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SYNANTHROPIZATION OF PHYTOCOENOSES

ABSTRACT

In recent times synanthropization is one of the main ecosystem-forming processes, thus no phytocoenosis can be adequately described without regard to human influences. Phytosociologists have classified anthropogenic plant communities and included them to the existing system of classification according to their structure and species composition, in which the degree of their synanthropization is reflected. Such problems are discussed as the formation, succession, degeneration and classification of phytocoenoses subject to human impact.

INTRODUCTION

The terms "synanthropization" and "anthropopressure" are commonly used in central-European phytosociology and phytogeography but not in the Anglo-Saxon literature. They denote a certain direction in the vegetation study. At first only cropland and settlements were the subject of this study, but then also other areas and all ecological systems have been included. Independent of our views on the role of man in the biosphere, it is not possible to study nature without regard to human influences. The human populations consists of more than four milliard people or over 200 million ton of biomass dispersed around the globe. Even if they trotted the earth with bare feet and picked plants with naked hands, they would produce deep changes in the vegetation. All these changes together with their mechanisms are called synanthropization.

SYNANTHROPIZATION AS A RESEARCH PROBLEM IN PHYTOSOCIOLOGY

The interest in the effect of man on plant communities appeared almost at the beginning of the development of phytosociology and was stimulated by several factors. On the one hand, by the character of plant cover in Europe, largely disturbed by man for a long time, with a mosaic of landscapes including crop fields, forests, meadows, and settlements. On the other hand, this interest was stimulated by the results of geographical and historical investigations of European floras, summed up in Thellung's theory [40, 41]. Phytosociology based the classification of plant communities on floristic characteristics, and due to this it considered the human effects earlier and deeper than other schools of vegetation science. The studies on natural alpine and forest plant communities were followed by the studies on weed communities and then on ruderal communities.

Already the first reviews of plant communities in different countries included natural and anthropogenic phytocoenoses into the same system [e.g. 19, 21, 43]. Sukopp [38] and Faliński [7] give a comprehensive review, including a rich bibliography, of the problems resulting from the effects of man on plant cover. In Poland the interest in synanthropic vegetation was stimulated by Kornaś [13—16] and Faliński [1—4, 7], and in particular by the following symposia on the synanthropization of plant cover, initiated by Faliński:

— Neophytism and apophytism of plant cover in Poland (1968),
— Synanthropic flora and vegetation of urban areas in relation to environmental conditions, history and function (1970),
— Theoretical principles and methods of the study on synanthropization of plant cover (1971),
— Synanthropization of plant cover in national parks and nature reserves (1971),
— Degeneration of phytocoenoses subject to natural and anthropogenic factors (1974),
— Extinction of plant species and its causes in Poland (1976),
— Synanthropization of plant cover on the Baltic coast (1978),
— Synanthropization of plant cover in river valleys (1980).

The proceedings of the first two symposia are in „Materiały Zakładu Fitosocjologii Stosowanej UW", and those of the other symposia are to be found in "Phytocoenosis".

Phytosociology is mostly concerned with the synanthropization acting on the level of plant communities and vegetation, although human activity also influences populations, ecosystems, and the whole environment. Thus, it is concentrated upon typological and syntaxonomic problems and not on the dynamics and function of ecological systems. For these and also other reasons the terminology and the ecological theory of synanthropization are not complete yet.

COMPLEXITY OF ANTHROPOPRESSURE AND DIVERSITY OF ITS EFFECTS

Synanthropization is a result of anthropopressure, which is a very complex factor including all direct and indirect, conscious and involuntary human effects on plant cover [27, 28]. Sukopp [37] points to the intensity, persistency, and spatial range of human pressure as factors responsible for the direction of its effects on plant cover. Faliński [7] distinguished factors of synanthropization and forms of man activities. He classified the latter into zoogenic, zoo-anthropogenic, and hyperanthropogenic. Olaczek [27] considered the forms of anthropopressure as the causes of definite patterns of changes in forest phytocoenoses, and he related them to historical stages of tool development; each historical period was characterized by specific forms of anthropopressure or "wave of anthropopressure".

The forms of human action are largely diversified and variable in time, and ecological systems may respond in different ways to the same type of pressure. As a result of anthropopressure some properties of a system can disappear, other may be modified, and new characters may evolve. The system may be either simplified or the degree of its complexity may increase. Therefore, the effects of synanthropization common to all or to many ecological systems can be described only in very general terms. According to Faliński [7] the effects of synanthropization can be classified as follows:

— eurytopization — the replacement of stenotopic components by eurytopic ones,
— cosmopolitization — the replacement of endemic components by cosmopolitan ones,
— allochtonization — the replacement of native components by alien components,
— differentiation and complication — the replacement of simple systems by more complex, the genetics, dynamics, history and geography of which are not homogeneous.

In fact, each ecological system responds in a different way to anthropogenie pressure. For instance, dry pine forests (*Cladonio-Pinetum*) are not susceptible to the lowering of water-table but they are very susceptible to air pollution. The opposite is true for woods on flood river terraces. Particularly important is the fact that the effects of synanthropization easily pass from one level of organization to another. Changes in the flora are followed by changes in phytocoenoses which in turn are followed by changes in the whole vegetation landscape (Fig. 1). Synanthropization of phytocoenoses, e.g. changes in weed communities after the application of new agricultural treatments, drainage of peat-bogs and wet meadows, fertilization, etc., promote changes in the flora of vast areas: some species of archaeophytes, as well as oligotrophic and hygrophilous species can disappear [12, 15, 16, 30].

