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CONTRIBUTION TO DEMARCATION AND PHYTOGEOGRAPHIC DIVISION OF THE ILLYRIAN FLORAL PROVINCE, BASED ON VEGETATION AND FLORA

CONTRIBUTO ALLA DELIMITAZIONE E DIVISIONE FITOGEOGRAFICA DELLA PROVINCIA FLORISTICA ILLIRICA, BASATO SULLA VEGETAZIONE E SULLA FLORA

Abstract - Considering zonal potential natural vegetation of the alliances *Erythronio-Carpinion* and *Aremonio-Fagion*, and the leading Illyrian species appearing in forest associations, the author suggests some demarcation changes in the area of the Illyrian floral province. Furthermore, he divides the Illyrian floral province into four phytogeographic regions: Pre-Alpine-Alpine, Subpannonic, Predinaric and Dinaric region.

Key words: Demarcation, Phytogeographic Division, Illyrian floral Province.

Riassunto breve - Considerando la vegetazione naturale potenziale dell'alleanza *Erythronio-Carpinion* e *Aremonio-Fagion*, e le specie illiriche dominanti presenti nelle associazioni forestali, gli autori suggeriscono alcune variazioni nella delimitazione dell'area della provincia floristica illirica. La provincia floristica illirica viene inoltre suddivisa in quattro regioni fitogeografiche: regione Prealpina-Alpina, Subpannonica, Predinarica e Dinarica.

Parole chiave: Delimitazione, Divisione fitogeografica, Provincia floristica illirica.

Introduction

The notion "illyricum" derives from the understanding of phytogeography at the break of this century. Comprehension of the area of this province rests primarily on a floristic basis. The areas of the so called Illyrian species, serving to determine the region of the Illyrian floral province, had not been studied in detail, which applies also to their ecology, so no solid gradation of the diagnostic significance of single Illyrian floral species was possible. Consequently, the Illyrian floral province was promoted as a rather vague phytogeographic notion with loosely determined area borders. In delimiting floral provinces while possessing no reliable data on their flora and vegetation, the authors resorted also to ecological criteria. As stated by FUKAREK (1979), "illyricum" indicates

above all vegetation on limestones and dolomites of the Dinaric Mountains. In the meantime, the notion "moesiicum" was used primarily with reference to the vegetation of the moderately acid soil of eruptive and metamorphic rocks of the Balkans and the Rhodope Mountains. Thorough investigations of the vegetal cover, complex ecological and floristic studies, and ample vegetation mappings led to a closer determination of the borders of the Illyrian floral province. Though it was already ADAMOVIĆ (1909) (and similarly also BECK v. MANNAGETTA, 1901), who, taking into account vegetation formation, drew a border-line between the Illyrian and the mesial floral province through the middle of Serbia, clearer and more concrete outlines of the Illyrian floral province began to appear only in the vegetational works of I. HORVAT (1929, 1938, 1942, 1950, 1951, 1954, 1962, 1963), TREGUBOV (1941, 1957, 1962), BLEČIĆ (1958), BORHIDI (1963), FABIJANIĆ et al. (1963, 1967), M. WRABER (1960, 1963, 1964, 1966, 1967, 1969), STEFANOVIĆ (1964, 1966), ZUPANČIĆ (1967, 1969), ŽAGAR (1979), and other authors who presented a fair picture of the southwestern part of the Balkans from an ecological, floristic and above all vegetational point of view.

I. Horvat engaged in detailed studies on the occurrence of the notions *Carpinion illyricum* and *Fagion illyricum*, embracing both Illyrian forests of hornbeam and Illyrian beech forests, which allowed an advanced approach to the demarcation of the Illyrian floral province. However, as the vegetational and floristic research in the southwestern part of the Balkan Peninsula was not equally intense throughout the Illyrian floral province, the latter was limited above all to the western part of the Dinaric Mountains and their hillsides or even only to western and northwestern Croatia. In 1964 M. Wraber still believed the northwestern border of the Illyrian floral province to run along middle of Slovenia. The eastern border of the Illyrian floral province proposed by ADAMOVIĆ in 1909 was the mostly accepted. The northern border of this province, governed by specific ecological circumstances of the subpannonic-Pannonic world, has always puzzled the scientists attempting to fix the boundaries of the Illyrian floral province, Pontic and Central European provinces, respectively.

Scientists disagree also with respect to placing the Illyrian floral province into higher systematic units, which has been one of the fundamental differences in demarcating the Illyrian floral province.

The latest vegetational investigations and conclusions drawn by a large number of vegetational scientists dealing with the western and central Balkans and their margins, namely TRINAJSTIĆ (1974, 1977, 1980, 1981), FUKAREK (1975, 1977, 1978, 1979), ACCETTO (1974, 1991), POLDINI (1987, 1989), MARINČEK (1979, 1980, 1981, 1983, 1987, 1988, 1991, 1993), MARINČEK & ZUPANČIĆ (1977, 1979, 1984), MARINČEK et al. (1980, 1983, 1983a), PUNCER (1980), ZUKRIGL (1989), MARINČEK & DAKSKOBLER (1988),

JOVANOVIĆ et al. (1986), PRAPROTNİK (1987), VUKELIĆ (1990, 1991) and others introduced some original views on the area of the Illyrian floral province.

Methods

An important point of departure in determining the area of the Illyrian floral province was the illyrian zonal potential natural vegetation from the planar to the subalpine stage and in certain cases azonal Illyrian associations. Thus, the phytogeographic and the vegetational divisions come quite close to each other. HORVAT et al. (1974) do not regard it in the sense of two colliding categories, for between flora and vegetation there exists a relationship of mutual conditioning; they can neither come into existence nor exist separately from each other. In establishing the boundaries of the Illyrian floral province, we usefully applied the map of potential natural vegetation of Yugoslavia (JOVANOVIĆ et al., 1986). Due to a poor research coverage of the territory of Yugoslavia, the authors of the map were forced to deal together with zonal vegetation of both the Illyrian and the mesial region. Drawing the border lines between the Illyrian and the mesial floral province I resorted above all to scientists specializing in the flora and vegetation of the Balkan Peninsula, namely, BLEČIĆ (1958), HORVAT (1967), STEFANOVIĆ (1964, 1979), FUKAREK (1975, 1978, 1979), HORVAT et al. (1974) and others. I made it a point to keep off the species *Fagus moesiaca* as a floristic criterion in drawing the border between the Illyrian and the mesial province. Due to its exceptional morphological heterogeneity, *Fagus moesiaca*, a hybrid between the species *Fagus sylvatica* L. and *Fagus orientalis* Lipsky, is a fairly unreliable criterion for area demarcation. In determining the area of the Illyrian floral province, the floristic criterion was on a par with the vegetational criterion. Taken into account were the so called Illyrian species, i.e. vegetal species optimally thriving in the south-European space, making part of the flora of forest associations. Priority was given to those whose area is restricted to primarily western and central Balkans. The floristic criterion was particularly welcome in the regions in which the habitat conditions allow only reflexes of zonal associations (silicate parent material, alluvial deposits under the influence of high underground water). By combining the vegetational criterion with the floristic, we deliberately avoided transitional areas between the Illyrian province and the bordering provinces (cf. FUKAREK, 1979).

The Illyrian floral province was divided into phytogeographic regions on the basis of zonal potential natural forest vegetation. In certain cases azonal Illyrian and also some other forest associations were taken into consideration, while their occurrence points to special ecological circumstances of a certain part of the potential natural vegetation of

Yugoslavia (JOVANOVIĆ et al., 1986). The nomenclature of the forest associations was taken from JOVANOVIĆ et al. (1986), there at considering some changes in naming associations such as recently proposed by some investigators of the Illyrian vegetation in conformity with binomial nomenclature on a strictly floristic basis (above all ZUKRIGL, 1989; MARINČEK, 1988, 1991, 1993; MARINČEK et al., 1993; WALLNÖFER, MUCINA & GRASS, 1993).

