

BASIC SPECIES OF GENUS *PILOSELLA* HILL IN LATVIA

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Species identification of genus *Pilosella* Hill (Asteraceae) traditionally is considered as problematic due to complicated morphology, frequent hybridization, facultative apomixis and variable taxonomic interpretation. Seven basic species belonging to the genus *Pilosella* were determined in Latvia based on morphological characters: *Pilosella aurantiaca* (L.) F. Schultz et Sch. Bip., *Pilosella echioides* (Lumn.) F. Schultz et Sch. Bip., *Pilosella lactucella* (Wallr.) P. D. Sell a. C. West; *Pilosella praealta* (Vill. ex Gochn.) F. Schultz et Sch. Bip., *Pilosella officinarum* F. Schultz et Sch. Bip., *Pilosella onegensis* Norrl and *Pilosella vaillantii* (Tausch) Soják. For each species a table with a main diagnostic morphological characters is provided. Active process of speciation can be observed nowadays due to interspecific and intraspecific hybridization and formation of stable apomictic populations. This process occur currently and occurred in past and can be characterized as dynamical.

Key words: genus *Pilosella*, basic species, intermediate species, hybridization.

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INTRODUCTION

The genus *Pilosella* Hill (formerly *Hieracium* subgen. *Pilosella*) is considered as one of the most taxonomically complicated group of vascular plants in Europe (Krahulcová et al. 2000), and is characterized by hybridization, polyploidy and facultative apomixis (Fehrer et al. 2007, Krahulcova et al. 2016).

The plants of genus *Pilosella* occur in open habitats such as dry slopes, sandy habitats, grasslands, edge of forests and etc. Basic species occur mainly in especially forest-free habitats. Intermediate species prefer to colonize anthropogenic habitats, such as roadsides, railways and forest cutting areas, generally in secondary habitats. *Pilosella* species are good invaders of open fields (Zahn 1921, 1930, Sell

& West 1976, Bräutigam & Schuhwerk 2002, Chrtěk 2002, 2004, Křišťálová et al. 2010, Urfus 2011).

Genus *Pilosella* is divided on two informal species groups: basic (i.e. non-hybrid) and intermediate (i.e. hybridogenous) species (Gottschlich & Drenckhahn 2005). All species actively hybridize in direct contact, with equal intensity. The hybrids are fertile and are able to cross with other *Pilosella* genus species or with parental forms (introgressive hybridization or introgression). Gene flow can differently include basic species, it can diminish the genome of basic species, thus endanger many species and even lead to their extinction (Wolf et al. 2000, Seehausen 2004, Urfus 2011). In Europe most species of *Hieracium* (incl. *Hieracium* subg. *Pilosella*) as well as other genera (for example

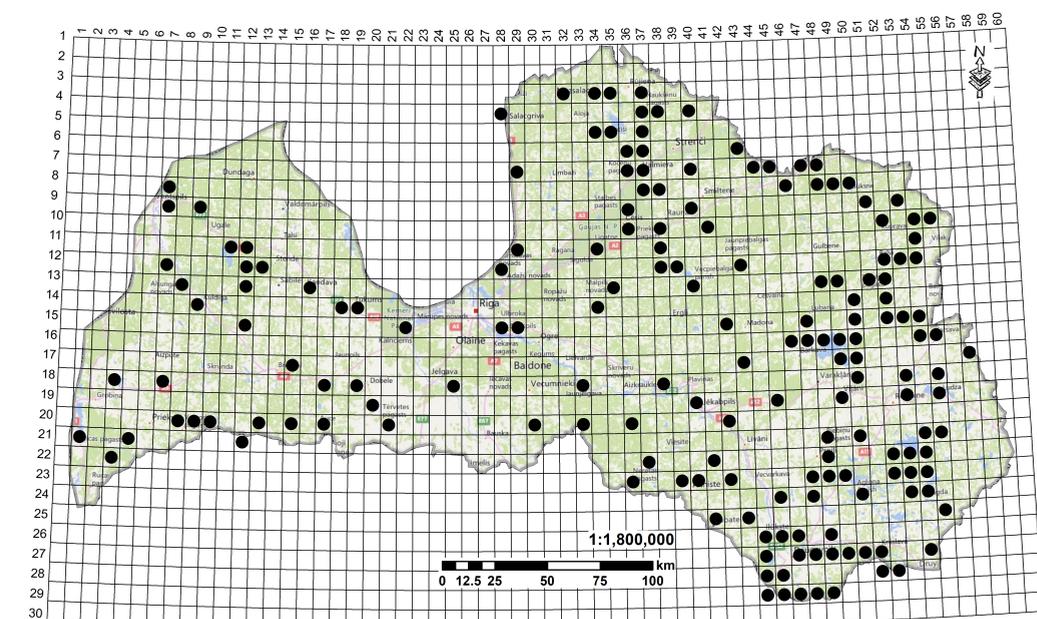
Sorbus and etc.) are the result of hybridization process and can have ancient hybrid origin. Basic species have unique morphological characteristics that can be regarded as one of the evolutionary units (Fehrer et al. 2009, Rich et al. 2010). Intermediate taxa share a combination of characters of two or more species (there are known 5 species hybrids).

