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# Potential landscape phytocomplexes of Sudety Mountains

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Abstract

The author presents his own concept of potential landscape phytocomplexes as the structural space units on the level of plant organization higher than an ecosystem (i.e. above biogeocenosis). He also defines the concept of vegetation landscape in a typological sense. Basing on the example of Sudety Mountains and Foreland regions, the author demonstrates a method of distinguishing landscape phytocomplexes and their utilization for regional description of vegetation and geobotanical regionalization.

## I. INTRODUCTION

High cognitive and practical value of studies on spatial differentiation of vegetation has recently resulted in making this area of phytosociology one of the most important ones. Studies on spatial differentiation of vegetation result not only in a deeper knowledge on plant systems, but also give several results directly applicable to socio-economic activities. Among others, results of cartographic and phytosociological studies are indispensable for proper spatial development and planing. Hence, in recent years there was a visible intensification of studies aimed at obtaining comprehensive data on spatial differentiation of vegetation in Poland. These studies are multi-directional, present different methods of vegetation assessment, refer to various size-classes of ecological plant systems and differ as regards the scale for which spatial differentiation of vegetation is being assessed.

Polish phytosociologists are recently most interested in problems connected with spatial differentiation of the so-called potential natural vegetation. A variety of maps has been presented, allowing for an interpretation of systems occuring in reality as well as for an indication and assessment of entire environmental conditions.

Within this area of studies a review map of potential natural vegetation in Poland is being currently prepared. These studies constitute a collective effort of many Polish phytosociologists, cooperating under the leadership of prof. dr Władysław Matuszkiewicz. As a participant in these works I was able to obtain some knowledge on spatial differentiation of vegetation occuring in Polish part of Sudety Mountains. These observations, coupled with utilization of a map of potential natural vegetation, constitute basic materials of the present study.

The present paper deals with differentiation of landscape units of potential natural vegetation in Sudety Mountains region, with special reference to their spatial distribution and typological differentiation. Due to the fact that general approach to landscape units of vegetation has not been fully developed as yet, more general theoretical aspects of vegetation organization are also discussed.

## II. SUBJECT OF THE PAPER

### 1. Concept of potential natural vegetation — its meaning and utility

The term potential natural vegetation has been introduced to phytosociological literature by Tüxen (1956). It refers to a hypothetical state of vegetation that would have occurred if there had been no human activities, nor any other external disturbances, so that natural development trends could have been fully accomplished. It should be noted that the concept takes no account of time. It is assumed that changes would occur immediately, i.e. without taking into account changes that could have occurred in habitat in course of time necessary for real accomplishment of vegetation development.

Hence, potential natural vegetation does not represent any future state of vegetation since both assumptions, i.e. lack of human impact and other external influences, and abstraction from time, in reality can never be fulfilled. The term constitutes a specific theoretical construction, reflecting the actual biotic potential of habitats. This potential is defined by the type of vegetation which represents an extreme limit of natural developmental trends of the given habitat at present. As regards differentiation of vegetation on the level of phytocoenoses, potential natural vegetation is defined by syntaxonomic units (for instance, an association) to which the given phytocoenosis would belong if it developed in these conditions.

In reality vegetation is always somehow deformed in relation to such ideal state, either due to human activities, or to some natural factors (for instance fires, floods, landslips). Consequently, habitat of the defined potential plant community (potential phytocoenosis) can contain — both, in time and space several different real communities.

Set of possible plant communities for the given type of habitat, defined by the type of potential plant community, is called a dynamic circle of plant communities (Schwickerath 1954). This circle constitutes an abstract set of syntaxonomic vegetation units. Within concrete habitat (i.e. within the range of potential phytocenosis) part of this set is being realized. One of the possible communities is a fully natural final community, identical with the potential one, the latter constituting a referring point for the whole circle. The remaining communities are more or less dynamically unstable and reflect either various phases of natural succession leading into a final community, or different forms of vegetation deformation due to human activities. It should be underlined that particular forms of human impact on vegetation (for instance, agricultural practices) result in specific deformation of vegetation, but they usually do not liquidate differences existing between various types of habitats. Hence, definition of potential plant community is possible even in cases of very strong deformation of the vegetation.

Definition of potential natural vegetation is a mental process, based on the knowledge of real vegetation and its dynamic relations, as well as of the habitat conditions. Although in practice many phytosociologists define potential natural vegetation almost exclusively on the basis of the analysis of real vegetation, the whole concept is based on the assumption that there is a strict relationship between vegetation differentiation and habitat differentiation. This relationship exists both, in case of natural vegetation, and in case of anthropogenic one, although it is not always equally visible.

Now it is worth to pay some attention to the utility of the concept of potential natural vegetation.

First of all, it allows for synthetic and univocal (from ecological point of view) definition of habitat types. Consequently, maps of potential natural vegetation can be used for a variety of aims, i.e. in all cases when it is necessary to possess data on habitat differentiation (forestry, agriculture, complex geography, environmental planing etc.).

In phytosociology, concept of potential natural vegetation is used in order to make proper interpretation of the results of many studies on real vegetation. Potential natural vegetation constitutes a referring point. Hence, it allows for comparisons of data obtained in course of various detail studies, undertaken in different communities. It is especially important in case of studies on relations between vegetation and habitats, or vegetation and human activities.

Furthermore, application of this concept makes possible any abstraction from all forms of human impact on vegetation. Consequently, it is possible then to study several problems (for instance, spatial differentiation of vegetation) which are totally invisible if only actual stage of plant communities is taken into account. Frequently human impact on vegetation is so strong that it conceals other relationships. They become visible only if concept of potential natural vegetation is used.

Cognitive and practical value of studies on potential natural vegetation is commonly known. These problems have been delt with in Poland among others by Faliński (*1966, 1971, 1972a, 1972b*), Kostrowicka and Solińska-Górnicka (1973), W. Matuszkiewicz (1966, 1967), W. Matuszkiewicz and A. Matuszkiewicz (1968), W. Matuszkiewicz, A. Matuszkiewicz and Solińska-Górnicka (1968), A. Medwecka-Kornaś and J. Kornaś (1963), Solińska-Górnicka (1973), Wojterski (1973), Wojterski, Leszczyńska, Piaszyk (1973), Wojterski et al. (1973). It is, however, worth noting that current studies are almost totally restricted to plant communities, i.e. to the level of phytocoenoses differentiation.

The present work deals with differentiation of potential natural vegetation upon landscape level. It is based on current phytosociological knowledge with respect to differentiation of potential plant communities.

## 2. Landscape units of potential natural vegetation

Term vegetation, or even potential natural vegetation, does not define the type and size of vegetation systems. I am of the opinion that vegetation is characterized by a certain space and organization structure, within which specific levels of ecological organization can be distinguished. Plant systems of the given level of organization, although to some extent similar to each other, are characterized by a differentiation, so that it is possible to distinguish theoretical typological units. Furthermore, they are characterized by spatial differentiation upon each level of organization, so that it is also possible to present them in a cartographic way.

Phytocoenosis, i.e. level of plant communities, constitutes basic level of vegetation organization. Hence, most works on potential natural vegetation deal with differentiation on the level of phytocoenoses, and presented maps of potential natural vegetation represent potential plant communities.

Although studies of vegetation on this basic level are quite valuable, it must be remembered that they cannot embrace all group phenomena. Assuming that, apart from phytocoenoses level, several other levels can be distinguished in vegetation organization (see J. M. Matuszkiewicz, 1978) I would like to discuss here the level of landscape units. These units will be referred to as potential landscape phytocomplexes (J. M. Matuszkiewicz 1978).

Landscape phytocomplexes constitute spatial-organizational vegetation systems; they are real ecological units, with a defined degree of complexity. They consist of plant systems of lower organization levels, i.e. of phytocoenoses, local aggregations of phytocoenoses and dependent communities. On the other hand, landscape phytocomplexes constitute a component of the biosphere. Hence, landscape phytocomplexes can be treated as a certain level in the hierarchy of vegetation organization.

Potential landscape phytocomplexes consist of many potential plant communities of various types. In other words, within the range of one potential landscape phytocomplex we can meet a variety of habitat types, representing particular types of potential plant communities.

Internal structure of landscape phytocomplexes is characterized by a specific feature, i.e. sequence in space (zonation) of plant communities, resulting from habitat differentiation. Neighbouring plant communities form zonation series, i.e. series of spatial sequence. Types and sequence of particular communities in these zonation series are to a high degree constant for each given landscape phytocomplex (J. M. Matuszkiewicz, in print).

Formation of zonation series within landscape phytocomplexes is caused by the differentiation and subsequent arrangement of habitat types within the given space (catana). Most frequently differentiation of habitats in local conditions is connected with the sculpture of earth's surface. Consequently, arrangement of plant communities within landscape phyotocomplexes can be presented against the background of vertical differentiation of earth's surface. In other words, local hills are usually characterized by different communities than their slopes, and different than in the lowest areas, such as — for instance — stream valleys. This fact seems rather obvious if we take into consideration that along with the differentiation of earth's surface other habitat factors also change, just to mention such as water conditions, fertility and type of soil, microclimate etc. As a result we deal with different types of habitats.

