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SOME NOTES ON THE GENUS *ACONITUM* IN CHORNOHORA MTS.

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Abstract. The paper is a contribution to ecology and chorology of *Aconitum* in high-mountain zone of the Ukrainian Carpathians. It was confirmed that genus *Aconitum* in the Chornogora mountain range is represented by 14 taxa, and 7 more taxa were listed as potential for this region. These taxa belong to 3 subgenera and are divided on 4 main biomorphological groups delimited on the base of their habitat, life form, ecology and altitudinal distribution. The soil and vegetation types for all taxa have been identified and the maps of their distribution have been prepared. The most influent threats and their categories were identified. Threat category for *A.* × *nanum* was changed from DD to VU, and for *A. firmum* subsp. *fussianum* from NT to VU.

Key words: *Aconitum*, Chornogora, sozology, ecology, chorology, soils, vegetation

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Introduction

The genus *Aconitum* L. (Ranunculaceae Juss.) is an interesting taxonomical group which is characterized by high level of morphological diversity, presence of a number of subspecific taxa, and high number of both infra- and interspecific natural hybrids (Gáyer 1922; Götz 1967; Seitz 1969; Seitz *et al.* 1972; Kadota 1981, 1987; Hoot 1991, 1995; Park *et al.* 1997; Mitka & Zemanek 1997; Mitka 2000, 2002, 2003, 2008; Starmühler 2001; Starmühler & Mitka 2001; Mitka & Szajna 2009; Новіков 2010a; Novikoff & Mitka 2011). The genus *Aconitum* during long time was not critically investigated in Ukrainian Carpathians, and as a result only two aggregated taxa (*A. anthora* and *A. lasiocarpum*) from this region have been included in Red Book of Ukraine in 2009 (Дідух 2009; Новіков 2010b, 2010c; Тасєнкевич *та ін.* 2011).

In the Carpathian Mountains one of the main centers of evolution and endemism of monkshoods in Europe is located (Mitka 2003; Новіков і Mitka 2011; Novikoff & Mitka 2011). For example, in Ukrainian Carpathians from total number (19 confirmed + 3 unconfirmed *Aconitum* taxa) 9 species and subspecies are listed as clearly endemic or subendemic and 2 more hybrid subspecies are considered as probably endemic (Novikoff & Hurdu 2015). From other side, if we consider all forms and varieties then we can tell about 17 subendemic and endemic taxa in general.

The Chornohora Mts. is the highest mountain range in Ukrainian Carpathians which is located on about 1270 km^2 area in Zakarpathia (Transcarpathia) and Ivano-Frankivsk regions (Fig. 1). These mountains are mostly consist of flysch that predetermines their comb-like relief. They are also characterized by high diversity of flora and vegetation and represent all vegetation belts: submontane (up to 600 m a.s.l.), lower montane (up to 1200 m a.s.l.), higher montane (up to 1550 m a.s.l.), subalpine (up to 1800 m a.s.l.), and alpine (up to 2061 m a.s.l.) (Чопик 1976, 1977; Стойко 1977; Малиновський 1980; Малиновский 1991; Малиновський і Крічфалушій 2000; Нестерук 2003; Новіков 2016).

It was showed that Chornogora Mts. is one of the most important center of diversity of monkshoods and include almost all

Tab. 1. Genus *Aconitum* in Ukrainian Carpathians. + – taxon confirmed during the last expeditions in 2008-2015; ▸ **?** – taxon is cited or suggested in literature, or there are herbarium vouchers but currently it is not confirmed by field expeditions; - – taxon is not known from this region.

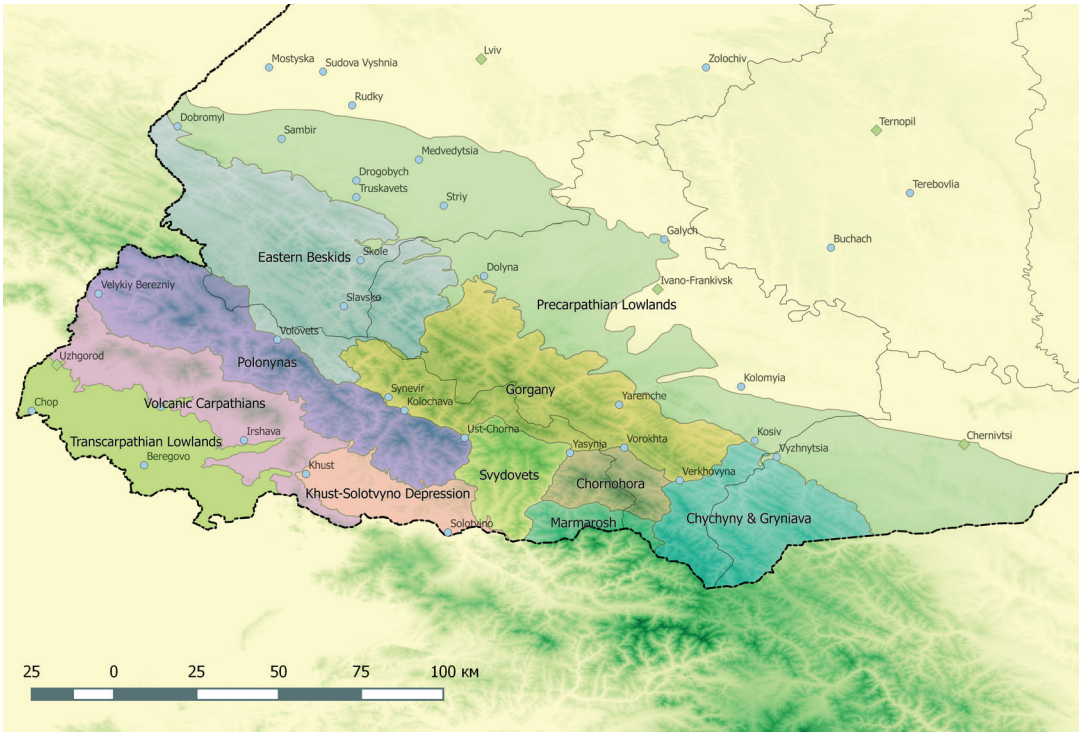

Fig. 1. Division of Ukrainian Carpathians (NOVIKOFF & HURDU 2015).

Aconitum taxa of the Ukrainian Carpathians (19 confirmed and 3 suggested) from which 16 are considered as endemic or subendemic and 10 – as threatened (Tab. 1) (HOBIKOB 2010b, 2010c; HOBIKOB 2016). Taking also into consideration that about 39,2% of the Chornogora area is under protection (Fig. 2), investigations of the genus in this territory is an important task.

Detailed descriptions of the taxa and the keys for their identification, as well as discussion on general chorology, can be found in our previous works (MITKA 2003, 2008; HOBIKOB 2009, 2010b, 2011a, 2011b, 2013, 2016; HOBIKOB I MITKA 2011; MITKA & NOVIKOFF 2011; NOVIKOFF & MITKA 2011). Here we are focusing on diversity, distribution, phytocoenotic and habitat properties, ecology, and protection of monkshoods in the Chornogora.

Material and methods

Preliminary analysis has been realized conducted on the base of field expeditions during 2008-2014. In 2015 special expedition to Chornohora with aim to evaluate main ecological parameters in known and to describe releves, as well as to find new habitats were realized by one of us (A. Novikoff). As a result, 26 localities (Apps. 1-3) were precisely analyzed.

Vegetation description follows the Braun-Blanquet method and quadrates of about 25 m^2. The following abundance scale coefficients was applied: r – 1 or very few plants; + – few

Taxon	Threat Category	Endemic Status	Occurrence in Ukrainian Carpathians	Occurrence in Chornohora
				Subg. *Aconitum*
Sect. *Aconitum*				
A. bucovinense Zapał. fo. *bucovinense*	EN	South-Eastern Carpathian endemic	+	+
A. bucovinense Zapał. fo. *orthotricha* Gáyer	EN	South-Eastern Carpathian endemic	+	+
A. × *czarnohorense* (Zapał.) Mitka	VU	Eastern Carpathian endemic	+	+
A. firmum Rchb. subsp. *firmum*	VU	Pan-Carpathian endemic	+	?
A. firmum Rchb. subsp. *fissurae* Nyárády	VU	Pan-Carpathian endemic	+	+
A. firmum Rchb. nothosubsp. *fussianum* Starmühl.	VU	Pan-Carpathian endemic	+	?
A. × *nanum* (Baumg.) Simonk.	VU	South-Eastern Carpathian endemic	+	+
Sect. *Cammarum* DC.				
A. variegatum L. subsp. *variegatum*	DD	none	?	?
A. variegatum L. subsp. *podobnikianum*	DD	none	?	?
A. lasiocarpum (Rchb.) Gáyer subsp. *lasiocarpum*	VU	Eastern Carpathian endemic	+	?
A. lasiocarpum (Rchb.) Gáyer subsp. *kotulae* (Pawł.) Starmühl. & Mitka	VU	Pan-Carpathian subendemic	+	?
A. degenii Gáyer subsp. *degenii* fo. *degenii*	LC	Pan-Carpathian endemic	+	+
A. degenii Gáyer subsp. *degenii* fo. *craciunelense* Gáyer	LC	Pan-Carpathian endemic	+	+
A. degenii Gáyer subsp. *degenii* var. *intermedium* (Zapał.) Mitka	LC	Pan-Carpathian endemic	+	+
A. × *gayeri* Starmühl.	LC	Eastern Carpathian endemic	+	+
Sect. *Acomarum* Starmühl.				
A. ×*cammarum* L. em. Fries	LC	none	+	+
				Subg. *Anthora* (DC.) Peterm.
Sect. *Anthora* DC.				
A. anthora L.	VU	none	+	+
				Subg. *Lycoctonum* (DC.) Peterm.
Sect. *Lycoctonum* DC.				
A. lycoctonum L. em. Koelle subsp. *lycoctonum*	DD	none	?	?
A. moldavicum Hacq. subsp. *moldavicum*	LC	Pan-Carpathian subendemic	+	+
A. moldavicum Hacq. subsp. *hosteanum* (Schur) Graebn. & P. Graebn.	LC	Pan-Carpathian subendemic	+	+
A. moldavicum Hacq. nothosubsp. *simonkaianum* (Gáyer) Starmühl.	DD	Eastern Carpathian (sub) endemic	+	+
A. moldavicum Hacq. nothosubsp. *porcii* Starmühl.	DD	South-Eastern Carpathian and Bihor endemic	+	-

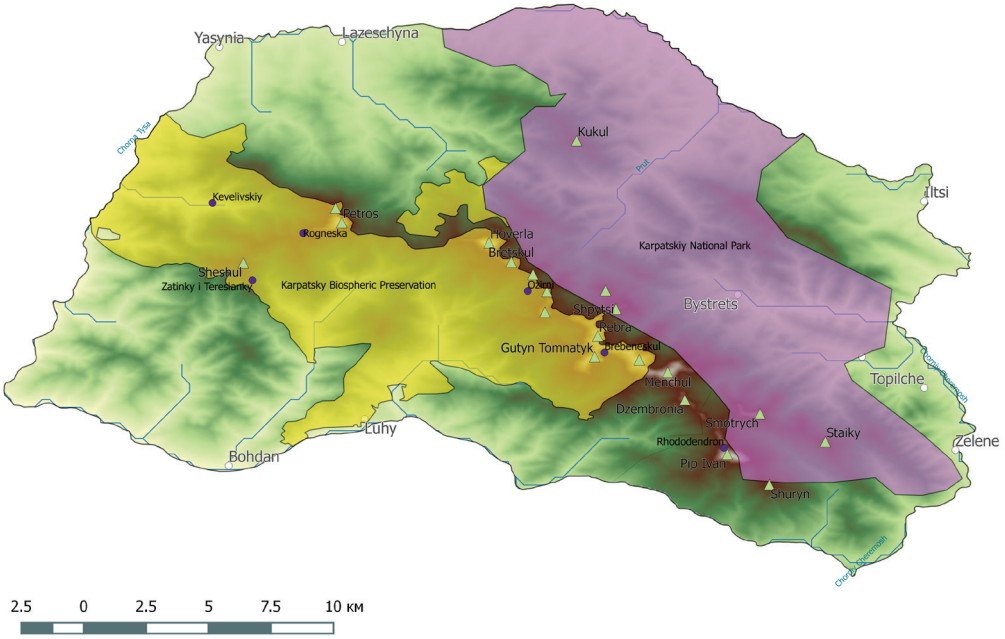

Fig. 2. General map of Chornohora and its protected areas. **Triangles** – the highest peaks; **white circles** – settlements; **blue circles** – local sanctuaries and nature monuments.

plants with slight covering; 1 – < 5% of covering with numerous plants; 2m – ~ 5% of covering; 2a – 6-12% of covering; 2b – 13-25% of covering; 3 – 26-50% of covering; 4 – 51-75% of covering; 5 – >75% of covering (Wikum & Shanholtzer 1978; Westhoff & van der Maarel 1978; Dietvorst *et al.* 1982). Identification of vegetation communities was realized on the base of several sources (Малиновський 1980; Matuszkiewicz 2001; Snowarski 2002-2016; Tasenkevich *et al.* 2011).