As a result of hybridization, hybrids between the same species can look diversely, taking an intermediate position between the parent species, often notably evading towards one of the parent species (Majevskij 2014). Due to human activity increase high hybridization rate of genus *Pilosella*. A large number of disturbed secondary habitats often combine species whose niches does not any other way connect (Wójcicki 1991, Urfus 2011). Hybrids often engross sizeable areas, form stable populations and often grow independent, without parental species (Krahulec et al. 2004, Wilson et al. 2015) and are regarded as “stabilized” taxa due to predominant apomictic reproduction strategy (Hand et al. 2015). Due to high ecological plasticity hybrids are very

abundant and often occur out of the areal border of the parental species (Tichomirov 2000). Both in nature and in herbarium collections hybrids often numerically prevail over the basic species (Tzvelev 2000, Sennikov 2003).

MATERIAL AND METHODS

Plants of genus *Pilosella* were collected in the field during years 2014 - 2017 and deposited in the herbarium of Institute of Life Sciences and Technology, Daugavpils University (DAU) in total 750 specimens. The herbarium material was collected from whole Latvia territory. Material is collected based on the square method, which is related to the geographical coordinates, one square is approximately 7.6 x 9.3 km (Tabaka et al. 1980). Herbarium localities in map is tagged with symbol ● – show collected herbarium data, all collected herbarium localities from the one square were marked by one point (Fig. 1.). Additional information was acquired during the revision of the herbarium specimens of Institute of Biology, University of Latvia (LATV) in total



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Fig.1. Collected material locations of genus *Pilosella*.

Table 1. Main diagnostic characters useful for determination of seven basic species

Character/ taxon	<i>Pilosella officinorum</i>	<i>Pilosella praealta</i>	<i>Pilosella lactucella</i>	<i>Pilosella vaillantii</i>	<i>Pilosella onogensis</i>	<i>Pilosella echioides</i>	<i>Pilosella aurantiaca</i>
Colour of ligules	Yellow	Yellow	Yellow	Yellow	Yellow	Orange- Yellow	Orange-red
Hairness of rosette leaves	Extremely dense stellate hairs beneath.	Glabrous above or with a few simple hairs along leaf margin and main vein.	Glabrous above or with a few simple hairs along leaf margin and main vein.	Sparse to dense stellate hairs on both sides; Simple hairs on the upper surface of leaves 0.5- 0.8(1) mm long.	Sparse stellate hairs on upper surface. Simple hairs (less than 1 mm long) throughout the upper surface of leaves.	Densely covered with stellate hairs on upper surface; All rosette leaves withering early (by the time of flowering season).	Numerous simple hairs on upper surface and simple and stellate hairs on lower surface.
Involucral bracts	8-10 mm	5-6 mm Gradually decrease in size towards stolon apex.	6-7 mm Numerous glandular hairs.	5-6 mm With numerous or dense glandular hairs, more densely in the upper part.	6-7 mm	6-7(8) mm Only simple and stellate hairs.	7-8 mm
Number of stem leaves	X	0-4	0-4	0-4	0-4	5-15	0-4
Hairness of stem	Simple hairs: absent; glandular hairs: scarce; stellate hairs: numerous	Lower part of stem glabrous or with a few light simple hairs.	Simple hairs: absents; glandular hairs: numerous; stellate hairs: absent.	Simple hairs in the lower part of stem bright, up to 1 mm long; stellate hairs: numerous	The lower part of stem with dense downwards directed simple hairs (2 mm long). Simple hairs with reddish base.	Densely covered with stellate hairs.	Simple hairs: numerous; glandular hairs: numerous; Stellate hairs: numerous.
Stolons	Leaves long. Spaced (less than rosette leaves). Decrease in size toward to stolon apex. Or absent.	Long, leaves gradually decrease in size. Or absent.	Long, have bigger leaves towards apex. Or absent.	X	Short, with large broad leaves. Or absent.	X	X
Stigmas colour	Yellow	Yellow	Yellow	Yellow	Black	Yellow	Yellow