Placing of the Illyrian Floral Province into Higher Systematic Units

MEUSEL, JAEGER & WEINERT (1965-1978) place the Illyrian floral province into the submediterranean subregion of the Moroccan-Mediterranean region. In their opinion the entire Balkan Peninsula, except for Slovenia and northwestern Croatia, makes part of the Mediterranean floral region. Of the scientists engaged in the studies of the flora and vegetation of the Balkans, FUKAREK (1979) came closest to this view of the matter. In placing the Illyrian floral province into higher systematic units we adopt the view of HORVAT et al. (1974) that the Illyrian floral subregion (or better still, province) is a constituent part of the Central European region (or better, subregion). Such systematic placing of the Illyrian floral province provides one with a solid basis for determining its area.

Results and discussion

The foremost characteristic of Illyrian vegetation and flora that make up zonal associations is their slight to moderate thermophilic and neutrophilic-basophilic character. This means that the Illyrian flora and vegetation thrive above all on soils covered with carbonate parental material, limestones and dolomites. In this sense, the borders of the Illyrian floral province are more easy to determine in all regions with predominantly carbonate parent material. Different opinions are known to exist with respect to the regions with predominantly silicate parent material and alluvial soils affected by high underground water. In such habitats flora and vegetation depend above all on edaphic circumstances in the sense of matching, or else they condition a specific flora and vegetation in which the climatic influences are not clearly expressed. Concurring with the opinion of the majority of investigators that the Illyrian floral province is a constituent part of the Central European region (subregion), it is easiest to establish its southern and northwestern border where carbonate parent material is predominating. Here and there, above all towards the Mediterranean, this results into a very distinct ecological border line, both with respect to the relief and the climate. The southern border of the Illyrian floral

province is quite clear in its upper part where the Dinaric plateau is falling steeply into the Adriatic Sea. In the central and lower part deep valleys are cut into the Dinaric plateau, allowing the spreading of Mediterranean influences far into the continent. This makes the establishing of the boundaries of the Illyrian floral province somewhat harder, though not to such an extent as to introduce a transitional area. The border of the Illyrian floral province runs along the juncture of the zonal associations *Seslerio autumnalis-Fagetum* M. Wraber ex Borhidi 1963 ascribed by most authors to the mountain grade of the Mediterranean (fig. 1) and *Quercetum cerris dinaricum* Stefanović 1968, and the zonal associations of the Mediterranean: *Ostryo-Quercetum pubescentis* (I. Horvat 1950) Trinajstić 1974 and *Quercetum orientalis* Horvatić 1939. We decided upon a uniform area of the Illyrian floral province. Islands of Illyrian flora and vegetation in the neighbouring floral provinces are considered extrazonal and are marked accordingly in the map (fig. 16).

It is rather surprising that the northwestern boundary of the Illyrian floral province is relatively easy to establish with the help of the recent vegetational literature by: POLDINI (1987, 1988), ZUKRIGL (1987), MARINČEK et al. (1989, 1990), MARINČEK & DAKSKOBLER (1988), ZUPANČIČ et al. (1987), MARINČEK (1990), DAKSKOBLER (1987, 1991). In the past the majority of scientists, engaging in the research of the Illyrian space and confronted with a lack of information, either avoided the problem or satisfied themselves with the statement that the Illyrian floral province coincides with the Dinaric Mountains and their immediate surrounding. I. HORVAT (1938) believes that the core of the Illyrian floral

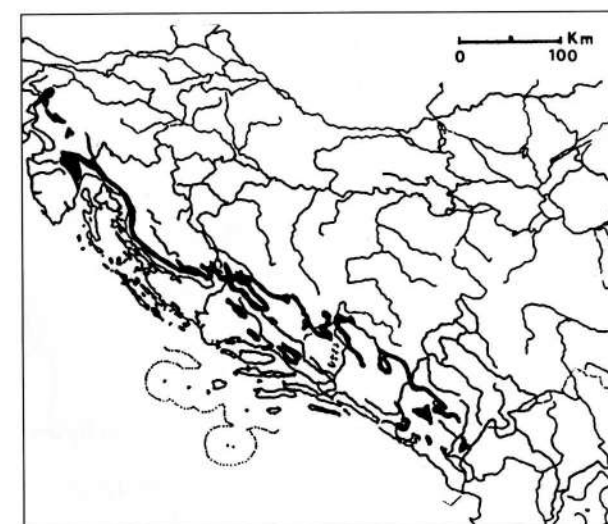


Fig. 1 - Distribution of the association *Seslerio autumnalis-Fagetum* in Yugoslavia (adapted from Prirodna potencialna vegetacija - "Potentially Natural Vegetation" - 1986, after DAKSKOBLER, 1990).
- Distribuzione dell'associazione *Seslerio autumnalis-Fagetum* in Yugoslavia (adattata da Prirodna potencialna vegetacija - "Potentially Natural Vegetation" - 1986, secondo DAKSKOBLER, 1990).

province is in fact western and central Croatia, and that, starting in the northwestern direction, the Illyrian floral elements gradually decrease both in number and coverage, so the border of the Illyrian floral province becomes blurred. Horvat et al. elegantly bypassed the problem by graphically presenting only the southeastern border of the Illyrian floral province. According to M. WRABER (1964) the boundary line between the Illyrian and the Central European province should run along the edge of the Dinaric Mountains. He therefore places the pre-Alpine and the subpannonic phytogeographic region of Slovenia into the Central European province. A similar view was entertained also by FUKAREK (1977); according to him, the north-west of Slovenia makes part of the Central European region, Alpine province, and furthermore, of the Alpine and pre-Alpine region. An almost identical view is defended also by MEUSEL et al. (1965), whereas HORVATIĆ (1967) draw the border of the Illyrian floral province as far as the very northwestern border of Yugoslavia. As evident from the recent vegetational investigations in the Karavanken Mountains and the Carnic Alps, performed by Slovenian scientists in collaboration with those from Italy and Austria, irrespective of the state borders, the Illyrian floral province extends to the eastern part of the Carnic Alps and the northern part of the Karavanken Mountains.

In our belief, the Illyrian floral province is demarcated in the south-west by the association *Anemono-trifoliae-Fagetum* Tregubov 1962 (fig. 2) and the Illyrian species concentrated in an area extending from the south-east and reaching the extreme border point in the Karavanken Mountains and the eastern Carnic Alps: *Lamium orvala* (fig. 3), *Homogyne silvestris*, *Hacquetia epipactis* (fig. 4), *Omphalodes verna* (fig. 5), *Rhamnus fallax* and *Anemone trifolia* (fig. 6).

