

Forest communities with *Hacquetia epipactis* (Scop.) DC. in the Cieszyńskie Foothills

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Abstract. The strictly protected *Hacquetia epipactis*, which natural range has its north-eastern limit in the area of the Cieszyńskie Foothills, is one of the most interesting rarities of Polish flora. For one and a half centuries *H. epipactis* was popular with scientists resulting in a relatively high number of papers addressing this plant. Usually, however, the characteristics of sites where *H. epipactis* occurs have been overlooked by the researchers. The aim of this work was to fill this gap, at least partly, by determining plant associations that are preferred by this species. Based on previous phytosociological records and by implementing numerical classification methods, it was found that the *Hacquetio-Fraxinetum excelsioris* Marinček 1990, which is divided into two subassociations (typicum and allietosum with other variants), is the main association in which this plant species occurs. In isolated sites, mostly outside the Cieszyńskie Foothills, it also appears in fragments of *Galio sylvatici-Carpinetum betuli* Oberd. 1957 and *Tilio cordatae-Carpinetum betuli* Tracz. 1962 associations.

Keywords: endangered species, plant communities, *Hacquetio-Fraxinetum excelsioris*, phytosociology, rare plant association

1. Introduction and aim of the study

The north-eastern edge of the territorial range of *Hacquetia epipactis* (Scop.) DC of the *Umbelliferae* (*Apiaceae*) family is found in Poland. Its sites in the Silesian areas of Cieszyn and Opole were the first ones described in today's Poland (Wimmer 1857), although the plant presumably was known in this area much earlier. Evidence of this observation is found, among others, in the specimens of a herbarium collected in 1830, which today is part of the herbarium collection of the Museum of Natural History at the University of Wrocław (Guzikowa 1970; Duda et al. 2001; Henel 2006).

Many researchers have devoted their attention to *Hacquetia epipactis*, mainly in determining its distribution in Europe, but also in describing its biology, morphology, ecology, classification of plant communities, protection, and even restoration, pharmacology and ethnography (Kolbenheyer 1862; Hegi 1926; Szafer 1929; Kozłowska 1936; Tumidajowicz 1964; Guzikowa 1970; Marinček 1990; Karcz, Trząski 1995; Duda et al. 2001; Henel 2006; Gajewski et al. 2011; Wika et al. 2014).

The popularity of *Hacquetia epipactis* among the inhabitants of the Cieszyńskie Foothills did not always benefit the

plant, which was already noted at the beginning of the 20th century (Simm 1924). Frequent flower picking and plant removal contributed to the reduction of its population (Guzik et al. 2008). *Hacquetia* was listed as a fully protected species only on 9 July 2004, as a result of the effort of naturalists. It is also on the “Red list of plants and fungi in Poland” as a species vulnerable to extinction in isolated stands outside of its main area of occurrence (Zarzycki, Szelağ 2006).

Research on the classification of plant communities which include *Hacquetia epipactis* in Poland, including the Cieszyńskie Foothills, as well as other parts of Europe, are incomplete. The adjoining Moravian Gate indicates a connection between the Polish sites of *H. epipactis* with sites in the southern part of its range. Therefore, it is reasonable to develop a classification of plant communities to protect the specific habitats and plant communities where *H. epipactis* is found. Despite many studies about this plant, no full phytosociological characterization exists or if so, it is limited to a specific, isolated site. The aim of this paper is to characterize the phytocoenoses of *Hacquetia epipactis* and to classify the plant communities where it occurs on the basis of collected phytosociological documentation.

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2. Methodology

The study included most of the known and new sites of *Hacquetia epipactis* in the Cieszyńskie Foothills (Pelc 1969), as well as some sites outside of this area (Tumidajowicz 1964; Guzikowa 1970; Zajac, Zajac 2001; Henel 2006). To carry out the analysis, 46 phytosociological records were made in selected areas using the Braun–Blanquet method (Pawłowski 1972) and 36 phytosociological records were used from the archives of the Department of Forest Botany and Nature Protection of the Agricultural Academy of Kraków (currently the Department of Forestry Biodiversity, Institute of Ecology and Silviculture, University of Agriculture, Kraków) (Skrzydłowski 2000; Różański 2001a, 2001b). The numerical classification was performed for a total of 82 phytosociological records, placed on an ATPOL grid (Fig. 1). The recorded sites of *Hacquetia epipactis* were located at an altitude of 160–650 meters above sea level.

Cluster analysis was used to determine the relationship of the similarity between each pair of compared phytosociological records (Sneath, Sokal 1973; Dzwonko 1977a, 1977b). Due to the non-vectorial nature of the Braun–Blanquet scale, the results had to be transformed into numerical data. We adopted a method in which species of low quantity have a relatively significant impact on the similarity between the compared records. In order to calculate the similarity between phytosociological records for qualitative and quantitative data, the modified Marczewski–Steinhaus index was used (Różański 1988). The matrix of similarities between each pair of phytosociological records was classified according to the agglomeration of unweighted pair group method with arithmetic mean (UPGMA) (Sneath, Sokal 1973; Dzwonko 1977a, 1977b). As a result, grouping the phytosociological records by cluster analysis produced dendrograms of qualitative and quantitative data. A dispersion diagram is produced when they are assembled together (Dzwonko, Grodzińska

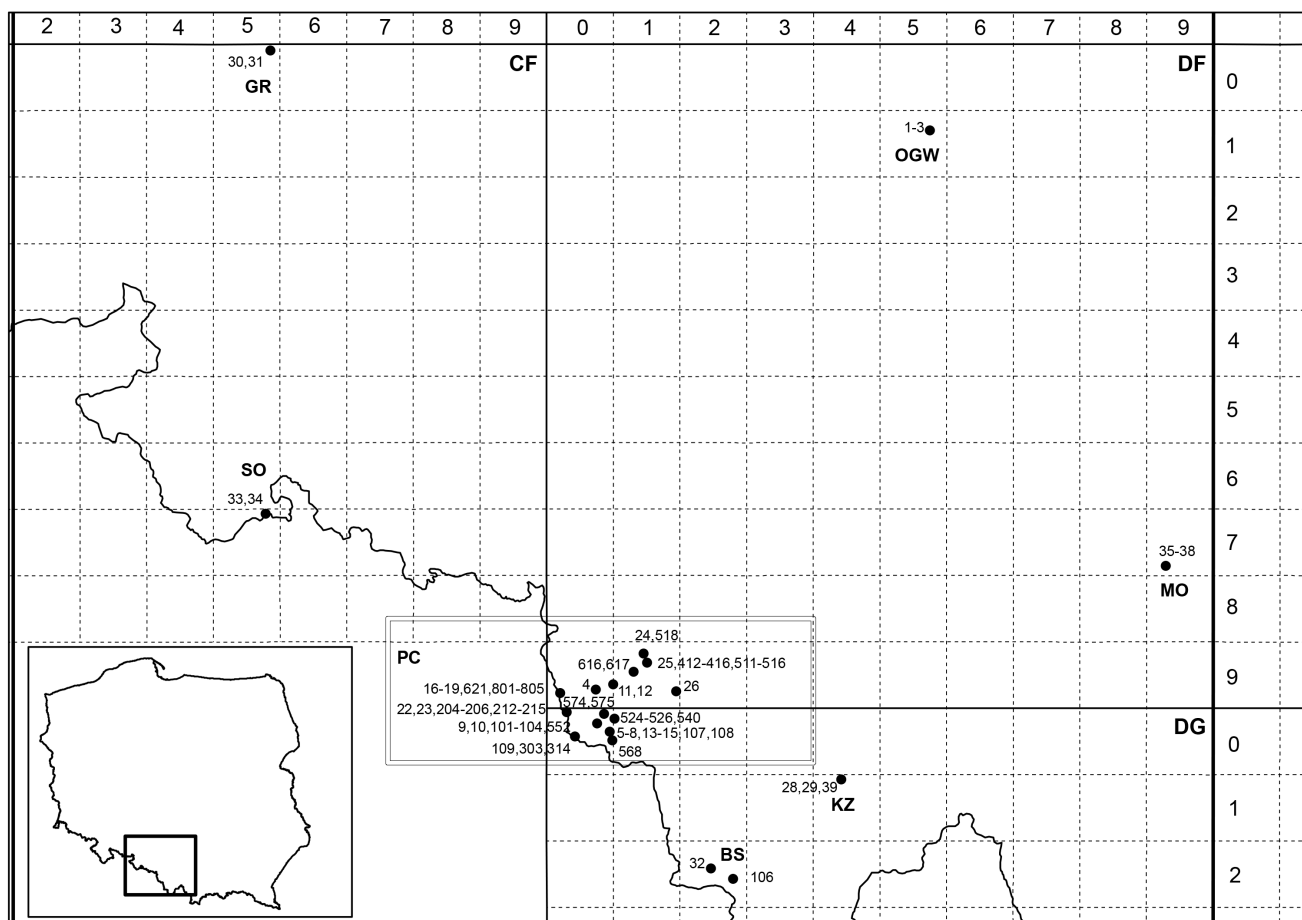


Figure 1. Localities of phytosociological records with *Hacquetia epipactis* in ATPOL grid system. Explanations: PC – Cieszyńskie Foothills with one plot in the Śląskie Foothills (26), GR – Grudzice, SO – Opole Silesia, OGW – Upper Warta Depression, MO – Mogilany, KZ – Żywiec Valley, BS – Silesian Beskid.

1979). The groups distinguished in this manner were used for the final classification of the analysed records and phytosociological tables were produced using the classical methods of observation and comparison (Pawłowski 1972). The study includes only those phytosociological tables for the distinguished *Hacquetio-Fraxinetum excelsioris* communities.

The calculations and figures in this part of the study were performed using Canoco and Statistica statistical software. The nomenclature of vascular plants is from Mirek et al. (2002).

3. Results

Classification of the plant communities with *Hacquetia epipactis*

In order to classify particular types of forest communities selected for the presence of one plant, a dendrogram pair was used, calculated for qualitative and quantitative data (Fig. 2, 3). A record as included in the same community when its similarity was no less than 0.33, although depending on the needs of study, this criterion can be somewhat modified (Dzwonko 1977a).

