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The systematic position of thermophilous beechwoods (Cephalanthero-Fagenion) in Poland

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ABSTRACT: The results of a syntaxonomical revision of the thermo- and calciphilous beechwood communities (*Cephalanthero-Fagenion* Suballiance) occuring in Poland are presented. The basic material was elaborated by using of some methods of the numerical taxonomy. Five regional types (some with any subordinated units), i.e. two "associations" and three "communities", are distinguished. The associations are new established according to the principles, rules and recommendations of the *Code of Phytosociological Nomenclature*; there are: *Carici albae-Fagetum* from the Pieniny Mountains and *Cephalanthero rubrae-Fagetum* from the Wolin Island.

KEY WORDS: syntaxonomy, numerical methods, thermophilous and calciphilous beechwoods, *Cephalanthero-Fagenion*, Poland

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SUBJECT MATTER AND AIMS

Thermophilous beech and fir forests, also known as "orchidaceous" forests, constitute a unique and extreme form of beech forest of the *Fagion sylvaticae* alliance that is reminiscent of communities of the order *Quercetalia pubescenti-petraeae*. Within their floristic composition an important role is also played by species of *Prunetalia* scrub communities and *Trifolio-Geranietea* forest-edge communities. Thermophilous beech forests are generally associated with steep, south-facing slopes and a calcareous substratum. From the geographical point of view they represent a southern element in Central Europe and are best developed in the lower montane zones and in the northern foothills of the Alps-System.

"Orchidaceous" beech forests reach the absolute north-eastern limits of their range in Poland and thus take on the character of rather rare extra-zonal permanent communities associated with a particular configuration of habitat conditions. For some time they escaped the attention of phytosociologists or were mentioned but rarely. The first more abundant documentation came only with the works of Michalik (1972) on the Kraków-Częstochowa Upland, as well as Pancer-Kotejowa (1973) in the Pieniny Mountains. Appearing later were the studies from Celiński *et al.* (1978), Cabała (1990) and Hereźniak

(1993), which contained relevés material on thermophilous beech forests, among other things. All of these studies refer to the southern belt of uplands, and information regarding the occurrence of orchid beech forests in the northern part of the country – in the Kaszuby Lakeland (Fałtynowicz & Machnikowski 1982; Herbich 1993) and most especially on Wolin Island (Piotrowska & Olaczek 1976; Piotrowska 1993) is thus particularly noteworthy.

The thermophilous "orchidaceous" beech forests occurring in Poland have almost always been identified with the *Carici-Fagetum* association described from the Swiss Jura by Moor (1952), in the conceptualisation expanded by Hartmann and Jahn (1967), and placed in the sub-alliance *Cephalanthero-Fagenion*. Such a systematic position evokes no reservations, though the identification of the association does raise doubts. Specifically, the communities of interest to us differ markedly from the Swiss and West German models, showing huge regional and habitat-related differences. The available material in the form of phytosociological relevés would seem to suffice for a syntaxonomic revision of the group of communities in Poland.

Materials and methods

The basis for the present work has been a collection of 119 relevés brought together in my TURBOVEG database. Besides published materials, this encompasses 10–20 relevés provided by Professor J. Hereźniak and Docent J. M. Matuszkiewicz, for which I am very grateful. Account was only taken of thermophilous beech forests on calcareous substrata. Thus the moist beech forest also on limestone but lacking xerothermic species has been omitted. The prototype for these is the "*Mercuriali-Fagetum*" described by Celiński (1962), but their syntaxonomic position represents a separate problem. The nomenclature for species accords with the Polish version of the TURBOVEG system (Szańkowski 1995), is thus basically in accordance with *Flora Europaea* (Tutin *et al.* 1964) where vascular plants are concerned, and has been adjusted to the "Checklist" from Mirek *et al.* (1995).

The material was elaborated using selected methods from numerical taxonomy, augmented by classical methodology in the final stage. The methods applied were thus:

– hierarchical classification using cluster analysis with percentage difference (PD) as a measure of the dissimilarity of relevés, as well as UPGMA average linking from the SYN-TAX-5.1 package (Podani 1993);

– hierarchical classification using the TWINSPAN program;

– ordination in three-dimensional space using principal coordinates analysis, PCoorAn, from the SYN-TAX-5.1 package.

The drawing-up of the table of relevés forming the basis of the syntaxonomic interpretation was done with the aid of the MEGATAB program (Hennekens 1996), while relevé order was adopted in line with the results of the classification (mainly TWINSPAN) and the species order in accordance with analysis by way of the classical methodology. The full table may not be presented due to lack of space, but a synoptic table at the level of "associations" and "sub-associations" was obtained using the SHIFTTAB program.

Results

The formal results of the study are compiled in diagrams and tables, with the most important being published here. Fig. 1 comprises a dendrogram of all 119 relevés with the numbers corresponding to the unified ordering in the TURBOVEG database wherein they may

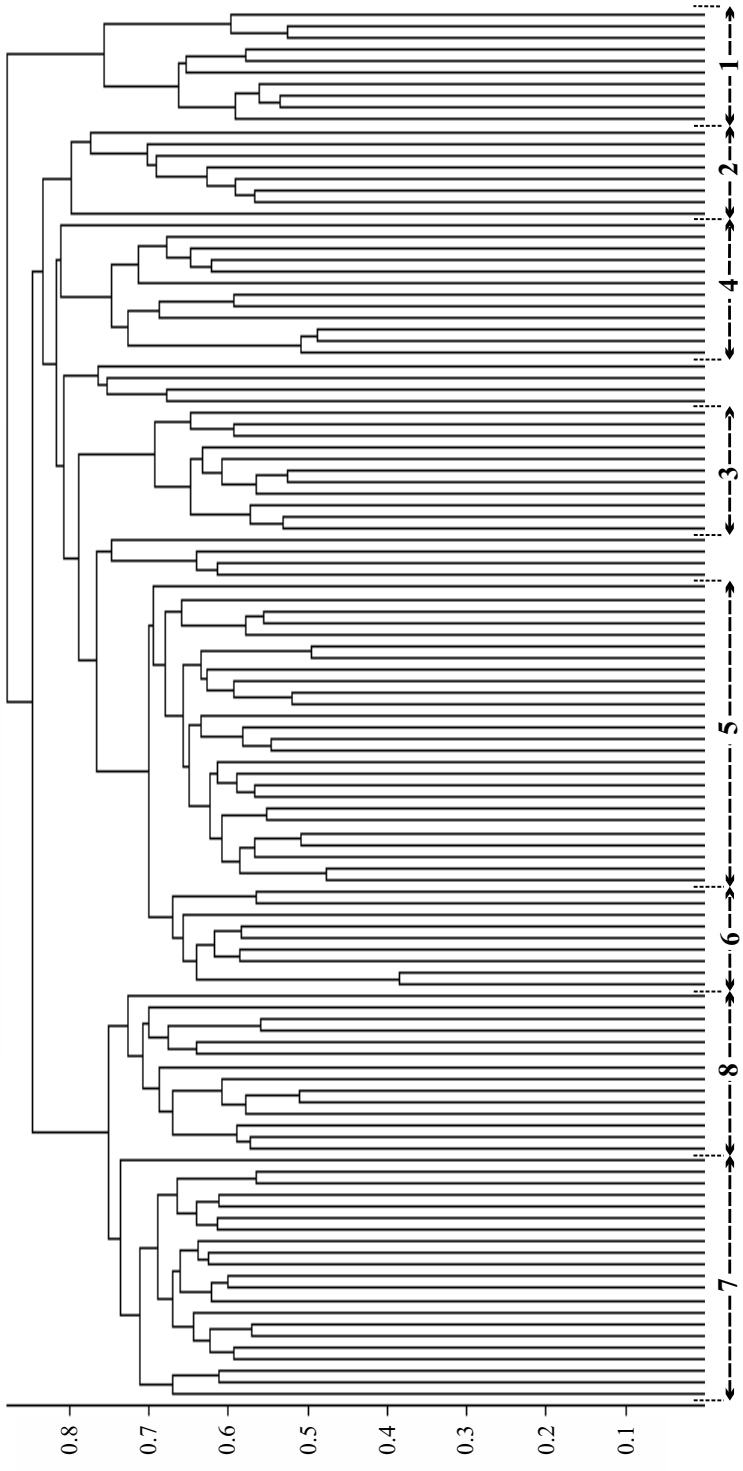

Fig. 1. *Cepahalanthero-Fagenion* in Poland (PC/UPGMA).

