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ECOLOGICAL-VEGETATIONAL PROPERTIES OF FOREST "ŽUTICA"

EKOLOŠKO-VEGETACIJSKE ZNAČAJKE ŠUME ŽUTICA

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The paper presents synecological-vegetational research carried out in the Management Unit "Žutica" over a total area of 6,116.68 ha.

During three-years' research in the forest "Žutica", its phytocoenology was described, and the forest recorded, systematized and mapped. The present condition of this forest was compared with that of the past, as well as with the research in lowland forests growing on pedunculate oak sites affected by dieback (Kalje, Turopoljski lug, Pokupski bazen).

Eight forests in all were phytocoenologically described, of which the forest of pedunculate oak and great green weed with common hornbeam was described for the first time. Changes pointing to a disturbed ecosystem were recorded in most cases.

Deviations from normal lowland forest associations, as well as general destabilization of the "Žutica" forest ecosystem, were caused by factors of synergetic nature.

According to research, over 700 ha of the most interesting and valuable forests of pedunculate oak were affected by abrupt external and internal influences of high intensity during the dieback period of some thirty years ago. The principal tree species were desiccated, site conditions and forest associations were changed, and a negative succession of forest vegetation took place.

A vegetation map of forest associations in the Management Unit "Žutica" on a scale of 1 : 25,000 was drawn up on the basis of phytocoenological and other research.

Site and stand degradation can only be curbed, and a return to a normal state and progression achieved, through a multidisciplinary approach to this and similar problems.

Key words: Žutica, synecological-vegetative research, forest associations, disturbed ecosystem, synergism, vegetative map, multidisciplinary approach

INTRODUCTION
UVOD

In the second half of this century, lowland forest regions of Croatia were subjected to strong meliorative, technological and other anthropogenic influences. Their synergistic action led to sporadic changes and instability of forest ecosystems. These influences caused extensive forest dieback in several regions along the river Sava in western Croatia, while in some other regions they led to various syndynamic changes linked to a retreat or expansion of individual tree species or forest associations.

The forest "Žutica" is particularly important in this sense. A disturbance in normal relationships among synecological factors has led to changes in principal tree species participation, floral composition and forest associations, resulting in unstable forest stands. For this reason, the forest "Žutica" is a very valuable and interesting object of scientific vegetational research.

It needs to be stressed that the study of such ecosystems should be multidisciplinary. Forest phytocoenology represents an indispensable factor in any study of the forest "Žutica". Phytocoenological research gives data on the original climatogenous vegetation and development trends of the existing vegetation. This makes the choice of the most natural methods of repairing degraded areas easier, and provides a base for silvicultural operations, and for the management, protection and exploitation of forests.

GOALS AND METHODS OF RESEARCH
CILJ I METODE ISTRAŽIVANJA

The research goals are:

- to provide a phytocoenological description of the Management Unit "Žutica",
- to obtain a phytocoenological recording of forest associations in the studied area,
- to systematise forest associations,
- to draw up a map of forest associations,
- to compare the present state of forest associations in the Management Unit "Žutica" with the present state of the same associations in the areas affected by pedunculate oak dieback (Kalje, Turopoljski lug, Pokupski bazen),
- to compare these associations with those in the areas where no disturbances of the above nature took place (Lipovljani forests and others),
- to predict the direction of syndynamic development of forest associations using other ecological research as well,
- to provide such practical solutions for this and similar problems in Croatian lowland ecosystems which will preserve their ecological stability, maintain

biological diversity, and achieve an optimal wood mass production. All this will make an important contribution to sustainable management.

The following research methods were used:
- classical principles of the Zürich-Montpellier school (Br-Bl. 1964),
- guidelines from the "Handbook of Typological Research and Vegetation Mapping" (Horvat et al., 1950),
- biological plant forms taken from Rauš and Šegulja (1983),
- plant nomenclature concorded according to Ehrendorfer (1973).
- data processing.

All these research methods have been concorded with the existing Phytocoenological Nomenclature Codex (Barkman et al., 1986).