The analysis of all 82 records in the dispersion diagram (Fig. 4) ultimately resulted in the identification of 74 records, with the remaining eight unclassified. Based on a qualitative scale, two large groups were identified as sub-associations: *typicum* (Table 1) and *allietosum* (Table 2) of the *Hacquetio-Fraxinetum excelsioris* association, as well as two small groups, designated as fragments of the *Tilio cordatae-Carpinetum betuli* and *Galio sylvatici-Carpinetum betuli* associations. On the other hand, based on quantitative scale five sub-association's variants were identified.

The final classification of the distinguished plant, confirming the results of the studies of Róžański (2001b) and Róžański and Dziedzic (2003), according to the taxonomy of Polish communities (Matuszkiewicz 2005) is as follows:

Class: *Quercus-Fagetalia* Br.-Bl. et Vlieg. 1937;

Order: *Fagetalia sylvaticae* Pawł. in Pawł. Sokoł. et Wall. 1928;

Alliance: *Tilio platyphyllis-Acerion pseudoplatani* Klika 1955;

Association: *Hacquetio-Fraxinetum excelsioris* Marinček 1990;

Sub-association: *Hacquetio-Fraxinetum excelsioris allietosum* – 34 records;

Variants:

Typical – 22 records;

With *Fagus sylvatica* – 12 records;

Sub-association: *Hacquetio-Fraxinetum excelsioris typicum* – 30 records;

Variants:

With *Ulmus scabra* – 12 records;

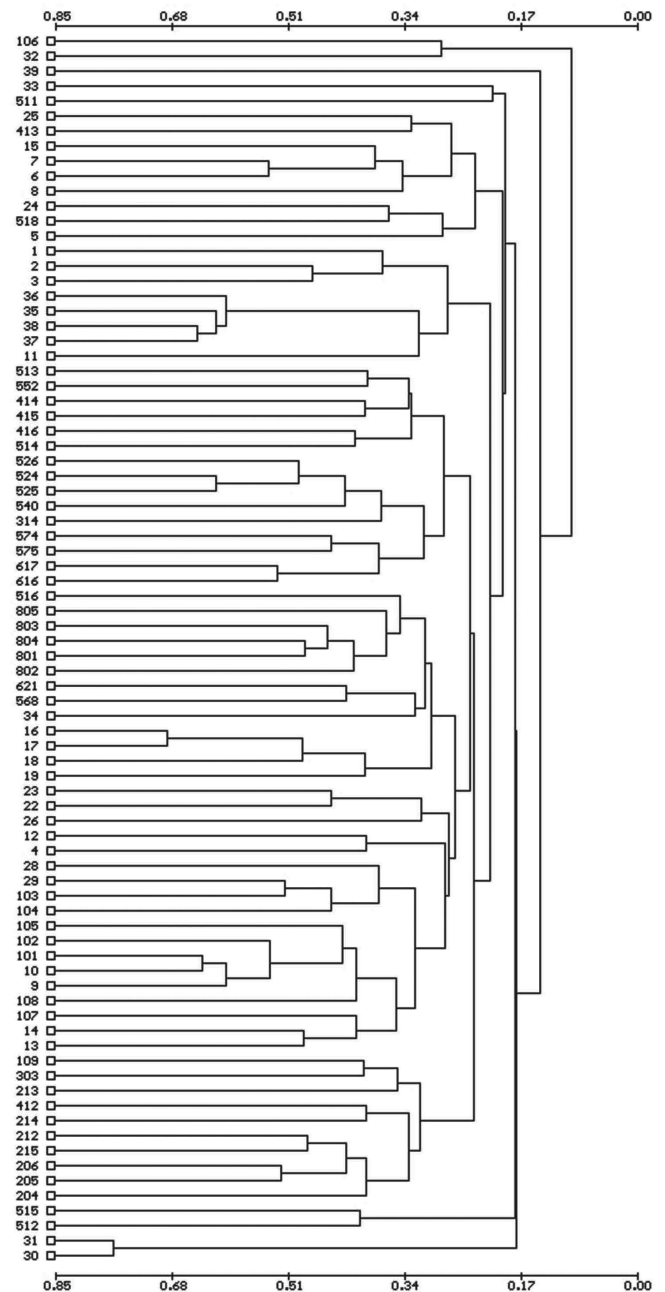


Figure 2. Dendrogram of phytosociological records similarity made for *Hacquetia epipactis* plots on Cieszyńskie Foothills and in the selected places in Poland according to quantitative scale

Poor – 9 records;

Disturbed – 9 records;

Alliance: *Carpinion betuli* Issl. 1931 em. Oberd. 1953;

Association: *Tilio cordatae-Carpinetum betuli* Tracz. 1962 – 8 records;

Association: *Galio sylvatici-Carpinetum betuli* Oberd. 1957 – 2 records.

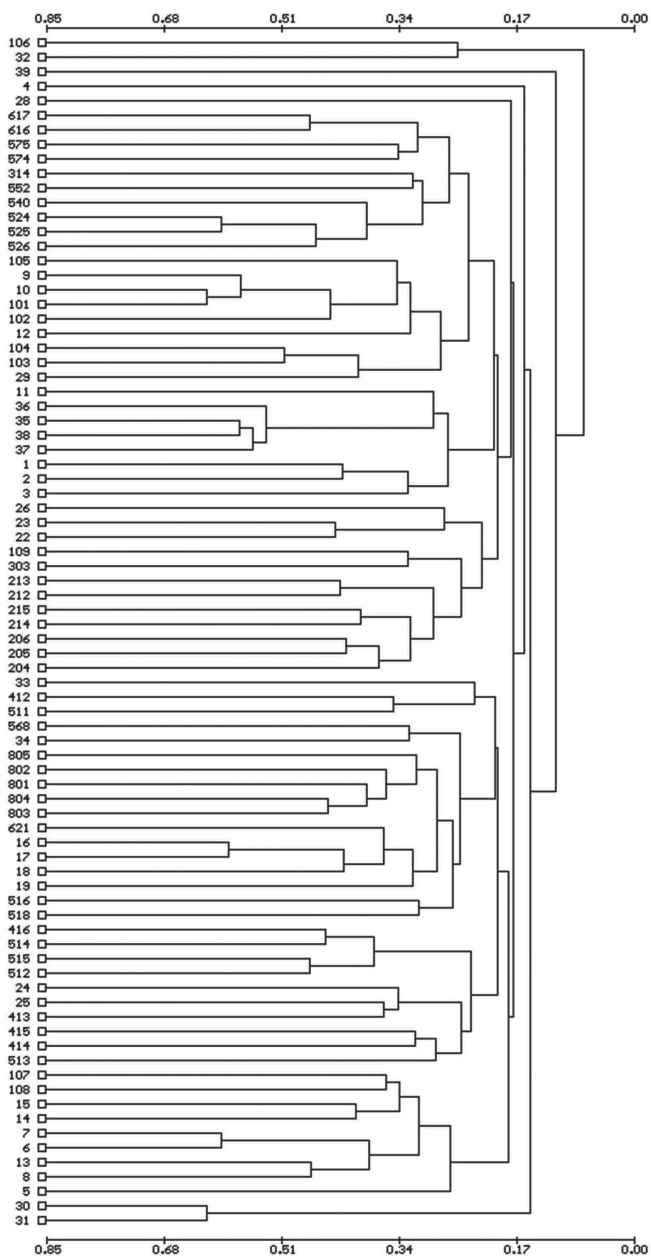


Figure 3. Dendrogram of phytosociological records similarity made for *Hacquetia epipactis* plots on Cieszyńskie Foothills and in the selected places in Poland according to transformed quantitative scale

Characteristics of forests with *Hacquetia epipactis*

1. *Tilio platyphylloides*-*Acerion pseudoplatani* alliance

1.1. *Hacquetio-Fraxinetum excelsioris* association

The vast majority of forests or their fragments in the Cieszyńskie Foothills part of this association, whose characteristic plant is primarily *Hacquetia epipactis*, as well as *Fragaria moschata*, *Veronica montana*, *Actaea spicata*, *Orchis pallens*, *Thalictrum*