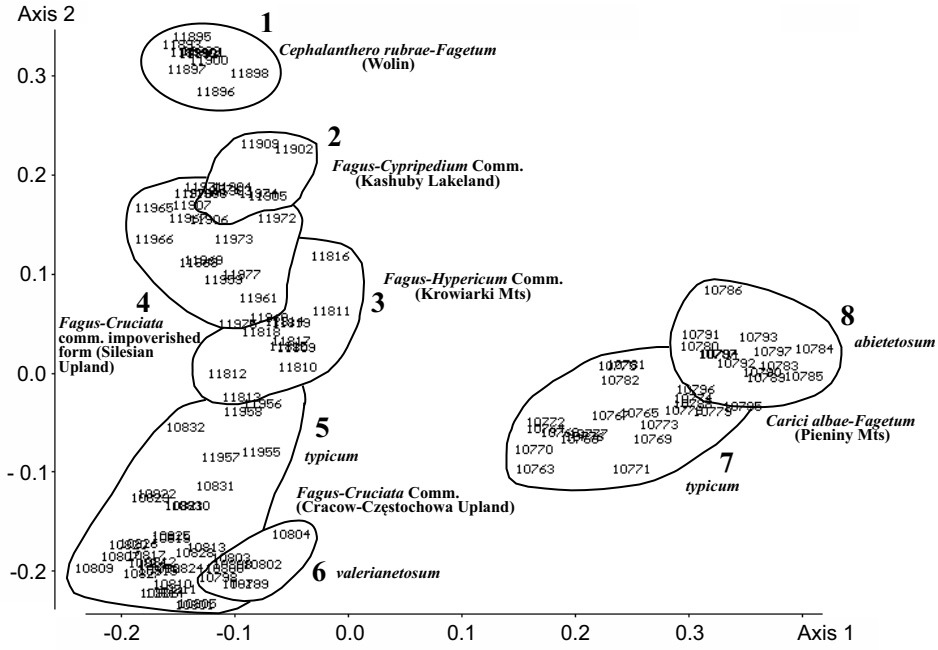

Fig. 2. *Cepahalanthero-Fagenion* in Poland (PCoorAn).

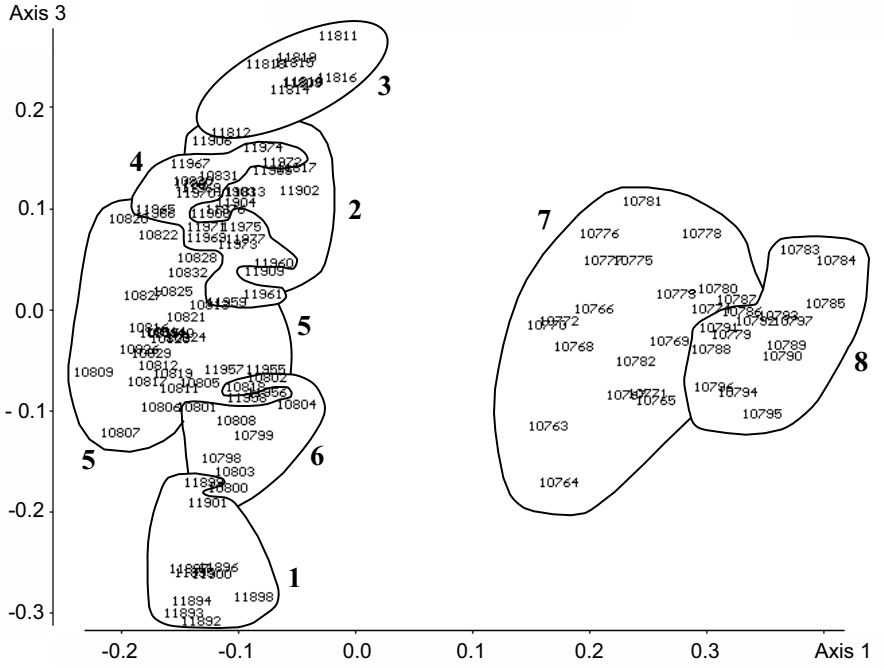

Fig. 3. *Cepahalanthero-Fagenion* in Poland (PCoorAn).

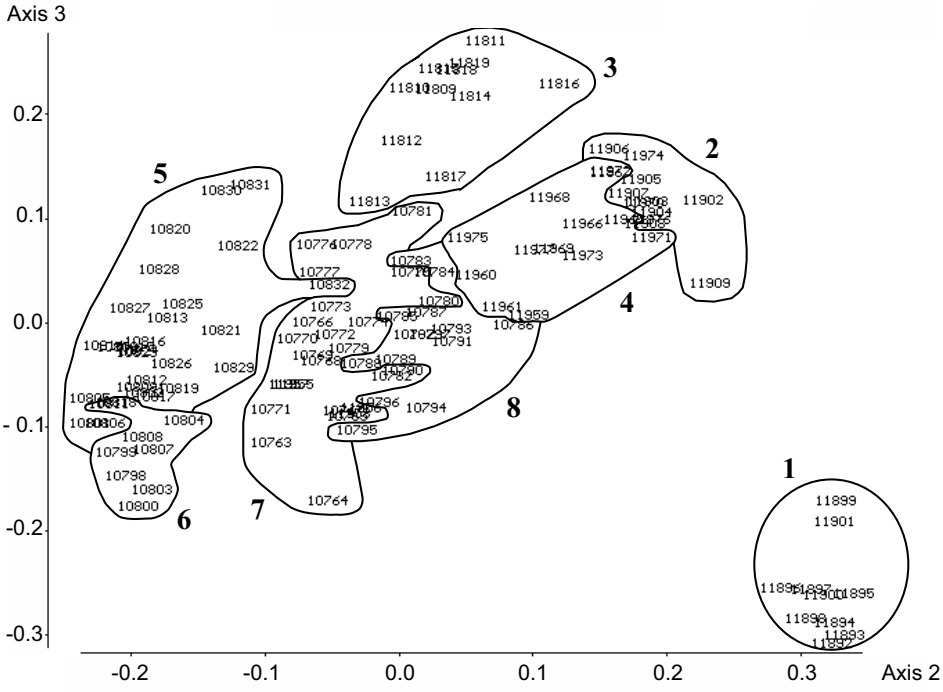

Fig. 4. *Cepahalanthero-Fagenion* in Poland (PCoorAn).

be identified with the original relevés from different authors. In this case, systematic distance is calculated with account taken of stratification as well as the Braun-Blanquet cover-abundance scale for species via a 9-point ordinal transformation. At a level of dissimilarity of ca 0.75 some 8–9 distinct clusters are discernible, as well as several scattered relevés. Extreme locations in the dendrogram and the highest degree of dissimilarity (>0.85) are characteristic of clusters of relevés from the Pieniny Mountains and Wolin Island. Very similar groups are obtained with the hierarchical divisive classification using the TWINSPAN program.

Figs 2–4 present the results of the ordination of 119 relevés using principle coordinates analysis PCoorAn on three planes at right angles to one another. The distinctiveness of certain groups is marked with each of the classification methods applied. The groups from Wolin, and especially from the Pieniny, show the highest degree of separate identity in this case too.

Table 1 is a synoptic table presenting differences in the floristic composition of five basic units, that we are inclined to consider equivalent to associations, (with three subordinated units as subassociations). In no unit did companions and accidentals attain 10% constancy, so these were omitted. The units distinguished are capable of being well-characterised by reference to a combination of floristic composition and a particular set of character- and differential-taxa. In addition, they show very clear regional differences.

Presented below is a concise review of the units distinguished.

Table 1. *Cephalanthero-Fagenion* in Poland.