NATURAL FEATURES OF THE STUDIED AREA
PRIRODNE ZNAČAJKE ISTRAŽIVANOGA PODRUČJA

GEOGRAPHICAL LOCATION, SURFACE AREA, AND GROWING STOCK
ZEMLJOPISNI POLOŽAJ, POVRŠINE I DRVNA ZALIHA

"Žutica" is a forest complex bounded by the Zagreb – Lipovac motorway in the north, the river Sava in the south, the river Lonja in the west, and the river Česma in the east. It is located between 16°21' and 16°31 eastern longitude, and 45°34' and 45°41 northern latitude. In a wider sense, it belongs to the region of Posavina.

Within the structure of the Public Enterprise "Croatian Forests", this area represents the Management Unit of "Žutica" with 200 departments. It belongs to Zagreb Forest Management, Forest Office of Novoselec Križ.

The Management Unit covers 6,116.68 ha, of which 5,107.41 ha are under forest stands, and 1,009.27 ha are non-forested and infertile soils (511.25 ha are non-forested – productive, 205.69 ha are non-forested – non-productive, and 292.32 ha are infertile).

The largest part of infertile and non-forested – non-productive land belongs to INA-Naftaplin Oil Company.

In terms of tree species, the structure is as follows: pedunculate oak - 622,397 m^3, or 55% of the total growing stock, black alder - 160,360 m^3 or 14.17% , narrow-leaved ash - 160,192 m^3, or 14.16%, common hornbeam - 119,004 m^3, or 10.52%, poplar - 30,021 m^3, or 2.65%, maple - 18,096 m^3, or 1.60%, OTL - 10,652 m^3, or 0.94%, common beech 4,422 m^3, or 0.39%, OML - 3,675 m^3, or 0.33%, and lowland elm 2,740 m^3, or 0.24%, which is a total of 1,131,559 m^3 of growing stock. The current annual increment is 37,191 m^3.

CLIMATIC CONDITIONS
KLIMATSKE PRILIKE

The data for the period 1983 – 1992, provided by the Sisak Meteorological Station, are as follows: the mean annual air temperature is 11.0°C, the mean annual precipitation quantity is 872 mm (471 mm in the vegetation period), and the mean annual relative air humidity is 77%, which, according to Köppen's classification, denotes a temperate rainy climate marked with Cfwbx" type.

Table 1. Mean monthly and annual air temperature (T) and quantity of precipitation (O) for the period 1983 - 1992.
Tablica 1. Srednje mjesečne i godišnje temperature zraka (T) i količine oborina (O) za razdoblje od 1983. do 1992. godine

Months *Mjeseci*	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Mean values *Srednjak*
T °C	0.5	0.9	6.5	11.4	15.9	18.6	21.4	20.7	16.4	10.7	4.9	1.5	11.0
O mm	58.1	56.7	63.5	60.6	107.3	97.5	66.0	64.8	74.9	84.4	95.3	42.8	871.7

Table 2. Annual trends in mean relative humidity (%) for the period 1983 - 1992.
Tablica 2. Godišnji hod srednje relativne vlage (%) za razdoblje od 1983. do 1992. godine

Months *Mjeseci*	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Mean values *Srednjak*
%	84	79	73	69	71	73	71	73	78	83	86	86	77

According to Lang's rain factor (annual) Kfg = O/T = 872/11 = 79, the climate type is semi-humid with a tendency towards a humid one.

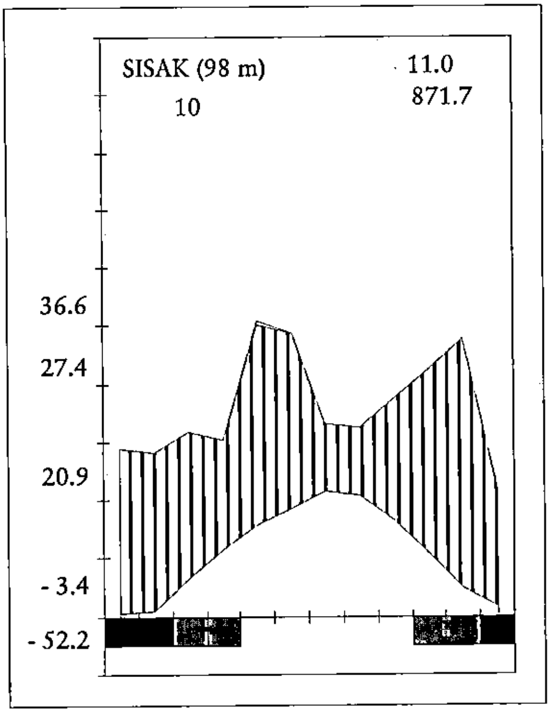
Gračanin's monthly rain factor (Kfm) shows that the annual climate type is semi-humid.

