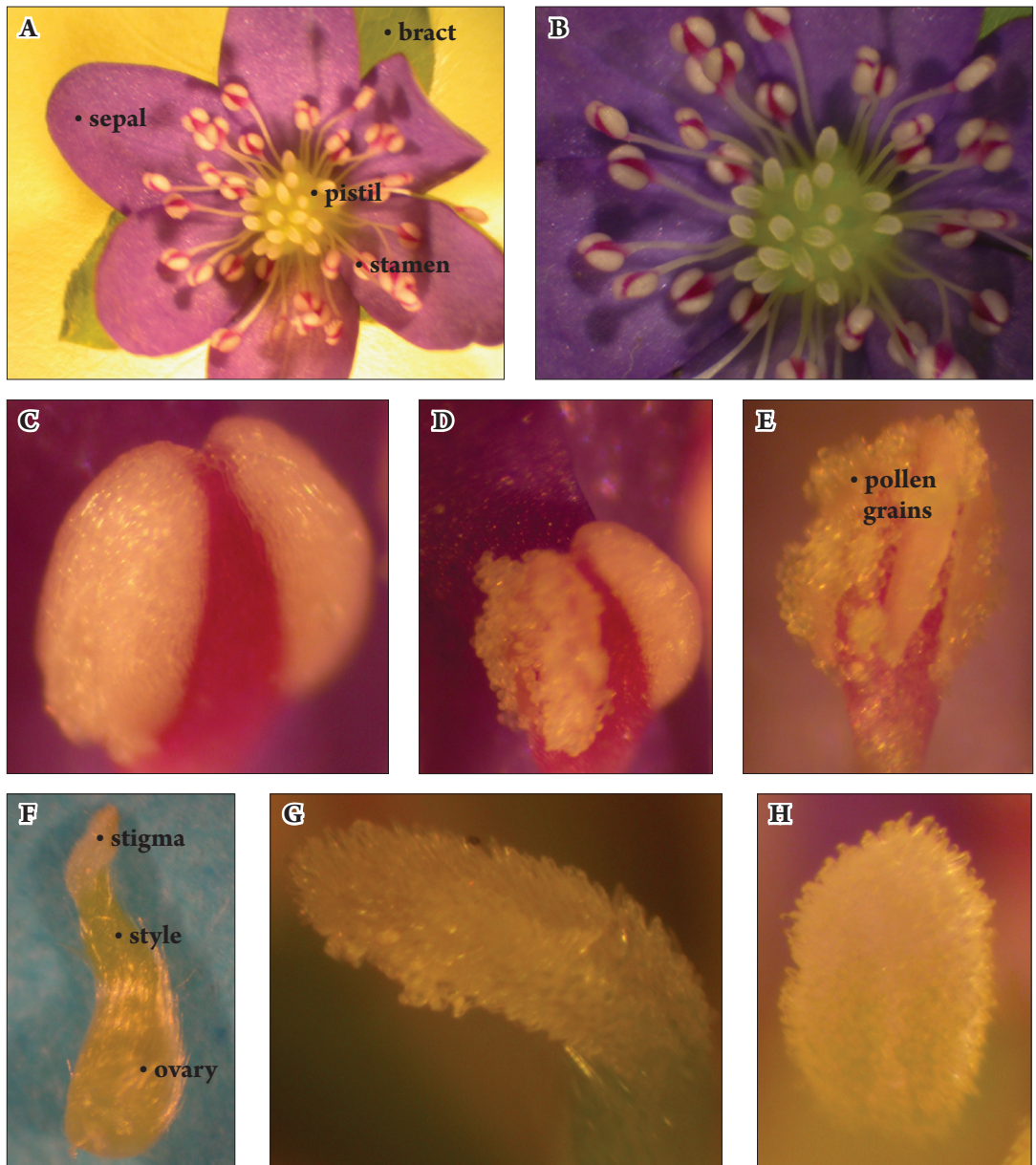


Fig. 1. Flower of *Hepatica nobilis*: **A, B** – common view; **C-E** – anther (subsequent stages of pollen release); **F** – pistil; **G, H** – stigma with elongated epidermal cells.

was assessed during three days of the full bloom period. The number of opened flowers was counted at 1-hr intervals between 7.00 am and 4.00 pm. Next, the percentage proportion of flowers that had opened within an hour to the number of all flowers opened during the whole day was calculated. The seasonal dynamics

of flower opening was studied for two years. Each day during the flowering period, opened buds were counted in a 1 m² plot and next their proportion to all opened flowers during the blooming season was calculated.