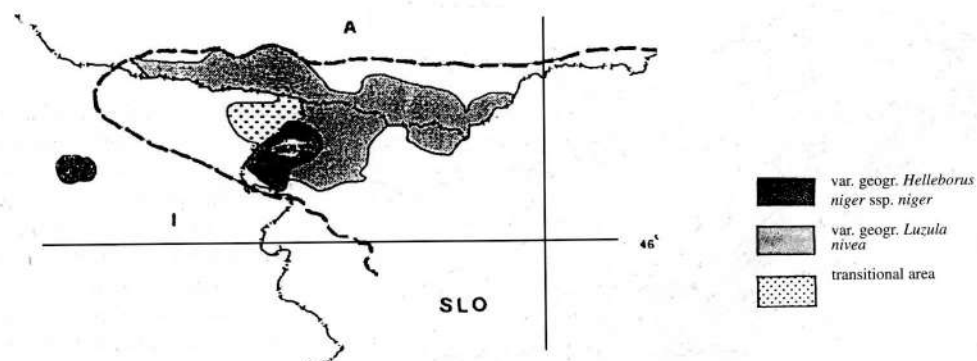


Fig. 2 - Distribution of the association *Anemono-Fagetum* (from MARINČEK et al., 1989). In all figures thick interrupted line indicates the area of the Illyrian floral province.
- Distribuzione dell'associazione *Anemono-Fagetum* (da MARINČEK et al., 1989). La spessa linea tratteggiata indica in tutte le figure l'area della provincia floristica illirica.

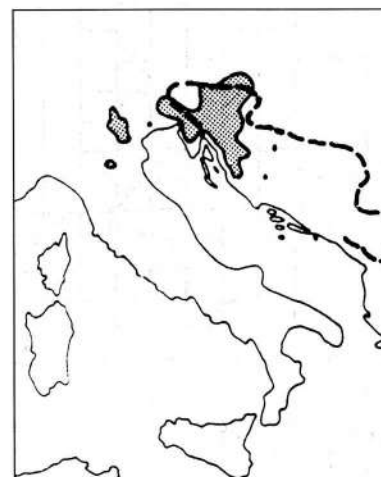


Fig. 3 - Distribution of *Lamium orvala* (from GAŽI-BASKOVA, 1963, 1973).
- Distribuzione di *Lamium orvala* (da GAŽI-BASKOVA, 1963, 1973).

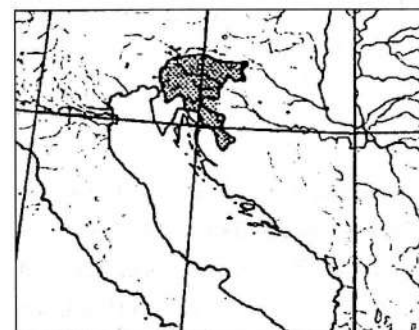


Fig. 4 - Distribution of *Hacquetia epipactis* (Scop.) DC (from MEUSEL et al., 1965).
- Distribuzione di *Hacquetia epipactis* (Scop.) DC (da MEUSEL et al., 1965).

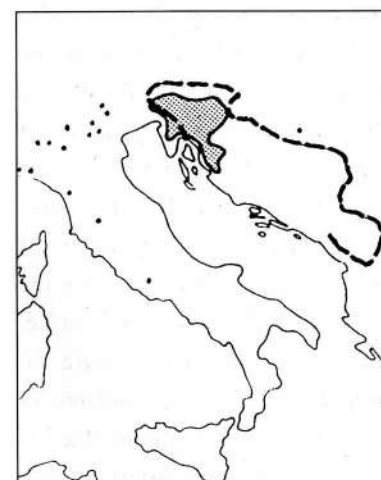


Fig. 5 - Distribution of *Omphalodes verna* Moench (from GAŽI-BASKOVA, 1963).
- Distribuzione di *Omphalodes verna* Moench (da GAŽI-BASKOVA, 1963).

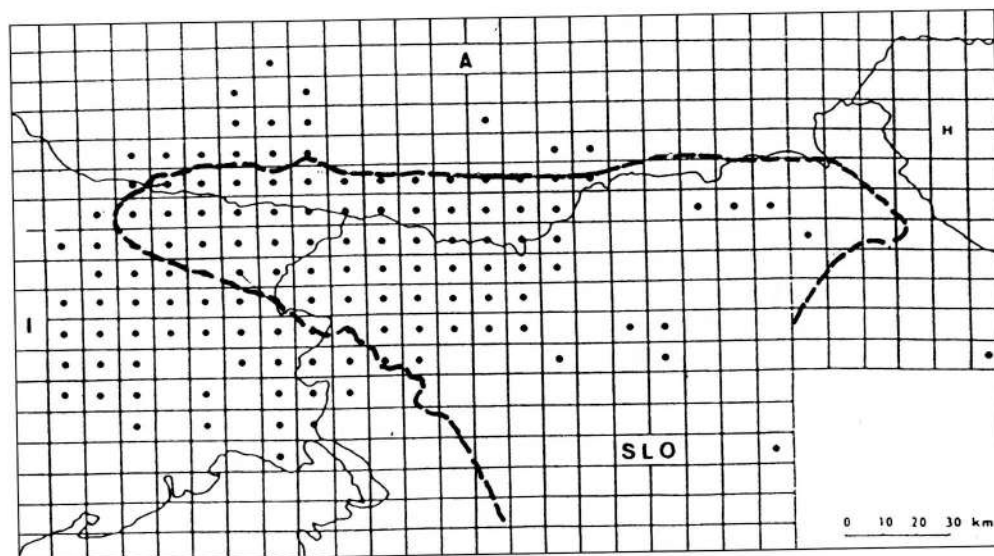


Fig. 6 - Distribution of *Anemone trifolia* L. (from MARINČEK et al., 1989).
- Distribuzione di *Anemone trifolia* L. (da MARINČEK et al., 1989).

The first to establish the eastern border of the Illyrian floral province was ADAMOVIĆ (1909). According to Adamović, the Illyrian floral province is separated from the mesial floral province by the line Priština-Kuršumlija-Stalač-Čuprija as far as Golubovac. Later on the border began to be moved further to the west. According to MEUSEL et al. (1965), the easternmost border of the Illyrian floral province runs along the river Ibar. HORVATÍĆ (1967) drew the boundary line of the Illyrian floral province as far as the roots of Kopaonik Mt., however, to the west of it they indicated an extensive enclave of mesial oak forests in the valleys of the Lim and the Drina. The one who came closest to a real division of the Illyrian from the mesial floral province was FUKAREK (1979) according to whom the easternmost border of the Illyrian floral province runs along the river Drina. The lower part of the border runs as far as northern Albania, Prokletije being included in the Illyrian floral province.

As mentioned above, the authors of the map of potential natural vegetation of Yugoslavia treated zonal vegetation under a common name of Illyrian-mesial. Drawing the border between the Illyrian and the mesial province, we substantially relied on flora i.e. distribution of certain species referred to as "Illyrian", namely: *Hacquetia epipactis* (fig. 7), *Omphalodes verna*, *Homogyne silvestris* (fig. 8), *Cardamine trifolia*, *Dentaria polyphylla* (fig. 9), *Vicia oroboides* (fig. 10), *Epimedium alpinum* (fig. 11), *Dentaria trifolia* (fig. 12) *Aremonia agrimonioides*. The easternmost border of this area was considered. With

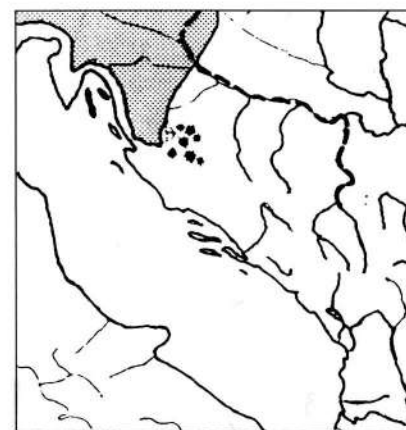


Fig. 7 - Eastern border of the area of *Hacquetia epipactis* (Scop.) DC in the Illyrian region (from FUKAREK, 1978).
- Limiti orientali dell'areale di *Hacquetia epipactis* (Scop.) DC nella regione illirica (da FUKAREK, 1978).

