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# Changes in the species composition and structure of the herb layer of a thermophilous oak forest subject to clear cutting

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Abstract

Changes in the herb layer of a thermophilous oak forest (*Potentillo albae-Quercetum*), subject to clear cutting and artificial reforestation with Scotch pine monoculture, were analysed by a comparative method. It was found that cutting of a tree stand and underbrush did not destroy phytocoenose totally. Floristically-rich clearance communities resembled in their composition and structure the ground layer of an natural form of an oak forest. The regress of the herb layer took place several years later in a young pine stand. Then, a compact tree canopy highly restricted light inflow to the bottom of a forest. Later, thinning of a forest stand enabled the herb layer to regenerate. Nevertheless, even 60 years after clear cutting it significantly differed from the herb layer of a natural oak forest.

*Key words*: *thermophilous oak forest, clear cutting, ground-layer changes*

## INTRODUCTION

The forest regeneration after cutting is usually considered as the process of secondary succession (Trojan 1978, Odum 1982). It is often compared to the regeneration of injured structures of a single organism. Thus, it is assumed to be relatively rapid, e.g. as it takes place under conditions of fully-formed, "ready" environment (Trojan 1978). The cutting of a tree stand is treated as the beginning of this process (Markowski 1982).

The forest management, associated with cuttings and reforestations, is presently thought to be the crucial form of anthropopressure on forest phytocoenoses (Olaczek 1972). The forest exploitation through clear cutting causes permanent simplification of their structure and pauperization of their species composition (Sokołowski 1972).

Olaczek (1974) has drawn up the scheme of the development of an oak-hornbeam forest after clear cutting and reforestation with Scotch pine monoculture. The papers of Markowski (1974, 1982) concern the thorough description of the course of secondary succession for the first eight years after cutting in some communities of decidous and pine forests. Halastra and Nowak (1983) have analysed the vegetation dynamics in clearance and young-stand communities on the oak-hornbeam habitat in the Niepołomice Primeval Forest.

This paper aims to demonstrate changes in the species composition and structure of the ground layer in the course of thermophilous oak forest succession after clear cutting and reforestation with pine.

## MATERIAL AND METHODS

The investigations were conducted in the large forest area, near Sulejów (Piotrków county), in Jaksonek Range, Opoczno Forest Inspectorate, where communities of thermophilous oak forest *Potentillo albae-Quercetum*, natural to various extent, prevail (Kurowski 1976). They are subject to intensive forest management with large-surface clear cuttings and reforestation. The latter lies in planting of Scotch pine, sometimes admixed with other species, in furrows. The cutting are usually done in 50-meters-wide stripes. Due to the vastness of oak-forest biochore a single cutting destroys only a small portion of it.

The studies were carried-out by a comparative method, the phytocoenoses at different stages of tree-stand development were compared. In field, series of relevés were recorded by Braun-Blanquet method, corresponding to so-called "degeneration series" (Olaczek 1974). Hence, they were recorded in close forest stands under the same habitat conditions and at the same time i.e.:

— in 80-120-years-old tree stands (oak and oak-pine), considered an mature (natural) form of a thermophilous oak forest;
— in young pine cultivations, two years after cutting;
— in 5-6-years-old pine cultivations;
— in 15-years-old pine young stands;
— in 60-years-old tree stands — pine monocultures.

The number of records representing successive stages of tree-stand development are similar (from 13 to 16 relevés).

To distinguish phytoceonose layers, the bottom limit of a tree layer (a) was established at 6 m, and that of underbrush (b) at 1 m.

The collected data were grouped in five phytosociological tables according to tree-stand age. Syntaxonomic position of species was determined, with a few exceptions, according to Matuszkiewicz (1981). The tables were applied to calculate synthetic characteristics of the analysed communities (average species number, group values of cover coefficients etc.). Because of large size of raw tables, only synthetic table with constancy and species cover coefficients was included in the paper. The data from relevés enabled to compute values of two indices of community structure — Shannon index of total diversity (Margalef 1968) and dominance index (Simpson 1949). The values of average per cent of cover were taken as importance values for single species, assuming that contribution of species to the herb layer in respect of their degree of abundance reflects, to a large extent, species contribution in respect of their biomass (Ralski 1930). Natural logarithms were applied in the calculations of total diversity index.