Syntaxon	1	2	3	4	5	6	7	8
Number of relevés	10	8	11	18	30	7	19	14
Fagus sylvatica (a)	V	V	V	V	V	V	V	II
Fagus sylvatica (b)	IV	V	IV	IV	V	III	V	III
Fagus sylvatica (c)	V	V	V	IV	III	V	V	III
Acer pseudoplatanus (a)	.	.	II	I	II	.	II	.
Acer pseudoplatanus (b)	.	.	I	II	III	III	II	I
Acer pseudoplatanus (c)	.	.	V	II	II	III	IV	III
Luzula luzuloides	.	.	+	.	+	.	+	.
Melica uniflora	.	.	.	.	+	.	.	.
Dentaria bulbifera	.	.	.	.	.	.	III	III
Polystichum aculeatum	.	.	.	.	.	.	II	+
Lunaria rediviva	.	.	.	.	.	.	.	+
Cephalanthera rubra	IV	.	.	IV	IV	III	.	.
Epipactis atrorubens	III	.	.	II	II	V	III	+
Epipactis helleborine	.	V	V	III	IV	V	III	+
Cephalanthera damasonium	.	.	IV	III	IV	V	III	+
Cephalanthera longifolia	.	.	.	I	II	IV	II	.
Convallaria majalis	IV	V	V	IV	V	V	III	.
Campanula persicifolia	IV	I	V	I	V	IV	IV	.
Clinopodium vulgare	III	II	IV	I	V	IV	III	II
Polygonatum odoratum	I	.	IV	II	IV	V	IV	II
Astragalus glycyphyllos	III	.	IV	II	IV	II	+	.
Campanula rapunculoides	I	II	.	II	III	IV	V	III
Digitalis grandiflora	.	.	+	I	II	IV	IV	III
Hypericum montanum	+	.	+	.	+	I	.	.
Viola hirta	.	.	.	+	III	III	.	.
Ranunculus polyanthemos	.	.	.	.	+	.	.	+
Peucedanum cervaria	.	.	.	.	.	III	.	.
Campanula rotundifolia	V	.	.	.	r	III	.	.
Achillea millefolium	V	.	+	+	+	.	.	.
Dactylis glomerata	V	.	I	.	r	.	.	.
Vicia sepium	V	II	.	.	.	.	.	.
Deschampsia flexuosa	V	II	.	II	II	.	.	.
Poa angustifolia	IV	I	+	+	.	.	.	.
Hieracium laevigatum	IV	II	.	.	.	.	+	.
Calamagrostis epigeios	IV	.	.	.	+	.	.	.
Poa pratensis	III	I	.	.	r	.	.	.
Torilis japonica	III	.	.	.	.	.	.	.
Festuca rubra subsp. *arenaria*	III	.	.	.	.	.	.	.
Cerastium fontanum subsp. *triviale*	III	.	.	.	.	.	.	.
Lathyrus montanus	III	.	.	.	.	.	.	.
Lathyrus pratensis	III	.	.	.	.	.	.	.
Plagiomnium undulatum	III	.	.	.	.	.	.	.
Sedum sexangulare	III	.	.	.	.	.	.	.
Trifolium pratense subsp. *maritimum*	III	.	.	.	.	.	.	.
Cypripedium calceolus	.	IV	.	.	.	.	.	.
Ranunculus lanuginosus	.	IV	.	.	.	.	.	.

Table 1. Continued.

Syntaxon	1	2	3	4	5	6	7	8
Frangula alnus	.	V	+	+	II	III	.	I
Rhamnus catharticus	.	V	.	I	r	II	.	I
Euonymus europaeus	.	V	.	II	I	.	+	.
Angelica sylvestris	.	IV	.	+	.	.	.	.
Rubus saxatilis	.	IV	.	.	I	III	.	I
Hypericum maculatum	.	.	IV	+	.	.	.	.
Viola collina	.	.	III	+	+	.	.	.
Streptopus amplexifolius	.	.	III	.	.	.	.	.
Festuca altissima	.	.	II	.	.	.	.	.
Digitalis purpurea	.	.	I	.	.	.	.	.
Hordelymus europaeus	.	.	+	.	.	.	.	.
Galium sylvaticum	.	.	+	.	.	.	.	.
Carex flacca	.	.	+	.	.	.	.	.
Cruciata glabra	.	.	.	V	V	V	+	II
Tortella tortuosa	.	.	.	II	V	V	II	II
Lathyrus niger	II	.	.	II	V	V	.	.
Euonymus verrucosus	.	.	.	II	V	V	.	+
Melittis melissophyllum	.	.	.	I	V	V	.	.
Viola mirabilis	.	II	.	I	IV	V	.	.
Galium schultesii	.	.	.	+	V	V	V	IV
Vincetoxicum hirundinaria	.	.	.	.	V	V	IV	II
Abies alba (a)	.	.	.	.	.	I	V	V
Abies alba (b)	.	.	.	.	II	IV	V	IV
Abies alba (c)	.	.	.	.	.	.	V	V
Valeriana tripteris	.	.	.	.	.	V	V	IV
Laserpitium latifolium	.	.	.	.	I	V	IV	.
Cotoneaster intergerrimus	.	.	.	.	.	V	II	II
Euphorbia amygdaloides	.	.	.	.	II	.	V	V
Salvia glutinosa	.	.	.	.	.	.	V	V
Cirsium erisithales	.	.	.	.	.	.	V	IV
Carex alba	.	.	.	.	.	.	IV	V
Poa stiriaca	.	.	.	.	.	.	V	III
Calamagrostis varia	.	.	.	.	.	.	V	II
Prenanthes purpurea	.	.	.	.	.	.	III	IV
Eurhynchium angustirete	.	.	.	.	.	.	III	IV
Clematis alpina	.	.	.	.	.	.	III	II
Viola reichenbachiana	V	V	V	V	V	V	IV	V
Mercurialis perennis	.	V	V	II	IV	IV	IV	V
Lathyrus vernus	.	V	II	III	V	V	IV	III
Daphne mezereum	.	IV	IV	III	IV	IV	V	III
Galium odoratum	.	IV	IV	III	III	.	IV	III
Actaea spicata	.	IV	IV	II	+	II	IV	III
Lilium martagon	.	.	II	II	IV	IV	V	III
Dryopteris filix-mas	I	.	+	III	I	I	IV	IV
Asarum europaeum	.	III	.	III	II	II	IV	IV
Galeobdolon luteum	.	II	+	II	III	II	III	V
Neottia nidus-avis	II	I	II	II	I	II	II	II

(cont.)

Table 1. Continued.

Syntaxon	1	2	3	4	5	6	7	8
Sanicula europaea	.	I	III	II	III	.	II	II
Pulmonaria obscura	.	IV	.	I	II	III	III	IV
Polygonatum multiflorum	.	II	.	+	I	.	II	III
Tilia platyphyllos	.	.	.	+	+	I	III	II
Epilobium montanum	+	.	II	+	+	.	III	+
Scrophularia nodosa	+	III	+	I	+	.	.	II
Atrichum undulatum	+	.	.	III	+	I	+	.
Paris quadrifolia	.	I	.	+	.	.	II	III
Ulmus glabra	.	.	II	I	.	.	II	.
Phyteuma spicatum	.	I	.	.	II	.	.	+
Carex sylvatica	.	.	+	I	r	.	+	.
Stachys sylvatica	.	.	.	I	r	.	.	.
Melica nutans	III	IV	V	V	V	V	V	V
Carex digitata	V	V	V	III	V	V	V	V
Lonicera xylosteum	IV	II	V	I	IV	III	V	V
Hepatica nobilis	IV	V	III	III	V	V	+	.
Poa nemoralis	IV	.	IV	IV	IV	III	III	II
Brachypodium sylvaticum	IV	IV	III	I	V	III	II	+
Anemone nemorosa	IV	II	.	IV	I	.	.	+
Campanula trachelium	.	III	IV	II	V	.	V	IV
Corylus avellana	.	IV	+	II	III	V	V	V
Acer platanoides	.	IV	III	III	III	I	IV	+
Aegopodium podagraria	.	V	+	IV	III	.	I	II
Fraxinus excelsior (c)	+	III	III	.	.	.	II	I
Ulmus minor	.	.	II	.	.	.	.	.
Melampyrum nemorosum	.	.	+	.	I	III	.	.
Carpinus betulus (a)	.	.	.	+	II	.	II	+
Carpinus betulus (b)	.	I	+	I	II	II	+	.
Carpinus betulus (c)	.	.	.	+	I	I	II	+
Tilia cordata	.	I	II	+	+	I	I	.
Stellaria holostea	.	II	.	.	.	.	I	.
Mycelis muralis	V	IV	V	IV	V	III	V	V
Sorbus aucuparia	IV	V	V	V	V	IV	IV	V
Oxalis acetosella	V	IV	I	II	r	II	II	V
Solidago virgaurea	V	II	III	II	IV	III	IV	III
Maianthemum bifolium	II	IV	+	V	IV	II	III	V
Hieracium murorum	III	II	V	V	V	V	V	IV
Fragaria vesca	+	I	II	II	IV	IV	IV	V
Viburnum opulus	I	II	III	I	III	III	II	II
Galium mollugo	V	IV	+	.	r	.	II	+
Pimpinella saxifraga	IV	II	II	.	III	II	+	.
Veronica chamaedrys	V	III	.	II	III	.	III	II
Orthilia secunda	IV	I	.	II	III	III	III	II
Hedera helix	+	I	IV	III	IV	II	IV	+
Taraxacum officinale	.	I	IV	I	II	.	II	II
Rubus idaeus	.	I	III	II	+	I	II	V
Aquilegia vulgaris	.	.	IV	II	I	II	I	+

Table 1. Continued.

