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"Orchidaceous" beech forests in the Góry Krowiarki Range (Eastern Sudety Mountains)

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ABSTRACT: The communities of beech forests with orchids belonging to the sub-alliance *Cephalanthero-Fagenion* are a rare element of vegetation in the Sudety Mountains. Described in the present study are beech forests assigned to the association *Taxo-Fagetum* or *Fagus-Hypericum maculatum* community and occurring in the small Góry Krowiarki Range of the Eastern Sudety Mountains. Phytosociological designation was augmented by an analysis of the conditions of occurrence of the above communities. Dependence on the altitudinal zonation and local variability of climate was noted, as was further conditioning founded upon the type of geological substratum (calcareous), the form and exposure of slopes and soil cover.

KEY WORDS: beech forests, *Cephalanthero-Fagenion,* Eastern Sudety Mountains, habitat conditions

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INTRODUCTION

The calcareous "orchidaceous" beech forest communities within the *Cephalanthero-Fagenion* sub-alliance have long been conceived of as a distinct group of communities among the beech forests of the *Fagion sylvaticae* alliance (see Oberdorfer 1957, 1992; Pott 1992; Medwecka-Kornaś 1977; A. Matuszkiewicz 1958; W. Matuszkiewicz 1973; W. Matuszkiewicz 1967, 1981; W. & J. M. Matuszkiewicz 1996; Dzwonko 1986). They have also been recognised in Poland for quite some time, albeit paradoxically with the relatively atypical forms from Wolin Island (1955) and Puszcza Bukowa Forest (Celiński 1962) being the first to be noted. Only much later were those that may be considered to represent the alliance better identified, in the Pieniny Mountains (Pancer-Kotejowa 1973) and the Kraków-Częstochowa Upland (Michalik 1972).

It had been known for a longer period that there were also "orchidaceous" beech forests in the Sudety Mountains. Such information, based on a single phytosociological relevé from Wojcieszów area of the Góry Kaczawskie Range was given by W. and

A. Matuszkiewicz (1973). The community was identified as the association *Taxo-Fagetum* Etter 1947 described from Switzerland. In addition, the general map of potential natural vegetation points to the existence of such habitats in the Sudety Mountains – apart from at the aforementioned single site in Góry Kaczawskie – a series of sites in Góry Kaczawskie (J. M. Matuszkiewicz 1995). In spite of the description of what is now quite a large number of "orchidaceous" beech forest communities in Poland, the taxonomic problems of the group remain unresolved, and there is a clear need for a synthetic study in this field. It is thus to be hoped that one of the studies contained in this volume will improve the situation.

The recognition and protection of these communities in the Góry Krowiarki Range is all the more indicated since these are communities very rare in this part of Europe. It may be recalled that information on the occurrence of beech forests of the sub-alliance *Cephalanthero-Fagenion* in areas of the Southern Polish Uplands Division other than the Kraków-Częstochowa Jura and Silesian Upland, as indicated on maps of potential natural vegetation, are not confirmed by field study in the opinion of the authors. No positive results accrued from the search for phytocoenoses of calcareous "orchidaceous" beech forest that was carried out in the years 1997 and 1998 in the Góry Świętokrzyskie Mountains region, in places indicated on the map of potential natural vegetation, i.e. the Pasmo Chęcińskie, Grzywy Korzeczkowskie, Pasma Małogoskie, Grzywy Bolmińskie and other ranges.

Aims of the study

The aims of this study have been the analytical description of the natural "phenomenon" that is the existence of a rare type of forest community dependent on particular conditions, as well as the determination of the habitat factors conditioning this community. It was accepted here that the characterisation would be achieved by describing the local form of the community, with no definitive decision even being taken regarding its syntaxonomic affinities. For a number of reasons, we consider that a reconnaissance of these specific communities is both important and urgent. As we indicate below, this is a highly-specific community from the point of view of floristic composition, and hence one playing a major role in the retention of the region's biological diversity. At the same time, these communities in the Góry Krowiarki Range do not enjoy any kind of legal protection and are thus habitats threatened with destruction. For this reason, there is an urgent need for reconnaissance with a view to ensuring appropriate protection.

Study area

The Góry Krowiarki Range comprises a small area of hills at the north-western extreme of the Śnieżnik Kłodzki Massif, in the fork of the rivers Nysa Kłodzka and Biała Lądecka. They are thus part of the Eastern Sudety Mountains, but small enough not to have been taken account of in the physico-geographical division of Poland into regions, being included in the Mesoregion of the Śnieżnik Massif (Kondracki 1994). The hills run north-west/south-east and divide clearly into a lower western part and a much higher eastern one running more or less north-south. In the western part they reach altitudes of ca 500–600 m a.s.l. from a basal elevation of 330–350 m a.s.l., and tend to increase in height in the direction of the main part of the Śnieżnik Massif. In the eastern part they exceed 900 m. The phytosociological studies presented here were carried out in the western part.