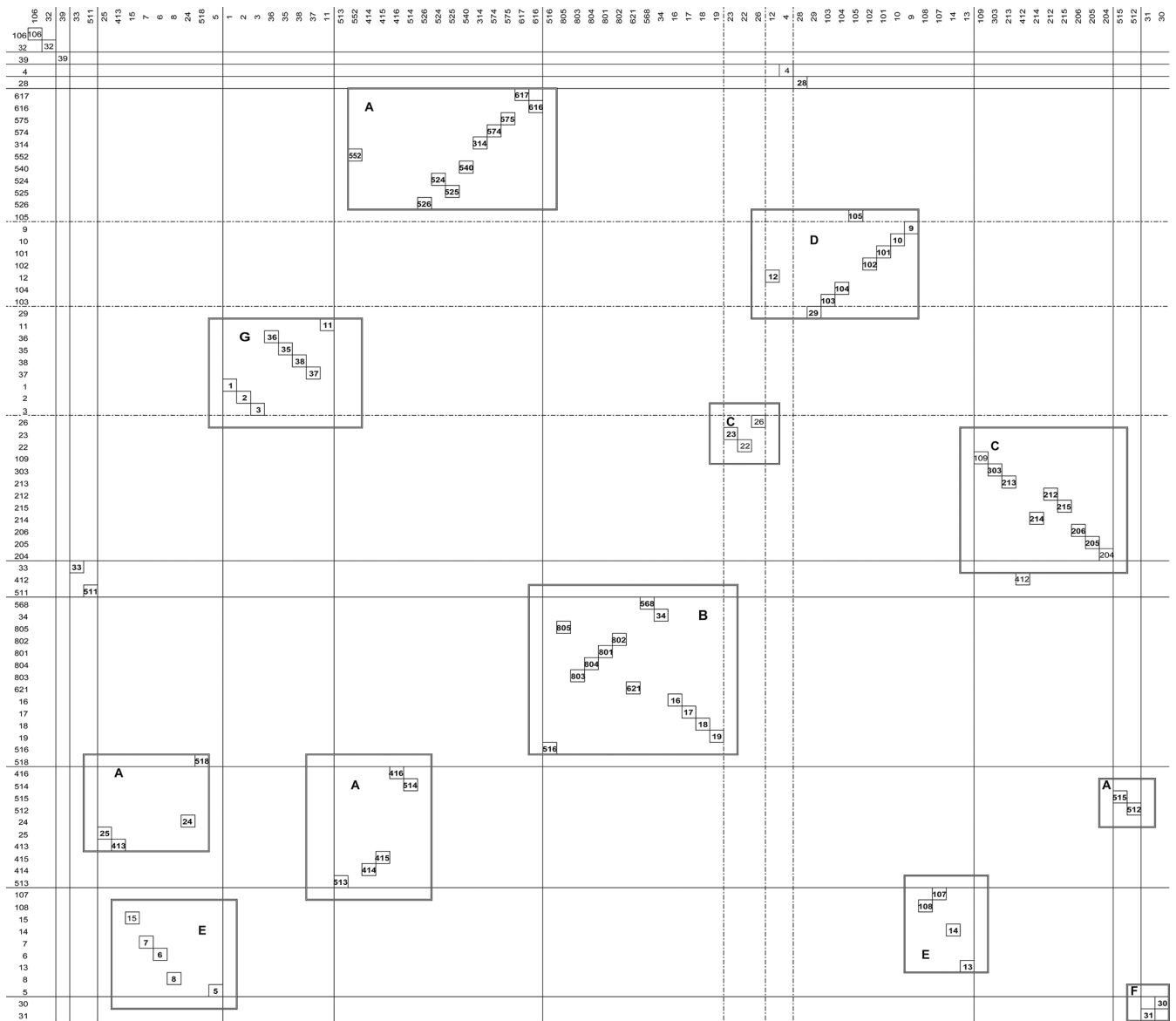
aquilegifolium and locally *Arum alpinum*. Distinguishing this new association in Poland has sorted out previously existing inconsistencies in the classification of different, multi-species, fertile deciduous forests in the Cieszyńskie Foothills. In numerically analyzing the records, two different sub-associations of this association were distinguished – *typicum* and *allietosum*, which were further divided into variants (Fig. 4).

1.1.1. Sub-association typical of *Hacquetio-Fraxinetum excelsioris typicum* (Table 1)

The main distinguishing feature of this sub-association is the almost complete lack of *Allium ursinum*. The frequency and coverage of the characteristic and differential species of the association, including *Hacquetia epipactis*, are much greater than in the *allietosum* sub-association. *Fraxinus excelsior* and *Quercus robur* form the tree layer, with *Tilia cordata*, *Acer pseudoplatanus* and *Ulmus scabra* also occurring. The artificially introduced species of *Picea abies* and *Larix decidua* are also found here, while *Fagus sylvatica* and *Acer campestre* are very rare. The second tree layer most often consists of *Carpinus betulus*, which is also present in the upper layer, with *Tilia cordata* and *Acer platanoides* in some patches. The shrub layer in this sub-association is poor, with only *Sambucus nigra*, *Lonicera xylosteum* and *Corylus avellana* occurring in significant amounts. The forest floor is covered in the range of 55–85% and there is no single dominant species. Some of the phytocoenoses are distinguished by a poor forest floor or tree layer. They are characterised by a significant share of *Anemone nemorosa*, *Mercurialis perennis*, *Galeobdolon luteum*, *Symphytum tuberosum*, and *Ficaria verna*. *Hacquetia epipactis* found in this sub-association has optimal conditions for development, forming large clumps with short stems, and is not threatened by competition.

Three variants were distinguished in the *typicum* sub-association: (1) with *Ulmus scabra*, (2) poor and (3) disturbed:

1.1.1.1. The *Ulmus scabra* variant seems to represent the most typical form of the association, even though it is not found in as fertile habitats as the *allietosum* sub-association. The tree stand almost always has two layers and is generally well preserved. The upper, emergent layer consists of *Fraxinus excelsior* and *Quercus robur*, but also *Ulmus scabra*, *Tilia cordata*, and less frequently *Acer pseudoplatanus* and *A. platanoides*. The second, tree layer is formed mostly of *Tilia cordata*, *Carpinus betulus* as well as *Acer platanoides* and *Ulmus scabra*. The shrub layer is not very varied, consisting of *Sambucus nigra*, a few *Crataegus monogyna* and *Crataegus laevigata* as well as *Corylus avellana*. The herb layer has relatively large numbers of *Hacquetia epipactis*, with an average coverage of 70%. Additional species most commonly include: *Galeobdolon luteum*, *Asarum europaeum*, *Symphytum tuberosum*, as well as *Anemone nemorosa* and *Ficaria verna*. In addition to *Hacquetia epipactis*, one of the characteristic *Hacquetio-Fraxinetum excelsioris* association species also found here is the locally



A allietosum variant typowy, B allietosum variant bukowy C typicum variant brzostowy D typicum variant ubogi E typicum variant zniekształcony F *Galio-Carpinetum* G *Tilio-Carpinetum*

Figure 4. Dispersion diagram made of two dendrograms according to quality and quantity scale for 82 phytosociological records with *Hacquetia epipactis* with determined syntaxa. Classification of plant communities: I – association *Hacquetio-Fraxinetum excelsioris*: I.I – sub-association *Hacquetio-Fraxinetum excelsioris allietosum*, A – typical variant, B – *Fagus sylvatica* variant, I.II – sub-association *Hacquetio-Fraxinetum excelsioris typicum*, C – *Ulmus scabra* variant, D – poor variant (vegetation quantity) E – disturbed variant, II – *Carpinion betuli*: F – *Tilio cordatae-Carpinetum betuli*, G – *Galio sylvatici-Carpinetum betuli*, without frame with letter – unclassified phytosociological records

differential *Arum alpinum*. No species from the *Vaccinio-Pice-etea* class were noted; *Carpinion betuli* species and other species were also rarely found. Species of the *Fagetalia sylvaticae* order and the *Quercus-Fagetea* class dominated.

1.1.1.2. The poor variant is primarily distinguished by the clearly distorted layer of trees. Artificially planted *Quercus robur* and *Picea abies* often dominate here. Gaps in the upper tree layer are filled by *Carpinus betulus* and *Acer*

pseudoplatanus. The tree stand is actually characterised by a single-layered structure. The shrub layer consists of large numbers of only *Lonicera xylosteum* and *Sambucus nigra*. No species characteristic for the association is found in the herb layer, except for the small number of *Hacquetia epipactis*. Only the *Fagetalia sylvaticae* order is represented by a large number of characteristic species, in even greater numbers than in the previous variant. Large coefficient va-

Table 1. Sub-association *Hacquetio-Fraxinetum excelsioris typicum* in the Cieszyńskie Foothills and adjacent areas

Association		<i>Hacquetio-Fraxinetum excelsioris</i> Marinček 1990												
Subassociation		typicum												
Variant		brzostowy z <i>Ulmus scabra</i> with <i>Ulmus scabra</i>												
Successive No of record		1	2	3	4	5	6	7	8	9	10	11	12	
Terrain No of record		26	22	23	109	303	213	214	212	215	206	205	204	
Location		Górki W.	Cieszyn	Cieszyn	Cieszyn	Cieszyn	Cieszyn	Cieszyn	Cieszyn	Cieszyn	Cieszyn	Cieszyn	Cieszyn	
Date - day		10	6	6	14	28	12	19	12	19	28	19	19	
Date - month		4	4	4	4	6	5	7	5	7	6	7	7	
Year		2004	2004	2004	2004	2001	2001	2001	2001	2001	2001	2001	2001	
Exposure		NW	SW	SW	WNW	W	SW	WSW	SW	WSW	W	SSW	W	
Slope degree		10	20	10	20	30	22	25	19	25	28	28	27	
Density of tree layer a1		80	55	95	50	65	60	.	40	50	70	60	65	
Density of tree layer a2		10	10	.	30	30	30	.	60	40	20	30	30	
Cover of shrub layer b		30	60	40	25	20	50	35	15	40	15	30	35	
Cover of herb layer c		50	70	70	70	50	90	65	80	70	75	50	60	
Cover of moss layer d		20	.	.	.	5	1	1	.	1	1	5	1	
Area of record [m ²]		100	100	150	225	250	400	400	400	400	250	250	250	
No.	Number of species	26	18	25	28	31	29	37	30	26	27	29	22	
Trees:														
V	<i>Fraxinus excelsior</i>	a1	3	.	3	+	.	3	4	3	.	3	4	2
		a2	2	.	.	.
		b	.	2	1	3	+	+	+
		c	2	2	2	1	2	+	1	+
I	<i>Acer pseudoplatanus</i>	a1	1	.	.	2	2	.	.
		a2	.	.	.	+	2
		b	2	.	.	1	1	+	.
		c	.	.	.	1	+	1	1	+	1	.	.	.
VI	<i>Acer campestre</i>	a2	+
		b	1	.	.	.	+	.
		c	+	+	.	.	.	+	.
I	<i>Ulmus scabra</i>	a1	.	.	1	.	1	.	.	1	1	3	2	3
		a2	2	2	.	2	.	2	1	2
		b	1	.	.	.	1	1	.
		c	+	+	.
I	<i>Tilia platyphyllos</i>	a1	+
		b	+
		c	+