Syntaxon	1	2	3	4	5	6	7	8
Senecio nemorensis subsp. *fuchsii*	.	.	IV	II	r	.	V	V
Cornus sanguinea	.	.	III	I	V	V	IV	III
Ajuga reptans	.	.	I	III	IV	III	II	II
Polypodium vulgare	II	.	.	+	II	V	IV	IV
Cardaminopsis arenosa	II	.	.	I	III	III	III	III
Brachythecium velutinum	II	.	.	IV	II	.	IV	+
Ribes alpinum	I	.	.	.	II	II	IV	III
Vaccinium myrtillus	II	I	.	III	II	III	.	.
Quercus petraea	+	.	II	I	III	III	.	.
Luzula pilosa	IV	.	.	III	II	I	.	+
Euphorbia cyparissias	.	.	+	I	IV	.	I	.
Asplenium trichomanes	.	.	+	+	+	V	III	I
Quercus robur	.	IV	.	II	II	III	.	.
Encalypta streptocarpa	.	.	.	I	IV	V	+	.
Geranium robertianum	.	.	.	.	I	II	III	III
Hieracium sabaudum	.	I	II	I	III	I	.	.
Hieracium vulgatum	II	.	II	II	II	.	.	+
Rosa canina	+	I	.	.	III	III	+	+
Pinus sylvestris	.	III	II	.	II	III	.	+
Juniperus communis	II	III	.	II	I	II	.	+
Ajuga genevensis	.	.	.	+	III	III	.	+
Dryopteris carthusiana	.	I	.	II	.	.	II	III
Dicranum scoparium	II	.	.	+	+	.	II	II
Plagiothecium laetum	I	.	.	II	II	.	.	.
Veronica officinalis	II	.	I	I	+	.	I	II
Picea abies (a)	.	.	+	+	+	.	II	II
Picea abies (b)	.	II	.	I	II	.	III	II
Picea abies (c)	.	.	I	.	.	.	II	III
Corallorhiza trifida	I	.	.	II	+	I	+	.
Leontodon hispidus	I	.	.	.	II	.	+	.
Hypericum hirsutum	.	.	.	.	r	.	II	II
Crataegus monogyna	.	I	.	II	II	.	.	.
Rubus hirtus	.	.	.	II	.	I	II	+
Sedum telephium subsp. *maximum*	.	.	.	.	II	III	+	.
Polygonatum verticillatum	.	I	.	III	.	.	I	.
Plagiomnium cuspidatum	+	.	.	III	.	.	+	+
Polytrichastrum formosum	I	.	.	II	I	I	.	.
Heracleum sphondylium subsp. *sphondylium*	.	.	+	+	II	.	.	.
Stachys alpina	.	.	.	.	r	.	II	II
Athyrium filix-femina	.	I	.	II	.	.	I	II
Hypnum cupressiforme	II	.	.	.	r	.	+	II
Eupatorium cannabinum	.	III	.	.	.	.	I	II
Prunus avium	.	.	II	+	+	.	+	+
Moehringia trinervia	III	I	.	.	+	.	.	+
Sambucus racemosa	.	.	.	I	r	.	I	II
Platanthera bifolia	II	II	I	+	r	.	.	.
Prunus padus	.	.	+	+	I	II	.	+
Brachythecium rutabulum	III	.	.	.	+	I	.	.

(cont.)

Table 1. Continued.

Syntaxon	1	2	3	4	5	6	7	8
Monotropa hypopitis	.	.	.	I	+	II	I	.
Populus tremula	.	II	.	+	.	.	I	I
Mnium hornum	III	I	.	+	.	.	.	.
Fragaria viridis	.	.	III	.	r	II	.	.
Prunella vulgaris	III	.	.	.	r	.	+	+
Urtica dioica	II	I	.	.	.	.	II	.
Pimpinella major	.	.	.	.	r	.	II	I
Arabis hirsuta	.	.	.	.	I	.	.	I
Rubus caesius	III	II	.	.	.	.	.	.
Pohlia nutans	+	.	.	II	r	.	.	.
Pteridium aquilinum	III	.	.	.	+	.	.	.
Pyrus communis	.	I	.	+	I	.	.	.
Seseli libanotis	.	.	.	.	+	.	II	.
Gymnocarpium robertianum	.	.	.	.	.	IV	I	.
Pleurozium schreberi	+	.	.	.	.	.	+	II
Primula veris	.	II	.	.	I	.	.	.
Brachythecium salebrosum	II	.	.	+	.	.	I	.
Plagiochila asplenioides	+	.	.	I	.	.	I	+
Trifolium alpestre	+	.	.	+	I	.	.	.
Vicia sylvatica	.	.	.	I	II	I	III	III
Fissidens taxifolius	.	.	.	.	+	I	I	+
Inula conyza	.	.	.	.	+	.	I	+
Cardaminopsis halleri	.	.	.	I	r	.	+	+
Listera ovata	II	II	.	.	.	.	+	.
Sambucus nigra	+	.	.	I	.	.	.	+
Larix decidua	+	.	I	.	.	.	I	.
Brachypodium pinnatum	.	.	+	+	.	.	I	.
Mnium stellare	.	.	.	I	+	.	+	.
Silene dioica	.	.	.	+	.	.	I	I
Prunus spinosa	+	.	.	.	+	I	.	+
Plagiomnium rostratum	I	.	.	.	.	.	I	+
Herzogiella seligeri	II	.	.	.	.	.	.	I
Saxifraga paniculata	.	.	.	.	.	II	I	.
Betula pendula	.	I	.	I	.	.	.	.
Rhytidiadelphus triquetrus	I	.	.	.	.	.	.	I
Gymnocarpium dryopteris	.	.	.	+	.	.	I	+
Impatiens parviflora	.	.	+	.	.	.	I	.
Cirsium vulgare	II	.	.	.	r	.	.	.
Pyrola chlorantha	+	.	.	I	r	.	.	.
Bupleurum longifolium	.	.	.	.	.	I	I	.
Hypericum perforatum	.	.	.	.	r	.	I	+
Acinos arvensis	II	.	.	.	.	.	.	+
Cirsium arvense	.	.	I	.	.	.	+	+
Aconitum variegatum	.	II	.	.	.	.	+	.
Ranunculus repens	.	I	.	I	.	.	.	.
Trientalis europaea	I	.	.	.	r	.	.	.
Valeriana officinalis	.	I	.	.	+	.	.	.
Scabiosa columbaria	I	.	.	.	r	.	.	.

Table 1. Continued.

