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Forest communities with European silver-fir (*Abies alba* Mill.) in the Sudety Mts.

Abstract: The available phytosociological literature were reviewed and compared with 12 original relevés made on representative of habitats of fir trees in the study area. Only in the eastern part of the Sudety Mts. silver-fir is still important forest tree. It is found most frequently in potential sites of acidophilic beech forest, which vegetation is now strongly transformed because of planting them with spruce. Typical, mainly acidophilic beech forest takes second place (in respect of frequent occurrence). Oak-hornbeam forest take third position.

Additional key words: phytosociology, ecology.

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Introduction

The centre of distribution of European silver-fir in Poland is located in the lower montane zone of the Carpathians. This species is also frequent in the Małopolska Upland and in Roztocze in south-eastern Poland (Boratyński 1983). In the comparison with those parts of Poland, the role of fir in forest communities of the Sudety Mts. (south-western Poland) is markedly lower. Only in the eastern part of Sudety it is still important forest tree.

The European silver-fir has a wide ecological scale and is a component of many forest communities – from oligotrophic pine forest, through mesotrophic mixed coniferous and mixed deciduous forest, to various types of eutrophic forest, such as beech forest, oak-hornbeam forest, or even wet deciduous forest (Table 1).

The aim of the present study was to determine phytosociological spectrum of *A. alba* on the Sudety and its foreland.

Material and methods

We reviewed the available phytosociological literature referring to the Sudeten, and compared the results with 12 original relevés representing habitats of fir trees in this area (made in order to characterize permanent plots for long-term monitoring of fir populations), which were selected from nearly 800 natural localities of European silver-fir in various parts of the Sudety Mts. Their vegetation was characterized by means of relevés, prepared according to the method of Braun-Blanquet. The names of syntaxa are consistent with Matuszkiewicz (2001).

Results

In the light of data from phytosociological literature (Fig 1), the European silver-fir prefer beech forest communities, especially acidophilic montane beech forest, *Luzulo luzuloidis-Fagetum*. This agrees with earlier observations of Boratyński (1991), from the Western Sudeten, and Kosiński (2001), from the

Table 1. List of forest communities with silver fir in Poland (according to Wojterski 1983, changed)

| Class | Order | Alliance | Association |
|--|----------------------|---------------------------------|--|
| Quercus-Fagetea | Fagetalia sylvaticae | Alno-Ulmion | · <i>Clathro laetae-Alnetum</i> |
| | | | · <i>Alnetum incanae</i> |
| | | | · <i>Fraxino-Alnetum</i> |
| | | | · <i>Ficario-Ulmetum</i> |
| | | Carpinion betuli | · <i>Galio sylvatici-Carpinetum betuli</i> |
| | | | · <i>Tilo cordate-Carpinetum betuli</i> |
| | | Fagion sylvaticae | · <i>Phyllitido-Aceretum</i> |
| | | | · <i>Sorbo aucupariae-Aceretum pseudoplatani</i> |
| | | | · <i>Carici albae-Fagetum</i> |
| | | | · <i>Dentario glandulosae-Fagetum</i> |
| · <i>Dentario enneaphylli-Fagetum</i> | | | |
| · <i>Luzulo luzuloidis-Fagetum</i> | | | |
| · <i>Luzulo pilosae-Fagetum</i> | | | |
| · <i>Galio rotundifolii-Abietenion</i> (suballiance) | | | |
| Vaccinio-Piceetea | Piceion abietis | · <i>Abieti-Piceetum</i> | |
| | | · <i>Abietetum polonicum</i> | |
| | | · <i>Polysticho-Piceetum</i> | |
| | Dicrano-Pinion | · <i>Quercu roboris-Pinetum</i> | |
| | | · <i>Leucobryo-Pinetum</i> | |
| | | | |

