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RECUEIL DE TRAVAUX DE GEOBOTANIQUE / REVIEW OF GEOBOTANICAL MONOGRAPHS

5

THE VEGETATION AND DYNAMICAL TENDENCIES IN THE VEGETATION OF BOSCO QUARTO, PROMONTORIO DEL GARGANO, ITALY

(maps in scale 1: 10,000 with comment)

Janusz B. Falinski & Franco Pedrotti

CAMERINO
1990

PUBLICATION DU DEPARTEMENT DE BOTANIQUE ET ÉCOLOGIE DE L'UNIVERSITÉ DE CAMERINO ET DE LA STATION INTERNATIONALE DE PHYTOSOCIOLOGIE DE BAILLEUL SOUS L'ÉGIDE DE L'ASSOCIATION AMICALE DE PHYTOSOCIOLOGIE ET DE L'ASSOCIATION INTERNATIONALE POUR L'ÉTUDE DE LA VÉGÉTATION

BRAUN-BLANQUETIA

Un héritage est enrichissant et ouvre de nouvelles possibilités créatrices. Mais il en découle en contre partie l'obligation de ne pas gaspiller le patrimoine reçu. Ceux qui, aujourd'hui étudient la végétation grâce à la phytosociologie peuvent utiliser des méthodologies bien au point et tirer profit d'un ensemble cohérent de connaisances.

C'est le résultat du travail méthodique de nombreux chercheurs de qualité pendant plusieurs décennies. Aujourd'hui, nous nous trouvons face à des problèmes qui ne sont sans doute pas tout à fait nouveaux mais qui paraissent infiniment plus graves que dans le passé: primauté de la technique, spécialisation, pénurie de matières premières, d'énergie et d'espace, crise de l'environnement...

Il se développe ainsi des problèmes spécifiques divers pour lesquels il est nécessaire de trouver des réponses nouvelles. Les chercheurs sont placés devant un véritable défi et il dépend de leur savoir et de leur imagination de montrer si la Science de la végétation est capable d'apporter une contribution appréciable à la solution de ces problèmes.

La tradition phytosociologique dans ce contexte constitue une base essentielle. La conception typologique de la végétation et la clarté du système qui en découle, l'habitude des chercheurs de vivre en contact étroit avec la végétation, les recherches basées sur l'observation condition antithétique de l'expérimentation, sont les traits caractéristiques de la phytosociologie.

Les lignes directrices qui nous ont été transmises par les maîtres de la Science de la végétation, Josias Braun-Blanquet et Reinhold Tüxen avant tout, constituent actuellement une part importante de notre patrimoine d'idées. Notre but est de valoriser cet héritage et d'honorer la mémoire du premier de ces maîtres et fondateur de la phytosociologie moderne par une nouvelle série de publications.

Pourront y trouver place des monographies étudiant concrètement la végétation selon les enseignements de J. Braun-Blanquet et R. Tüxen qui, à travers la créativité des auteurs, produiront de nouveaux fruits.

Disciples nous-mêmes de J. Braun-Blanquet et ayant collaboré à son activité, nous pensons qu'à travers cette série de publications son héritage restera vivant dans l'esprit originel et avec de nouvelles idées.

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(maps in scale 1: 10,000 and a comment on the maps)

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J. BRAUN-BLANQUET, 1954
Drawn form a photograph by Françoise M. Dansereau

I. INTRODUCTION. THE AIM IN VIEW

The diversity of the anthropogenic influences on the vegetal cover, the environment and the landscape as well as the variability of these forms in space and time have caused a secondary differentiation of the vegetation. In many parts of the world this is manifested by a greater degree of complication than in primary differentiation. In other regions it has led to a simplification of the original picture and even caused areas completely deprived of vegetation to arise owing to the activity of man.

The coexistence of phenomena of this kind becomes even more interesting when it is accompanied by the consequences of release of the vegetation on part of the area from anthropogenic pressure of long duration. Under the circumstances described, all ecological processes may be expected to occur in the vegetation.

Such a physiographic object in which this multiplicity of phenomena and ecological processes connected with the intermediate and direct, older and recent activity of man is observed, proved to be the foothills of the Promontorio del Gargano in southern Italy on a peninsula of the Adriatic coast (Fig. 1; Plates I-IV; FALINSKI & PEDROTTI, 1985; PEDROTTI, 1987a and 1987b).

The geobotanical relations and ecological phenomena prevailing here were considered convenient for verifying our earlier geobotanical-cartographic concepts. This research resulted in two double-sheets of the vegetation and of the dynamical tendencies in it and two derived maps supplemented by a common theoretical-methodical text and the necessary documentation.

II. MAN-TRANSFORMED VEGETATION. ITS CARTOGRAPHIC PRESENTATION AND INTERPRETATION

II. 1. ORIGIN, DIFFERENTIATION AND STATE OF PRESERVATION OF VEGETATION AS A SUBJECT OF GEOBOTANICAL STUDIES

The secondary differentiation of vegetation is only one of many symptoms of the process ongoing in the whole biosphere. As far as it concerns our study subject, this process can be called after Polish geobotanists: synanthropisation of the plant cover (FALINSKI, 1963, 1966, 1972, 1975, 1986a; KORNAS, 1972, 1983).

The role of man in the transformation and origin of vegetation can be expressed, in an arbitrary and simplified way; by its division into natural, seminatural and synanthropic vegetation. These notions apply also to plant communities and their spatial complexes. Regarding specific composition and defining the syntaxonomic community types, that is associations, the distinction of autogenic ("naturogenic") and anthropogenic combinations seems more appropriate (FALINSKI, 1969).

In fact, the impact of man results in a multiplied diversity of communities. Such diversity includes, on the one hand, various anthropogenic transformations of natural communities, and on the other, a wealth of anthropogenic, especially synanthropic, communities substituting the specific natural, mainly forest communities. The latter facts are presented, to some extent, in the studies on anthropogenic vegetation on postglacial lowlands, at the boundary between central and eastern Europe (FALINSKI, 1966, 1986a; HERBICH, 1982). For instance, the most common *Tilio-Carpinetum* deciduous forest community is substituted in the anthropogenic landscape by 33

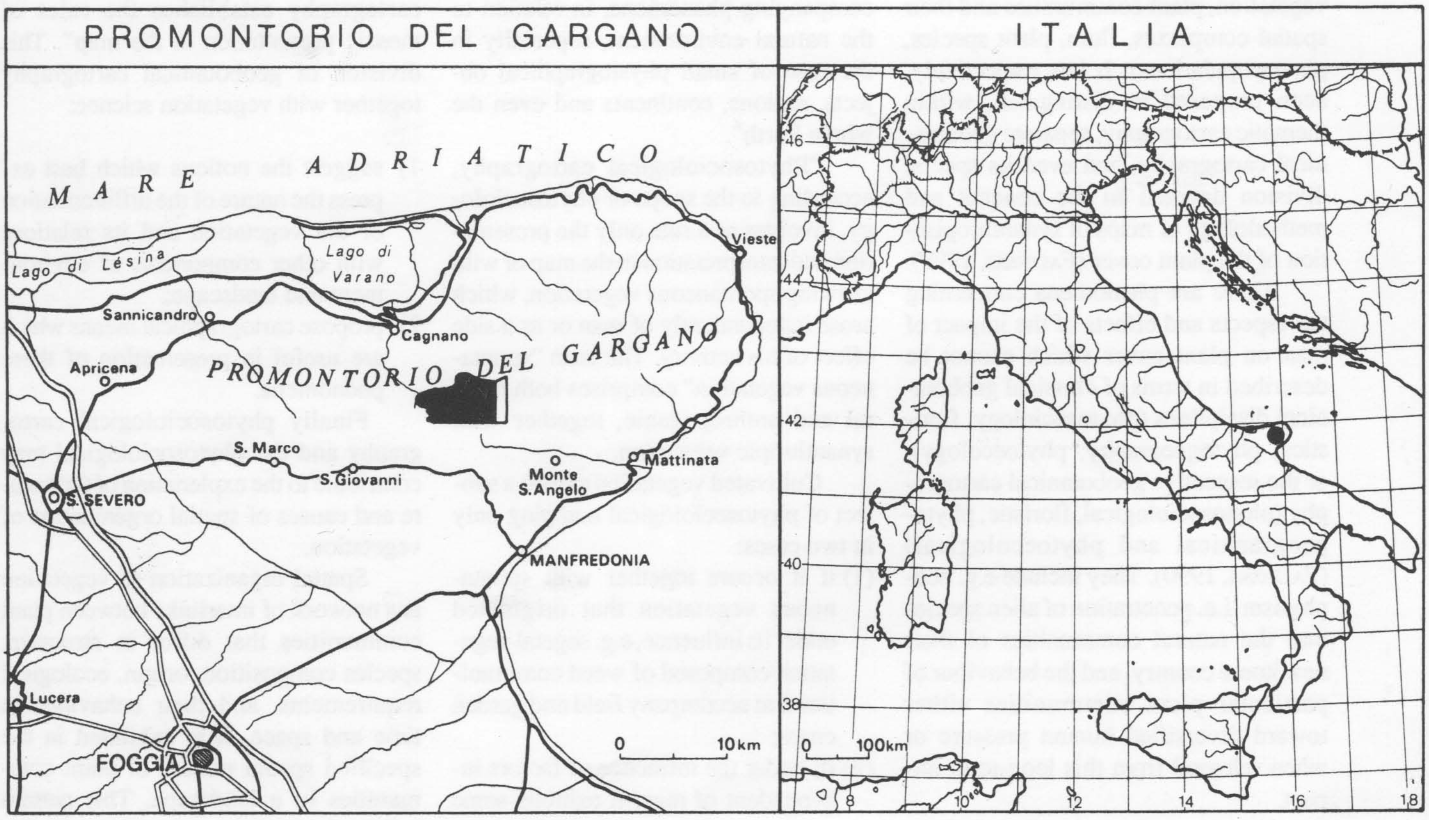


Fig. 1 — Study area of Bosco Quarto: location in Promontorio del Gargano in Italy. Source: orig. elab. of JBF & FP.

seminatural and synanthropic ones, while in habitats previously occupied by streamside flood-plain forest (*Circaeo-Alnetum*) the communities representing 20 meadow and pasture associations may develop. Thus within the small area of Bialowieza Forest (1250 km²) 17 primary forest associations are substituted by 80 anthropogenic ones.

Both anthropogenic and man-transformed vegetation can be a subject of geobotanical studies, just as the vegetation of natural origin (primeval vegetation). Fundamental aspects of diversity and variability of vegetation types, regardless of their origin, can be analyzed and described by the same terms and methods of vegetation science (phytosociology). This concerns also the aspects of the spatial vegetation pattern as the subject of phytosociological maps (Chap. II.3).

However, the specificity of human impact and its effects often obliges us to supplement classic terms of vegetation science with those of dynamic phytoecology and phytogeography, and even to form new terms. In time the studies on synanthropisation of the plant cover have developed into a separate branch of geobotany, that analyses the causes, mechanisms and effects of the influence of man at various levels of organization of the plant cover (vegetational landscape, vegetation, plant communities and their spatial complexes, flora, plant species, plant populations). It has respectively, been proposed to distinguish, within thematic cartography, separate geobotanical cartography, and even its special division devoted to the concept and methodology of maps of synanthropisation of the plant cover (FALINSKI, 1990).

There are phenomena concerning the aspects and effects of the impact of man on plant cover which cannot be described in terms of classical geobotanical disciplines (phytosociology, floristics, phytogeography, phytoecology), or the respective geobotanical cartography (phytosociological, floristic, phytogeographical and phytoecological) (FALINSKI, 1990). They include e.g. neophytism, i.e. penetration of alien species into the natural communities of their new home country, and the behaviour of particular plant communities either toward diversified human pressure or when released from this long-term impact.

However, the Authors are of the opinion that in all possible cases one should apply classic terms of vegetation science in order to preserve the uniformity of the description of the "vegetation phenomenon". Such terms can be expanded when need arises. This seems also appropriate when the influence of man on the initiation and course of processes going on in the vegetation (fluctuation, succession, regression, degeneration and regeneration, seasonality) is analysed.

Hence in order to present the nature and genesis of man-transformed vegetation in the map, one should mainly apply extended terms of phytosociological cartography and dynamic ecology (cf. Chap. II.4 and II.5). This concerns especially studies on the vegetation of smaller, more homogeneous physiographic objects, the results of which can be presented in large-scale maps.

II.2. THE SCOPE AND RANGE OF PHYTOSOCIOLOGICAL CARTOGRAPHY. VEGETATION IN LANDSCAPE AND ENVIRONMENT

The scope and range of geobotanical cartography can be, after FALINSKI (1990), described as follows: "Phytosociological cartography produces maps that illustrate the nature, spatial pattern and differentiation of present-day, past, and even future vegetation, and the accompanying phenomena, in relation to the natural environment, especially in the case of small physiographical objects, regions, continents and even the whole Earth".

"Phytosociological cartography, according to the scope of phytosociology, involves as a rule only the presentation and interpretation in the map of wild growing spontaneous vegetation, which arose independently of man or as a side effect of his activity. The term "spontaneous vegetation" comprises both natural and anthropogenic, together with synanthropic vegetation.

Cultivated vegetation can be a subject of phytosociological mapping only in two cases:

(1) if it occurs together with spontaneous vegetation that originated under its influence, e.g. segetal vegetation composed of weed communities that accompany field and garden crops;
(2) if, under the influence of factors independent of man, it exhibits some properties of spontaneous vegetation and tends to develop towards an autonomic ecological system, e.g. meadow communities grown from grass and pasture herb cultures, vegetation of old abandoned cemeteries and forest substitute communities in tree plantations, but not intensively managed forest plantations.

On the other hand, spontaneous vegetation (or its structural elements) does not fall into the scope of phytosociological cartography, if it is considered as an element of the terrain cover (forests, meadows, marshes), or forms of land use (forest, tree stand, meadow, pasture, wasteland). Then the vegetation is either the subject of topographical, or land use maps.

The regions of the Earth, its environments and landscapes, devoid of their plant component (strictly speaking plant cover, with its flora and vegetation) can be of interest to geobotany and geobotanical cartography only as free analyses of the primary reasons for the lack of vegetation, or the causes of its extinction. Only explanation of the latter and attempts to counteract them can, to some extent fall into the scope of geobotanical cartography: specific, general and applied".

According to KÜCHLER (1981) the subject of phytosociological map can be initially determined as a mosaic of plant communities in a landscape. FALINSKI (1990) goes further: "Phytosociological cartography establishes the rules of mosaic presentation in the map". This division of geobotanical cartography together with vegetation science:

1) suggest the notions which best express the nature of the differentiation of the vegetation and its relations with other components of environment and landscape;
2) propose cartographical means which are useful in presentation of these phenomena.

Finally phytosociological cartography and the phytosociological map contribute to the explanation of the nature and causes of spatial organization of vegetation.

Spatial organization of vegetation is a network of interlinks between plant communities that differ in structure, species composition, origin, ecological requirements, and their behaviour in time and space. It is exhibited in the specified spatial pattern of plant communities in a landscape. This pattern reflects both the response of vegetation to diversified habitat-environment conditions and its nature, as well as the nature of relationships between communities (common origin, colonisation sequence, sequence in time, nature of contacts, one-sided dependence of co-occurrence)".

The organization of vegetation, so defined, corresponds to the following terms: "vegetation pattern" (Engl.), "organization spatiale de la végétation" (French), and "räumliche Vegetationsanordnung" (Germ.)