SYNANTHROPIZATION AND THE LEVEL OF ORGANIZATION OF ECOLOGICAL SYSTEMS

Faliński [7] points out that there are differences in synanthropization processes among different levels of the organization of plant cover. Simpli-

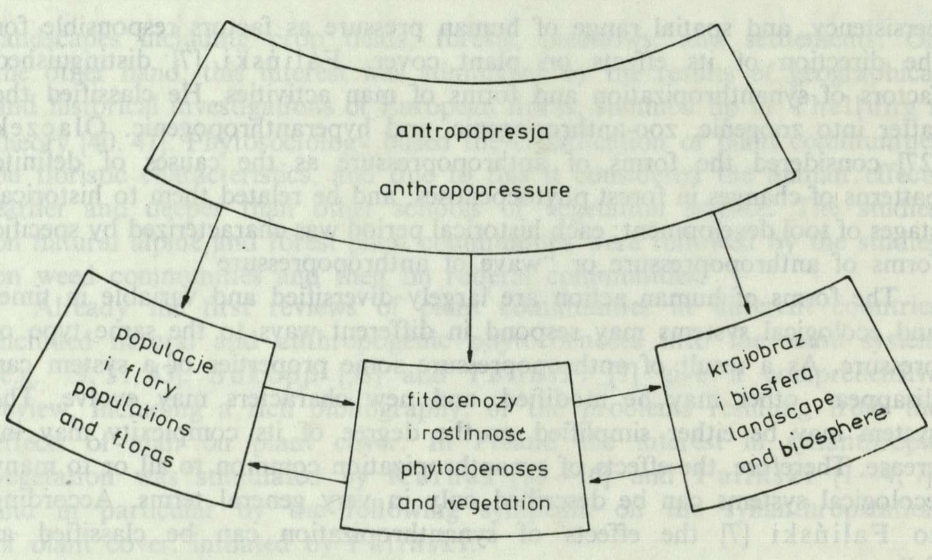

Fig. 1. Relationships between ecological systems subject to anthropopressure.

fying this problem, we can say that differences in the effects of synanthropization at various organization levels follow the pattern disappearance-modification-appearance of new characters.

In plant populations selective action of anthropopressure eliminates some phenotypes and enhances others. This may be followed by changes in the genetic structure of a population. Some genes may be eliminated and local populations may die out. Breaking of geographical and ecological barriers and introduction of mutagenic factors results in the development of populations showing new characters, having impoverished or enriched gene pools.

The most evident effects of plant synanthropization occur at the floristic level. They include the extinction of some species, changes in geographical ranges, colonization of new habitats (apophyta), and occurrence of alien species (anthropophyta).

At the level of phytocoenosis such processes can be observed as the shrinking of ranges and disappearance of native plant communities, their degeneration, and the development of new, synanthropic phytocoenoses. At the level of vegetation in response to synanthropization some plant communities disappear, abiotic zones are formed, new communities are developed, and the area occupied by synanthropic communities increases with the growing dęgree of synanthropization.

Synathropization at the level of the whole landscape brings about disappearance of natural physiocoenoses, disturbances in their functioning, and development of new physiocoenoses, e.g. in urban areas.

There are no systems undergoing synanthropization in isolation. Even if the human impact is directed towards a particular system, it also affects other systems; it spreads in space like echo reflected many times (Fig. 1). For instance, the deforestation of an area is not limited to changes in the type of vegetation landscape. It also produces changes at the population and floristic levels, enhancing photophilous herbs and, on the other hand, it has an effect on inner-water ecosystems. The network of roads and railways opened new ways for migration of many steppe and desert plants, while sea transport accounted for bringing American plants to Europe, which sometimes was followed by deep genetical changes in easily intercrossing species.

This total character of synanthropization and its common occurrence are reasons for searching for general measures of its results [11], and sometimes they obliterate differences in synanthropization effects on various biological systems such as flora and vegetation, population, phytocoenosis, etc. We are not sure whether or not the mechanisms of this process are identical at all levels and for all types of ecological systems.

PHYTOCOENOSIS AS AN OBJECT OF SYNANTHROPIZATION

Synanthropization of phytocoenoses is a part of synanthropization of the whole ecological systems. This process is usually considered together with synanthropization of the vegetation, thus it will be useful to indicate differences between these two concepts.

Synanthropization of phytocoenoses is the process of the decomposition of plant communities and the development of new communities, better adapted to environmental conditions and human pressure. These new communities consist of local and alien components, frequently coming from very different natural communities. Their structure, species composition, phenology, etc. depend on both habitat conditions and anthropopressure. A change in any feature of the habitat, or in the form of plant utilization, gives rise to further changes in the phytocoenosis towards its adaptation to a new situation. When environmental conditions are stable over long periods of time, anthropogenic phytocoenoses behave like stable, balanced systems [14].

Phytocoenoses that have been formed and maintained due to human actions are called anthropogenic phytocoenoses, and only some of them belong to synanthropic phytocoenoses. Most anthropogenic phytocoenoses consist of the same plant species that occur in natural phytocoenoses, but these species form new combinations. These new combinations are due to the fact that anthropopressure disturbs interactions within ecosystems, in particular competitive interactions, and this reveals the real (physiological) limits of plant tolerance, as well as enable plants to enter into new interactions.

Frequently anthropopressure destroys selectively some components of the phytocoenosis, e.g. tree layer in clear-cut forest or some weeds in agrocoenoses treated with herbicides. These treatments create favourable conditions for the development of other components of the phytocoenosis. Human pressure has also a limiting effect which may be as strong as competition in natural phytocoenoses [14].

In general, synanthropization of phytocoenoses involves ecological processes occurring within a phytocoenosis, and induced as a result of either direct human action on plants or indirect action through their habitats. The measure of synanthropization is the proportion of species with various degrees of synanthropization or belonging to different syntaxonomic units.

Synanthropization of the vegetation concerns changes on the scale of the whole landscape, and it includes such processes as changes in ranges of different types of phytocoenoses, replacement of natural plant communities by anthropogenic ones, or the replacement of the communities less dependent on man by more dependent. The measure of this process is the proportion of anthropogenic communities in the plant cover of a given area.