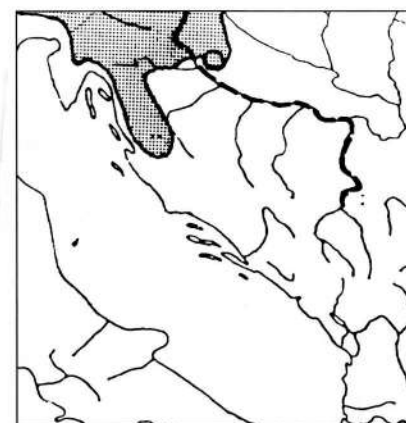


Fig. 8 - Eastern border of the area of *Homogyne silvestris* (Scop.) Cass. in the Illyrian region (from FUKAREK, 1978).
- Limiti orientali dell'areale di *Homogyne silvestris* (Scop.) Cass. nella regione illirica (da FUKAREK, 1978).

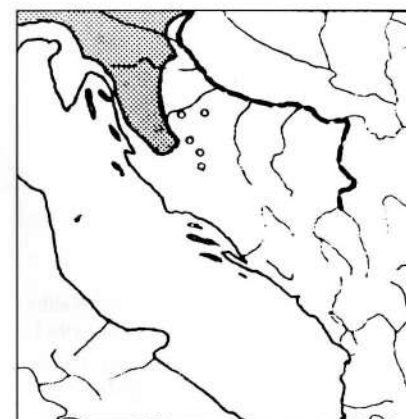


Fig. 9 - Eastern border of the area of *Dentaria polyphylla* Waldst. et Kit. in the Illyrian region (from FUKAREK, 1978).
- Limiti orientali dell'areale di *Dentaria polyphylla* Waldst. et Kit. nella regione illirica (da FUKAREK, 1978).

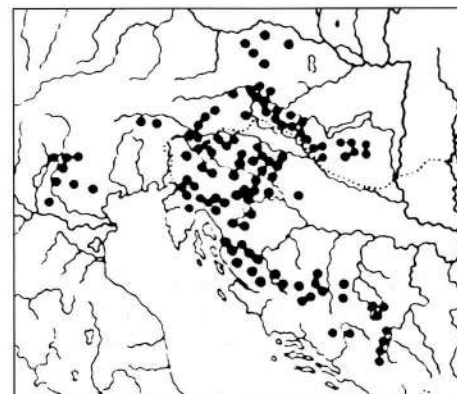


Fig. 10 - Distribution of *Vicia oroboides* Wulf.
(from GAŽI-BASKOVA, 1963).
- Distribuzione di *Vicia oroboides* Wulf.
(da GAŽI-BASKOVA, 1963).

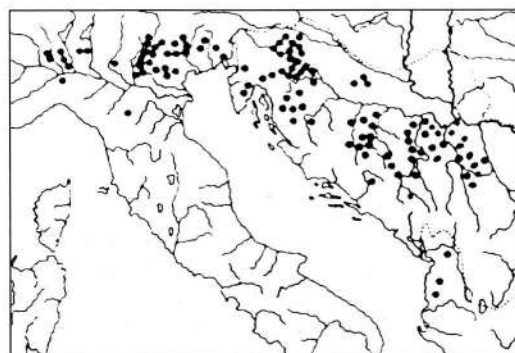


Fig. 11 - Distribution of *Epimedium alpinum*
L. (from GAŽI-BASKOVA, 1963).
- Distribuzione di *Epimedium alpinum*
L. (da GAŽI-BASKOVA, 1963).

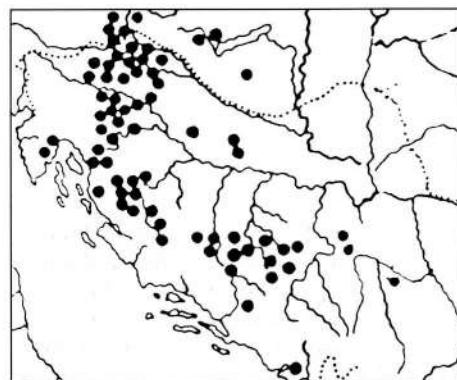


Fig. 12 - Distribution of *Dentaria trifolia* Waldst.
et Kit. (from GAŽI-BASKOVA, 1963).
- Distribuzione di *Dentaria trifolia*
Waldst. et Kit. (da GAŽI-BASKOVA,
1963).

respect to the floral elements, a reliable border of the Illyrian floral province should run along the line of the Vrbas-Neretva rivers. The rest of the region as far as the Drina is covered by degraded Illyrian vegetation offering no reliable basis for determining the border line between the two provinces. Certain Illyrian species such as *Dentaria trifolia*, *Epimedium alpinum*, *Aremonia agrimonioides* are scattered around the area but can also be found in the mesial floral province. We therefore followed FUKAREK (1979) whose border line between the Illyrian and the mesial floral province is based on the western border of a concentrated area of the zonal mesial association *Quercetum frainetto-cerris* Rudski (1940) 1949 (fig. 13). Thus, the eastern border of the Illyrian region, exposed to a strong Pannonic influence, is supposed to run along the river Drina. The islands of mesial flora and vegetation in the Illyrian floral region and those of Illyrian flora and vegetation in the mesial region are ascribed to extrazonal occurrence. In this way a large transitional Illyrian-mesial range between the river Drina and Ibar was by-passed. FUKAREK (1979) put the eastern border of this transitional range down to an area of the species *Ostrya carpinifolia* reaching as far as Kopaonik. In our belief the area of the species *Ostrya carpinifolia* is much larger than that of the Illyrian floral province, so it cannot be decisive in establishing the borders of the Illyrian floral province.

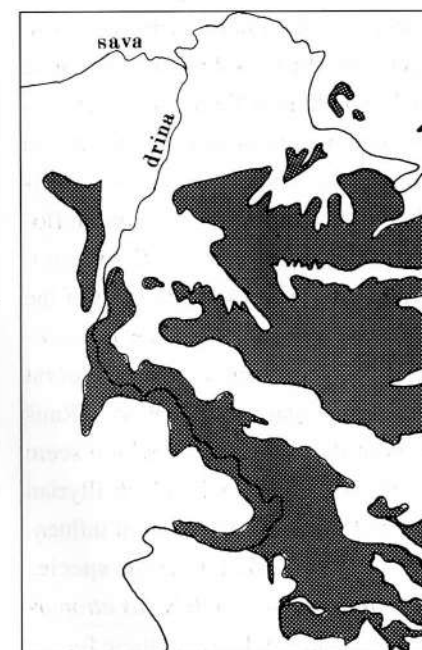


Fig. 13 - Western border of the area of the association *Quercetum frainetto-cerris* (adapted from Prirodna potencialna vegetacija Jugoslavije - "Potentially Natural vegetation of Yugoslavia" - 1986) - dark surfaces.
- Limite occidentale dell'areale dell'associazione *Quercetum frainetto-cerris* (adattato da Prirodna potencialna vegetacija Jugoslavije - "Potentially Natural vegetation of Yugoslavia" - 1986) - superficie scura.

The map of the potentially natural vegetation of Yugoslavia shows that the area between the rivers Drina and Ibar is of a markedly mesial character, with islets of Illyrian flora and vegetation.

Considering the southern border of the Illyrian floral province, which is, in part, open to Mediterranean influences, we fully agree with FUKAREK (1979), HORVATIĆ (1967) who included northern Albania into the Illyrian floral province.

