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Classification of synanthropic plants in relation to vegetation changes during the Holocene

Zbigniew MIREK

1. INTRODUCTION

In the last decades a great deal of attention has been given to the classification of synanthropic plants (RIKLI 1903, SIMMONS 1910a, THELLUNG 1915, 1919, LINKOLA 1916, PREUSS 1930, WIDDER 1947, JALAS 1955, HYLANDER 1960, HOLUB and JIRASEK 1967, KORNAS 1968, 1977, SCHROEDER 1969, SUKOPP 1969, KRAWIECOWA and ROSTANSKI 1972, HOLUB 1974, KRAWIECOWA 1977). The number of attempts made is significant of a complexity of the problem and of the acquisition of yet new data on the subject. This is also partly the result of accepting various criteria of the division or of their different valorization.
Without evaluation of subsequent classifications, the author turned his attention towards selected problems connected with the classifications at use in Poland (HOLUB 1974, KORNAS 1968, 1977, KRAWIECOWA 1951, KRAWIECOWA and ROSTANSKI 1972) based on the geographical and historical criteria and on the status in the flora, which are continuation of an earlier classification by THELLUNG (1919) based on the same criteria.

2. BASIC CRITERIA OF THE DIVISION SPONTANEOPHYTES VS. ANTHROPOPHYTES

The synanthropic flora is composed of all the plant taxa included in synanthropic communities of a given area (KORNAS 1972). Two basic groups are

usually distinguished: anthropophytes (taxa of a foreign origin) and apophytes (native taxa, also called taxa of a local origin). However, inconspicuous certain incoherence of the limit between the synanthropic communities and other types of communities formed or changed to different degree by man (FALINSKI 1969, KORNAS 1972) and also the absence of a clear definition of the terms: native taxon, taxon of a foreign origin, make it difficult to distinguish the synanthropic flora from the whole flora of a given area and to distinguish the so-called native taxa from anthropophytes.

Much confusion was caused by an exchangeable use of the epithets native, local, indigenous, autochtonic and alien, introduced, adventive, allochtonic, anthropogenic.

The taxa which were introduced in a given area by man are considered to be of alien origin (anthropophytes), they are also labelled as allochtonic, and are juxtaposed to the taxa of local origin also called native or autochtonic. However, the term "native taxon" may be understood in two ways:

- as originated spontaneously in a given area from some parental form (autochtonic taxon sensu stricto)
- as spontaneously arriving in a given area most often in connection with climatic changes (allochtonic taxon sensu stricto).

Such an approach to the group of "native" species has been already suggested in geobotany (DANSEREAU 1957, HOLUB 1974, HOLUB and JIRASEK 1967).

Analogously, the two above instances, may be referred to a group of anthropophytes with the exception that the occurrence of these cases in this group will be conditioned causatively by man's activity.

Thus, it seems that the term spontaneophyte, i.e. "naturally existing taxon" would be more suitable than the term "native taxon" ("of local origin" as it is understood by Polish authors). Following this way of thinking the whole flora of a given area should be divided into two basic groups:

- Spontaneophytes (spontaneophyta), i.e. taxa originated in a given area or which arrived without man's contribution.
- Anthropophytes (anthropophyta), i.e. introduced and adventive taxa which arrived in a given area or originated[1)] there due to the (intended, unintended, direct or indirect) influence of man.

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1) The origination of a taxon under the influence of man is understood in a wider sense, i.e. also as an indirect contribution through creating new or disturbed habitats accessible to mutants, hybrids or introgressive forms or as making it possible for the taxa to cross the barriers limiting the gene flow in natural conditions.

This seems obvious and it has already been stressed (PORSILD 1932, KAMYSHEV 1959, KORNAS 1968) that the status of species expressed in the categories of synanthropic plant classification has local significance and that it varies from region to region. No attention has been put so far to the time relativity.