Phytosociology is interested in synanthropization mostly from the point of view of syntaxonomy and typology of phytocoenoses, their origin, and environmental effects. The similarity of plant communities can be established either on the basis of their characters depending on the way of their utilization by man, or on the basis of the characters related to habitat conditions. A natural plant community can be transformed into many communities differing in their structure and species composition, according to the way of its utilization, even if habitat conditions remain unchanged. Such transformed communities are called secondary communities, and together with the natural climax community they are called the dynamic range of plant communities. In Poland secondary communities developed on the site of oak-hornbeam forests include monocultural woods (e.g. spruce or poplar woods), wet meadows, xerothermic grasslands, blackthorn thickets, weed communities in crop fields, ruderal communities in urban areas, etc. All secondary communities developed on the same habitat are called homologous communities. Secondary communities that resemble each other because of a similar type of their utilization, e.g. meadows on the sites of such communities as oak-hornbeam forests, riverine forests, and oak-pine humid forests, are called analogous communities [20]. The recognition of analogous and homologous communities is of great practical importance. For example, the vegetation mapping is possible only when the effects of human action and the following synanthropization processes are well known.

SYNANTHROPIZATION AS A HISTORICAL PROCESS

It may be discussed whether or not synanthropization differ from other ecological processes and whether or not human effects are of specific character as compared with natural effects. But a more important problem is the common occurrence and the force of anthropopressure, and also our anxiety resulting from the fact that we do not know with which organisms and ecological systems we will coexist, and which one we will use or control. In recent times we pay much attention to synanthropization but it does not mean that this process has appeared right now. Our interest firstly results from the fact that synanthropization has been largely intensified recently as a result of rapid changes in the technology of agriculture, transport, engineering, and so on. Synanthropization represents a new stage in the evolutionary development of the living world, and due to its range and power it also influences the relation of man to nature. This cultural aspect of synanthropization is reflected in the differentiation of views on the role of man in nature. They range from an uncritical fascination by the submission of the wilderness and a metaphysical belief that man can do everything to the negation of the value of civilization progress.

From the Neolithic Age the human oecumene (cropland and settlements) have been enlarging at the expense of the suboecumene (woodland). Agricultural treatments used in the past affected ancient natural phytocoenoses not less than many contemporary actions. But the human action has never been so powerful and widespread as nowadays. Now not only the utilization of phytocoenoses is involved but also new habitats are formed, not known in nature so far. The vegetation is rapidly exploited and totally destroyed, genetical and geographical changes are produced. This new, hyperanthropogenic pressure [7] not only destroys natural systems and produces anthropogenic ones but also changes the trends of succession or initiates new succession series. Kostrowicki [18, pp. 173—174] aptly noticed that there are two kinds of nature: "... both the natural and the anthropogenic systems are equally logical. They are, however, independent of each other in time and space, forming in fact two kinds of nature. The first, natural, conforms to the laws of nature, is authentic in relation to environmental conditions, and almost without history. Its time is measured in geological time units. The second kind of nature is subject to both the natural and the human laws. It is not authentic in relation to environmental conditions, and has history because its structure reflects the state of technical and organizational development of human societies ...".

More and more frequently the synanthropization of phytocoenoses is an irreversible process. It also gives rise to the development of new combinations of native and alien plant species, formerly not interacting with each other. In wet meadows (*Molinietum coeruleae*), for example, there are plants associated with alder-wood (e.g. *Caltha palustris, Galium palustre*), shady and fertile alder-ash carrs (e.g. *Geum rivale, Deschampsia caespitosa*), moist oak-pine forest (e.g. *Molinia coerulea, Iris sibirica*), light mesotrophic oak forests (e.g. *Serratula tinctoria. Galium boreale. Trollius europaeus*), and also plants characteristic of low moors and margins of water bodies.

All these are native plants and they continue to occur in their primary natural communities as well. Sometimes they move from meadows as apophytes into largely transformed phytocoenoses such as weed or ruderal communities. In the latter communities native plants interact with alien plants of Asiatic or American origin, archaeophytes with kenophytes.

The forms of anthropopressure vary rapidly and without any pattern, thus phytocoenoses developed in response to this pressure become variable and temporary. In Central Europe weed communities under conditions of regular crop rotation and organic fertilization developed for several hundred years. This was also the case of meadows and pastures. During last 200 years they have been subject to new, heavy impact such as drainage, isolation of meadows from river floods, impoverishment of the gene pool of crop plants, pollution with chemicals, application of herbicides, and so on.

Anthropopressure affects simultaneously many components of an ecosystem, including soil, primary producers, consumers, and decomposers (Fig. 2). It has a selective effect on the species composition of plant communities and on the gene pools of particular plant populations. By damaging the interactions established among plants it makes way to the species usually developed in response to similar forms of anthropopressure in other areas, or it promotes the expansion of local populations, casually preadapted to new conditions [6].

Adaptational changes in phytocoenoses produced in response to anthropopressure need some time. Spatial and temporal aspects of synanthropization are shown in Figure 3, and the mechanism of the development of a theoretical anthropogenic phytocoenosis is shown in Figure 4.

Each successive wave of anthropopressure is followed by modifications of earlier developed phytocoenoses. The major mechanisms of these changes are always the same: populations of native species are selected, some of them move into new habitats and adapt to new phytocoenoses (apophytes), and new components appear (anthropophytes). Sometimes these new components can hybridize with local ones. When anthropopressure does not exceed a certain level, various types of phytocoenoses, such as natural, semi-natural, made up of apophytes or of apophytes and anthropophytes, and finally those dominated by anthropophytes, can coexist in the same area.

DEGREES OF SYNANTHROPIZATION

The most frequently investigated feature of anthropogenic communities is the degree of their transformation, as compared to natural phytocoenoses. To estimate this we may use floristic criteria since we know the origin and the degree of synanthropization of the European flora. Thus we have a quite objective basis, sufficient for identification and classification of plant communities.