For each of the local populations the extent of anthropogenic pressure and general condition (bad, normal, good, and prosperous) were recognized. The mean or, if it was possible, strict number of pregenerative, generative and postgenerative plants in each of populations were calculated. On the base of these calculations, the class of population vitality was identified following Mirkin (Миркин и др. 2001) criteria: a) invasive – pregenerative plants predominate; b) normal – generative plants predominate; c) regressive – postgenerative plants predominate. Density and general area of population were also taken into account.

Measurements of soil parameters were made just near the plants, on depth of about (5)18-20 cm. Soil temperature was analyzed by Ezodo MP-103S, and soil moisture – by Rixen M-700S. Air temperature, air relative humidity, Illumination, and wind speed were analyzed by multifunctional tool Flus ET-965. Soil pH and superficial soil moisture were measured in laboratory on the base of collected soil samples. Superficial soil moisture was calculated by standard gravimetric method. A profile-genetic principle adopted for the WRB nomenclature was applied for soils classification (IUSS Working Group WRB 2006).

Next ecological categories were applied (Дідух *та ін.* 2000; Новіков і Барабаш-Красни 2015). For illumination: a) sciophytes – plants grow in shady places; b) helio-sciophytes – plants prefer shady places but also tolerate bright sunlight; c) scio-heliophytes – plants prefere bright sunlight but also tolerate partial shade; d) heliophytes – plants grow

on open places under bright sunlight. For soil acidity: a) hyperacidophils – grow on the substrates with ph < 3,7; b) peracidophils – pH = 3,7-4,5; c) acidophils – pH = 4,5-5,5; d) subacidophils – pH = 5,5-6,5; e) neutrophils – pH = 6,5-7,0; f) basiphils – pH = 7,0-8,0; g) hyperbasiphils – pH > 8,0. For water relation: a) hydrophytes – aquatic plants; b) helophytes – partially aquatic, partly submerged or littoral plants; c) hygrophytes – plants living in moist habitats; d) hygro-mesophytes – plants intermediate between hygro- and mesophytes; e) mesophytes – plants which are adapted to moderate moisture; f) meso-xerophytes – plants intermediate between meso- and xerophytes; g) xerophytes – plants adopted to dry environment.

Maps are built in QGis Wien 2.8.2 on the base both of literature and herbarium data, as well as own field observations. In case of literature and herbarium data the points are given for nearest identified place that is pointed in the source.

Threat categories by IUCN (2015) are given on the base of our previous studies (Новіков 2010b, 2010c; Новіков і Мітка 2011; Мітка & Novikoff 2011; Novikoff & Мітка 2011) completed with new obtained data.

Results

A. bucovinense

Ecological preferences: Heliophytes, rarely – scio-heliophytes; mesophytes or meso-xerophytes, rarely – hygro-mesophytes; peracidophils or acidophils.

Distribution and habitats in Ukrainian Carpathians: In Ukrainian Carpathians are known only few confirmed localities in Chornohora, Chyvchyny, Gorgany and Eastern Beskids. This species is mostly associated with higher montane and subalpine belts, however also occurs in alpine and lower montane belts. These plants grow mostly on open places in tall-herb communities, on screes, in rock cracks, sometimes in ecotones with shrubs or just inside of the crown of low shrubs in subalpine and alpine belts. They also could be found along the streams and near mountain lakes. The species take a part in several communities – *Juniperetum sibiricae, Pulmonario-Alnetum viridis, Pinetum mughi,* and *Poo-Deschampsietum*.

Distribution and habitats in Chornogora: There are confirmed only two isolated mixed populations near Petrosul Mt. and on the saddle between Pozhyzhevska Mt. and Breskul Mt. (Fig. 3; Apps. 1-3, entries 4, 5 and 9). In general these populations are in normal condition, but consist of less than 100 plants and cover less than 1 km^2 of area. Generative plants there dominated and, as a result, populations could be identified as belonging to normal class of vitality. In Chornogora the species is known from *Poo-Deschampsietum*, and *Juniperetum sibiricae* communities on leptic cambisols and umbric gleysols.

Threats: The overgrowing by woody plants and changes in the hydrological regime of habitats, as well as trampling by tourists. For Ukrainian Carpathians in general it could be designated as EN.

A. firmum

Ecological preferences: Heliophytes or scio-heliophytes; hygro-mesophytes, mesophytes or rarely meso-xerophytes; peracidophils or acidophils, rarely – hyperacidophils or subacidophils.

Distribution and habitats in Ukrainian Carpathians: This species is rare for Ukrainian Carpathians, where is mostly represented in Chornohora and Svydovets but also sporadically occurs in Gorgany, Polonynas, Marmarosh and Chyvchyny. It is mostly related to alpine and subalpine belts, but also occurs in higher and lower montane belts. There it grows in tall-herb communities, on stone screes, in rock cracks, sometimes in ecotones with shrubs or just inside of the crown of low shrubs in subalpine and alpine belts. They also could be found along the streams and near mountain lakes. The species take a part in *Poo-Deschampsietum, Aconitetum firmi, Ranunculo platanifolii-Adenostyletum alliariae, Caricetum sempervirentis*, and *Juniperetum sibiricae* communities.

Distribution and habitats in Chornogora: In Chornohora only subsp. fissurae is confirmed

during our own observations, but there are herbarium vouchers of other two subspecies from this region too. There are confirmed three mixed populations on Petros Mt., Turkul Mt., and near the lake Brebeneskul in good and prosperous conditions. However we found also one isolated population on slopes of Goverla Mt., which is in extremely bad condition and represented by just few postgenerative plants (Fig. 4; Apps. 1-3, entries 1, 14, 15 and 22). In general *A. firmum* in Chornogora is represented by ~1000 plants predominantly in pregenerative and generative condition (normal class of vitality) which cover about 1-2 km^2. In Chornohora this species is registered in *Poo-Deschampsietum, Aconitetum firmi, Ranunculo platanifolii-Adenostyletum alliariae, Caricetum sempervirentis,* and *Juniperetum sibiricae* communities on cambic leptosols, umbric or mollic gleysols and leptic cambisols.

Threats: In general, this species is very rare for Chornogora Mts. and requires protection due to the intense burning and trampling of its habitats by tourists. In Ukrainian Carpathians it has VU category.

A.* × *czarnohorense

Ecological preferences: Heliophytes, rarely – scio-heliophytes; mesophytes or meso-xerophytes, rarely – hygro-mesophytes; acidophils, rarely – peracidophils or subacidophils.

Distribution and habitats in Ukrainian Carpathians: The species occurs very often in Chornohora Mts., but it also grows in Svydovets, Gorgany, Polonynas and Marmarosh Mts. It very often occurs in mixed populations with *A. firmum, A.* × *nanum* and sometimes – with *A. bucovinense.* It is usually related to alpine and subalpine belts, but also occurs in higher montane belt. These plants grow on stone screes, in cracks of the rocks, in natural depressions and low cavities, and sometimes occur near the streams and high-mountain lakes. The species take a part in *Pulmonario-Alnetum viridis, Juniperetum sibiricae, Pinetum mughi, Caricetum sempervirentis, Aconitetum firmi, Primulo-Caricetum curvulae,* and *Poo-Deschampsietum* communities.

Distribution and habitats in Chornogora: In Chornogora Mts. the species has a center of distribution and is represented here by five main local mixed populations in good and prosperous condition – on mountains Petros, Gutyn-Tomnatyk, Brebeneskul, Menchul, and near the lake Brebeneskul (Fig. 5; Apps. 1-3, entries 1, 2, 15, 16, 24, and 25). The most of plants are in pregenerative and generative stages; therefore vitality of these populations is normal. In general *A.* × *czarnohorense* here includes about 2000 plants which cover more than 5 km^2. In Chornohora this species is registered in all of mentioned above communities on cambic leptosols, umbric or mollic gleysols and leptic cambisols.

Threats: This species is represented on Chornogora in enough amounts but nevertheless it needs a protection because it grows mostly on the touristic paths and near the camping places. Among other threats the overgrowing of habitats by shrubs. In Ukrainian Carpathians it has VU category.

A.* × *nanum

Ecological preferences: Heliophytes, rarely – scio-heliophytes; mesophytes or meso-xerophytes, rarely – hygro-mesophytes; acidophils, rarely – peracidophils or subacidophils.

Distribution and habitats in Ukrainian Carpathians: The one of the most distributed high-mountain monkshoods in Eastern Carpathians. In Ukrainian Carpathians it occurs in Chornohora, Svydovets, Gorgany, Marmarosh, as well as in Polonynas and Eastern Beskids. The plats very often grow in mixed populations together with *A. firmum*, *A.* × *czarnohorense* and sometimes – with *A. bucovinense*. The species is related to alpine and subalpine belts, but also occurs in higher montane belt. These plants grow on stone screes, in cracks of the rocks, in natural depressions and low cavities, and sometimes occur near the streams and high-mountain lakes. The species take a part in numerous communities such as *Pulmonario-Alnetum viridis, Juniperetum sibiricae, Pinetum mughi, Caricetum sempervirens, Aconitetum*

firmi, Ranunculo platanifolii-Adenostyletum alliariae, Primulo-Caricetum curvulae, and *Poo-Deschampsietum*.

Distribution and habitats in Chornogora: Together with *A.* × *czarnohorense* it is one of the most distributed high-mountain *Aconitum* species in Chornogora. There are known several main mixed populations on mountains Petros and Brebeneskul, as well near the lake Brebeneskul which consist of about 1000-1500 plants of mostly pregenerative and generative age, and which cover about 2 km^2 (Fig. 6; Apps. 1-3, entries 1, 15, and 24). Mentioned populations are in good and prosperous conditions with normal vitality. In Chornogora the species is known from *Caricetum sempervirens, Aconitetum firmi, Ranunculo platanifolii-Adenostyletum alliariae*, and *Poo-Deschampsietum* communities on cambic leptosols and umbric or mollic gleysols.

Threats: Trampling by tourists, burning of habitats, overgrowing of habitats by woody plants. In Ukrainian Carpathians it has VU category and together with *A. firmum, A.* × *czarnohorense* and *A. bucovinense* requires strict protection.

A. variegatum

Ecological preferences: Scio-heliophytes or helio-sciophytes; hygrophytes or hygro-mesophytes, rarely – mesophytes; probably subacidophils (Дідух *та ін.* 2004).

Distribution and habitats in Ukrainian Carpathians: There are mentions of this species from the region of the lake Synevyr in Zakarpatia region (Gorgany Mts.) (Новіков і Митка 2011), however they are still not confirmed. The only specimen of *A. variegatum* from Ukrainian Carpathians (Chornohora) is deposited in herbarium of Ivan Franko National University of Lviv (LW). Nevertheless, this species in Ukraine is known from lower altitudes in Volhynia and Ciscarpathia. Probably it could be found in submontane or lower montane belts in such communities as *Alnetum incanae* and *Arunco-Doronicetum*.