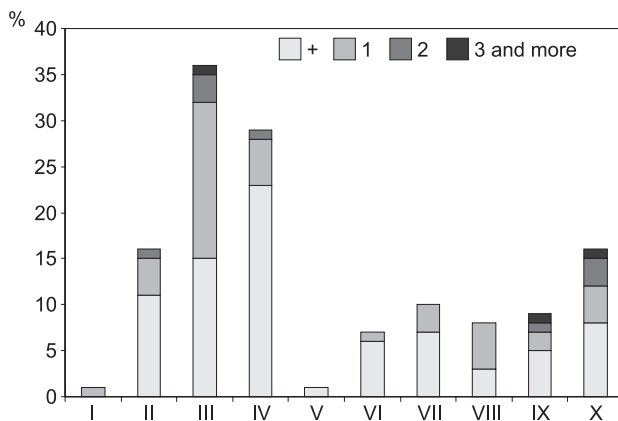


Fig. 1. Occurrence of silver fir in forest communities of Sudety, based on 131 relevés (Anioł-Kwiatkowska, Dajdok 1993; Celiński 1965; Fabiszewski 1968; Kuczyńska 1972, 1973; Kuczyńska, Macicka 1984; Kwiatkowski 1995; Macicka 1988; Macicka, Wilczyńska 1990, 1991, 1995; Matuszkiewicz W., Matuszkiewicz A. 1973; Pender 1998; Pender K., Macicka-Pawlik 1996). Forest communities: I – wet deciduous forest (*Alno-Ulmion*), II – oak-hornbeam forest (*Carpinion betuli*), III – acidophilic montane beech forest (*Luzulo-Fagenion*), IV – eutrophic beech forest (*Dentario glandulosae-Fagenion*), V – montane sycamore maple forest (*Acerenion pseudoplatani*), VI – acidophilic oak forest (*Quercion robori-petraeae*), VII – mixed coniferous forest (*Quercu roboris-Pinetum*), VIII – Scots pine forest (*Leucobryo-Pinetum*), IX – Norway spruce-silver fir forest (*Vaccinio-Abietenion*), X – anthropogenic spruce stands

Eastern Sudeten. In comparison with the Carpathian *Dentario glandulosae Fagetum*, typical of Sudeten *Dentario enneaphylli-Fagetum* covers a relatively small area (e.g. surrounding of “Jaskinia Niedźwiedzia” reserve), so its real significance as a habitat for fir trees is much smaller than it could be concluded from Fig. 1. Moreover, fir trees are less frequent there. It is noteworthy that fir occurs also in patches of thermophilous beech forest (with orchids) of the suballiance *Cephalanthero-Fagenion* in the Krowiarki mountain range, in the Eastern Sudeten (Kosiński 1996). Patches of this forest community colonize shallow and dry soils on steep slopes exposed to the south. Such conditions are not favourable for fir trees, which show there a markedly lower vitality. Outside beech forest stands, fir is also frequent in remnants of the lower montane fir-spruce forest, *Abieti-Piceetum*, and generally of communities of the suballiance *Vaccinio-Abietenion*, as well as in spruce stands planted on sites suitable for acidophilic beech forest (these substitute communities are characterized with a similar physiognomy, which makes it difficult to determine the true limits of the natural range of fir-spruce forest). At lower altitudes, in the submontane belt and in lowlands, fir is quite frequently found in oak-hornbeam forest, *Galio sylvatici-Carpinetum betuli*, and rarely in less fertile pine forest sites (*Peucedano-Pinetum* and *Leucobryo-Pinetum*) and in acidophilic oak forest (*Calamagrosti arundinaceae-Quercetum petraeae* and *Luzulo luzuloidis-Quercetum petraeae*).

The communities of the plots investigated (Table 2 and Fig. 2) are more or less degraded, they can be di-

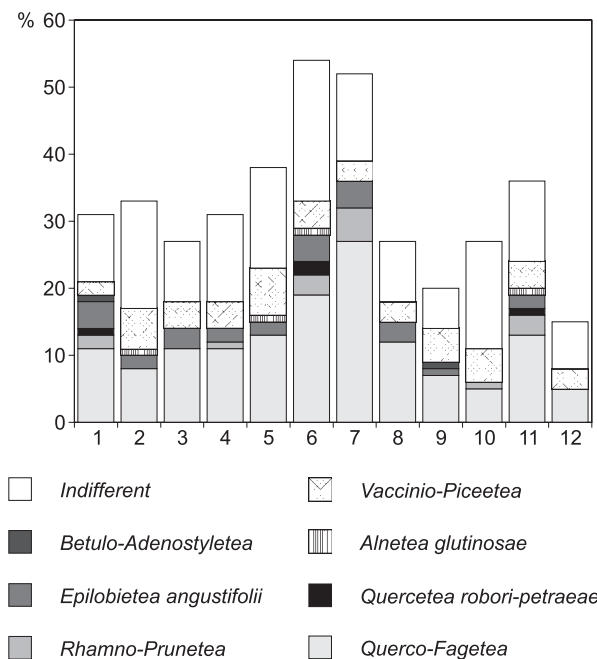


Fig. 2. Percentage of species characteristic for given forest communities in 12 chosen habitats of silver fir in Sudety Mts. 1–12 – relevés location according table 2