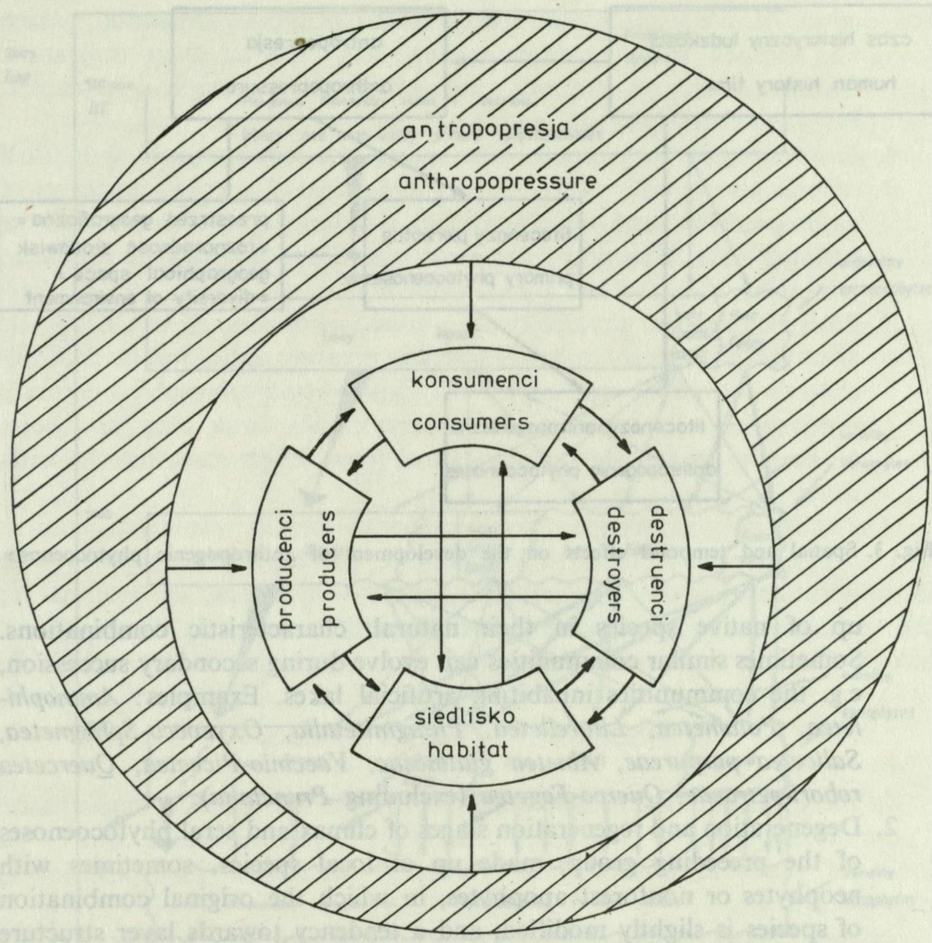

Fig. 2. An ecosystem subject to anthropopressure.

Jalas [11] made first attempts at classifying plant communities by distinguishing the degrees of hemeroby. Sukopp [37] compares various classifications of this type. The classification developed by Faliński [5] seems to be the best from the point of view of synanthropization of plant communities. This is a hierarchical, 4-degree classification, which consists of nine basic units. It considers the degree of transformation, decreasing or increasing tendencies in the range of phytocoenoses, the proportion of local and alien species, the contribution of man to the development of these communities, and finally the degree of habitat transformation. A simplified Faliński's classification, in which seven degrees of synanthropization of plant communities are distinguished, is given below.

Autogenic phytocoenoses

1. Primeval and natural phytocoenoses: forest and nonforest climax communities and, seral phytocoenoses in primary succession, made

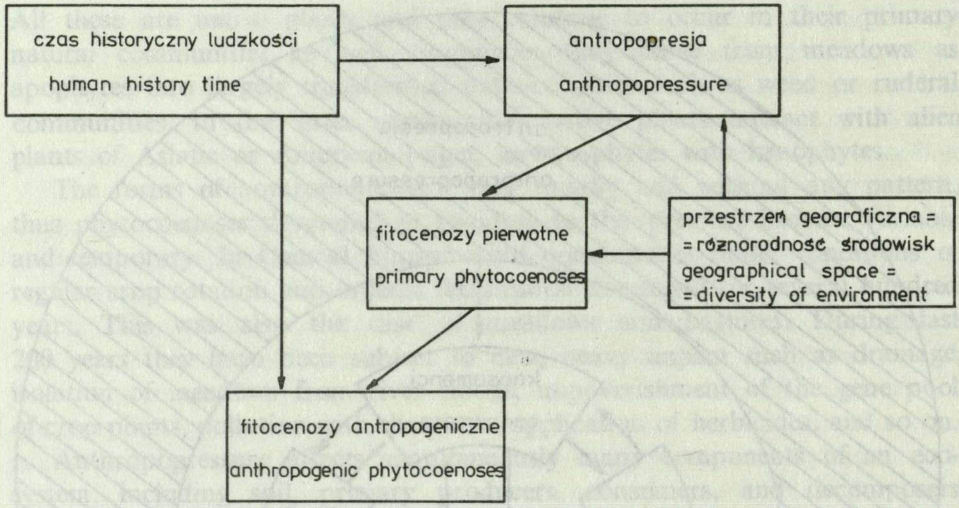

Fig. 3. Spatial and temporal effects on the development of anthropogenic phytocoenoses.

up of native species in their natural, characteristic combinations. Sometimes similar communities can evolve during secondary succession, e.g. the communities inhabiting artificial lakes. Examples: *Ammophiletea, Potametea, Litorelletea, Phragmitetalia, Oxycocco-Sphagnetea, Salicetea purpureae, Alnetea glutinosae, Vaccinio-Piceetea, Quercetea robori-petracae, Querco-Fagetea* (excluding *Prunetalia*).

2. Degeneration and regeneration stages of climax and seral phytocoenoses of the preceding group, made up of local species, sometimes with neophytes or nonforest apophytes, in which the original combination of species is slightly modified, and a tendency towards layer structure changes and proportion of particular components is observed. Examples: oak-hornbeam forests with introduced pines (*Pinus silvestris*) and beech forests (*Luzulo-Fagetum*) with simplified age and layer structure of the cultivated beech stand.