Distribution and habitats in Chornogora: The species is not confirmed for Chornohora Mts. The approximate location of abovementioned specimen (LW, Woloszczak E., 17.08.1888) is shown on Fig. 7.

Threats: Due its unclear chorology – DD.

A. lasiocarpum

Ecological preferences: Scio-heliophytes or helio-sciophytes; hygrophytes or hygro-mesophytes, rarely – mesophytes; probably subacidophils (Дідух *та ін.* 2004).

Distribution and habitats in Ukrainian Carpathians: The species is mostly distributed in Western and Eastern Carpathians, but also sporadically occurs in Southern Carpathians and related lowlands. In Ukrainian Carpathians it is mostly represented in Eastern Beskids while in other regions it occurs irregularly and rarely. The presence of the species in Eastern Beskids and Chyvchyny Mts. is confirmed by own observations, while the presence of it in Marmarosh, Gorgany and Svydovets Mts. requires further validation. In Eastern Beskids the species is distributed mostly in submontane and lower montane belts while in Chyvchyny Mts. it was observed in upper montane and subalpine belts. These plants grow mostly in semi-shady places, between shrubs and at the forest edges. Very often they occur near the water. However in Chyvchyny Mts. the plants grow in open and dry place, in subalpine herbal communities. As a result, these plants differ by their common habitus. They are high and branched in lower altitudes, and compact with few flowers – in higher altitudes. In general, the species is known from *Alnetum incanae, Carici remotae-Fraxinetum, Dentario glandulosae-Fagetum, Trollio-entauretum, Adenostylion, Calthion*, and *Carpinion* communities.

Distribution and habitats in Chornogora: There are known several specimens collected from Chornohora Mts (Fig. 8). Also there are known one population from neighborhoods of Vorokhta village. However current condition of all these populations is unknown. Today this species seems to be absent or very rare for Chornohora Mts.

Threats: This species is protected by Bern Convention and included to the Red Book of Ukraine (Мельник і Баточенко 2009) too. In general it can be evaluated as vulnerable

taxon which requires strict protection on whole territory of Ukrainian Carpathians. The probably threats are hydrological changes and deforestations (Мельник і Баточенко 2009).

A. degenii

Ecological preferences: Scio-heliophytes or helio-sciophytes; hygrophytes or hygro-mesophytes, rarely mesophytes, or very rarely hygro-helophytes; peracidophils, acidophils or subacidophils.

Distribution and habitats in Ukrainian Carpathians: In Ukrainian Carpathians the species is represented by only one subspecies – *A. degenii* subsp. *degenii* which includes two forms (fo. *degenii* and fo. *craciunelense*) and one variety (var. *intermedium*). The last one coresponds to *A.* × *hebegynum*, taxonomical status of which was revised and then decreased (Ilnicki & Mitka 2011). This taxon is widely distributed in Ukrainian Carpathians up to subalpine or even alpine belt. It can be often found along the streams, near the lakes, in wet meadows, both in open and semi-shaded places. It mostly grow in large mixed populations together with *A.* × *gayeri*. This taxon is confirmed for Chornohora, Chyvchyny, Gryniava, Eastern Beskids, Gorgany, Marmarosh, Svydovets, and Volcanic Carpathians. It takes a part in a lot of communities including *Juniperetum sibiricae, Vaccinio myrtilli-Pinetum mughi, Phleo alpini-Deschampsietum caespitosae, Carici remotae-Fraxinetum, Alnetum incanae, Calthetum laetae, Caltho-Alnetum, Dentario glandulosae-Fagetum allietosum*, and *Ranunculo platanifolii-Adenostyletum alliariae*.

Distribution and habitats in Chornogora: In Chornohora Mts. this species very often occurs from submontane up to subalpine belt. There are confirmed 10 local populations which include about 2000 plants (Fig. 9; Apps. 1-3, entries 4, 5, 10-13, 17-21, 23). These populations are represented mostly by pregenerative and generative plants and are in general in good condition with normal or invasive type of vitality. In Chornohora Mts. this species mostly is represented in *Juniperetum sibiricae, Vaccinio myrtilli-Pinetum mughi, Phleo alpini-Deschampsietum caespitosae, Calthetum laetae, Ranunculo platanifolii-Adenostyletum alliariae,* and *Calthion* communities on haplic fluvisols and leptic cambisols.

Threats: As a result of wide distribution the species is considered as LC taxon. However there are also threats which can reduce the number of *A. degenii* plants. Among them – changes in hydrological conditions, water clogging by domestic waste, deforestations, and floods which destroys the vegetation cover.

A.* × *gayeri

Ecological preferences: Scio-heliophytes or helio-sciophytes; hygrophytes or hygro-mesophytes, rarely – mesophytes or sometimes hygro-helophytes; acidophils or subacidophils.

Distribution and habitats in Ukrainian Carpathians: Together with *A. degenii* it is one of the most usual monkshood in Ukrainian Carpathians, which is mostly distributed in submontane and lower montane belts of Chornohora, Chyvchyny, Gryniava, Eastern Beskids, Gorgany, Marmarosh, Svydovets, as well as Volcanic Carpathians and Polonynas. These plants similarly grow along the streams, near the lakes, in wet meadows, both in open and semi-shaded places. They are represented in the same communities as *A. degenii*.

Distribution and habitats in Chornogora: This species is represented in mixed populations with *A. degenii* and is very similar with it. Therefore it is not easy to clearly evaluate the total quantity, which is approximately about 1000 plants. For this research *A.* × *gayeri* was evaluated from 2 local populations in good condition (Fig. 10; Apps. 1-3, entries 11, 12, and 19). The most of the plants are in pregenerative and generative condition, while the general vitality of populations can be evaluated as normal. These plants are represented in *Carici remotae-Fraxinetum, Alnetum incanae, Calthion,* and *Adenostylion* communities on haplic fluvisols.

Threats: Similarly to *A. degenii it* is LC taxon. The main threats are changes in hydrological conditions, water pollution by domestic waste, deforestations, and floods which destroys the vegetation cover.

A.* × *cammarum

Ecological preferences: Scio-heliophytes or helio-sciophytes; hygro-mesophytes or mesophytes, rarely – meso-xerophytes; subacidophils or neutrophils.

Distribution and habitats in Ukrainian Carpathians and Chornogora: This is an ornamental species which is regularly planted near houses in the most of villages.

Threats: This taxon is not threatened.

A. anthora

Ecological preferences: Heliophytes or scio-heliophytes; xerophytes or meso-xerophytes, rarely – mesophytes; basiphils or neutrophils, rarely – hyperbasiphils or subacidophils.

Distribution and habitats in Ukrainian Carpathians: This is one of the rarest monkshoods in Ukrainian Carpathians which is sporadically represented on different altitudes from lower montane up to beginnings of alpine belts. This species is confirmed for Chornohora, Chyvchyny, Gryniava, and Eastern Beskids. It also known from Marmarosh Mts., and there are few herbarium specimens from Svydovets. These plants mostly grow on open xerothermic spaces between stones or just on the rocks, sometimes they occur among the short grasses or near the shrubs of alder, juniper or pine. From other side, the population from Stinka Mt. (Eastern Beskids) is located on rocks directly in shady forest.

Distribution and habitats in Chornogora: Several localities are usually mentioned for Chornohora, but we found only one of them. This population is located on the slopes of Petrosul and Petros Mts (Fig. 11; Apps. 1-3, entries 4 and 5). It includes only about 20 generative plants and can be classified as of normal vitality. However the general condition of the population seems to be bad because it is overgrowing by woody plants. Its communities can be determined as *Juniperetum sibiricae* or *Pulmonario-Alnetum viridis*. Soil type is subacidic leptic cambisol.

Threats: Overgrowing by tall herbs and woody plants.

A. lycoctonum

Ecological preferences: Sciophytes or helio-sciophytes; hygrophytes or hygro-mesophytes, rarely – hygro-helophytes; probably subacidophils (Дідух *та ін.* 2004).

Distribution and habitats in Ukrainian Carpathians and Chornogora: Presence of this species in Ukrainian Carpathians is under question. In general this species prefer *Tilio-Carpinetum* and *Adenostylion* communities in lower altitudes. There are some reports about its occurrence in Chornohora on the slopes of Pozhyzhevska Mt. (road from Zarosliak station to High-Mountain Station of Institute of Ecology of Carpathians; see Fig. 12). We inspected abovementioned plants, however they are not blooming and therefore we cannot undoubtedly identify them.

Threats: Confirmation of this taxon for Ukrainian Carpathians is needed.

A. moldavicum

Ecological preferences: Sciophytes or helio-sciophytes; hygrophytes or hygro-mesophytes, rarely – hygro-helophytes; from basiphils up to hyperacidophils.

Distribution and habitats in Ukrainian Carpathians: These plants are widely distributed in Ukrainian Carpathians, especially on low altitudes; however they also occur up to subalpine belt. They prefer wet and semi-shaded locations, especially in forests along the streams. However they also can be found on open places far away from water. The last plans differ by short and compact habitus, mostly ortotropic position of the shoot, lower number of flowers in unbranched or very slightly branched inflorescences, as well as more dark color of flowers. These plants have the widest ecological amplitude and very often can be found along the roads, in mountain villages, in forest fringes etc. From other side, this species do not make big populations with numerous plants, mostly there are few plants separated by comparatively big distances. In Ukrainian Carpathians this species occurs in all regions. In general there are information about participation of *A. moldavicum* in *Pulmonario-Alnetum viridis, Juniperetum sibiricae, Calthetum*

laetae, and *Ranunculo platanifolii-Adenostyletum alliariae* communities.

Distribution and habitats in Chornogora: In Chornohora Mts. this species is mostly represented by subsp. *moldavicum* and subsp. *hosteanum* which form a lot of small local populations (Fig. 13; Apps. 1-3, entries 3-8, 11, 12, 17, 18, 20, 21 and 26). These two subspcies commonly are represented by several hundreds of generative and postgenerative plants. The condition of most populations is bad or near the normal because of low number of plants. They can be classified as regressive or rarely normal. These plants take a part in such communities as *Pulmonario-Alnetum viridis, Juniperetum sibiricae, Calthetum laetae, Ranunculo platanifolii-Adenostyletum alliariae,* and *Calthion*. They grow on very different soils including cambic leptosols, leptic cambisols, haplic cambisols, calcic fluvisols, and haplic fluvisol. There are also herbarium vouchers of nothosubsp. *porcii* from this region. However neither nothosubsp. *porcii* nor nothosubsp. *simonkaianum* (which probably could be refind too) were not confirmed during our expeditions on Chornohora.

Threats: Confirmation of nothosubsp. *porcii* and nothosubsp. *simonkaianum* for Chornohora is needed. There are no special threats for this species and there no need for its protection in Chornohora. As it seems small populations, low number of plants with presence of long-lived senile individuals is a normal condition for this species.

Discussion

In general, the genus *Aconitum* in Chornogora, such as in the in all Ukrainian Carpathians, includes four main biomorphological groups which have different ecological and altitudinal preferences, morphological features and also demonstrate different life forms (Hobikob 2010a; Novikoff & Mitka 2011).

The fist biomorphological group is represented by subg. *Lycoctonum* and includes semi-rosette semi-orthotropic or plagiotropic plants which mostly are distributed in lower altitudes and prefer semi-shaded and wet forest habitats. We have ascertained these plants before as mesophytes (Novikoff & Mitka 2011) but these studies demonstrated that they are usually hygro-mesophytes or rarely hygrophytes. They have the widest ecological optimums can grow in very different soils.