3. TIME RELATIVITY OF THE DIVISION

Both the taxon and its range change in time[2)] in connection with the change in habitat factors (especially climate). The development of vegetation in the post-glacial areas during the Holocene well illustrates the creation of distribution range of a number of species (GODWIN 1975). Considering the point of interest here, let us imagine changes occurring in the Holocene, not in the whole flora, but in selected examples (Fig. 1). Let us consider the plants which both in the previous interglacial periods and in the Holocene occurred in the first phases and then, parallel to the changes in climate and vegetation were gradually disappearing (SRODON 1966, GODWIN 1975). As the preceding interglacial periods (TOBOLSKI 1976 and literature) it may be assumed that in the Holocene as well, the plant groups in question would have died out, losing their natural habitats in open areas because of the climatic changes and growing forest expansion.

On the other hand, some representatives of the above mentioned plant groups have been occurring since the beginnings of the Holocene without any or with short intervals up till now. This phenomenon may be justified by the presence of man whose activity in the Holocene is fairly conspicuous, and contrary in its results (deforestation, disturbance of habitats, etc.) to the natural changes in the vegetation.

Thus a question arises: how the taxa 1, 2, and 3, given in Fig. 1 should be treated. These plants have arrived in our territory independent of man and they have been occurring there till now, they are, therefore, in some sense spontaneophytes.

Looking at Fig. 1A, however, it may be found out that without man's presence the group in question would have died out. Indeed, we are dealing here with anthropophytes. In spite of the fact that the cases presented in Fig. 1 are principally hypothetical, in pollen diagrams of the interglacial periods and of the

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2) Both this and other problems dealt with in the previous chapter were noticed already in plant geography. This found an expression in distinguishing different types of elements of the flora (geographical, genetic, historical, etc.).

Holocene some curves may be found (e.g. for some representatives of *Chenopodiaceae*, *Polygonaceae*, *Compositae* and *Gramineae*) which are clearly referred to by the curves in Fig. 1 (GODWIN 1975, SRODON 1966). At this point two earlier-mentioned groups i.e. spontaneophytes and anthropophytes should be considered. Namely, if the essence of these two groups is to be preserved, their definitions should read as follows:

- Spontaneophytes (taxa naturally occurring in a given area) - the taxa which arrived or originated in the area studied and that can survive there without man's (i.e. by nature).
- Anthropophytes - taxa which originated in a given area under the influence of man (anthropophyta anthropogena), or they got there owing to man (anthropophyta adventiva), or they survived there in anthropogenic habitats (without man's contribution they would have perished as the result of natural changes in the vegetation) (anthropophyta resistentia).

It is suggested that the above division should be preserved independent of already existing classifications of anthropophytes, which does not interfere with including them in these divisions. Thus, for example, epecophytes, which originated as taxa in a given area owing to man's activity, would be considered as epecophyta anthropogena. Correspondingly, archeophytes which sur-