The diversified geological substratum of the Góry Krowiarki is worth emphasising. Various types of pre-Cambrian rocks reach the surface, including mica slates, amphibolites and crystalline dolomites (Cwojdziński 1978; Wroński 1981). Particularly noteworthy is the presence of crystalline dolomites (dolomitic-calcitic and dolomitic marbles), for these are calcareous rocks of alkaline reaction. Such substrata are rarely met with in the Sudety Mountains, and then only in small outcrops.

Materials and methods

The study is based on phytosociological research carried out in the years 1998 and 1999. This was directed at the field search for the maximum number of “orchidaceous” beech forest sites within the western part of Góry Krowiarki. On the basis of earlier data, including observations made in the course of mapping potential natural vegetation (J. M. Matuszkiewicz 1995) there was particular field penetration of:

a – the southern slopes of the hills;

b – the places where geological maps indicate outcrops of calcareous rocks;

c – the places of the real occurrence of beech in stands.

Reconnaissance in numerous phytocoenoses led to the discovery of 8 patches of “orchidaceous” beech forest of varying size and with a total area of some 19–20 ha. 11 phytosociological relevés were obtained and brought together in Table 1 using the Braun-Blanquet method. The areas of relevé ranged 400 m^2. An analysis was carried out regarding the shares of species characteristic for different syntaxonomic units in a table based on the division of characteristic species proposed by W. Matuszkiewicz (1981) with later amendments (W. Matuszkiewicz & J. M. Matuszkiewicz 1996). A summary of knowledge on the structure of the studied communities was also made. The phytocoenoses described were compared with the communities of similar composition known previously from other regions of Poland (Table 2).

The main features of “orchidaceous” beech forest sites were described and an analysis made of their distribution against the background of the relief and geological substratum (Figs 1 and 2). In seeking out the climatic conditioning of the studied communities, an analysis was produced of climatic data (Chomicz 1977; Anonymous 1986; Hess *et al*. 1980). On the basis of data from the stations, probable values at 500 m a.s.l. were calculated for the whole Polish Sudety Mountains and Góry Krowiarki Range (Table 3). These data were obtained on the basis of differences in parameters at stations of varied altitude.

Community structure

The communities of “orchidaceous” beech forests from Góry Krowiarki are uniform beech forests, of moderate (70–80%) closure, with trees of normal habit and a limited

Table 1. Beech forests of the *Cephalanthero-Fagenion* suballiance from the Góry Krowiarki Range.

Number	Ch	D	1	2	3	4	5	6	7	8	9	10	11	f (frequency)	f[%]
Field no.	Characteristic (Ch) of	Distinguishing (D) of	DS98-8	DS98-9	DS98-12	DS98-11	DS98-10	DS98-5	DS98-7	DS98-4	DS98-3	DS98-6	DS98-2		
Date			17.07.98	17.07.98	18.07.98	18.07.98	18.07.98	17.07.98	17.07.98	16.07.98	16.07.98	17.07.98	16.07.98		
Altitude a.s.l.			460	575	565	560	510	515	520	430	440	400	410		
Exposition			SSW	S	SWW	SW	S	S	SSW	S	SSW	SSW	SSW		
Cover of tree layer [%]			70	70	70	80	70	80	80	90	80	60	80		
Cover of shrub layer [%]			1	0	1	1	1	10	1	10	1	20	1		
Cover of herb layer [%]			50	80	80	40	40	30	60	60	60	50	40		
Cover of bryophytes layer [%]			0	0	0	0	0	0	0	0	0	0	0		
Number of species			31	33	35	36	39	39	41	42	48	49	51		
Trees															
Fagus sylvatica a1	ChAll.Fag.		4	4	4	3	4	4	5	5	4	4	4	11	100
Fagus sylvatica a2	ChAll.Fag.		2	1	1	3	1	2	1			1	2	11	100
Fagus sylvatica a3	ChAll.Fag.			+	+	+	+	+	+		+	2	1	11	100
Acer pseudoplatanus a2	ChAll.Fag.		+		1						1			3	27
Pinus sylvestris a2			1							+	+			3	27
Larix europaea a2			1							+				2	18
Acer platanoides a2	ChCl.Q.-F.						2							1	9
Ulmus glabra a3	ChO.F.silv.						+							1	9
Picea abies a2										+				1	9
Tilia cordata a1	ChAll.Carp.										1			1	9
Lower layers															
Acer pseudoplatanus b	ChAll.Fag.										+	+		11	100
Acer pseudoplatanus c	ChAll.Fag.		1	+	1	1	+	+	1	1	+	+	+	11	100
Epipactis helleborine c	ChCl.Q.-F.	DSAll.	1	1	+	1	1	1	1	1	1	+	1	11	100
Fagus sylvatica b	ChAll.Fag.		+			+	+	+		+	+	1	1	11	100
Fagus sylvatica c	ChAll.Fag.		+	2	1	1	1	1	1	+	2	+	2	11	100
Lonicera xylosteum b	ChCl.Q.-F.		+		+			+		+		+	+	11	100
Lonicera xylosteum c	ChCl.Q.-F.		1	+	1	1	+	+	1	+	+	1	+	11	100