Thus, it can be stated that habitat changes within one landscape phytocomplex. On the other hand, however, it possesses certain features constant for the whole area covered by the given phytocomplex. This phenomenon results in the fact that habitats connected with particular elements of earth's surface sculpture are very similar within a given phytocomplex, and occupied by plant communities of the same type. For example, within an area of one landscape phytocomplx, all local hill tops are covered by cup-moss forest *(Cladonio-Pinetum)* due to the fact that all hills are dunes, while in other phytocomplex all hills may be of kames type and would constitute a habitat for thermophilous oak forest *(Potentillo albae-Quercetum)*. Hence, differentiation of habitats within landscape phytocomplex will result in formation of zonation series of plant communities, whereas their relative uniformity (i.e. uniformity of the structure of variability) will result in certain similarity of these series.

All these facts become totally clear if we remember that epigeosphere (Isaczenko 1965) is characterized by a differentiation with respect to geosystems of different rank, resulting in certain organization and spatial hierarchy. As regards vegetation organization, one of the geosystem classes corresponds to the level of landscape phytocomplexes. It should be now defined which geosystem class corresponds to this unit of vegetation. However, this is rather difficult, mostly due to the fact that classification of complex physico-geographical units is presented differently by different authors.

Nevertheless, it seems that landscape phytocomplexes would correspond to geosystems defined as "terrains" by Marsz (1975), and "miestnosti" by Basalykas and Šleinite (1965). According to Marsz (1975) these units correspond to Kondracki's (1965) microregions. So far everything seems clear. However, Kondracki (1976) states that microregions correspond to German microchores (Neef 1963) and ecochores (Haase 1967), while I would rather assume (on the basis of an explanation I was given by G. Haase at a Symposium in Leipzig in 1978) that landscape phytocomplexes correspond more to mesochores. These problems should be clarified in future.

Taking landscape phytocomplexes as real units of an above-ecosystem level of organization, it should be assumed that their abstract typological units are represented by vegetation landscapes (Tüxen 1956), similary as in case of phytocenoses (and also dependent communities and synusia), for which typological units of vegetation are represented by syntaxa. Landscape phytocomplexes belonging to the same vegetation landscape will have similar sets of plant communities, and similar spatial structure.

It should be underlined that potential landscape phytocomplexes are characterized by a much simpler structure than real systems of this type. It results from the fact that in habitats of particular plant communities (within a range of potential phytocenoses) usually there are more than one community. Differentiation of plant communities within a biochore of potential community results from different human impacts, as well as from an impact of several natural factors. Hence, analysis of the structure of real landscape phytocomplexes should take into consideration level of local aggregations of phytocoenoses (J. M. Matuszkiewicz 1978), i.e. the so-called "sigmasociations", which constitute systems of plant communities occurring in a homogenous habitat. On the other hand, in case of potential landscape phytocomplexes (especially in case of rough analysis) this level of plant systems can be omitted in great degree. To illustrate the situation let us refer to Fig. 1.

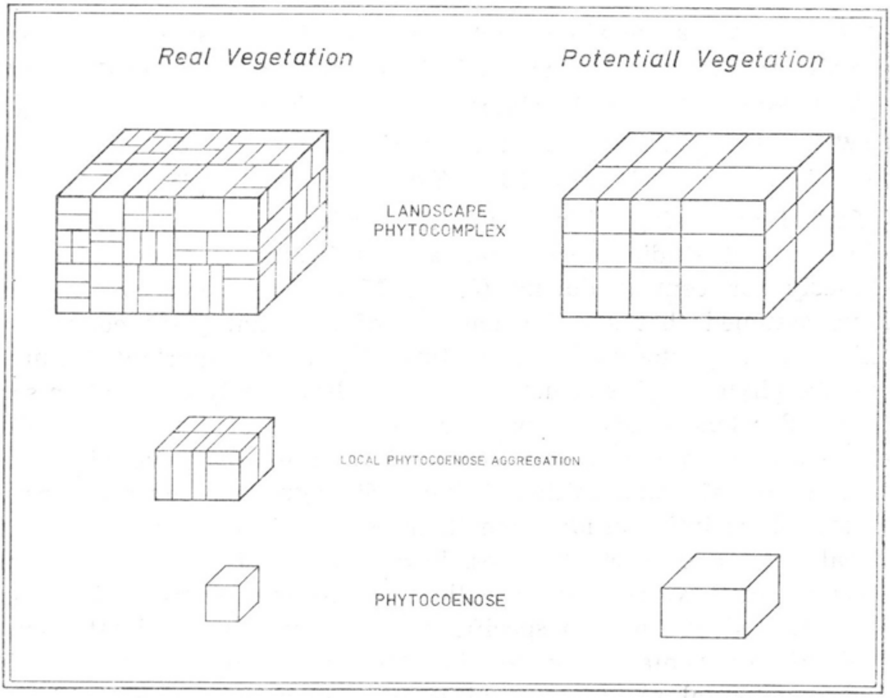



Fig. 1. Degrees of vegetation organization.

Obviously, apart from less complicated structure, potential landscape phytocomplexes are also less differentiated as regards typology of their plant communities.

Analysis of the differentiation of potential landscape phytocomplexes of a given region is characterized by similar advantages and disadvantages as an analysis of the differentiation of potential plant communities.

## III. METHOD OF DISTINGUISHING POTENTIAL LANDSCAPE PHYTOCOMPLEXES

The present work is essentially based on the map "Potential Natural Vegetation of Sudety and Przedgórze Sudeckie Regions" prepared by W. Matuszkiewicz, A. Matuszkiewicz, J. M. Matuszkiewicz (1978), published in the scale 1:300 000. I also disponed of several "working" maps in the scale 1:100 000, which allowed for a recognition of topographic situation of particular points, relations between distribution of potential plant communities and earth's surface sculpture, ground-water level, altitude, and — after confrontation with geologic maps (Rühle 1948, 1950, 1952) — also the type of geologic substrate. Furthermore, taking part in cartographing of potential plant communities, I have gathered several observations, which served for proper interpretation of the map. To a certain extent I also used phytosociological works, especially those containing an analysis of relations between distribution of plant communities and habitat conditions (Celiński 1965; Fabiszewski 1968, 1970; Hueck 1939; W. Matuszkiewicz, A. Matuszkiewicz 1960, 1967, 1974; Sokołowski 1963).

Method of distinguishing potential landscape phytocomplexes used during present studies constituted a modification of the method used previously for central Poland (J. M. Matuszkiewicz, in print). I have assumed that specific zonation of potential plant communities which form a phytocomplex constitutes the most important feature of landscape phytocomplex structure. Hence, I have analysed zonation series in particular land areas, taking into account sets of plant communities, their sequence in series, and share of surface area covered by particular types of communities. I have distinguished several types of habitats taking into consideration their position in a series, namely: top of local hill, upper part of slopes, lower part of slopes, base of slopes, valleys of small water courses, valleys of bigger streams, and wetlands with restricted outflow. In specific cases I have also paid attention to hill slopes differentation in relation to their exposition. I have then analysed potential plant communities occupying particular positions in zonation series of successive land areas. Range of potential landscape phytocomplex was defined as an area upon which zonation series of potential plant communities are similar. I have also paid attention to territorial compactness of each landscape phytocomplex. In the final stage potential landscape phytocomplexes were presented on a map of potential plant communities, in the scale 1:300 000; precision of delimitation being adapted to this scale.

## IV. CHARACTERISTIC OF THE STUDY AREA

Area under study occupies south-western part of Poland, covering over 3% of the total area of our country. It is situated in the vicinity of Wrocław, south and west of this city.

From physico-geographical point of view the whole area belongs to the Sudety Subprovince. It embraces belt of Sudety Mountains, its plateau, and foreland. The region is highly differentiated both, as regards the altitude (from about 100 to 1600 m above sea level), and geological structure, climate, and several other factors.

Basing on physico-geographical division made by Kondracki (1965, 1977), six main physico-geographical regions should be distinguished here. As regards their potential vegetation the regions may be briefly characterized as follows:

Western Sudety. This macroregion embraces Izerskie Mountains, Kaczawskie Mountains, Karkonosze Mountains, Rudawy Janowickie and Jeleniogórska valley. All the mountains (with the exception of Kaczawskie Mountains) are of poor granite and metamorphic rocks. Consequently, potential plant communities of lower forest belt, and of the plateau, represent poorer forest forms. In the plateau poor oak-hornbeam forests (*Galio-Carpinetum* association) dominate, while lower forest belt is predominated by *Luzulo-Fagetum* association.

This region is characterized by strong layering of the vegetation, resulting from climatic differences noted upon various altitudes. We note here plateau level (domination of oak-hornbeam forest habitats), level of lower forest belt (communities of *Fagion* alliance), level of higher forest belt (spruce forest) level of subalpine vegetation (*Pinus mughus* shrubs), and part of alpine vegetation level at the top of Śnieżka.

Middle Sudety. Embrace a series of medium height mountains (maximal altitude 1084 m) and a few hollows and lowland zones. Main mountain belts are: Wałbrzyskie, Kamienne, Sowie, Stołowe, and Bystrzyckie.

Geological structure of this region is highly complicated, its most important feature is frequent occurance of neutral or alkaline rocks.

Layering of vegetation is less pronounced in this region, mostly due to lower altitude. We deal here with plateau level (oak-hornbeam forest), and lower forest belt. The latter embraces both, poor beech forests *Luzulo-Fagetum)*, and fertile beech forests *(Dentario enneaphyllidis-Fagetum)*. Upper forest belt is developed only partially, at the highest points of Sowie Mountains (Wielka Sowa 1014 m) and Orlickie Mountains (Orlica 1084 m above sea level).