Spontaneous anthropogenic phytocoenoses

3. Seminatural secondary phytocoenoses and their degenerating forms: meadows, xerothermic grasslands, sandy grasslands, and thickets. They are made up of native species, mostly of the ecotypes adapted to human impact, with a small proportion of alien species. Examples: *Plantaginetea majoris, Magnocaricetalia* (in part), *Sedo-Scleranthetea, Molinio-Arrhenatheretea, Festuco-Brometea* (in part), *Nardo-Callunetea*, and *Prunetalia*.
4. Xenospontaneous phytocoenoses (neophytocoenoses) — new combinations composed of alien species (anthropophytes) and of native species, developed as a result of the invasion of neophytes largely reducing native plants; habitat conditions and layer structure of the

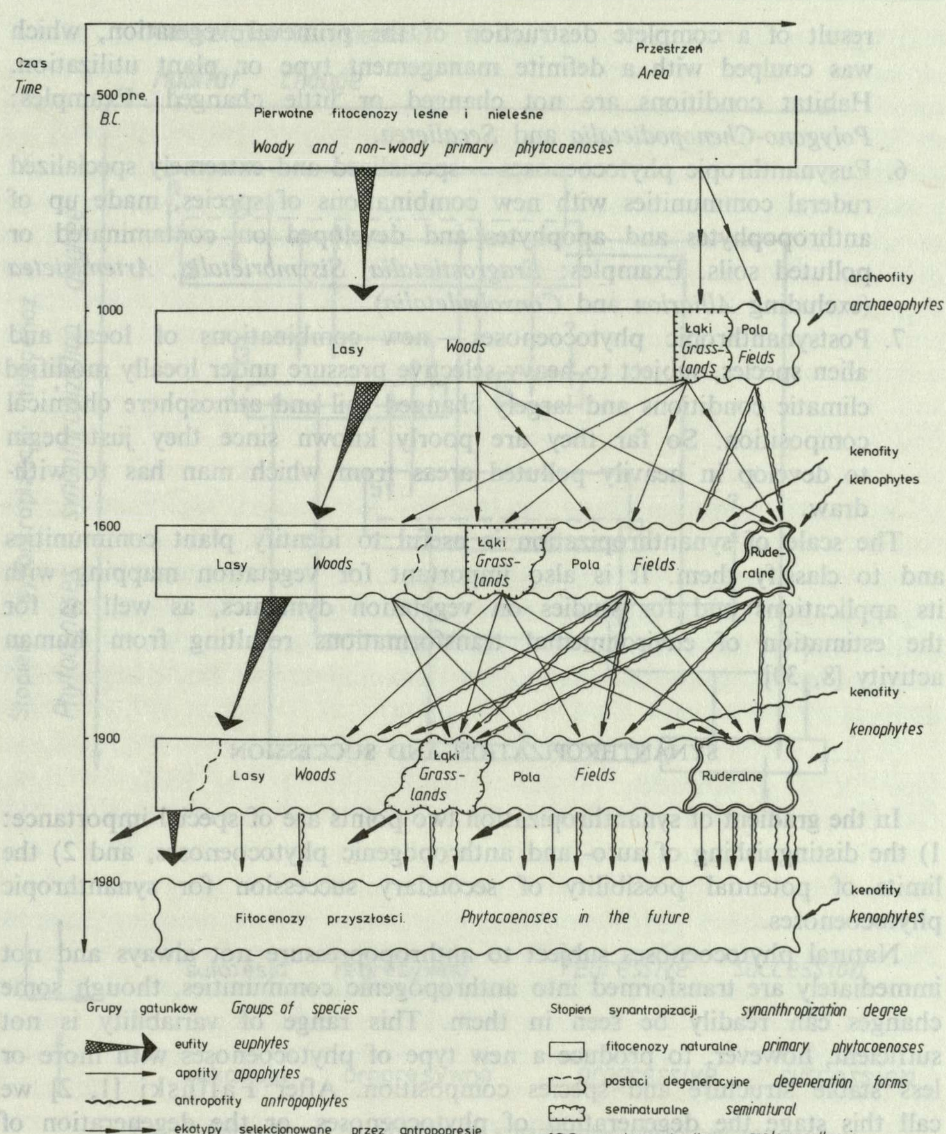

Fig. 4. Development of synanthropic phytocoenoses and heterogeneity of their components.

phytocoenosis remain unchanged. Examples: communities with *Elodea canadensis* and *Acoretum calami*, forests with *Impatiens parviflora*.

Synanthropic anthropogenic phytocoenoses

5. Protosynanthropic phytocoenoses — segetal and non-specialized ruderal communities in rural areas, also forest plantations and urban parks, including their degenerated forms. These are new combinations of species, made up of apophytes and anthropophytes, developed as a

result of a complete destruction of the primeval vegetation, which was coulped with a definite management type or plant utilization. Habitat conditions are not changed or little changed. Examples: *Polygono-Chenopodietalia* and *Secalietea*.

6. Eusynanthropic phytocoenoses — specialized and extremely specialized ruderal communities with new combinations of species, made up of anthropophytes and apophytes and developed on contaminated or polluted soils. Examples: *Eragrostietalia, Sisymbrietalia, Artemisietea* (excluding *Alliarion* and *Convolvuletalia*).
7. Postsynanthropic phytocoenoses — new combinations of local and alien species, subject to heavy selective pressure under locally modified climatic conditions and largely changed soil and atmosphere chemical composition. So far they are poorly known since they just begin to develop in heavily polluted areas from which man has to withdraw.

The scale of synanthropization is useful to identify plant communities and to classify them. It is also important for vegetation mapping with its applications and for studies on vegetation dynamics, as well as for the estimation of environmental transformations resulting from human activity [8, 30].