Melica nutans c	ChCl.Q.-F.		1	+	1	1	+	+	2	2	1	1	2	11	100
Mercurialis perennis c	ChO.F.silv.		2	2	2	2	2	1	2	2	3	1	3	11	100
Mycelis muralis c			+	+	1	1	+	1	+	1	1	1	1	11	100
Carex digitata c	ChCl.Q.-F.		+	+	+	+	+	1	+		2	1	2	10	91
Convallaria maialis c		DSAll.	3	+	2	2		2	+	+	+	1	1	10	91
Hieracium murorum c			2		+	1	+	1	1	1	1	1	1	10	91
Campanula persicifolia c	ChO.Q.pub.	DAss.		+	r	+	1	+	+		+	+	+	9	82
Sorbus aucuparia b								+		+		+		9	82
Sorbus aucuparia c			1		+	+	+		+	+			+	9	82
Viola reichenbachiana c	ChO.F.silv.			+	+	+		+	+	1	1	+	+	9	82
Polygonatum odoratum c		DAss.	+	+		+	+	1		+	1	+		8	73
Aquilegia vulgaris c			+	+	r	+	+		+		+		+	8	73
Galium odoratum c	ChO.F.silv.		+	3	+	1			1	1	+		1	8	73
Astragalus glycyphyllos c	ChCl.T.-G.	DSAll.	+		+	+			+	+	+	+	+	8	73
Campanula trachelium c	ChCl.Q.-F.		+				1	1	1	1	1	1	+	8	73
Cephalanthera damasonium c	ChAll.Fag.	DSAll.	+	+	+	+			+	+	+		1	8	73
Rosa sp. c			+	+	+	+	+				+	+	+	8	73
Senecio fuchsii c			+	1	2	1			+	1	+		+	8	73
Taraxacum officinale c			+		+		+	+		+	+	+	+	8	73
Viola collina c			+				1			1	1	1	1	8	73
Clinopodium vulgare c	ChCl.T.-G.	DAss.		+		+	+	+	+		+	+	+	8	73
Daphne mezereum b	ChO.F.silv.							+						8	73
Daphne mezereum c	ChO.F.silv.			+	1	+		+	+	+	+		+	8	73
Hedera helix c					1	+	1	1		1	+	2	+	8	73
Actaea spicata c	ChO.F.silv.			+	1	+		+	+	+	+			7	64
Poa nemoralis c	ChCl.Q.-F.			2		1	2	1	+			+	+	7	64
Sanicula europaea c	ChO.F.silv.			+	r	+			1	+	+		+	7	64
Hypericum maculatum c						+	+	+	+	+	+	+		7	64
Solidago virgaurea c			+	+		1	1	+	+					6	55
Fraxinus excelsior c	ChCl.Q.-F.		1	1		+	1		+	+				6	55
Crataegus sp. b												+		6	55
Crataegus sp. c							+	+	+		+	+	+	6	55
Streptopus amplexifolius c			+	+	+	+			+					5	45

(cont.)

Table 1. Continued.

Number	Ch	D	1	2	3	4	5	6	7	8	9	10	11	f	f[%]
Fragaria viridis c	ChCl.T.-G.		1							1	1	+	1	5	45
Rubus idaeus c			+		+					1	1		2	5	45
Acer platanoides c	ChCl.Q.-F.			+			+			+		+	+	5	45
Brachypodium sylvaticum c	ChCl.Q.-F.				1	+			1		+	+		5	45
Viburnum opulus c					+		+	+	+			+		5	45
Hepatica nobilis c	ChCl.Q.-F.							1		+	+	1	+	5	45
Cornus sanguinea c	ChCl.Rh.-Pr.								+	+	+	+	+	5	45
Lilium martagon c	ChO.F.silv.		+				1					1	+	4	36
Festuca silvatica c	ChAll.Fag.			1				+	1			+		4	36
Tilia cordata b	ChAll.Carp.											1		4	36
Tilia cordata c	ChAll.Carp.			+			+							4	36
Cerasus avium c	ChAll.Carp.				+			+				+	+	4	36
Fragaria vesca c					+	+	+	+						4	36
Neotia nidus-avis c	ChO.F.silv.				+				+		+		+	4	36
Lathyrus vernus c	ChO.F.silv.						+	1			+	+		4	36
Pimpinella saxifraga c			+						+			+		3	27
Epilobium montanum c	ChO.F.silv.			+						+	+			3	27
Selinum carvifolia c	ChCl.M.-Arr.					+		+				+		3	27
Hieracium sabaudum c							+	+				+		3	27
Quercus petraea c								+			+		+	3	27
Rubus fruticosus c								+	+				+	3	27
Ulmus minor c	ChAll.Al.-U.							+				+	+	3	27
Fragaria moschata c									1			1	+	3	27
Euphorbia dulcis c	ChO.F.silv.									+	+		+	3	27
Hieracium lachenalii c										+	+		+	3	27
Ulmus glabra c	ChO.F.silv.		+						+					2	18
Oxalis acetosella c				+						1				2	18
Dactylis glomerata c	ChCl.M.-Arr.				+		+							2	18
Veronica officinalis c					r								+	2	18
Digitalis purpurea c							r	+						2	18