Syntaxon	1	2	3	4	5	6	7	8
Ranunculus acris	.	II	.	.	.	.	.	+
Epilobium angustifolium	.	.	.	+	.	.	.	I
Festuca gigantea	.	I	.	I	.	.	.	.
Linaria vulgaris	+	I	+	.	.	.	.	.
Fissidens adianthoides	.	.	.	.	.	I	+	+
Pyrola media	.	I	.	.	.	.	.	+
Trifolium dubium	II	.	.	.	.	.	.	.
Hieracium umbellatum	I	.	.	.	.	.	.	.
Trifolium repens	I	.	.	.	.	.	.	.
Lysimachia vulgaris	.	II	.	.	.	.	.	.
Equisetum pratense	.	II	.	.	.	.	.	.
Abietinella abietina	.	I	.	.	.	.	.	.
Anthriscus sylvestris	.	I	.	.	.	.	.	.
Dactylis glomerata subsp. *aschersoniana*	.	I	.	.	.	.	.	.
Elymus caninus	.	I	.	.	.	.	.	.
Equisetum hyemale	.	I	.	.	.	.	.	.
Filipendula ulmaria	.	I	.	.	.	.	.	.
Galeopsis pubescens	.	I	.	.	.	.	.	.
Hieracium racemosum	.	I	.	.	.	.	.	.
Plantago media	.	I	.	.	.	.	.	.
Thalictrum aquilegifolium	.	I	.	.	.	.	.	.
Ulmus laevis	.	I	.	.	.	.	.	.
Crataegus species	.	.	III	.	.	.	.	.
Selinum carvifolia	.	.	II	.	.	.	.	.
Fragaria moschata	.	.	I	.	.	.	.	.
Plagiothecium denticulatum	.	.	.	II	.	.	.	.
Circaea lutetiana	.	.	.	II	.	.	.	.
Epipogium aphyllum	.	.	.	I	.	.	.	.
Viola riviniana	.	.	.	I	.	.	.	.
Brachythecium populeum	.	.	.	I	+	.	.	.
Homalothecium sericeum	.	.	.	I	+	.	.	.
Festuca rubra	.	.	.	+	II	.	.	.
Stachys officinalis	.	.	.	.	III	III	.	.
Coronilla varia	.	.	.	+	IV	I	.	.
Crataegus laevigata	.	.	.	+	II	III	.	.
Anthericum ramosum	.	.	.	+	+	II	.	.
Cotoneaster niger	.	.	.	.	+	I	.	.
Carex montana	.	.	.	.	+	I	.	.
Geranium sanguineum	.	.	.	.	r	II	.	.
Inula salicina	.	.	.	.	+	I	.	.
Trifolium rubens	.	.	.	.	+	I	.	.
Silene nutans	.	.	.	.	II	.	.	.
Campanula glomerata	.	.	.	.	I	.	.	.
Carlina vulgaris	.	.	.	.	I	.	.	.
Plagiomnium affine	.	.	.	.	I	.	.	.
Hieracium bifidum	.	.	.	.	.	II	.	.
Cimicifuga europaea	.	.	.	.	.	I	.	.
Euphorbia angulata	.	.	.	.	.	I	.	.

(cont.)

Table 1. Continued.

Syntaxon	1	2	3	4	5	6	7	8
Hieracium caesium	.	.	.	.	.	I	.	.
Neckera crispa	.	.	.	.	.	I	.	.
Pulmonaria mollissima	.	.	.	.	.	I	.	.
Lonicera nigra	.	.	.	.	.	.	II	IV
Cardamine impatiens	.	.	.	.	.	.	II	III
Petasites albus	.	.	.	.	.	.	II	II
Glechoma hirsuta	.	.	.	.	.	.	II	II
Carduus glaucus	.	.	.	.	.	.	II	I
Hylocomium splendens	.	.	.	.	.	.	I	II
Ribes uva-crispa	.	.	.	.	.	.	II	II
Bromus benekenii	.	.	.	.	.	.	II	.
Orobanche species	.	.	.	.	.	.	II	.
Rhizomnium punctatum	.	.	.	.	.	.	II	.
Rosa pendulina	.	.	.	.	.	.	II	.
Sesleria albicans	.	.	.	.	.	.	II	.
Sorbus aria	.	.	.	.	.	.	I	I
Tanacetum corymbosum subsp. *clusii*	.	.	.	.	.	.	II	.
Myosotis sylvatica	.	.	.	.	.	.	.	II
Tussilago farfara	.	.	.	.	.	.	.	I
Mnium spinosum	.	.	.	.	.	.	.	I
Asplenium viride	.	.	.	.	.	.	.	I

1 = *Cephalanthero rubrae-Fagetum* (Wolin)
2 = *Fagus sylvatica-Cypripedium calceolus* community (Kashuby Lakeland)
3 = *Fagus sylvatica-Hypericum maculatum* community (Krowiarki Mts – Sudety)
4 = *Fagus sylvatica-Cruciata glabra* community, impoverished form (Silesian Upland)
5 = *Fagus sylvatica-Cruciata glabra* community, *"typicum"* (Cracow-Częstochowa Upland)
6 = *Fagus sylvatica-Cruciata glabra* community, *"valerianetosum"* (Cracow-Częstochowa Upland)
7 = *Carici albae-Fagetum typicum* (Pieniny Mts – Carpathians)
8 = *Carici albae-Fagetum abietetosum* (Pieniny Mts – Carpathians)

Carici albae-Fagetum Panc.-Kotej. *in* W. Mat. 2000 (*ass. nova hoc loco*)

(= *Carici-Fagetum*, 35 relevés in Table 10 in Pancer-Kotejowa E. 1973, Fragm. Flor. Geobot. 19(2): 197–258; omitted from the synoptic table were relevés 19 [10781] and 29 [10791], considered to depart too markedly from the others).

The nomenclatural type (lectotype) for the association and at the same time the *typicum* sub-association is relevé 7 [10769] in the aforementioned Table 10. The Character-taxa of the association are *Carex alba* (78%) and *Poa stiriaca* (75%).

Differential-taxa, i.e. the species distinguishing this association in relation to other "orchidaceous" beech forests in Poland, are *Calamagrostis varia* (69%), *Salvia glutinosa* (93%), *Euphorbia amygdaloides* (87%), *Cirsium erisithales* (81%), *Prenanthes purpurea* (60%), *Eurhynchium angustirete* (54%) and *Clematis alpina* (42%).

Character-taxa of the *Fagion* alliance: *Fagus sylvatica* (97%), *Acer pseudoplatanus* (60%), *Dentaria bulbifera* (51%) *and Polystichum aculeatum* (20%).

Character- (*) and Differential-taxa of the *Cephalanthero-Fagenion* alliance: *Campa-*

nula rapunculoides (71%), *Digitalis grandiflora* (69%), *Polygonatum odoratum* (51%), *Campanula persicifolia* (37%), *Clinopodium vulgare* (37%), **Epipactis helleborine* (37%), **Cephalanthera damasonium* (31%), *Convallaria majalis* (31%), **Epipactis atrorubens* (26%), **Cephalanthera longifolia* (14%).

Character-taxa of higher syntaxa and accompanying species – see Table 1.

Floristically, *Carici albae-Fagetum* is the best defined of all the thermophilous beech forests in Poland. This is due to its having its own Character-taxa with a high degree of fidelity and supraregional significance. This syntaxon is also the closest to the Western European communities of sub-alliance *Cephalanthero-Fagenion* in as far as its identity with *Carici-Fagetum* as conceptualised by Moor (1952) might be considered. The clear floristic differences, geographical substitution or vicariousness of many species (e.g. *Galium sylvaticum/G. schultesii, Valeriana montana/V. tripteris* and others), different division into lower units and isolated and discontinuous range all incline one to regard the Pieniny community as a separate regional association, albeit one in the same group.

The species *Carex alba* used in naming is accepted as being characteristic of the whole association, in spite of its reaching an undoubted optimum of occurrence in only one of its forms (the fir form). Though less abundant in other forms, it is nonetheless present with a high (4th) degree of constancy and is quite evenly spread across different phytocoenoses. Away from communities with *Cephalanthero-Fagenion*, the species occurs abundantly in a certain type of relict pine forest on limestone that is representative of impoverished borderline forms of the communities from the class *Erico-Pinetea*.

In the Pieniny Mountains, the community under discussion is defined very clearly from the ecological point of view. The study by Pancer-Kotejowa (1973) presents a detailed analysis of habitat conditions and distinguishes as specific to the Pieniny the two sub-associations: *Carici-Fagetum cephalantheretosum* and *Carici-Fagetum abietetosum.* This division has gained basic confirmation in the elaboration using numerical methods. The first sub-association (20 relevés) is representative of the form typical from the floristic and habitat points of view; under the new, narrower conceptualisation of the association, we distinguish it as *Carici albae-Fagetum typicum* Panc.-Kotej. *in* W. Mat. 2000. The lectotype is relevé 7 [10769] from Table 10 in the study: Pancer-Kotejowa 1973, Fragm. Flor. Geobot. 18(2): 197–258. This is at the same time the lectotype of the association.