Most elusive and hard to establish is the northern border of the Illyrian floral province in the extensive region between the Dinaric Mountains with their promontory and the Pannonic Lowlands. According to MEUSEL et al. (1965) it runs somewhat to the south of the river Sava. According to HORVATIĆ (1967), the northern border of the Illyrian floral province reaches as far as the Danube. FUKAREK (1977, 1979) fixes the northern border of the Illyrian floral province at the hillsides of the Dinaric Mountains, while placing the remaining territory as far as the river Sava and further north, into the prepannonic region i.e. the Pannonic province.

The difficulties encountered in determining the northern border of the Illyrian floral province arise from specific ecological circumstances of the prepannonic-Pannonic world. The range between the rivers Danube and Sava, as well as south of the Sava at the upper sections of the tributaries Vrbas, Bosna, Tinja, Lukovac and Drina, is under the influence of high underground water. The soil consists of fine particles of alluvial origin. Ecological circumstances of this kind are only propitious to markedly mesophilous and hygro- to hydrophilous vegetal species. Illyrian flora and vegetation thrive solely on carbonate islands and silicates rich in bases. It may be presumed that Illyrian flora and vegetation would prevail as far as Blatno jezero, provided a carbonate material predominated in the prepannonic region. A similar conclusion was also drawn by POCS (1963) who describes this region as "praeillycum". A reliable and clearly outlined border of the Illyrian floral province runs along the northern margins of the hornbeam forest (*Erythronio-Carpinion*). In the figure this border is hatched. Towards the river Sava and in most of the region between the Sava and the Danube there prevail riverine forests of the *Leucoio-Fraxinetum angustifoliae* type Glavač 1979, *Genisto elatae-Quercetum roboris* I. Horvat 1938, and oak forests with hornbeam – *Lonicero caprifoliae-Quercetum roboris* (Rauš 1971) ex Marinček (fig. 14). The habitats of the forests of this association, which seem to be minimally affected by high underground water, are the only areas in which Illyrian vegetal species can thrive. However, as the high underground water exerts, a certain influence upon them due to special edaphic circumstances, the so called Illyrian species *Crocus napolitanus* (= *C. vitatus*), *Primula acaulis*, *Galanthus nivalis*, *Helleborus atropurpureus* appear with a rather poor coverage. The author (MARINČEK, 1993) places these forests



Fig. 14 - Area of the association *Carpino-Quercetum* south to the Sava river (adapted from Prirodna potencialna vegetacija Jugoslavije 1986 - "Potentially Natural vegetation of Yugoslavia").
- Areale dell'associazione *Carpino-Quercetum* a sud del fiume Sava (adattato da Prirodna potencialna vegetacija Jugoslavije 1986 - "Potentially Natural vegetation of Yugoslavia").

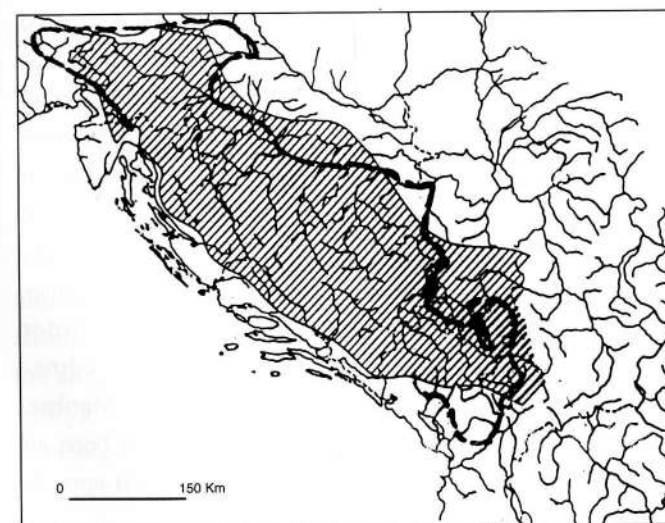


Fig. 15 - Area of *Crocus napolitanus* hort. ex Mordant in southeastern Europe (from Pulević, 1976).
- Areale di *Crocus napolitanus* hort. ex Mordant nell'Europa sud-orientale (da Pulević, 1976).

in the alliance *Erythronio-Carpinion* and suballiance *Lonicero caprifoliae-Carpinenion* Vukelić ex Marinček 1993 group *Quercus robur*; however, they reveal a transitional character between the Illyrian and the Central European forests. We therefore decided to draw the northern border of the Illyrian floral province on the basis of the area of the species *Crocus napolitanus* (fig. 15) which MARINČEK et al. (1983) consider a cardinal vegetal species of the Illyrian hornbeam forests. According to PULEVIĆ (1976), its area extends further north to the Sava river. The rest of the range between the river Sava and Blatno Jezero is considered to make part of the Central European region (subregion) and the Pontic province, respectively, with extrazonal islets of Illyrian flora and vegetation.

Division of the Illyrian Floral Province into Phytogeographic Regions

The Illyrian floral province was divided into four phytogeographic regions: pre-Alpine-Alpine, Subpannonic, Predinaric and Dinaric.

Pre-Alpine-Alpine Phytogeographic Region

The leading investigators of the vegetation in the Illyrian space i.e. I. HORVAT et al. (1974), M. WRABER (1964, 1969), FUKAREK (1975, 1978, 1979), treated the Julian Alps, the Savinjske Alps, and the corresponding pre-Alpine world separately from the Illyrian region. HORVAT (1967), however, places a part of the Alpine and pre-Alpine world into the Illyrian region, though without presenting suitable phytogeographic arguments.

Most authors (M. WRABER, 1969; ZUPANČIČ et al., 1987; MARINČEK, 1987) treated the Alpine and the pre-Alpine world on a separate basis. As the border between the two is very hard to define and since the foremost intention of our study was to divide the Illyrian region into basic macrophytogeographic units, we decided to describe the pre-Alpine-Alpine region as a whole. Our demarcation of the pre-Alpine-Alpine region is based on the works by Italian (above all POLDINI, 1989), Austrian (above all ZUKRIGL, 1973, 1989), and Slovenian investigators of flora and vegetation (ZUPANČIČ et al., 1987; MARINČEK et al., 1989; MARINČEK, 1993). As concluded from these investigations, the Illyrian pre-Alpine-Alpine region encompasses the eastern part of the Carnic Alps; the northern border proceeds along the rivers Zilja and Drava, the southern along the Dinaric-predinaric hillsides, slightly more to the south of the line Tolmin-Idrija-Ljubljana-Celje-Maribor. The pre-Alpine-Alpine region as a part of the Illyrian floral province has never been an object of a complex ecological and vegetational study. It will therefore be dwelt upon at some length in the present paper.