Platanthera bifolia c									+				+	2	18
Picea abies c										r	r			2	18
Ajuga reptans c										+			+	2	18
Cirsium arvense c											r		+	2	18
Dryopteris filix-mas c	ChO.F.silv.			+										1	9
Galeobdolon luteum c	ChO.F.silv.			+										1	9
Ribes spicatum c	ChAll.Al.-U.			r										1	9
Deschampsia caespitosa c	ChCl.M.-Arr.				r									1	9
Galium rotundifolium c					r									1	9
Frangula alnus b						+								1	9
Maianthemum bifolium c						1								1	9
Poa angustifolia c						+								1	9
Arrhenatherum elatius c	ChCl.M.-Arr.						+							1	9
Asplenium trichomanes c							+							1	9
Festuca pratensis c	ChCl.M.-Arr.						1							1	9
Galium mollugo c							+							1	9
Linaria vulgaris c							+							1	9
Aegopodium podagraria c	ChCl.Q.-F.							+						1	9
Impatiens parviflora c								+						1	9
Luzula luzuloides c								+						1	9
Carex glauca c									+					1	9
Corallorhiza trifida c									+					1	9
Hordelymus europaeus c	ChAll.Fag.									+				1	9
Geum urbanum c										+				1	9
Scrophularia nodosa c	ChO.F.silv.									+				1	9
Brachypodium pinnatum c	ChCl.F.-Br.										+			1	9
Digitalis grandiflora c											+			1	9
Heracleum sphondylium c	ChCl.M.-Arr.										+			1	9
Achillea millefolium c	ChCl.M.-Arr.											+		1	9
Campanula patula c	ChCl.M.-Arr.											+		1	9
Carpinus betulus b	ChAll.Carp.											+		1	9
Leucanthemum vulgare c	ChCl.M.-Arr.											+		1	9
Corylus avellana c	ChCl.Q.-F.											+		1	9

(cont.)

Table 1. Continued.

Number	Ch	D	1	2	3	4	5	6	7	8	9	10	11	f	f[%]
Euphorbia cyparissias c	ChCl.F.-Br.											+		1	9
Galium sylvaticum c	ChAll.Carp.											2		1	9
Melampyrum nemorosum c	ChAll.Carp.											+		1	9
Scabiosa ochroleuca c												+		1	9
Carex sylvatica c	ChO.F.silv.												+	1	9
Cypripedium calceolus c													+	1	9
Hypericum montanum c	ChO.Q.pub.												+	1	9
Padus avium c	ChAll.Al.-U.												+	1	9
Acer campestre c	ChCl.Q.-F.												+	1	9

ChCl.Q.-F. – characteristic species of class *Querco-Fagetea*
ChO.F.silv. – characteristic species of order *Fagetalia silvaticae*
ChO.Q.pub. – characteristic species of order *Quercetalia pubescentis*
ChAll.Fag. – characteristic species of alliance *Fagion silvaticae*
ChAll.Carp. – characteristic species of alliance *Carpinion betuli*
ChAll.Al.-U. – characteristic species of alliance *Alno-Ulmion*
DSAll. – species distinguishing the suballiance *Cephalanthero-Fagenion*
DAss. – species distinguishing the *Carici-Fagetum* association (*Cephalanthero-Fagenion*)
ChCl.M.-Arr. – characteristic species of class *Molinio-Arrhenatheretea*
ChCl.F.-Br. – characteristic species of class *Festuco-Brometea*
ChCl.Rh.-Pr. – characteristic species of class *Rhamno-Prunetea*
ChCl.T.-G. – characteristic species of class *Trifolio-Geranietea*

admixture of sycamore (*Acer pseudoplatanus*) in the lower stand layer (Table 1). Other species of tree are met with occasionally. The shrub layer is weakly-developed and mostly low, consisting of stand species plus *Lonicera xylosteum*. The ground cover layer most often covers around half of any given area, while the bryophyte layer is lacking. *Mercurialis perennis* is the species of greatest abundance in the herb layer, while a major role is also played by *Melica nutans*, *Convallaria majalis* and *Hieracium murorum*, as well as other species appearing in different phytocoenoses with varying abundance. The presence of orchids is specific, there being 6 species: *Epipactis helleborine* in every phytocoenosis, *Cephalanthera damasonium* in a decided majority and *Neottia nidus-avis*, *Platanthera bifolia* and *Corallorhiza trifida* more rarely. The beautiful orchid *Cypripedium calceolus* was found at only one site, while individual relevés featured between 1 and 5 species (mean 2.45) of orchids.