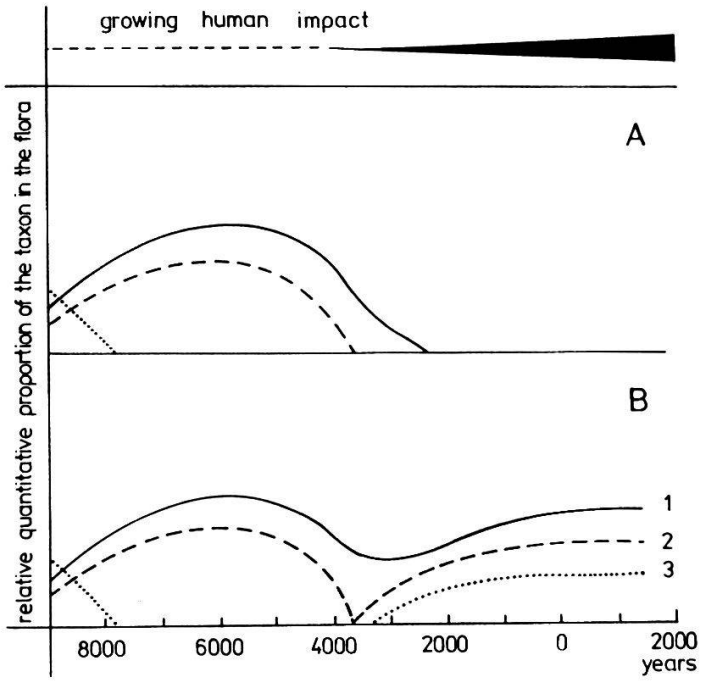

Fig. 1. Proportion changes of hypothetical taxa (1-3) in the flora during Holocene.
A = hypothetical spontaneous changes (human impact excluded)
B = real changes including human impact

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vived owing to man would be determined as archeophyta resistentia. It should be noted that if the 15th century is assumed to be the time limit separating kenophytes from archeophytes, then the taxon included in this last group must have either arrived, or originated, or lost its natural habitats and pass to the anthropogenic habitats before the 15th century. At the same time, it should be noted that within the anthropophyta anthropogena, i.e. elements originated in a given area due to man's activity (in a broad sense), taxa originated from anthropophytes and from spontaneophytes (e.g. segetal forms of *Stachys palustris*, *Rubus caesius*, etc.) or established hybrids, or introgressive forms, whose one parent form is an anthropophyte and the other spontaneophyte, may be found.

4. INDICATORS OF SPONTANEOPHYTISM

The terms spontaneophyte and anthropophyte given above, and the criteria used in their distinction have no empirical sense as they refer to unobservable phenomena. Hence, by necessity we must refer to indicators, i.e. directly observable phenomena, which will allow for certain (absolute) or merely probable solutions in this matter. In literature there are no clearly given indicators for distinguishing spontaneophytes (i.e. "native components") from anthropophytes. There is also no critical analysis of the only indicator in use (rather a criterion), i.e. the occurrence of the taxon in natural communities.
It has been accepted so far that if the taxon occurs in undisturbed primary or natural communities with the simultaneous absence of data on its introduction, then we may conclude, with great probability, that it occupied the area without man's help, so it is a spontaneophyte (native according to Polish authors). However, in relation to the known cases of holoagriophytism (KORNAS and MEDWECKA-KORNAS 1967, SUKOPP 1966) (= neophytism sensu Thellung) and in relation to almost global changes in the natural environment caused by man in the last several thousand years, this method does not secure dependable solutions (cf. also PORSILD 1932) and it may be treated only accessorily. DARLINGTON (1973) also provides cases which make it impossible to apply the above-mentioned approach. One of such cases is man's control over all the wild populations of a given taxon, or taxa passing onto the synanthropic habitats with its simultaneous destruction in natural habitats. Among plants the date-palm is an example (cf. DARLINGTON 1973). Man could have also eliminate from the environment certain abiotic factors (e.g. floods of rivers eliminated by regulation) or biotic (e.g. in the case of some zoogenic communi-