II.3. INFLUENCE OF MAN ON VEGETATION AS THE SUBJECT OF A GEOBOTANICAL MAP

Within the maps that present the factors and effects of the impact of man on the vegetation, at least five groups can be distinguished (FALINSKI, 1990):

1) analytical factor maps, large-, medium-, and small-scale that illustrate the response of the given communities or physiographic objects to some anthropogenic impacts (e.g. decline of forests and bogs because of human colonization, changes in tree stand structure due to forest management);
2) fundamental phytosociological maps (phytocenose maps) presenting various groups of anthropogenic communities, according to the rules established for natural communities;
3) series of two, or more, fundamental large-scale phytosociological maps of a single subject that illustrate subsequent vegetation states. The reader, through their comparison, can recognize changes from natural, through seminatural, to synanthropic communities, or more rarely a reverse process.
   Such maps are elaborated by reconstruction or re-mapping of single subjects, often with the use of remote sensing sources (e.g. SEIBERT, 1962; WILKON-MICHALSKA, 1970; KÜCHLER 1972; VAN DORP, BOOT & VAN DER MAAREL, 1985; REICHHOFF, 198; KÜCHLER & ZONNEVELD eds., 1988).
   The differentiation of vegetation in such maps is expressed by means of cartographic vegetation units that correspond to syntaxa of various ranks. Series of these maps could have certain features of dynamic vegetation maps if completed by a synthetic map;
4) synthetic synanthropisation maps which show the course, mechanisms and causes of synanthropisation process or their overall consequences. They require the application of a special concept and new notions adjusted to the specificity of the problem. The following concepts serve as a basis for synthetic maps of synanthropisation:
   - hemerobia of plant communities or flora (SUKOPP ed. 1979). Ökologische Gutachten Tiergarten-Berlin (West). Hemerobiestufen, 1-7 degrees. Scale 1: 3,876),
   - naturalness of vegetation (MIYAWAKI *et alii* 1973. Karte des Naturlichkeitsgrads nach Vegetation dér Stadt Kamakura. 1-5 degrees. Scale 1: 10,000),
   - artificiation of vegetation (LE FLOC'H *et alii* 1973. Végétation actuelle. Atlas Régional Languedoc-Roussillon. 0-4 degrées. Scale 1: 740.000; LONG, THIAULT & TRABAUD 1975? Carte de l'Occupation des terres Région du Golo Corse. 1-6 degrées. Scale 1: 25,000),
   - anthropogenic changes in plant communities (MICHALIK, 1979. Map of anthropogenic changes in plant communities of the central part of the Cracow upland. 1-3 degrees. Scale 1: 37,383),
   - degeneration of phytocenoses (FALINSKI & FALINSKA 1965: Phases de la dégénération des groupements végétaux de la réserve "Vallée de la rivière Walsza". 0-6 degrées. Scale 1: 24,324; FALINSKI, 1966: Dégénération des groupements végétaux de la Forêt Municipale d'Ilawa. 0-6 degrées. Scale 1: 2,500),
   - substitution of primary by secondary vegetation systems (FALINSKI, 1966 & 1986a: Transformation of plant cover in the western part of Bialowieza Forest. 0-5 degrees. Scale 1: 250,000; FALINSKI, 1975 & 1976: Anthropogenic changes of the vegetation of Poland. 1-7 degrees. Scale 1: 2,000.000);
5) maps presenting the effect of human impact on the course of important ecological processes occurring in plant communities (e.g. succession, degeneration, regeneration, regression, fluctuation; cf. Chapter II.4).

II.4. VEGETATION DYNAMICS AND MAPS OF VEGETATION DYNAMICS

II.4.1. CONCEPT, SUBJECT AND CONTENTS OF THE MAP OF VEGETATION DYNAMICS, ITS RELATION TO THE MAPS OF DYNAMICS OF PHYTOCENOSES AND PLANT POPULATIONS

Vegetation dynamics is mainly the inner dynamics of phytocenoses (Fig. 2, Tab. 1) (cf. PAWLOWSKI & ZARZYCKI 1972; FALINSKI, 1986a & 1986b). All crucial ecological processes, that involve also zoocenosis and biotope, like succession, regression, fluctuation, degeneration, regeneration, and seasonality, take place in the system.

The effects of these processes can be the subject of respective dynamic vegetation maps. However, they do not comprise the whole variety of phenomena that can be presented in a map. The map can also concern the role of an individual or a population in the course of ecological processes, migration, origin and development of a phytocenose through primary succession, differentiation and integration of a phytocenose under succession, phytocenose fragmentation, the developmental stages of a tree stand. These phenomena, due to their relation to space, can be presented in large-scale phytoecological maps, strictly speaking: maps of the dynamics of phytocenoses and plant population (FALINSKI, 1990).

II.4.2. SURVEY, SCOPE AND METHODOLOGY OF THE MAPS OF VEGETATION DYNAMICS

The maps of vegetation dynamics should not be confused with those of the history and evolution of vegetation. The maps of vegetation dynamics only partly comprise those that present the genesis of contemporary vegetation. However, they include maps illustrating the phenomena of interaction between the components of one phytocenose and other phytocenoses, not necessarily adjacent. This is exemplified in the migration of anemochorous tree seeds into distant areas and their colonization, and in phenomena outside phytocenoses, but influenced considerably by them and different for various phytocenoses (e.g. influence of active herbivores).

Table 1 — Vegetation dynamics as an ecological process. See Fig. 2.

The notion of vegetation dynamics is here deliberately limited to processes and phenomena occurring within one climatic period, whereas evolution and history of vegetation is used for processes running in geological time during a sequence of climatic episodes. Research in the latter field (syngenetics, synchronology) aims, therefore, at elucidation of the genesis and principles of the development of definite plant communities, the causes of their diversity, the plant successional patterns and the relations between on the one hand the transformation of the flora, climate and environment and the other hand the geological processes.

Vegetation dynamics is above all dynamics of phytocenoses and plant populations, and thus, subject to the laws of their development and principles of functioning. Vegetation dynamics is also ecosystem dynamics. Investigations into the vegetation dynamics (syndynamics) are meant to describe and elucidate the conditions for the development and future fate of a given phytocenosis, sometimes also of a spatial complex of phytocenoses or the condition for the successive appearance of series of phytocenoses situated in the same space (linked by the same biochore).

In this scope the main objects of investigation are autonomous endogenous transformations evoked by intraphytocenotic and population factors, as well as changes caused by factors exogenous to the phytocenoses, i.e; biocenotic-biotopic and environmental together with anthropogenic factors.

The contemporary vegetation dynamics comprise above all processes and phenomena in phytocenoses which can be studied directly and in parallel with their course in time by menas of permanent plots. Reconstruction methods are indispensable in studies of the evolution and hystory of the vegetation and of course in attempts to reconstruct the dynamics of vanished phytocenoses.

The vegetation dynamics comprise (Fig. 2):

1) **two distinctly directional processes**, succession s.s. and regression as the opposite;

2) **certain reversible processes consisting of irregular changes** which occur at variable intervals, viz. fluctuation, regeneration and degeneration of phytocenoses.

By the latter is meant disintegration and reconstruction of structures specific to the given phytocenosis (biocenosis) under the influence of external factors.

At these processes do not lead to irreversible changes in the structure and function of phytocenoses and as they ensure their stability (permanence) they may be called the internal dynamics of the phytocenosis;

3) **strictly cyclic and periodical processes such as seasonality.**

The index of dynamics (DI) may serve as measure of intensity of the process in time. Most of the processes can be described for instance by the state of the biomass, the ratio of primary production to respiration, the leaf area index (LAI), the index of species diversity, the coverage, the volume of fresh plant cormus.

As a criterion of the state of the habitat at the moment of initiation of succession is univocal, we see no difficulty in distinguishing between **primary** and **secondary succession.**

Suitable and correct for essential and etymological reasons is consideration of **succession** and **regression** as independent processes. All findings concerning the mechanisms of succession in recent years support this view. The process of regression is not possible without the process of succession, it will always be secondary to the latter and, as far as it is known today, it may be elicited exclusively by exogenic factors.

It is necessary to distinguish two frequently confused processes - **regeneration** and **regenerative succession.** During **regeneration** the damaged phytocenosis is rebuilding part of its structures and function by "its own forces", that is by means of the components present in this biocenosis and diaspores produced by it.

Secondary succession is leading to the recreation of a phytocenosis, of the same type as at previously existing on the given site, by means of external forces, thus by diaspores from other phytocenoses. In order to avoid confusion I suggest to call this type of secondary succession, not regenerative, but **recreative succession.** This term stresses better the nature of the process, that is complete recreation of the system from its very beginning. The best example of this type of succession is no doubt succession towards forest or prairie on abandoned fields and pastures.

In some cases the development of the biocenosis initiated on a secondary site does not lead to the restoration of the original system. This is true for instance for secondary succession in habitats deprived of forest and then drained. In this case the result may be a biocenosis of completely different type. Of peculiar character is finally the continously repeated complete renewal of a biocenosis of the same type after its destruction by the repeated action of an external factor, e.g. the formation of a shrub biocenosis of chaparral type or of the Mediterranean garririgue after each fire. The catastrophic or cyclic climax is reached by way of a cyclic succession which I suggest to call **secondary replicative succession.** A certain form of replicative succession can also be distinguished in primary succession. It is in general characterised by short repeatable series following repeatedy occurring catastrophic phenomena, resulting in a primary habitat every time again.

For practical reasons it may be useful to distinguish **secondary succession** of a particular **constrained type**, i. e. caused by planting trees, thus stimulating the development of the habitat and vegetation towards some final substitutive forest community.

Source: J.B. Falinski, 1986a p. 5-8.

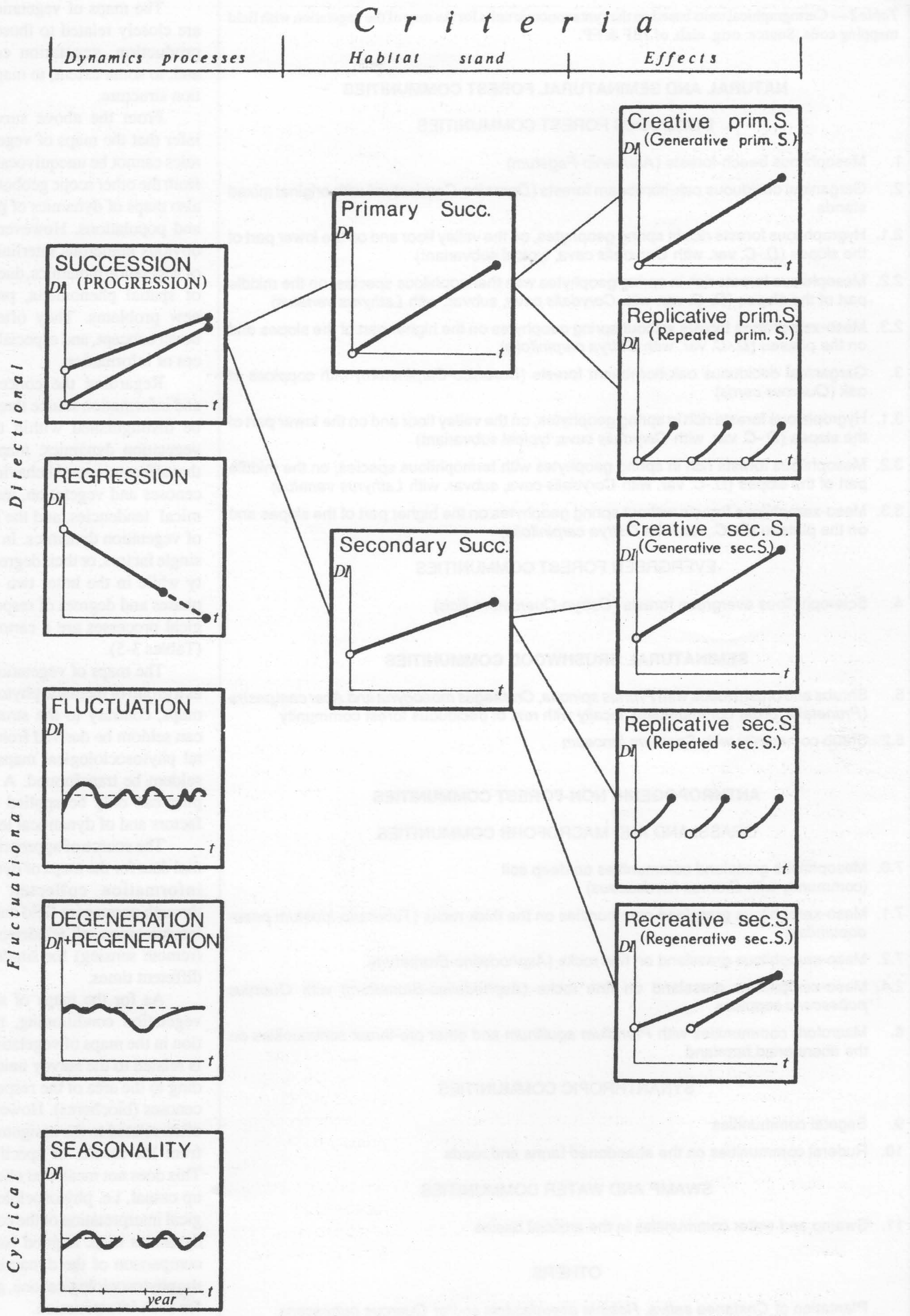


Fig. 2 — Basic dynamical processes in vegetation. DI - Dynamic index. See tab. 1. Source: FALINSKI (1986a).

Table 2 — Cartographical units based on the syntaxonomic units for the map of the vegetation with field mapping code. Source: orig. elab. of JBF & FP.

NATURAL AND SEMINATURAL FOREST COMMUNITIES

DECIDUOUS FOREST COMMUNITIES

1. Mesophilous beech-forests (*Aremonio-Fagetum*)
2. Garganical deciduous oak-hornbeam forests (*Doronico-Carpinetum*) with original mixed stands

2.1. Hygrophilous forests rich in spring geophytes, on the valley floor and on the lower part of the slopes (*D.-C.* var. with *Corydalis cava*, typical subvariant)

2.2. Mesophilous forests rich in spring geophytes with thermophilous species, on the middle part of the slopes (*D.-C.* var. with *Corydalis cava*, subvar. with *Lathyrus venetus*)

2.3. Meso-xerophilous forests without spring geophytes on the higher part of the slopes and on the plateau (*D.-C.* var. with *Ostrya carpinifolia*)

3. Garganical deciduous oak-hornbeam forests (*Doronico-Carpinetum*) with coppices of oak (*Quercus cerris*)

3.1. Hygrophilous forests rich in spring geophytes, on the valley floor and on the lower part of the slopes (*D.-C.* var. with *Corydalis cava*, typical subvariant)

3.2. Mesophilous forests rich in spring geophytes with termophilous species, on the middle part of the slopes (*D.-C.* var. with *Corydalis cava*, subvar. with *Lathyrus venetus*)

3.3. Meso-xerophilous forests without spring geophytes on the higher part of the slopes and on the plateau (*D.-C.* var. with *Ostrya carpinifolia*)

EVERGREEN FOREST COMMUNITIES

4. Sclerophyllous evergreen forests (*Ostryo-Quercetum ilicis*)

SEMINATURAL BRUSHWOOD COMMUNITIES

5. Shrubs and brushwoods with *Prunus spinosa*, *Crataegus monogyna* and *Acer campestre* (*Prunetalia* order communities), locally with rest of deciduous forest community

5.2. Shrub community with *Spartium junceum*

ANTHROPOGENIC NON-FOREST COMMUNITIES

GRASSLAND AND MACROFORB COMMUNITIES

7.0. Mesophilous grassland communities on deep soil (community with *Bromus hordeaceus*)

7.1. Meso-xerophilous grassland communities on the thick rocks (*Tuberario-Iridetum pseudopumilae*)

7.2. Meso-xerophilous grassland on fine rocks (*Asphodelino-Brometum*)

2.4. Meso-xerophilous grassland on fine rocks (*Asphodelino-Brometum*) with *Quercus pubescens* coppices

8. Macroforb communities with *Pteridium aquilinum* and other pre-forest communities on the abandoned farmland

SYNANTHROPIC COMMUNITIES

9. Segetal communities
10. Ruderal communities on the abandoned farms and roads

SWAMP AND WATER COMMUNITIES

11. Swamp and water communities in the artificial basins

OTHERS

Plantation of *Castanea sativa*, *Robinia pseudacacia* and/or *Quercus pubescens*

Plantation of *Pinus halepensis*

Old culture of *Castanea sativa*

The maps of vegetation dynamics are closely related to those of primary production, vegetation conditioning, and, to some extent, to maps of vegetation structure.

From the above survey one can infer that the maps of vegetation dynamics cannot be unequivocally separated from the other scope geobotanical maps, also maps of dynamics of phytocenoses and populations. However, in spite of obvious numerous interlinks, the maps of vegetation dynamics, due to the nature of spatial phenomena, provide many new problems. They often require a novel concept, and especially new sources of information.

Regarding the concept, contents and information source three groups can be distinguished within the maps of vegetation dynamics: maps of factors that affect temporal behaviour of phytocenoses and vegetation, maps of dynamical tendencies, and the proper maps of vegetation dynamics. In the first one single factors, or their degrees of intensity while in the latter two - the stages, phases and degrees of respective ecological processes are a cartographic unit (Tables 3-5).

The maps of vegetation dynamics, as a group of thematic phytosociological maps, contrary to the structural maps, can seldom be derived from fundamental phytosociological maps, and hence seldom be transformed. A single mapping can only be applied for maps of factors and of dynamical tendencies.

The source of appropriate and optimal data for the maps of dynamics is the information collected repeatedly through permanent field mapping or the interpretation of teledetection images (remote sensing) for single subjects at different times.