“Orchidaceous” beech forests are quite rich floristically. Well-developed patches of the community have ca 50 species, while the mean for the communities studied was 40.4 species per relevé. Together, the 11 patches included 107 species of vascular plant, with the 6 aforementioned orchid species being complemented by 8 more species that are under protection (*Aquilegia vulgaris*, *Daphne mezereum*, *Hedera helix*, *Lilium martagon*, *Convallaria majalis*, *Digitalis grandiflora*, *D. purpurea* and *Galium odoratum*).

A floristic and phytosociological characterisation of the community

The Sudetic orchid beech forests of Góry Krowiarki Range have a decided preponderance of broadleaved forest (most especially beech forest) species. 13 species characteristic of class *Querco-Fagetea* were recorded, among which the more frequently occurring are *Epipactis helleborine*, *Lonicera xylosteum*, *Melica nutans*, *Carex digitata*, *Campanula trachelium*, *Poa nemoralis*, *Fraxinus excelsior*, *Acer platanoides* and *Brachypodium sylvaticum* (Table 1).

Fifteen species were characteristic of the order *Fagetalia*, and among these *Mercurialis perennis*, *Viola reichbenachiana*, *Daphne mezereum*, *Galium odoratum*, *Actaea spicata* and *Sanicula europaea* attain more than 50% frequency. A significant feature is the almost total lack of *Galeobdolon luteum*, a species that is common in the neighbouring beech forests of the *Dentario enneaphyllidis-Fagetum* association.

Four species are characteristic of beech forests of the alliance *Fagion sylvaticae*. Of these, the more frequently-occurring are *Fagus sylvatica* and *Cephalanthera damasonium*. There is a noteworthy absence of both *Dentaria glandulosa* and *D. enneaphyllos*, both more frequent and diagnostically-important species in comunities of fertile beech forest of the *Dentario enneaphyllidis-Fagetum* association.

From other groups of plant community a feature worth underlining as specific to this type of beech forest is the share of species characteristic of communities of class *Trifolio-Geranietea* (namely *Astragalus glycyphyllos*, *Clinopodium vulgare*, *Polygonatum odoratum* and *Fragaria viridis*). There is also a high level of representation of species considered to distinguish “orchidaceous” beech forest (sub-alliance *Cephalanthero-Fagenion*) from among other beech forests, such as the aforementioned *Epipactis helleborine, Cephalanthera damasonium, Astragalus glycyphyllos, Clinopodium vulgare* and *Polygonatum odoratum*, as well as *Convallaria maialis*.

While *Taxus baccata*, a species characteristic of the *Taxo-Fagetum* association, does not occur in any of the phytocoenoses recognised, it may be recalled that a site for it is known in analagous beech forest from the Góry Kaczawskie Range (near Wojcieszów). In turn, *Cephalanthera damasonium (= C. alba)* and *Epipactis helleborine (= E. latifolia)* may probably be regarded as regionally characteristic species.

The syntaxonomic affinities of Sudetic “orchidaceous” beech forest

The “orchidaceous” beech forest of the Sudety Mountains may undoubtedly be assigned to the sub-alliance *Cephalanthero-Fagetum* of the alliance *Fagion sylvaticae,* order *Fagetalia sylvaticae* and class *Querco-Fagetea*. It was described very provisionally as the association *Taxo-Fagetum* by W. and A. Matuszkiewicz (1973), on the basis of very sparse data (one phytosociological relevé). The characterisation presented here admits such a solution but does not go on to confirm it. On the basis of comparison with the orchid beech forests of the Pieniny Mountains (Pancer-Kotejowa 1973) and the Kraków-Częstochowa Upland (Michalik 1972), it is possible to indicate a series of differences between these local types (Table 2). These may be defined as considerable, something which tends not to speak for the inclusion of all the communities into one association. However, the relationship between this unit and other communities of the sub-alliance *Cephalanthero-Fagenion* is not resolved here. For this reason, we are holding to the previous syntaxonomic conceptualisation as the *Taxo-Fagetum* association, in full awareness of the fact that the doubts aroused may not be resolved without comparative material from other regions of Europe, in particular the Czech Republic. It is also possible to identify the studying beech forest with *Fagus-Hypericum maculatum* community after W. Matuszkiewicz (in this volume).

Habitat conditioning

The Sudetic “orchidaceous” beech forest is a community of very specific conditions of occurrence. These are created by:

– a local climate proper to the described altitudinal belt;
– the types of geological substratum;
– the morphology of landforms;
– the exposure.