| No. of relevés | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|--|---|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| <i>Taxus baccata</i> | a | . | . | . | . | . | . | 1.1 | . | . | . | . | . |
| <i>Tilia cordata</i> | a | + | . | . | . | . | + | + | . | . | . | . | . |
| | b | 2.1 | . | . | . | . | . | . | . | . | . | . | . |
| | c | . | . | . | . | . | . | + | . | . | . | . | . |
| <i>Ulmus glabra</i> | a | . | . | . | . | . | . | . | 1.1 | . | . | + | . |
| | b | . | . | . | . | . | . | . | 1.1 | . | . | . | . |
| <i>Aesculus hippocastanum</i> | a | . | . | . | . | . | . | . | . | . | + | . | . |
| <i>Quercus rubra</i> | a | . | . | . | . | . | + | . | . | . | . | . | . |
| | b | + | . | . | . | . | . | . | . | . | . | . | . |
| Characteristic or differential species for: | | | | | | | | | | | | | |
| <i>Fagion</i> | | | | | | | | | | | | | |
| <i>Rubus hirtus</i> | b | 3.4 | . | 2.3 | 4.3 | 2.2 | 4.5 | 4.4 | . | 4.5 | 1.2 | 4.4 | . |
| <i>Viburnum opulus</i> | b | . | . | . | . | . | + | . | . | . | . | . | . |
| <i>Festuca altissima</i> | c | . | . | . | . | . | 3.4 | + | . | . | . | . | . |
| <i>Lunaria rediviva</i> | c | . | . | . | . | . | . | . | 1.1 | . | . | . | . |
| <i>Prenanthes purpurea</i> | c | . | + | 2.2 | + | + | . | 1.2 | 3.3 | 2.1 | . | + | . |
| <i>Luzulo-Fagenion</i> | | | | | | | | | | | | | |
| <i>Carex leporina</i> | c | . | . | . | . | + | . | . | . | . | . | . | . |
| <i>Deschampsia flexuosa</i> | c | 2.3 | 3.4 | 1.1 | 3.5 | 4.5 | 2.4 | . | + | 1.2 | 3.3 | . | 2.3 |
| <i>Gymnocarpium dryopteris</i> | c | . | 1.2 | . | + | . | . | . | . | . | . | . | . |
| <i>Luzula luzuloides</i> | c | . | . | 1.2 | 2.3 | . | . | . | . | . | . | . | . |
| <i>Senecio fuchsii</i> | c | . | 1.1 | + | + | + | + | 1.1 | 1.1 | . | . | 1.2 | . |
| <i>Dicranella heteromala</i> | d | . | 1.1 | . | . | 1.2 | . | . | . | 1.2 | . | . | 1.2 |
| <i>Hypnum cupressiforme</i> | d | . | + | . | . | . | . | . | . | 1.2 | . | . | 1.1 |
| <i>Carici-Fagetum</i> | | | | | | | | | | | | | |
| <i>Campanula persicifolia</i> | c | . | . | . | . | . | . | . | + | . | . | . | . |
| <i>Carpinion</i> | | | | | | | | | | | | | |
| <i>Dactylis aschersoniana</i> | c | 1.2 | . | . | . | . | 1.2 | . | . | . | . | . | . |
| <i>Melampyrum nemorosum</i> | c | . | . | + | . | . | . | + | . | . | 2.2 | . | . |
| <i>Vinca minor</i> | c | . | . | 1.2 | . | . | . | . | . | . | . | . | . |
| <i>Alno-Ulmion</i> | | | | | | | | | | | | | |
| <i>Frangula alnus</i> | b | 2.2 | . | . | . | 3.3 | . | . | . | . | . | . | . |
| <i>Agropyron caninum</i> | c | . | . | . | . | . | . | 2.1 | . | . | . | + | . |
| <i>Circaea lutetiana</i> | c | . | . | . | . | . | . | 1.1 | . | . | . | . | . |
| <i>Festuca gigantea</i> | c | . | . | . | . | . | . | . | . | . | . | 1.3 | . |
| <i>Lysimachia vulgaris</i> | c | . | . | . | . | . | . | . | . | . | . | + | . |
| <i>Rumex sanguineus</i> | c | . | . | . | . | . | 1.1 | . | . | . | . | . | . |
| <i>Stachys sylvatica</i> | c | . | . | . | . | 1.1 | . | 1.1 | . | . | . | 1.2 | . |
| <i>Fagetalia sylvaticae</i> | | | | | | | | | | | | | |
| <i>Daphne mezereum</i> | b | . | . | . | . | . | . | + | . | . | . | . | . |
| <i>Actaea spicata</i> | c | . | . | . | . | . | . | + | . | . | . | . | . |
| <i>Asarum europaeum</i> | c | . | . | . | . | . | . | + | . | . | . | . | . |
| <i>Carex sylvatica</i> | c | . | . | . | . | . | + | . | . | . | . | 1.1 | . |
| <i>Dryopteris filix-mas</i> | c | 1.1 | . | . | 2.1 | . | 1.1 | 1.1 | 3.4 | . | . | + | . |
| <i>Euphorbia dulcis</i> | c | . | . | . | . | . | . | + | . | . | . | . | . |