<i>Hacquetio-Fraxinetum excelsioris</i> Marinček 1990																		Constancy			
typicum																					
poor (vegetation quantity)									disturbed									1-12	13-21	22-30	1-30
13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30				
9	10	101	102	105	104	103	29	12	13	14	107	108	15	7	6	8	5				
Gutdowy	Gutdowy	Gutdowy	Gutdowy	Gutdowy	Gutdowy	Gutdowy	Żywiec	Ogrodzona	Dzięgielów	Dzięgielów	Dzięgielów	Dzięgielów	Dzięgielów	Dzięgielów	Dzięgielów	Dzięgielów	Dzięgielów				
2	2	13	13	13	13	13	15	3	5	5	14	14	5	22	22	22	22				
5	5	4	4	4	4	4	4	5	4	4	4	4	4	4	4	4	4				
2003	2003	2004	2004	2004	2004	2004	2004	2003	2004	2004	2004	2004	2004	2004	2003	2003	2003				
SW	SW	SW	SW	WSW	W	ESE	NNW	PLS	W	W	NW	NW	W	N	N	N	PLS				
7	6	7	7	15	5	5	30	.	5	5	4	2	4	5	5	5	.				
80	80	75	65	60	90	85	85	80	80	80	70	95	80	80	80	60	60				
20	5	20	.	30	.	.	.	10	.	.	20	.	10	.	.	.	30				
20	30	25	30	30	10	5	15	30	40	15	20	10	5	30	30	40	5				
90	90	65	80	60	85	80	50	90	70	80	70	85	65	60	70	50	65				
10	5	5	10	.	5	5	.	5	5	.	5	.	.	.	.	.	5				
400	400	250	225	225	225	225	200	400	400	400	225	225	400	150	200	200	200				
32	27	31	33	30	27	25	24	25	27	26	41	27	21	17	23	15	33				
+	1	3	3	1	.	.	.	.	3	2	3	1	2	3	3	3	2				
.	.	.	.	+	.	.	.	.	.	.	2	.	.	.	.	.	.
+	.	+	.	.	.	.	.	.	1	+	1	2	.	.	.	.	.	V	III	V	V
+				
+	+	+	+	+	1	2	1	.	2	.	+	+	.	.	.	1	2				
2	1	2	.	2	.	.	.	.	.	.	+	.	.	.	.	.	.	IV	V	III	IV
1	.	2	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	1	1	1	1	+	.	.	.	+	+	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	I	.	I
.				
.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	IV	.	I	II
.				
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	I
.				

III	<i>Carpinus betulus</i>	a1	.	.	1	.	.	.	1	.	.	+	.	.	
		a2	1	2	.	2	2	1	.	+	2	2	2	2	2
		b	.	+	+	.	1	1	.	1	.	.	1	1	1
		c	+	.	+	+
III	<i>Tilia cordata</i>	a1	+	1	1	3	3	1	+	.	2	.	.	.	
		a2	.	.	.	1	.	2	.	1	1	.	+	.	
		b	.	2	1	.	.	.	1	2	2	1	+	+	
		c	.	+	.	.	+	+	1	+	1	.	.	.	
IV	<i>Fagus sylvatica</i>	a1	.	.	.	.	.	.	.	.	.	.	.	.
		a2	.	.	.	.	.	.	.	2	.	.	.	.
		b	.	.	.	.	.	.	.	.	.	.	.	.
III	<i>Cerasus avium</i>	a1	+	.	.	.	.	.	.	.	.	.	.	.
		a2	.	.	.	.	.	.	.	.	.	.	.	+
		c	.	.	.	.	.	.	.	.	+	.	.	.
VI	<i>Acer platanoides</i>	a2	.	.	.	.	.	.	.	.	+	.	+	.
		b	.	.	.	.	.	1	2	.	1	+	3	3
		c	.	.	.	.	+	+	1	+	+	+	+	1
		a1	2	3	2	+	2	3	1	2	3	1	+	.	
	<i>Quercus robur</i>	a2	.	.	.	.	.	1	.	2	.	.	.	.
		b	.	.	.	.	.	.	.	.	.	.	.	.
		c	.	.	.	.	1	.	1	.	.	.	.	+
		a1	.	+	.	.	.	.	.	.	.	.	.	.
	<i>Alnus glutinosa</i>	a1	.	.	.	.	.	.	.	.	.	.	.	.
		a1	.	.	.	.	.	.	.	.	.	.	.	.
		c	.	.	.	.	.	.	.	.	.	.	.	.
II	<i>Padus avium</i> s.s.	a1	.	.	.	.	.	.	.	.	.	.	.	.
		a2	.	.	.	1	.	.	.	.	.	.	.	.
		b	.	1	2	1	1	.	.	1	.	.	1	.	
		c	.	.	.	+	+	.	.	.	.	.	.	.
	<i>Picea abies</i>	a1	.	.	.	.	.	.	.	.	.	.	.	.
		a1	.	.	.	.	.	.	.	.	.	.	.	.
		a1	.	.	.	.	.	.	.	.	.	.	.	.
		a1	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Betula pendula</i>	a1	.	.	.	.	.	.	.	.	.	.	.	.
		a1	.	.	.	.	.	.	.	.	.	.	.	.
		a1	.	.	.	.	.	.	.	.	.	.	.	.
		a1	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Sorbus aucuparia</i> s.s.	b	.	.	.	.	.	.	.	+	.	.	.	.
		b	.	.	.	.	.	.	.	.	.	.	.	.
		b	.	.	.	.	.	.	.	.	.	.	.	.
		b	.	.	.	.	.	.	.	.	.	.	.	.
	Shrubs:	b	.	1	+	1	2	1	1	1	1	1	1	.	
		c	+	.	.	.	.	.	.	.	.	.	.	.
		b	2	.	+	2	.	.	1	+	1	.	.	1	
		c	.	.	.	.	+	+	+	.	.	.	.	.
VI	<i>Corylus avellana</i>	b	.	.	.	.	.	.	1	1	+	2	.	
		c	.	.	.	.	.	.	.	.	.	.	.
		b	.	.	.	.	.	.	1	1	+	2	.	
	<i>Crataegus laevigata</i>	c	.	.	.	.	.	.	.	.	+	+	+
		c	.	.	.	.	.	.	.	.	.	.	.
		c	.	.	.	.	.	.	.	.	.	.	.
VI	<i>Lonicera xylosteum</i>	b	.	.	+	.	.	.	+	.	.	.	.
		c	.	.	.	.	.	.	.	.	.	.	.
V	<i>Hedera helix</i>	b	.	.	.	.	.	.	.	.	.	.	.
		c	.	.	.	2	1	.	+	.	.	.	2		

2	1	+	.	.	2	1	5	1	.	+	.	3	2	.	.	.	+				
.	.	+	.	.	.	.	.	1	.	.	.	.	1	.	.	.	2	V	IV	III	IV
.	+	.	.				
.				
.	.	.	+	.	+	.	.	1	1	3	1	.	.	1	1	+	1				
.				
.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.
+	+	.	+	1	+	.	.	1	2	1	+	.	+	2	2	2	.	V	IV	V	V
.	.	.	.	.	.	.	.	+	.	1	.	.	1	+	.	.	.				
.	+	+				
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	I	.	II	I
.	+				
.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	II	.	II	I
.				
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	IV	.	.	II
.				
3	3	3	1	4	3	3	.	3	.	.	1	.	+	.	.	.	+				
.				
.				
.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	V	V	II	IV
.				
+	+	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	1	+	+	.	.	.	1	1	.	+	I	I	III	II
.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	+	.	I	II	I
.	+	+	.	.				
.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	III	I	II	II
.				
2	2	2	3	.	.	.	.	2	.	.	1	1	.	1	1	.	.	.	III	III	II
.	.	.	.	.	.	.	.	.	.	.	.	2	2	2	2	.	+	.	.	III	II
.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	+	.	.	III	I
.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	I	.	I	I
.				
1	.	1	2	1	.	.	.	+	2	+	1	1	.	.	.	1	.	V	IV	III	IV
+				
.	.	+	.	.	1	+	+	.	.	.	.	.	.	.	.	.	.	IV	III	.	III
.				
.	+	+	1	1	.	+	.	.	+	.	1	+	.	.	.	.	.	II	IV	II	III
.	+	.	+				
1	2	2	+	.	+	+	+	.	1	.	+	.	.	.	+	2	.	I	IV	III	III
.	+	+	.	.	.	+	+	+				
.				
.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	II	II	II
.	+	+	.	.	+	+				