The conditioning factor easiest to define is the type of geological substratum. As with other cases of “orchidaceous” beech forest, a substratum rich in calcium carbonate is a precondition. All of the patches of the association under discussion in Góry Krowiarki

Table 2. Comparison of beech forests of the *Cephalanthero-Fagenion* suballiance from three regions of Poland

	Species	Characteristic of	Krowiarki Range (11 relevés)	Kraków-Częstochowa Upland (35 relevés)	Pieniny Mts (35 relevés)
			Proportion of relevés (%)		
	1	2	3	4	5
Distinguishing species of the Cephalanthero-Fagenion suball.					
	Astragalus glycyphyllos	ChCl.T.-G.	73	69	3
*	*Epipactis latifolia*	ChCl.Q.-F.	100	83	37
*	*Cephalanthera damasonium*	ChAll.Fag.	73	71	31
	Convallaria maialis		91	100	31
	Vincetoxicum hirundinaria		0	83	46
*	*Cephalanthera rubra*		0	66	0
Characteristic species of the Carici-Fagetum ass.					
*	*Cephalanthera longifolia*		0	43	14
Species distingushing the Carici-Fagetum ass.					
	Campanula persicifolia	ChO.Q.pub.	82	83	37
	Calamintha vulgaris	ChCl.T.-G.	73	66	49
	Polygonatum odoratum		73	83	51
*	*Epipactis atrorubens*		0	43	26
	Campanula rapunculoides		0	49	71
Unifying species					
	Fagus sylvatica (a)	ChAll.Fag.	100	100	66
	Melica nutans	ChCl.Q.-F.	100	97	89
	Mercurialis perennis	ChO.F.silv.	100	74	80
	Lonicera xylosteum (bc)	ChCl.Q.-F.	100	63	97
	Carex digitata	ChCl.Q.-F.	91	91	97
	Viola reichenbachiana	ChO.F.silv.	82	86	77
	Daphne mezereum (bc)	ChO.F.silv.	73	80	71
	Campanula trachelium	ChCl.Q.-F.	73	71	77
	Poa nemoralis	ChCl.Q.-F.	64	60	37
	Sanicula europaea	ChO.F.silv.	64	37	29
	Brachypodium sylvaticum	ChCl.Q.-F.	45	80	14
	Lathyrus vernus	ChO.F.silv.	36	97	57
	Lilium martagon	ChO.F.silv.	36	66	80
*	*Neotia nidus-avis*	ChO.F.silv.	36	17	26
*	*Corallorhiza trifida*		9	11	3
*	*Cypripedium calceolus*		9	0	6
Differentiating species					
	Viola collina		73	6	0
	Hypericum maculatum		64	0	0
	Streptopus amplexifolius		45	0	0
	Aquilegia vulgaris		73	20	0
	Hepatica nobilis	ChCl.Q.-F.	45	86	3

(cont.)

Table 2. Continued.

1	2	3	4	5
Cornus sanguinea (bc)	ChCl.Rh.-Pr.	45	86	0
Senecio fuchsii		73	0	91
Actaea spicata	ChO.F.silv.	64	17	63
Digitalis grandiflora		9	46	69
Galeobdolon luteum	ChO.F.silv.	9	40	69
Galium schultesi		0	83	83
Polypodium vulgare		0	46	63
Asarum europaeum		0	31	69
Euphorbia amygdaloides		0	23	89
Valeriana tripteris		0	20	80
Ribes alpinum (bc)		0	17	63
Galium vernum		0	100	17
Euonymus verrucosus (bc)		0	89	3
Lathyrus niger		0	89	0
Melittis melissophyllum		0	89	0
Viola mirabilis		0	83	0
Coronilla varia		0	60	0
Viola hirta		0	60	0
Abies alba (a)		0	3	91
Carex alba		0	0	80
Salvia glutinosa		0	0	80
Cirsium erisitales		0	0	77
Poa stiriaca		0	0	74
Calamagrostis varia		0	0	66
Prenanthes purpurea		0	0	60

ChCl.Q.-F. – characteristic species of class *Querco-Fagetea*
ChO.F.silv. – characteristic species of order *Fagetalia silvaticae*
ChO.Q.pub. – characteristic species of order *Quercetalia pubescentis*
ChAll.Fag. – characteristic species of alliance *Fagion silvaticae*
ChCl.Rh.-Pr. – characteristic species of class *Rhamno-Prunetea*
ChCl.T.-G. – characteristic species of class *Trifolio-Geranietea*
* – orchids

occupy sites with surface outcrops of crystalline Proterozoic dolomites (dolomitic-calcitic and dolomitic marbles), creating a belt of three NW-SE sequences more or less easily-seen on the map (Fig. 1) (Cwojdziński 1978; Wroński 1981). In these sequences, the layers are inclined at an angle of 45–50^{o}, sloping down in the NE direction (Cwojdziński 1979). Field studies reveal the presence of “orchidaceous” beech forests along the middle of these sequences only.