Plant nomenclature follows Flora Europaea (Tutin 1964–1980).

## RESULTS AND DISCUSSION

### CHANGES IN THE DENSITY OF LAYERS

Already in the second year after cutting the herb layer becomes distinctly more compact (Fig. 1). This results from an increase in light

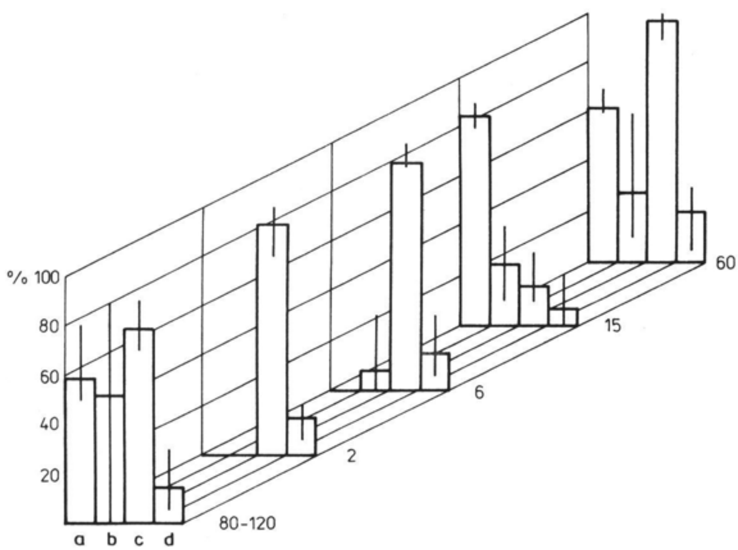


Fig. 1. Average layer density (variation range included) at successive stages of phytocoenose development; a — tree layer, b — underbrush (shrub layer), c — herb layer, d — moss layer

Table 1

Synthetic phytosociological comparison of investigated stages of thermophilus oak-farest (*Potentillo albae-Quercetum*) regeneration. S – constancy, P – cover coefficient. Species which were found in one phytosociological record are not included

| Tree stand age (years) Number of record | | 80-120 14 | | 2 16 | | 6 13 | | 15 13 | | 60 13 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | S | P | S | P | S | P | S | P | S | P |
| 1 | | 2 | | 3 | | 4 | | 5 | | 6 | |
| **Trees and shrubs:** | | | | | | | | | | | |
| *Pinus sylvestris* | a | V | 4036 | – | | – | | V | 6154 | V | 6750 |
| | b | III | 364 | – | | III | 842 | II | 92 | – | |
| | c | I | 14 | V | 888 | V | 1904 | – | | I | 15 |
| *Quercus petraea* + | a | IV | 2750 | – | | – | | V | 1981 | – | |
| *Q. robur* × *petraea* | b | IV | 1382 | – | | II | 23 | IV | 846 | V | 1381 |
| | c | V | 971 | V | 600 | V | 1673 | IV | 69 | V | 369 |
| *Betula pendula* | a | I | 71 | – | | – | | III | 461 | – | |
| | b | I | 143 | – | | II | 100 | I | 15 | II | 254 |
| | c | III | 107 | III | 169 | V | 877 | – | | II | 108 |
| *Populus tremula* | a | I | 71 | – | | – | | I | 154 | – | |
| | b | I | 71 | – | | I | 8 | II | 231 | III | 115 |
| | c | II | 354 | IV | 188 | V | 154 | III | 123 | III | 46 |
| *Picea abies* | a | I | 71 | – | | – | | – | | – | |
| | b | II | 157 | – | | – | | – | | – | |
| | c | II | 100 | – | | II | 108 | – | | – | |
| *Sorbus aucuparia* | a | – | | – | | – | | I | 77 | – | |
| | b | III | 314 | – | | I | 8 | II | 108 | IV | 500 |
| | c | V | 400 | IV | 231 | III | 46 | IV | 61 | III | 200 |
| *Larix decidua* | a | – | | – | | – | | V | 1365 | – | |
| | c | – | | I | 6 | II | 31 | – | | – | |
| *Corylus avellana* | b | V | 3446 | – | | II | 23 | IV | 923 | IV | 627 |
| | c | V | 1144 | V | 1146 | V | 1077 | IV | 269 | III | 323 |
| *Frangula alnus* | b | IV | 450 | – | | I | 15 | V | 1769 | V | 1469 |
| | c | V | 736 | V | 613 | V | 1162 | V | 723 | V | 508 |
| *Crataegus monogyna* | b | II | 164 | – | | – | | II | 31 | I | 15 |
| | c | IV | 143 | I | 19 | II | 23 | III | 46 | I | 15 |
| *Juniperus communis* | b | II | 21 | – | | – | | I | 85 | – | |
| | c | III | 186 | I | 19 | I | 8 | I | 15 | IV | 285 |
| *Euonymus verrucosus* | b | I | 79 | – | | – | | – | | – | |
| | c | III | 57 | I | 6 | I | 15 | I | 15 | – | |
| *Salix caprea* | b | I | 79 | – | | I | 77 | II | 308 | IV | 415 |
| | c | II | 93 | IV | 531 | V | 508 | II | 108 | III | 185 |
| *Pyrus communis* | b | I | 7 | – | | – | | I | 85 | I | 23 |
| | c | III | 57 | I | 13 | I | 15 | III | 54 | II | 31 |
| *Malus sylvestris* | b | – | | – | | – | | II | 92 | – | |
| | c | II | 36 | – | | I | 8 | II | 23 | I | 8 |
| *Carpinus betulus* | b | – | | – | | – | | I | 8 | I | 154 |
| | c | I | 71 | – | | I | 8 | I | 15 | I | 77 |
| *Salix cinerea* | b | – | | – | | – | | – | | I | 77 |