Eastern Sudety. Only small part of this region lies within Polish territory. It embraces Śnieżnik massif, Złote Mountains, and Opawskie Mountains. The highest point of this part of Sudety is Śnieżnik (1422 m).

Geological character of this region is rather differentiated. Krowiarki Mountains are characterized by the occurance of limestone, covered by rare beech forest of the *Cephalanthero-Fagion* suballiance.

Layering of vegetation is clearly visible (levels: plateau, lower forest belt, higher forest belt, subalpine). Contrary to Western Sudety no *Pinus mughus* is found here at the subalpine level. Subalpine level at the top of Śnieżnik is formed of subalpine low grasslands.

Western Sudety Plateau. This region is situated north of Sudety Mountains. It is a plateau of the altitude of 200 — 500 m above sea level, with highly differentiated earth's surface sculpture, and variable geological character. Layering of vegetation is not noted. Plateau communities occur over the whole territory.

S u d e t y F o r e l a n d. This region is situated north-east of Sudety Mountains. Its average altitude ranges between 150 and 300 m above sea level. A few higher points are also noted, the highest one being Ślęża massif (718 m).

Geological character is less variable. The region is predominated by loesses, but basalt rocks (granite, gabbro, serpentine etc.), as well as river silts, are also frequent. Earth's surface sculpture is strongly differentiated. Along with low or slightly hilly areas we meet here also higher hills.

To a large extent this region is overgrown with typical lowland vegetation. Only Ślęża massif is characterized by a plateau and lower forest belt levels.

Ś l ą s k o - Ł u ż y c k a P l a i n. Northern part of the area under study embraces a small part of Śląsko-Łużycka Plain. It is a lowland section, 150 m above sea level, rather flat. Loesses predominate over the whole area.

Vegetation is rather uniform; no layering is noted. Fertile oak--hornbeam forest *(Galio-Carpinetum)* is the most frequent type of potential plant community.

## V. DIFFERENTIATION OF POTENTIAL LANDSCAPE PHYTOCOMPLEXES UPON THE AREA UNDER STUDY

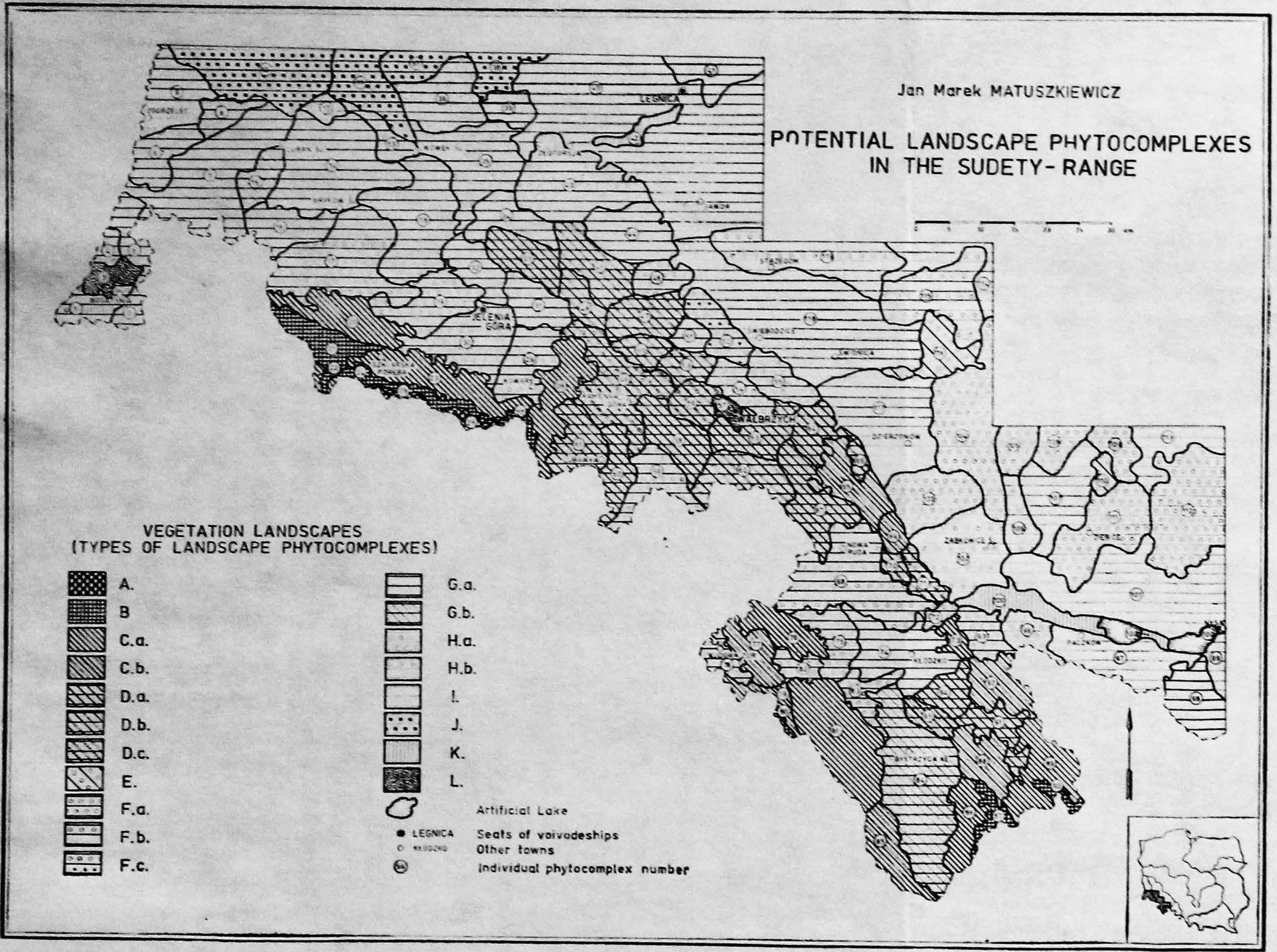
### 1. Number, size, and arrangement of potential landscape phytocomplexes

119 potential landscape phytocomplexes were distinguished upon the area under study (about 10 thousand km$^2$). It should be, however, pointed out that the basic material of this study consisted of a mean scale map of potential plant communities. Hence, some phytocomplexes might have been omitted, especially in case when similar phytocomplexes lied close to each other. Consequently, data on the number and size of landscape phytocomplexes should be treated as an approximation.

Analysis of potential landscape phytocomplexes showed that they can considerably vary in size. The smallest ones covered an area of about 15 km$^2$, the biggest ones — over 400 km$^2$. Most frequently size of landscape phytocomplexes ranges between 20 and 80 km$^2$. Also bigger complexes (80—160 km$^2$) are frequent. Phytocomplexes of other sizes are rare.

Generally speaking, regions with highly differentiated habitat conditionts are characterized by phytocomplexes of smaller size, and vice versa. Consequently, in mountain areas (especially in Middle Sudety) potential landscape phytocomplexes are smaller than in lowland areas.

Arrangement of potential landscape phytocomplexes upon the area under study reflects significant differences in habitat conditions,




A — Landscape of dwarf pine zone.
B — Landscape of spruce forests in the upper forest belt,
C — Landscape of beech forests in the lower forest belt,
  a. variant with acidophilous beech forests dominating,
  b. variant with a great share of fertile beech forests.
D — Landscape of beech forests and submontane oak-hornbeam forests,
  a. variant with acidophilous beech forests dominating,
  b. variant with fertile beech forests,
  c. variant with beech forests with orchids.
E — Landscape of beech forests and acidophilous oak forests.
F — Landscape of submontane oak-hornbeam forests and acidophilous oak forests,
  a. variant with a great share of oak forests,
  b. variant with a little share of oak forests,
  c. variant with thermophilous oak forests.
G — Landscape of submontane oak-hornbeam forests,
  a. typical variant,
  b. variant with fertile submontane beech forests.
H — Landscape of acidophilous oak forests and lowland oak-hornbeam forests,
  a. variant with a great share of oak forests,
  b. variant with a little share of oak forests.
I — Landscape of lowland oak-hornbeam forests.
J — Landscape of lowland oak-hornbeam forests and pine-oak mixed forests.
K — Landscape of ash-elm carrs.
L — Devastated landscape.

especially with respect to vertical differentiation, but also as regards geological structure. Looking at the map it is readily visible that even without, typological units, it would be quite easy to imagine the earth's sculpture of this area. The map shows very clearly that there is distinct difference between mountain area, lowland, and foreland area.

## 2. Vegetation landscapes of the area under study

Particular potential landscape phytocomplexes were characterized as regards their arrangement, surface area, and sequence of potential plant communities in zonation series. Hence, it was possible to make comparisons, and then to distinguish typological units. Vegetation landscape (Tüxen 1956) was selected as the basic typological unit, reflecting differentiation of vegetation on the level of landscape phytocomplexes. Lower typological units are represented by variants of vegetation landscape, and higher — by groups of vegetation landscapes.

Types of distinguished potential landscape phytocomplexes can be described as follows:

### a. Landscape of subalpine *Pinus mughus* shrubs

Landscape phytocomplexes representing landscape of *Pinus mughus* shrubs (no. 25 and 26) from a subalpine level of Karkonosze Mountains. Other regions do not have such phytocomplexes due to low altitude.

Systems of plant communities in these two phytocomplexes can be generally characterized as follows. Upper parts of mountain ribs constitute potential habitats of *Pinus mughus* shrubs. At present they are partly covered by poor meadows (*Carici-Nardetum*) association which constitute a relic of sheepherding in Karkonosze Mountains, and partly by natural community of *Pinetum mughi sudeticum*. Only the highest points are occupied by a totally different community, i.e. alpine low grassland belonging to the *Caricetea curvulae* class.