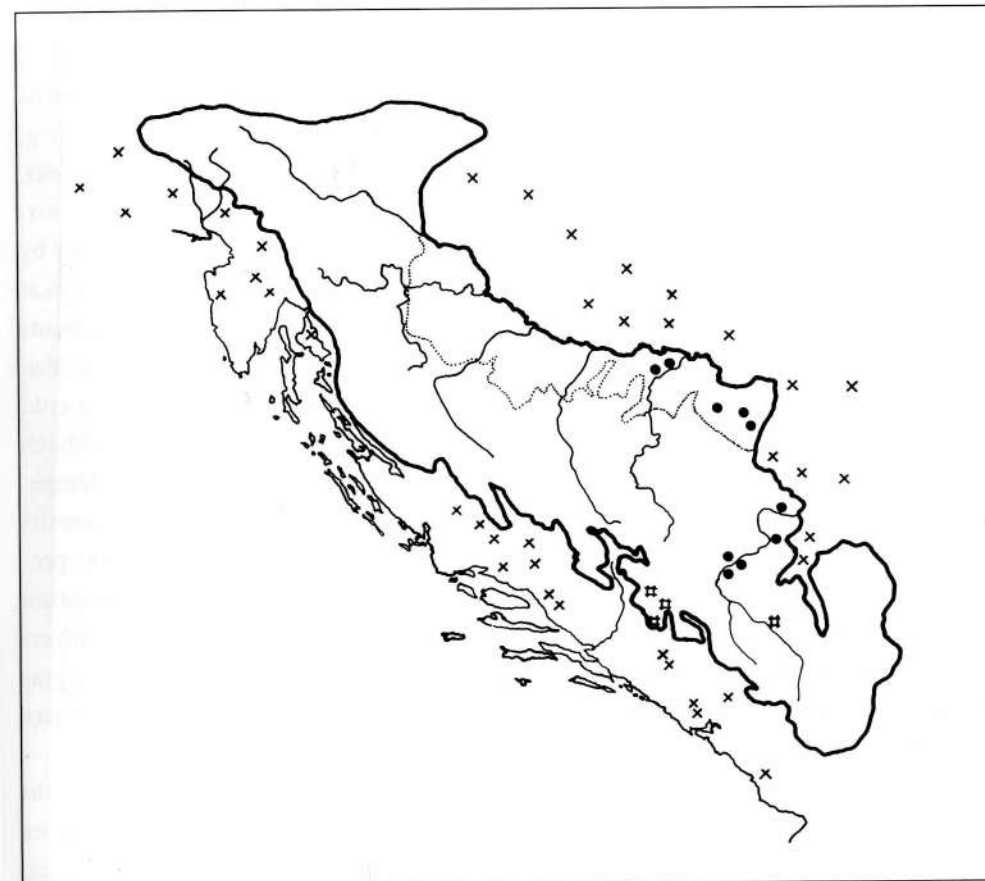


Fig. 16 - Area of the Illyrian floral province; x islands of Illyrian vegetation; • islands of mesial vegetation, # islands of Mediterranean vegetation.
- Delimitazione dell'area della provincia floristica Illirica; x isole di vegetazione illirica; • isole di vegetazione mesiale, # isole di vegetazione mediterranea.

The relief of the pre-Alpine-Alpine region is quite lively. High mountain peaks fall into deep Alpine valleys. Highlands and hills predominate towards the predinaric region. Rising above them are single massifs, remains of the Pliocene level; none of them exceeds the altitude of 1700 m. This bold relief is associated with cold local climates in Alpine valleys, while on the other hand the pre-Alpine-Alpine world is not impenetrable to the influences of the Mediterranean climate in the west and of the continent in the east. Due to the effects of local climates the climatic circumstances are quite varied. Reigning on higher levels is a moderate subpolar climate, cool and humid, with an abundance of snow,

a short vegetation period from June to October. Lower marginal areas have a humid climate with fresh summers and cold winters.

Precipitations are abundant, the western part receiving most of them. They are particularly abundant in certain pre-Alpine valleys cut deep into the Alpine world (e.g. Kamniška Bistrica, 2263 mm per annum). Towards the east the quantity of precipitations, passing under the influence of the continent, decrease to 1000 mm per annum. The west-east direction, which is under a growing continental influence, is characterized not only by a varying quantity but also an uneven distribution of precipitations. In the west they are at their lowest in February or March, and at their highest in October and November. Towards the east the winter minimum becomes more pronounced while the autumnal one nears that of the early summer. Characteristic of most of the pre-Alpine-Alpine world is a cold winter period from December to February and, at high altitudes, from November to March when average monthly temperatures are around or below zero. The local summer temperatures are very high, while mean July temperatures range from 17 to 20 °C. This results to a large extent from the continental influence which may penetrate deep into pre-Alpine valleys due to the general (east-west) direction of the massifs. Temperature extremes are well pronounced, especially in the Alpine valleys where temperature inversions are quite frequent. Temperature may fall as low as -28 °C. During the last glacial period a great deal of the pre-Alpine-Alpine world was covered with glaciers (MARINČEK, 1981).

The geologic parent material of the western part of the pre-Alpine-Alpine world consists primarily of carbonate rocks; the most frequent among them are Trias dolomites and Dachstein limestones. In the pre-Alpine world there prevail non-carbonate rocks; markedly acid Permian carboniferous clay schists, sandstones and breccias. In the eastern part (Pohorje in particular) large surfaces are covered with basic non-carbonate rocks: gneiss, tonalite, amphibolites etc.

On dolomites there prevails rendzinas at different developmental stages, from protorendzinas to brown rendzinas. Calcic cambisols, usually strongly skeletal, are less common. Locally well developed on limestones are also calcic cambisols lessivé. Prevailing on non-carbonate parent material is acid brown soil.

The flora of the pre-Alpine-Alpine region consists of Illyrian, Central European, as well as some boreal elements. Illyrian flora is well represented in the planar, collin and submontane area. With an increasing altitude Central European and boreal species assume the principal role.

The vegetation of the pre-Alpine-Alpine region consists of the associations of the alliance *Erythronio-Carpinion*, its suballiance *Piceo-Carpinenion*, and alliances

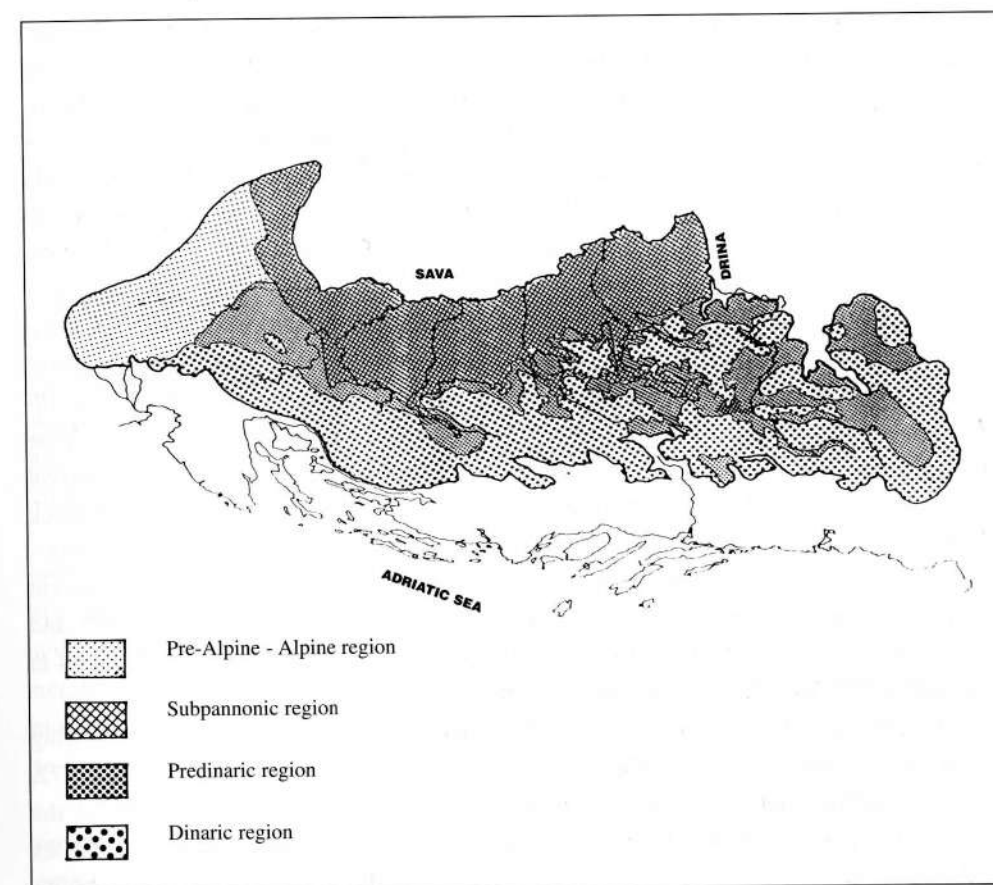


Fig. 17 - Phytogeographic regions of the Illyrian floral province.
- Regioni fitogeografiche della provincia floristica illirica.