Second group is represented by the diploid (sect. *Cammarum*) or triploid (sect. *Acomarum*) erosulate plants which prefer mostly open or rarely semi shaded habitats in montane zone. These plants were characterized before as mesophytes (Novikoff & Mitka 2011). However our current studies in Chornohora showed that they are rather hygro-mesophytes or even hygrophytes preferring the habitats along the open streams and wet meadows. This is erosulate orthotropic or semi-orthotropic plants. They are not so exposed to winds and therefore can grow higher, developing elongated (sometimes up to 2 m of high) branched shoots with ramified inflorescences.

Members of the subg. *Aconitum* sect. *Aconitum* are tetraploidic arctic-alpine plants (Hultén 1937) prefered open habitats (Mitka *et al.* 2007). These are mesophytes or meso-xerophyes adapted to oligothermic conditions of subalpine and alpine belts, only in some cases occurring in lower altitudes. These plants are not so depended from water sources like members of sect. *Cammarum*, but they also very often could be found along the streams and near the high-mountain lakes. They have strong, short and compact orthotropic erosulate shoots and mostly condensed inflorescences mostly because the higher plants have the higher risk to be destroyed by winds or hails. The most interesting adaptation of these plants against the stormy winds in alpine and subalpine belts is their integration in clumps of shrubs which protect them also against of freezing in winter and mechanical destruction.

Fourth group includes the only species *A. anthora* from subg. *Anthora*. These are xerophytic or meso-xerophytic plants with wide altitudinal range of distribution. These plants prefer open warm habitats, and in fact can be identified as xerothermic relicts (Hegi 1912). However they also could be found in shaded forest localities (i.e. on Stinka in Eastern Beskids) which probably are the second habitats

for these plants. They are also erosulate and mostly orthotropic plants. The most interesting point about *A. anthora* is that it combines different features from other biomorphological groups (Novikoff & Mitka 2011). Currently we ascertained that *A. anthora* in Chornohora is growing on subacidic leptic cambisol while before it was strongly suggested that this plans are calciphilic petrophyls (Дідух *ma ін.* 2004; Кобів 2010). This is of special interest because the Chornohora is mostly constructed from uncarbonated flysches which determine the development of short profiles of acidic soils (Нестерук 2003) and there are no open calcareous rocks like in Chyvchyny Mts. There are mostly acidic cambisols, leptosols or regosols, which however could be partly neutralized by salts containing in subterranean or piestic waters (Скиба *ma ін.* 2006). As a result, specific vegetation which prefers more neutral conditions is mostly organized along the streams or has island type of distribution near the very local outcrops.

Many monkshoods play important role in mountain riparian ecosystems (Andersson *et al.* 2000; Le Cadre *et al.* 2008; Šibíková *et al.* 2008; Čarni & Matevski 2010; Pielech 2015). However, occurrence of the monkhoods along the streams and rivers in mountains, beside of water availability, is seems to be correlating with several other factors: a) watercourses form the natural landscape depressions covering the plants and protecting them from unfavorable weather conditions; b) water wash out the number of minerals including calcium from bedrocks and therefore along the torrents appear so called "island habitats" (Кобів 2007) with more neutral soils containing less organic material; c) in montane belt the sloped banks of rivers crossing the forests are more or less open and sunny localities with significantly fewer tree cover; d) such water flows serve as excellent spreading agents for dispersion of seeds (Cappelletti & Poldidni 1984; Danvind & Nilsson 1997) and even serve for vegetative propagation of monkshoods to lower elevations, and as a result – for occupation of new sites.

Conclusions

1. Our long-term field studies combined with herbarium investigations showed that the genus *Aconitum* in Chornogora is represented by 14 taxa belonging to 3 subgenera – *Aconitum* (sect. *Aconitum* – 5 taxa, sect. *Cammarum* – 4 taxa, and sect. *Acomarum* – 1 taxon), *Anthora* (sect. *Anthora* – 1 taxon), and *Lycoctonum* (sect. *Lycoctonum* – 3 taxa). 7 more taxa were pointed as potential for this region.

2. Detailed studies of current condition of local populations in Chornogora and comparison of them with both our observations from previous years and studies on herbarium collections allow us to identify most important threats for all of taxa and to clarify threat category for *A.* × *nanum* (it was changed from DD to VU), and for *A. firmum* subsp. *fussianum* (it was changed from NT to VU). As a result, for Ukrainian Carpathians in general, 10 taxa from 19 totally confirmed were ascertained as threatened. 3 more taxa are listed as those that can be potentially found in this region.

3. This study allowed clarifying ecological preferences of *Aconitum* taxa listed for the Chornogora Mts. in Ukrainian Carpathians. It was shown that the most of taxa have more or less wide ecological amplitudes (i.e. altitudinal distribution, relation to illumination, relation to soil acidity and soil moisture), and can grow in different communities. However we can conclude, as it was suggested before, that there are four main biomorphological groups which correspond to main sections of the genus and represent their general ecological preferences.

4. Other ecological parameters as air temperature, air humidity, illumination and wind speed etc. require more long-term investigations with application of datalogers. However obtained results could also be useful and applied further as a starting point.

5. Association *Aconitetum firmi* Pawł., Sokoł. et Wall. 1927 was described for the first time for the Ukrainian Carpathians. It is located near the lake Brebeneskul on Chornogora mountain range and includes *A. firmum, A.* × *nanum*, and *A.* × *czarnohorense*.

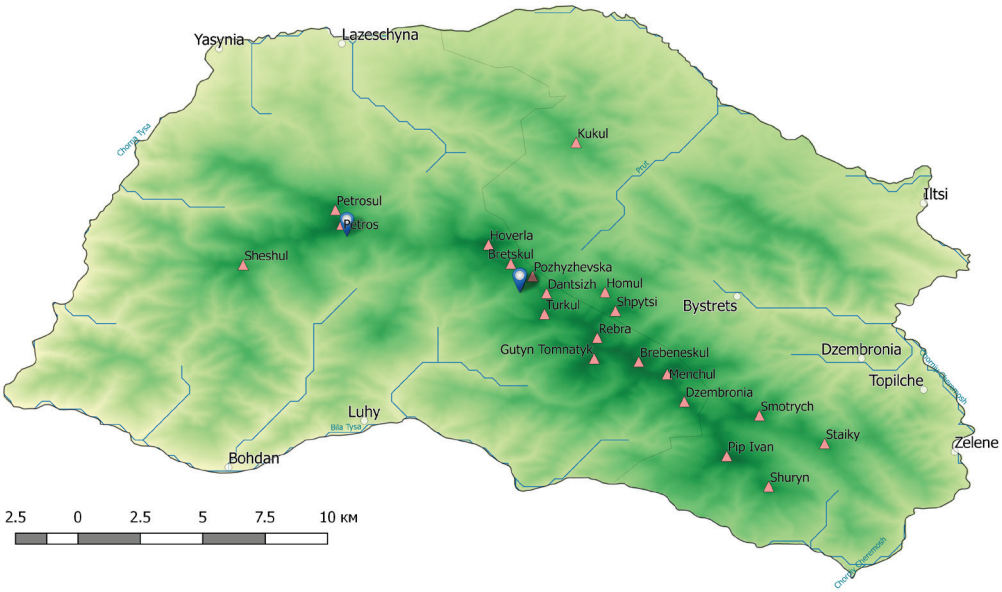

Fig. 3. Distribution of *A. bucovinense* in Chornohora Mts. **Blue points** – locations confirmed during expeditions; **red points** – locations known only from the herbarium collections and/or literature.

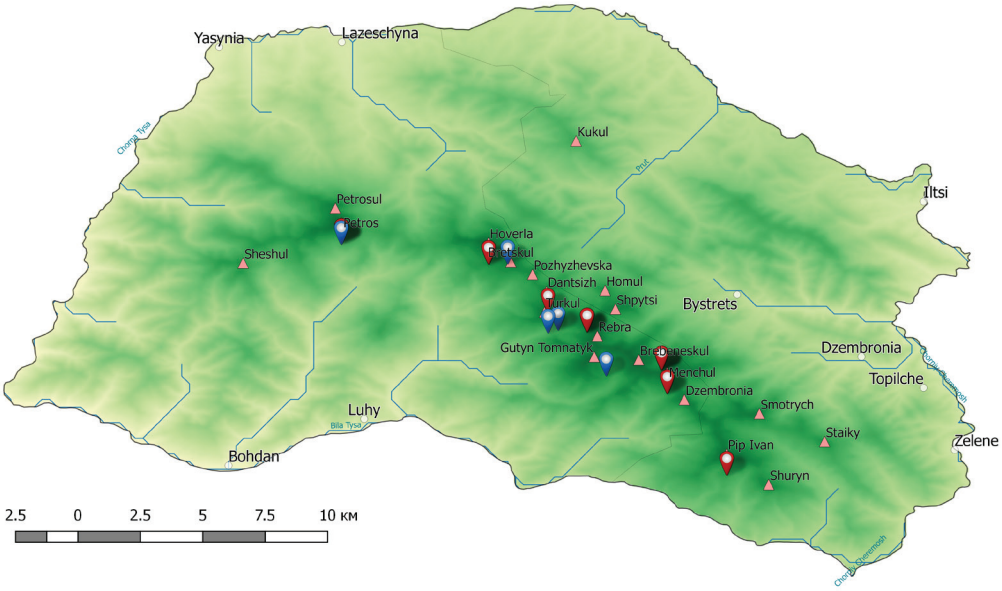

Fig. 4. Distribution of *A. firmum* in Chornohora Mts. Abbreviations correspond to Fig. 3.

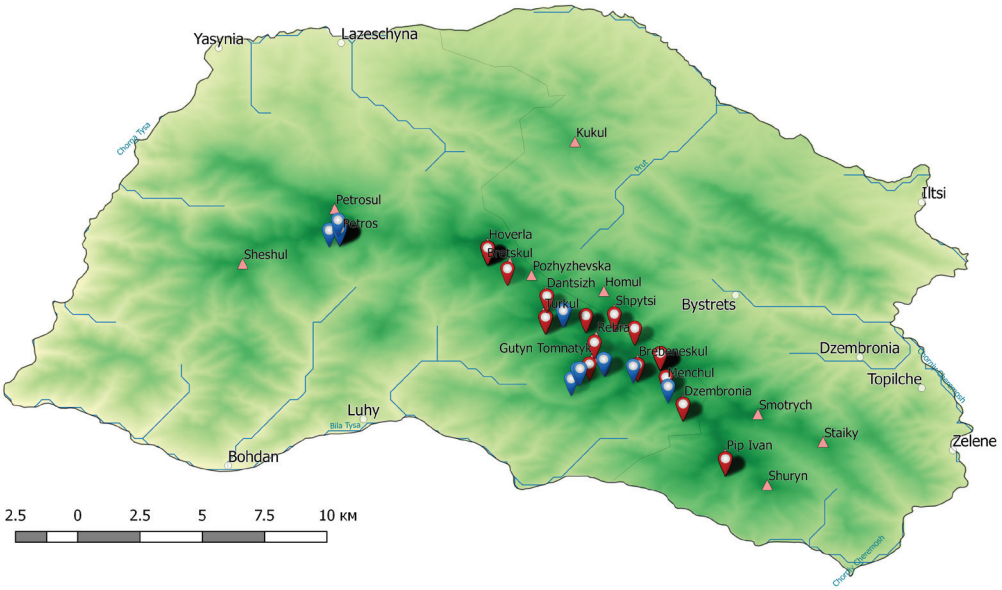

Fig. 5. Distribution of *A.* × *czarnohorense* in Chornohora Mts. Abbreviations correspond to Fig. 3.