As for the maps of structure and vegetation conditioning, the information in the maps of vegetation dynamics is related to the survey units corresponding to the area of the respective phytocenoses (biochores). However, they are often related to the assignments derived from the results of specific mapping. This does not mean that one should give up casual, i.e. phytosociological-ecological interpretation of the contents of the dynamics map. A good basic map and comparison of the dynamics map with the phytosociological one, give a chance for such interpretation.

II.5. THE IMPACT OF MAN ON THE PROCESSES GOING ON IN PLANT COMMUNITIES AS THE SUBJECT OF THE GEOBOTANICAL MAP

Due to the activity of man, various ecological processes such as secondary succession, regression, degeneration and regeneration have become more pronounced and common. Spatial distribution and the intensity of the processes can be analyzed either as factor-dependent or -independent. The direct anthropogenic effects, i.e. phenomena at basic levels of organization of the plant cover, as for instance neophytism, phytocenose degeneration, can be the subjects of special maps.

For instance, such a first attempt illustrates by the system of degeneration phases (I-VI) the degree of transformation of forest communities by man (FALINSKI & FALINSKA, 1965). The next map shows the relation between degeneration and regeneration of communities, and neophytism (FALINSKI, 1966). A map of the forms of community degeneration, i.e. their responses to different anthropogenic impacts on the forest, has been prepared (CZYZEWSKA in FALINSKI, 1990). And so has a map that interprets the progress of recreative secondary succession of vegetation on abandoned fields (FALINSKI 1986a, 1986b).

Among the maps elaborated so far which interpret the role of man in the development of contemporary vegetation of the Gargano foreland one has been selected based on the concept of dynamical tendencies in the vegetation. This concept was developed and verified earlier by one of the Authors (FALINSKI, 1986a, 1986b).

II.6. MAP OF DYNAMICAL TENDENCIES IN THE VEGETATION. ITS CONCEPT AND METHODOLOGY

The map of dynamical tendencies, is to some extent a substitute of the true map of vegetation dynamics. The former should be constructed only for selected ecological processes in an area fairly uniform regarding habitat and phytosociology. Then, their diversity and intensity can be found by comparative vegetation analysis and registered in one field mapping, teledetection, or best both. However, great circumspection is required, while the mapping should be restricted to areas with simple phytosociologi-

Table 3 — Fluctuation (units) and degeneration (consecutive phases) mapped in the vegetation of Bosco Quarto. Source: orig. elab. of JBF & FP.

	FLUCTUATION
Fa	Fluctuation in the natural forest communities
Fb	Fluctuation in the seminatural brushwood communities
Fc	Fluctuation in the anthropogenic non-forest communities
	DEGENERATION
Phases	
Phase 0	- Stable, natural or nearly natural forest community with well preserved structure and proper species composition
Phase 1	- Natural or nearly natural forest community with well preserved vertical structure, with patches of nitrophilous indicators of grazing *(Alliaria petiolata, Chaerophyllum temulum, Galium aparine)*
Phase 2	- Forest community with well preserved treestand; herb layer changed due to spreading grassland species (cespitisation)
Phase 3	- Forest community with well preserved treestand. Beside grasses, single specimens of *Asphodelus microcarpus* present in herb layer
Phase 4	- Forest community (dominated by *Quercus cerris*) with simplified vertical structure and impoverished species composition. In herb layer, *Asphodelus microcarpus* spreads in place of forest species
Phase 5	- Forest community (dominated by *Quercus cerris*), with simplified vertical structure. *Ilex aquifolium* present in shrub layer
Phase 6	- Forest community (dominated by *Quercus cerris*), with simplified vertical structure and impoverished species composition. Dense shrub layer with dominating *Ilex aquifolium* restrains the growth of herbs
Phase 7	- Forest community transformed into brushwood associated with grassland communities on rocks (oak/ash coppices; brushwood-grassland complex)

Table 4 — Regression consecutive phases mapped in the vegetation of Bosco Quarto. Source: orig. elab. of JBF & FP.

	REGRESSION
Phases	
Phase 0	- Stable, natural forest community with well preserved structure and proper species composition
Phase 1	- Stable, natural forest community with thinned treestand and small clearings on shallow soil or on uncovered rocks
Phase 2	- Stable, natural forest community with thinned treestand and patches of heliophilous plants on small clearings
Phase 3	- Stable forest community with changes in the shrubs layer; treestand renewal restrained by grazing; patches of heliophilous plants in the herbs layer increase in size
Phase 4	- Forest community with looser structure; grassland species penetrate into forest; clearings increase in size; macroforb communities initiate on the border between forest and clearing
Phase 5	- Formation of grassland in place of the forest; changes in the tree habits (trees with rachis shoot bitten off and numerous offshoots formed at the base)
Phase 6	- Merging of patches of grasslands from the neighbouring clearings; the clearings are separated by small groups of trees with bushy offshoots, surrounded by macroforb communities
Phase 7	- Disappearance of trees between clearings; small clearings merge into big glades; integration of treeless grassland; penetration of grassland and nitrophilous species into adjacent forest due to grazing
Phase 8	- Fragmentation of the grassland due to heavy grazing
[Phase 9]	- Patches of grasslands remain only in crevices in sharp-edged rocks [not expressed]
[Phase 10]	- Barren rock, no vegetation cover except for patches of cryptogamic plants; single vascular plants with thorny or spiky shoots and leaves [not expressed]

Table 5 — Secondary succession consecutive phases mapped in the vegetation of Bosco Quarto. Source: orig. elab. of JBF & FP.

SECONDARY SUCCESSION

Phases	
Phase 0	- Weed communities associated with plant culture, changing according to crop rotation (or ruderal communities around human dwellings and ruins). Permanent or cultivated and intensively utilized pasture communities
Phase 1	- Non-stable fallow-ground communities with weed species on newly abandoned fields (or pasture communities with ruderal species)
Phase 2	- Communities typical for abandoned fields (or abandoned pastures) with pioneering patches of *Pteridium aquilinum*
Phase 3	- Communities typical for abandoned fields with *Pteridium aquilinum* dominating or partially *Rubus* sp. div.; fern macroforb communities
Phase 4	- Fern macroforb communities with seedlings and saplings of trees and shrubs growing under *Pteridium aquilinum*
Phase 5	- Fern macroforb communities with saplings of trees and shrubs taller than *Pteridium aquilinum* and single specimens of forest herbs)
Phase 6	- Fern macroforb communities with single trees, mostly anemochorous *(Populus tremula, Salix caprea)*
Phase 7	- Brushwood without forest herbs
Phase 8	- Brushwood with patches of forest herbs
[Phase 9]	- Brushwood in the phase of forest structure formation; species typical for early phases of succession present [not expressed]
[Phase 10]	- Stable forest community with well formed structure and proper species composition [not expressed]

cal relations. This should prevent chance but serious errors.

The first map of dynamical tendencies in the vegetation was constructed for the Bialowieza National Park. It resulted mainly from teledetection mapping. However, all data from the studies of many years on permanent plots (FALINSKI, 1986a) were also taken into account. The map describes the dynamic state of the vegetation within a given time by notions that determine the dominance of fundamental ecological processes: fluctuation, primary and secondary succession, regression, degeneration and regeneration (Tab. 1, Fig. 2).

As compared with earlier ones, this map has been obtained mainly by more accurate presentation of the intensity of two processes that, due to man, dominate in Gargano, i.e. those of degeneration and regression of vegetation. Their intensity is expressed through the notions of degeneration and regression phases (Tables 3-5, Fig. 3B).

The vegetation in Gargano, especially in Bosco Quarto, comprises also vegetation released from long-term anthropopressure, which appears mainly in abandoned, scattered settlements and numerous old fields at the bottom of karstic dolines. Forest and grassland vegetation in Bosco Quarto is marked by the effects of long-term anthropopressure variable in form, persistence and intensity. Although the impact of man on forest and grassland communities has relented owing to a recent decrease in human population, the changes that resulted from the past selection management, charcoal production, and continuous cattle, sheep and goat grazing are still considerable. Hence, it seems appropriate to expose the effects of these factors, i. e. of the impact of man and his management on the initiation, course and intensity of crucial ecological processes, especially those of regression and degeneration. The system of phases describing temporary states of these processes in communities was established in comparative studies. It enabled a fairly detailed presentation of their range and intensity, related to ecological and phytosociological differentiation of the vegetation (Maps 1 and 2, Figs. 3 and 6).

The map of vegetation dynamics based on its dynamical tendencies has some more advantages. It illustrates relatively well the current structural differentiation of the vegetation and plant communities, as well as the state of their preservation (naturalness), or conversely the degree of their transformation.

III. METHOD OF FIELD MAPPING OF VEGETATION AND ITS DYNAMICAL TENDENCIES. ELABORATION OF MAP DRAFTS AND FAIR DRAFT OF MAPS

III.1 PRELIMINARY WORK. ANALYSIS OF VEGETATION FROM THE VIEWPOINT OF CARTOGRAPHIC MAPPING REQUIREMENTS

Mapping of vegetation and its dynamical tendencies was preceded by preliminary exploration of the terrain and basic analysis of the vegetation. This analysis was based on phytosociological records. Records were made of both well developed and preserved patches of communities and those severely impaired by grazing, thus undergoing regression and degeneration changes as well as in communities liberated from man and animal pressure and undergoing secondary succession. Care was taken that the vegetation patch described by the method of phytosociological recording would be homogeneous as regards physiognomy and structure.

The general analysis of the vegetation and elaboration of the records in phytosociological tables served for:

1) distinguishing the basic types of plant communities and their identification with already known syntaxons (e.g. *Aremonio-Fagetum* or *Ostryo-Quercetum ilicis*) or description of new syntaxons when the literature did not supply any basis for their phytosociological identification (*Doronico-Carpinetum, Tuberario-Iridetum pseudopumilae, Asphodelino-Brometum*);
2) gaining knowledge of the local phytosociological differentiation of the more severely changed and common types of plant communities by distinguishing variants and subvariants of communities, and accompanying definite habitat-ecological conditions;
3) statement of the basic conditions determining the occurrence and variability of the communities representing earlier described syntaxons (i. e. establishment of the general localization rules for the particular types of plant communities);
4) revealing of fundamental ecological processes prevailing in the plant

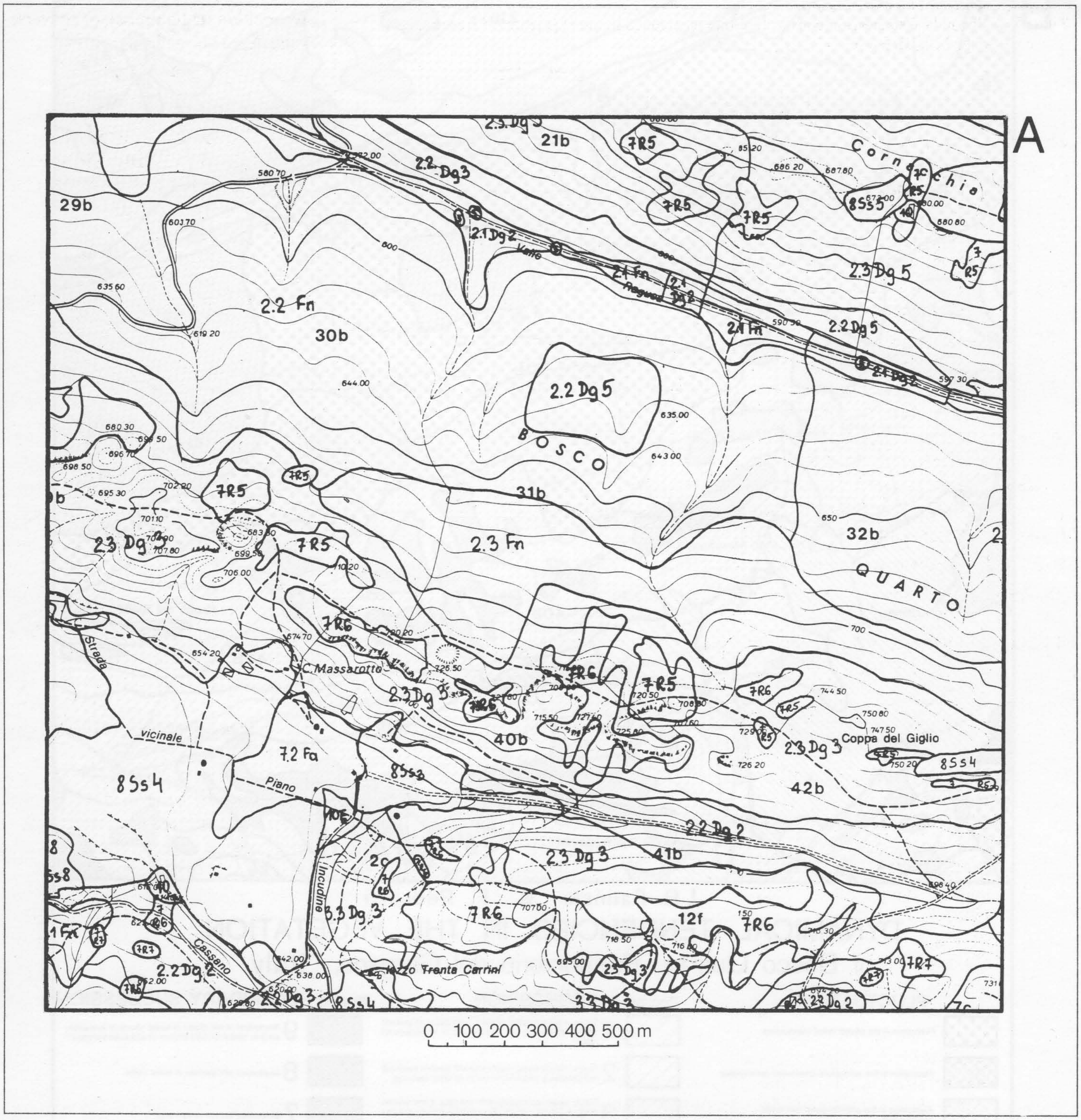


Fig. 3 A— Method of field mapping in Bosco Quarto. A - field map draft (fragment) and derivated maps: B - map of dynamical tendencies in the vegetation, C - map of the real vegetation (map of plant communities). On map B - explication of all dynamical units, on map C - present syntaxonomical units only. Source: orig. elab. of JBF & FP.

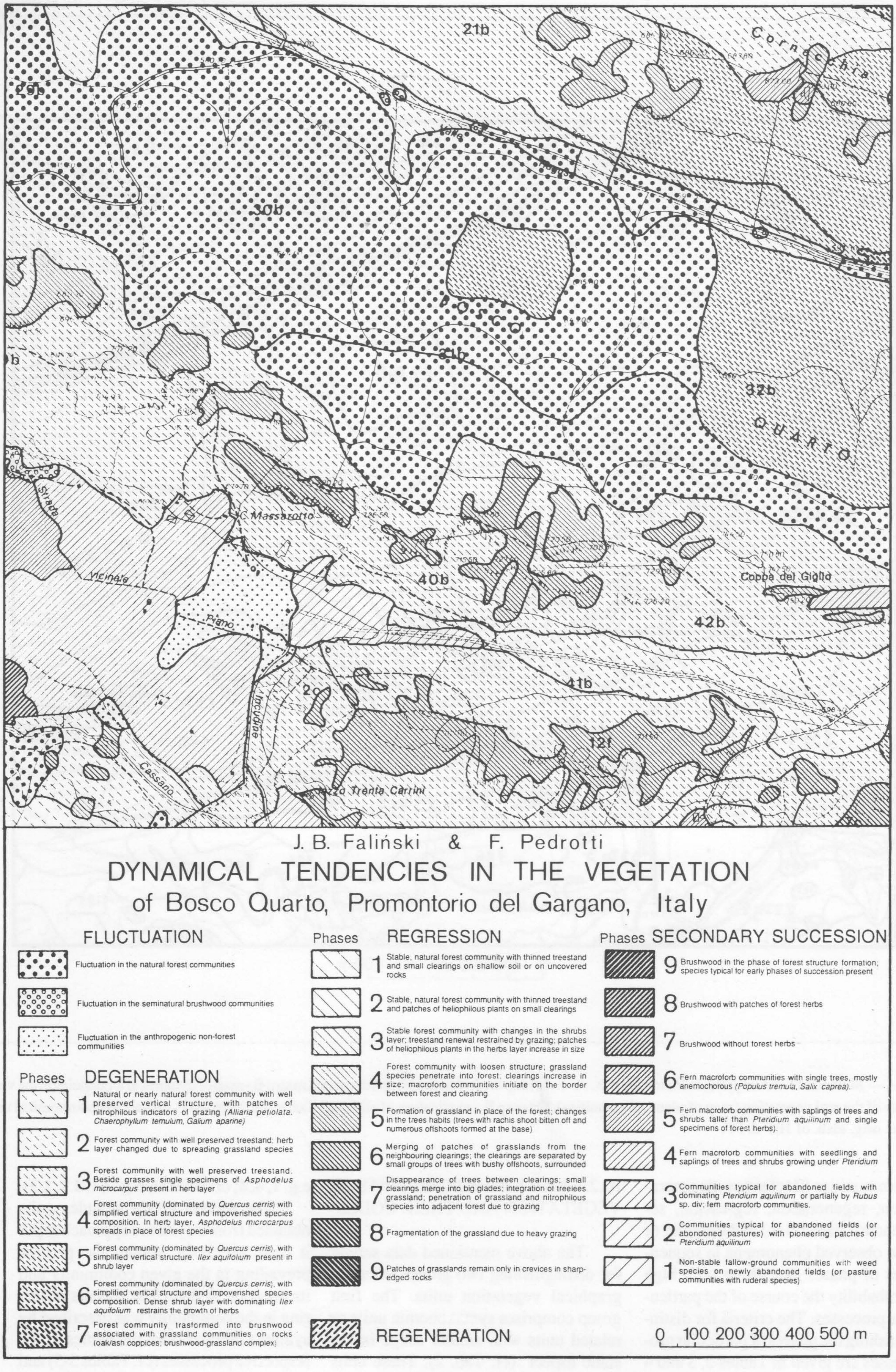
communities (fluctuation, degeneration, regeneration, regression, secondary succession) and ordering of the observed phenomena in sequences of phases describing with high probability the course of the particular processes. The criteria for distinguishing the phases of particular processes are given in Tables 2, 3 and 4 (cf. Chapters II and VI).