The second of the sub-associations distinguished (15 relevés) is confirmed by us as *Carici albae-Fagetum abietetosum* Panc.-Kotej. *in* W. Mat. 2000, with relevé 33 [10795] from Table 10 in the aforementioned study being regarded as the lectotype. This is the form with fir in which beech appears in the stand rarely (with a constancy of ca 20%) and in small numbers (cover/abundance + –2), albeit with a level V degree of constancy in all layers taken together. Fir, which has 100% constancy in both forms, is the undoubted dominant in the tree layer of *C.a.-F. abietetosum*, with a mean abundance of 4.1. In contrast, in *C.a.-F. typicum* the value in question is only 1.9. Of similar significance as a distinguishing species is *Carex alba*, which, while being characteristic of the whole association, has its undoubted centre of occurrence in the sub-association with fir. Com-

pared with the typical form this unit is poor in characteristic thermophilous species, lacking *Cephalanthera longifolia, C. rubra, Campanula persicifolia, Convallaria majalis* and *Laserpitium latifolium* amongst others, and having others present more rarely and at lower abundance. On the other hand, mesotrophic shade-tolerant species are present in abundance (e.g. *Oxalis acetosella, Maianthemum bifolium, Rubus idaeus*, etc.), while species linked with coniferous forests of class *Vaccinio-Piceetea* also appear, if rarely and in small numbers. Examples here include Scots pine and juniper in the upper layers, as well as *Pyrola media* and the weakly-acidophilous mosses *Hylocomium splendens, Hypnum cupressiforme, Pleurozium schreberi* and *Rhytidiadelphus triquetrus* in the ground-cover layer. This is probably linked with the mild acidification of the surface layers of the soil as a consequence of the presence of a weakly-decomposed moder humus.

Cephalanthero rubrae-Fagetum Piotrowska & Olaczek *ex* W. Mat. 2000

(*hoc loco*) (*nom. nudum, invalid.* in Piotrowska H., Olaczek R. 1976, mscr.; = "*Carici-Fagetum* Moor 1952 *em.* Hartm. & Jahn 1967, Baltic race" – 10 relevés from Table 1 in Piotrowska H. 1993, Zesz. Nauk. Uniw. Gdańsk. Biologia 10: 5–27).

The name adopted by us, introduced in 1976 in the study by Piotrowska and Olaczek 1976 mscr., not published validly (typescript) and cited in a later text (Piotrowska 1993) constitutes a *nomen nudum* with no diagnosis offered. This means it has not been published validly in the meaning of the *Code of Phytosociological Nomenclature*. The validation of the name and its classification according to type is thus necessary. The basis for distinguishing the beech forests of Wolin as a separate association is provided by 10 relevés published by H. Piotrowska (1993).

Nomenclatural type (lectotype) of the association: relevé 2 [11893] in the aforementioned Table 1.

– Character-taxa (regionally) of the association are: *Cephalanthera rubra* (80%) and *Epipactis atrorubens* (60%).

– Differential-taxa of the association as against other "orchidaceous" beech forests in Poland: *Campanula rotundifolia* (100%), *Achillea millefolium* (100%), *Dactylis glomerata* (100%), *Vicia sepium* (100%), *Deschampsia flexuosa* (90%), *Calamagrostis epigeios* (70%), *Hieracium laevigatum* (70%), *Poa angustifolia* (70%), *Cerastium fontanum f. triviale* (= *C. holesteoides*) (60%), *Festuca rubra* subsp. *arenaria* (60%), *Poa pratensis* (60%), *Torilis japonica* (60%), *Lathyrus montanus* (50%), *L. pratensis* (50%), *Plagiomnium undulatum* (50%), *Sedum sexangulare* (50%), *Trifolium pratense maritimum* (50%)

– Character-taxon of the *Fagion* alliance is *Fagus sylvatica* (100%).

– Character- (*) and Differential-taxa of the sub-alliance *Cephalanthero-Fagenion*: *Campanula persicifolia* (90%), **Cephalanthera rubra* (80%), *Convallaria majalis* (80%), **Epipactis atrorubens* (60%), *Astragalus glycyphyllos* (50%), *Clinopodium vulgare* (50%), *Campanula rapunculoides* (20%), *Polygonatum odoratum* (20%), *Hypericum montanum* (10%).

– Character-taxa of higher syntaxa and accompanying species – see Table 1.

Within the *Cephalanthero-Fagenion* sub-alliance, the association *Cephalanthero ru-*

brae-Fagetum holds the most isolated position. Against the background of other "orchidaceous" beech forests in Poland it stands out in the positive sense in the high constancy of occurrence of many of the aforementioned species (see also Table 1). These are mainly light-loving plants of non-forest habitats that are often typical of drier meadows or sandy grasslands. Moreover, the distinctiveness of this association is particularly clearly emphasised in the negative sense in reference to the lack of many character-taxa of the order *Fagetalia* (like *Mercurialis perennis, Daphne mezereum, Galium odoratum, Actaea spicata* and *Lathyrus vernus*) and the class *Querco-Fagetea* (*Campanula trachelium, Corylus avellana, Acer platanoides* and *Aegopodium podagraria*), species which play an important role in all of Poland's other *Cephalanthero-Fagenion* communities. This community is clearly distinct on both the local and supraregional scales. Also speaking for its separate identity as an association are the special conditions of the habitat, isolated range and original phytocoenogenesis. Its assignment to the *Cephalanthero-Fagenion* sub-alliance therefore arouses serious reservations.

Piotrowska (1993) drew a distinction between the "*typicum*" and "*deschampsietosum*" sub-associations. The latter had, as Differential-taxa, *Deschampsia flexuosa* (abundantly), *Luzula pilosa, Dicranum scoparium, Herzogiella seligeri, Hypnum cupressiforme, Plagiothecium laetum, Polytrichum formosum, Trientalis europaea* and *Vaccinium myrtillus*, with a lack of *Brachypodium sylvaticum, Cerastium fontanum* subsp. *triviale, Clinopodium vulgare, Festuca rubra arenaria, Lathyrus pratensis, Pimpinella saxifraga, Poa pratensis* and *Torilis japonica*. The share of mesotrophic meadow species is lower, while that of acidophilous species of coniferous forests relative to those of "acid" oak forests is higher.This happens in connection with the more marked acidification of the surface soil horizon. This division is confirmed in the analysis by numerical methods, but this may not be validated formally since the number of relevés in each of the units distinguished does not reach the minimum required by the *Code of Phytosociological Nomenclature*. *Cephalanthero rubrae-Fagetum* is only present on the cliffsides of Wolin Island and is perhaps a form subendemic to this region. A similar, but not identical community is known from the limestone cliffs of Rugia Island (Jeschke 1964).

Fagus sylvatica-Cruciata glabra community

(*Carici-Fagetum convallarietosum* 1972, 35 relevés in Table 1 in Michalik S. 1972, Fragm. Flor. Geobot. 18(2): 215–225).

Michalik studied in detail, including from the point of view of habitat, the thermophilous "orchidaceous" beech forests of the Kraków-Częstochowa Upland, classifying them within an association already known from the Pieniny Mountains called *Carici-Fagetum* (Moor 1952) *em.* Hartmann and Jahn (1967). In the face of such serious differences in relation to both the Pieniny form and the "classical" Swiss and Western German communities, it was decided that a new, *convallarietosum* sub-association should be distinguished. It emerged in subsequent years that this unit has an extensive range, taking in at least the whole Silesian-Kraków Uplands sub-province (Cabała 1990; Hereźniak 1993; Hereźniak in litt.) and maybe also part of the Central Małopolska Upland. This sub-asso-

ciation is at present documented by the greatest number or relevés (55) of any *Cephalanthero-Fagenion* community in Poland.