SYNANTHROPIZATION AND SUCCESSION

In the gradient of synanthropization two points are of special importance: 1) the distinguishing of auto- and anthropogenic phytocoenoses, and 2) the limits of potential possibility of secondary succession for synanthropic phytocoenoses.

Natural phytocoenoses subject to anthropopressure not always and not immediately are transformed into anthropogenic communities, though some changes can readily be seen in them. This range of variability is not sufficient, however, to produce a new type of phytocoenoses with more or less stable structure and species composition. After Faliński [1, 2] we call this stage the degeneration of phytocoenoses, or the degeneration of plant associations, to emphasize its typological implications [27, 28]. The degeneration of phytocoenoses is thus the first, mildest effect of anthropopressure, which lies in the modification of structure and species composition of plant communities. This concept can also be used in relation to anthropogenic phytocoenoses which continue to change but these changes are not sufficient to shift their position in the system of classification.

This range of variability can be considered as an exogenous succession, usually regressive. Various stages of degeneration maintain a spatial and typological continuity with the original phytocoenosis; they represent small steps in succession that can be reversed through secondary succession if their cause disappears (Fig. 5).

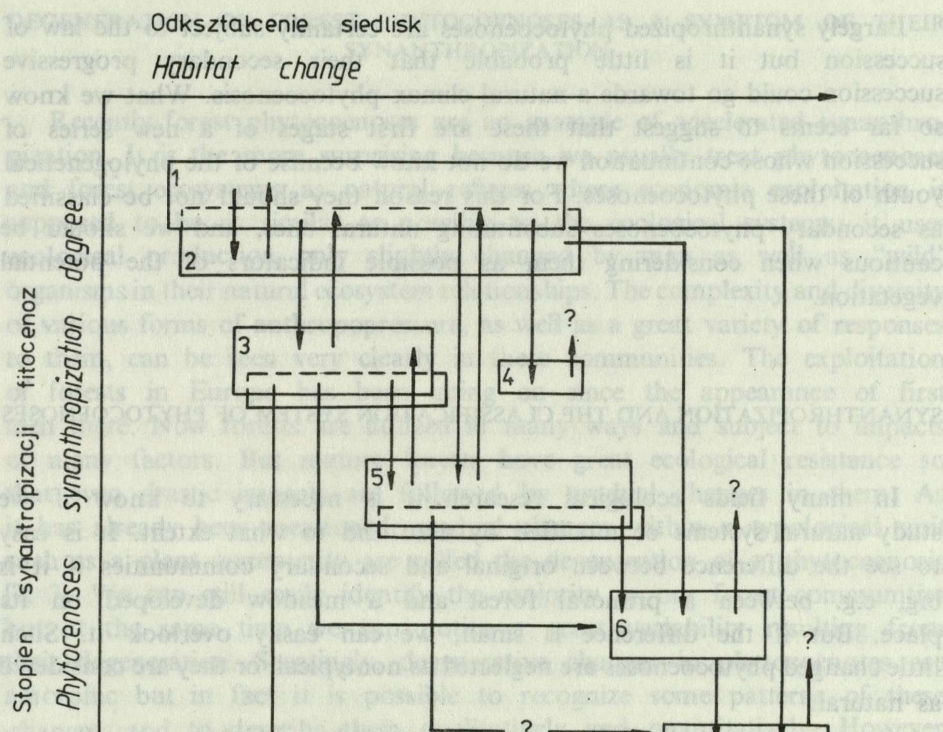

Fig. 5. Successional relationship in synanthropic phytocoenoses.

But when a certain degree of synanthropization is exceeded such a return to the original state is not possible because of changes in habitat conditions or in the other components of the ecosystem. We do not know exactly the trends in succession of eu- and post synanthropic phytocoenoses, nor the rate of these processes, and the type of the possible climax (Fig. 5). The ruins of towns are first covered with ruderal vegetation, then with shrub communities, and finally with woods [39] but these woods differ from original forest communities growing there before the establishment of a town. Maybe we should call this climax an "anthropoclimax".

Largely synanthropized phytocoenoses are certainly subject to the law of succession but it is little probable that their secondary progressive succession could go towards a natural climax phytocoenosis. What we know so far seems to suggest that these are first stages of a new series of succession whose continuation we do not know because of the phylogenetical youth of these phytocoenoses. For this reason they should not be classified as secondary phytocoenoses substituting natural ones, and we should be cautious when considering them as possible indicators of the potential vegetation.

SYNANTHROPIZATION AND THE CLASSIFICATION SYSTEM OF PHYTOCOENOSES

In many fields ecological research it is necessary to know if we study natural systems or modified by man and to what extent. It is easy to see the difference between original and secondary communities if it is big, e.g. between a primeval forest and a meadow developed on its place. But if the difference is small, we can easily overlook it. Such little changed phytocoenoses are neglected as nontypical, or they are considered as natural.

A great achievement of the central-European phytosociology is the development of a classification of plant communities on the basis of about 500 thousand phytosociological surveys made by a unified method. This classification involves both autogenic and anthropogenic communities. Using the principle of floristic similarity, this classification adequately reflects dynamic relations of phytocoenoses and the degree of their synanthropization. Plant communities differing in the degree of their synanthropization belong to different syntaxonomic units, usually to different classes of plant communities. Phytosociological syntaxonomy is very useful for analysis of anthropogenic changes in the vegetation. It is not suitable, however, for analysis of synanthropization of phytocoenosis since it does not include small effects of human impact, that only modify the structure and species composition but do not produce new types of plant communities. That is why various keys for the identification of plant communities, or reviews of plant communities in various countries, disappoint when confronted with real nature. This is frequently experienced by phytosiociologists preparing large-scale maps of the vegetation when they have to identify and describe in general terms the vegetation of each stand, independent of whether or not it is included into the classification system they use.

Therefore, the studies on synanthropization of plant communities are necessary for improving the system of classification. They are also needed for developing the programme of nature conservation, and for ecologically reasonable utilization of the vegetation.