Mountain slopes, similary as ribs, constitute potential habitat of *Pinus mughus* shrubs, although in case of very steep slopes this habitat is substituted by grass communities belonging to the *Calamagrostion* alliance of the *Betulo-Adenostyletea* class (most frequently *Crepido-Calamagrostietum villosae* association).

Close to water courses herbs or bush communities are found, most frequently belonging to the *Adenostylion* alliance of the *Betulo-Adenostyletea* class (associations: *Adenostyletum allinae, Athyrietum alpestris, Pado-Sorbetum*). Wetlands are occupied by peat plants communities associations: *Emptero-Trichophoretum austraci, Caricetum fuscae subalpinum,* and *Bartsio-Caricetum fuscae).*

It should be underlined that these phytocomplexes are highly differentiated as regards their vegetation (see: W. Matuszkiewicz, A. Matuszkiewicz 1974), so that the above picture is a simplified one. Schematic presentation of this differentiation is given in Fig. 2A.

b. Landscape of spruce forests in the upper forest belt

Potential landscape phytocomplexes representing landscape of upper belt spruce forests (no: 21, 24, 27, 80, 87, 90) constitute level of upper forest belt. They cover parts of about 1000 — 1250 m above sea level. Potential plant communities of these phytocomplexes are not differentiated — almost all habitats are occupied by upper belt spruce forest (*Plagiothecio-Piceetum hercynicum* association) of different forms: typical *(P.-P. h. typicum),* fern *(P.-P. h. filicetosum),* and bog one *(P.-P. h. sphagnetosum).* Extremely boggy habitats contain peat bogs of the *Schenchzerio-Caricetea fuscae* class. Schematic presentation of vegetation differentiation in these phytocomplexes is given in Fig. 2B.

c. Landscape of beech forests in lower forest belt

Potential landscape phytocomplexes no. 20, 22, 23, 28, 65, 69, 73, 76, 77, 79, 81, 85, 86, 88, 89 and 92 represent this landscape. Differentiation of potential plant communities in these phytocomplexes can be presented as follows:

Higher parts are covered by spruce-fir forest of lower forest belt (*Abieti-Piceetum montanum* association) or acidophilous beech forests (*Luzulo nemorosae-Fagetum* association). Slopes constitute potential habitats for beech forest which, depending on the soil, can be either poor *(Luzulo-Fagetum)* or fertile *(Dentario-enneaphyllidis-Fagetum)* of the montane form.

As regards surface area distribution, landscape of lower beech forest belt can be divided into two variants: variant with the predomination of poor beech forests (phytocomplexes no: 20, 22, 23, 28, 73, 76, 81, 86, and 89), and variant with high share of fertile beech woods (no: 65, 69, 77, 79, 85, 88, and 92). Usually, share of fertile beech forest increases down along the slope, i.e. from higher to lower parts.

In habitats connected with small water courses potential landscape phytocomplexes of the lower beech forest belt usually contain sycamore forests belonging to the *Acerion pseudoplatani* suballiance. In lower zones they are sometimes substituted by ash riparion forest *(Carici re-*

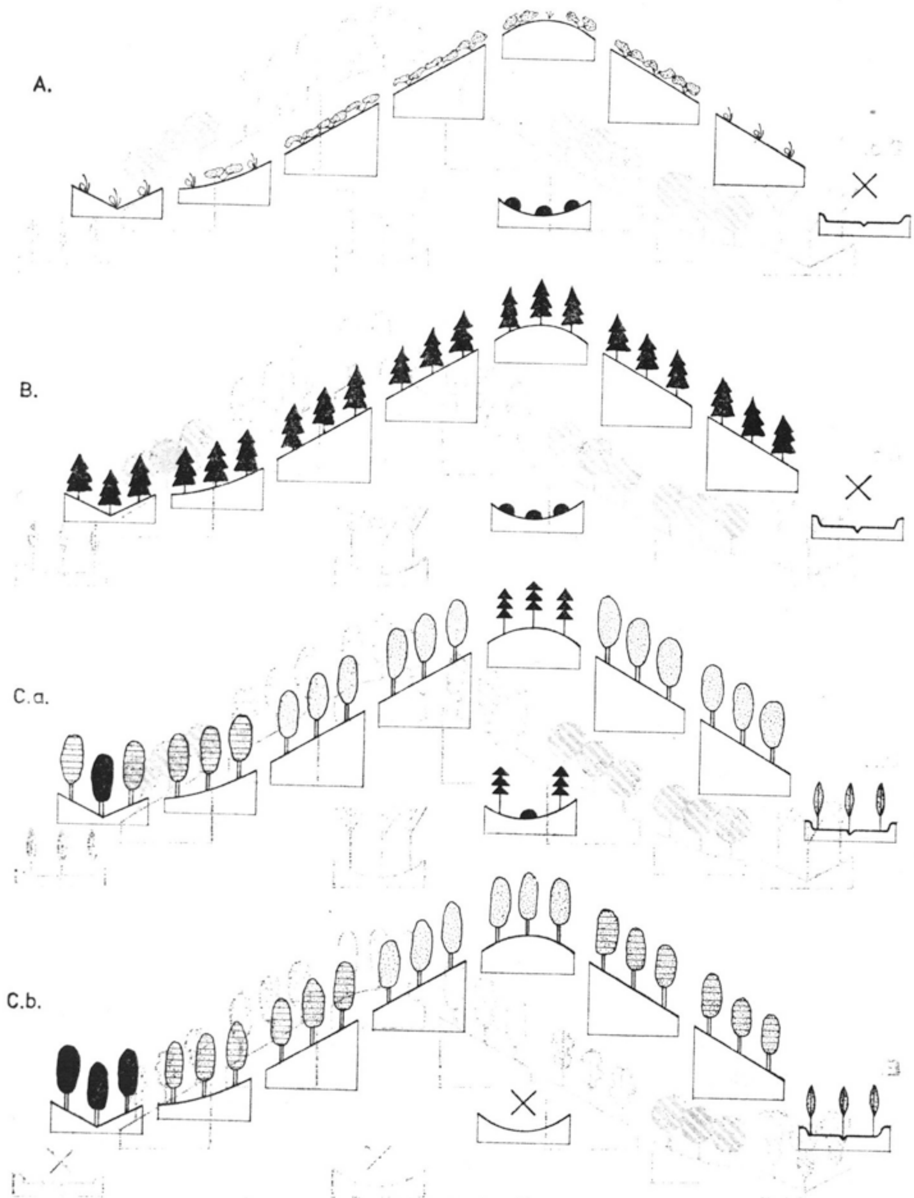



Fig. 2 A—C

**Explanation of the symbols and the legend to the figures on this and on the following pages, are situated on page 15.**