In the elaboration using numerical methods, the thermophilous beech forest with spring crosswort *Cruciata glabra* was distinguished as a syntaxon well-justified floristically. Of all the communities compared it is the one best provided for in terms of light-demanding and thermophilous species typical for *Cephalanthero-Fagenion*. It differs from the most-closely related Pieniny association not only in the lack of its character-taxa and the majority of the montane species, but also positively in the presence of numerous plants that distinguish the community under discussion from the remaining thermophilous beech forests in Poland. The most important among these are *Cruciata glabra* and *Cephalanthera rubra*, occurring with a high degree of constancy in all forms of the community, as well as *Melittis melissophyllum*, *Lathyrus niger, Euonymus verrucosus* and *Viola mirabilis*, which are of markedly lower constancy in some forms. In contrast, *Convallaria majalis* – the species Michalik used in naming the sub-association – only takes on values qualifying it as a Differential-taxon in relation to *Carici albae-Fagetum* from the Pieniny Mountains. In the other thermophilous beech forests in Poland it occurs with lesser constancy than in the Małopolska community. The aforementioned species may be considered distinguishing where the regional association is concerned, were we to decide to treat the thermophilous beech forest in this way (as *Cruciato-Fagetum*?). The difficulty lies with the absence of species that could without reservation be regarded as character-taxa. *Cephalanthera rubra* might perhaps be a case in point, but only one of regional significance because it is present with the same constancy in the association from Wolin Island to which it gives its name. Relevé 13 [10810] from Table 1 in the study by Michalik (1972) might be pointed to as the nomenclatural type (lectotype) of an association accepted in this way; this would at the same time be the lectotype of the typical sub-association (the typical variant of Michalik). The matter of the rank of the community under discussion should be resolved by further research. Michalik (1972) identified two units of lower rank as variants: the typical one and the one with *Valeriana tripteris*. This division was confirmed in the numerical study. In the case of the Małopolska thermophilous beech forest being identified as a separate regional association, these units would need to be validated as the sub-associations *C.-F. typicum* and *C.-F. valerianetosum tripteridis*. The species distinguishing the last form are – apart from *Valeriana tripteris* itself, *Cotoneaster integerrimus* and *Laserpitium latifolium*. *Epipactis atrorubens* and *Cephalanthera longifolia* occur here with markedly greater constancy. As has already been noted by Michalik, this community is more clearly reminiscent than others of the *Carici albae-Fagetum* community of the Pieniny Mountains from both the floristic and habitat points of view. As the lectotype for the sub-association I would nominate relevé 2 [10799] from Table 1 of the cited work of Michalik (1972).

Besides the two units mentioned, the computer study revealed one more form encompassing 18 relevés. mainly from the macroregion of the Silesian Upland (Cabała 1990; Hereźniak 1993; Hereźniak 1999). This is a clearly impoverished form first and foremost lacking in *Vincetoxicum hirundinaria* and *Galium schultesii*, while having all the Differential-taxa of the association, except *Cruciata glabra* at a very low level of constancy.

In addition, the majority of the species distinguishing the sub-association *Cephalanthero-Fagenion* have a markedly lower constancy than is noted in the other forms of the association. This is also true of many Character-taxa of the order *Fagetalia* and the class *Querco-Fagetea*. The positive differences (rather higher constancy of species like *Anemone nemorosa, Atrichum undulatum, Dryopteris carthusiana, Dryopteris filix-mas, Plagiomnium cuspidatum* and *Polygonatum verticillatum*) are limited and ambiguous. The unit may perhaps be presumed to represent degenerative phases at least partically conditioned anthropogenically.

Fagus sylvatica-Hypericum maculatum community

Computer-aided comparison of the thermophilous "orchidaceous" beech forests occurring in Poland revealed the unique character of the communities from the Sudetic region. These are relatively rare because calcareous rocks occur in only a few places here, and their extent is very limited. Communities of the *Cephalanthero-Fagenion* alliance have hitherto been known only from the calcareous parts of the Kaczawskie Mountains near Wojcieszów, as well as from the limestone Krowiarki belt in the Ziemia Kłodzka region. On the basis of the presence of yew in one relevé obtained from the Wojcieszów area, W. and A. Matuszkiewicz identified the thermophilous beech forest present there as the calcareous beech forest of the association *Taxo-Fagetum* described by Moor (1952) from the Swiss Jura. In fact this association was later included within *Carici-Fagetum* in its wider conceptualisation (Hartmann & Jahn 1967). The communities from the Krowiarki range were studied by J. M. Matuszkiewicz and A. B. Kozłowska and described in detail in a study, included in this volume. My comparative study took in 11 relevés from the aforementioned authors. Not entering into discussion with them, I state only that syntaxonomic revision showed the systematic distinctiveness of the communities referred to at a level equivalent to the regional association. Its final conceptualisation and rank may be a matter for further study and the name used in this article is nothing more than a provisional description. The community well represents the sub-alliance *Cephalanthero-Fagenion*: present at a high level of constancy from among the character-taxa are *Epipactis helleborine* and *Cephalanthera damasonium*, while the distinguishing thermophilous species accounting for a significant share are *Campanula persicifolia, Convallaria majalis, Astragalus glycyphyllos, Clinopodium vulgare* and *Polygonatum odoratum*. The calcareous beech forests of Góry Krowiarki showed the greatest similarity with analogous communities from the Silesian-Kraków Upland, though are – it would seem – poorer floristically. In addition, they differ in their distinct geographical character, lacking for example the Sarmatian species *Cruciata glabra, Euonymus verrucosus, Galium schultesii, Vincetoxicum hirundinaria*, etc., as well as those associated in Poland with the Carpathians. In contrast, species that are present, if rarely, are those with a "western" tendency to their distribution, like *Digitalis purpurea, Festuca altissima, Galium sylvaticum* and *Hordelymus europaeus*. Beyond these, the synoptic table of the numerical review study gave as "differential-taxa" *Hypericum maculatum, Streptopus amplexifolius, Viola collina and Fragaria viridis*, though their real syntaxonomic value is hard to determine at this stage.

Fagus sylvatica-Cypripedium calceolus community

This community was described by Fałtynowicz and Machnikowski (1982) from the Las Ostrzycki Nature Reserve in the Kashuby Lakeland under the neutral name "moist calcareous beech forest". It is so far known from this single site only and is unfortunately documented by as few as eight relevés. The numerical processing left it very clearly separated – in a position between that of *Cephalanthero rubrae-Fagetum* from Wolin Island (from which it differs markedly, however) and that of the thermophilous beech forests of the Sudetic Mountains and the Silesian Upland. In this, the species revealed as "distinguishing" (see Table 1) are uniform in character. There is a noteworthily high degree of constancy of *Cypripedium calceolus*. The affinity with the sub-alliance *Cephalanthero-Fagenion* is manifested more weakly here than with any of the other communities compared. The only one of the Character-taxon to occur is *Epipactis helleborine*, while among the distinguishing thermophilous species only *Convallaria majalis* shows a high degree of constancy, while the three others appear but rarely. On the other hand, species of the order *Fagetalia* and class *Querco-Fagetea* are well-represented. The authors referred to suggest an affinity between the community under discussion and the sub-alliance *Eu-Fagenion* (now *Galio-Fagenion*), and also perceive a similarity to *Mercuriali-Fagetum* of Puszcza Bukowa near Szczecin (Celiński 1962), as well analogous forms of fertile calcareous beech forest from the Elbląg Elevation (Tokarz 1971), Krajeńskie Lakeland (Boiński 1973) and Darżlubska Forest (Dąbrowski 1978) as well as some forms of beech-woods from the Dylewskie-Hills (Jutrzenka-Trzebiatowski 1980). However, all of these communities occur on very moist or wet soils, while that from near Lake Ostrzyckie occupies a habitat that is specific in that it occurs on the fresh or slightly-moist (not wet) soils that have arisen from bog lime. Speaking for its systematic distinctiveness is the existence of specific homologous substitute communities, e.g. the segetal association *Sileno inflatae-Linarietum minoris* identified by Herbich (1993). The latter author also has no doubts as to the separate identity of the "orchidaceous beech forest" from the Kashuby Lakeland (as compared with *Mercuriali-Fagetum* and related communities) or as to its being assigned to sub-alliance *Cephalanthero-Fagenion*. A final accounting for the systematic position of the community under discussion would require the discovery and documentation of still other sites for it in the Kaszuby Lakeland – something which seems very unlikely, however.

Conclusions

The syntaxonomic analysis of the results obtained led to the drawing of the following conclusions.

1. *Cephalanthero-Fagenion* may be taken to include the "orchidaceous" beech forests occurring in Poland in the Pieniny Mountains, or the Silesian-Cracow Upland, in the central Sudetic Mountains (Góry Krowiarki), in the Kaszuby Lakeland ("Las Ostrzycki") and on Wolin Island. The moist beech forests on calcareous substrata of which the prototype is Celiński's "*Mercuriali-Fagetum*" do not belong here, however.