| No. of relevés | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|-----------------------------------|---|-----|-----|-----|-----|-----|-----|-----|-----|-----|----|-----|----|
| <i>Galeobdolon luteum</i> | c | . | . | . | . | . | . | . | 2.2 | . | . | . | . |
| <i>Galium odoratum</i> | c | . | . | . | . | . | . | 1.3 | . | . | . | . | . |
| <i>Impatiens noli-tangere</i> | c | . | . | . | . | . | 3.4 | 4.5 | . | . | . | . | . |
| <i>Lilium martagon</i> | c | . | . | . | . | . | + | . | . | . | . | . | . |
| <i>Lysimachia nemorum</i> | c | . | + | . | + | 1.2 | . | . | . | . | . | . | . |
| <i>Mercurialis perennis</i> | c | . | . | . | . | . | . | 1.2 | . | . | . | . | . |
| <i>Milium effusum</i> | c | . | . | . | . | + | 1.2 | 1.2 | . | . | . | . | . |
| <i>Paris quadrifolia</i> | c | . | . | . | . | . | . | + | . | . | . | . | . |
| <i>Scrophularia nodosa</i> | c | + | . | . | . | . | + | + | . | . | + | + | . |
| <i>Quercus-Fagetea</i> | | | | | | | | | | | | | |
| <i>Corylus avellana</i> | b | 1.1 | . | . | . | . | + | + | . | . | . | . | . |
| <i>Poa nemoralis</i> | c | 3.3 | . | 1.2 | 1.2 | . | 2.3 | 1.2 | . | . | . | . | . |
| <i>Luzulo-Quercetum</i> | | | | | | | | | | | | | |
| <i>Genista tinctoria</i> | c | . | . | . | . | . | + | . | . | . | . | + | . |
| <i>Rhamno-Prunetea</i> | | | | | | | | | | | | | |
| <i>Prunus spinosa</i> | b | . | . | . | . | . | . | . | . | . | . | + | . |
| <i>Rubus angustipaniculatus</i> | b | . | . | . | . | . | 1.1 | 1.1 | . | . | . | 1.1 | . |
| <i>Rubus constrictus</i> | b | . | . | . | . | . | . | 2.2 | . | . | . | . | . |
| <i>Rubus crispomarginatus</i> | b | . | . | . | . | . | . | 2.2 | . | . | . | . | . |
| <i>Rubus grabowskii</i> | b | . | . | . | . | . | . | + | . | . | . | . | . |
| <i>Rubus gracilis</i> | b | . | . | . | . | . | 1.1 | . | . | . | . | . | . |
| <i>Rubus koehleri</i> | b | 1.2 | . | . | + | . | . | . | . | . | . | 1.1 | . |
| <i>Rubus kuleszae</i> | b | . | . | . | . | . | . | 3.3 | . | . | . | . | . |
| <i>Rubus plicatus</i> | b | + | . | . | . | . | . | . | . | . | + | . | . |
| <i>Rubus radula</i> | b | . | . | . | . | . | 2.3 | . | . | . | . | . | . |
| <i>Alnetea glutinosae</i> | | | | | | | | | | | | | |
| <i>Calamagrostis canescens</i> | c | . | . | . | . | 3.3 | + | . | . | . | . | 3.4 | . |
| <i>Epilobietea angustifolii</i> | | | | | | | | | | | | | |
| <i>Calamagrostis epigejos</i> | c | . | . | . | . | . | . | . | . | . | . | 3.4 | . |
| <i>Chamaenerion angustifolium</i> | c | . | . | 2.2 | . | 1.1 | . | . | + | . | . | . | . |
| <i>Digitalis purpurea</i> | c | + | 2.1 | . | . | . | . | . | . | . | . | . | . |
| <i>Fragaria vesca</i> | c | . | . | . | . | . | . | . | + | . | . | . | . |
| <i>Sambuco-Salicion</i> | | | | | | | | | | | | | |
| <i>Rubus caesius</i> | c | . | . | . | . | . | . | 1.1 | . | . | . | . | . |
| <i>Rubus dollnensis</i> | b | . | . | . | . | . | 1.1 | + | . | . | . | . | . |
| <i>Rubus orthostachys</i> | b | . | . | . | . | . | 2.2 | 2.2 | . | . | . | 1.1 | . |
| <i>Sambucus nigra</i> | b | + | . | . | 1.1 | . | 1.1 | 3.3 | . | . | . | . | . |
| <i>Sambucus racemosa</i> | b | 2.1 | . | 1.1 | 2.2 | 1.1 | 1.1 | . | 1.1 | 1.2 | . | . | . |
| <i>Betulo-Adenostyletea</i> | | | | | | | | | | | | | |
| <i>Lonicera nigra</i> | b | . | . | . | . | . | . | . | . | + | . | . | . |
| <i>Polygonatum verticillatum</i> | c | 1.2 | . | . | . | . | . | . | . | . | . | . | . |
| <i>Vaccino-Abietenion</i> | | | | | | | | | | | | | |