Since whether the climate is cold, temperate or warm with certain humidity levels is relevant for the occurrence and growth of plants, Gračanin also adds a climate temperature character (TK). In the area under research, the TK is moderately warm, since the mean annual air temperature ranges between 8.0 and 12.0°, or 11.0°C on average.

Table 3. Monthly rain factor (Kfm), humidity (H) and climate warmth nature (TK) according to Gračanin for the period 1983 - 1992.
Tablica 3. Mjesečni kišni faktor (Kfm), humiditet (H) i toplinski karakter klime (TK), prema Gračaninu, u razdoblju od 1983. do 1992. godine

Months *Mjeseci*	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual *Godišnje*
Kfm	116	63	9.8	5.3	6.8	5.2	3.1	3.1	4.6	7.9	19.4	28.5	79
H	ph	ph	h	sh	h	sh	a	a	sa	h	ph	ph	sh
TK	n	h	uh	ut	t	t	v	v	t	ut	uh	h	ut

Figure 1. Climate diagram according to Walter for the period 1983–1992.
Slika 1. Klimatski dijagram prema Walteru za razdoblje 1983–1992. god.



Late and early frosts (and especially the former) also play an important role. As they usually occur in May, they interfere with flower pollination and fruit embryo formation, and kill young shoots. Early autumn frosts prevent crops from ripening.

The most harmful winds come from a south-westerly and westerly direction, but their impact is not too negative.

It can be concluded from the above that the climatic conditions in the studied area are favourable for the growth of vegetation.

GEOLOGICAL SUBSTRATE AND SOIL
GEOLOŠKA PODLOGA I TLO

The Management Unit "Žutica" and the Posavina Plain where it is located, are developed on a geological substrate of pebbles, sands, clays and loams. It was formed in the Pleistocene as the result of depositions in the Pannonian Sea and of river deposits. The main characteristic of such a geological base is its horizontal and vertical heterogeneity. Genetically, a younger alluvial layer composed of clays, loams, mud and pulverized materials lies above this heterogeneous material.

The lowest river valleys are composed of deposits of the Holocenic age (Mayer, 1996).

The erosion of recent alluvial substrate under the influence of a specific water regime has resulted in the formation of hydromorphous soils, in the first place pseudogleys, semigleys and gleys.

A number of authors (Vajda, Kalinić, Škorić, Martinović, Vranković, Prpić, Bašić, Mayer, and others) have always pointed out that specific hydrological conditions represent a dominant pedogenetic factor in valleys. A richly indented lowland microrelief, which determines the redistribution of incoming water, is a decisive factor in the formation of drier and wetter sites, and consequently of differently productive forest soils.

In 1996, Mayer drew up a table of pedological-vegetational pairs for natural pedotaxons in lowland pedunculate oak forests in Croatia, which he based on the data from different papers (Rode 1960; Ćirić 1984; Škorić et al. 1989; Vranković and Bašić, 1989; Dekanić 1962, 1971, 1974, 1975; Rauš 1974; Rauš et al. 1992; Prpić et al. 1979; Prpić 1985). Table 4 shows a part of the table referring to forest associations in the Management Unit "Žutica".