	<i>Crataegus monogyna</i>	b	1	+	+	.	.	1	.	.	.	.	.	.
		c	.	.	.	.	.	+	.	.	.	.	.	.
VI	<i>Euonymus europaeus</i>	b	.	.	.	+	.	+	.	.	.	.	+	.
		c	.	.	.	+	.	+	.	+	.	.	+	.
VI	<i>Viburnum opulus</i>	b	.	.	.	.	.	.	.	.	.	.	+	.
		c	.	.	.	.	+	.	.	.	.	.	.	.
V	<i>Ribes uva-crispa</i>	b	.	.	.	.	.	.	.	.	.	.	.	.
V	<i>Daphne mezereum</i>	b	.	.	.	.	.	.	.	.	.	.	.	.
	Herbs:													
	Ch. et *Dif Hacquetio-Fraxinetum excelsioris Marinček													
I	1990 et **Tilio platyphyllis-Acerenion pseudoplatani Klika													
	1955													
	<i>Hacquetia epipactis</i>		1	2	2	1	1	2	3	2	2	3	2	1
	* <i>Symphytum tuberosum</i>		+	1	1	1	+	1	2	2	2	2	+	1
	* <i>Ranunculus lanuginosus</i>		1	+	+	.	.	+	1	+	1	1	1	+
	** <i>Actaea spicata</i>		.	.	.	+	.	.	.	.	.	.	.	.
	<i>Fragaria moschata</i>		.	.	.	.	.	.	1	+	.	.	1	.
	* <i>Arum alpinum</i>		.	.	.	+	1	2	.	.	.	.	.	.
II	Ch. Alno-Ulmion minoris Br.-Bl et R. Tx. 1943													
	<i>Ficaria verna</i>		1	1	1	1	.	3	.	3	.	.	.	.
	<i>Anthriscus nitida</i>		.	.	.	.	.	.	.	.	.	.	.	.
	<i>Circaea lutetiana</i>		.	.	.	.	2	.	.	+	2	.	.	1
	<i>Stachys sylvatica</i>		.	.	+	.	.	.	.	.	.	.	.	.
III	Ch. Carpinion betuli Issler 1931 em. Oberd.1953													
	<i>Lathyrus vernus</i>		.	.	.	+	.	.	.	+	+	.	.	.
	<i>Vinca minor</i>		.	.	.	.	.	.	.	.	.	.	.	.
	<i>Galium schultesii</i>		.	.	.	.	.	.	+	.	.	.	.	.
IV	Ch. Fagion sylvaticae R.Tx.et Diem. 1936													
	<i>Galium odoratum</i>		.	.	.	.	.	.	.	.	.	.	.	.
	<i>Dentaria glandulosa</i>		.	.	.	3	.	.	.	.	.	.	.	.
V	Ch. Fagetalia sylvaticae Pawl. 1928													
	<i>Asarum europaeum</i>		1	+	.	+	1	1	2	1	2	2	3	2
	<i>Galeobdolon luteum s.l.</i>		+	+	+	2	2	.	3	2	3	2	3	2
	<i>Mercurialis perennis</i>		.	.	.	.	+	.	+	.	3	.	.	2
	<i>Primula elatior</i>		1	+	.	.	1	+	+	+	.	.	.	.
	<i>Carex sylvatica</i>		+	+	+	+	1	1	1	+	1	+	+	.
	<i>Polygonatum multiflorum</i>		R	.	+	+	+	+	1	.	.	+	2	1
	<i>Pulmonaria obscura</i>		+	.	.	.	.	.	.	.	.	.	.	.
	<i>Hepatica nobilis</i>		.	.	.	.	.	.	.	.	.	.	.	.
	<i>Isopyrum thalictroides</i>		.	.	1	.	.	.	.	.	.	.	.	.
	<i>Euphorbia amygdaloides</i>		.	.	+	.	.	.	+	.	.	.	.	.
	<i>Glechoma hederacea</i>		+	.	.	.	.	.	.	.	.	.	.	.
	<i>Paris quadrifolia</i>		.	.	.	.	.	.	.	.	.	.	.	.
	<i>Allium ursinum</i>		.	.	+	+	.	+	.	.	.	.	+	.
	<i>Euphorbia dulcis</i>		.	.	.	.	.	.	1	.	1	1	1	1

	<i>Ajuga reptans</i>	.	.	.	.	.	+	.	+	.	.	1	.
	<i>Impatiens noli-tangere</i>	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Lilium martagon</i>	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Adoxa moschatellina</i>	.	.	.	+	.	.	.	.	.	.	.	.
	<i>Sanicula europaea</i>	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Corydalis cava</i>	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Gagea lutea</i>	.	.	.	.	.	.	.	.	.	.	.	.
VI	Ch. Quercu-Fagetea Br.-Bl. et Vlieg. 1937												
	<i>Anemone nemorosa</i>	1	2	2	3	1	3	+	4	.	1	.	.
	<i>Aegopodium podagraria</i>	+	.	.	.	.	.	.	.	.	3	2	.
	<i>Geum urbanum</i>	.	+	+	+	1	+	1	.	1	+	1	+
	<i>Milium effusum</i>	.	.	.	1	+	.	.	.	.	.	+	.
	<i>Viola reichenbachiana</i>	.	.	+	+	+	.	+	+	+	+	1	+
	<i>Brachypodium sylvaticum</i>	.	.	.	.	.	+	2	+	2	+	1	.
	<i>Rubus hirtus</i>	+	.	.	.	.	.	.	.	.	.	.	.
	<i>Melica nutans</i>	.	.	.	.	.	.	1	.	.	1	.	.
	<i>Catharinea undulata</i>	.	.	.	.	.	1	.	.	.	.	.	.
VII	Ch. Betulo-Adenostyletea Br.-Bl. 1948												
	<i>Petasites albus</i>	.	.	.	.	.	.	.	.	.	.	.	.
VIII	Other:												
	<i>Chaerophyllum temulum</i>	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Oxalis acetosella</i>	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Urtica dioica</i>	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Galium aparine</i> s.s.	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Alliaria petiolata</i>	+	.	.	.	1	.	.	.	.	.	.	.
	<i>Lamium album</i>	+	.	.	.	.	.	.	.	.	.	.	.
	<i>Brachythecium</i> sp.	.	.	.	.	+	.	+	.	+	+	.	2
	<i>Eurhynchium</i> sp.	.	.	.	.	.	.	+	.	+	+	.	2

Occasionally species: *Aesculus hippocastanum* 204:R; *Athyrium filix-femina* 213:R; *Caltha palustris* 5:1; *Carex digitata* 107:+; *Chrysosplenium alternifolium* 12:+; *Corydalis solida* 109:+; *Dentaria bulbifera* 102:1; *Dryopteris filix-mas* 107:+; *Galanthus nivalis* 12:1; *Geranium phaeum* 105:R; *Hypericum hirsutum* 214:+; *Impatiens parviflora* 303:+; *Lamium maculatum* 26:+; *Luzula luzuloides* 5:+; *Maianthemum bifolium* 5:+; *Marchantia polymorpha* 5:+; *Mnium undulatum* 12:+; *Plagiotechium laetum* 205:+; *Plagiotechium* sp. 303:+; *Poa nemoralis* 205:1; *Quercus rubra* 215:+; *Rubus caesius* 303:+; *Rubus idaeus* 214:1; *Rosa canina* (b) 23:R; *Salvia glutinosa* 214:+; *Senecio fuchsii* 214:+; *Stellaria holostea* 105:R; *Viola mirabilis* 206:+.

Ch. – characteristic species; **Dif*** – local differential species

lues of coverage were attained for *Mercurialis perennis*, *Symphytum tuberosum*, *Ficaria verna*, *Anemone nemorosa*, *Polygonatum multiflorum* and *Pulmonaria obscura*, which was not noted in the previous variant.

1.1.1.3. The disturbed variant, like the poor variant, is characterised by an unnatural, single-layered tree stand, which consists of *Fraxinus excelsior*, *Larix decidua*, *Picea abies*, as well as a smaller numbers of *Alnus glutinosa* and *Betula pendula*, mostly from plantings. The only substantial species in the shrub layer is *Sambucus nigra*. *Hacquetia epipactis* is the only plant characteristic of the association. The forest floor is generally very poor, with only *Fagion sylvaticae* being dis-

tinguished with a larger coverage ratio compared to other variants, and this is due to two species – *Galium odoratum* and *Dentaria glandulosa*. Also important are *Mercurialis perennis*, *Hepatica nobilis* and *Anemone nemorosa*.

1.1.2. The *Hacquetio-Fraxinetum excelsioris allietosum* sub-association (Table 2)

This sub-association is distinguished primarily by the mass occurrence of *Allium ursinum*. Despite this, the phytocoenosis included in this syntaxon is characterized by a large number of species, more than in the typicum sub-association (by an average of three in specific surveys). The tree stand is made up of

+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	II	I	I	I	
.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	II	.	I
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	I
.	.	.	R	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	II	.	I
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	I
.	.	.	.	3	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	I
.	.	.	.	1	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	I
.	1	+	.	+	3	4	3	2	2	1	2	2	2	2	2	2	1	1	+	IV	IV	V	V	
+	.	+	1	+	.	+	1	.	+	+	+	+	.	+	1	+	+	+	+	II	IV	V	III	
.	.	+	+	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	+	V	II	II	III
+	.	+	+	+	+	.	.	.	.	.	+	+	.	.	.	.	+	+	+	II	III	II	II	
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	IV	.	.	II	II
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III	.	.	.	I
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	I	II	I	I
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	I
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	I	.	.	I
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	II	I
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	I
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	I
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III	I
.	+	1	+	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	I
.	+	.	1	+	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	II	I
.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	I
+	.	.	.	.	.	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	I	I
1	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III	II
1	1	+	1	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	II	I

multiple species and consists of two layers. The emergent layer most often consists of *Fraxinus excelsior*, *Acer pseudoplatanus*, *Fagus sylvatica*, *Tilia cordata* and *Ulmus scabra*; while the second tree layer usually has *Carpinus betulus*, and more rarely, *Tilia cordata*. The only unnatural element in the tree layer of this sub-association appears to be *Quercus robur*. The shrub layer has a very large proportion of *Sambucus nigra*, consisting of over 50% of coverage, and more rarely *Crataegus monogyna*. The herb layer is characterised by 90–100% coverage, with the aforementioned *Allium ursinum*, as well as considerable proportions of *Mercurialis perennis*, *Asarum europeum*, *Ficaria verna* and *Galeobdolon luteum*. *Hacquetia epipactis* has a low abundance, small clumps and long stems.

Two variants were distinguished in the *allietosum* sub-association – typical and with *Fagus sylvatica*:

1.1.2.1. The typical variant is characterised by a significant share of *Fraxinus excelsior* and *Quercus robur* in the upper, emergent layer, while *Carpinus betulus*, *Acer campestre* and

Tilia cordata are the most abundant in the second, tree layer. The shrub layer is represented by *Sambucus nigra* and *Crataegus monogyna* as well as *C. laevigata*. The forest floor has a much larger share of individual species than in the *Fagus sylvatica* variant. *Hacquetia epipactis* is characterised by small numbers, in contrast to the large proportion of species from the *Alno-Ulmion* alliance, especially *Ficaria verna*; as well as from the *Fagetalia sylvaticae* order, in which *Mercurialis perennis* is distinguished. *Aegopodium podagraria*, from the *Quercus-Fagetea* class, has a large coverage ratio. It seems that if it were not for the large proportion of *Quercus robur*, this variant could be considered completely natural and optimal for *Hacquetia epipactis*, subject to interspecific competition.