2. In no way can these communities continue to be upheld as a single association, or in particular be wholly identified with the *Carici-Fagetum* known from Switzerland and Germany, in spite of the undoubted floristic and ecological analogies. They form five distinguishable regional types of which each has a linked range. The greatest degree of distinctiveness is that shown by the communities from the Pieniny Mountains and Wolin, and I consider these identifiable associations. The remaining communities are closely related to one another. The distinctiveness of each is not really in dispute, but it would at present be difficult to assign to them good characteristic species that do not also play the role in the communities of other higher-rank taxa present in the same areas (e.g. in the order *Quercetalia pubescenti-petraeae*). We will for now bracket them under informal and provisional names as regional or local forms of the sub-alliance *Cephalanthero-Fagenion*. After all, some of these communities are for now represented by too few phytosociological relevés to make any other course of action possible.

3. A consequence of the beech forests of Pieniny and Wolin being regarded as distinct associations in their own right is the need for their effective and valid naming, along with the provision of nomenclatural types. In these cases we allow ourselves to be guided by the principles, rules and recommendations of the Polish edition of the *Code of Phytosociological Nomenclature* of Barkman, Moravec and Rauschert (1995).

References

Barkman J. J., Moravec J. & Rauschert S. 1995. Kodeks Nomenklatury Fitosocjologicznej [Code of Phytosociological Nomenclature – Code der Pflanzensoziologischen Nomenklatur – Code de Nomenclature Phytosociologique]. – Polish Bot. Stud., Guideb. Ser. **16**: 1–58 (in Polish, translated by K. Czyżewska & W. Matuszkiewicz).

Boiński M. 1973. Lasy liściaste środkowej części Pojezierza Krajeńskiego [The deciduous forests central part of Pojezierze Krajeńskie district]. – Studia Soc. Sc. Torun., Sec. D (Bot.) **9**(5): 1–104 (in Polish with English summary).

Cabała S. 1990. Zróżnicowanie i rozmieszczenie zbiorowisk leśnych Wyżyny Śląskiej [Differentiation and distribution of forest communities in the Silesian Upland]. – Pr. Nauk. Uniw. Śląsk. Katowice **1068**: 1–142 + 13 tab. (in Polish with English summary).

Celiński F. 1962. Zespoły leśne Puszczy Bukowej pod Szczecinem [The forest communities of the Puszcza Bukowa near Szczecin]. – Monogr. Bot. **13**(Suppl.): 1–208 (in Polish with English summary).

Celiński F., Sendek A. & Wika S. 1978. Zbiorowiska leśne bogatszych siedliskKatowickiego Okręgu Przemysłowego [Forest communities on more fruitful habitats of Silesian Industrial Area]. – Pr. Nauk. Uniw. Śląsk., Acta Biol. Siles. **5**: 123–168 (in Polish with English summary).

Dąbrowski A. 1978. Zespoły leśne Puszczy Darżlubskiej na tle siedliskowych typów lasu ["Forest associations of the "Puszcza Darżlubska" region in comparison with the forest sites types"]. Mscr. of Ph. D. thesis, Gdańsk University, Gdańsk (in Polish).

Fałtynowicz W. & Machnikowski M. 1982. Zbiorowiska roślinne rezerwatu "Las Ostrzycki" na Pojezierzu Kaszubskim [Plant communities of the "Ostrzyce Forest" nature reserve in the Kashubian Lake District]. – Zesz. Nauk. Uniw. Gdańsk. Biologia **3**: 37–54 (in Polish with English summary).

HARTMANN F. K. & JAHN G. 1967. Waldgesellschaften des mitteleuropäischen Gebirgsraumes nördlich der Alpen. 636 pp. G. Fischer, Stuttgart.

HENNEKENS S. 1996. MEGATAB, a visual editor for phytosociological tables, version 1.0. 18 pp. Giesen & Geurts, Ulft.

HERBICH J. 1993. Roślinność dynamicznego kręgu zbiorowisk buczyny storczykowej *Carici-Fagetum* na Pojezierzu Kaszubskim [The vegetation of a dynamic circle of *Carici-Fagetum* communities in the Kashuby Lakeland (northern Poland]. – Zesz. Nauk. Uniw. Gdańsk. Biologia **10**: 31–60 (in Polish with English summary).

HEREŹNIAK J. 1993. Stosunki geobotaniczno-leśne północnej części Wyżyny Śląsko-Krakowskiej na tle zróżnicowania i przemian środowiska [The variability and changes of forest vegetation in the northern part of the Silesia-Cracow Uplands]. – Monogr. Bot. **75**: 1–368 (in Polish with English summary).

JESCHKE L. 1964. Die Vegetation der Stubnitz. – Natur u. Naturschutz in Mecklenburg **2**: 1–154.

JUTRZENKA-TRZEBIATOWSKI A. 1980. Zespoły leśne Wzgórz Dylewskich [Forest associations of Wzgórza Dylewskie (north-eastern Poland)]. – Monogr. Bot. **58**: 1–191 (in Polish with English summary).

MATUSZKIEWICZ J. M. & KOZŁOWSKA A. B. 2000. "Orchidaceous" beech forests in the Góry Krowiarki range (Eastern Sudetic Mountains). – Fragm. Flor. Geobot. **45**(1–2): 373–391.

MICHALIK S. 1972. Ciepłolubne lasy bukowe na Wyżynie Krakowsko-Częstochowskiej [Thermophilous Beech Forest *Carici-Fagetum* (Moor 1952) emend. Hartmann, Jahn (1967) in the Cracow-Częstochowa Upland]. – Fragm. Flor. Geobot. **18**(2): 215–225 (in Polish with English summary).

MIREK Z., PIĘKOŚ-MIRKOWA H., ZAJĄC A. & ZAJĄC M. 1995. – Vascular plants of Poland: a checklist. – Polish Bot. Stud. Guideb. Ser. **15**: 1–303 (in English and Polish).

MOOR M. 1952. Die *Fagion* Gesellschaften im Schweizer Jura. – Beitr. geobot. Landesaufn. Schweiz **31**: 1–201.

PANCER-KOTEJOWA E. 1973. Zbiorowiska leśne Pienińskiego Parku Narodowego [Forest Communities of Pieniny National Park (Western Carpathians)]. – Fragm. Flor. Geobot. **18**(2): 197–258 (in Polish with English summary).

PIOTROWSKA H. 1993. Buczyna storczykowa wzdłuż nadmorskiego klifu na wyspie Wolin (północno-zachodnia Polska) [A beech forest with orchids atop a maritime cliff on Wolin Island (NW Poland)]. – Zesz. Nauk. Uniw. Gdańsk. Biologia **10**: 5–29 (in Polish with English summary).

PIOTROWSKA H. & OLACZEK R. 1976. Inwentaryzacja fitosocjologiczna wraz z kartowaniem zbiorowisk roślinnych Wolińskiego Parku Narodowego ["Phytosociological inventorying and cartography of the plant communities in the Wolin National Park"]. 68 pp. Gdańsk University and Łódź University, Gdańsk (in Polish).

PODANI J. 1993. SYN-TAX-pc Computer Programs for Multivariate Data Analysis in Ecology and Systematics, User's Guide, Version 5.0. 104 pp. Scientia Publish., Budapest.

SZAŃKOWSKI M. 1995 Instrukcja użytkowania systemu bazy danych TURBOVEG ["User's Guide for TURBOVEG Data-Base System"]. 19 pp. Nakład własny, Warszawa (in Polish).

TOKARZ H. 1971. Zbiorowiska leśne z udziałem buka (*Fagus silvatica*) w obszarze północno-wschodniej granicy jego zasięgu. Część 1. *Melico-Fagetum* [Forest communities with the beech (*Fagus sylvatica*) in areas near its north-eastern range. Part I. *Melico-Fagetum*]. – Acta Biol. Med. Soc. Sc. Gedan. **15**(3): 227–274.

TUTIN T. G., HEYWOOD V. H., BURGES N. A., MOORE D. M, VALENTINE D. H., WALTERS S. M. & WEBB D. A. (eds). 1964–1980. Flora europaea. **1–5**. Cambridge University Press, Cambridge.