All the patches of “orchidaceous” beech forest are located in the upper, or sometimes also the central, parts of slopes with a considerable incline and southern or near-southern

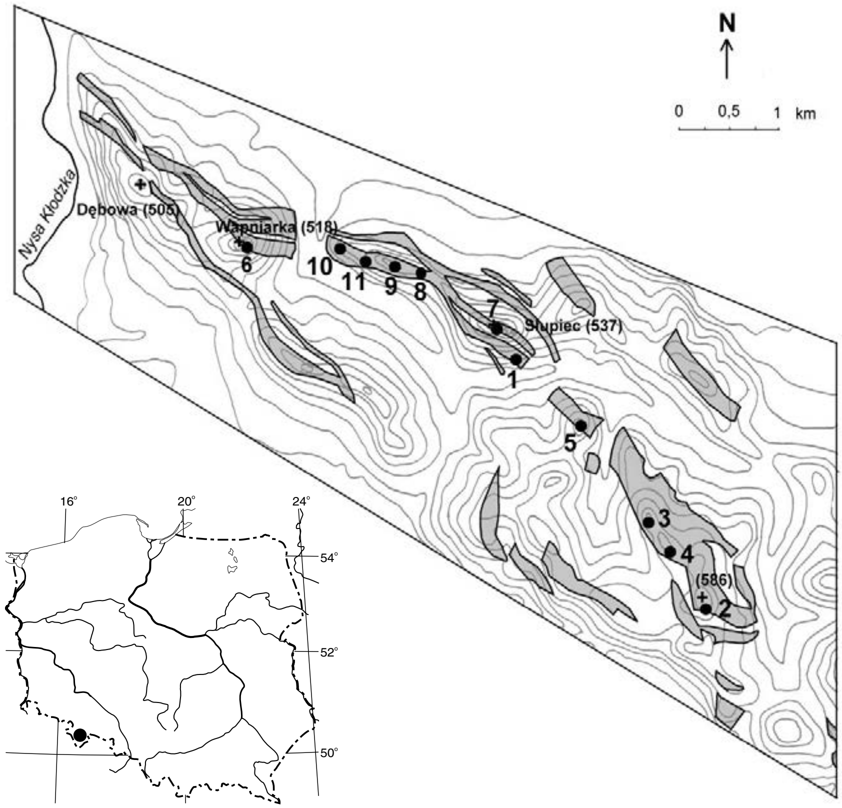

Fig. 1. Location of studying patches of "orchidaceous" beech forest in Góry Krowiarki Range as against the distribution of marbles (shaded areas) as a geological substratum. Numbers 1–11 represent studying patches.

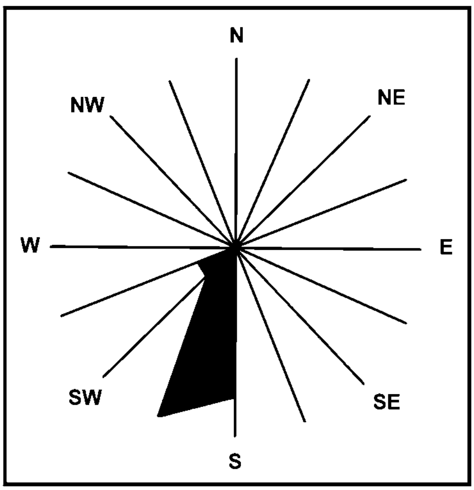

Fig. 2. Exposure of patches of "orchidaceous" beech forest.

exposure (Fig. 2). The attachment to southern exposures is undoubted and to be seen unambiguously in the field, while the apparent tendency towards western exposures seems to result from the general configuration of the chain. In many places, it is possible to observe a very narrow boundary line running along the crest of an elevation and separating "orchidaceous" beech forest from the "normal" fertile type occupying the northern slope (Fig. 3).

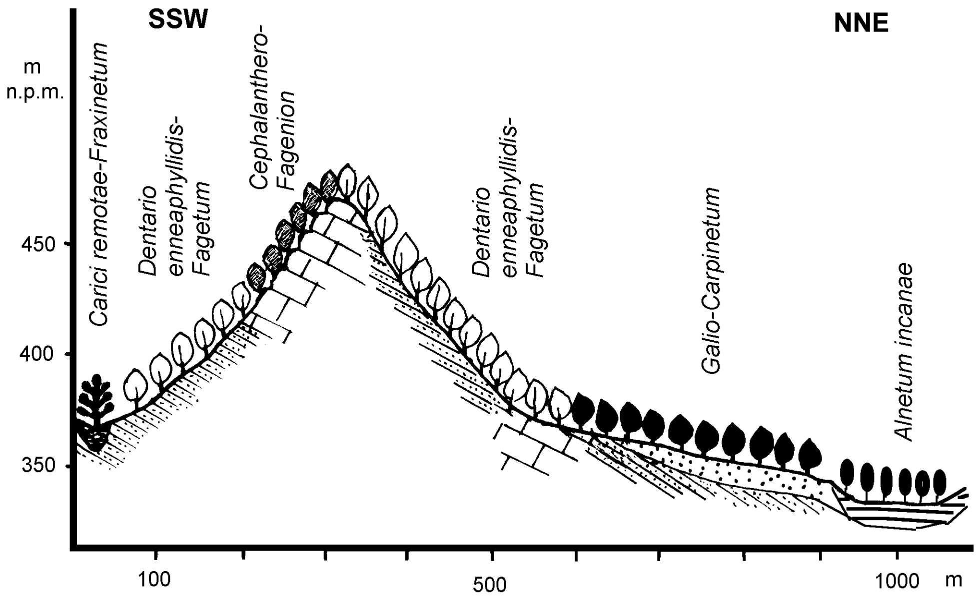

Fig. 3. The place of "orchidaceous" beech forest in the landscape structure of Góry Krowiarki.