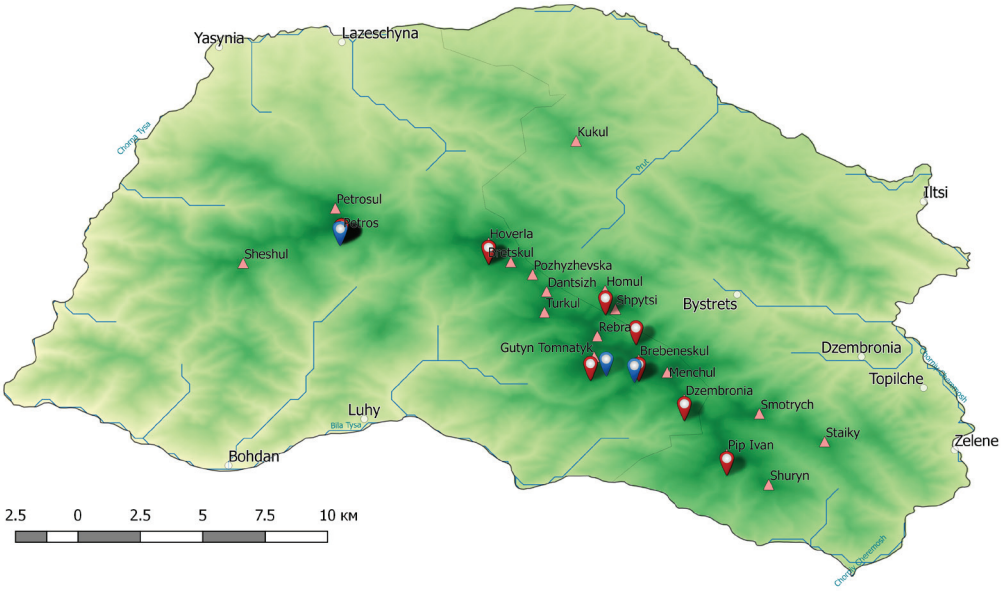

Fig. 6. Distribution of *A.* × *nanum* in Chornohora Mts. Abbreviations correspond to Fig. 3.

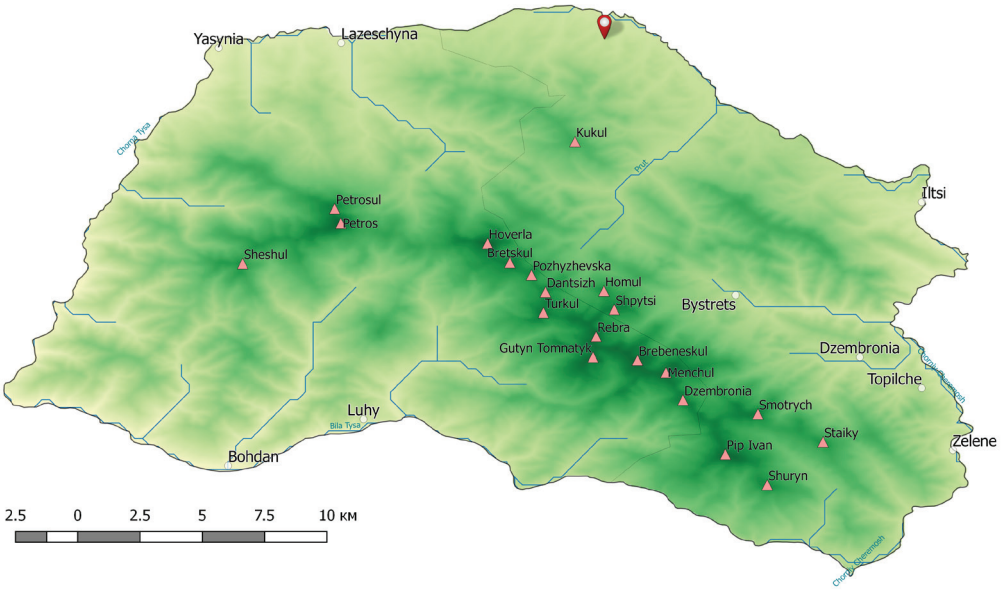

Fig. 7. Distribution of *A. variegatum* in Chornohora Mts. Abbreviations correspond to Fig. 3.

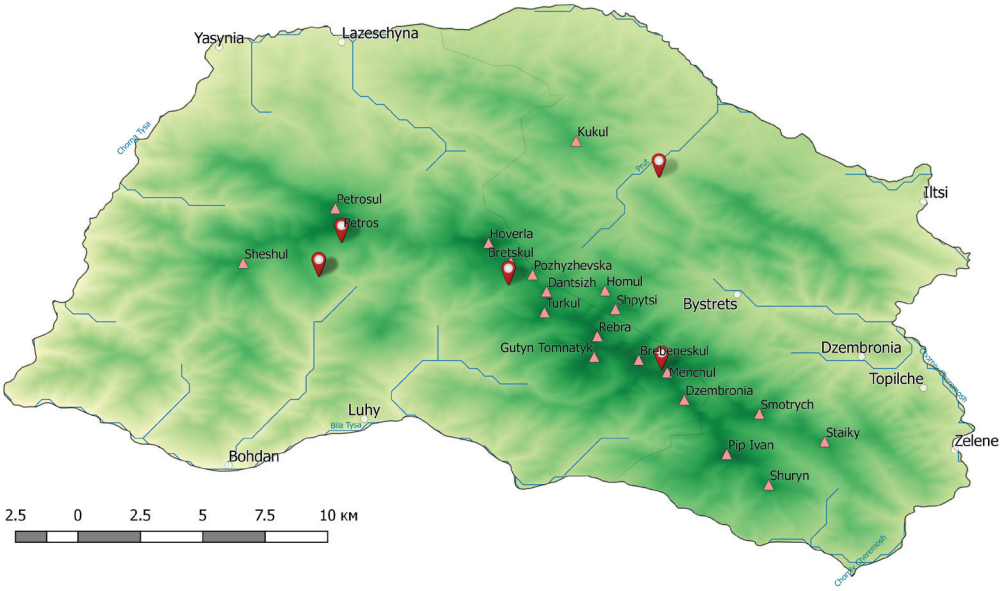

Fig. 8. Distribution of *A. lasiocarpum* in Chornohora Mts. Abbreviations correspond to Fig. 3.

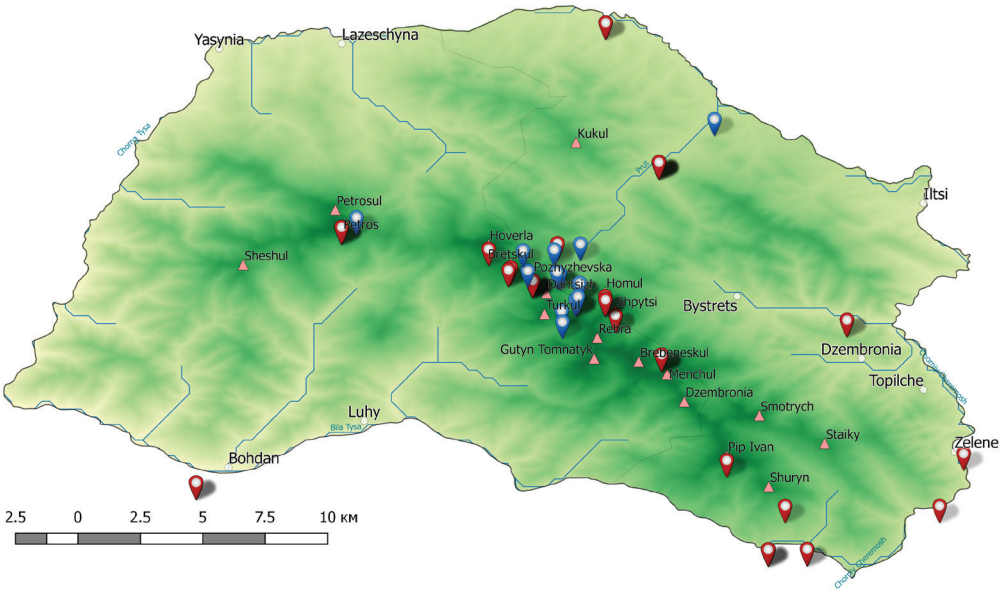

Fig. 9. Distribution of *A. degenii* in Chornohora Mts. Abbreviations correspond to Fig. 3.

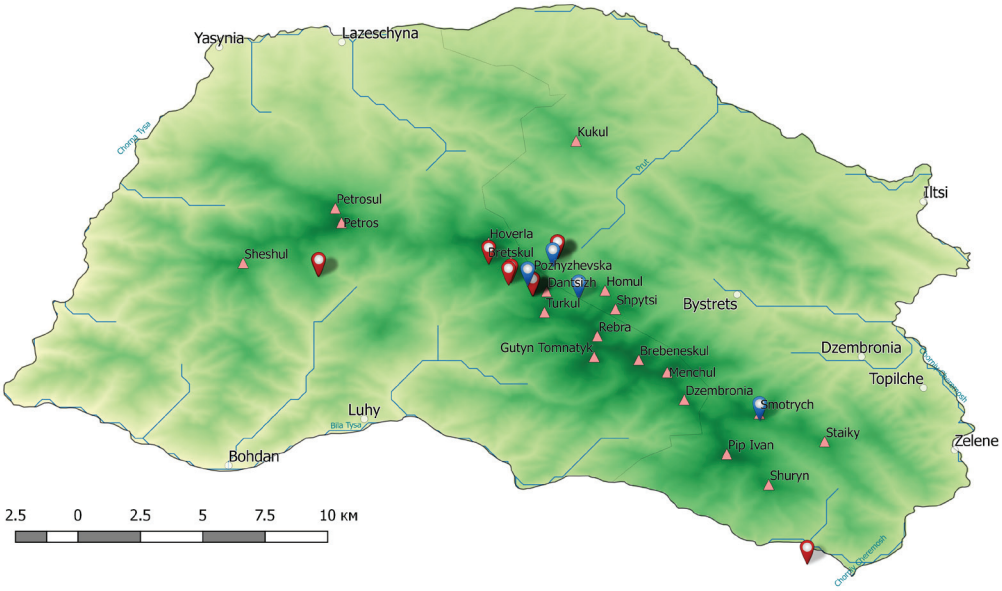

Fig. 10. Distribution of *A.* × *gayeri* in Chornohora Mts. Abbreviations correspond to Fig. 3.

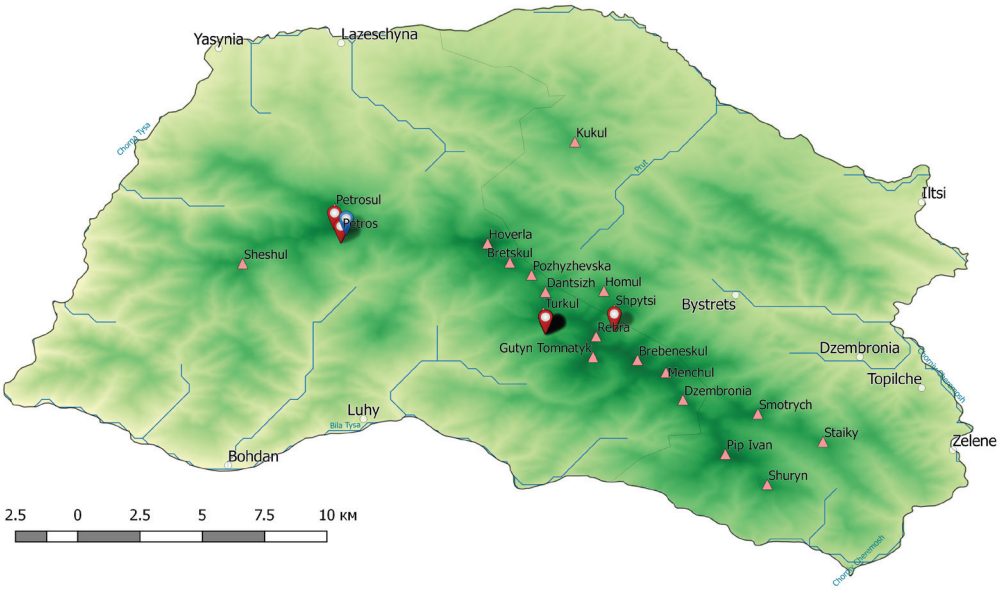

Fig. 11. Distribution of *A. anthora* in Chornohora Mts. Abbreviations correspond to Fig. 3.