Aremonio-Fagion and its suballiances *Epimedio-Fagenion*, *Ostryo-Fagenion*, *Lamio orvalae-Fagenion*, *Saxifrago rotundifoliae-Fagenion*; further *Luzulo-Fagion* and *Lamio orvalae-Acerenion*.

The zonation of the fundamental forest associations is not well pronounced, due to a bold relief, steep to abysmal, locally unstable slopes, and locally prevailing non-carbonate parent material.

The zonal association of the planar and partly collin area is *Helleboro nigri-Carpinetum* Marinček in Wallnöfer, Mucina et Grass 1993. It thrives on fluvioglacial deposits of predominantly dolomite origin, at altitudes from 300 to 450 m. A moderately non-carbonate parent material is favourable to the association *Vaccinio myrtilli-*

Carpinetum (M. Wraber 1969) ex Marinček 1993. The pre-Alpine world of Slovenia being an ancient cultural country, hornbeam forests are preserved but fragmentarily. The rest of the space, here and there up to the tree-line, is overgrown with beech and spruce-beech forests: *Hacquetio-Fagetum* Košir 1962 var. geogr. *Laburnum alpinum* Marinček 1992 (mscr.), *Lamio orvalae-Fagetum* var. geogr. *Dentaria pentaphyllos* (Marinček 1981) – nomenclature type is releve No. 1, Table 1 from Marinček 1981, *Ranunculo platanifolli-Fagetum* Marinček et al. 1993 var. geogr. *Hepatica nobilis* Marinček 1993, *Anemono-Fagetum* var. geogr. *Luzula nivea* Marinček et al. 1989 in the north-western most part of the area of the association, and var. geogr. *Helleborus niger* Marinček et al. 1989 in the central and eastern part of the area of the association *Anemono-Fagetum*. On the north-western border of the pre-Alpine-Alpine area there is the association *Dentario pentaphylli-Fagetum* H. Mayer et A. Hofmann 1969. On the littoral part of the pre-Alpine-Alpine region the tree-line is made up of the association *Polysticho lonchitis-Fagetum* (I. Horvat 1938) Marinček in Poldini et Nardini 1993 var. geogr. *Salix waldsteniana* (Marinček 1980) – nomenclature type var. geogr. is releve No. 6 from the table by Marinček 1980a – (*Saxifrago rotundifolia-Fagetum* Zukrigl 1989 p.p.). Appearing locally on carbonate parent material are spruce-beech forests *Homogyno sylvestris-Fagetum* Marinček et al. 1993, and *Luzulo-Abieti-Fagetum* H. Mayer (1963) 1969 *praealpinum* (Marinček 1977) Marinček et Dakskobler 1988 on noncarbonate parent material.

The Illyrian vegetation of the pre-Alpine-Alpine region includes also the following azonal and extrazonal associations: *Ostryo-Fagetum* M. Wraber ex Trinajstić 1972, *Arunco-Fagetum* Košir 1962, mostly in the submontane and the lower levels of the montane belt at about 1000 m a.s.l., and *Aconito paniculati-Fagetum* (Zupančič 1969) ex Marinček et al. 1993, *Isopyro-Fagetum* var. *Adenostyles alliariae* Košir 1962, and *Myrrhidi-Fagetum* Zukrigl 1989 in the upper montane belt.

Distributed on non-carbonate parental material – the submontane and partly also montane belt – and covering larger surfaces are azonal associations *Querco-Luzulo-Fagetum* Marinček et Zupančič 1979 and *Polygonato verticillati-Luzulo-Fagetum* var. geogr. *Cardamine trifolia* Marinček 1983 in the upper part of the montane grade. Counted as Illyrian azonal vegetation of the pre-Alpine-Alpine region are also forests of precious deciduous trees: *Hacquetio-Fraxinetum* Marinček in Poldini et Nardini 1993 on carbonate parent material and *Dryoperido tavellii-Fraxinetum* Marinček 1992 (mscr.) on non-carbonate parent material.

Subpannonic Phytogeographic Territory

The area of the subpannonic phytogeographic territory overlaps with that of Illyrian hornbeam forests. It embraces a large region from Slovenske Gorice in the west as far as

the river Drina in the east. The southern border follows the northernmost hillsides of the Dinaric Mountains, and the northern border the river Sava. FUKAREK (1977) places most of this area into the prepannonic region within the Pannonic floral province. According to BERTOVIĆ (1968) its climate is moderately continental and according to KOŠIR (1962, 1979) humidly continental.

The precipitations range between 600 and 1500 mm per year. It is important to take note of the fact that most precipitations fall during the vegetational period, the maximum being attained in the early summer. Summer droughts are rather moderate, with the exception of the easternmost parts, eastern Slavonia, where the precipitations do not exceed 600 mm. Summers are hot, mean July temperatures between 18.7 and 22 °C; winters are sharp, mean January temperatures from -0.2 to -5 °C (according to HORVAT et al., 1974). The vegetational period lasts about 6 months, from 170 to 190 days, from about 20th April to about 20th October.

Characteristic of the edaphic circumstances of this area are deposits of various clays and loesses on different parent materials, from carbonate to red Tertiary argillaceous earths and crystalline rocks prevailing above all in the eastern part of the area. In the lowlands with larger rivers the alluvial deposits are of different age and structure. In the broader neighbourhood of the river Sava and its tributaries the high underground water occasionally penetrates onto the surface. The soils on these substrata vary from cambisols to lessivé, pseudogleis and gleis.

Zonal potential natural vegetation of the subpannonic phytogeographic territory is represented by forests of durmast oak and hornbeam of the suballiance *Lonicero caprifoliae-Carpinenion* Vukelić ex Marinček 1993, of the alliance *Erythronio-Carpinion: Epimedio-Carpinetum* (Horvat 1938) Borhidi 1963 and *Festuco drymeiae-Carpinetum* (Horvat 1938) Vukelić 1990. Similar to this association are hornbeam forests described in connection with Bosna as *Querco-Carpinetum illyricum* Stefanović 1961. They thrive above all on crystalline rocks; compared with the association *Epimedio-Carpinetum*, they are poorer in Illyrian species. Described for the territory of eastern Slavonia is the association *Rusco aculeati-Carpinetum* I. Horvat 1962, which, however, is deprived almost completely of Illyrian floral elements.

The westernmost part of the subpannonic phytogeographic territory, northeastern Slovenia, is overgrown with forests of the *Pruno padi-Carpinetum* (Marinček et Zupančič 1984) ex Marinček 1993, and *Pseudostellario-Carpinetum* Accetto 1974, with numerous elements of the alliance *Alno-Padion* Knapp 1942. The habitats, affected by high underground water, are overgrown with forests of the association *Lonicero caprifoliae-Quercetum roboris* (Rauš 1971) ex Marinček 1993.

Predinaric Phytogeographic Region

FUKAREK (1977) was the first to deal, in a macro sense, with the predinaric territory within the Illyrian floral province but he did not study it from an ecological, floristic and vegetational aspect.