180. The study of basic species of genus *Pilosella* was based on collected material review, literature analysis and herbarium review.

For species distribution evaluation scale was used: very rare (1-10 points in the map), rare (11-30 points), rather rare (31-100 points), not rare (101-250 points), rather frequent (251- 500 points), frequent (501-750 points), and very frequent (more than 751 points) (Fatara 1992).

Species occurrence is shown in three stages in Latvia: 1. The researches at the turn of the 19th - 20th centuries till 1940. 2. The period from 1941 till 1990 (World War II and the years of Soviet occupation when Latvia experienced significant changes in land processing methods and transport flow, mainly the flow of railway transport from the East). 3. 1991 - till nowadays, when land processing methods and directions of transport flow have again significantly changed. The actual distribution of the species can be discussed only according to the collected herbarium after 1990 (Evarts-Bunders et al. 2016).

Determination of plant material

The identification of basic species is the first step for the more extensive research of the genus *Pilosella*. Main diagnostic characters useful for determination of seven basic species were summarized during the analyse of different literature sources (Tichomirov 2000, Tzvelev 2000, Kuk & Gudžinskas 2003) as well as personal observations. Only most important morphological characters are given (Table 1).

The taxonomically significant characters suitable for species determination is length of hairs and their distribution, presence/absence of simple/glandular/stellate hairs, inflorescence, pedicels, phyllaries, stem and rosette leaves (form, color), color of flowers and styles, presence/absence of ground stolon. Plants of genus *Pilosella* have three different types of pubescens. Simple hairs occur on most plant parts. Glandular hairs are predominantly on the upper part of plant, on peduncles and involucre bracts, more rarely in the lower part of the stem and on the

tips of cauline leaves. Glandular hairs may be microscopically small. Stellate hairs in the case of an abundant presence form a grayish or white indumentum (Kuk & Gudžinskas 2003).

RESULTS AND DISCUSSION

Analysis of the basic species

Morphological revision of plant material indicated that in Latvia there are seven basic species: *Pilosella aurantiaca* (L.) F. Schultz et Sch. Bip., *Pilosella echioides* (Lumn.) F. Schultz et Sch. Bip., *Pilosella lactucella* (Wallr.) P. D. Sell a. C. West, *Pilosella praealta* (Vill. ex Gochn.) F. Schultz et Sch. Bip. (Fig.2.), *Pilosella officinarum* F. Schultz et Sch. Bip., *Pilosella onegensis* Norrl and *Pilosella vaillantii* (Tausch) Soják (Fig.3.).

Pilosella aurantiaca – Central European species that is commonly found in cultivated or disturbed habitats, in Latvia rarely goes wild (Kuk & Gudžinskas 2003, Loomis & Fishman 2009, Majevskij 2014) (Fig.4.).

Distribution in Latvia: very rare. Actively hybridize with other species that grow in direct contact. In Latvia there are known three localities of this species, all locations have anthropogenic origin (roadsides).

Pilosella echioides – During genus revision not found in Latvia, only in historical herbarium material. Known in two historical localities in Daugavpils city (NW coast of Lake Stropu in dry pine forest).