III.2. CARTOGRAPHICAL UNITS OF VEGETATION AND THEIR CODES

The above mentioned data served for distinguishing two groups of cartographical vegetation units. The first group comprises syntaxonomic units or related units with similar scope in the static aspect (cf. Tab. 2). These units were assigned numeral symbols (single, e.g. **1**, **4**, **8**; or decimal, e. g. **2.1**, **2.2**, **2.3**).

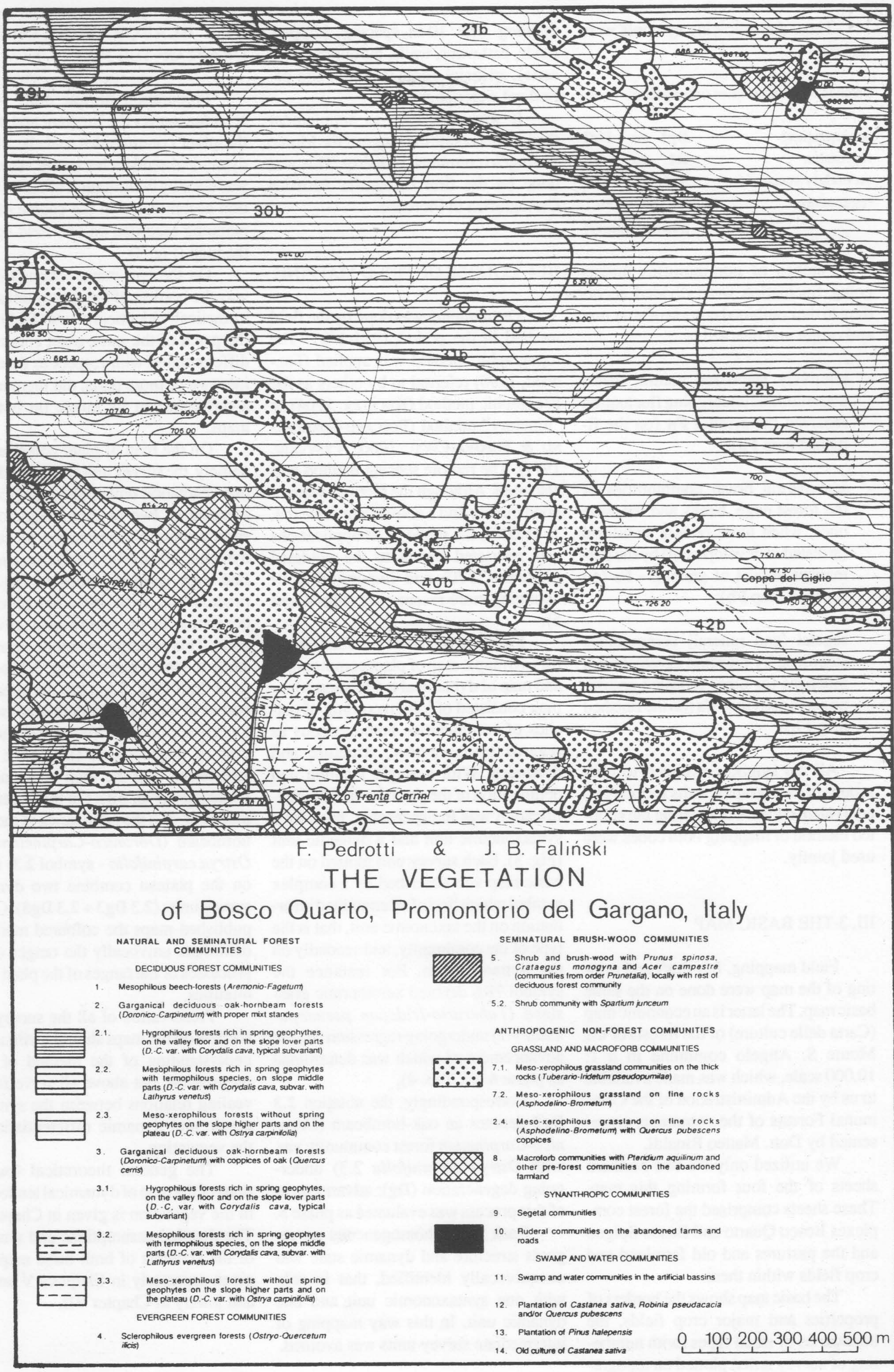
The second group includes units obtained from a dynamic approach to put it more precisely: stating the process prevailing in the given community and its progress in time. The process occurring in the community was described by symbols derived from the names of the respective processes (cf. Tables 3-5) and numbers of the successive phases.

B



21b
Cornacchia
29b
30b
BOSCO
32b
QUARTO
C. Massarotto
Strada
Vicinale
Piano
40b
Coppa del Giglio
42b
41b
2c
Incudine
Cassano
121
Jazzo Trenta Carrini
J. B. Faliński & F. Pedrotti
DYNAMICAL TENDENCIES IN THE VEGETATION
of Bosco Quarto, Promontorio del Gargano, Italy
FLUCTUATION
Fluctuation in the natural forest communities
Fluctuation in the seminatural brushwood communities
Fluctuation in the anthropogenic non-forest communities
Phases DEGENERATION
1 Natural or nearly natural forest community with well preserved vertical structure, with patches of nitrophilous indicators of grazing (Alliaria petiolata, Chaerophyllum temulum, Galium aparine)
2 Forest community with well preserved treestand; herb layer changed due to spreading grassland species
3 Forest community with well preserved treestand. Beside grasses single specimens of Asphodelus microcarpus present in herb layer
4 Forest community (dominated by Quercus cerris) with simplified vertical structure and impoverished species composition. In herb layer, Asphodelus microcarpus spreads in place of forest species
5 Forest community (dominated by Quercus cerris), with simplified vertical structure. Ilex aquifolium present in shrub layer
6 Forest community (dominated by Quercus cerris), with simplified vertical structure and impoverished species composition. Dense shrub layer with dominating Ilex aquifolium restrains the growth of herbs
7 Forest community trasformed into brushwood associated with grassland communities on rocks (oak/ash coppices; brushwood-grassland complex)
Phases REGRESSION
1 Stable, natural forest community with thinned treestand and small clearings on shallow soil or on uncovered rocks
2 Stable, natural forest community with thinned treestand and patches of heliophilous plants on small clearings
3 Stable forest community with changes in the shrubs layer; treestand renewal restrained by grazing; patches of heliophilous plants in the herbs layer increase in size
4 Forest community with loosen structure; grassland species penetrate into forest; clearings increase in size; macroforb communities initiate on the border between forest and clearing
5 Formation of grassland in place of the forest; changes in the trees habits (trees with rachis shoot bitten off and numerous offshoots formed at the base)
6 Merging of patches of grasslands from the neighbouring clearings; the clearings are separated by small groups of trees with bushy offshoots, surrounded
7 Disappearance of trees between clearings; small clearings merge into big glades; integration of treelees grassland; penetration of grassland and nitrophilous species into adjacent forest due to grazing
8 Fragmentation of the grassland due to heavy grazing
9 Patches of grasslands remain only in crevices in sharp-edged rocks
REGENERATION
Phases SECONDARY SUCCESSION
9 Brushwood in the phase of forest structure formation; species typical for early phases of succession present
8 Brushwood with patches of forest herbs
7 Brushwood without forest herbs
6 Fern macroforb communities with single trees, mostly anemochorous (Populus tremula, Salix caprea).
5 Fern macroforb communities with saplings of trees and shrubs taller than Pteridium aquilinum and single specimens of forest herbs).
4 Fern macroforb communities with seedlings and saplings of trees and shrubs growing under Pteridium
3 Communities typical for abandoned fields with dominating Pteridium aquilinum or partially by Rubus sp. div; fern macroforb communities.
2 Communities typical for abandoned fields (or abondoned pastures) with pioneering patches of Pteridium aquilinum
1 Non-stable fallow-ground communities with weed species on newly abandoned fields (or pasture communities with ruderal species)
0 100 200 300 400 500 m

Fig. 3 B



C
21b
29b
30b
31b
32b
40b
41b
42b
BOSCO
QUARTO
Coppe del Giglio
Trenta Carrini
F. Pedrotti & J. B. Faliński
THE VEGETATION
of Bosco Quarto, Promontorio del Gargano, Italy
NATURAL AND SEMINATURAL FOREST COMMUNITIES
DECIDUOUS FOREST COMMUNITIES
1. Mesophilous beech-forests (Aremonio-Fagetum)
2. Garganical deciduous oak-hornbeam forests (Doronico-Carpinetum) with proper mixt standes
2.1. Hygrophilous forests rich in spring geophythes, on the valley floor and on the slope lover parts (D.-C. var. with Corydalis cava, typical subvariant)
2.2. Mesophilous forests rich in spring geophytes with termophilous species, on slope middle parts (D.-C. var. with Corydalis cava, subvar. with Lathyrus venetus)
2.3. Meso-xerophilous forests without spring geophytes on the slope higher parts and on the plateau (D.-C. var. with Ostrya carpinifolia)
3. Garganical deciduous oak-hornbeam forests (Doronico-Carpinetum) with coppices of oak (Quercus cerris)
3.1. Hygrophilous forests rich in spring geophytes, on the valley floor and on the slope lover parts (D.-C. var. with Corydalis cava, typical subvariant)
3.2. Mesophilous forests rich in spring geophytes with termophilous species, on the slope middle parts (D.-C. var. with Corydalis cava, subvar. with Lathyrus venetus)
3.3. Meso-xerophilous forests without spring geophytes on the slope higher parts and on the plateau (D.-C. var. with Ostrya carpinifolia)
EVERGREEN FOREST COMMUNITIES
4. Sclerophilous evergreen forests (Ostryo-Quercetum ilicis)
SEMINATURAL BRUSH-WOOD COMMUNITIES
5. Shrub and brush-wood with Prunus spinosa, Crataegus monogyna and Acer campestre (communities from order Prunetalia), locally with rest of deciduous forest community
5.2. Shrub community with Spartium junceum
ANTHROPOGENIC NON-FOREST COMMUNITIES
GRASSLAND AND MACROFORB COMMUNITIES
7.1. Meso-xerophilous grassland communities on the thick rocks (Tuberario-Iridetum pseudopumilae)
7.2. Meso-xerophilous grassland on fine rocks (Asphodelino-Brometum)
2.4. Meso-xerophilous grassland on fine rocks (Asphodelino-Brometum) with Quercus pubescens coppices
8. Macroforb communities with Pteridium aquilinum and other pre-forest communities on the abandoned farmland
SYNANTHROPIC COMMUNITIES
9. Segetal communities
10. Ruderal communities on the abandoned farms and roads
SWAMP AND WATER COMMUNITIES
11. Swamp and water communities in the artificial bassins
12. Plantation of Castanea sativa, Robinia pseudacacia and/or Quercus pubescens
13. Plantation of Pinus halepensis
14. Old culture of Castanea sativa
0 100 200 300 400 500 m

Fig. 3 C

Thus, the following symbols were assigned to:

patches of communities undergoing:

degeneration:	**Dg1** to **Dg7**
regression	**R1** to **R8**
secondary succession:	**SS1** to **SS9**
regeneration:	**Rg** (no distinguished phases)

Patches of communities undergoing fluctuation were divided according to the combined criteria of structure and origin and denoted:

- relatively stabilized natural forest communities undergoing fluctuation received the symbol **Fn** (on the finished map **Fa**);

- seminatural brush communities of the forest edge, banks and roadside ones, when more or less stabilized (arrested in development) by the permanent impact of grazing - **Fs** (on finished map **Fb**);

- segetal (and ruderal) communities stabilized by repeated agrotechnical practices (or other repeated anthropogenic activity) - **Fs** (on the finished map **Fb**).

All the symbols assigned to both groups of cartographic units formed two equivalent codes. Considering the adopted method of mapping both codes were used jointly.

III. 3 THE BASIC MAP

Field mapping, fair draft and printing of the map were done on the same basic map. The latter is an economic map (Carta delle culture) of the forests of the Monte S. Angelo commune in a 1: 10,000 scale, which was made available to us by the Administration of the Communal Forests of the commune, represented by Dott. Matteo Rinaldi.

We utilized only the two northern sheets of the four forming this map. These sheets comprised the forest complexes Bosco Quarto and Bosco Spigno and the pastures and old farmland and crop fields within them.

The basic map shows the borders of properties and major crop fields, the boundaries of stand types (with numbering of survey units) plotted on topographic information and the hypsometric drawing with 10-m spacing, klippen, roads, pathways, walls, buildings (masserie), artificial pools (piscine) and periodical water courses.

It was necessary to supplement these data outside the range of the Monte S. Angelo commune property. This was done by the firm Litografia Artistica Cartografica in Florence.

III.4. COURSE OF FIELD MAPPING

The mapping was done by the field method in the period 1984-1987. The topographic method was applied (FALINSKI, 1990) referred to by others as the geographic method (KÜCHLER, 1964) or "itinerary" method (PUSCARU-SOROCEANU & POPOVA-CUCU, 1966; VYSYVKIN, 1977). The remote sensing method was also used. Although the pictures were of good quality and a convenient scale (ca. 1: 15,000), the scope of its applications was restricted owing to the outdated pictures (1970) and impossibility of obtaining more recent ones (Figs 4 and 5).

Mapping was done simultaneously for two maps: map of plant communities and map of dynamical tendencies. Mapping consisted of joint recording of patches of communities homogeneous as regards syntaxonomy, structure and dynamics. With a single location and delimitation of the patch its double identification was indispensable, thus, by a syntaxonomic unit and a dynamic unit (Fig. 3). Each survey unit plotted on the basic map was described by a complex symbol which first of all contained information on the taxonomic unit, that is the type of the community, and secondly on the dynamic unit. For instance the symbol **7R6** denoted xerothermic grassland (*Tuberario-Iridetum pseudopumilae* = **7**) undergoing regression (**R**) the advancement of which was determined as phase **6** (cf. Tab. 4).

Correspondingly, the notation **2.3 Dg5** denotes an oak-hornbeam (*Doronico-Carpinetum* forest community var. with *Ostrya carpinifolia* 2.3) undergoing degeneration (**Dg**); advancement of this process was evaluated as phase **5**.

Each patch homogeneous as regards structure and dynamic state was unequivocally identified, that is only with one syntaxonomic unit and one dynamic unit. In this way mapping of intermediate survey units was avoided.

III.5. ELABORATION OF FAIR DRAFT OF THE MAPS

Preparation of fair draft of two separate maps - the fundamental map of the plant communities and the map of dynamical tendencies in the vegetation was done by delimitation of the information accumulated in the course of field mapping recorded on one field draft of the map (Fig. 3).

On the two maps obtained in this way the borders of the survey units have a practically identical course. Only when the patch of the same plant community differentiated with respect to dynamics into two or more parts, did there appear a difference in its image on both the maps.

On the map of plant communities, namely, the survey unit corresponding to one vegetation unit could arise from the merging of two or three neighbouring survey units corresponding to various dynamic units. The former unit identified then various phases of the same process and even different processes occurring in an identifiable environment. This principle becomes clear if we study the three maps in Fig. 3. From the field draft (Fig. 3A - see north-eastern corner of map) the borders of all survey units describing the intensity of the process of degeneration (**Dg**) have been transferred into the map of dynamical tendencies (Fig. 3B). On the vegetation map (Fig. 3C) the boundaries of the oak-hornbeam (*Doronico-Carpinetum* var. *Ostrya carpinifolia* - symbol **2.3**) forest on the plateau combine two dynamic survey units (**2.3 Dg3** + **2.3 Dg5**). On the published maps the coloured markings delimitate univocally the ranges of the processes or the ranges of the plant communities.