| 1 | | 2 | | 3 | | 4 | | 5 | | 6 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | c | I | 14 | II | 150 | III | 192 | I | 77 | I | 15 |
| *Fagus sylvatica* | b | – | | – | | – | | II | 100 | – | |
| | c | – | | I | 13 | IV | 62 | II | 92 | I | 77 |
| *Prunus spinosa* | b | – | | – | | – | | I | 8 | I | 161 |
| | c | – | | I | 6 | II | 23 | II | 169 | I | 85 |
| *Prunus padus* | b | – | | – | | – | | I | 85 | – | |
| | c | – | | – | | – | | II | 23 | – | |
| *Viburnum opulus* | c | II | 157 | – | | I | 15 | – | | I | 8 |
| *Ribes uva-crispa* | c | – | | – | | – | | I | 8 | I | 15 |
| **Herbs and mosses:** | | | | | | | | | | | |
| *Potentillo albae-Quercetum* | | | | | | | | | | | |
| *Ranunculus polyanthemos* | | II | 86 | I | 13 | II | 23 | – | | II | 23 |
| *Quercetalia pubescentis* | | | | | | | | | | | |
| *Campanula persicifolia* | | V | 300 | II | 206 | II | 38 | II | 23 | I | 8 |
| *Digitalis grandiflora* | | IV | 200 | IV | 238 | IV | 415 | – | | IV | 200 |
| *Trifolium alpestre* | | II | 29 | I | 13 | I | 8 | – | | I | 8 |
| *Melittis melissophyllum* | | II | 29 | I | 6 | – | | I | 15 | I | 8 |
| *Hypericum montanum* | | I | 14 | III | 113 | II | 31 | – | | – | |
| *Primula veris* | | I | 7 | – | | I | 8 | – | | – | |
| *Querco-Fagetea* | | | | | | | | | | | |
| *Anemone nemorosa* | | V | 1150 | V | 838 | V | 515 | II | 38 | IV | 492 |
| *Melica nutans* | | V | 1150 | IV | 363 | II | 23 | V | 592 | IV | 492 |
| *Galium schultesii* | | V | 864 | III | 631 | IV | 569 | III | 400 | V | 854 |
| *Hepatica nobilis* | | III | 379 | I | 19 | – | | II | 38 | – | |
| *Phyteuma spicatum* | | III | 43 | – | | – | | I | 8 | – | |
| *Viola reichenbachiana* | | II | 157 | – | | – | | – | | – | |
| *Astrantia major* | | II | 157 | – | | – | | – | | – | |
| *Atrichum undulatum* | | II | 100 | V | 1625 | II | 308 | III | 408 | I | 15 |
| *Sanicula europaea* | | II | 93 | – | | – | | – | | – | |
| *Epilobium montanum* | | II | 86 | I | 19 | – | | – | | II | 23 |
| *Milium effusum* | | II | 36 | I | 125 | – | | I | 8 | II | 161 |
| *Scrophularia nodosa* | | I | 79 | I | 19 | I | 15 | – | | – | |
| *Dryopteris filix-mas* | | I | 7 | – | | I | 8 | I | 8 | II | 23 |
| *Vaccinio-Piceetea* | | | | | | | | | | | |
| *Vaccinium myrtillus* | | V | 1696 | V | 769 | V | 646 | V | 1169 | IV | 692 |
| *Trientalis europaea* | | V | 1079 | V | 1125 | V | 1085 | V | 300 | IV | 631 |
| *Pleurozium schreberi* | | III | 729 | I | 6 | II | 246 | II | 108 | III | 331 |
| *Melampyrum pratense* | | III | 507 | III | 444 | I | 8 | – | | – | |
| *Vaccinium vitis-idaea* | | III | 179 | I | 69 | II | 100 | III | 115 | I | 8 |
| *Orthilia secunda* | | III | 107 | – | | – | | – | | – | |
| *Lembotropis nigricans* | | II | 100 | II | 31 | III | 192 | – | | I | 15 |
| *Pyrola minor* | | II | 93 | – | | – | | – | | – | |
| *Pseudoscleropodium purum* | | I | 143 | I | 6 | I | 154 | I | 15 | V | 646 |
| *Hylocomium splendens* | | I | 71 | I | 63 | – | | I | 8 | – | |
| *Solidago virgaurea* | | I | 14 | I | 6 | – | | I | 15 | – | |
| *Trifolio-Geranietea* | | | | | | | | | | | |
| *Clinopodium vulgare* | | IV | 464 | III | 406 | IV | 492 | – | | V | 1031 |
| *Astragalus glycyphyllos* | | III | 243 | II | 263 | II | 385 | I | 15 | IV | 708 |
| *Polygonatum odoratum* | | II | 29 | – | | I | 77 | – | | II | 161 |