| No. of relevés | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|-----------------------------|---|---|-----|---|---|-----|-----|-----|-----|---|-----|----|----|
| <i>Urtica dioica</i> | c | . | . | . | . | . | 1.1 | 1.1 | 1.1 | . | . | . | . |
| <i>Veronica officinalis</i> | c | . | . | + | . | . | . | . | . | . | . | . | . |
| <i>Dicranum scoparium</i> | d | . | . | . | . | 1.2 | . | . | . | . | 3.3 | . | . |
| <i>Dicranum scoparium</i> | d | . | 2.2 | . | . | . | . | . | . | . | . | . | . |
| <i>Hypnum cupressiforme</i> | d | . | . | . | . | . | . | . | . | . | 2.2 | . | . |
| <i>Mnium undulatum</i> | d | . | . | . | + | . | . | . | . | . | 3.3 | . | . |
| <i>Mnium undulatum</i> | d | . | . | . | . | . | 2.2 | . | . | . | . | . | . |
| <i>Pleurozium schreberi</i> | d | . | . | . | . | . | . | . | . | . | 4.4 | . | . |
| <i>Polytrichum commune</i> | d | . | 1.1 | . | . | . | . | . | . | . | . | . | . |
| <i>Polytrichum formosum</i> | d | . | . | . | . | . | . | . | . | . | 3.3 | . | . |

a – tree layer, b – skrub layer, c – herb layer, d – moss layer

vided in respect of floristic similarity into two major groups: related to deciduous forests communities of the class *Quercio-Fagetea* (Figs. 3A and 3B) and to coniferous forests of the class *Vaccinio-Piceetea* (Fig. 3C). Three communities belonging to the first group can be unambiguously classified as patches of acidophilic montane beech forest: plots 2, 8, and 12; plot 3 is also relatively close to this forest community. A separate subgroup is formed by communities in plots 6 and 7, which have the richest flora, including many *Rubus* spp. and a large contribution of *Quercus petraea*. They should probably be assigned to oak-hornbeam forest or mesotrophic types of beech forest. Other communities of the first group are anthropogenic substitutes, usually developed on sites of acidophilous beech forest or acidophilous oak forest. Within the second group, the community in plot 10 is the poorest (probably a site of pine forest). Plots 5, 9 and 11 are similar, but their herb layer contains some species typical of *Luzulo nemorosae-Fagetum*.

It can be concluded that in the Sudety Mts. fir is found most frequently in potential sites of acidophilic beech forest, whose vegetation is strongly transformed because of planting them with spruce trees. Sites of typical, mainly acidophilic beech forest take second place, while oak-hornbeam forest communities rank third (in respect of frequent occurrence).

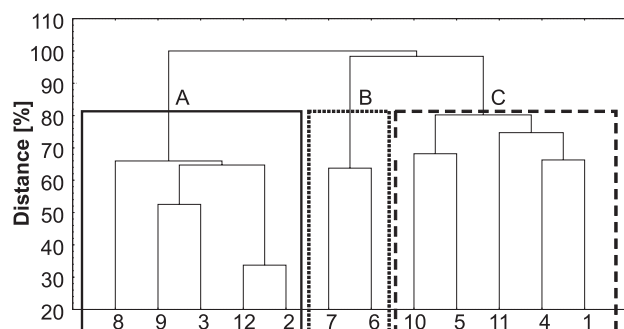


Fig. 3. Dendrogram illustrating floristic similarity of 12 chosen habitats of silver fir in Sudety Mts. based on species composition and abundance (according to Ward method). 1–12 – relevés location according table 2

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