1.1.2.2. The with *Fagus sylvatica* variant in the tree layer is also characterized by the presence of *Tilia cordata*, *Acer pseudoplatanus*, *Quercus robur* and *Larix decidua* in addition to the species from which it derives its name. The shrub layer is actually represented by only *Sambucus nigra*. As in the pre-

<i>Hacquetio-Fraxinetum excelsioris</i> Marinček 1990																			Constancy					
<i>allietosum</i>																								
typical									bukowy z <i>Fagus sylvatica</i> with <i>Fagus sylvatica</i>										1-22	23-34	1-34			
14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32				33	34	
540	314	574	575	617	616	516	512	515	805	803	804	801	802	621	568	34	16	17	18	19				
Bażanowice	Cieszyn	Bażanowice	Bażanowice	Wilamowice	Wilamowice	Wiślica	Wiślica	Wiślica	Cieszyn	Cieszyn	Cieszyn	Cieszyn	Cieszyn	Cieszyn	Cieszyn	Leszna G.	Rozumice	Cieszyn	Cieszyn	Cieszyn	Cieszyn			
30	22	20	20	17	17	8	8	8	9	9	9	8	8	18	12	3	6	6	6	6				
4	5	5	5	6	6	4	4	4	5	5	5	5	5	6	5	5	4	4	4	4				
2000	2003	2000	2000	2000	2000	1999	1999	1999	2002	2002	2002	2002	2002	2000	2000	2005	2004	2004	2004	2004				
S	W	NNE	NW	WSW	W	NW	ENE	NE	SSW	S	NW	S	SSE	SSE	N	NNW	SE	SW	SE	E				
.	32	5	7	4	5	12	15	10	22	4	17	18	15	25	2	7	10	15	45	.				
60	50	.	.	.	.	60	50	70	80	70	75	85	80	.	55	70	80	95	70	70			
30	25	.	.	.	.	35	50	20	10	15	20	15	.	.	30	40	.	.	20	20			
25	30	25	25	20	5	5	15	15	5	15	20	10	5	25	25	15	30	5	30	30				
80	65	90	100	95	95	60	80	100	80	90	50	100	100	90	100	100	90	70	60	100				
.	1	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
400	200	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	225	225	225	400				
48	36	37	42	52	56	33	21	18	22	32	26	26	32	35	38	24	17	22	26	29				
2	1	3	3	5	4	.	.	2	.	.	.	.	+	.	.	1	.	.	.	.
+	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
+	.	2	+	.	+	+	.	2	.	+	.	.	.	.	1	.	.	.	.	+	V	III	V
+	+	+	.	+	+	+	+	+	+	+	.	.	+	.	+	+				
.	.	.	1	.	.	.	.	.	1	3	1	2	.	+	2	1	+	+	.	.			
.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	+	.	.	.	.	II	V	III
.	.	.	+	R	+	+	+	.	1	+	+	+	+	+	+	+	.	.	.	.
.				
.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III	I	III
.	+				
.	+	.	+	+	.	+	+	.	+				
.	.	.	.	.	.	.	.	2	.	.	.	+	1	+	1	.	.	.	.	1			
.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	1	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	II	III	II
.	.	.	.	.	R	.	.	.	.	.	.	+	.	R	+	.	.	.	.	.
.				
.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	I	I	I

.	.	.	2	.	2	.	.	.	1	2	.	.	.	+	.	+	+	+	+	1			
2	2	.	.	.	.	3	3	2	2	1	2	2	.	.	2	2	.	.	2	2	V	V	V
1	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
+	+	.	+	+	+	+	+	.	+	.	+	.	+	+			
.	3	3	1	.	.	.	2	.	4	.	.	.	.	1	2	2	2	1	1	3			
1	1	.	.	.	.	.	.	+	.	2	1	1	.	.	2	1	.	.	.	.	IV	V	V
+	1	+	2	.	.	+	+	.	1	2	1	2	+	+	2	+	2	+	+	.			
.	+	+	+	+	+	+	+	.	+	+	.	.	.			
.	.	.	.	.	.	3	1	.	2	2	3	4	5	5	.	.	3	4	2	1			
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	II	V	III
.			
.	+	+	.	.	.	+	+	.	.	+	.	.	+	+	+	.			
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	I
+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	I
3	.	.	3	.	2	1	.	.	.	2	3	1	1	.	3	2	.	.	2	1	III	IV	III
.	+			
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	I
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	R	.	I
.	.	.	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	I
+	.	.	.	+			
.	.	.	.	.	.	.	.	+	.	1	.	.	.	+	.	.	+	.	+	.			
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	II	II
.			
.	.	.	.	.	.	.	.	.	1	.	.	+	+	.	.	.	1	1	1	+	I	III	II
.	+	.	.	.			
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	I	I
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	I	I
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	I
.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	I
+	2	+	+	+	.	.	2	2	2	1	2	1	1	2	+	.	1	+	2	2	V	V	V
.	+	.	.	.	+	+	.	.	.	+	.	+	+			
.	+			
+	+	.	.	.	+	+	.	.	.	.	.	+	.	+	R	.	+	1	.	+	II	III	III
.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	I	II	II
.			
.			
.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	II	I	II
.	.	.	R	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	+	2	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	II	II	II
+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	II	II	II
.	1	.	1	.	.	.	1	.	.	.	.	.	.	+	1	.	.	.	+	+	I	II	II
.	+			

	<i>Crataegus laevigata</i>	b	.	.	.	.	1	.	.	.	.	1	.	.	.
		c	.	.	.	.	.	.	.	.	.	+	.	.	.
VII	<i>Viburnum opulus</i>	c	.	.	.	.	.	.	.	.	.	.	.	.	.
VI	<i>Daphne mezereum</i>	c	.	.	.	.	.	.	.	.	.	.	.	.	.
VI	<i>Cornus sanguinea</i>	b	.	.	.	.	.	.	.	+	.	.	.	.	.
	Herbs:														
I	Ch. et *Dif Hacquetio-Fraxinetum excelsioris Marinček 1990 allietosum														
	* <i>Allium ursinum</i>		4	5	4	5	+	4	+	4	5	+	+	+	+
	<i>Hacquetia epipactis</i>		1	+	1	+	+	R	1	+	+	+	1	1	1
	* <i>Ranunculus lanuginosus</i>		.	.	.	.	.	+	+	+	+	2	1	+	1
	* <i>Symphytum tuberosum</i>		.	.	.	.	.	+	.	.	+	1	1	2	2
	<i>Fragaria moschata</i>		.	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Arum alpinum</i>		.	.	.	.	.	.	.	.	.	.	.	.	.
II	Ch. et *Dif Tilio platyphyllis-Acerenion pseudoplatani Klika 1955														
	* <i>Actaea spicata</i>		.	.	.	.	.	1	+	+	.	+	.	.	.
	* <i>Veronica montana</i>		.	.	.	.	.	.	+	.	.	.	.	.	+
III	Ch. Alno-Ulmion minoris Br.-Bl et R. Tx. 1943														
	<i>Ficaria verna</i>		.	+	.	.	.	+	.	+	.	4	3	2	2
	<i>Anthriscus nitida</i>		.	1	.	.	+	1	2	1	+	1	.	+	.
	<i>Circaea lutetiana</i>		.	+	.	.	.	+	2	+	+	.	.	.	.
	<i>Stachys sylvatica</i>		.	+	+	.	.	1	1	+	.	+	.	.	.
	<i>Lamium maculatum</i>		.	.	.	.	.	.	.	+	+	+	+	+	+
	<i>Chrysosplenium alternifolium</i>		.	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Geranium phaeum</i>		.	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Festuca gigantea</i>		.	.	.	.	.	.	.	.	.	.	.	.	.
IV	Ch. Carpinion betuli Issler 1931 em. Oberd.1953														
	<i>Lathyrus vernus</i>		.	.	.	.	.	.	.	.	.	.	1	+	2
	<i>Vinca minor</i>		+	+	.	.	.	.	+	.	.	.	.	.	.
	<i>Lathrea squamaria</i> s.s.		.	.	.	.	.	.	.	.	+	.	.	.	+
	<i>Galium schultesii</i>		.	.	.	.	.	.	.	.	.	.	.	.	.
V	Ch. Fagion sylvaticae R.Tx.et Diem. 1936														
	<i>Galium odoratum</i>		.	+	+	1	.	.	2	+	.	.	.	.	.
	<i>Dentaria glandulosa</i>		.	.	.	2	.	.	.	.	.	.	.	.	.
VI	Ch. Fagetalia sylvaticae Pawl. 1928														
	<i>Mercurialis perennis</i>		1	2	+	2	2	2	3	3	2	2	1	1	2
	<i>Asarum europaeum</i>		+	1	.	.	+	+	1	1	.	1	+	1	1
	<i>Galeobdolon luteum</i> s.l.		+	1	+	2	2	2	+	2	.	2	2	1	2
	<i>Pulmonaria obscura</i>		.	.	.	.	+	.	+	+	+	2	2	2	1
	<i>Primula elatior</i>		.	.	+	1	.	.	.	R	+	1	1	1	2
	<i>Glechoma hederacea</i>		.	.	.	.	1	+	+	+	+	+	+	1	+
	<i>Polygonatum multiflorum</i>		.	+	.	+	.	.	.	.	.	.	2	1	2
	<i>Hepatica nobilis</i>		+	+	.	.	.	.	+	.	.	.	+	.	.
	<i>Euphorbia amygdaloides</i>		+	.	.	+	.	+	+	.	.	.	.	.	+
	<i>Impatiens noli-tangere</i>		.	.	.	.	+	+	3	+	1	+	.	.	.