Table 4. Natural pedological-vegetation pairs in lowlend forests of penduculate oak in Croatia

Tablica 4. Prirodni pedološko-vegetacijski parovi u nizinskim šumama hrasta lužnjaka u Hrvatskoj

Forest association	List of pedotaxons	Topographic sequences	Groundwater veget. average
Forest of pedunculate oak and great green weed with remote sedge	amphigley, hypogley, epigley, humogley	Micro-depressions	about 150 cm (Dekanić 1962)
Forest of pedunculate oak and great green weed with quaking sedge	amphigley, epigley, pseudogley-gley, hyopgley	Micro-depressions on micro-elevations, humid micro-elevation, transition micro-depression - micro- elevation in western Posavina	about 200 cm (Dekanić 1962)
Forest of pedunculate oak and common hornbeam	pseudogley lowland, pseudogley-gley, semigley, hypogley, eutric brown, luvisol pseudogleyic	Micro-elevations and humid micro-elevations in valleys, Pleistocene terraces	about 220 cm (Dekanić 1962)
Forest of pedunculate oak and common hornbeam with beech	pseudogley lowland, pseudogley-gley, semigley, hypogley, eutric brown, luvisol pseudogleyic	Micro-elevations in valleys, Pleistocene terraces	about 220 cm (Dekanić 1962)

So, for example, the association of pedunculate oak and common hornbeam grows on lowland pseudogley, the association of pedunculate oak and great green weed on mineral-swampy soils and lowland pseudogley, and the associations of black alder with dogwood, and narrow-leaved ash with autumn snowflake on eugley soils (the former on an amphigley subtype, and the latter on epigley).

In general, it was found (Forestry Institute Jastrebarsko, 1979) that the above soils are of slight to neutral acidity, have a clayey mechanical composition, are mostly non-carbonate, and have a high humus content, but low nitrogen and phosphorus content.

The study of redox potential carried out by Vranković and Bašić (1989), showed that unfavourable reduction conditions in swampy compartments last over the entire growing season. Particularly strong reduction is caused by surface water (flood and precipitation) which cannot run off, because forest roads and other communications make its retreat after floods more difficult. On the basis of research in Lipovljani, Škorić and Vranković (1975) concluded that the degree of anaerobiosis correlates with dieback intensity, which increases from pseudogley towards gley soil; therefore, pollution is excluded as a possible cause of dieback.

GEOMORPHOLOGIC AND HYDROLOGICAL CONDITIONS
GEOMORFOLOŠKE I HIDROLOŠKE PRILIKE

The Management Unit "Žutica" is an undulating plain with mild elevations and equally mild depressions, intersected with smaller and larger water courses. The lowest points are characterised by swamps of stagnant water over the best part of the year. Altitude ranges between 93 and 99 m. Crna Humka is the central elevation from which numerous other elevations extend in all directions. The largest part of "Žutica" consists of flatlands with very small height differences. In this sense, the region called Ravneš is particularly characteristic. The total height difference of 6 m over a distance of 4.5 km between Crna Humka and the river Lonja gives an average gradient of 1.33%, which only just enables the run-off of surface water in "Žutica".

A very rich hydrographic system, which is characteristic of lowland Posavina, is made up of the rivers Lonja and Česma, the streams Črnec and Lonjica, and a number of smaller water courses with indistinct river beds.

Other hydrographic features include micro-depressions and swamps with mainly stagnant water. According to Šarin et al. (1994), top layers in the forest "Žutica" are impermeable to medium permeable.

Until the beginning of the 20th century, vast areas of Posavina were covered with floods, but due to hydro-technical operations in this century, flooding has been considerably reduced.

Since the end of the 19th century, water regimes of most Croatian rivers have been extensively regulated. This has disturbed water relations in forest sites. Groundwater levels have dropped, and floods are either absent, or occur at inconvenient periods (or when water management authorities release water into forests). A combination of the above and of other negative factors has resulted in a lowered resistance of individual trees, tree dieback, and regression processes both in plant communities and in sites.

Unfortunately, most of the roads and dams built through forest ecosystems do not have adequate water draining systems. Therefore, as water coming into the area cannot retreat as it would under a normal regime, it remains trapped until it evaporates. The result is a waterlogged terrain. The sites degrade, the soil oxygen content drops, microbiological activity is reduced, and vegetation not accustomed to such conditions dies.

Since the influence of human activity on the Management Unit "Žutica" and its water regime is very strong, the site has been turned into a retention area for the rivers Sava, Česma and Lonja by the water management authorities. Thus, the whole region, except for that of Žalkovo, has been surrounded with new river courses and dams. However, this has conflicted with natural relationships in the area, and has badly disturbed the whole ecosystem.