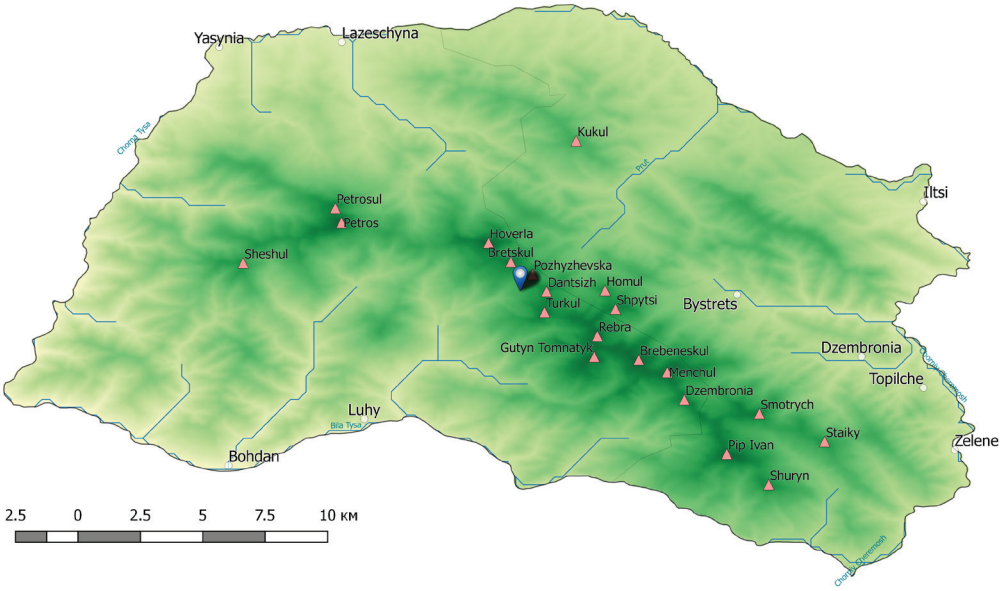

Fig. 12. Distribution of *A. lycoctonum* in Chornohora Mts. Abbreviations correspond to Fig. 3.

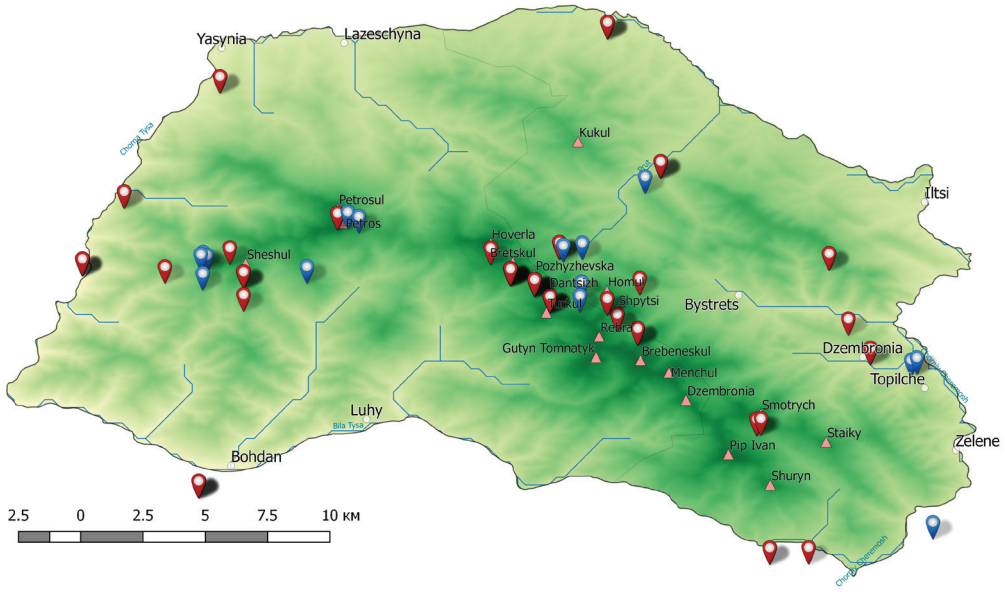

Fig. 13. Distribution of *A. moldavicum* in Chornohora Mts. Abbreviations correspond to Fig. 3.

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Appendix 1. Analyzed localities.

Location data:					
Nr	1	2	3	4	5
Description	NW slope of Petros Mt., near the summit, between stones and grasses	NE slope of Petros Mt. from the side of Petrosul Mt., stones + grasses	Rocks on E slope of Petrosul Mt., *Alnus* shrubs on steep rocks	At the foot of Petrosul Mt., rocks + shrubs	
N, °	48.171472	48.17614	48.18049	48.17815	
E, °	24.420417	024.41957	024.42319	024.42910	
Altitude, m a.s.l.	2010	1846	1724	1458	
Exposition, °	310	40	70	110	
Slope, °	15	40	80	20	
Date	22.07.2015	22.07.2015	22.07.2015	22.07.2015	
Time	13:00	14:07	15:20	16:40	
Author(s)	Novikoff A.V.	Novikoff A.V.	Novikoff A.V.	Novikoff A.V.	
Area of releve, m^2	10	10	10	10	
Fragmentation	medium	medium	high	low	
Mowing	no	no	no	no	
Pasture	no	no	no	no	
Trampling	low	no	no	no	
Succession	no	no	no	no	
Domestic animals	na	na	na	na	
Air data:					
Air t, °C	27.2	27.3	28.7	26.8	
Air relative humidity, %	43.3	40.1	43.5	46.9	
Illumination, klx	75.2	80.2	77.5	59.4	
Wind speed, m/s	8.3	7.6	3.8	2.4	
Soil data:					
Soil type (UA)	бурозем гірсько-лучний кислий альпійський слаборозвине-ний середньосу-глинковий	бурозем гірсько-лучний кислий альпійський коротко-профільний лег-косуглинковий	дерновий скелетний слабо-розвинений важ-косуглинковий	бурозем кислий коротко-профільний середньосуглинковий	
Soil type (EU)	Cambic Leptosols (Humic Distric)	Cambic Leptosols (Humic Distric)	Haplic Leptosols (Distric)	Leptic Cambisols (Distric Siltic)	
Soil t, °C	14.2	14.3	16.9	16.2	
Soil moisture, %	40.7	38.5	40.8	32.3	
Superficial soil moisture, %	165.12	160.21	89.01	135.21	
Soil pH	4.30	4.24	4.84	3.72	

Appendix 1. Continued.

Location data:					
Nr	6	7	8	9	10
Description	Road from Goverla Mt. to Pavlyk Mt., the lower travers, under the Petros Mt., slopes with shrubs	Road from Keveliv to high-mountain station of Lviv University, *Fagus-Acer-Picea* mixed forest	Stream in mixed forest near the road from Polonyna Vesnarka to Polonyna Kinets	Saddle between Breskul Mt. and Pozhyzhevska Mt., alpine grasslands, sampled just after the rain	Path from High-mountain Station of Institute of Ecology of Carpathians on Pozhyzhevska Mt. to Nesamovyte lake, along the stream on open place
N, °	48.15110	48.15773	48.14749	48.14704	48.14887
E, °	024.40123	024.34424	024.34522	024.51665	024.53673
Altitude, m a.s.l.	1526	1248	1243	1771	1372
Exposition, °	90	25	245	110	55
Slope, °	60	60	39	10	20
Date	22.07.2015	23.07.2015	23.07.2015	24.07.2015	25.07.2015
Time	19:50	12:40	17:25	19:05	10:55
Author(s)	Novikoff A.V.	Novikoff A.V.	Novikoff A.V.	Novikoff A.V.	Novikoff A.V.
Area of releve, m^2	10	10	10	10	10
Fragmentation	medium	high	no	no	medium
Mowing	no	no	no	no	no
Pasture	medium	low	low	no	no
Trampling	low	low	no	medium	high
Succession	low	low	low	no	medium
Domestic animals	cows, horses	cows	cows	na	na
Air data:					
Air t, °C	21.0	24.5	25.3	16.7	31.1
Air relative humidity, %	59.8	51.4	55.7	77.2	39.5
Illumination, klx	1.5	1.09	24.2	9.5	91.6
Wind speed, m/s	0	1.2	0	8.4	1.1
Soil data:					
Soil type (UA)	бурозем кислий коротко-профільний середньосуглинковий	бурозем кислий потужний сильнощебенистий середньосуглинковий	алювіальний дерновий середньосуглинковий	лучно-болотний легкоглинистий	алювіальний дерново-буроземний легкосуглинковий
Soil type (EU)	Leptic Cambisols (Distric Siltic)	Haplic Cambisols (Distric Skeletic Siltic)	Calcic Fluvisols (Calcaric Eutric Siltic)	Umbric Gleysols (Distric Clayic)	Haplic Fluvisols (Eutric Siltic)
Soil t, °C	14.7	14.7	14.4	12.9	12.1
Soil moisture, %	40.5	39.0	43.9	41.5	42.5
Superficial soil moisture, %	83.23	278.43	136.92	57.95	77.14
Soil pH	5.32	5.11	7.23	5.02	5.81

Appendix 1. Continued.

Location data:				
Nr	11 12	13	14	15
Description	Path from High-mountain Station of Institute of Ecology of Carpathians of NAS of Ukraine on Pozhyzhevska Mt. to Nesamovyte lake, along the stream in shady *Picea* forest	Lake Nesamovyte, in grasses	N slope of Turkul Mt. above the lake Nesamovyte, in grasses, sampled in low rain	Lake Brebeneskul, on wet places and along the stream, sampled after the rain
N, °	48.14292	48.12208	48.12420	48.10136
E, °	024.54886	024.53961	024.53189	024.56233
Altitude, m a.s.l.	1387	1741	1846	1783
Exposition, °	10	335	10	0
Slope, °	12	9	37	0
Date	25.07.2015	25.07.2015	26.07.2015	26.07.2015
Time	12:55	16:00	12:00	13:55
Author(s)	Novikoff A.V.	Novikoff A.V.	Novikoff A.V.	Novikoff A.V.
Area of releve, m^2	10	10	10	10
Fragmentation	medium	medium	medium	high
Mowing	no	no	no	no
Pasture	no	no	no	no
Trampling	medium	high	high	high
Succession	low	medium	no	medium
Domestic animals	na	na	na	na
Air data:				
Air t, °C	21.7	31.2	17.9	13.8
Air relative humidity, %	55.3	35.6	67.7	77.4
Illumination, klx	1.35	23.2	4.9	14.6
Wind speed, m/s	0	1.5	1.5	7.6
Soil data:				
Soil type (UA)	алювіальний дерново-буроземний легкосуглинковий	бурозем кислий коротко-профільний легкосуглинковий	бурозем гірсько-лучний кислий альпійський слаборозвинений середньосуглинковий	болотний мінеральний легкоглинистий
Soil type (EU)	Haplic Fluvisols (Calcaric Eutric Siltic)	Leptic Cambisols (Distric Siltic)	Cambic Leptosols (Humic Distric)	Mollic Gleysols (Humic Distric Clayic)
Soil t, °C	13.7	13.0	14.2	12.3
Soil moisture, %	41.1	40.1	36.3	40.5
Superficial soil moisture, %	115.84	65.95	37.27	410.20
Soil pH	6.13	3.96	3.50	5.93

Appendix 1. Continued.