All the sites for "orchidaceous" beech forest are in places where the steep slope is set at right angles to the layers of marble rocks, usually creating the crest along the ridge, with the result that the slope there is very rocky (Figs 4–7). In Góry Krowiarki there are cases in which a marble substratum and south-facing slope were lacking in "orchidaceous" beech forest, having the association *Dentario enneaphyllidis-Fagetum* instead. However, in these cases, the configuration of layers in relation to the slope was different from that described above: the slope was less steep and overlain with a thicker layer of soil. It would be worth studying whether some of the sites with "orchidaceous" beech forest are places created by humankind in the course of the search for marble.

The communities of Sudetic "orchidaceous" beech forest studied occur at altitudes of between 390 and 565 m a.s.l., i.e. in general terms within the upper submontane belt and lower part of the lower montane belt. However, it must be noted at the same time, that the forests in the surrounding area were of beech in every case, rather than of oak-hornbeam or oak as is typical in the submontane belt. For this reason, it should be accepted

Fig. 4. View of the Góry Krowiarki Range. Phot. A. Kozłowska.

Fig. 5. View of marble workings in Góry Krowiarki Range with the characteristic configuration of inclined layers. Phot. J. Matuszkiewicz.

Fig. 6. The southern slopes of Góry Krowiarki Range with “orchidaceous” beech forest. Phot. J. Matuszkiewicz.

Fig. 7. The ground cover layer of “orchidaceous” beech forest. Phot. J. Matuszkiewicz.

Table 3. Selected climatic characteristics of the study area.

Station	Altitude a.s.l.	Annual precipitation	Mean annual temperature	Temperature of warmest month	Temperature od coldest month	Amplitude	Duration of snow cover	Thermic winter (t<0)	Growing season (t>5)	Growing season (t>10)	Thermic summer (t>15)
	m	mm	°C	°C	°C	°C	days	days	days	days	days
Kłodzko	316	622	7.2	16.7	-3.0	19.7	64	77	218	155	87
Bystrzyca Kłodzka	365	737	7.3	17.0	-2.8	19.8		80	216	157	88
Duszniki Zdrój	540	997					94	99	197	135	61
Śnieżnik Kłodzki	1218		2.8	11.8	-6.3	18.1		146	154	79	0
Ziemia Kłodzka (mean for 6 stations)	413	794									
Sudety Mts (hypothetical value)	500	833	6.7	15.9	-2.4	18.4	85	92	209	142	49
Krowiarki Range (hypothetical value)	500	960	6.6	16.1	-2.9	19.0	86	92	202	140	70

that we are dealing with a lower limit of the lower montane belt that is located at relatively low altitude.

A characterisation of climatic parameters is presented in Table 3, where data are brought together from several stations in Ziemia Kłodzka, along with those predicted for an altitude accepted by convention to be 500 m a.s.l. and considered to mark the boundary of the lower montane belt throughout the Polish Sudety Mountains and Góry Krowiarki. In the course of calculations it became apparent that the increase in precipitation with altitude is exceptionally great in the case of the Ziemia Kłodzka area. A consequence of this is a predicted precipitation total for Góry Krowiarki that is unexpectedly high, and much above the average for the same altitude in the Sudety Mountains as a whole.

On the basis of the thermal data presented, the Góry Krowiarki Range can be considered marked by a relative longer period of thermal summer, rather cooler winters and a greater amplitude of temperature. Put together with high precipitation, these conditions may be judged to favour thermophilous communities having their centre of occurrence in near-Mediterranean areas. Such a configuration of climatic conditions is probably in turn influenced by the local relief: an extensive basin opening out in a southward direction.

Summary

The research carried out allowed for the determination of the set of habitat factors that condition the existence of the specific and rare form of beech forest occurring in the Sudety Mountains and marked by the presence of a range of protected species. We con-

tinue to uphold the provisional identification as the *Taxo-Fagetum* association of the *Cephalanthero-Fagenion* sub-alliance from among the beech forests of the *Fagion* alliance. It is also possible to identify the studying beech forest with *Fagus-Hypericum maculatum* community after W. Matuszkiewicz. The co-existence of the following conditions is required if this association is to develop:

– the mountain climate proper for the lower montane zone in a variant characterised by both high levels of precipitation and relatively warm summers;

– a geological substratum formed from calcareous rocks;

– steep hill slopes with a southern exposure;

– shallow and very rocky soils;

– non-interference on the part of humankind allowing for the maintenance of beech stands.

The requirement that all of these conditions should be met simultaneously is what ensures the infrequency with which "orchidaceous" beech forest communities develop. In turn, it is this rarity which obliges us to take particular care to protect these communities and their habitats.

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