2	.	.	+	1	+	+	II	I	II
+	.	.	+	+	+	+	I	.	I
.	R	I	II	I
.	.	.	.	R	R	R	+	I	.	I
+	1	.	.	5	1	3	5	5	.	3	1	5	2	4	3	.	4	3	2	3	V	V	V	
1	+	1	2	1	2	2	2	R	2	+	1	+	1	1	2	2	+	1	1	2	V	V	V	
1	1	1	1	+	+	+	.	.	.	+	+	+	.	+	+	.	.	.	.	.	IV	III	III
3	1	.	.	2	2	.	.	.	.	1	1	+	1	+	+	+	.	+	+	1	III	V	III
.	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	I
.	1	I	I
.	+	R	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	II	I	II
.	.	+	.	.	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	II	I	I
1	3	1	2	.	.	.	+	.	1	.	+	1	+	.	+	.	.	1	.	+	III	III	III	
+	+	1	+	+	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	III	I	III
.	+	.	.	1	2	.	.	+	1	1	1	+	1	.	.	.	.	.	.	.	III	III	III
.	.	.	.	1	1	.	1	.	.	+	.	+	+	.	.	.	.	.	.	+	III	II	II
+	+	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	+	R	.	+	III	II	II
.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	I
.	.	.	+	.	R	.	.	.	.	.	.	.	.	R	.	.	.	.	.	.	I	I	I
.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	I
+	R	.	+	.	+	.	.	.	.	.	+	.	+	+	+	+	.	.	+	.	II	III	II
.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	I
.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	I	I	I
+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	I	I	I
.	.	2	+	+	2	+	.	.	2	1	3	1	2	+	.	.	.	+	.	III	III	III		
.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	I	I	I
+	2	+	.	2	+	+	2	2	3	1	1	.	4	1	+	3	1	+	1	.	V	V	V	
1	2	1	2	1	1	1	.	.	1	2	2	+	1	2	2	1	1	1	+	+	IV	V	V	
1	1	2	1	2	1	2	2	2	.	.	.	1	.	2	+	+	+	+	+	1	V	IV	V	
+	.	+	2	2	2	+	.	.	1	1	.	.	.	.	+	.	.	R	.	.	IV	II	III
1	+	+	1	1	1	2	.	.	.	+	.	.	.	+	1	.	.	.	.	+	IV	II	III
R	+	.	1	.	+	+	+	+	+	.	.	.	.	.	.	.	.	.	.	.	IV	I	III
2	+	.	1	+	.	+	.	.	2	1	1	.	1	+	+	1	+	+	+	+	III	V	III	
+	+	.	.	.	+	1	.	.	.	+	.	.	.	.	+	+	.	+	+	+	II	III	III
.	.	.	.	+	+	1	.	.	1	.	.	.	1	+	+	1	.	.	+	.	II	III	III	
.	.	+	.	+	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	II	I	II

	<i>Paris quadrifolia</i>	.	.	.	.	.	.	.	.	.	1	.	.	
	<i>Isopyrum thalictroides</i>	.	.	+	.	.	.	.	+	.	.	1	+	1
	<i>Euphorbia dulcis</i>	.	.	.	.	.	.	+	.	.	.	1	+	+
	<i>Ajuga reptans</i>	.	.	.	.	.	.	.	+	+	+	.	.	+
	<i>Carex sylvatica</i>	.	.	.	.	.	.	+	.	.	+	.	.	.
	<i>Adoxa moschatellina</i>	.	.	.	.	.	.	.	.	.	.	+	+	+
	<i>Lilium martagon</i>	.	.	.	.	.	.	.	.	.	.	1	+	1
	<i>Galanthus nivalis</i>	+	.	+	.	.	.	.	.	.	.	2	1	1
	<i>Sanicula europaea</i>	.	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Corydalis cava</i>	.	.	.	+	.	.	.	.	.	.	2	1	2
	<i>Dryopteris filix-mas</i>	.	.	.	.	.	.	.	+	.	.	.	.	.
	<i>Astrantia major</i>	.	.	.	.	.	.	.	.	.	.	.	.	.
VII	Ch. <i>Quercu-Fagetea</i> Br.-Bl. et Vlieg. 1937													
	<i>Anemone nemorosa</i>	.	+	+	+	.	.	.	+	.	.	1	2	1
	<i>Aegopodium podagraria</i>	+	.	.	.	.	2	.	3	1	2	2	3	3
	<i>Milium effusum</i>	.	+	.	.	.	1	1	+	.	+	+	1	.
	<i>Viola reichenbachiana</i>	.	+	.	.	.	.	.	.	.	+	+	+	.
	<i>Geum urbanum</i>	.	.	.	.	.	+	.	.	.	2	+	+	+
	<i>Geranium robertianum</i>	.	.	.	.	2	.	.	.	1	.	+	.	.
	<i>Brachypodium sylvaticum</i>	.	.	.	.	.	.	+	.	.	+	.	.	.
	<i>Poa nemoralis</i>	.	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Salvia glutinosa</i>	.	.	.	.	.	1	.	.	.	.	.	.	.
	<i>Campanula trachelium</i>	.	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Melica nutans</i>	.	.	.	.	.	.	.	.	.	.	.	.	.
VIII	Ch. <i>Betulo-Adenostyletea</i> Br.-Bl. 1948													
	<i>Petasites albus</i>	.	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Senecio nemorensis</i> s.s.	.	.	.	.	.	.	.	.	.	.	.	.	.
IX	Ch. <i>Epilobietea angustifolii</i> R. Tx. Et Prsg. 1950													
	<i>Fragaria vesca</i>	.	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Senecio fuchsii</i>	.	.	.	.	.	.	.	+	.	.	.	.	.
X	Inne / Other:													
	<i>Urtica dioica</i>	.	.	.	.	1	.	.	+	+	2	2	1	1
	<i>Oxalis acetosella</i>	.	+	.	1	.	.	.	+	.	.	.	.	.
	<i>Galium aparine</i> s.s.	.	.	.	.	+	1	.	+	+	+	.	1	1
	<i>Maianthemum bifolium</i>	.	.	.	.	.	.	.	.	.	.	.	1	.
	<i>Alliaria petiolata</i>	.	.	.	.	.	.	.	.	+	.	.	.	.
	<i>Athyrium filix-femina</i>	.	.	.	.	.	+	.	.	.	.	.	.	.
	<i>Impatiens parviflora</i>	.	.	.	.	.	+	.	+	.	.	.	.	.
	<i>Dryopteris carthusiana</i>	.	.	.	+	.	.	.	.	.	.	.	.	.
	<i>Hypericum hirsutum</i>	.	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Chaerophyllum hirsutum</i> s.s.	.	.	.	.	.	.	.	.	.	.	.	+	.
	<i>Carex brizoides</i>	.	.	.	.	.	.	.	.	.	.	.	.	.

Occasionally species: *Anemone ranunculoides* 526:+; *Caltha palustris* 5:1; *Carex panicea* 617:+; *Carex pilosa* 34:3; *Carex* sp. 540:+; *Colchicum autumnale* 552:1; 526:R; *Deschampsia caespitosa* 415:+; *Dryopteris dilatata* 414:+; *Equisetum arvense* 526:+; 617:+; *Eurhynchium* sp. 314:+; *Fissidens taxifolius* 512:+; *Melandrium rubrum* 540:+; *Myosoton aquaticum* 526:+; *Phyteuma spicatum* s.s. 414:R; *Plagiotecium* sp. 303:+; *Pteridium aquilinum* 540:+; *Pyrus communis* (b) 526:+; *Rubus hirtus* 616:+; *Rubus idaeus* 214:1; *Rubus plicatus* 616:+; *Rumex* sp. 540:R; *Rumex sanguineus* 616:+; *Scilla bifolia* 526:+; *Scrophularia nodosa* 526:R; *Stellaria holostea* 540:+; *Taraxacum sect. vulgaria* 552:R; 525:+

Ch. – characteristic species; **Dif*** – local differential species

.	1	+	2	+	+	.	.	.	.	+	+	.	.	.	.	.	II	II	II				
.	.	2	.	.	.	.	+	+	.	.	.	1	.	.	.	1	II	I	II				
1	.	+	+	2	1	.	.	.	.	+	+	+	.	.	.	.	III	II	II				
+	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	II	.	II				
.	.	+	+	+	+	+	.	.	1	+	+	.	.	.	.	.	II	II	II				
+	.	+	1	+	+	.	.	.	.	.	.	.	.	.	.	.	II	.	II				
.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	.	.	I	I	I				
2	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	I	I	I				
.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	R	+	I	II	I			
.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	II	.	I				
.	R	.	.	+	+	.	.	.	.	.	.	.	+	.	.	.	I	I	I				
+	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	I	.	I				
2	1	+	2	1	1	1	.	.	2	1	2	+	1	.	3	2	+	1	1	2	IV	V	IV
3	1	3	2	2	1	+	.	.	.	2	.	+	.	+	2	1	1	1	+	+	IV	IV	IV
+	+	+	+	+	+	.	.	.	.	+	+	+	+	+	.	.	.	.	.	.	III	III	III
.	.	.	.	+	+	+	.	.	+	.	.	.	.	.	.	.	.	R	.	.	II	II	II
+	.	+	+	+	1	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	III	I	II
.	+	+	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	II
+	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	I	I	I
.	+	.	.	+	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	I	I	I
.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	I	I
.	.	+	+	R	R	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	I
.	.	.	.	.	.	.	.	.	.	+	.	.	1	.	.	.	.	.	.	.	.	I	I
.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	I
+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	I
+	.	.	+	R	+	+	.	.	.	.	.	.	R	.	.	.	.	.	.	.	II	I	I
.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	I	I	I
+	+	+	+	1	1	.	1	+	.	.	.	.	.	.	.	.	.	.	+	.	IV	I	III
.	.	+	.	+	+	+	.	.	+	+	.	.	.	+	.	.	.	.	.	.	II	II	II
+	.	+	1	.	.	.	.	+	.	.	.	.	.	.	1	.	.	.	.	.	III	I	II
.	.	.	+	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	R	.	I	II	I
.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	I	.	I
.	+	+	.	.	+	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	I	I	I
+	.	1	.	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	I
.	.	.	.	+	+	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	I	I	I
.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	I
+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	I
.	.	.	.	+	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	I

vious variant, the forest floor is dominated by *Allium ursinum*, with *Hacquetia epipactis* characterised by a larger share, and *Ficaria verna* occurring sporadically in contrast to the previous variant. Significantly greater consistency is achieved by *Ga-*

lium odoratum, *Mercurialis perennis*, *Asarum europaeum* and *Anemone nemorosa*. The remaining species are more common in the typical variant, as is the average number of total species in individual records (by an average of five species).