Hybridize with other species, which grow in dry habitats. Hybrid leaves and stem become grey-green with numerous simple hairs, the upper surface of leaves with stellate hairs (Majevskij 2014). Baltic region is NW border of distribution area (Kuk & Gudžinskas 2003). Grow in dry pine forest and dry edge of forest. *Pilosella echioides* hybridize widely in Latvia. Hybrids are very abundant due to high ecological plasticity and often occur out of the areal border



Fig.2. *Pilosella praealta* (Vill. ex Gochn.) F. Schultz et Sch. Bip.



Fig.3. *Pilosella vaillantii* (Tausch) Soják



Fig.4. *Pilosella aurantiaca* (L.) F. Schultz et Sch. Bip.

of the parental species, therefore in Latvia more often occur hybrids with *Pilosella. echioides* are represented. While in Belarus *Pilosella echioides* in the S and SE is not a rare species (Tikhomirov 2000).

Pilosella lactucella – During the revision not found in Latvia, only in historical herbarium material.

Species had widespread distribution before the beginning of the 60s of the last century (Kukk & Gudžinskas 2003). Bloom before other species and quickly lade (Tichomirov 1999). More often hybridize with *Pilosella praealta*, *Pilosella onegensis* and *Pilosella officinarum*, involucre bracts become light, with light to white margin, with very rare simple hairs and more or less pressed glandular hairs. Leaves on upper surface become bare along main vein and can have yellowish shade, plant become lower and thinner. Outwardly gets characteristic egg-yellow shade (is noticeable in herbarium specimens) (Majevskij 2014). Very often is as one of the parental species of hybrids.

Pilosella praealta – Distribution in Latvia: rare. Current species is the second most common basic species found in Latvia.

Often hybridize with other species. Hybrid leaves on upper surface become bare along the main vein (Majevskij 2014). This species most frequently was found in dry slopes, forest edges, dry meadows, sometimes in anthropogenic habitats (fallow land, roadsides, along railways).

Pilosella onegensis – Distribution in Latvia: very rare. Often is such as one of the parents of hybrids. There known only two localities of this species, from mesophytic forest communities. Hybridize with other species, the lower part of stem become reddish, and have a large number of simple hairs with reddish base. Stigmas is black or partly black. Leaves have “grass-green” shade or become darker. Involucre bracts and upper part of stem have a large number of glandular hairs (Majevskij 2014).

Pilosella officinarum – Highly polymorphic species (Kukk & Gudžinskas 2003). Distribution in Latvia: rather frequent. Most frequently recorded *Pilosella* species in Latvia. Grow in meadows, fallow lands, pine forests, at the forest edges, on hillslopes and etc.

Hybridize with other species, it is manifested in the increase of the size of capitula's (usually develops two or more) and ligules, pubescence of stem and rosette leaves with longer and coarser simple hairs. Stem, lower surface of leaves and branches of inflorescence abundantly (not extremely dense) covered with stellate hairs, and leaves can have a plumbeous color. Involucre bracts become widest and widely triangular at base (Majevskij 2014).

Pilosella vaillantii – Distribution in Latvia: very rare. Not frequent in Latvia (Kukk & Gudžinskas 2003). This species is occurring in semi-natural dry grasslands on calcareous substrates, dry, pine forest edges.

The hybrids is characterizes by presence of stellate hairs on upper surface of rosette leaves.

As a result of active hybridization between plants of genus *Pilosella*, intermediate species consists biggest part of the collected material in herbarium and basic species is represented with small group of plants. Hybrids prevail over parental species. Species like *Pilosella lactucella*, *Pilosella echioides*, *Pilosella onegensis* and *Pilosella vaillantii* were not very common and were eliminated in the frequent process of hybridization. *Pilosella lactucella* and *Pilosella echioides* are known only from literature or historical herbarium data. Approximately 20% of DAU herbarium collected during the last four years comprised of the basic species. Largest part of basic species were common species, such as *Pilosella officinarum* and *Pilosella praealta*. Other basic species - *Pilosella lactucella*, *Pilosella echioides*, *Pilosella onegensis* and *Pilosella vaillantii*, more often arise as one of the parents of hybrids.

Due to hybridization, apomixes and polyploidy in genus *Pilosella* actively is going on process of speciation. Process occur currently and occurred in past and can be characterized as dynamical. Thereby genus *Pilosella* is considered as complicated and difficult to determination.

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