| 1 | 2 | | 3 | | 4 | | 5 | | 6 | |
|---|---|---|---|---|---|---|---|---|---|---|
| *Silene nutans* | I | 14 | I | 13 | – | | – | | I | 8 |
| *Coronilla varia* | I | 7 | II | 25 | I | 162 | – | | – | |
| *Anthericum ramosum* | I | 7 | – | | – | | I | 8 | I | 8 |
| *Molinio-Arrhenatheretea* | | | | | | | | | | |
| *Poa pratensis* | IV | 579 | V | 1647 | V | 1673 | – | | III | 408 |
| *Lysimachia vulgaris* | III | 507 | III | 694 | II | 238 | – | | V | 861 |
| *Selinum carvifolia* | III | 171 | I | 6 | I | 8 | I | 23 | II | 46 |
| *Trifolium repens* | II | 29 | IV | 406 | I | 15 | – | | – | |
| *Ranunculus acris* | II | 29 | I | 6 | II | 92 | – | | I | 15 |
| *Cerastium fontanum* | I | 14 | I | 19 | II | 31 | – | | III | 123 |
| *Leontodon hispidus* | I | 14 | – | | I | 8 | – | | – | |
| *Achillea millefolium* | I | 7 | II | 144 | III | 331 | – | | II | 31 |
| *Deschampsia cespitosa* | I | 7 | I | 138 | I | 8 | – | | II | 23 |
| *Leontodon autumnalis* | I | 7 | I | 6 | – | | – | | – | |
| *Taraxacum officinale* | I | 7 | I | 6 | – | | – | | – | |
| *Campanula patula* | I | 7 | – | | I | 15 | – | | I | 8 |
| *Stachys officinalis* | I | 7 | – | | I | 8 | – | | I | 8 |
| *Angelica sylvestris* | I | 7 | – | | I | 8 | – | | I | 8 |
| *Juncus effusus* | – | | V | 256 | IV | 933 | – | | II | 23 |
| *Trifolium dubium* | – | | II | 150 | I | 15 | – | | – | |
| *Knautia arvensis* | – | | I | 19 | II | 92 | I | 8 | I | 15 |
| *Galium boreale* | – | | – | | I | 77 | – | | I | 8 |
| *Nardo-Callunetea* | | | | | | | | | | |
| *Hypericum maculatum* | IV | 193 | IV | 575 | IV | 500 | II | 31 | V | 646 |
| *Potentilla erecta* | III | 121 | IV | 406 | III | 185 | II | 23 | V | 446 |
| *Carex pilulifera* | II | 93 | IV | 569 | III | 115 | – | | – | |
| *Lycopodium clavatum* | II | 29 | – | | – | | – | | – | |
| *Luzula multiflora* | II | 21 | V | 538 | V | 369 | – | | I | 8 |
| *Hieracium pilosella* | I | 79 | II | 194 | II | 185 | – | | – | |
| *Calluna vulgaris* | – | | – | | III | 192 | – | | – | |
| *Sedo-Scleranthetea* | | | | | | | | | | |
| *Festuca ovina* | III | 500 | I | 6 | IV | 854 | II | 31 | II | 23 |
| *Rumex acetosella* | II | 100 | V | 1019 | V | 708 | – | | III | 477 |
| *Sedum telephium* subsp. *maximum* | I | 7 | I | 6 | – | | – | | I | 8 |
| *Polytrichum piliferum* | – | | I | 131 | I | 85 | – | | – | |
| *Jasione montana* | – | | I | 6 | I | 15 | – | | – | |
| *Epilobietea augustifolii* | | | | | | | | | | |
| *Fragaria vesca* | V | 1293 | V | 1313 | V | 1385 | III | 261 | V | 1315 |
| *Rubus idaeus* | III | 300 | III | 219 | II | 381 | I | 15 | IV | 1361 |
| *Epilobium angustifolium* | I | 150 | II | 144 | II | 238 | – | | IV | 346 |
| *Omalotheca sylvaticum* | – | | V | 550 | V | 377 | – | | – | |
| *Senecio sylvaticus* | – | | IV | 531 | I | 8 | – | | – | |
| *Calamagrostis epigejos* | – | | I | 125 | II | 169 | – | | II | 177 |