ties), which secured the existence of a given taxon or a whole plant community. The example for this are North-American "beaver-meadows" (TISCHLER 1971), which practically disappeared after the extermination of beavers.
A relatively safe basis for any decisions is provided by historical data. This regards especially palaeobotanical studies which aim at reconstructing the past of a given taxon in a given area and at determining its relation to man's activity. However, taking into consideration great complexity of the problem resulting from the parallel influence of the climate and the over-all anthropogenic factors on the vegetation (for at least several thousands of years now) and the deficient historical data - it turns out that even this approach is insufficient.
The recent attempts at reconstructing the history of whole phytosociological entities seem interesting from the point of view of the present problem (TÜXEN 1974).
Insufficiency (or absence) of the above-mentioned types of data makes the researchers look for other ways of analysing the problem in question. The attempts at complex studies on the conditioning of biotopes occupied by a given taxon within its whole geographical range on the one hand, and at studying of a broadly understood ecology and biology of the taxon on the other are worth following (SUKOPP and SCHOLZ 1968).
Valuable data are also provided by the studies in which a detailed analyses on variability and ecology of the taxon are combined with the studies on material culture (ZINGER 1909).
The above outline of the complexity of the problem forces us to look at the indicators in a different way than we used to. Namely, if we are to determine the spontaneophytes and anthropophytes as it was done in chapter 3, then each type of data allowing of deciding about the dependence upon or independence of the existence of a given taxon in a given area of man's activity, is useful. It is necessary, however, to realize, that the majority of the indicators considered here are of a probabilistic character, thus the statements made with their aid, especially these referring to archeophytes, if they are possible at all, will usually be made with certain probability, rarely final.
The species without proper data should be regarded as indeterminate cases and they should not be included in one of categories "by force". The advantage of such an approach is twofold: a) it does not lead to the spread of unfounded (thus often false) opinions, b) it indicates taxa which require thorough investigations.

5. PROBLEM OF APOPHYTISM

The relation of a given taxon to the communities dependent or not dependent in various degrees on man's activity turns out to be very important both in the analysis of apophytism and in distinguishing spontaneophytes from anthropophytes. In Poland the division into primary, natural, seminatural and synanthropic communities was accepted (PAWLOWSKA 1965, KORNAS 1972). This division, however, because of its incoherence caused by the absence of precise definitions, clear criteria and by the occurrence of transitory types of communities (FALINSKI 1969) is, according to the present author, not convenient to the analysis of the status of species. The above divisions take the origin of a community, the origin being as little known as the record of the taxa investigated, for a starting point. In this situation the only useful information available is whether the community may survive in nature without man's interference. The question here is of a possibility of survival in time of a community (association) and not of its single stands, which in the case of the so called "non-climax" communities are temporary. Anyway, a community may last in time owing to natural (spontaneous) renewal of a corresponding biotopes in other places. This renewal must, however, occur with the frequency appropriate for the time of existence of single stand of a given community and within the range of its expansion ability. Taking the above-presented approach the communities may be divided into two basic types: a) autoassociations, which may exist without permanent or temporary influence of man, b) anthropoassociations, which may exist only in the case of permanent or temporary influence of man.

Based on this division two groups may be distinguished within spontaneophytes: 1) spontaneophytes occurring solely in autoassociations, and 2) spontaneophytes occurring in anthropoassociations as well - apophytes.

This approach towards the apophytes is in accordance with the heretofore approach towards this group (ANDERSON 1949, KORNAS 1968, 1972, 1977, KRAWIECOWA and ROSTANSKI 1972), though it is defined in somewhat different categories. The degree of attachment of an anthropophyte to synanthropic habitats has usually a deeper ecological sense. Thus, the author suggests that in the analysis of synanthropic floras apophytes occurring ephemerically in synanthropic habitats should be distinguished from these which are stable components of such habitats (MIREK 1981, TRZCINSKA-TACIK 1979). The degree of constancy and phytosociological fidelity may be useful in such an analysis.

6. IMPORTANCE OF THE RANK

When including taxa in the distinguished groups of synanthropic plants, attention has to be put to their rank. The determination valid for the species may often be false when referred to its subspecies or varieties. And thus, among the many species considered as occurring spontaneously, there occur subspecies attached to particular synanthropic habitats, e.g. segetal (MALCEV 1933, LEVINA 1957, KORNAS 1972), ruderal (SIMMONS 1910a, PORSILD 1932), or meadow ones (SCHOLZ 1975 and literature). These are frequently forms originated under man's influence. The examples of creation of new anthropogenic forms - often little different from native species - as the result of introgression between a spontaneophyte and anthropophyte are given by ANDERSON (1949). The remarks by STEBBINS (1958) prove that the taxa of this type, though little known yet, may be numerous. Thus, when dealing with species we may record that it occurs in a given area by nature, and its subspecies or a variety attached exclusively to synanthropic habitats, which came into existence owing to man, should be treated as anthropophytes.