In recent times, the monitoring of hydropedological research has been introduced (Mayer 1981, 1988, 1991, 1995) into lowland forests in Croatia. The forest of "Žutica" should on no account be excluded from the research as the changes in its ecosystems are very great.

Field monitoring of water movement in and on the soil with piezometers, carried out by the Forestry Institute in Jastrebarsko, has proved to be the best method of obtaining accurate data on forest water regimes. It is also the main indicator for forest ecosystem management in lowland regions.

RESULTS OF RESEARCH
REZULTATI ISTRAŽIVANJA

FOREST ASSOCIATIONS IN THE STUDIED AREA AND THEIR SYSTEMATIC POSITION
ŠUMSKE ZAJEDNICE ISTRAŽIVANOGA PODRUČJA I NJIHOV SISTEMATSKI POLOŽAJ

Observations, which were part of field research, have shown that the studied area abounds in numerous forest associations, which can be classified into the following systematic groups:

Class: *Querco-Fagetea* Br.-Bl. Et Vlieg. 1973
Order: *Fagetalia sylvaticae* Pawl. 1928
Alliance: *Carpinion betuli* Ht. 1956

Ass: *Carpino betuli-Quercetum roboris* (Anić 1959) emend. Rauš 1969
Subass: *typicum* Rauš 1971
Subass: *fagetosum* Rauš 1971

Class: *Alno-Populetea* Fk. et Fb. 1964
Order: *Populetalia albae* Br. - Bl. 1931
Alliance: *Alno-Quercion roboris* Ht. 1938
Ass: *Genisto elatae-Quercetum roboris* Ht. 1938
Subass: *caricetosum remotae* Ht. 1938
Subass: *caricetosum brizoides* Ht. 1938
Subass: *carpinetosum betuli* Glav. 1961
Ass: *Frangulo-Alnetum glutinosae* Rauš 1968
Subass: *typicum* Rauš 1971
Ass: *Leucoio-Fraxinetum angustifoliae* Glav. 1959
Subass: *typicum* Glav. 1959
Subass: *alnetosum glutinosae* Glav. 1959

Initial vegetation of willows and reed is also present, as well as the cultures of Euro-American poplars (*Populus* x *euroamericana*) enriched with natural, pioneering species of narrow-leaved ash and black alder, There is a spruce culture (*Picea abies*) and Waymouth pine (*Pinus strobus*) in a very small area.

FOREST OF PEDUNCULATE OAK AND COMMON HORNBEAM
ŠUMA HRASTA LUŽNJAKA I OBIČNOGA GRABA
(*Carpino betuli-Quercetum roboris* /Anić 1959/ Rauš 1969)

Research so far: The forest of pedunculate oak and common hornbeam in Croatia has been a frequent subject of research. From a vegetational standpoint, it has been studied by Horvat (1938, 1959, 1962), Anić (1940, 1959), Glavač (1960, 1961, 1962, 1968), Rauš (1966-1995) and others.

It has sometimes been described as an association, and sometimes as a subassociation under different names: *Querco-Genistetum elatae* Ht. 1938, subass. *Carpinetosum betuli* Vuk. 1959 prov., *Querco-Carpinetum ruscetosum aculeati* Ht. 1949, *Querceto roboris-Carpinetum betuli* Anić 1959, *Querco-Genistetum elatae carpinetosum betuli* Glavač 1961, *Querco robori-Carpinetum slavonicum* Soó 1962, and *Carpino betuli-Quercetum roboris* /Anić 1959/ Rauš 1969. The last has been accepted today, as well as its status as an association.

Gračanin (1948, 1951), Dekanić (1959, 1962), Bertović (1960), Šafar (1963), Prpić (1966-1995), and others have studied this forest from various ecological-management standpoints.

Distribution of phytocoenosis: The association of pedunculate oak and common hornbeam is distributed over the entire region of the pedunculate oak range.

The best stands grow along the large lowland rivers Sava and Drava and their tributaries, and in the region of Pokuplje in central Croatia. In the Management Unit "Žutica", the association is distributed over about 40% of the total area, mainly in the central part of the Unit and in the regions of Žalkovo, Pleso and Vratoč.