DEGENERATION OF FOREST PHYTOCOENOSES AS A SYMPTOM OF THEIR SYNANTHROPIZATION

Recently forest phytocoenoses are an example of accelerated synanthropization. It is the more surprising because we usually treat phytocoenoses and forest ecosystems as natural refuges where economic exploitation is supposed to be as similar as possible to the ecological systems: it uses ecological production only slightly changed by man as well as "wild" organisms in their natural ecosystem relationships. The complexity and diversity of various forms of anthropopressure, as well as a great variety of responses to them, can be seen very clearly in these communities. The exploitation of forests in Europe has been going on since the appearance of first men there. Now forests are utilized in many ways and subject to impacts of many factors. But mature forests have great ecological resistance so that even drastic impacts are followed by gradual changes in them. As it has already been mentioned, gradual changes within a typological unit such as a plant community are called the degeneration of a phytocoenosis [2, 3]. We can still easily identify the majority or our forest communities but at the same time we can notice a great variability resulting from their degeneration. Seemingly, degenerative changes in phytocoenoses are amorphic but in fact it is possible to recognize some patterns of these changes, and to describe them qualitatively and quantitatively. However, the typology and terminology used by different authors at this level of variability in plant communities are not consistent [9, 10, 17, 18, 22, 23—29, 32—36, 42].

The theory of the phases of degeneration developed by Faliński [2] is used to quantify the processes of degeneration. There is a certain sequence in the disappearance of species from degenerating phytocoenoses. Specialized species disappear first, and then the species with more and more broad ecological amplitudes decline in turn. They are replaced by alien species, and the vertical and horizontal structure of the phytocoenosis is modified. This pattern provides a basis for classifying the phytocoenosis to a lower or higher phase of degeneration.

The qualitative patterns of degeneration are characterized by the theory of the forms of degeneration developed by Olaczek [27, 28]. Long-term impacts produce directional changes in the layer structure and species composition of phytocoenoses. So far the following forms of degeneration have been distinguished:

— monotypization: a simplification of the layer and age-structure of the tree stand, a slight decline in the number of species;
— fruticetization: a strong development of the undergrowth as a result of lowered stand density or clear cutting in the past and a spontaneous regrowth of the forest;

— caespitization: an excessive development of grass with a simultaneous disappearance of some species in response to monocultural afforestation. It is frequently observed on afforested old fields;
— juvenilization: the maintenance of a phytocoenosis at a young developmental stage by repeated cutting out young stands;
— neophytization: the introducing of geographically alien species into tree stands, or the facilitation of the colonization by alien plants (neophytes);
— pinetization: a shift in the flora from that characteristic of deciduous and mixed forests towards that associated with coniferous forests, which is produced by artificial introduction of coniferous trees, mainly of the genera *Pinus* and *Picea*. This is the most common and dangerous form of degeneration.

The form of degeneration characterizes the direction of the regressive succession with the increasing impact of the factor responsible for degeneration processes. For instance, fruticetization transforms forest communities into shrubberies, and caespitization into grasslands.

The knowledge of the phases and forms of degeneration enables us to identify plant communities, prepare maps of the vegetation, and to evaluate the degree of transformation or synanthropization of the vegetation. A good example here is the evaluation of forests of the Wolin National Park (north-western Poland) (Tab. 1), given by Olaczek and Piotrowska [31].

So far we use historical and comparative methods for studying the degeneration of phytocoenose, e.g. the analysis of degeneration series [27—29]. But in the future studies on permanent plots will be needed.

Table 1. Evaluation of the degree of transformation of forest communities in the Wolin National Park (after Olaczek i Piotrowska 1978)

Degree of degeneration	Phase of degeneration (acc. to Faliński 1966)	km²	%
Natural or almost natural phytocoenoses	0 = I	11.28	24.4
Little degenerated	I = II	19.50	42.2
Heavily degenerated	II = III	13.15	28.5
Very heavily degenerated	IV = V	1.26	2.7
Temporary change in formation of vegetation	VI	0.57	1.2
Permanent change in formation of vegetation	VI	0.44	1.0
Total		46.20	100.0

CONCLUSIONS AND DEFINITIONS

1. To identify correctly ecological units it is necessary to take into account synanthropization since this is one of the major processes transforming natural systems subject to human action. For this reason and also because

of an increasing importance of anthropogenic phytocoenoses to the economy and environmental quality we should make efforsts to recognize the mechanism, causes, and effects of synanthropization, to develop methods for studying this process, and also a general and detail theory of this process.

2. Because of the universal presence of anthropopressure, any investigation of relationships between organisms and their environment, or of ecosystem functioning, dynamics, succession, etc. without regard to human impacts and their effects, would mean the investigation of phenomena that do not exist more in the present world.

3. Synanthropization of phytocoenoses is a sequence of changes produced by direct or indirect, conscious or involuntary human impacts on plants and their environment, which lead to the degeneration of natural phytocoenoses, to the development of anthropogenic communities, or to an increase in the degree of their synanthropization. As a result of this process, the phytocoenosis becomes adapted to new conditions.

4. Degeneration of a phytocoenosis involves all changes caused by all kinds of human impacts on this phytocoenosis or its habitat, which are reflected in its structure and species composition but which do not exceed the threshold of a within-system variability, that is, which do not result in the formation of a new type of phytocoenosis.

5. Synanthropization of the vegetation is a process of the replacement of autogenic plant communities by anthropogenic ones, or little synanthropized communities by more synanthropized, which leads to changes in the composition of plant communities on a given area.