Location data:										
Nr	16	17	18	19	20	21				
Description	ES slope of Gutyn-Tomnatyk Mt., inside the *Juniperus* shrubs separately located on alpine grassland, highly fragmented population	Path from High-mountain Station of Institute of Ecology of Carpathians on Pozhyzhevska Mt. to Nesamovyte lake, along the open stream in *Picea* forest		Road from Zarosliak to Station of Institute of Ecology of Carpathians, open wet places along the road in Picea forest	Road from Vorokhta to Zarosliak, open stream in *Picea* forest					
N, °	48.09629	48.13560		48.16082	48.16387					
E, °	024.54967	024.54792		024.53525	024.54923					
Altitude, m a.s.l.	1915	1458		1310	1179					
Exposition, °	11	335		50	52					
Slope, °	25	20		10	2					
Date	26.07.2015	26.07.2015		27.07.2015	27.07.2015					
Time	16:00	18:55		11:25	14:00					
Author(s)	Novikoff A.V.	Novikoff A.V.		Novikoff A.V.	Novikoff A.V.					
Area of releve, m^2	10	10		10	10					
Fragmentation	high	no		medium	no					
Mowing	no	no		no	no					
Pasture	no	no		no	no					
Trampling	no	low		high	low					
Succession	no	no		medium	low					
Domestic animals	na	na		na	na					
Air data:										
Air t, °C	22.6	17.9		14.4	23.7					
Air relative humidity, %	55.4	66.9		78.8	64.1					
Illumination, klx	33.4	1.43		9.8	4.6					
Wind speed, m/s	8.6	0		0.9	1.3					
Soil data:										
Soil type (UA)	бурозем гірсько-лучний кислий альпійський слаборозвинений середньосуглинковий	алювіальний дерново-буроземний легкосуглинковий		алювіальний дерново-буроземний легкосуглинковий	алювіальний дерново-буроземний легкосуглинковий					
Soil type (EU)	Cambic Leptosols (Humic Distric)	Haplic Fluvisols (Calcaric Eutric Siltic)		Haplic Fluvisols (Calcaric Eutric Siltic)	Haplic Fluvisols (Calcaric Eutric Siltic)					
Soil t, °C	10.9	12.5		11.7	12.3					
Soil moisture, %	39.8	39.8		40.5	41.1					
Superficial soil moisture, %	180.90	120.03		55.66	293.81					
Soil pH	3.70	5.42		4.90	4.52					

Appendix 1. Continued.

Location data:						
Nr	22	23	24 stones	24 grasslands	25	26
Description	N slope of Goverla Mt., in alpine grasslands on open place	Waterfall Prutskiy under Goverla Mt., in grasses along the stream	Mt. Brebeneskul, just near the summit on alpine grasslands and in depressions between stones		Near the summit of Menchul Mt., in grasses between stones	Road from Pogorilets to Zelene (Yavirnyk) village, on the steep slopes along the road, on the edge of mixed forest
N, °	48.16132	48.16039	48.09775		48.08686	48.01366
E, °	024.51023	024.51841	024.57818		024.59693	024.73768
Altitude, m a.s.l.	1793	1459	1978		1882	822
Exposition, °	70	40	325		300	170
Slope, °	32	20	18		32	60
Date	27.07.2015	27.07.2015	28.07.2015		28.07.2015	29.07.2015
Time	16:30	17:15	14:30		16:00	8:10
Author(s)	Novikoff A.V.	Novikoff A.V.	Novikoff A.V.		Novikoff A.V.	Novikoff A.V.
Area of releve, m^2	10	10	10		10	10
Fragmentation	no	no	low		no	high
Mowing	no	no	no		no	no
Pasture	no	no	no		no	medium
Trampling	no	low	low		low	high
Succession	no	no	no		no	high
Domestic animals	na	na	na		na	cows, horses
Air data:						
Air t, °C	15.6	17.8	14.2		11.0	16.1
Air relative humidity, %	64.0	71.9	62.7		69.5	76.0
Illumination, klx	21.1	16.7	101.2		11.9	2.0
Wind speed, m/s	8.1	0	1.7		9.8	0
Soil data:						
Soil type (UA)	бурозем кислий субальпійський коротко-профільний легкосуглинковий	алювіальний дерново-буроземний легкосуглинковий	дерновий скелетний слаборозвинений легкоглинистий	бурозем гірсько-лучний кислий альпійський коротко-профільний важкосуглинковий	бурозем гірсько-лучний кислий альпійський коротко-профільний легкосуглинковий	алювіальний дерновий легкосуглинковий
Soil type (EU)	Leptic Cambisols (Distric Siltic)	Haplic Fluvisols (Calcaric Eutric Siltic)	Haplic Leptosols (Distric)	Leptic Cambisols (Distric Siltic)	Leptic Cambisols (Distric Siltic)	Calcic Fluvisols (Calcaric Eutric Siltic)
Soil t, °C	17.0	14.3	9.5	9.7	10.7	15.2
Soil moisture, %	40.3	41.3	39.8	40.9	40.5	41.0
Superficial soil moisture, %	17.89	113.46	15.81	100.85	38.04	26.26
Soil pH	5.06	5.66	3.93	5.04	4.20	7.40

Appendix 2. Population data. Numbers of entries correspond to App. 1.

Nr	Taxa analyzed in July 2015	Taxa totally observed	Postgenerative plants, pcs./m^2	Generative plants, pcs./m^2	Pregenerative plants, pcs./m^2	Density, pcs./m^2	Total quantity, pcs.	Condition, 1-4	Area of population, m^2
1	*A.* × *czarnohorense*	*A.* × *czarnohorense*, *A.* × *nanum*, *A. firmum* ssp. *fissurae*	0	3	2	5	~100	3	>500
2	*A.* × *czarnohorense*	*A.* × *czarnohorense*	1	3	3	6	<50	3	~500
3	*A. moldavicum* ssp. *moldavicum*	*A. moldavicum* ssp. *moldavicum*	0	1	2	3	<10	2	~20
4	*A. moldavicum* ssp. *hosteanum*	*A. moldavicum* ssp. *hosteanum*, *A. degenii* ssp. *degenii* f. *craciunelense*, *A. bucovinense* f. *orthotricha*, *A. anthora*	0	2	3	3	8	2	~20
5	*A. degenii* ssp. *degenii* f. *craciunelense*	*A. moldavicum* ssp. *hosteanum*, *A. degenii* ssp. *degenii* f. *craciunelense*, *A. bucovinense* f. *orthotricha*, *A. anthora*	0	3	3	3	9	2	~20
6	*A. moldavicum* ssp. *hosteanum*, *A. moldavicum* ssp. *moldavicum*	*A. moldavicum* ssp. *hosteanum*, *A. moldavicum* ssp. *moldavicum*	1	5	5	11	~20	4	~200
7	*A. moldavicum* ssp. *hosteanum*	*A. moldavicum* ssp. *hosteanum*	1	0	0	0	1	1	~10
8	*A. moldavicum* ssp. *hosteanum*	*A. moldavicum* ssp. *hosteanum*	0	2	3	5	5	2	~20
9	*A. bucovinense* f. *orthotricha*	*A. bucovinense* f. *orthotricha*	2	14	4	20	>50	4	>500
10	*A. degenii ssp. degenii* f. *degenii*	*A. degenii* ssp. *degenii* f. *degenii*, *A. degenii* ssp. *degenii* var. *intermedium*	3	10	12	25	>200	4	~250
11	*A. moldavicum* ssp. *hosteanum*	*A. moldavicum* ssp. *hosteanum*, *A. degenii* ssp. *degenii* var. *intermedium*, *A.* × *gayeri*	0	1	3	4	~10	4	~100
12	*A. degenii* ssp. *degenii* var. *intermedium*	*A. moldavicum* ssp. *hosteanum*, *A. degenii* ssp. *degenii* var. *intermedium*, *A.* × *gayeri*	0	10	5	15	>40	4	~100
13	*A. degenii* ssp. *degenii* f. *degenii*	*A. degenii* ssp. *degenii* f. *degenii*	1	9	20	30	~50	2	<30
14	*A. firmum* ssp. *fissurae*	*A. firmum* ssp. *fissurae*	1	2	4	7	>300	4	~500
15	*A.* × *czarnohorense*	*A.* × *czarnohorense*, *A.* ×*nanum*, *A. firmum ssp. fissurae*	8	10	12	30	>500	4	~400

Appendix 2. Continued. Numbers of entries correspond to App. 1.

Nr	Taxa analyzed in July 2015	Taxa totally observed	Postgenerative plants, pcs./m^2	Generative plants, pcs./m^2	Pregenerative plants, pcs./m^2	Density, pcs./m^2	Total quantity, pcs.	Condition, 1-4	Area of population, m^2
16	*A.* × *czarnohorense*	*A.* × *czarnohorense*	2	2	2	6	~50	3	>1000
17	*A. degenii* ssp. *degenii* f. *craciunelense*	*A. degenii* ssp. *degenii* f. *craciunelense*, *A. degenii* ssp. *degenii* var. *intermedium*, *A. moldavicum ssp. hosteanum*	0	4	8	12	>50	4	~60
18	*A. moldavicum* ssp. *hosteanum*	*A. degenii* ssp. *degenii* f. *craciunelense*, *A. degenii* ssp. *degenii* var. *intermedium*, *A. moldavicum ssp. hosteanum*	1	2	3	6	~10	3	~60
19	*A. degenii* ssp. *degenii* var. *intermedium*	*A. degenii* ssp. *degenii* var. *intermedium*, *A.* ×*gayeri*	0	4	5	9	~50	3	~100
20	*A. moldavicum* (sterile mutant)	*A. moldavicum* (sterile mutant), *A. degenii* ssp. *degenii* f. *degenii*	1	1	1	3	<5	1	~10
21	*A. degenii* ssp. *degenii* f. *degenii*	*A. moldavicum* (sterile mutant), *A. degenii* ssp. *degenii* f. *degenii*	1	7	12	20	>500	4	>500
22	*A. firmum* ssp. *fissurae*	*A. firmum* ssp. *fissurae*	0	1	0	1	1	1	1 (?)
23	*A. degenii* ssp. *degenii* f. *degenii*	*A. degenii* ssp. *degenii* f. *degenii*	1	8	3	12	>400	4	>400
24 s	*A.* × *czarnohorense*, *A.* × *nanum*	*A.* × *czarnohorense*, *A.* × *nanum*	0	2	5	7	>1000	4	~1000
24 g	*A.* × *czarnohorense*, *A.* × *nanum*	*A.* × *czarnohorense*, *A.* × *nanum*	6	14	10	30	>1000	4	~1000
25	*A.* × *czarnohorense*	*A.* × *czarnohorense*	0	6	10	16	>200	4	~500
26	*A. moldavicum* ssp. *moldavicum*	*A. moldavicum* ssp. *moldavicum*	1	2	2	5	<10	2	~50

Appendix 3. Releves. Numbers of entries correspond to App. 1.