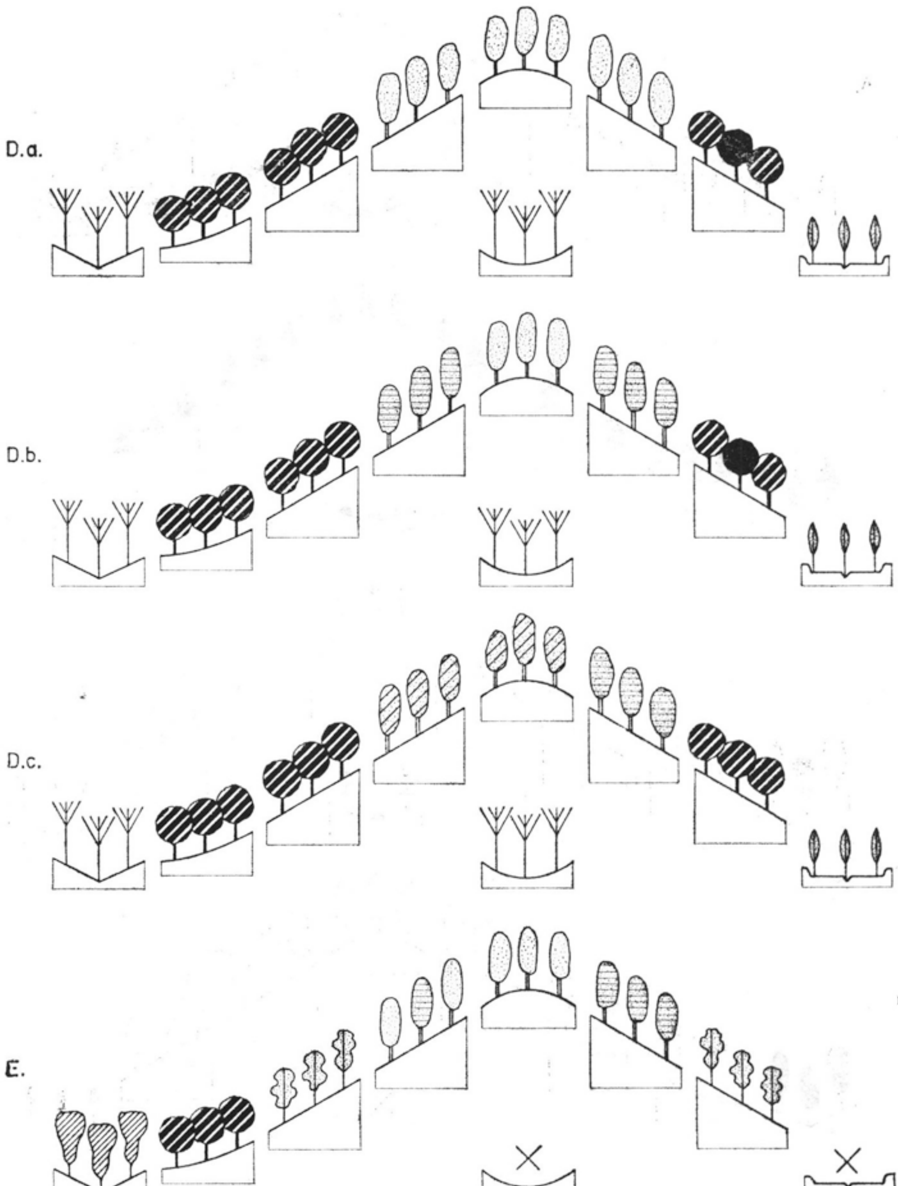



Fig. 2 D—E

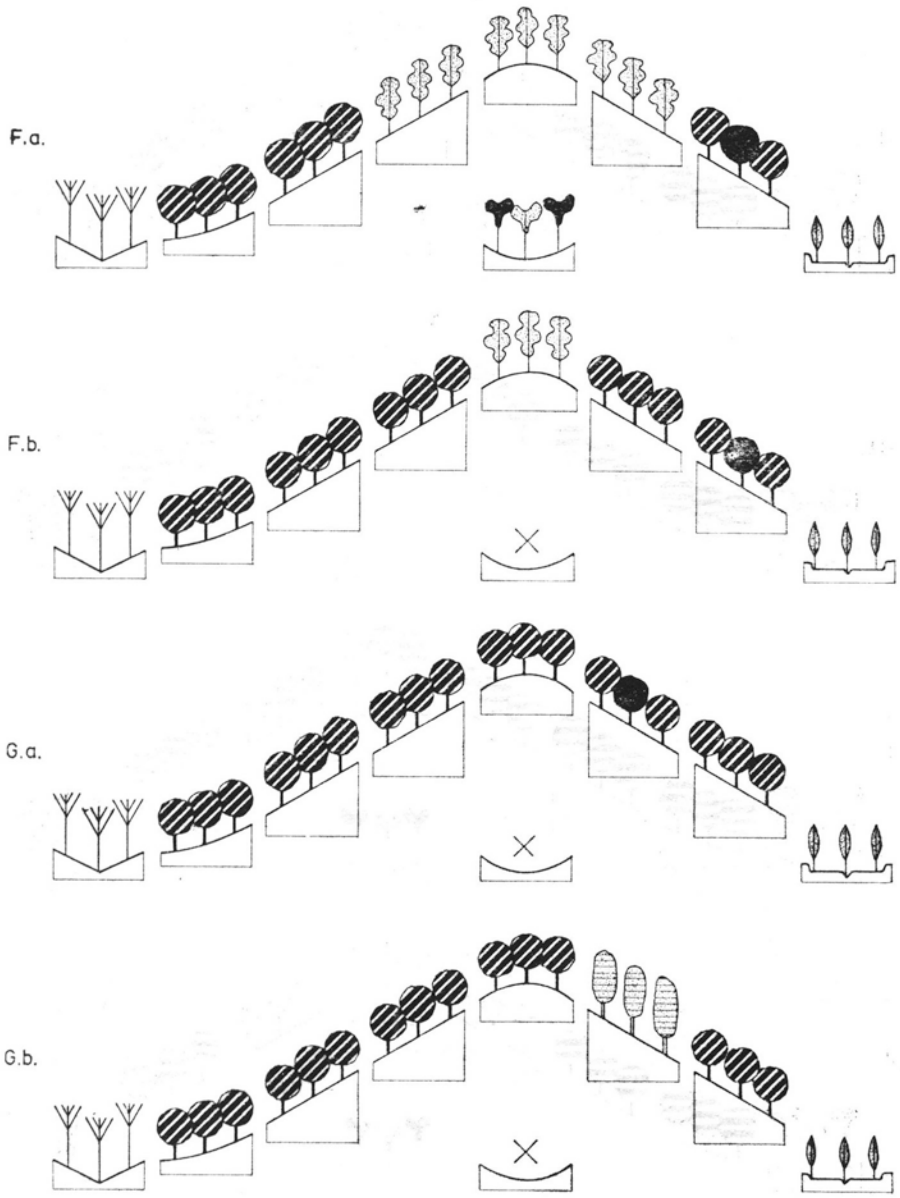



Fig. 2 F—G

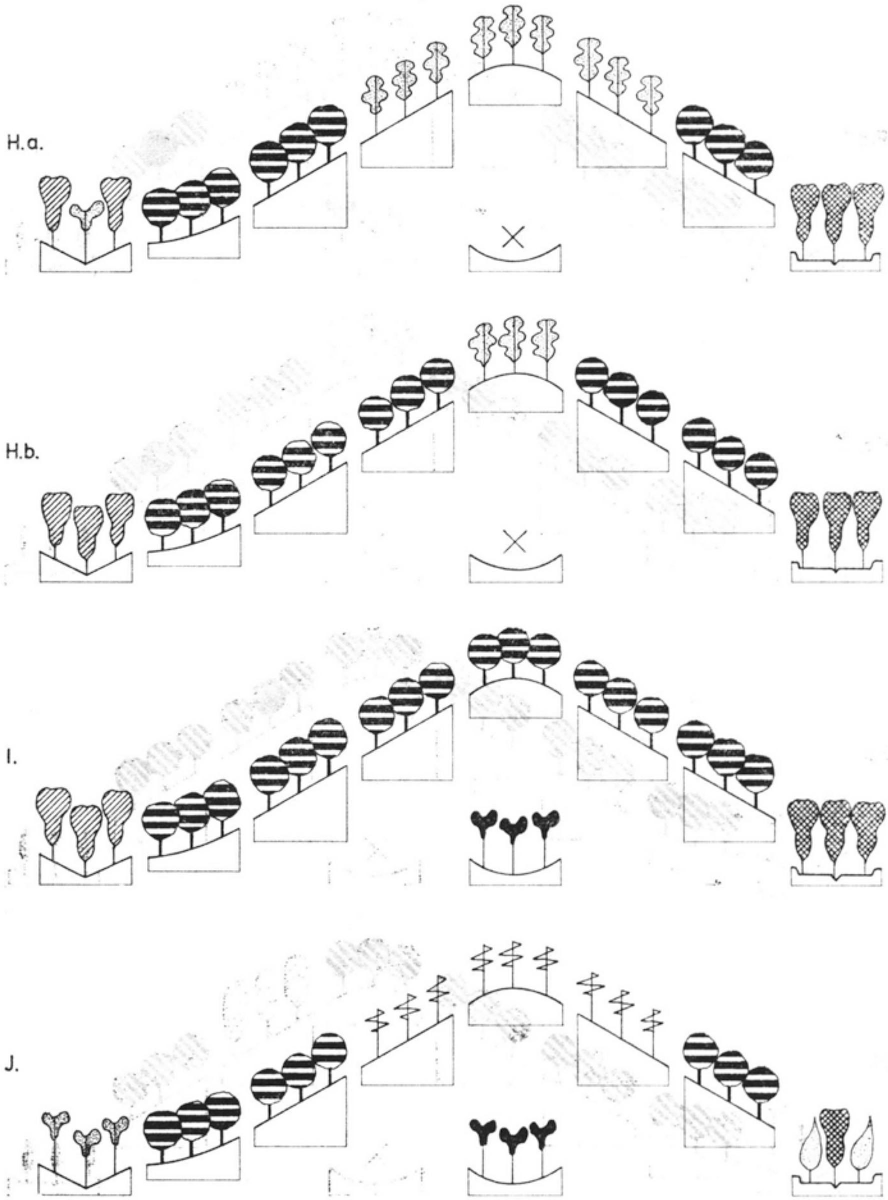



Fig. 2 H—J

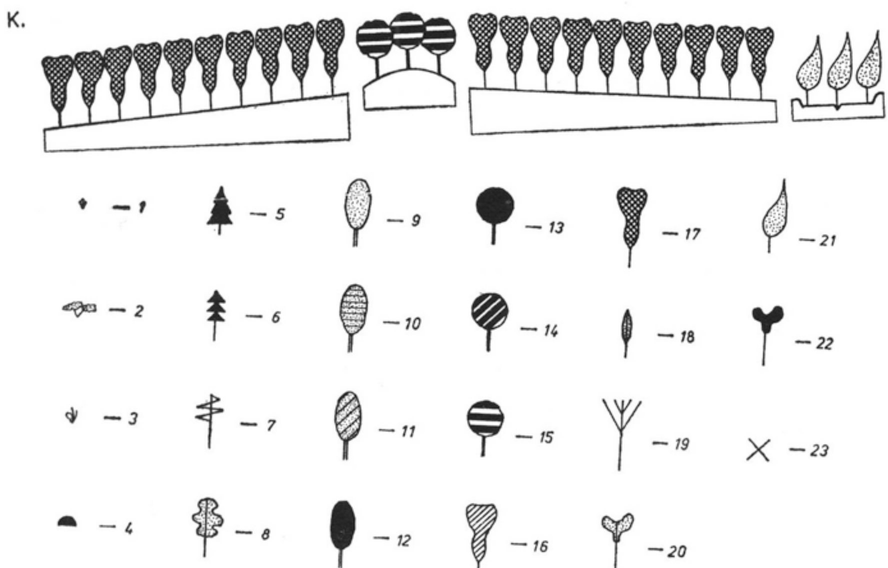



Fig. 2. Scheme of the toposequence of potential communities in different vegetation landscapes (denotations A—K as in the legend to the map).