Larger concentrated surfaces of this region lie in the west, between the rivers Kolpa and Sava. In all other areas it is restricted to narrow stretches between the subpannonic and the Dinaric world. The climate there is similar, in temperatures, to that of the subpannonic region. Summers are relatively warm (from July to August mean temperatures rise to about 18.5 °C at lower levels and to about 16 °C in the mountains). Winters are cold (mean monthly temperatures from December to February are from 0.2 to about -3 °C). However, compared to the subpannonic region, the precipitations are much higher, amounting to 1400 mm in the west and to about 800 mm in the east, but with a similar distribution of precipitations throughout the year. A higher altitude brings along a fresher climate with a relatively high humidity, 80% on the average or even more, while the temperature extremes are not significant. The period of vegetation lasts about 150 to 160 dazs, from about the fifth of May to the middle of October.

In the west the geological parent material consists primarily of carbonate rocks, various limestones and dolomites. In the central and the eastern part non-carbonate rocks are on par with carbonate rocks. Solid parent material is locally covered with deposits of Pleistocene clays and argillaceous earths. More frequent than rendzinas on carbonate rocks are calcic cambisol; not unusual are also calcic cambisols lessivé. Acid brown soils prevail in non-carbonate rocks. The flora consists of Illyrian and Central European species. The vegetational cover is made up of markedly Illyrian forest associations of the alliance *Erythronio-Carpinion* with the suballiance *Piceo-Carpinenion*, and the alliance *Aremonio-Fagion* with the suballiances *Epimedio-Fagenion*, *Ostryo-Fagenion*, *Lamio orvalae-Fagenion*, and the alliance *Luzulo-Fagion*.

Distinction is made between two vegetational belts: submontane and lower montane belts. Included in the western part of the Predinaric region where the climate is humid, are also the planar and the collin world. At lower altitudes of the western predinaric phytogeographic region the dominant association is *Abio-Carpinetum* (Marinček 1980) ex Marinček 1993. The submontane belt from 300 to 600 (700) m includes the following associations: *Hacquetio-Fagetum* var. geogr. *Epimedium alpinum* Košir 1962, *Festuco drymeiae-Fagetum* Magič 1968 var geogr. *Polystichum setiferum* Cimpešek 1988, both described on the westernmost part of the predinaric region. Linked with them is the association *Vicio oroboidi-Fagetum* Pócs et Borhidi in Borhidi 1960 and *Fagetum croaticum boreale lathyretosum verni* I. Horvat 1938 reaching as far as the river Una. The

central and eastern part of the predinaric phytogeographic region is covered with forests of the *Medico nutantis-Fagetum* Fabijanić, Fukarek et Stefanović ex Marinček et al. 1993. Appearing on dolomite parent material in the submontane-montane belt are the following azonal associations: *Ostryo-Fagetum* var. geogr. *Acer obtusatum* Marinček, Puncer et Zupančič 1979, *Arunco-Fagetum* var. geogr. *Epimedium alpinum* Košir 1962, *Aceri obtusati-Fagetum* Fabijanić, Fukarek et Stefanović 1967, *Erico-Fagetum* Horvat ex Trinajstić 1971.

The vegetational belt between the Illyrian submontane beech forests and spruce beech forest *Omphalodo verni-Fagetum* (Tregubov 1957) ex Marinček et al. 1993 consists of almost pure beech forests. Prevailing in the western part of the predinaric phytogeographic region are the zonal association *Lamio orvalae-Fagetum* var. geogr. *Dentaria polyphylla* (Košir 1962) – the nomenclature type of the var. geogr. is releve No. 4 tab. 7 by Košir 1962 – and *Cardamini-savensi-Fagetum* Košir 1962. The leading associations of the central and eastern part of the region is *Fagetum montanum illyricum* Fukarek et Stefanović 1958.

Wherever the predinaric phytogeographic region includes moderately acid non-carbonate rocks, there appears the association *Quercus-Luzulo-Fagetum*, frequently geogr. var. *Epimedium alpinum* (*Epimedio-Luzulo-Fagetum* Marinček 1981).

Dinaric Phytogeographic Territory

The Dinaric phytogeographic territory was described already by FUKAREK (1977). His ecological and vegetational description was supplemented with some recent data.

The Dinaric region covers the Dinaric Mountains. In the west it reaches almost as far as the river Soča. Viewed in the southeastern direction, it becomes increasingly broader, attaining the maximal breadth in Croatia, Bosnia and Montenegro.

The climate in the Dinarid region is very humid, relatively mild, markedly oceanic. The precipitations, amounting from 1200 to 1300 per year, have a favourable distribution, so there are no summer droughts. As a results of higher altitudes the temperatures are slightly lower, however, high humidity of about 85% per year (after PUNCER, 1980) prevents significant temperature extremes. Low temperatures are locally conditioned by the relief.

There prevail Mesozoic, primarily Jurassic and cretaceous limestones. Dolomites are less frequent. Carbonate parent material is covered with rendzinas at different developmental stages, calcic cambisol and cambisol lessivé. Dominant is Illyrian-Balkan flora, revealing certain Central European influences. The vegetation of the Dinaric region is represented by the following associations of the suballiance *Lamio orvalae-Fagenion*,

Saxifraga-Fagenion and *Ostrya-Fagenion*. The basic zonal vegetation of the Dinaric phytogeographic territory are spruce-beech forests of different types forming a vegetational belt around 800 to 1200 (1400) m a.s.l.. The floristic differences between the western part of the Dinaric Mountains with Illyrian floral elements *Omphalodes verna*, *Cardamine trifolia*, *Homogyne silvestris*, *Hacquetia epipactis*, *Scopolia carniolica*, *Lamium orvala*, and some others, and the eastern part of the Dinaric Mountains where these vegetal species are completely missing, are so outstanding that the entire area of the Dinaric spruce-beech forests could roughly be divided into two parts. The zonal vegetation would be represented by *Omphalodo-Fagetum* (Tregubov 1957) ex Marinček et al. 1993. Due to a warmer climate of the eastern part of the Dinaric Mountains the association *Omphalodo-Fagetum* moves to higher altitudes, so it includes subalpine species: *Adenostyles glabra*, *Saxifraga rotundifolia*, *Mulgedium alpinum*, *Ranunculus platanifolius*, *Luzula silvatica* and some others. According to FUKAREK (1977), the southern Dinaric region is characterized by numerous endemic and subendemic species, among them also arboreal and shrubby species: *Acer heldreichi* subsp. *visiani*, *Pinus leucodermis*, *Rhamnus orbiculatus*, *Daphne malyana*. Substantial ecological differences between the western and eastern part of the Dinaric phytogeographic region are reflected in certain azonal associations. The markedly humid western part is propitious to spruce forests of the *Blechno-Abietetum* type I. Horvat 1950. Appearing on the coastal side of the south-Dinaric region, between the rivers Neretva and Drina which is under a strong Mediterranean influence and is the warmest part of the Dinaric region, are isles of pine forests: *Pinetum heldreichi* s. lat. and *Pinetum peucis* s. lat.. Along outstandingly warm and dry valleys there appear fragments of the association *Quercetum frainetto-cerris* Rudski (1940) 1949.

At about 1200 (1300) m a.s.l. spruce-beech forests pass into relatively pure beech forests of the *Ranunculo platanifolii-Fagetum* var. geogr. *Calamintha grandiflora* Marinček 1982 (mscr.) and above 1400 m a.s.l. into *Polysticho lonchitis-Fagetum* var. geogr. *Allium victorialis* Marinček 1988 (mscr.). Locally there appears azonal association *Stellario glochidispermae-Fagetum* (Zupančič 1967) ex Marinček et al. 1993. The zonal subalpine association on the eastern part of the Dinaric region is *Aceri visiani-Fagetum* Fukarek et Stefanović 1958.

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