Nr	1	2	3	4	5	6	7	8	9	10	11	12
Community	*Caricetum sempervirentis*	*Caricetum sempervirentis*	*Pulmonario-Duschekietum viridis*	*Juniperetum sibiricae*	*Juniperetum sibiricae*	*Pulmonario-Duschekietum viridis*	-	-	*Poo-Deschampsietum*	*Vaccinio myrtilli-Pinetum mughi*	*Calthion*	*Calthion*
Mosses & lichens, %	5	10	5	3	3	5	8	5	2	10	20	20
Herbs, %	70	70	30	40	40	20	40	60	98	50	60	60
maximal height, cm	70	60	50	70	70	120	100	140	80	140	120	120
average height, cm	25	25	20	30	30	60	50	20	50	60	30	30
Shrubs, %	2	5	40	25	25	40	20	10	0	20	5	5
maximal height, cm	20	30	200	160	160	180	170	320	0	200	300	300
average height, cm	10	20	60	100	100	140	120	250	0	160	60	60
Trees, %	0	0	0	2	2	20	0	10	0	0	0	0
maximal height, cm	0	0	0	500	500	400	0	500	0	0	0	0
average height, cm	0	0	0	350	350	250	0	250	0	0	0	0
Uncovered soil, %	0	0	5	0	0	10	30	12	0	0	5	5
Rocks and stones, %	25	15	20	30	30	5	2	3	0	20	10	10
Taxa and projective covering:												
Achillea carpatica				2m	2m				1			
Aconitum anthora				+	+							
Aconitum bucovinense f. *orthotricha*				r	r				1			
Aconitum × *czarnohorense*	r	r										
Aconitum degenii ssp. *degenii* f. *craciunelense*				r	r							
Aconitum degenii ssp. *degenii* f. *degenii*										1		
Aconitum degenii ssp. *degenii* var. *intermedium*										1	1	1
Aconitum firmum ssp. *fissurae*	r											
Aconitum × *gayeri*											+	+
Aconitum moldavicum ssp. *hosteanum*				r	r	+		r			+	+
Aconitum moldavicum ssp. *moldavicum*			r			r	r					
Aconitum ×*nanum*	r											
Adenostyles alliariae												
Agrostis tenuis				2a								
Alchemilla sp.				2a	2a					2b		

13	14	15	16	17	18	19	20	21	22	23	24 s	24 g	25	26
Phleo alpini-Deschampsietum caespitosae	*Poo-Deschampsietum*	*Aconitum firmi / Ranunculo platanifolii-Adenostyletum alliariae*	*Primulo-Caricetum curvulae*	*Calthetum laetae*	*Calthetum laetae*	*Calthion*	*Ranunculo platanifolii-Adenostyletum alliariae*	*Ranunculo platanifolii-Adenostyletum alliariae*	*Poo-Deschampsietum / Juniperetum sibiricae*	*Ranunculo platanifolii-Adenostyletum alliariae*	-	*Poo-Deschampsietum*	*Poo-Deschampsietum*	-
5	5	0	10	30	30	5	20	20	0	10	20	0	0	0
80	80	90	10	40	40	60	70	70	80	85	10	90	70	60
80	70	80	40	150	150	120	190	190	70	80	60	60	80	140
30	30	40	30	70	70	30	60	60	60	40	20	10	30	50
0	5	10	80	10	10	20	5	5	18	5	0	0	10	10
0	40	60	40	80	80	140	140	140	100	200	0	0	90	200
0	20	40	30	60	60	80	20	20	80	140	0	0	40	160
0	0	0	0	0	0	15	5	5	0	0	0	0	0	0
0	0	0	0	0	0	800	300	300	0	0	0	0	0	0
0	0	0	0	0	0	500	200	200	0	0	0	0	0	0
0	0	0	0	5	5	0	0	0	0	0	0	0	0	13
15	10	0	0	15	15	0	0	0	2	2	70	10	20	2
										1				
		1	1								r	2a	+	
				1	1		2m	2m						
2b										2a				
				+	+	1								
	2m	r							r					
						r								
				+	+									
							r	r						r
		1								4	r	+		
		2m					3	3						
						3								

Appendix 3. Continued. Numbers of entries correspond to App. 1.

Nr	1	2	3	4	5	6	7	8	9	10	11	12
Alchemilla subcrenata												
Allium ursinum								1				
Alnus viridis			5	2m	2m	5				2b		
Anthoxanthum alpinum		2b		2a					2m			
Anthoxanthum odoratum										2m		
Arcticum lappa												
Aruncus sylvestris							2a					
Astrantia major										1		
Athyrium filix-femina				1		2a	2b	+		2a	2a	
Atrichum undulatum							2a					
Avenula versicolor	2a		2b			+						
Calamagrostis villosa							2b					
Calliergonella cuspidata							3					
Caltha palustris ssp. *laeta*												
Campanula cervicaria												
Campanula kladniana												
Campanula glomerata				2a	2a							
Campanula patula ssp. *abietina*										r	1	
Campanula polymorpha ssp. *rotundifolia*	2b	3	2b									
Carduus bicolorifolius										2a		
Cardamine opizii												
Carex atrata												
Carex curvula												
Carex echinata												
Carex rostrata												
Carex sempervirens	2b	2m										
Carex sylvatica								1				
Centaurea phrygia ssp. *carpatica*						2b						
Centraria islandica	1								2b			
Cerastium fontanum									+			
Chaerophyllum hirsutum											4	
Cimicifuga europaea								2a		2m		
Cirsium vulgare												
Cirsium waldsteinii						2m						
Clematis alpina			r									
Crepis paludosa								2m			2b	
Cystopteris fragilis								r				
Dactylis glomerata												
Daphne mezereum				1	1							
Deschampsia caespitosa	2m	4	1	3				1	5	1	r	

13	14	15	16	17	18	19	20	21	22	23	24 s	24 g	25	26
				1	1					3				
										2m				
		1												
														1
+	+			2a		+	2a			2m			+	
		2a		2b		3	+					r		
										r				2b
2m														
	2a		2m						2m		r	2m	2a	
							1							
		3												
		+												
			2m											
						2a								
				+										
	2m		1											
						1								1
			1											
				2a		1	2m							
														+
				3		2a	1			2m				
				1		2b				r				
														+
														r
4	4		1	2b		2a	2m		4	2a		5	5	

Appendix 3. Continued. Numbers of entries correspond to App. 1.

Nr	1	2	3	4	5	6	7	8	9	10	11	12
Dicranella varia												
Dicranum scoparium												
Dicranum sp.											2b	
Doronicum austriacum										2m	1	
Doronicum carpaticum												
Empetrum nigrum												
Epilobium alpestre										2a		
Epilobium alsinifolium												
Epilobium angustifolium								+				
Epilobium montanum						2a						
Euphorbia amygdaloides												
Equisetum sylvaticum												
Fagus sylvatica								2a				
Festuca airoides	3		2b						2b			
Festuca picturata												
Festuca rubra									2b	1		
Festuca supina												
Filipendula ulmaria												
Fragaria vesca								2b				
Galeopsis speciosa											3	
Galium bellatulum			+									
Galium carpaticum						1						
Gentiana acaulis			1									
Gentiana asclepiadea				1	1	1	2m					
Gentiana punctata												
Geranium alpestre		1							r			
Geranium sanguineum								1				
Geum montanum	1	1	+									
Geum urbanum												
Grimmia sp.			2b									
Hieracium alpinum ssp. *alpinum*	2b	+	1						1			
Hieracium pilosella												
Hieracium sp.			1							1		
Hieracium umbrosum												
Homogyne alpina	+			+	+				+			
Huperzia selago		+										
Hygroamblystegium varium								1				
Hylocomium splendens												
Hypericum maculatum										2b		
Hypericum richeri	1	2b		+		2m			+	2b		
Hypericum perforatum												

13	14	15	16	17	18	19	20	21	22	23	24 s	24 g	25	26
2a														
							4							
							2m							
		+								1				
			3											
		2a												
				1	1									
							1	1						
							r							+
						+								1
														+
		4	3							2a		3		
	2a	2a												
3											2m		1	
			2b						3	+			1	
				2a			2a							
							1	1						+
														+
									r					
						1								
		1												
									r	r				
2b									1			2m	1	
							+							1
1	2b		2a									1	+	
				r										
2b	+		+				3	1	r					
							1	1			r			
	+													
							2a							
1	2b									1		r	1	
													1	

Appendix 3. Continued. Numbers of entries correspond to App. 1.

Nr	1	2	3	4	5	6	7	8	9	10	11	12
Hypochoeris uniflora		+										
Juncus alpino-articulatus ssp. *fuscoater*												
Juncus effusus												
Juncus trifidus	2m	2a	1									
Juniperus communis	+	1	3	3	4							
Laserpitium krapfii												
Leontodon croceus												
Leucanthemum rotundifolia											2m	
Leucanthemum waldsteinii				1		1	r					
Leucanthemum vulgare										r		
Ligusticum muttelina									r			
Luzula alpinopilosa	1											
Luzula luzuloides									2a			
Luzula sylvatica												
Marchantia polymorpha							2b	2a				
Melica nutans												
Myosotis alpestris												
Myosotis caespitosa									1	+		
Myosotis strigulosa											4	
Myosoton aquaticum									1			
Nardus stricta				2m	2m							
Origanum vulgare												
Oxalis acetosella							+				2b	2b
Pedicularis verticillata												
Petasites albus										2a	1	1
Petasites kablikianus								1			2b	2b
Phleum alpinum				3						r		
Phyteuma vagneri		1	1									
Picea abies								r			1	1
Pinus mugo										3		
Plagiomnium rostratum										2a		
Poa alpina				2b								
Poa chaixii				3					3			
Poa deylii	1		2a									
Poa media												
Poa nemoralis												
Polygonum bistorta										1		
Polypodium vulgare												
Polytrichum formosum									2a	2a		
Potentilla aurea		1							+			
Potentilla erecta	2m											

13	14	15	16	17	18	19	20	21	22	23	24 s	24 g	25	26
						3								
							1							
2a	4		4						1		+	+	2b	
	2a	2m	5						3				1	
2a														
		1												
		r		2m		2b				1				
							2a							1
		1												
		r							1				2m	
	2m													
						2a	4							
														+
		1												
				2b		2m	3			+				
1		1												
														2m
				2b	2b	+	2b	2b						
		2m												
				5	5	4								
2a										1				
	2a													
				1	1	+	+	2a					r	
						+	2a							
											2m			
1	2a												2m	
									+					
												1		
														+
										2m				
							r							
				3	3	2b	4	4		1	2a			
2m			+						+			+	+	

Appendix 3. Continued. Numbers of entries correspond to App. 1.

Nr	1	2	3	4	5	6	7	8	9	10	11	12
Prenanthes purpurea												
Primula elatior ssp. *poloninensis*								+				
Prunella vulgaris				1		1				3		
Pulmonaria mollis												
Pulsatilla alba		3	1									
Ranunculus acris							2m					
Ranunculus illyricus									1			
Ranunculus lanuginosus								1				
Ranunculus platanifolius												
Ranunculus repens											3	
Rhodiola rosea		2m										
Rhododendron myrtifolium		2m										
Rhytidiadelphus squarrosus										3		
Rhytidiadelphus triquetrus			2a									
Rosa pendulina												
Rumex alpestris										r		
Rumex carpaticus											r	
Rubus idaeus				4	4	2a	3			1	1	1
Rubus sp.										1		
Salix silesiaca												
Salvia glutinosa												
Saxifraga paniculata	+	+	+									
Schistidium sp.		1										
Scrophularia scopolii						1						
Sedum carpaticum				1		1						
Senecio carpaticus												
Senecio nemorensis						2b	1				4	
Sesleria bielzii	2b	2a	3									
Silene vulgaris ssp. *carpatica*												
Silene dioica						+						
Soldanella marmarossiensis												
Solidago virgaurea ssp. *alpestris*		+							r	+		
Sphagnum sp.												
Spiraea ulmifolia				2a								
Stellaria graminea										2m		
Stellaria nemorum											2b	
Streptopus amplexifolius											r	r
Symphytum cordatum							1					
Telekia speciosa											2m	
Thalictrum aquilegiifolium				1			2m	2b		+		
Thymus alpestris	2a	2a	2m	1	1					2a		

13	14	15	16	17	18	19	20	21	22	23	24 s	24 g	25	26
							r							
						2m	2b							1
												2a		
	+		+										1	
							r			1				
										r				
	1		4										1	
														1
						+	1	1						1
							1	1						
		3				2m								2a
												r		
				+										
		1	2b								+	3		
	+								1					
+	1		2a						1		r	+	+	
1	3	+					1		1	1		2		r
				2a										
							r							
													3	
								1				1		

Appendix 3. Continued. Numbers of entries correspond to App. 1.

Nr	1	2	3	4	5	6	7	8	9	10	11	12
Trollius europaeus										2m		
Torilis japonica												
Trifolium repens				+								
Urtica dioca						+		+			r	r
Vaccinium myrtillus		1	2a	2m	2m					+		
Vaccinium vitis-ideae			2a									
Vaccinium uliginosum	2a		4									
Valeriana tripteris								4				
Valeriana sambucifolia										2a		
Veratrum album		1				1	+			+		
Veronica chamaedrys												
Veronica officinalis										2m		
Veronica urticifolia							3					
Viburnum opulus							1					
Vicia cracca												
Viola biflora											4	
Viola declinata			1	+					+			

13	14	15	16	17	18	19	20	21	22	23	24 s	24 g	25	26
		2b												
														1
														+
	1		2b	4	4		2b	2b	1				+	
			1						1					
1		r					r	r						
														+
														2m
						3								
												1	1	