Symbols of potential communities:

**1** — *Carici-Festucetum supinae (Caricetea-Curvulae)*; **2** — *Pinetum mughi sudeticum (Vaccinio-Piceetea)*; **3** — *Betulo-Adenostyletea*; **4** — *Oxycocco-Sphagnetea* and *Scheuchzerio-Caricetea fuscae*; **5** — *Piceetum hercynicum (Vaccinio-Piceetea)*; **6** — *Abieti-Piceetum montanum (Vaccinio-Piceetea)*; **7** — *Pino-Quercetum (Dicrano-Pinion, Vaccinio-Piceetea)*; **8** — *Luzulo-Quercetum (Quercetea robori-petraeae)*; 9 — *Luzulo-Fagetum (Fagion, Querco-Fagetea)*; **10** — *Dentario enneaphyllidis-Fagetum (Fagion, Querco-Fagetea)*; **11** — *Taxo-Fagetum* (?) *(Cephalanthero-Fagion, Querco-Fagetea)*; **12** — *Lunario-Aceretum (Acerion, Querco-Fagetea)*; **13** — *Aceri-Tilietum (Carpinion, Querco-Fagetea)*; **14** — *Galio-Carpinetum* — submontane form *Carpinion, Querco-Fagetae)*; **15** — *Galio-Carpinetum* — lowland-upland form; **16** — *Ficario-Ulmetum chrysosplenietosum (Alno-Padion, Querco-Fagetae)*; **17** — *Ficario-Ulmetum typicum*; **18** — *Alnetum incanae (Alno-Padion, Querco-Fagetae)*; **19** — *Carici remotae-Fraxinetum (Alno-Padion, Querco-Fagetae)*; **20** — *Circaeo-Alnetum (Alno-Padion, Querco-Fagetae)*; **21** — *Salici-Populetum (Salicetea purpureae)*; **22** — *Carici elongatae-Alnetum (Alnetea glutinosae)*; **23** — lack of the corresponding habitats *motae-Fraxinetum).* Valleys of bigger streams are, as a rule, a habitat of montane alder swamp forests *(Alnetum incanae).*

Peat bog habitats are rather rare in this type of landscape phytocomplexes. Nevertheless, even large bog area can be found upon certain zones (for instance, Zieleniec in Bystrzyckie Mountains or Batorowo in Stołowe Mountains). Bog habitats contain either peat bog communities (in deep peats), or communities of swampy spruce forests of a lower forest belt, most probably belonging to the *Abieti-Piceetum montanum* association. Schemes of the differentiation of potential plant communities of this landscape are presented in Fig. 2: Ca and Cb.

### d. Landscape of beech forests and submontane oak-hornbeam forests

Upon the area of low mountains, as for instance in Kamienne, Wałbrzyskie, or Kaczawskie Mountains, we meet potential landscape phytocomplexes representing beech forests and oak-hornbeam forests. In these phytocomplexes hill peaks and upper parts of slopes are occupied by beech forests of various types, whereas lower areas form a habitat of submontane oak-hornbeam forests. *Galio-Carpinetum* association of submontane form. Depending on the syntaxonomic affiliation of beech forest three variants of this landscape can be distinguished.

First variant embraces potential landscape phytocomplexes (no. 33, 58, 60, 61, 63, 64, 67, 91, and 94) in which beech forests are represented almost exclusively by acidophilous beech forest *(Luzulo-Fagetum).*

Second variant is represented by potential landscape phytocomplexes no: 45, 47, 48, 50, 53, 62, 66, nad 70, characterized by high share of fertile beech forests *(Dentario enneaphyllidis-Fagetum).*

Differentiation of plant communities in potential landscape phytocomplex no. 95 is quite interesting. Hills and upper parts of southern slopes of low mountains (Krowiarki Mountains) are covered with limestone beech forests of the *Cephalanthero-Fagion* suballiance, whereas in upper parts of northern slopes we meet beech forests belonging to *En-Fagion* suballiance *(Dentario enneaphyllidis-Fagetum)* of a very specific form. This phytocomplex is represented by a variant with high share of beech forest with orchids, and submontane oak-hornbeam forests.

In all phytocomplexes of the beech wood and submontane oak-hornbeam forest landscape, riparian ash forests (*Carici remotae-Fraxinetum*) occur close to small water courses. Valleys of bigger streams contain habitats of mountain alder swamp forest *(Alnetum incanae).* Bog habitats are very rare in this group of phytocomplexes; sometimes wet habitats occur, usually covered by communities of the *Carici remotae-Fraxinetum* association. Schematic differentiation of vegetation in this group of phytocomplexes is presented in Fig. 2: Da, Db, and Dc.

e. Landscape of beech forests and acidophilous oak forests

Potential landscape phytocomplexes no. 110 and 116 were classified as landscape of beech forests and acidophilous oak forests. They occur in higher parts of Sudety Foreland (for instance Ślęża massif). Upper parts of slopes are occupied by beech forests (both acidophilous and eutrophic), while lower parts constitute habitats of acidophilous oak forests belonging to the *Luzulo nemorosae-Quercetum* association.

Hill bases are covered by oak-hornbeam forests, and valleys of small streams constitute habitats of ash-elm carrs riparian forests *(Ficario--Ulmetum chrysosplenietosum)*. There are no bigger streams in this area, and marshes are so small that they could not have been included in the mean scale map. Schematic distribution of potential plant communities in landscape phytocomplexes of this group is presented in Fig. 2E.

f. Landscape of submontane oak-hornbeam forests and acidophilous oak forests

Frequently plateau areas form landscape phytocomplexes classified as submontane oak-hornbeam forests and acidophilous oak forests. Upper parts of hills and slopes are characterized by the presence of acidophilous oak forests *(Luzulo-Quercetum)*. Lower parts of slopes are occupied by habitats of submontane oak-hornbeam forests (*Galio-Carpinetum* of the submontane type). Close to small water courses there are riparian ash forests *(Carici remotae-Fraxinetum)*, while valleys of bigger streams are overgrown with montane swamp alder forests *(Alnetum incanae)*.

Boggy habitats are very rare, and their potential communities are represented either by swamp alder forests *(Carici elongatae-Alnetum)*, or riparian ash-alder forests *(Circaeo-Alnetum)*.

Landscape of submontane oak-hornbeam forests and acidophilous oak forests should be differentiated into two variants, depending on the share of oak forests. This way we can distinguish variants with high and low share of oak forests.

Potential landscape phytocomplex no. 52 constitutes a specific form of the landscape under discussion. In this phytocomplex upper parts of southern slopes are occupied by oak forests with high share xerothermic plants. So far, it is not clear whether these communities constitute a form of *Luzulo-Quercetum* association (*Quercetea robori-petraeae* class), or should be classified to the *Quercetalia pubestentis* order, *Querco-Fagetea* class.

Differentiation of potential plant communities in this landscape is presented in Fig. 2: Fa, Fb.

g. Landscape of submontane oak-hornbeam forests

Potential landscape phytocomplexes belonging to this landscape occur on the plateau (mainly Izerskie Plateau) and in Kłodzka valley.

Submontane oak-hornbeam forests *(Galio-Carpinetum* submontane form) constitute most typical plant community, predominating over the whole area. They occupy habitats from hill tops to stream valleys. Only the valleys are covered by riparian ash forests belonging to the *Carici remotae-Fraxinetum* association (near small streams), or mountane swamp alder forests (*Alnetum incanae*) near bigger streams.

In some cases upper points (especially north-western slopes) can constitute habitats of fertile beech forests (*Dentario enneaphyllidis-Fagetum*) of the submontane form. These phytocomplexes form a specific variant of submontane oak-hornbeam forest landscape, with high share of beech forests.

Schemes illustrating variability of potential vegetation in this group of landscape phytocomplexes are presented in Fig. 2: Ga, Gb.

h. Landscape of lowland oak-hornbeam forests and acidophilous oak forests

Area of Sudety foreland is frequently characterized by potential landscape phytocomplexes representing landscape of lowland oak-hornbeam forests and acidophilous oak forests. Within these phytocomplexes hill tops, and upper parts of slopes, are occupied by oak forests belonging to the *Luzulo-Quercetum* association. On the other hand, lower parts of slopes constitute habitats of oak-hornbeam forests *(Galio-Carpinetum* in the lowland form). Close to small water courses riparian ash-alder forests *Ficario-Ulmetum chrysosplenietosum*) occur, or — less frequently — riparian ash-alder forests (*Circaeo-Alnetum*). River valleys are occupied by habitats of riparian forest communities, belonging to the *Ficario-Ulmetum typicum* subassociation.

This landscape is very similar to the landscape of submontane oak--hornbeam forests and acidophilous oak forests. Nevertheless, it differs from the latter not only as regards its affinity to other altitude forms, but most of all by the presence of different type of riparian forests.

Landscape of lowland oak-hornbeam forests and acidophilous oak forests is differentiated into two variants, depending on the share of oak forests.

Variability of potential plant communities in zonation series of the landscape under discussion is presented schematically in Fig. 2: Ha, Hb.