The characteristics of meteorological conditions prevailing during the present study

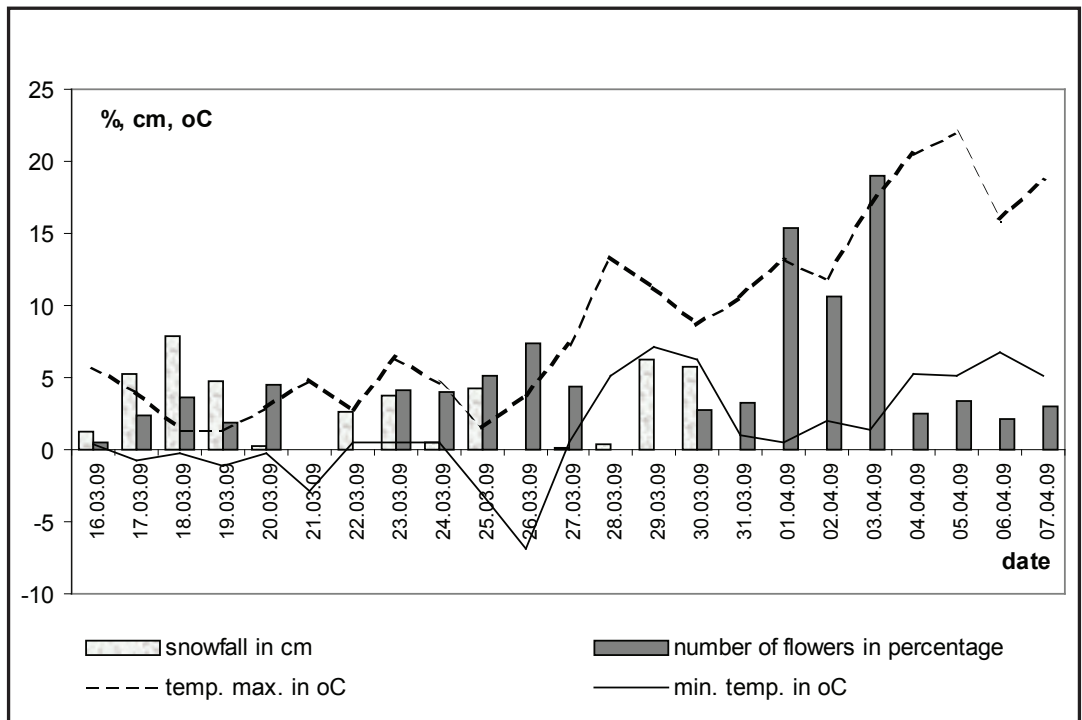


Fig. 2. The distribution of selected weather parameters and flowering rate of *Hepatica nobilis* in 2009.

were made based on the data obtained from the Weather Station of the Maria Curie-Skłodowska University located in the Botanical Garden.

Results and discussion

Morphology

H. nobilis forms an underground rhizome, which produces evergreen three-part leaves and short stalks with a single flower (SZEWCZYK-TARANIEK 2012). The plant reproduces by monospermous achenes. These fruits are equipped in a fat body – the elaiosome, which as a high-calorie attractant for ants, contributes to seed dispersal (PIĘKOŚ-MIRKOWA & MIREK 2006). Liverleaf flowers reach a diameter of 15-30 mm (Fig. 1 A, B). There are three bracts under the flower, which form a pseudo calyx. The perianth is composed of 5-6(11) purple petal-like sepals. There are 30-45 stamens (mean 40) spirally arranged on the convex axis of the flower (Fig. 1 C-E). The apocarpous gynoecium consists of 10-15 pistils with ovaries covered by delicate hairs (Fig. 1 F). The

shield-like stigma bears numerous elongated epidermal cells that facilitate adhesion of tiny pollen grains (Fig. 1 G, H). The liverleaf flower is characterized by dichogamy in the form of protogyny, which is a form of xenogamy. This type of adaptation for cross-pollination is also characteristic for *Eranthis* and *Helleborus* from the family Ranunculaceae (ŻURAW & DENISOW 2002; RYŚIAK & ŻURAW 2011).