Preservation of all the survey unit borders on the maps should facilitate the understanding of the method of map preparation, but above all serve for revealing relations between the syntaxonomic and dynamic differentiation of the vegetation.

The general theoretical foundations of the map of dynamical tendencies in the vegetation is given in Chapter II. The detailed assumptions and analysis of the contents of both these maps are given separately in Chapters V and VI and jointly in Chapter VII.

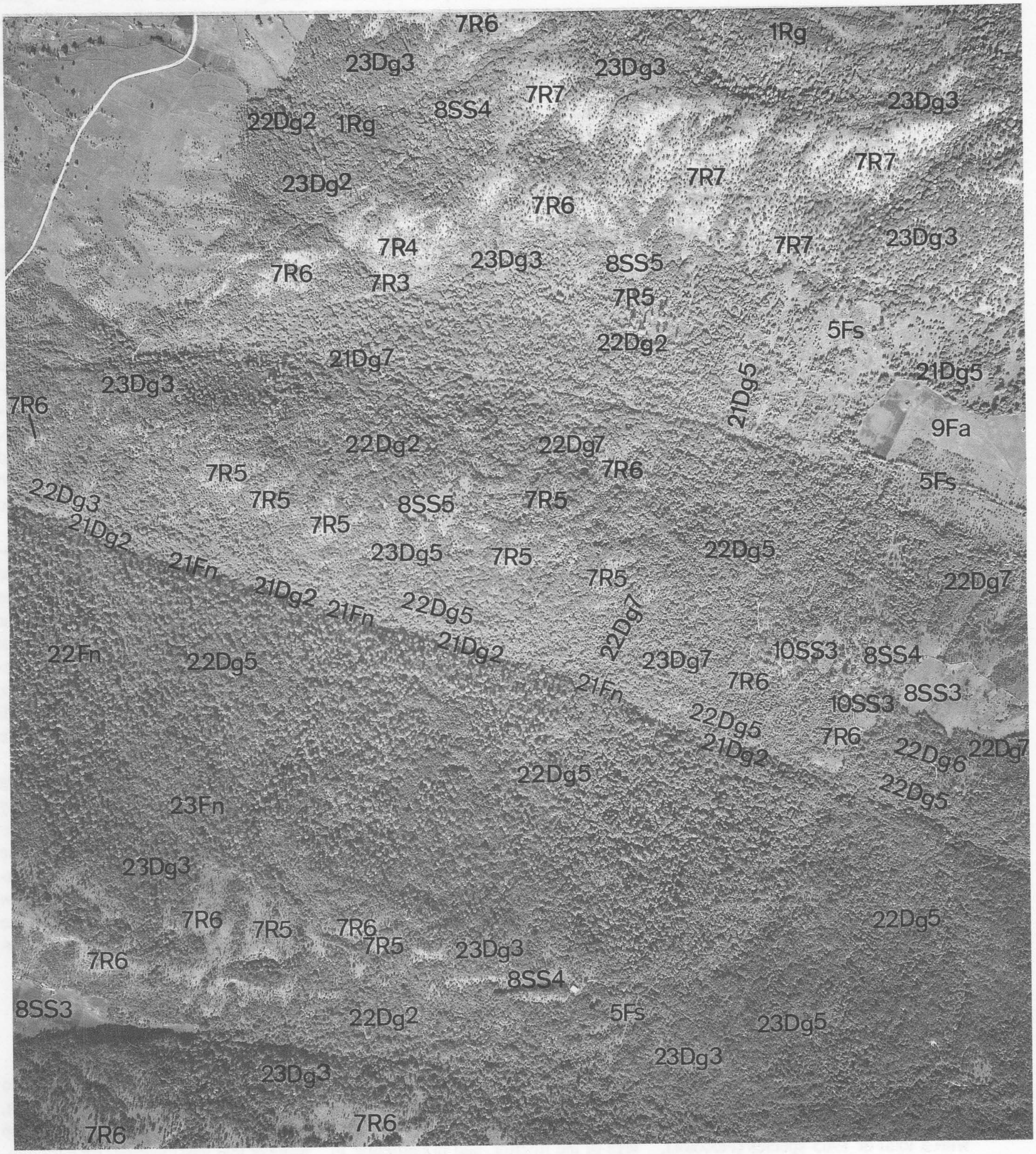


Fig. 4 — Interpretation of vegetation cartographical units on the air-photos in Bosco Quarto (Bufalara, Cornaccia, Valle Ragusa, Coppa del Giglio). Source: Air-photos by Laboratorio Fotointerpretazione e Aerofotogrammetria, Concessione nr. 54, 22.1.1971. Interpretation by J. B. Falinski & F. Pedrotti. Code symbols - see p. 11 and 14, and Tables 2 … 5.

IV. MAPPING AREA

IV. 1. GENERAL FEATURES OF THE GARGANO PROMONTORY

The Gargano promontory is ca 60-km-long and 30-km-wide autonomous mountain chain, distinctly separated from the Apennines by the Foggia high, or "Tavoliere". It has the aspect of a flat montane relief formed by a series of high plains with the highest points Monte Calvo (1065 m asl), Monte Nero (1014 m asl) and Monte Spigno (1008 m asl).

The whole Gargano promontory is formed of Cretaceous and Jurassic sedimentary rocks; karst phenomena are highly developed with the presence of caverns, dolines and sink-holes. In fact it is for this reason that the Gargano lacks any permanent surface water net except for the occasional temporary wells, mostly man-made, known as "piscine". The built-up areas are in part distributed along the coast (Rodi Garganico, Peschici, Vieste, Mattinata and Manfredonia), and partly in the hills of the interior (Cagnano Varano, Carpino, Ischitella, Vico del Gargano, S. Nicandro Garganico, Apricena, S. Marco in Lamis and S. Giovanni Rotondo). Monte S. Angelo at 843 m asl is the only center that can really be considered a mountain one.

Apart from these effective built-up areas, over the whole interior of the Gargano there is very wide distribution of temporary residences (i. e. those occupied by man in the summer months only) called "masserie". Also frequently found are the so-called "addiacci", or summer enclosures for animals.

Despite the fact that the impact of man over the centuries has been very considerable in the Gargano, as shown by the vast zones completely deforested, at the same time there are still some densely wooded areas, such as the Foresta Umbra, the Bosco Sfilzi, the Bosco Quarto, the Bosco of Manfredonia, etc.

The Gargano promontory is widely recognized for the richness of its flora with a total of 1965 species (FENAROLI, 1966, 1970, 1972, 1973, 1974); instead, its vegetation is less well-known, despite the publication of some research relating prevalently to the Foresta Umbra (HOFMANN, 1961 & 1969; FENAROLI, 1966 & 1969; GUALDI 1974) and to the Mediterranean vegetation of the coast and the interior (CORTI, 1952; AGOSTINI 1964 & 1969; CORTINI PEDROTTI & TROIANO 1984; BIONDI, in print). For other zones, such as the Bosco Quarto, there is an almost complete lack of data in the works cited, except for their mentioning some species of flora.

IV. 2. THE BOSCO QUARTO

The Bosco Quarto is the Gargano territory chosen for this first investigation of a geobotanical nature. A similar research project will follow on the Foresta Umbra, which will be the object of a general monographic paper.

The Bosco Quarto covers an area of ca 5,000 hectares in the municipal territory of Monte S. Angelo. It lies on an undulating high plain from 500 m to 850 m asl in altitude, formed of a series of parallel valleys, which includes the locality of Bufalara and the Parco of S. Benedetto and that of S. Michele, Valle Ragusa extending into Valle Pezzente, and Valle della Piana dell'Incudine. These three valleys are cut by relief chains with rounded summits reaching altitudes of slightly less than 700 m, with a maximum at the Coppa del Giglio (752 m asl) almost in the center of the Bosco Quarto (cf. also the profile AB on the Real Vegetation Map).

To the NE of Bosco Quarto there is the Monte Spigno chain (1008 m asl) with its summit consisting in a high plain sloping prevalently NE-ward and containing numerous and sometimes considerably large dolines. Monte Spigno is bounded to the north by the Valle Panizza.

The geology of the zone in question is very homogeneous: in fact, over most of the territory the so-called Monte Spigno Malm limestone crops out almost exclusively to form, in addition to the Monte Spigno chain, the secondary chains of the Bosco Quarto high plain. The S. Giovanni Rotondo limestone, and that of Monte Pizzuto as well, both Malm in age, crop out only in some peripheral areas of the western and eastern sectors, respectively.

In the previously mentioned valleys of the interior, and in particular in the Bufalara-Parco di S. Benedetto-Parco di S. Michele zone, there are vast Holocene-Pleistocene "terra rossa" deposits. Elsewhere, instead, the forest soils are brown earths. For a study of the weather conditions, the Monte S. Angelo station (843 m asl) is the only point of reference; the climatic diagram is reported in Fig. 6. The rainfall follows a typically Mediterranean pattern with winter and spring maxima and a considerably marked aridity in summer, even though this is less than in the regime prevailing along the coast: there a marked general drop in rainfall is also observed (445 mm at Manfredonia and 543 mm at Vieste). The mean annual temperature is 12.4 °C, considerably lower than that at Manfredonia and Vieste (14.4 °C and 16.4 °C, respectively).

Cloudy conditions are very frequent in the higher altitude sector; however, low cloud is often observed homogeneously covering the whole Bosco Quarto high plain.

As a consequence of the particular weather conditions on the Gargano, a marked compression of the vegetation belts occurs, as has already been evidenced by FENAROLI (1966); that can be particularly well noted in the Bosco Quarto, too, where the ilex facing southward reaches 1000 m asl, whereas the beech wood on the northern slopes does not go down below an altitude of 620 m.

In the Bosco Quarto zone the impact of man has been particularly intense in certain sectors, both as regards the numerous "masserie" and "addiacci", or enclosures for sheep, of which TANCREDI (1938) listed as many as 16, and as regards some vast cultivated clearings, known as "parchi", such as the Parco di S. Benedetto, the Parco di S. Michele and the Piana dell'Incudine.

In spite of this very marked impact of man, the Bosco Quarto still today conserves well-preserved and considerably extensive areas of forest, as on the left-hand slope of the Ragusa and Pezzente valleys (*Doronico-Carpinetum* community) and on the slopes to the north of Monte Spigno (*Aremonio-Fagetum* community).

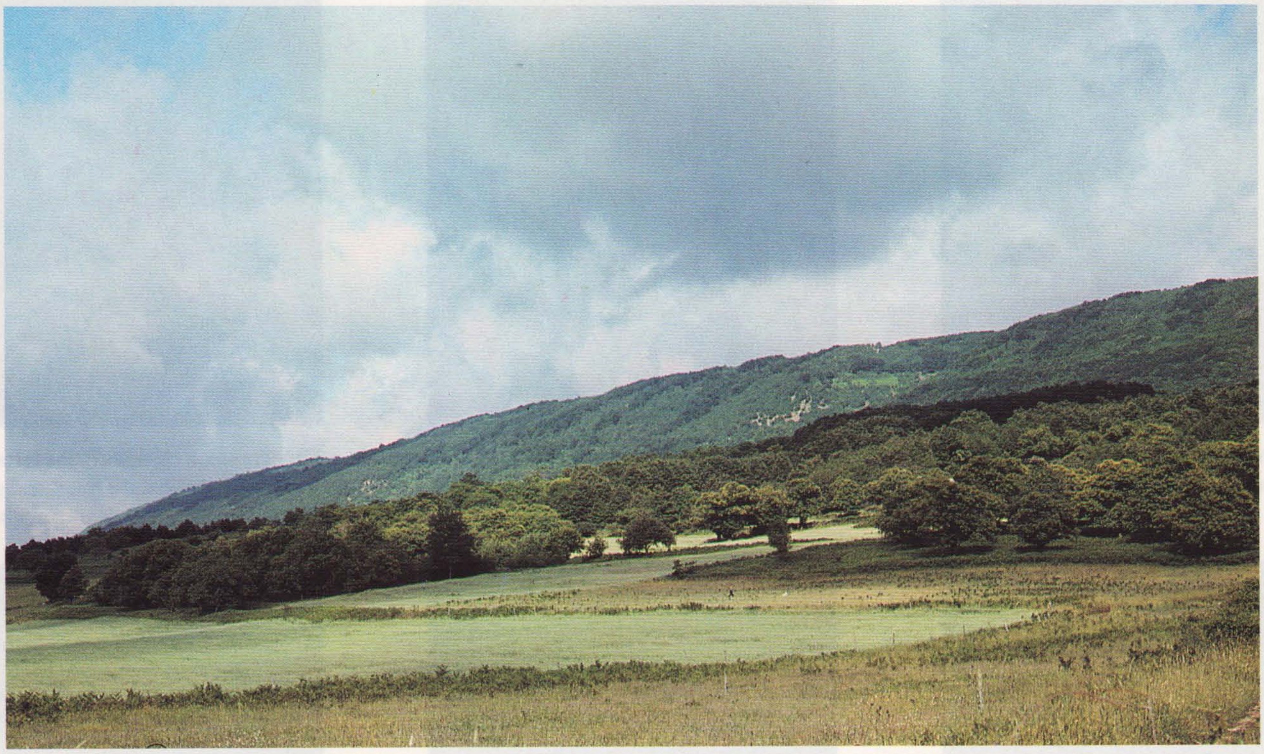
IV. 3. THE VEGETATION

The vegetation of the Bosco Quarto is mainly formed of forests, in which, over the centuries, man has opened up more or less vast clearings for agricultural crops and grazing.

For this reason, alongside the natural vegetation of the forest communities, numerous anthropogenic associations have been formed in the Bosco Quarto; these, mainly herbs but also shrubs as well, today occupy all those spaces where the forest has been eliminated.

Still now in the wooded areas that have been preserved, the impact of man is considerable both as regards pasture-

Plate I — Forest landscape in Bosco Quarto and Bosco Spigno.

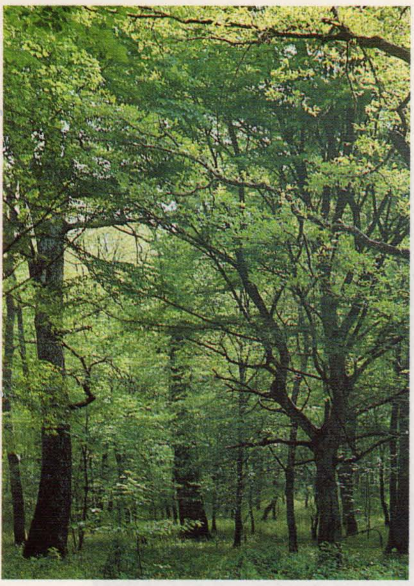


Forest on slope of Monte Spigno - photo from deforested valley Piano dell'Incudine.

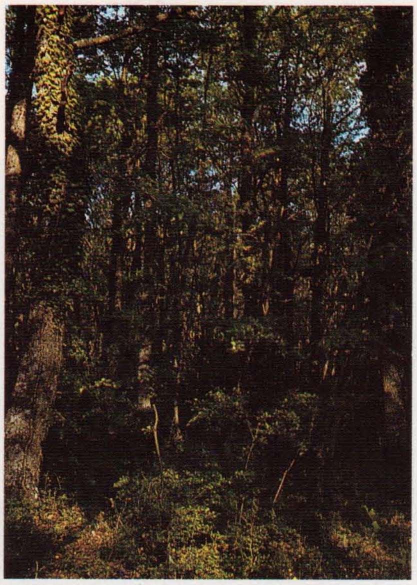
Beech forest (*Aremonio-Fagetum*) in Bosco Spigno.

Oak-hornbeam forest (*Doronico-Carpinetum*) in Bosco Quarto.

Plate II — Degeneration of hornbeam-oak forest communities (*Doronico-Carpinetum*) under man impact and grazing.

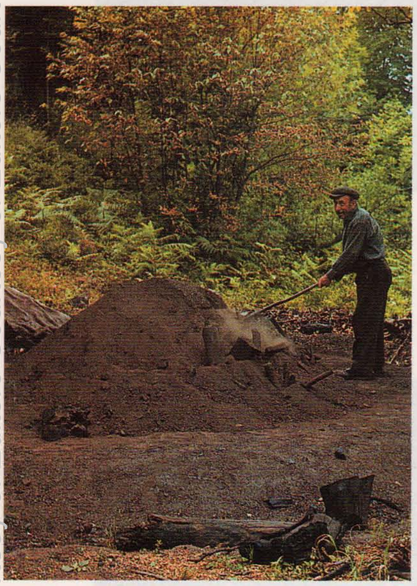


Oak-hornbeam forest community changed by grazing. Degeneration phase 1.