2

i. Landscape of lowland oak-hornbeam forests

Potential landscape phytocomplexes no. 9, 40, 41, 97, 99, 101, 107, 113, 114, 117, and 118 represent landscape of lowland oak-hornbeam forests. They occupy areas of fertile soil, usually only slightly differentiated with respect to earth's surface sculpture.

Lowland oak-hornbeam forest *(Galio-Carpinetum)* constitutes a predominating plant community in these phytocomplexes. Most frequently it represents a fertile form. Oak-hornbeam forests occupy here both, tops of local hills, and lowler areas, the only exception being wetland habitats. Local variability of habitats is reflected only in an internal differentiation of oak-hornbeam forest communities.

Riparian ash-elm forests constitute potential plant communities in valleys of water courses. In case of small streams they belong to the *Ficario-Ulmetum chrysosplenietosum* subassociation, whereas in river valleys — to *Ficario-Ulmetum typicum* (see J. Matuszkiewicz 1976). Rare bog areas are occupied by swamp alder forests *(Carici elongatae-Alnetum).*

Scheme of the differentiation of potential plant communities in this landscape is presented in Fig. 2: I.

j. Landscape of oak-hornbeam forests and pine-oak mixed forests

In the north-western part of the region under study, at the border with northern area of Dolnośląskie Forests, we meet potential landscape phytocomplexes representing landscape of oak-hornbeam and mixed pine-oak forests. Hills and upper parts of slopes constitute habitats of mixed pine-oak forests of the *Dicrano-Pinion* alliance *(Pino-Quercetum* association). Low areas are occupied by poor oak-hornbeam forests.

Valleys of smaller streams are occupied in this landscape by riparian ash-alder forests *(Circaeo-Alnetum),* whereas close to bigger streams we meet riparian ash-elm forests of riparian willow-poplar communities (*Salici-Populetum* association). Bog areas represent swamp alder forest *(Carici elongatae-Alnetum).*

Landscape of oak-hornbeam and mixed pine-ash forests develops in lowland areas, on sandy soil. Its typical scheme of variability of potential plant communities is presented in Fig. 2: J.

k. Landscape of riparian ash-elm forests

In valleys of bigger rivers develop potential landscape phytocomplexes in which riparian ash-elm forests *(Ficario-Ulmetum typicum)* constitute dominating plant community. These communities potentially occupy a larger part of the accumulation plain of rivers. Only the highest points of valleys can be occupied by habitats of oak-hornbeam forests, whereas areas neighbouring the rivers are covered by riparian willow-poplar communities *(Salici-Populetum)*.

In the present work only two potential landscapes of this type were distinguished, i.e. by the Nysa Kłodzka and Kaczawa rivers. This is caused by the scale of the map. If the scale was bigger it would be probably possible to distinguish a few more complexes of this type (for instance, by the Nysa Łużycka river). Due to the necessity of being more general I had to omit them.

Scheme of the distribution of potential plant communities in phytocomplexes belonging to the landscape of riparian ash-elm forests is presented in Fig. 2: K.

## 2. Devastated landscape

In the region under study I have distinguished two potential landscape phytocomplexes in which spatial structure of potential plant communities is determined, most of all, by human activities. As a result habitat conditions are totally changed. One case refers to a quarry and a dumping ground of rock material, the other to waste heaps of underground mines.

Potential plant communities of these two areas were not identified, so it may happen that they do not represent uniform units. Common feature of both areas is not the distribution and zonation of potential plant communities, but significant deformation of natural conditions and totally anthropogenic structure of these landscape phytocomplexes.

## 3. Groups of vegetation landscapes in the region under study

Comparing the above vegetation landscapes it is possible to distinguish several groups of them. First group embraces landscapes of upper mountain parts (a, b), which are predominated by communities belonging to the *Vaccinio-Piceion* alliance, from *Vaccinio-Picetea* class. This group can be called a group of high mountain vegetation landscapes.

Second group would embrace vegetation landscapes which are predominated, or characterized by high share of beech forests, of the *Fagion silvaticae* alliance, *Querco-Fagetea* class (c, d, e). This group differs from the first one by a totally different composition of plant communities. It can be called a group of low mountain vegetation landscape.

Third group embraces landscapes predominated by submontane oak-hornbeam forests (f, g). Apart from oak-hornbeam forests this group is also characterized by high share of communities of *Quercetea robori-petraeae* class (especially *Luzulo-Quercetum* association). Riparian forest habitats are occupied by typical submontane communities of *Carici remotae-Fraxinetum* and *Alnetum incanae* associations. Compared to previous group, this group is characterized by significantly lower share of communities from the *Fagion silvaticae* alliance, as well as by sporadic occurrence of typical lowland communities, such as *Circaeo-Alnetum* and *Carici elongatae-Alnetum.* This group should be called a group of submontane vegetation landscapes.

The remaining landscapes (with the exception of devastated ones) should be classified as a group of lowland landscapes. However, this unit is treated here as a preliminary one since in all probability it is not uniform. Vegetation landscapes grouped here (h, i, j, k) differ from the previous ones mostly by the occurrence of riparian forest communities. While in the group of low mountain and submontane landscapes riparian forests were represented by *Carici remotae-Fraxinetum* and *Alnetum incanae* associations, in lowland landscapes they are represented by the following associations: *Salici-Populetum, Ficario-Ulmetum,* and *Carici-Alnetum.* In this group of landscapes we also meet lowland form of oak-hornbeam forest, as also mixed oak-pine forests of the *Dicrano-Pinion* alliance.

Lowland landscapes distinguished in this work can be probably divided into 2 or 3 groups. The most preferable criterium of this division would be the presence of subatlantic communities in poor habitats, of the *Quercetea robori-petreae* class, or of subcontinental communities of the *Dicrano-Pinion* alliance, *Vaccinio-Piceetea* class. It was not possible to clarify this problem in the present work due to the fact that lowland areas only partly occurred in the region under study.

It is quite obvious that devastated landscape (1) cannot be classified.

As it was mentioned before, groups of vegetation landscapes, similary as the landscapes themselves, constitute only typological units. Nevertheless, it is quite clear that these units are characterized by significant inequality of spatial distribution. Knowing this, we have a good basis for geobotanical division of the region under study.

## VI. UTILIZATION OF THE MAP OF POTENTIAL LANDSCAPE PHYTOCOMPLEXES FOR GEOBOTANICAL REGIONALIZATION

Map of potential landscape phytocomplexes presented in this study can be rather well utilized as a basic material for geobotanical regionalization of this region of the country. It can be assumed that potential

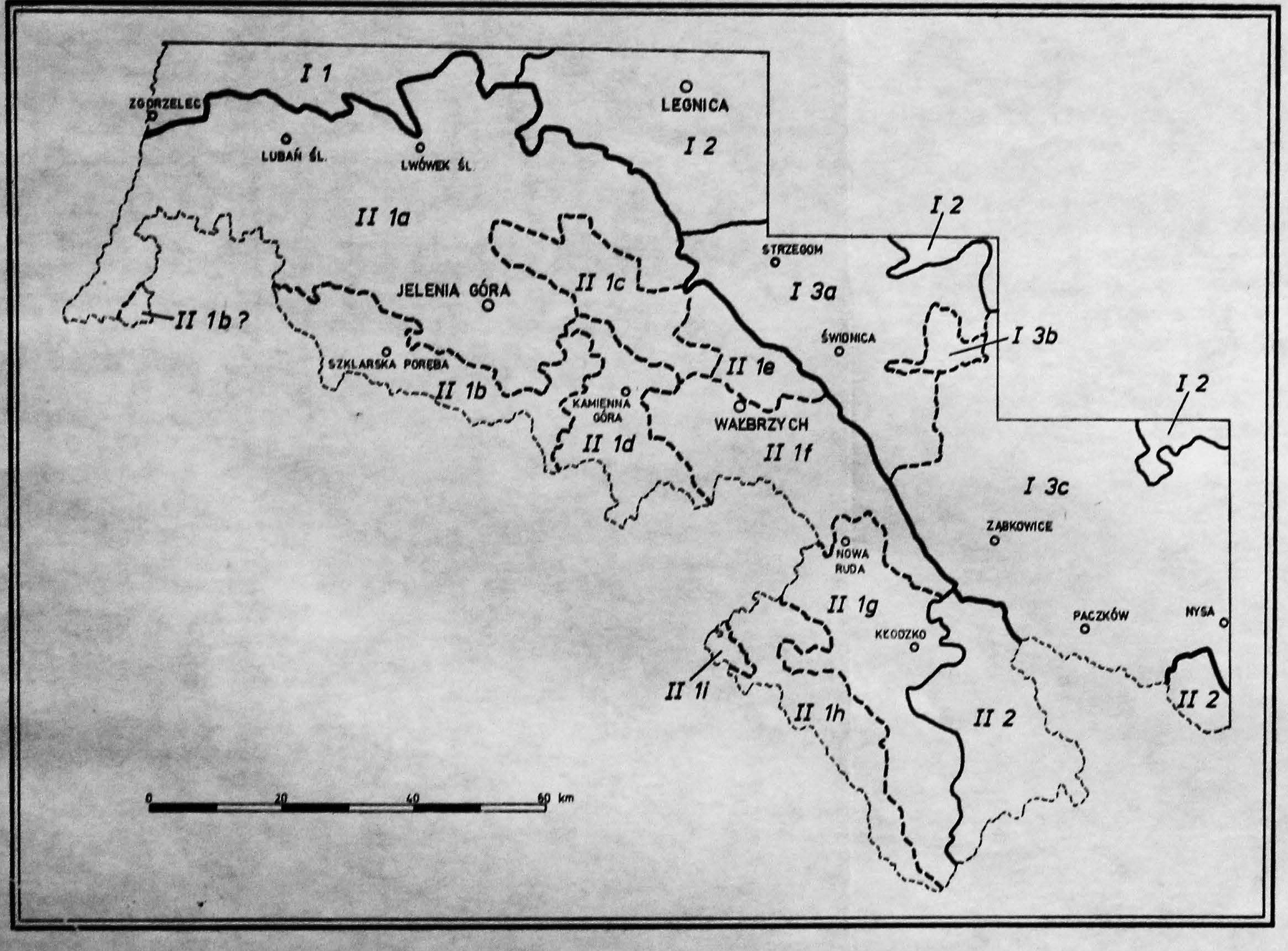



Fig. 3. Geobotanical division of the region udner study.