**Accompanying species** (the list comprises species with at least the third degree of constancy in one regeneration stage; the stages of regeneration in which the following species occur are given in brackets);

(80-120, 2, 6, 15, 60) — *Agrostis cappilaris, Ajuga reptans, Carex pallescens, Convallaria majalis, Cruciata glabra, Hieracium murorum, H. vulgatum, Holcus mollis, Luzula pilosa, Maianthemum bifolium, Moehringia trinervia, Oxalis acetosella, Plagiomnium* flow and advanced humus decomposition, followed by soil enrichment in water and mineral substances. Then, not only herbs, but also numerous trees and shrubs develop as suckers and natural or planted seedlings (Table 1). In ten years the development of planted pine results in a young stand with compact canopy. This profoundly alters the conditions of life and development of herb-layer species. Besides overshading of the forest bottom, also constant, high needle fall is a significant limiting factor. It forms on the soil surface thick layer of acid litter that negatively affects soil structure and climate, as well as causes crucial changes in its chemistry (acidification, pauperization in nutrients) (Obmiński 1978). Management (first stage and other early thinnings) and natural selection processes thin tree stand for the next tens of years, hence re-increase light inflow to the ground layer. In 60-years-old pine stands underbrush is still poorly developed, thus light conditions of the herb layer are more favourable compared to those in the natural form of the phytocoenose, where average undergrowth density amounts to 50%.