2. *Carpinion betuli*

2.1. *Tilio cordatae-Carpinetum betuli*, fragments of the association

In contrast to the *Hacquetio-Fraxinetum excelsioris*, the phytocoenosis of *Tilio cordatae-Carpinion betuli* with *Hacquetia epipactis* has this plant most often found in patches at isolated sites. Only one *Tilio cordatae-Carpinion betuli* was noted in the Cieszyńskie Foothills (phytosociological record no. 11). All recorded phytosociological sites classified to this association are distinguished by flat or slightly inclined surfaces. The tree layer usually consists of *Quercus robur*, *Acer pseudoplatanus* and *Carpinus betulus*, which occur in both tree layers. Insignificant proportions of *Larix decidua* and *Alnus glutinosa* are also found here. The shrub layer consists of *Sambucus nigra*, *Corylus avellana* and *Viburnum opulus*. *Hacquetia epipactis* has an average coverage ratio, approximately at an intermediate level with *Ulmus scabra* variant and the disturbed variant of *Hacquetio-Fraxinetum excelsioris typicum*. The herb layer lacks the species characteristic for the *Fagion sylvaticae* alliance, as well as for the *Carpinion betuli* alliance, including those characteristic for the association. Significant coverage is provided by *Polygonatum multiflorum*, *Hedera helix*, *Pulmonaria obscura*, *Asarum europaeum*, *Aegopodium podagraria* and *Galeobdolon luteum*. The proportions of *Paris quadrifolia*, *Ficaria verna* and *Oxalis acetosella* are also quite significant.

2.2. *Galio sylvatici-Carpinetum betuli*, fragments of the association

This association was only identified in Grudzice. Fragments of this association have very few species, although the characteristic *Ranunculus auricomus* occurs here. The tree stand has a two-layered structure. The emergent layer consists of *Quercus robur*, *Tilia cordata* and *Ulmus laevis*, while the canopy layer is made up of *Carpinus betulus* and *Acer pseudoplatanus*. The shrub layer is very dense and occupies 50% of the surface. It is made up of *Sambucus nigra*, *Acer pseudoplatanus* and *A. platanoides*, *Fraxinus excelsior*, *Tilia cordata* and *Padus avium*. *Hacquetia epipactis* occupies very small fragments of the forest floor. In addition, the forest floor is very poor in species and contains small numbers of *Aegopodium podagraria*, *Anemone nemorosa*, *Ficaria verna*, *Viola reichenbachiana*, *Ribes uva-crispa* and many seedlings of the main tree species. A significant proportion of *Hedera helix* also occurs.

4. Discussion

The high interest in *Hacquetia epipactis* over many years has generated various publications written by authors representing diverse fields of science, from different backgrounds and periods, resulting in much contradictory and not always reliable information, which cannot be unequivocally confirmed.

The earliest studies noted the close association of *Hacquetia epipactis* to mixed deciduous forests. Hegi (1926) reports that in Europe, *Hacquetia epipactis* occurs in deciduous forests, as well as in alder forests and high in the mountains on grassy slopes adjacent to dwarf mountain pine. Then, these forests were included into the *Fagetalia* order (Koczwara 1960). Studies from Poland mention *H. epipactis* as belonging to a specific association. Kozłowska (1936) included *H. epipactis* in the *Fagetum calcareum cieszyńskie* association, but the literature most often reports that its optimal occurrence is in hornbeam associations (Tumidajowicz 1964; Pelc 1969; Guzikowa 1970; Duda et al. 2001; Henel 2006; Gajewski et al. 2011). Wika et al. (2014) described *H. epipactis* in a fertile beech forest – as a variant with *Hacquetia epipactis* (a site in the Wiślicka Escarpment reserve). Henel (2006) also lists the riverine ash-alder and elm-ash and mountain alder marshes as places where *H. epipactis* occurs. In Slovakia in turn, this plant was listed in the “Vápnitá Lipová Javorina vyššieho stupňa” assemblage, which belongs to the *Tilieto-Aceretum* alliance (Hančinský 1972). In 1990, Marinček described the limestone association *Hacquetio-Fraxinetum excelsioris* from the Alps, and then identified it in Austria (Mucina et al. 1993). Its centre of distribution is located in the Julian Alps, Austria and Croatia. In Poland, the description of this syntaxon is from the Wiślicka Escarpment, Municipal Woods on the Puńcówka Brook and Municipal Woods on the Olza River reserves, while fragments have been found in the Municipal Woods of Błogocice nature-landscape park complex (Róžański 2001a, 2001b; Róžański, Dziedzic 2003).

The mosaic of habitats in the Cieszyńskie Foothills and selected sites from all over Poland were not easy to analyse and difficulties were exacerbated by the slight differences in the values of similarities between groups of records and individual ones, which represented very similar habitats serving as the biochore for one plant species – *Hacquetia epipactis*. During the analysis, it was found that the fertile deciduous forests with *H. epipactis* located in the Cieszyńskie foothills, classified earlier as lowland hornbeam or alluvial forests, can be identified as the *Hacquetio-Fraxinetum excelsioris* association of the *Tilio-Acerion* alliance (Róžański 2001a, 2001b; Róžański, Dziedzic 2003), and only a few phytocoenoses with sites of *Hacquetia epipactis* represent non-typical hornbeam communities of the *Carpinion betuli* alliance. Additionally, the research conducted shows that the optimum occurrence of *Hacquetia epipactis* in a compact range in Poland is the *Hacquetio-Fraxinetum excelsioris* association, despite the fact that in many places this association is strongly altered or difficult to identify, and additionally lacking those species that are characteristic of the southern European range. This problem was the basis for distinguishing two, differing sub-associations (*typicum* and *allietosum*). Marinček (1990) distinguished two sub-associations – *dentarietosum trifoliae* (including the variant with *Allium ursinum*) and *omphalodetosum*. None of the species distinguishing the

Slovenian sub-associations occurs in the phytocenoses with *H. epipactis* in Poland. The classification of phytosociological records showed that as much as 78% of the total area belongs to *Hacquetio-Fraxinetum excelsioris*, 12% represents hornbeam associations and 10% are unidentified phytocenoses.

The characteristic and differential species of the *Hacquetio-Fraxinetum excelsioris* association, such as *Lamium orvala*, *Helleborus odorus*, *Oryzopsis virescens*, *Crocus neapolitanus*, *Omphalodes verna* often have a southern European range and do not exist in Poland. Others, such as *Actaea spicata*, *Orchis pallens* and *Fragaria moschata* are very rare in the *Hacquetio-Fraxinetum excelsioris* (Tables 1 and 2). This may be because *Hacquetio-Fraxinetum excelsioris* is very poorly known in Poland and is represented by a very impoverished form of this syntaxon at the extreme edge of its range. The dominant and differential association species most often occurring with *H. epipactis* the association, i.e. *Symphytum tuberosum*, *Allium ursinum*, *Ranunculus lanuginosus*, *Corydalis cava*, *Polygonatum multiflorum* and *Isopyrum thalictroides* were also listed by Mucina et al. (1993) from Austria.

Hacquetia epipactis occupies specific microhabitats and does not tend to spread. Tumidajowicz (1964) noted the absence of *H. epipactis* in adjacent forests with similar habitat conditions, which is characteristic of the Mogilany site; Gajewski et al. (2011) confirmed that this species has not spread there. The same is true for the Cieszyńskie Foothills, where the plant remains in specific locations, does not change its site nor colonise new ones, and only exhibits annual fluctuations in the size of its population (Różański 2001b; Różański, Dziedzic 2003). Protecting the phytocenoses of the *Hacquetio-Fraxinetum excelsioris* will enable the maintenance and survival of *Hacquetia epipactis* as a species associated with this syntaxon. Four locations of *H. epipactis* in the Cieszyńskie Foothills are in protected nature reserves. In addition, foresters in woods administered by the State Forests ensure the special protection of this species at sites that are outside of statutorily protected areas. Rational forest management, due to the need to maintain the phytocenoses occupied by this plant, can contribute to its effective active protection, which has been signalled in various studies of *H. epipactis*. The most important protective actions include not allowing the excessive natural regeneration of species unrelated to the *Hacquetio-Fraxinetum excelsioris* community and avoiding excessive shade and sunlight (Duda et al. 2001; Malara et al. 2004; Henel 2006). Some believe that the fertile soils of the Cieszyńskie Foothills, which today are mostly crop fields or abandoned agricultural lands, indicate that they were covered by primary forests in the past (Wilczek et al. 2014), probably with a much higher number of patches of the *Hacquetio-Fraxinetum excelsioris* community than today. Evidence of this may be the occurrence of *Hacquetia epipactis* in each, even small forested site of this area, although in limited and specific micro-habitats.

5. Summary and conclusions

Based on the study, the following conclusions have been formulated:

1. The main assemblage that includes *Hacquetia epipactis* in Poland is *Hacquetio-Fraxinetum excelsioris*, recorded in nearly all the sites analysed in the Cieszyńskie Foothills, as well as outside of it (Żywiecka Valley, Silesian Foothills and fragmentarily in Silesian Opole).

2. The assemblages of isolated sites of *Hacquetia epipactis* are represented by two hornbeam associations – fragments of *Tilio cordatae Carpinetum betuli* (Wieliczka Foothills, the Upper Warta Depression) and fragments of *Galio sylvatici Carpinetum* (Grudzice).

3. Some of the phytocenoses are very strongly distorted, making it impossible to classify them (the Silesian Beskid and Żywiecki Beskid). Other phytocenoses are transitional and were not classified because they diverged from the diagram.

4. The sub-associations *typicum* and *allietosum* and the variants for each of them were distinguished in the *Hacquetio-Fraxinetum excelsioris* association for the first time in Poland.

5. The following species, which most frequently occur with *Hacquetia epipactis*, should be acknowledged as distinguishing the association: *Symphytum tuberosum*, *Allium ursinum*, *Ranunculus lanuginosus* and *Corydalis cava*.

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