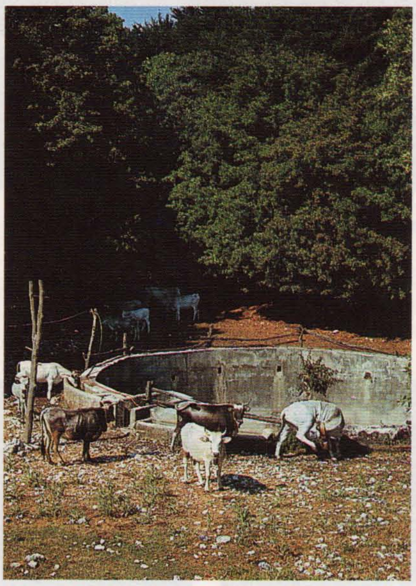


Oak-hornbeam forest community with strong developed shrub layer (*Ilex aquifolium*). Degeneration phase 6.

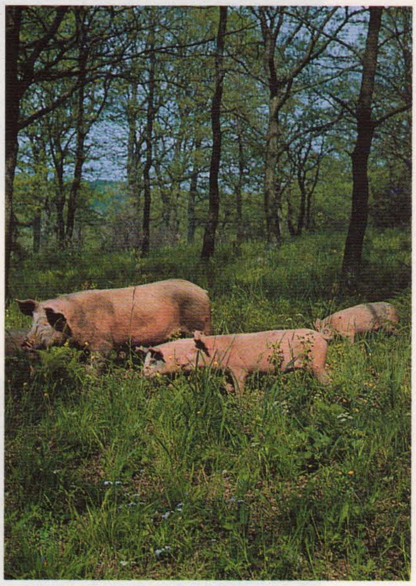
Very common changes in the terrain relief: stone walls divided the forest and grassland complexes to multitude of parcels.



Charcoal processing - very important factor of forest destruction.



Water bassin for cattles ("piscina") - local centrum of changes in the evironment and in the vegetation.



Pig pasturing in hornbeam-oak forest.

Rest of forest on the slope.

Selected felling in the oak tree stand.

Xerothermic grassland developed after deforestation and adapted for animal pens, abandoned at present.

Plate III — Animal impact as factor of constitution and regression of xerothermic grassland communities.

Goat grazing in the xerothermic grassland as very important factor of vegetation regression.

Formation of grassland in place of the forest. Regression phase 5.

Small groups of trees with bushy offshoot. Regression phase 6.

Disappearrance of trees between clearings. Regression pahse 7.

Patches of xerothermic grassland reman only in crevices in sharp-edges rocks. Regression phases 9.

Xerothermic grassland in regression phase 10.

Plate IV — Fluctuation and secondary succession in the anthropogenic vegetation.

Cultivated fields in the direct contact with spontaneous vegetation.

Segetal communities under repeated agrotechnical influences. Dynamical tendencies identified with the fluctuation.

Pasture communities permanently grazed. Dynamical tendencies identified with the fluctuation.

Contact of two plant communities in the regression and in the secondary succession.

Development of spontaneous vegetation on the abandoned field in the carstic doline. Secondary succession phase 5.

Secondary succession in the karstic doline constrained by tree plantation.

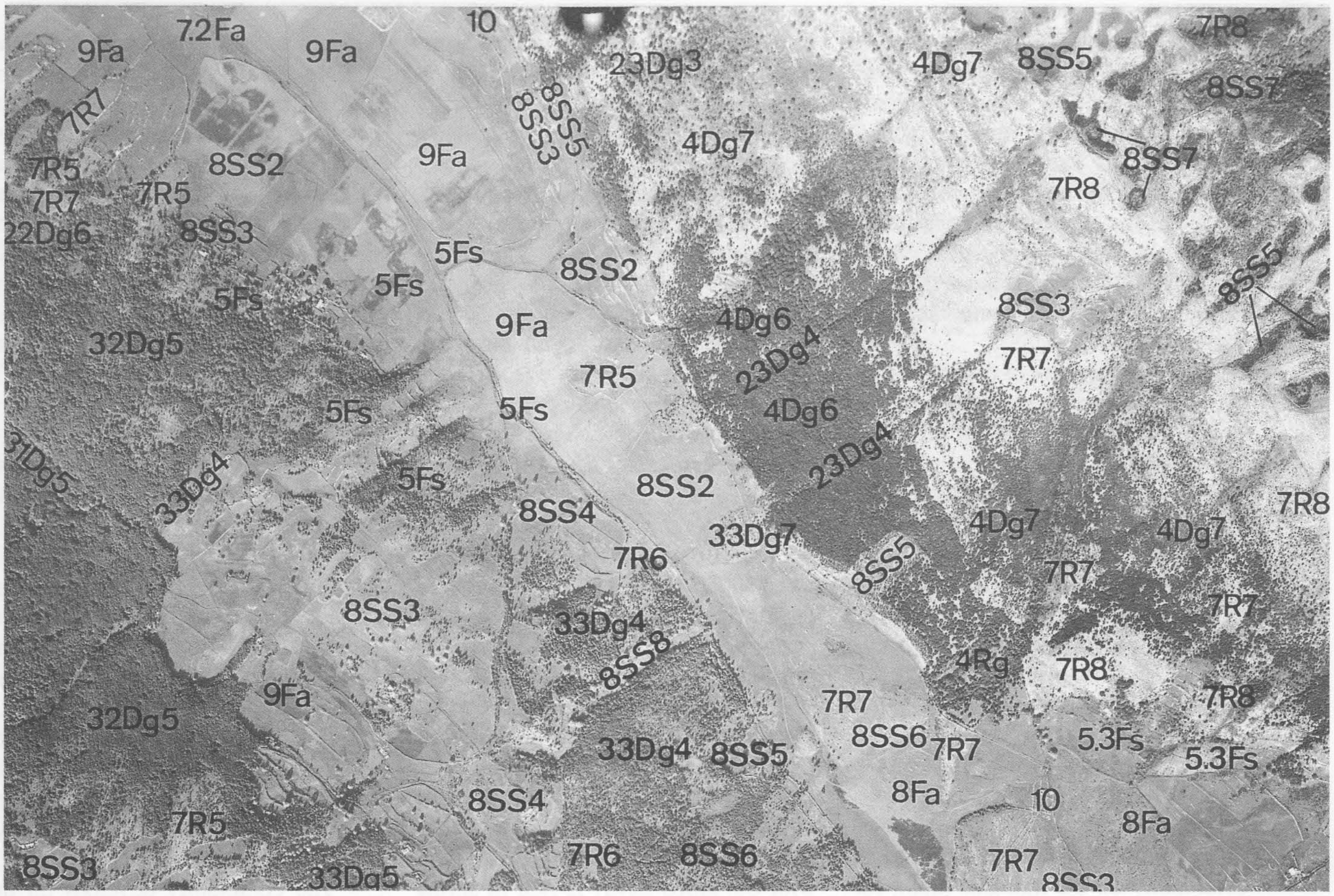


Fig. 5 — Interpretation of vegetation cartographical units on the air-photos in Bosco Quarto (SW slope of Monte Spigno, Parco S. Michele, Parco Purgatorio). Source: Air-photos by Laboratorio Fotointerpretazione e Aerofotogrammetria, Concessione nr. 54, 22.1.1971. Interpretation by J. B. Falinski & F. Pedrotti. Code symbols - see Tables 3 … 5.

land and selected felling and thinning. Instead, the anthropogenic pressure on the wood is much less today for what concerns charcoal production; very intense in the past, it is currently limited to a few localities on the northern slope of Monte Spigno.

The Bosco Quarto forests are all formed of mesophilous deciduous trees and only to a small extent of evergreen sclerophyllous ones. Among the former, there are the beech forests (*Fagus sylvatica*) with the *Aremonio-Fagetum* community and mixed forests of hornbeam (*Carpinus betulus*) and oak (*Quercus cerris*) with the *Doronico-Carpinetum* community. The only evergreen sclerophyllous forest is the ilex one (*Quercus ilex*) with the *Ostryo-Quercetum ilicis* community.

There are numerous anthropogenic meso-xerophilous pasture associations and synanthropic associations that have developed near human settlements (masserie), in cultivated fields, in ruderal zones and along sheep tracks.

Phytosociological surveys have been carried out on these types of vegetation to identify the vegetal communities; however, in some cases, as in that of *Pteridium aquilinum* macroforbs in

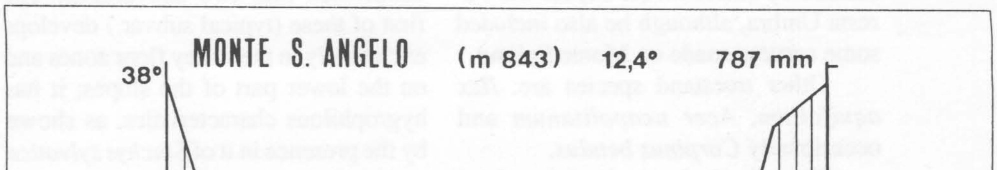


Fig. 6 — Climatic diagramm of Monte S. Angelo (m 843); the data of precipitations relate to the period 1921-50, those of temperatures to period 1926-55.
Source: CORTINI PEDROTTI & TROIANO (1984).

abandoned fields, it has been considered best not to speak of a community. In fact, these correspond to unstable dynamic phases tending to be rapidly transformed. In other cases more extensive phytosociological investigations are required. The phytosociological tables used as a basis for describing the vegetation will be published in one of the forthcoming numbers of "Documents Phytosociologiques".

For the purposes of the present study, the various vegetational units of Bosco Quarto have been lumped together into large physiognomic-structural categories, as indicated in the map legend (cf. also Tab. II); a brief description is given for every vegetational unit, together with some information on its distribution in the Bosco Quarto area, the main forms of utilization and a short list of the main species.

1. Mesophilous beech-forests (*Aremonio-Fagetum* Hofmann 1961)

A mesophilous deciduous forest community on the montane plain, formed for a very great part of beech (*Fagus sylvatica*) and rich in spring geophyte undergrowth. This community was described by HOFMANN (1961) for the Foresta Umbra, although he also included some surveys made on Monte Spigno.

Other treestand species are: *Ilex aquifolium*, *Acer neapolitanum* and occasionally *Carpinus betulus*.

The shrub layer is formed of *Daphne laureola*, *Ruscus aculeatus* and *Acer campestre*.

Species of the herb layer are: *Cyclamen neapolitanum*, *Lathyrus venetus*, *Anemone apennina*, *Dentaria bulbifera*, *Agrimonia agrimonioides*, *Galanthus nivalis*, *Viola sylvestris*, *Festuca exaltata*, *Sanicula europaea*, *Galium odoratum*, *Mercurialis perennis*, *Milium effusum* and *Carex sylvatica*.

The community has developed on the northern slopes of Monte Spigno between 620 m and 980 m; it is a high forest used for occasional and clearcut felling, at least in the past. In the case of clearcut felling, after the beech wood has been cut *Ostrya carpinifolia* and other deciduous thermophilous stands developed with a consequent sharp regression of the beech wood.

2. Garganical deciduous oak-hornbeam forests (*Doronico-Carpinetum* ass. nova)

A mesophilous deciduous community of the hilly plain with a mixed treestand layer formed of hornbeam (*Carpinus betulus*), oak (*Quercus cerris*) and maple (*Acer obtusatum*).

Other shrub species are: *Ilex aquifolium* and *Acer campestre*.

In the herb layer, common plants are: *Doronicum orientale*, *Allium pendulinum*, *Anemone apennina*, *Galanthus nivalis*, *Corydalis cava*, *Ranunculus lanuginosus* and *Ornithogalum pyrenaicum*.

The community is developed all over the Bosco Quarto high plain between 500 m and 780 (800) m, mostly in the form of high trees and in some more peripheral areas considerably transformed into coppices.

This is the southernmost expression in the whole Italian peninsula of *Carpinion* or of a possibly new substitutional alliance having Mediterranean or submontane characteristics. It can be divided into two variants: the first (var. with *Corydalis cava*) is rich in spring geophytes (*Anemone apennina*, *Allium pendulinum*, *Corydalis cava* and *Galanthus nivalis*) and can in its turn be subdivided into two subvariants. The first of these (typical subvar.) develops exclusively in the valley floor zones and on the lower part of the slopes; it has hygrophilous characteristics, as shown by the presence in it of *Stachys sylvatica* and *Lathyrus venetus*. The second subvariant (subvar. with *Lathyrus venetus*) develops on the valley slopes with mesophilous characteristics.

Finally on the upper parts of the slopes with their very rounded profile, a meso-xerophilous variant develops with *Ostrya carpinifolia* in which geophytes are rare or absent (Fig. 7).

The impact of man on the Bosco Quarto forest vegetation has already been mentioned; in particular, in the *Doronico-Carpinetum* community, a mixed wood of hornbeam and oak, this impact occurred through selective felling which in some zones progressively eliminated the hornbeam, a less valuable wood, in favor of the oak, which was spared and thus became predominant.

For these reasons, vast areas of the forest today are formed exclusively of oak, while the hornbeam has virtually disappeared. The forests of oak alone derive, therefore, from a progressive transformation of the *Doronico-Carpinetum*; for these oak forests, too, the variants already described for the *Doronico-Carpinetum* (hygrophilous, mesophilous and meso-xerophilous) have been identified. These assume the same importance and therefore occupy the same positions as those described previously. This can be particularly noted in the zones surrounding the Piana dell'Incudine and Trenta Carrini, as well as in vast areas at the head of the Valle Ragusa around the locality of Tre Carpini.

4. Sclerophyllous evergreen forests (*Ostryo-Quercetum ilicis* Trinajstic (1965) 1974)

A prevalently sclerophyllous evergreen forest community of the Mediterranean plain with the presence of some deciduous trees as well, among which in particular *Ostrya carpinifolia*.

In the shrub layer there is the presence of *Ruscus aculeatus*, *Asplenium onopteris*, *Rubia peregrina*, *Carex hallerana*, *Asparagus officinalis*, *Neottia nidus-avis*.

The community develops on the southern slopes of Monte Spigno where it reaches 950 m to 980 m, the maximum altitude attained in the zone under study. This, too, is a deciduous forest community, however a fairly closed one which in the past was subject to periodic felling, above all for charcoal production.

5. Seminatural brushwood communities from order *Prunetalia*

These are shrub formations of *Prunus spinosa*, *Crataegus laevigata* and *Acer campestre* which form the hedges along the roads and sheep tracks. In various localities, which in the past were cultivated, or used for grazing but have now been abandoned for several years, these shrub species may occupy vast surface areas, as in the localities of Bufalara, Parco Gentile e Parco del Purgatorio.

In the cooler stations, the *Milio-Aceretum campestris* Pedrotti 1982 community has been noted; this was described for the Central Apennines (PEDROTTI, 1982) and spreads along the whole Apennine chain in the high plains. It is formed prevalently of *Acer campestre* together with *Crataegus laevigata*, *Prunus spinosa*, *Clematis vitalba*, *Cornus sanguinea* and, in the herbs layer, of *Milium vernale*, *Lamium maculatum*, *Geranium lucidum*, *Geum urbanum* and other species.

In the more xeric stations the composition of these shrubs changes considerably and other communities appear.

Also the *Spartium junceum* community, present on some southern slopes near the masserie, is probably of the *Prunetalia* order (unit 5.2).

7.1 Meso-xerophilous grassland communities on the thick rocks (*Tuberario-Iridetum pseudopumilae* ass. nova)

This is an arid pastureland community occupying the clearings and formed of a large number of species among which: *Tuberaria guttata*, *Iris pseudopumila*, *Brachypodium distachyum*, *Bromus erectus*, *Crepis lacera*, *Orchis papilionacea*, *Orchis quadripunctata*, *Ophrys lutea*, *Ophrys sphecodes*, *Ophrys crabronifera* ssp. *sundermannii* and *Serapias lingua*.

7.2 Meso-xerophilous grassland communities on fine rocks (*Asphodelino-Brometum* ass. nova)

This community is distinguished from the previous one by the presence of *Asphodeline liburnica*, *Crucianella angustifolia* and other species. It develops exclusively on the southward facing slopes of Monte Spigno on substrata which are rocky but with relatively deep soil.

Often, large isolated trees of *Quercus pubescens* and occasionally also of *Ostrya carpinifolia* are found in the *Asphodelino-Brometum* even giving the impression of a coppice; however, the herb layer flora is not that of a coppice but rather of the *Asphodelino-Brometum* pastureland community.