Flowering

The development of *H. nobilis* flowers begins in very early spring. In the first year of study flowering of *H. nobilis* lasted 23 days in the term from March 16th to April 7th. In the second year of the study, the flowering period started significantly earlier (3-30.03.2010), i.e. by approximately 2 weeks compared with the first year of observations. The first flowers appeared on February 24th. The flowering period was also longer (28 days). The seasonal flowering dynamic and the diurnal flower opening and pollen release dynamic may have been influenced by the significantly higher

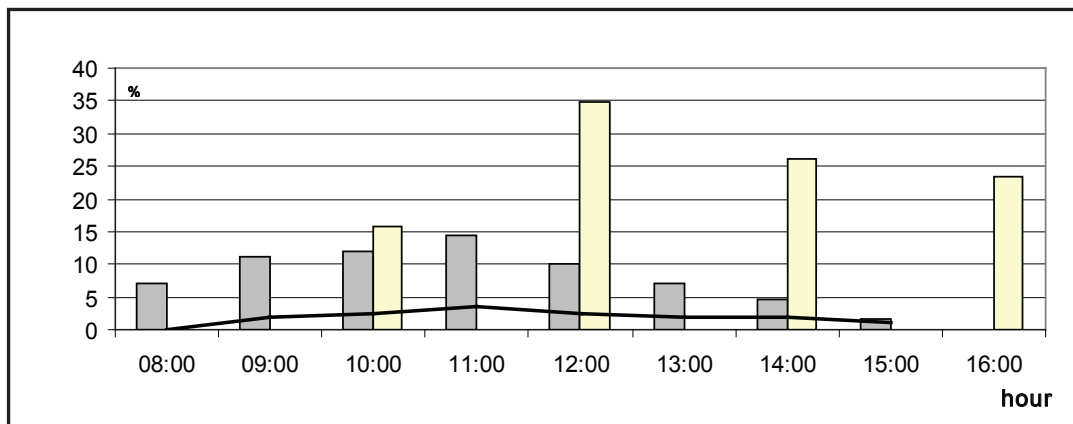


Fig. 3. The daily flowering, visiting by bees and pollen release rate in *Hepatica nobilis* flowers.

8:00-16:00



– observation hours,

– number of flowers opening during 1-hour time periods, expressed as a percentage of all flowers opened during the whole day;



– number of opening anthers during 2-hours time periods, expressed as a percentage of all anthers opened during the whole day;



– number of honey bee foragers observed during 1-hour time periods, expressed as a percentage of all foragers observed on a particular day.

temperature prevailing in March in the second year of the study (Tab. 1). The flowering was clearly inhibited by adverse atmospheric conditions, with snowfall being the primary inhibiting factor rather than the temperature (Fig. 2). 148 flowers were analysed and the area of 1 m². During a day, opening of new flower buds began at 8.00 am and lasted until 3.00 pm with a maximum at 11 o'clock (Fig. 3). The ranges of the diurnal flowering dynamics for the *H. nobilis* were similar to the data for the winter aconite, another Ranunculaceae family representative blooming in March (RYSIAK & ŻURAW 2011).

Pollen release

Pollen release from flower stamens proceeded between 10.00 am and 4.00 pm; in relation to the diurnal dynamics, it was shifted by an hour. The average weight of pollen produced by 10 flowers was estimated at 7.4 mg (1.85 mg/100 stamens).

Flower visiting by insects

During the day-long observation of the flowering dynamics, honeybee pollen foragers were observed on the flowers. The mean density

of these insects was 3.75 individuals per 1m² of the flowerbed containing 74 open flowers on average. Sparse Diptera representatives were also noticed.

Conclusions

1. In the conditions of Lublin, the flowering of *H. nobilis* lasts from the end of February to the begin of April.
2. Snowfall occurring during the flowering of *H. nobilis* inhibits the opening of new buds, but it does no damage to blooming buds.
3. Depending on weather conditions, during the day new flowers open from 8.00 am to 3.00 pm and stamens shed pollen from 9.00 to 4.00 pm.

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Table 1. Meteorological data during the 2009-2010 study period.

Year	Monthly air temperature (°C)			
	January	February	March	April
2009	-2,2	-0,6	2,1	11,8
2010	-7,8	-1,6	3,8	9,9

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