When considering the problem of apophytism in no way can the group of species which are characteristic components of fresh mowing meadows and pastures be omitted. These species (e.g. *Arrhenatherum elatius*, *Cynosurus cristatus*, *Lolium perenne*, etc.) are often regarded as "meadow apophytes" in analyses of synanthropic floras. However, certain inconsistency of this term may be discerned. By denominating the taxon occurring in the habitats created by man (e.g. ruderal habitats) as a meadow apophyte, the following facts, inter alia, are pointed at: a) the taxon is a spontaneous component of the flora of the area investigated, b) meadows are its natural biotopes.

On the other hand, the same meadows or pastures are (according to the definitions accepted) seminatural communities, and the scrubs, forest margins, riverside habitats, etc. are considered to be the primary habitats of the taxa which compose them (cf. PAWLOWSKA 1965). If so, then independent of the fact whether these taxa occur in ruderal and segetal habitats or in meadows, they should be regarded as forest, scrub or so on apophytes, indicating a natural habitat for each taxon. Nevertheless, for many meadow species (the above-mentioned included) no possible natural habitats in Central Europe can be indicated. Therefore the types of communities discussed either should be regarded as existing by nature (currently only of wider secondary distribution), or they should be considered as anthropogenic, relatively young formations (TÜXEN 1974), then, however, the species discussed should not be treat-

ed as apophytes but should consistently be included in the group of anthropophytes. In the latter case, their majority should be included in the group of archeophytes (cf. PIEKIELKO and ZAJAC 1977, ZAJAC and ZAJAC 1975). Genetical, cyto- and chemotaxonomical and embryological studies carried out in the postwar period on numerous meadow species (SCHOLZ 1975 and literature) seem to indicate that some of them should be included, within the anthropophytes, in the group, of taxa originated under the influence of man. This problem needs further detailed studies.

SUMMARY

The problems of the classification of synanthropic plants are presented. Considering the relation of the flora to the current and historic human activity, it seems justified to divide the whole flora of a given area into two groups: A) spontaneophytes: taxa which immigrated to (allochtonic) or originated (autochtonic) in a given territory and may still occur there without man's contribution, and B) anthropophytes: taxa which owe its occurrence in a given area to man, i.e., a) they came to the area due to man: allochtonic taxa (Anthropophyta adventiva); b) originated under man's influence in the area in question: autochtonic taxa (Anthropophyta anthropogena); c) survived in a given area owing to man (Anthropophyta resistentia). Time and space relativity of terms (inter alia spontaneophyte, anthropophyte) used in the classification of synanthropic plants was emphasized. It was noted that the type of community in which a given taxon occurs is important when two problems are analysed, namely, a) spontaneity of the taxon, and b) apophytism. In relation to the above, the division of communities into two types was proposed: a) autoassociations, and b) anthropoassociations. The synanthropic flora may be distinguished in the flora of a given region. It is composed of two basic groups: apophytes and anthropophytes. Both groups are to be divided into permanent components of anthropoassociations and these which get there rather ephemerically. An anthropophyte in a narrow meaning is a taxon which owes its occurrence on the territory considered to man's activity. At the same time, however, all or at least part of its populations exist against or despite man's will. Thus the cultivated taxa which occur in a given area outside the places where they were sown or planted would belong here. Based on the analysis of terms "apophyte" and "seminatural community" and on the current treatment of meadows as seminatural communities, the author records a formal inconsistency of the term "meadow apophyte". Attention was also paid to the fact that fairly often species may be a heterogenous entity. Important consequences for the use of ecological, geographical, historical, and other diagnosis in relation to a particular species may result from the above.

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