8. Macroforb communities with *Pteridium aquilinum* and other pre-forest communities on the abandoned farmland

Pteridium aquilinum is a species tending progressively to invade abandoned fields until forming communities with a coverage equal to 100%. Today this species has invaded both the vast flat land sectors which in the past were intensely farmed, such as Piana dell'Incudine, and the floors of the Monte Spigno dolines. Previously, the majority of these dolines were cultivated but now the

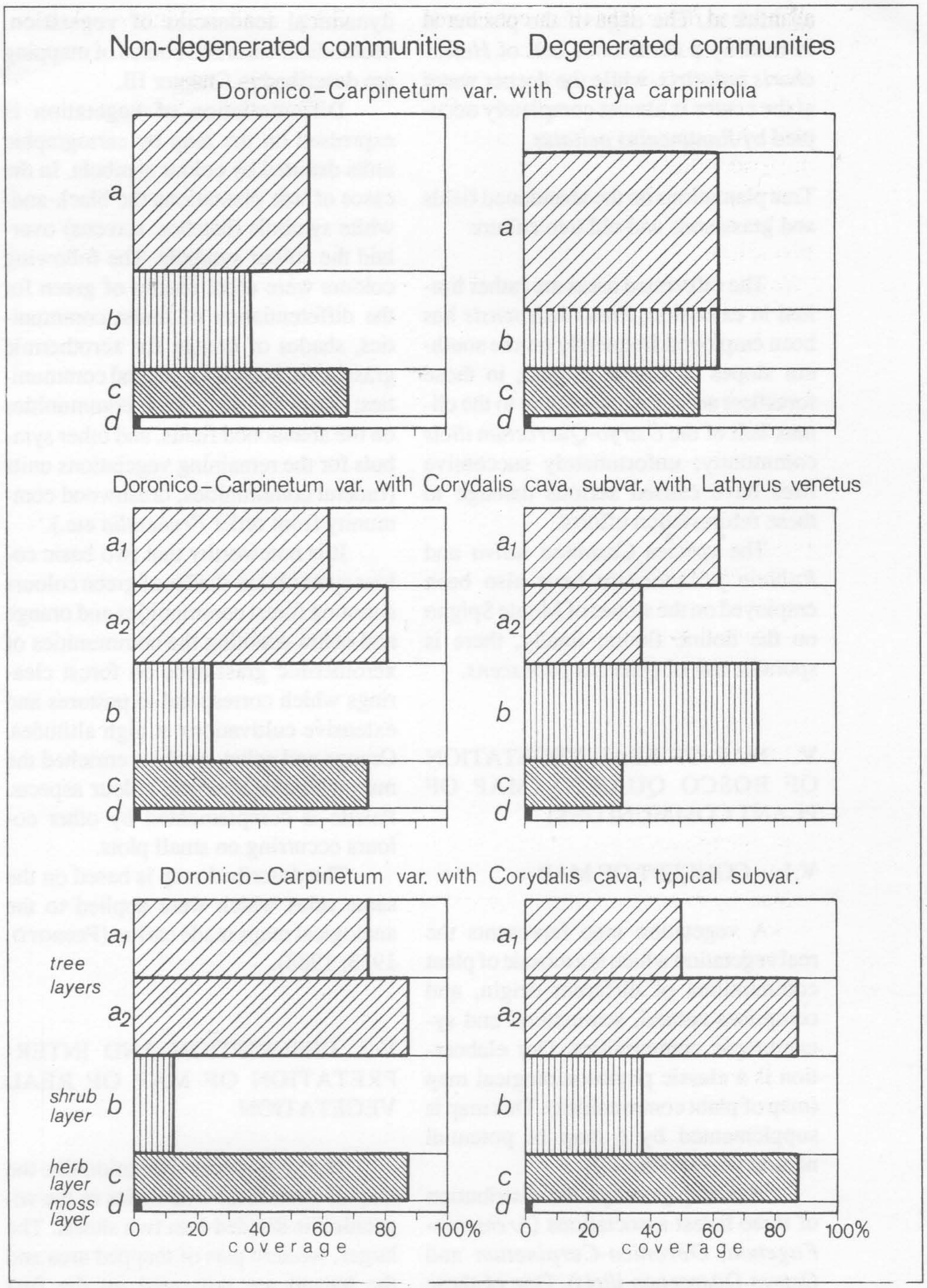


Fig. 7 — Comparison of vertical structure of non-degenerated and degenerated forest communities of *Doronico-Carpinetum* in the consecutive phytosociological variants. Development of shrub layer is an effect of grazing. Source: orig. elab. of JBF & FP.

communities with *Pteridium aquilinum* have developed in the deep soils, which have formed on the doline floors.

In the Chapter dealing with the dynamical tendencies in the vegetation, further information is given on the different evolutionary phases characterized by *Pteridium aquilinum*; after a certain number of years the pre-forest community with *Populus tremula*, *Salix caprea* and above all with *Quercus cerris* takes over.

9; 10 Synanthropic communities (segetal and ruderal communities)

These are segetal communities in the wheat fields, as in the Parco S. Benedetto zone, and ruderal and nitrophilous communities present in the neighborhood of the "masserie".

11. Water and swamp communities in the artificial basins

These communities have developed only in some artificial basins known as "piscine" that are found along the sheep track in the locality of Parco S. Benedetto; they are water reservoirs for animals to drink at. The edge of the piscine is formed by a continuous belt of *Heleocharis palustris*, while the deeper water at the center is almost completely occupied by *Ranunculus peltatus*.

Tree plantations on the abandoned fields and grasslands and old tree culture

The reforested areas are rather limited in extension; *Pinus halepensis* has been employed frequently on the southern slopes of Monte Spigno, in those forestless areas corresponding to the climax belt of the *Ostryo-Quercetum ilicis* community; unfortunately successive fires have caused serious damage to these reforestation efforts.

The species *Castanea sativa* and *Robinia pseudacacia* have also been employed on the slopes of Monte Spigno on the doline floors; finally, there is sporadic use of *Quercus pubescens*.

V. MAP OF REAL VEGETATION OF BOSCO QUARTO (MAP OF PLANT COMMUNITIES)

V.1. CONCEPT OF MAP

A vegetation map represents the real vegetation which is a mosaic of plant communities of different origin, and comprises natural, seminatural and synanthropic communities. Our elaboration is a classic phytosociological map (map of plant communities). This map is supplemented by a map of potential natural vegetation.

The map portrays the distribution of three forest associations (*Aremonio-Fagetum*, *Doronico-Carpinetum* and *Ostryo-Quercetum ilicis*). One of these associations (*Doronico-Carpinetum*) is represented by variants and sub-variants. The map shows two associations of xerothermic grassland, *Tuberario-Iridetum pseudopumilae* and *Asphodelino-Brometum*. However, it proved impossible to phytosociologically identify the synanthropic associations which were fragmentarily developed in the mapped area. Such cases are included in the map under the general names.

V.2. METHOD OF CARTOGRAPHICAL EXPRESSION

The map of real vegetation is a result of joint field mapping, which consisted in the mapping of the dynamical tendencies of vegetation. Methodical basis and course of mapping are described in Chapter III.

Differentiation of vegetation is expressed on the map by cartographic units denoted by colour symbols. In the cases of tree plantations the black-and-white symbols (hatches, screens) overlaid the colour symbols. The following colours were used: shades of green for the differentiation of forest communities, shades of orange for xerothermic grasslands; brown for segetal communities; ochre for macroforb communities on the abandoned fields, and other symbols for the remaining vegetations units (ruderal communities, brushwood community from order *Prunetalia* etc.).

It is noteworthy that two basic colour symbols are shades of green colours denoting forest communities and orange and ochre denoting the communities of xerothermic grasslands on forest clearings which correspond to pastures and extensive cultivations at high altitudes. Orange and ochre symbols enriched the map with characteristic colour aspects. Palette is complemented by other colours occurring on small plots.

The described map is based on the same rules which were applied to the analogical maps made earlier (PEDROTTI, 1983, 1988).

V.3. DESCRIPTION AND INTERPRETATION OF MAP OF REAL VEGETATION

The map of real vegetation like the map of dynamical tendencies in the vegetation is divided into two sheets. The larger, western part of mapped area and the legend are presented on the first sheet. In the legend the vegetation units are combined into broader physiognomic-structural community groups. The second sheet comprises the smaller, eastern part of the area and three insets illustrating geology, terrain formation and relief, and potential natural vegetation. Profiles inserted in the second sheet of map of dynamical tendencies in the vegetation show the dependence of vegetation differentiation on the terrain formation.

The map of vegetation like the map of dynamical tendencies in the vegetation was elaborated and published in scale 1: 10,000. It is, therefore, a detailed map, which at least in respect of forest communities may be termed a map of phytocoenose (FALINSKI 1990).

The described map portrays 17 vegetation units and additionally 3 particular units (tree plantation and old tree culture).

The aim of the map is the presentation of spatial vegetation patterns and the distribution of vegetation in relation to environmental conditions.

The map particularly well represents the spatial pattern of forest vegetation. A community of beech forest, *Aremonio-Fagetum* is clearly connected with north-ern slope as the highest altitudes in the massif of Monte Spigno, while the evergreen oak forest *Ostryo-Quercetum ilicis* is located on southern slopes.

The most common forest community is the deciduous forest, *Doronico-Carpinetum*. This community occupied all higher altitudes: plateau, slopes and valleys between them. It can be read from the map that hygrophilous and mesophilous variants of *Doronico-Carpinetum* developed in valley bottoms and lower parts of slopes only. The patches of meso-xerophilous variants of *Doronico-Carpinetum* are well developed on the hill plateaux. The prevailing part of this community was substituted by the secondary xerothermic grassland *Tuberario-Iridetum pseudopumilae*.

Most of the mapped area is forested. Nonetheless, human impact in Bosco Quarto is clearly visible due to development of pastures, fields and scattered settlements (masserie). These phenomena are well readable from the map. The scale of map employed made it possible to draw them not only in the extensive low-laying valleys previously cultivated, but also in small areas on slopes and hill plateaux, and even in tiny karstic dolines (e. g. on Monte Spigno). The same can be said about grazed grasslands.

V.4. MAP OF POTENTIAL NATURAL VEGETATION

Map of potential natural vegetation in scale 1: 25,000 is derived from the map of real vegetation and was formed by transformation of this map in larger scale with the necessary generalization and modification of survey units.

Potential vegetation is represented by 4 forest communities. Of these, *Ostryo-Quercetum ilicis* is a Mediterranean association. Its patches in the massif of Monte Spigno penetrate into Gargano and reach the upper limit of altitudinal range. *Aremonio-Fagetum* is a montane association, and *Doronico-Carpinetum* a submontane association.

It proved impossible to strictly determine the community with *Quercus pubescens*. It belongs to the order *Quercetalia pubescentis;* however, it will be necessary to define the phytosociological character of this community in detail.

Clear floristic and phytosociological differentiation of *Doronico-Carpinetum* expressed by a system of variants and subvariants is related to the differentiation of local habitats. *Doronico-Carpinetum* is the most widespread plant community in Bosco Quarto and represents the type of mesophilous community. In the terrain it is located between a sclerophyllous community *Ostryo-Quercetum ilicis* and mesophilous community *Aremonio-Fagetum.*

Our elaboration contributes the first information about this mesophilous community of oak-hornbeam forest in Promontorio del Gargano that was known mostly for its well preserved beech forests (Foresta Umbra). The *Doronico-Carpinetum* community described here for the first time was once widespread. It was decreasing in area due to foundations of pastures, fields and settlements on deforested clearings. Far-reaching changes in the structure of this community caused by grazing and charcoal processing in the forest are presented on the second map as examples of degeneration of communities. Primarily forest management is responsible for the transformation of some fragments of beech forests into thermophilous oak-hornbeam forests (*Doronico-Carpinetum* var. with *Ostrya carpinifolia*), especially so in the Monte Spigno massif.

VI. MAP OF DYNAMICAL TENDENCIES IN THE VEGETATION OF BOSCO QUARTO. INTERPRETATION AND GENERALIZATION

VI.1. CONCEPT OF MAP IN DETAIL

The concepts of the map of dynamical tendencies of the vegetation and the methods of its preparation are presented in the foregoing Chapters (II.6. and III). It should only be added here that the map of the dynamical tendencies of the Bosco Quarto vegetation illustrates the range and spatial differentiation of the major ecological processes observable in concrete definite plant communities in a direct single field observation.

Although the map of dynamical tendencies in its final form does not supply immediate information in what plant communities the given process takes place in the given field location, the finding of this process in the field without reference to definite communities would not have been possible, and the ecological interpretation and generalization of this map would have been greatly limited. The same condition is true for spatial differentiation of the particular processes expressed by a system of phases expressing the probably state of advancement of the given process in the given community and location.

VI.2. METHOD OF CARTOGRAPHIC EXPRESSION. CARTOGRAPHIC UNITS AND SYSTEM OF SYMBOLS

According to the concept and method applied in preparing the map of dynamical tendencies, the particular cartographic vegetation units express separately the ecological processes occurring in the vegetation (and their advancement). Thus, the dynamical tendencies of the Bosco Quarto vegetation are described by 29 cartographic units, 25 of which being ordered in three independent series corresponding to the three systems of developmental phases.

As planned, the map illustrates firstly, by means of coloured symbols the occurrence and range of five ecological processes, secondly - by means of different-coloured scales - the spatial differentiation of three of these processes in respect to their advancement.

Thus, patches of communities undergoing degeneration are shown in a scale of green and blue colours. Patches undergoing regression are expressed in a scale of light yellow to dark orange. Patches undergoing secondary succession are presented in a scale from amaranth to violet. Regeneration, as a local process of minor significance is rendered by only one coloured sign (without distinction of phases). Fluctuations are expressed by three independent dark colours, which differentiate this process in three groups of communities differing in origin, structure and physiognomy.

The degree of advancement of the three major ecological processes in the vegetation of Bosco Quarto, that is degeneration, regression and secondary succession is illustrated according to the same rules: thus, initial phases are rendered by light colours, intermediate ad final ones by ever darker hues. It was also endeavoured to visualize the initial and terminal phases of the respective processes in reference to a certain stability of vegetation of various types, that is fluctuation.

The application of colour scales gives the map certain features of a quantitative-qualitative, and not only qualitative map.

VI.3. DESCRIPTION AND INTERPRETATION OF THE MAP OF DYNAMICAL TENDENCIES IN THE VEGETATION

The map may be analyzed and interpreted both as an independent work and in combination with the simultaneously prepared map of vegetation (of plant communities) published in the same volume. It is obvious that the kind of information obtained and its reliability will not be the same in both these cases.

The map of dynamical tendencies in the vegetation when considered alone allows one to establish the range and spatial differentiation of all the illustrated processes. When all the information contained in the legend and basic map is taken into account it may also supply quite deep causative information.

In the first place the map discloses the three co-dominant processes: degeneration of forest communities, regression of xerothermic grassland communities and secondary succession in communities of abandoned fields and pastures. These processes on smaller areas are accompanied by: regeneration in forest communities and fluctuation in forest and synanthropic communities, mainly segetal ones of field crops. The situation of the areas where the particular processes prevail and simultaneous occurrence of accompanying processes are not accidental. The existing regularities were as far as possible expressed on the inset in scale 1: 25,000 on the eastern sheet of the main map. This map is the appropriate interpretation of the map of dynamical tendencies, and its commentary (Chapter VI.4) should substitute the verbal description of the contents of this map. The latter map gives good information on the advancement of the three co-dominant processes (Plate II; Plate III).

On the mapped area all or nearly all the consecutive phases of these processes are illustrated: degeneration, regression, and secondary succession. In the particular processes, however, different regularities appear. Degeneration is most advanced in forest communities, above all in phases **5** and **7**. Degeneration is expressed in these cases by far reaching changes in the structure and species composition of forest communities, caused by permanent grazing and coppice forest management. The response of forest communities to these factors is a vigorous development of under-growth and dominance in the latter of *Ilex aquifolium*, a general lowering of the forest canopy and a simplified vertical structure of the forest. Comparison with the map of the vegetation leads to the conclusion that the spread of forest communities in phase **5** of degeneration concerns oak-hornbeam (*Doronico-Carpinetum*) deciduous forest communities. Communities undergoing degeneration in phase **7** are mainly represented by low, poor in species evergreen communities of oak forest (*Ostryo-Quercetum ilicis*). The regression process was noted above all on xerothermic grassland. It also seems to show some connection with the differentiation of this group of communities. Here reference to the vegetation map is not very helpful, because our earlier analysis and phytosociological identification in this group of communities was only provisional.