Site of phytocoenosis: The association inhabits raised terrains (micro-elevations) out of reach of flood water. Groundwater is relatively low, and its average level, according to some earlier research, ranges from 1.5 to 4 m. In winter, the soil is saturated with water. It has a slightly acid to neutral reaction, and its type is lowland pseudogley.

Floral composition and vegetational structure: The above factors are reflected in the association's floral composition. Apart from pedunculate oak, there is also considerable participation of hornbeam and maple, and various shrubs and herbaceous plants of drained terrains commonly found in forests of sessile oak and hornbeam. M. Anić (1959) describes this association as a pedunculate forest of a drier type.

The tree layer is made up mostly of pedunculate oak and common hornbeam, and a small percentage of the beech in the beech subassociation.

The shrub layer consists of hazel, dogwood, wayfaring tree, hawthorn and other plants.

Numerous mesophyllic species indicating fresh and drained sites, but not wet and flooded areas, as shown in Table 5, occur in the ground layer.

Biological range: According to Ranunkiaer (1905), the biological range of biological (live) forms from 20 phytocoenological recordings (Table 5) show the following structure of plant species: phanerophytes (Ph) 27%, chamaephytes (Ch) 11%, hemicryptophytes (H) 45%, geophytes (G) 12%, and therophytes (Th) 5%. This is an indication of a hemicrypto-phanerophytic (45 + 27%) association with a significant participation of geophytes (12%). A high presence of hemicryptophytes places this association into a central European region and shows its resistance to winter colds. A large number of phanerophytes indicates very warm summers, while that of geophytes reflects the micro-relief and micro-climatic conditions in this association, and shows a large participation of many plants of the *Fagetalia* order.

Classification of the phytocoenosis: The classification of these forests done and described by Rauš (1969-1971) has been fully accepted today. According to Rauš, there are four subassociations:

- subass.: *typicum* Rauš 1971
- subass.: *fagetosum* Rauš 1971
- subass.: *quercetosum cerris* Rauš 1969
- subass.: *tilietosum tomentosae* Rauš 1969.

Research carried out over three years in the forest "Žutica" has confirmed the presence of the first two subassociations. Their phytocoenology has been recorded and described and they have been inserted into the forest association distribution map.

Phytocoenotic syndynamics: According to various researches carried out by many researchers and by this author, the forest of pedunculate oak and common hornbeam is a culminating point in a natural development of lowland forests. It is a point to which all foresters should aspire, but always bearing in mind the state in the field. This forest is the result of a natural succession from the forest of pedunculate oak and great green weed *(Genisto elatae-Quercetum roboris)*, and represents a terminal association, marking the final stage in the development of lowland vegetation.

Stability of the phytocoenosis: Of all the associations in the area, the forest association of pedunculate oak and common hornbeam has proved to be the most stable and the most resistant to dieback. However, even this association is not completely immune to changes in ecological conditions. In all other localities (Kalje, Turopoljski lug, and Pokupski bazen), which, together with the Management Unit "Žutica", represent the most extreme examples of pedunculate dieback in Croatia, it was shown that this association is the least dependent on high groundwater levels. Here, pedunculate oak has adapted to dry conditions, and its growth has not been stunted by a changed water regime. However, other changes of a different character have taken place in this association, which will be described in more detail later.

Forest-economic characteristics: As already mentioned, the tree layer is dominated by pedunculate oak, with an ample presence of common hornbeam in the understorey. This combination suits the pedunculate oak very well: the trees are large, clean and full-bodied. The forests are characterised by a large wood mass, so from the economic standpoint it is the most favourable stand form in the lowland region.

Allowing for the state of the sites, the association of pedunculate oak and common hornbeam is the ideal to which every forester in this and similar lowland regions should aspire. All forest activities should be directed towards that goal. Stands of pedunculate oak grow much better and have more thinning material if the understorey is rich in hornbeams. Such stands benefit from sunlight much more, because the part of light which penetrates through rarified oak crowns is stopped by the hornbeams in the understorey, and is put to use for the increase of wood mass, while in pure oak stands this part of light remains unused. Understorey hornbeams are useful not only because they provide shade for the soil under oak stands, but also because their leaf litter creates a thick humus layer and improves the physical and chemical properties of the soil.