## DIVERSITY ANALYSIS

Changes in the layer density are associated with differentiation in the average number of tree, shrub, herb and moss species in single record (Table 2). In a young stand a total species number is remarkably smaller than in an mature community, the decrease concerns exclusively herbaceous species, whereas the number of mosses, as well as trees and shrubs in a record is even larger than at other stages of the phytocoenose development. In 60-years-old tree stand a smaller average species number than in a mature oak forest, where herb layer density is lower, is associated with the dominance of some abundant species like *Pteridiüm aquilinum* and species from the genus *Rubus* (cover coefficients 2661 and 5481, respectively). It is highly significant that the largest average species number in a record was found for two-years-old cultivations, thus in the community that initiates regeneration process. The reason for such floristic richness lies in, both, the presence of numerous oak-forest species that survive cutting and encroachment of clearing species into cultivation.

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*affine*. *Pteridium aquilinum*. *Rubus* sp., *Veronica chamaedrys*. *V. offićinalis*. *Viola riviniana*; (80-120, 2, 6, 15) — *Dicranella heteromala*. *Polytrichum commune*; (80-120, 2, 6, 60) — *Anthoxanthum odoratum*. *Calamagrostis arundinacea*. *Festuca rubra*. *Galium mollugo*. *Genista tinctoria*. *Hypericum perforatum*. *Mycelis muralis*. *Stellaria graminea*; (80-120, 2, 15, 60) — *Dryopteris carthusiana*. *Galeopsis bifida*. *Polytrichum formosum*. *Brachythecium curtum*; (80-120, 2, 6) — *Genista germanica*; (80-120, 15, 60) — *Rubus saxatilis*; (2, 6, 15) — *Ceratodon purpureus*; (2, 6) — *Carex ovalis*; (15, 60) — *Carex hirta*; (2) — *Hypericum humifusum*.

The value of total diversity index changes similarly to species number in a record (Fig. 2). In clearing community the species diversity is higher than in mature oak forest, then its value rapidly declines (rapid development of planted pine) to the minimum in a compact young stand. Next, the value of diversity index increases again. However, even in 60-years-old

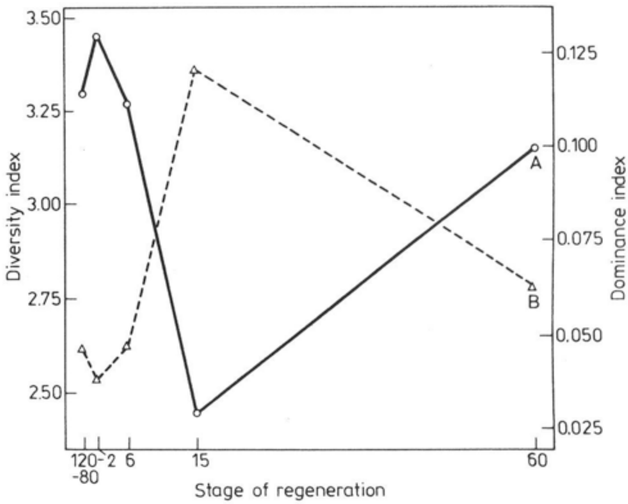


Fig. 2. Shannon index of total diversity (A) and dominance index (B) at analysed stages of oak-forest succession

tree stand its value is lower than that characteristic of natural oak forest.

Changes in dominance index are nearly symmetric (Fig. 2). Its minimum characterizes 2-years-old cultivation, maximum — 15-years-old young stand.

The obtained results indicate that for plants of the ground layer not

Table 2

Mean number of species in record

| Stage of regeneration | Trees and shrubs | Herbs | Mosses | All species |
|---|---|---|---|---|
| 80–120 | 10.3 ±0.66 | 42.6 ±4.27 | 3.8 ±0.85 | 56.7 |
| 2 | 8.1 ±0.57 | 45.5 ±2.89 | 4.2 ±0.79 | 57.8 |
| 6 | 10.0 ±1.04 | 40.0 ±3.84 | 2.8 ±0.54 | 52.8 |
| 15 | 10.6 ±0.87 | 17.8 ±2.13 | 4.8 ±1.04 | 33.2 |
| 60 | 9.0 ±1.04 | 37.1 ±1.67 | 3.2 ±0.59 | 49.3 |

cutting itself but conditions in a compact young stand afterwards are an "ecological disaster" (Aleksandrova 1964). This phenomenon seems to be a rule when cuttings in the deciduous-forest habitat are followed by reforestation with pine at dense pattern of seedlings (Olaczek 1974).