I. Province: Middle European Lowland, Baltic area;

Land: Nizina Śląska.

1 — Region of Dolnośląskie Forests;
2 — Nadodrzański Region;
3 — Region of Sudety Foreland.
*a* — Subregion Świdnicko-Strzegomski
*b* — Subregion Ślęża massif
*c* — Subregion Niemczańsko-Strzeliński

II. Province: Middle European Mountains, Subprovince Hercyńsko-Sudecka, Sudety area.

1. Region: Western Sudety.
*a* — Subregion: Western Sudety Plateau;
*b* — Subregion: Izerskie and Karkonosze Mountains;
*c* — Subregion: Kaczawskie Mountains;
*d* — Subregion Kamiennogórski;
*e* — Subregion: Wałbrzyskie Plateau;
*f* — Subregion: Sowie and Kamienne Mountains;
*g* — Subregion Kłodzki;
*h* — Subregion: Bystrzyckie and Stołowe Mountains;
*i* — Subregion Nachodzki:
2. Region: Eastern Sudety.

landscape phytocomplexes constitute basic regional units of vegetation differentiation. Hence, higher regional units can be established by grouping potential landscape phytocomplexes treated as basic units, and hence indivisible.

It is obvious that differentiation of vegetation into potential landscape phytocomplexes cannot constitute the only criterium of geobotanical division. Consequently, map of potential landscape phytocomplexes will, most of all, be a map of basic areas. On the other hand, characteristic of particular units must, apart from the differentiation of vegetation landscapes, take into account also such elements as differentiation of flora and plant communities. This refers especially to higher regional units.

Accepting geobotanical division of Poland proposed by Szafer and Pawłowski (1972) it is now possible to verify it. It should be pointed out that higher regional units represent in this paper exactly the same units as defined by the mentioned authors. Deeper analysis of this term is not possible within the frames of this study. Geobotanical division of the region under study is presented in a map (Fig. 3).

The region under study belongs to two visibly divided units. The first one embraces mountain area of Sudety, belonging to the Middle European Mountain Province (subprovince Hercyńsko-Sudecka, Sudety area), and the second — lowland area of the Middle European Lowland-Upland Province (Baltic area, Kotlina Śląska region). Differences between these parts are quite well visible on the attached map of potential landscape phytocomplexes. These differences consist of totally different set of vegetation landscapes in both units. This result supports my suggestion of the necessity of divisions on higher levels.

As regards the units of lower levels, we can distinguish five regions — two within mountain area, and three upon lowland. This division is in agreement with the one proposed by Szafer and Pawłowski.

Within Sudety Mountains area two regions can be distinguished i.e. Region of Western Sudety, and region of Eastern Sudety. Basic difference between the two regions (with respect to landscape differentiation of vegetation) consists of the lack of *Pinus mughus* shrubs *(Pinetum mughi sudeticum)* in subalpine level of Eastern Sudety.

In the present study subregions were distinguished only in the region of Western Sudety, since the region of Eastern Sudety was not totally covered. I have distinguished 9 subregions in the first region, which are characterized by the domination of particular vegetation landscapes.

— Subregion of Western Sudety Plateau is characterized by the domination of two types of vegetation landscapes, i.e. landscape of submontane oak-hornbeam forests and acidophilous oak forests, and landscape of submontane oak-hornbeam forest. There are no phytocomplexes with higher share of beech forests. here.

— Subregion Izersko-Karkonoski embraces Izerskie Mountains, Karkonosze Mountains, and Rudawy Janowickie at the level of lower and higher forest belts. This region is distinguishable by: beech forest in the lower forest belt, of the variant with *Luzulo-Fagion* domination, and upper belt spruce forests.
— Subregion of Kaczawskie Mountains, where beech forest and submontane oak-hornbeam forests occur, mainly of the variant with high share of fertile beech forests.
— Subregion Kamiennogórski embraces lower part of Sudety. Vegetation landscapes are rather differentiated so that character of this region is not univocal.
— Subregion of Sowie and Kamienne Mountains embraces also part of Wałbrzyskie and Bardzkie Mountains. Predominating landscapes: lower belt beech forests, and beech forests with submontane oak-hornbeam forests.
— Subregion of Wałbrzyskie Plateau covers a small area predominated by the landscape of submontane oak-hornbeam forest and acidophilous oak forests, partly the variant of "thermophilous" oak forest.
— Subregion Kłodzki embraces Kłodzka and Noworudzka valleys. Landscape of submontane oak-hornbeam forests predominates in this region.
— Subregion of Bystrzyckie and Stołowe Mountains is characterized by the presence of potential landscape phytocomplexes belonging almost exclusively to the landscape of beech forest of the lower forest belt. Distinct character of this region is obvious even in nature due to the presence of tectonic faults.
— Subregion Nachodzki embraces a small part of the area under study, in the neighbourhood of Kudowa Zdrój. We meets here landscape of submontane oak-hornbeam forest and acidophilous oak forests.

Upon lowland area (Middle European Lowland-Upland Province, region of Kotlina Śląska) I have distinguished (similary as Szafer and Pawłowski) three regions, i.e. Region of Dolnośląskie Forests, Region Nadodrzański, and Region of Sudety Foreland. Differences between these regions are very distinct, although in each of them potential plant communities are represented by oak-hornbeam forests.

In the southern part of the Region of Dolnośląskie Forests most frequent is the landscape of oak-hornbeam forests and mixed pine-oak forests, of the *Dicrano-Pinion* alliance. In the Nadodrzański Region, which is also only partly covered by the present study, we deal almost exclusively with the landscape of lowland oak-hornbeam forest. On the other hand, in the region of Sudety Foreland, high share of potential landscape phytocomplexes is represented by acidophilous oak forests *(Luzulo-Quercetum)*; beech forests are also met here. Region of Sudety Foreland represents a transitory area between lowland and mountain regions. This region can be divided into three subregions: Świdnicko--Strzegomski, Ślęża massif, and Niemczańsko-Strzeliński. Division into these subregions seems quite justified in view of the map of potential landscape phytocomplexes, although situation of bordering lines is not totally clear.

Generally speaking, my geobotanical division of this part of Poland constitutes a further development of works by Szafer and Pawłowski. It is consistent with the previous division, but at the same time more detailed and precise.

On the other hand, if we compare this geobotanical division with physico-geographical division given by Kondracki (1965, 1977), it appear that — apart from visible similarity of the general outline — significant differences are noted between both divisions. In physico--geographical division units of lower level (mezoregion) are understood in a narrower sense than in geobotanical division (subregions). This phenomenon is caused by the fact that very frequently geological and tectonic differentiation of the land (which is essential for physico--geographical division) is not sufficiently reflected in landscape differentiation of potential vegetation.

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## *Potencjalne fitokompleksy krajobrazowe Sudetów*

### Streszczenie

W niniejszej pracy autor dokonał próby wydzielenia krajobrazowych jednostek roślinności w obszarze Sudetów i ich północnego przedpola. U podstaw teoretyczno-metodycznych pracy leżą dwie koncepcje. Pierwszą jest opracowana przez R. Tüxena (1956) koncepcja potencjalnej roślinności naturalnej; drugą natomiast — koncepcja hierarchicznej przestrzennej organizacji roślinności (J. M. Matuszkiewicz 1978). Przedstawia to rys. 1.

Metoda wydzielania potencjalnych fitokompleksów krajobrazowych, tu zastosowana, stanowi modyfikację metody stosowanej przez autora na obszarze centralnej Polski (J. M. Matuszkiewicz w druku). Materiałem podstawowym dla opracowania była mapa potencjalnych zbiorowisk roślinnych Sudetów i Przedgórza Sudeckiego w skali 1:300000 (W. Matuszkiewicz, A. Matuszkiewicz, J. M. Matuszkiewicz 1978), na której analizowano zonację zbiorowisk roślinnych w poszczególnych fragmentach terenu, wydzielając potencjalne fitokompleksy krajobrazowe jako obszary o jednolitej zonacji.

Wśród wydzielonych potencjalnych fitokompleksów krajobrazowych wyróżniono następnie krajobrazy roślinne (Tüxen 1956), rozumiejąc je jako typologiczne jednostki zróżnicowania roślinności na poziomie fitokompleksów krajobrazowych. Rozkład przestrzenny potencjalnych zbiorowisk roślinnych w fitokompleksach krajobrazowych należących do różnych krajobrazów roślinnych przedstawiono na rys. 2.

W pracy wykorzystano mapę wydzielonych fitokompleksów krajobrazowych dla weryfikacji geobotanicznego podziału tego terenu zaproponowanego przez W. Szafera i B. Pawłowskiego (1972).