Matić (1996) points out the importance of natural rejuvenation or natural regeneration. It is the most perfect form of regeneration of every stand, as it does not break the continuity of the joint action and mutual influence of ecosystem members. Most importantly, natural regeneration preserves the forest soil - the most perfect and the most important part of the ecosystem containing the entire living world on the planet in its full wealth.

The minimal rotation in pedunculate oak forests is 140 years. Treatments involving natural regeneration should be carried out in stands with normal structural

Table 5. - *Tablica 5.*

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Degree of presence	Biological form
Association:		*CARPINO BETULI-QUERCETUM ROBORIS* Rauš 1969																					
Subassociation:		*typicum* Rauš 1971										*fagetosum* Rauš 1971											
Number of recording:		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20		
Area:		Žutica																					
Department, compartment:		156a	187a	128b	123d	113a	83a	36e	33a	122b	60b	124a	116a	112a	88a	29a	31a	48b	104a	79a	40a		
Plot size (m^2):		400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400		
Date:		3.VI.	16.VI.	26.VI.	26.VI.	23.VI.	1.VII.	3.VII	2.VII.	27.VI.	4.IX.	26.VI.	27.VI.	27.VI.	1.VII.	2.VII.	2.VII.	26.VIII.	27.VIII.	24.IX.	3.VII.		
Cover (%):																							
Tree layer		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	95	95	100	90		
Shrub layer		1	1	1	5	1	20	1	20	1	5	1	1	5	15	5	10	5	5	5	60		
Ground vegetation layer		50	60	40	80	70	90	70	50	90	30	20	50	60	90	80	70	70	40	70	40		
FLORAL COMPOSITON																							
Characteristic and distinguishing species of the association:																							
Quercus robur L.	A	4	4	4	5	4	4	4	4	4	5	4	4	4	5	4	4	5	4	4	4	V	Ph
Quercus robur L.	B	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	Ph
Veronica montana L.	C	1	.	2	2	1	1	1	1	.	1	.	1	1	2	.	1	.	+	.	1	IV	Ch
Quercus robur L.		+	2	.	1	2	1	.	2	.	1	+	.	2	1	2	1	.	1	2	1	IV	Ph
Carex brizoides L.		2	.	1	2	1	2	.	.	+	1	2	2	2	1	1	+	.	1	1	2	IV	H
Rubus hirtus W.K.		1	.	1	+	+	4	1	+	.	+	+	.	+	+	+	+	+	.	.	+	IV	Ch
Lysimachia nummularia L.		+	.	+	+	.	.	+	1	+	.	+	.	.	.	.	.	.	.	.	1	II	Ch
Carex remota L.		+	.	.	+	+	.	+	+	1	.	.	.	.	.	.	.	.	.	+	+	II	H
Glechoma hederacea L.		+	.	.	.	.	.	+	.	1	+	.	.	.	.	.	.	.	.	.	.	I	Ch
Distinguishing species of the subassociations (*fagetosum*):																							
Fagus sylvatica L.	A	.	.	.	.	.	.	.	.	.	.	1	2	1	1	3	2	+	2	2	1	III	Ph
Ruscus aculeatus L.	B	.	.	+	.	.	.	.	.	.	.	+	+	+	.	.	+	+	.	+	.	II	Ch
Fagus sylvatica L.		.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	1	.	+	.	.	I	Ph
Fagus sylvatica L.		.	.	.	.	.	.	.	.	.	.	1	2	.	.	.	1	.	.	.	.	I	Ph
Mycelis muralis (L.) Rchb.		.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	I	H
Luzula pilosa (L.) Willd.		.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	I	H
Characteristic and distinguishing species of the alliance (*Carpinion betuli*):																							
Carpinus betulus L.	A	4	3	3	3	3	3	4	3	3	3	2	3	3	3	2	3	2	3	3	2	V	Ph
Carpinus betulus L.	B	+	+	+	.	.	+	.	2	.	+	.	+	.	+	+	+	+	1	.	1	IV	Ph
Euonymus europaea L.		+	.	+	.	.	+	+	+	.	1	.	.	.	+	+	.	+	.	+	+	III	Ph
Acer campestre L.		.	.	.	.	.	+	+	+	+	+	.	.	+	.	.	.	+	.	+	+	III	Ph