## CHANGES IN FLORA

Among 138 species* of the ground layer recorded at analysed stages of the phytocoenose development, 115 species grow in a natural oak-forest form, 110 — in 2-years-old cultivations, only 61 — in a young stand and 87 — in pine monoculture. The group of 36 species are present at all regeneration stages. Six species, such as *Astrantia major*, *Sanicula europaea*, *Lycopodium clavatum*, are found only in a mature oak forest (Table 1).

The number of species common to a natural oak forest and 60-years-old pine stand reflects the degree of ground-layer regeneration. However, only 79 such species are recorded, less than for an oak forest and 2- or 6-years-old cultivations (90 and 85, respectively). The least of common species are present in a young stand (56) which means that less than a half of natural species composition can survive under the conditions prevailing there.

The occurrence of new species following cutting seems interesting. As many as 19 are found in 2-years-old cultivations. Most are present in older, 6-years-old cultivations, but almost completely die in a young stand. Those species, like *Omalotheca sylvaticum*, *Senecio sylvaticus*, *Carex ovalis*, *Hypericum humifusum*, are called "clearing weeds".

## GROUP REACTION OF SPECIES

Heterogeneous nature of a thermophilous oak forest is its natural characteristics (Olaczek 1972). It is composed of species from syntaxonomic groups differing in respect of their habitat requirements (Table 1).

The obtained results indicate that the reactions of single species groups to changing conditions in the course of oak-forest development after cutting are diversified. They are represented e.g. by changes in the number of species in a group and group value of coefficient of cover (Figs. 3 and 4). Species from the classes *Querco-Fagetea* and *Vaccinio-Piceetea*, as well as partly from the order *Quercetalia pubescentis* retreat after cutting and later, in the course of regeneration, do not regain their earlier importance. The conditions in a young stand considerably dateriorate also for other species groups, compared to those in a mature oak forest. In cultivations and in 60-years-old pine stand species from the classes *Molinio-Arrhenatheretea* and *Epilobietea angustifolii* increases the former probably due to favourable light conditions, the latter — to increase in nitrogen content in soil. Species from the classes *Sedo-Scleranthetea* and *Nardo-Callunetea* are most fully represented in cultivations. In 60-years-old

* Species found only in one phytosociological record were not included in the analysis.

pine stand species from the class *Trifolio-Geranietea* are numerous and abundant, whereas in cultivations their number is reduced, but at the same group value of coefficient of cover as in a natural phytocoenose.

* * *

The general scheme of the development of thermophilous oak forest subject to cutting and pine introducing corresponds to the model of oak-hornbeam forest succession after reforestation with pine, presented by Olaczek (1974).

1. The cutting results in full destruction of tree stand and underbrush, as well as in slight changes in the structure and species composition