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SYNANTROPIZACJA FITOCENOZ

STRESZCZENIE

Synantropizacja fitocenoz jest procesem przemian zbiorowisk roślinnych pod wpływem antropopresji, polegającym na ich przystosowaniu się do form użytkowania szaty roślinnej (np. wypas zwierząt), użytkowania ziemi (np. las lub pole) lub zmian siedliska. Oddziaływania człowieka trwają od bardzo dawna, ale zmieniają się ich formy, zasięg przestrzenny i intensywność — przy czym występuje tendencja do akceleracji tych zmian — w ślad za tym ulegają przekształceniom wszystkie układy ekologiczne dotknięte tymi oddziaływaniami (Fig. 1). Antropopresja wpływa na wszystkie składniki ekosystemu (Fig. 2), jakkolwiek działa z reguły w sposób selektywny na poszczególne organizmy w każdej grupie funkcjonalnej: jednym uniemożliwia lub utrudnia funkcjonowanie, inne proteguje. Mechanizmy oddziaływania człowieka oraz czynniki synantropizacji mają częściowo charakter swoisty, częściowo naśladują zjawiska fizyczne i chemiczne występujące w biosferze, zmieniając jedynie ich kierunek, natężenie i rytmy.

Fitosocjologia środkowoeuropejska interesuje się synantropizacją fitocenoz nieomal od początku swego istnienia, głównie w aspekcie typologii i klasyfikacji skutków tego procesu. Przegląd problemów oraz nowe koncepcje teoretyczno-metodyczne zawarte są przede wszystkim w pracach Falińskiego, Sukopp'a, Jalasa, Kornasia, Kostrowickiego, Olaczka. Ważniejsze osiągnięcia w tym zakresie polegają na:
— sklasyfikowaniu zbiorowisk antropogenicznych, zbadaniu ich struktury, zmienności, uwarunkowań oraz włączenie ich do systemu zbiorowisk roślinnych;
— opracowaniu teorii faz i form degeneracji fitocenoz jako wyrazu ich synantropizacji;
— określeniu ogólnych efektów synantropizacji roślinności i flory, takich jak: eurotopizacja, kosmopolityzacja, allochtonizacja, dyferencjacja i komplikacja;
— ustaleniu stopni synantropizacji fitocenoz, czyli sklasyfikowanie zbiorowisk z punktu widzenia ich zależności od antropopresji;

— zwróceniu uwagi na nowe zjawiska, zachodzące pod wpływem człowieka w fitocenozach i biosferze, jak neofityzm i degeneracja fitocenoz;
— zwróceniu uwagi na powszechność zjawisk synantropizacji, obejmujących wszystkie poziomy organizacji ekologicznej, na konsekwencje poznawcze i praktyczne wynikające z nieuwzględniania tego procesu w różnych dziedzinach badań ekologicznych.

Skutki synantropizacji fitocenoz mają charakter ilościowy i jakościowy, co znajduje odzwierciedlenie na poziomie organizacyjnym roślinności w postaci stopni synantropizacji fitocenoz, a na poziomie fitocenozy w postaci faz degeneracyjnych i form degeneracji. Do pewnego momentu, w zależności od czasu trwania i natężenia czynników degeneracji, zmiany zachodzące w obrębie fitocenozy jedynie modyfikują jej strukturę i skład florystyczny (degeneracja fitocenozy), jednakże po przekroczeniu pewnego progu oddziaływania następuje zniszczenie dotychczasowej fitocenozy i kształtuje się zupełnie nowa organizacja, nowy typ fitocenozy. Fitocenozy antropogeniczne, pozostając w zależności od zróżnicowania siedlisk, są jednocześnie uzależnione od bardzo różnorodnych i zmiennych działań człowieka (Fig. 3). Możliwe jest grupowanie zbiorowisk w szeregi homologiczne (wszystkie typy fitocenoz wykształcające się na takim samym siedlisku np. las, plantacja, łąka, pastwisko itd. na siedlisku grądu) lub analogiczne (wszystkie typy fiocenoz ukształtowane pod wpływem tego samego czynnika antropopresji, np. pod wpływem koszenia — łąka świeża na siedlisku grądu i wilgotna na siedlisku łęgu).

Gatunki roślin, budujące fitocenozy antropogeniczne, mają trojakie pochodzenie (Fig. 4). Mogą to być gatunki rodzime, pochodzące z fitocenoz pierwotnych i poddane presjom selekcyjnym antropopresji, w wyniku czego pewne ich populacje dostosowują się do nowych warunków. Inną grupę stanowią apofity, przechodzące z fitocenoz naturalnych o odmiennej strukturze, ale mające szerokie granice tolerancji. Trzecią grupę tworzą antropofity, rośliny zawleczone z odmiennych obszarów geograficznych i z zupełnie obcych fitocenoz. Stopień synantropizacji fitocenozy wyraża się w zmiennym udziale gatunków tych trzech grup.

Synantropizacja fitocenoz może być rozumiana jako przejaw sukcesji regresywnej allogenicznej; bardzo rzadko zdarza się, aby była to sukcesja progresywna. Natomiast wszystkie fitocenozy antropogeniczne mogą podlegać sukcesji progresywnej (lub rzadko regresywnej) autogenicznej, o ile ustaną czynniki synantropizacji, nie zawsze jednak ta sukcesja może prowadzić do odtworzenia fitocenozy pierwotnej (Fig. 5).

We wszystkich badaniach ekologicznych, w których niezbędna jest poprawna identyfikacja typu fitocenozy, muszą być uwzględnione efekty synantropizacji jako jednego z najważniejszych procesów kształtujących we współczesnym świecie układy ekologiczne. Niezbędność ta szczególnie widoczna jest w kartografii roślinności, w konserwacji i ochronie szaty roślinnej, w badaniach wzajemnych zależności komponentów ekosystemu itp.

СИНАНТРОПИЗАЦИЯ ФИТОЦЕНОЗОВ

РЕЗЮМЕ

Синантропизация является одним из наиболее важных процессов, обуславливающих формирование экосистем в современных условиях. В связи с этим никакой фитоценоз не может быть всесторонне изучен, если не будет принято во внимание влияние человека. Фитосоциология произвела классификацию антропогенных растительных сообществ, включая их в классификационную систему растительности согласно их структуре и составу флоры, в которых отражается степень их синантропизации. В работе обсуждены проблемы возникновения, сукцессии, дегенерации и классификации фитоценозов, подверженных процессу синантропизации.