The spread of secondary succession and the degree of its advancement are directly related with the process of liberation from anthropopressure of the Gargano foothills and abandonment of cultivation of, firstly the high situated numerous small karstic valleys, and further the extensive valleys on the southern foreground of Monte Spigno and the western part of the mapped area (Piana dell'Incudine). Therefore macroforb communities with *Pteridium aquilinum* dominate here, sometimes with the participation of a single shrub or forest tree the origin and development of which may be traced back to earlier succession phases.

The degree of secondary succession advancement expressed by the early phases of this process does not, as it seems, represent the full time elapsing since cultivation was abandoned. Apart from occasional disturbance of the course of this process by sporadic grazing or fire, what seems to be decisive here his the negligible spread, and in many places complete absence of pioneer tree and shrub species of the genera *Salix*, *Betula* and *Populus*. These species clearly determine the course of secondary succession in analogous conditions in northern Europe. The species with wind-borne seeds such as *Salix caprea* and *Populus tremula* are rare, and their survival at the bottom of some deep small karstic valleys does not promise their spread to other areas freed at present from the influence of anthropogenic factors. In the course of early succession phases, maples *(Acer campestre*, *A. opalus*, *A. obtusatum*) common in the neighbouring forest communities play an insignificant role. Penetration of oak (*Quercus cerris*, *Q. pubescens*, *Q. ilex*), ash (*Fraxinus ornus*) and hornbeam (*Carpinus betulus*, *C. orientalis*) and hop-hornbeam (*Ostrya carpinifolia*) is rare in the communities of early succession phase and cannot be decisive in speeding up of this process.

Regeneration as a process reverse to degeneration and fluctuation occurs only in those forest communities in which the anthropogenic activity connected with forest management or zoogenic influence such as grazing were weaker even in the past and more restricted than in other parts of Bosco Quarto and Bosco Spigno. Decisive here was perhaps the poor accessibility of the terrain, utilization of the forest for charcoal burning or special protection of some parts of the forest. The first information concerns the deciduous oak-hornbeam forests (*Doronico-Carpinetum*) in the Ragusa and Pezzente valleys, the second the beech forest (*Aremonio-Fagetum*) in the north-western parts of Bosco Spigno. In the latter at present the selection instead of coppice management is applied.

The dynamical tendencies in brushwood communities of the order *Prunetalia* overgrowing banks, wasteland and forest edges were also identified, by analogy to the natural forest communities, as fluctuation since their development was arrested by permanent inhibition by fires and domestic animals seeking shade in their neighbourhood. Penetration of proper forest species, especially trees, into such communities is limited by their compactness. The close neighbourhood of the forest and ageing of shrubs may perhaps in the future release the natural tendencies to development toward forest, inherent in these communities. Such possibilities are illustrated by the cases described in phytosociological records.

Fluctuation in segetal communities is dealt with the next subchapter.

VI.4. SYNTHETIC MAP OF CO-OCCURRENCE OF ECOLOGICAL PROCESSES

As mentioned earlier, the "Map of dynamical tendencies..." in spite of the complexity of the image given by it, reveals the essential regularities in the spatial image which appeared as the result of anthropogenic influence and the zoogenic influences (grazing) enhanced by the latter. The finding of spatial regularities concerns also the vegetation of the parts of the mapped area the image of which is a mosaic (e. g. the Monte Croce and Parco Purgatorio regions). It was attempted to bring out and interpret these regularities by means of an additional map - the "Co-occurrence of ecological processes in the vegetation and its dependence on anthropogenic factors". The latter map is the result of a far reaching qualitative generalization of the "Map of dynamical tendencies...". Since the contents on the new map are partly expressed by means of new or extended notions interpreting spatial phenomena, the generalization performed exhibits qualitative conceptual features (BERTIN 1968, RATAJSKI 1973, FALINSKI 1990). The newly prepared map with a greatly reduced but clearer and more understandable text confirms the Author's thesis (FALINSKI 1990) that "Every correctly elaborated map should be transformable to another map. If this proves impossible we must have made a mistake while preparing it or our scientific imagination is at fault".

The system of six cartographic units (I-VI; including one divided into two subunits: IIIa, IIIb) allows not only a clear expression of the rather complex spatial image, but also brings out the role of the main factors responsible for the present differentiation of the vegetation dynamics. To these factors belong, according to the order of their importance, definite anthropogenic (and zoo-anthropogenic) influences evoking various processes in plant communities. This information is expressed jointly by appropriate cartographic units, a system of coloured symbols and their descriptions in the legend to the map. The situation, shape and size of the surveys obtained by way of generalization can also be considered from the point of view of the influence of the abiotic environment (terrain relief, geological substrate) on the progress or inhibition of certain ecological processes.

A system of coloured symbols assigned to these cartographic units is connected with the system applied in the initial map ("Dynamical tendencies..."), thus enabling one to check on the generalization performed.

On the derivate map the symbol system consists in a coloured scale. This allows the superior spatial regularities corresponding to the forms and consequences in the increasing activity of man to be shown. The units from I to II, namely, interpret the area (Ragusa und Pezzente valleys and the adherent slopes) on which the ecological processes evoked by human activity have not yet led to essential transformation of the vegetation. In spite of certain changes, forest communities of primary origin specific for the definite habitat-environment conditions have been preserved and respond by their floristic-phytosociological differentiation to the variability of the conditions. This is also true for part of unit III (IIIa and IIIb) describing areas on which the process of degeneration of forest communities is accompanied by a mosaic of processes of regression of xerothermic grassland communities which had formed earlier at the coast of the forest. This occurred under conditions favourable to effective transformation of vegetation formations (ridges and plateau) exposed to strong heating in mountain chains with rather loose forest cover and shallow soil. Unit IV describing especially the situation in the highest part of Monte Spigno expresses the highest degree of changes in the vegetation structure up to local disappearance of the vegetal cover and exposure of the parent rock. The process of regression caused by man and domestic animals first destroyed forest communities, and then the xerothermic grassland communities (pastures) which superseded them. The decrease of man and domestic animal penetration in this region has made possible in some places the appearance of secondary succession (in several places also primary). This process, however, progresses very slowly under the conditions of deeply transformed land relief and substrate on the ruins of farmstead buildings and stone delimitation walls separating countless enclosures for domestic animals. It is only at the bottom of small karstic valleys, once used as small crop fields that the succession is more advanced (cf. map "Dynamical tendencies..."; Plate IV).

Unit V and VI describe areas freed from the influence of man, on which secondary succession has prevailed. It occurs under two kinds of conditions:

- in the greatly destroyed and loosened epilithic swards on slopes and peaks of Monte Spigno and Monte Croce and in the numerous surrounding karstic dolines; here the process was disturbed at a certain time by trials of afforestation (partly by planting, partly by seeding by aircraft). As a final effect we are dealing with an anthropogenically enforced process. This concerns particularly the earlier succession phase (survey units corrisponding to unit V);
- on abandoned crop field, pastures, wide valleys (Piana dell'Incudine, Parco Purgatorio, Parco San Benedetto, Parco San Michele; survey units corresponding to unit VI). This succession is of spontaneous character, but in many places its course is violently interrupted by resumption of crop cultivation on part of the fields. In other places the fields cultivated up till the recent past have been abandoned for many years. Hence, although the ecological process prevailing in a well developed segetal environment was identified with fluctuation, the vegetation of areas subject to secondary succession and fluctuation were combined into one unit.

The above presented effect of transformations may also be interpreted as an attempt at distinction of more or less natural areas with vegetation better preserved or greatly transformed ones and also vegetation liberated from anthropogenic pressure of long duration.

VII. DISCUSSION AND CONCLUSIONS

The vegetation map (plant community map) discussed in Chapter V and the map of the dynamical tendencies in the vegetation in Chapter VI are complementary to each other. It is so not only because of the methods of their preparation, but, above all, their value as sources of information. Each of these maps brings a different kind of information to the vegetation. All this information separately is not so full or deep as is information obtained by reading and association of both maps. From the point of view of the traditional role of the phytosociological map as the "growing of the work" aimed at analysis of the vegetation of a chosen physiographic object, the information contained in the vegetation map is more important. As a map of phytocenoses it has many features of a fundamental vegetation map and will always be a source of information on the spatial organization of the vegetation and its dependence on environment (FALINSKI 1990). It is also more useful for a many-sided causative-comparative or structural interpretation than the particular phytosociological maps. Only such a map may be the source of a large number of valuable derivate ones arising by generalization or transformation. However, the information contained in a basic vegetation map has, as any map, its saturation point. Inclusion into such a map of additional information of dynamic or genetic character is difficult, and in nearly every case complicates its concept, disturbs the uniformity on the subject and limits the readability of the final work.

In various phases of the present studies the possibility was considered of expressing the results of mapping (see Chapter III) jointly on one map by simultaneous utilization of two marking systems: of coloured signs to express the basic differentiation of the vegetation, and of graphic symbols (e. g. hatches of different density and orientation) for showing the prevailing ecological processes, or vice versa.

Considering the restriction of decipherability and other shortcomings of such a solution (see remarks above) it was finally decided to elaborate two separate maps. The contents of both are expressed by two independent systems of coloured symbols (of course mostly with the use of the same basic colours, cf. Chapters V and VI).

It was also possible to introduce on both maps the same double code symbol for denoting the same survey unit as done on the field draft of the map.

For some selected transects through Bosco Quarto the relations of interest to us can be analyzed additionally on the three profiles in the eastern sheet of the map.

Nowadays is easy to imagine that the fundamental phytosociological map recorded in the memory of a computer could be capable of joining and associating all the desired information concerning every survey unit. A suitable program could then transform the initial map or generate the necessary subject map, e. g. the map of community dynamics, of structure, of biological production, etc.

Such a possibility can be advanced by elaboration of concepts and methods of special phytosociological maps (e. g. maps of dynamics) as is done in the present study, although we realize the many shortcomings concerning both the maps. The cognitive value of the fundamental vegetation maps is depressed for instance by an insufficient knowledge of the differentiation as a whole of the mapped object; and, in this connection, provisional treatment of certain groups of communities in the tabular documentation and on the map. We may only be excused because of our poor knowledge of the vegetation (also forest vegetation) of this part of the Apennine Peninsula.

We also have some critical remarks on the map of "Dynamical tendencies of the vegetation", elaborated for Bosco Quarto in Promontorio del Gargano, notwithstanding the great progress achieved as compared with the first cartographic trial concerning the vegetation of the Bialowieza National Park (see Chapter II; FALINSKI 1986a, 1986b). We namely succeeded, unlike in the former map, not only in ascertaining the processes occurring in the vegetation, but in showing the degree of advancement of three of them. Unfortunately this had to be done after considerable simplification and numerous preliminary assumptions and without preceding long-standing investigations on permanent plots on the dynamics of the plant communities. Therefore, the most important basis for revision of the assumption on the course of processes could not be found, especially as regards their dating. In this regard, we hope to find certain data by analysis of old maps and archival sources, especially those concerning initiation of the processes. Interviews with the local population may also be helpful. It is also worthwhile to study the age and species composition of charcoal in the numerous pits here. Such a possibility is indicated by our field observations and the recently published historical-economic study dealing with charcoal producing in the Gargano (D'ARIENZO 1985). We also consider the fact that the influence of some anthropogenic factors on the differentiation and preservation of forest communities (charcoal burning, grazing, coppice management) and xerothermic grassland (grazing and burning) seem to have certain common features even in regions of Europe distant from one another.

The diversity, profusion and in general better state of preservation of vegetation and environment in the Promontorio del Gargano than in other parts of South Italy prompted us to these studies, especially to test our earlier geobotanical-cartographic concepts (see Chapter II) by way of cooperation.

Possibly after this study further ones will succeed in this interesting object and a later synthesis of our research may be possible.

SUMMARY

The map of dynamical tendencies is to some extent a substitute of the true map of vegetation dynamics.

The first map of dynamical tendencies in the vegetation was constructed for the Bialowieza National Park (NE-Poland).

The map describes the dynamic state of the vegetation within a given time by notions that determine the dominance of fundamental ecological processes: fluctuation, primary and secondary succession, regression, degeneration and regeneration (Tab. 1; Plates I-IV).

As compared with earlier ones, the map of dynamical tendencies in the vegetation of Bosco Quarto has been obtained mainly by more accurate presentation of the intensity of two processes that, due to man, dominate in Gargano, i. e. those of degeneration and regression of vegetation. Their intensity is expressed through the notions of degeneration and regression phases (Tables 3-5, Fig. 3B).

The vegetation in Gargano, especially in Bosco Quarto, comprises also vegetation released from long-term anthropopressure, which appears mainly in abandoned, scattered settlements and numerous old fields at the bottom of karstic dolines. Forest and grassland vegetation in Bosco Quarto is marked by the effects of long-term anthropopressure variable in form, persistence and intensity. Although the impact of man on forest and grassland communities has relented owing to a recent decrease in human population, the changes that resulted from the past selection management, charcoal production, and continuous cattle, sheep and goat grazing are still considerable. Hence, it seems appropriate to expose the effects of these factors, i. e. of the impact of man and his management on the initiation, course and intensity of crucial ecological process, especially those of regression and degeneration.

The geobotanical relations and ecological phenomena prevailing here were considered convenient for verifying our earlier geobotanical-cartographic concepts. This research resulted in two double-sheets of the vegetation and of the dynamical tendencies in it and two derived maps supplemented by a common theoretical-methodical text and the necessary documentation.

Field mapping, fair draft and printing of the map were done on the same basic map. The latter is an economic map (Carta delle culture) of the forests of the Monte S. Angelo commune in a 1: 10,000 scale.

The mapping was done by the field method in the period 1984-1987. The topographic method was applied (FALINSKI 1990) referred to by other Authors as the geographic method (KÜCHLER 1964) or "itinerary" method (PUSCARU-SOROCEANU and POPOVA-CUCU 1966, VYSYVKIN 1977). The remote sensing method was also used.

Mapping was done simultaneously for two maps: map of plant communities and map of dynamical tendencies. Mapping consisted in joint recording of patches of communities homogeneous as regards syntaxonomy, structure and dynamics. With a single location and delimitation of the patch its double identification was indispensable, thus, as a syntaxonomic unit and a dynamic unit (Fig. 3). Each survey unit plotted on the basic map was described by a complex symbol which first of all contained information on the taxonomic unit, that is the type of the community, and secondly on the dynamic unit.

Preparation of fair drafts of two separate maps - the fundamental map of the plant communities and the map of dynamical tendencies in the vegetation was done by delimitation of the information accumulated in the course of field mapping and recorded on one field draft of the map (Fig. 3).

As planned, the map illustrates firstly, by means of coloured symbols the occurrence and range of five ecological processes, and secondly, by means of different-coloured scales the spatial differentiation of three of these processes in respect to their advancement.

The degree of advancement of the three major ecological processes in the vegetation of Bosco Quarto, that is degeneration, regression and secondary succession is illustrated according to the same rules; thus, initial phases are rendered by light colours, intermediate and final ones by ever darker hues. It was also endeavoured to visualize the initial and terminal phases of the respective processes with reference to a certain stability of vegetation of various types, that is fluctuation.

The map of the dynamical tendencies of the Bosco Quarto vegetation illustrates the range and spatial differentiation of the major ecological processes observable in concrete definite plant communities in a direct single field observation.

The map may be analyzed and interpreted both as an independent work and in combination with the simultaneously prepared map of vegetation (of plant communities) published in this volume .

The map of dynamical tendencies in the vegetation when considered alone allows one to establish the range and spatial differentiation of all the illustrated processes. When all the information contained in the legend and basic map is taken into account it may also supply quite deep causative information.

In the first place the map discloses the three co-dominant processes: degeneration of forest communities, regression of xerothermic grasslands communities and secondary succession in communities of abandoned fields and pastures. These processes on smaller areas are accompanied by: regeneration in forest communities and fluctuation in forest and synanthropic communities, mainly segetal ones of field crops. The situation of the areas where the particular processes prevail and simultaneous occurrence of accompanying processes are not accidental.

As mentioned earlier, the "Map of dynamical tendencies..." in spite of the complexity of the image given by it, reveals the essential regularities in the spatial image which appeared as the result of anthropogenic influence and the zoogenic influences (grazing) enhanced by man. The finding of spatial regularities concerns also the vegetation of the parts of the mapped area the image of which is a mosaic (e.g. the Monte Croce and Parco Purgatorio regions). It was attempted to bring out and interpret these regularities by means of an additional map - the "Co-occurrence of ecological processes in the vegetation and its dependence on anthropogenic factors". The latter map is the result of a far reaching qualitative generalization of the "Map of dynamical tendencies...".

The vegetation map (plant community map) discussed in Chapter V and the map of the dynamical tendencies in the vegetation in Chapter VI are complementary to each other. It is so not only because of the methods of their preparation but, above all, their value as sources of information. Each of these maps brings a different kind of information to the vegetation. All this information separately is not so full or deep as is information obtained by reading and association of both maps.

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