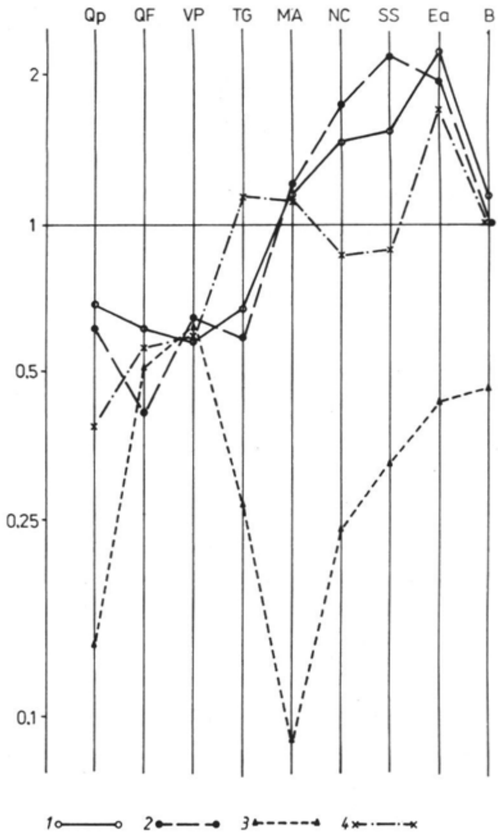


Fig. 3. Quotient deviations of the average number of species of group in a record in relation to a natural community (horizontal line). 1 — 2-years-old cultivations, 2 — 6-years-old cultivations, 3 — 15-years-old young stands, 4 — 60-years-old pine stands. Qp — *Quercetalia pubescentis*, QF — *Querco-Fagetea*, VP — *Vaccinio-Piceetea*, TG — *Trifolio-Geranietea*, MA — *Molinio-Arrhenatheretea*, NC — *Nardo-Callunetea*, SS — *Sedo-Scleranthetea*, Ea — *Epilobietea angustifolii*, B — accompanying species

of the herb layer. In the first years after cutting the herb layer is highly compact, species-diversified and floristically-rich. Some species groups typical of a natural phytocoenose are slightly reduced, other flourish.

2. The degradation of the ground layer is associated with the development of planted pine (from 6th-7th year) and attains its maximum in a young

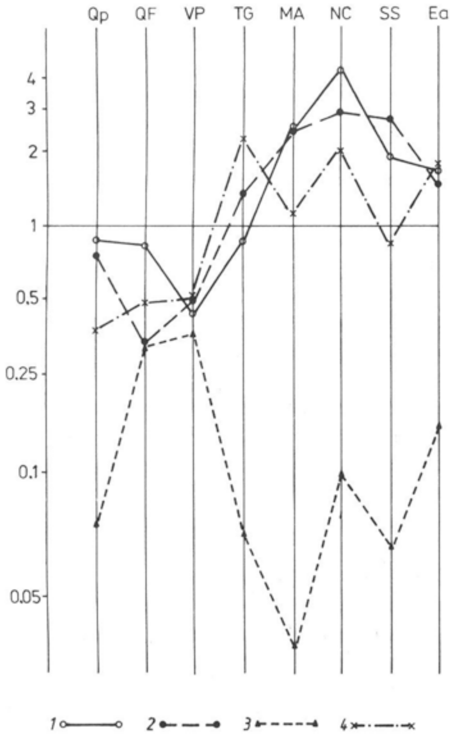


Fig. 4. Quotient deviations of group values of cover coefficients in relation to a natural community. Explanations see Fig. 3

stand with compact canopy (10–20 years). Then, the density of the herb layer decreases, species number or their abundance declines (it concerns all syntaxonomic groups typical of a mature oak-forest), while dominance index rapidly increases.

3. The thinning of a tree stand after young-stand development enables the herb layer to regenerate slowly. However, the community 60 years after cutting, with Scotch pine dominance in a tree stand, differs in many respects from a natural community, such as species composition, density of layers, diversity index, dominant species. Hence, it may be inferred that even after 100–200 years of regeneration it will still differ from precedant thermophilous oak forest.

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## *Zmiany składu gatunkowego i struktury runa dąbrowy świetlistej po zrębie zupełnym*

### Streszczenie

Analizowano metodą porównawczą zmiany runa dąbrowy świetlistej (*Potentillo albae-Quercetum*) po zrębie zupełnym i sztucznym odnowieniu monokulturą sosny. Stwierdzono, iż wycięcie drzewostanu i podszytu nie niszczy w zupełności fitocenozy. Bogate florystycznie zbiorowiska porębowe w swoim składzie i strukturze są podobne do runa wyjściowej postaci

dąbrowy. Regresja warstwy zielonej następuje kilkanaście lat później — w młodniku sosnowym. Skutkiem zwarcia koron drzew następuje tu drastyczne ograniczenie dopływu światła do dna lasu. Późniejsze rozrzedzenie drzewostanu umożliwia regenerację runa, które jeszcze w 60 lat po zrębie jest istotnie odmienne of runa naturalnej postaci dąbrowy.