Stellaria holostea L.	C	.	2	3	2	+	3	+	.	+	.	2	1	.	2	+	+	.	2	.	.	IV	H
Acer campestre L.		.	+	.	+	+	.	.	.	+	+	.	.	.	1	.	.	.	+	+	.	II	Ph
Carpinus betulus L.		+	.	.	.	1	3	.	.	.	.	1	.	2	2	2	2	.	.	.	.	II	Ph
Vinca minor L.		.	.	.	.	.	.	.	.	.	.	.	.	2	+	.	.	.	.	.	+	I	Ch
Characteristic species of the order (*Fagetalia*) and class (*Querco-Fagetea*):																							
Corylus avellana L.	B	+	.	.	.	+	2	+	1	.	1	.	.	.	2	1	+	1	.	1	3	III	Ph
Crataegus oxyacantha L.		.	.	+	1	+	.	.	+	+	+	.	+	1	.	+	.	.	.	+	+	III	Ph
Crataegus monogyna Jacq.		.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	1	+	.	.	1	II	Ph
Circaea lutetiana L.	C	1	+	.	1	+	+	2	1	+	2	+	1	+	+	+	1	+	1	+	2	V	G
Viola reichenbachiana Jor. ex Bor.		+	+	1	1	1	+	1	1	1	1	1	2	2	2	+	.	2	+	2	+	V	G
Galium odoratum (L.) Scop.		.	1	1	3	4	3	1	1	1	.	2	.	3	3	3	3	2	2	3	2	V	G
Lamiastrum galeobdolon (L.) E.et P.		.	3	2	3	2	1	3	.	2	.	1	2	1	1	2	3	1	1	3	1	V	Ch
Polygonatum multiflorum (L.) All.		+	1	+	1	+	+	+	1	.	.	1	+	+	1	+	+	+	+	1	.	V	G
Ajuga reptans L.		2	1	1	1	+	+	1	.	3	+	1	1	1	1	1	+	+	1	2	1	V	H
Dryopteris filix mas (L.) Sch.		+	+	1	+	+	+	.	+	+	.	+	.	+	+	+	1	+	+	.	+	IV	H
Carex maxima L.		.	.	.	1	.	.	2	3	1	+	.	.	2	+	1	1	+	.	+	2	III	H
Brachypodium silvaticum R.S.		+	.	.	+	.	+	.	+	+	.	.	.	+	+	.	+	+	.	.	.	III	H
Anemone nemorosa L.		.	1	2	1	1	+	.	1	.	.	.	2	.	.	.	.	.	+	.	+	III	G
Paris quadrifolia L.		+	.	+	.	.	.	1	.	1	.	+	1	.	1	1	+	.	.	.	+	III	G
Carex silvatica Huds.		+	.	.	1	.	.	1	1	+	.	.	.	.	.	.	.	3	.	1	.	II	H
Asarum europaeum L.		.	2	.	.	.	+	2	.	.	.	.	.	1	1	+	.	+	.	2	.	II	H
Scrophularia nodosa L.		+	.	.	+	.	.	.	.	.	.	.	.	+	1	+	+	.	.	+	.	II	H
Primula vulgaris Huds.		.	+	.	.	.	.	.	1	.	+	.	.	.	.	1	.	.	.	.	1	II	
Sanicula europaea L.		-	.	+	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	+	.	I	H
Euphorbia amygdaloides L.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	I	Ch
Other species:																							
Rhamnus cathartica L.	B	.	.	.	+	+	.	+	+	.	.	.	.	+	+	+	.	+	+	.	1	III	Ph
Viburnum opulus L.		.	.	.	.	.	.	.	+	.	+	.	.	.	+	.	.	+	+	.	+	II	Ph
Ulmus carpinifolia Gled.		+	.	.	.	.	.	+	.	+	.	.	.	.	+	+	.	.	.	.	.	II	Ph
Sambucus nigra L.		+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	I	Ph
Pyrus pyraster (L.) Borkh.		.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	+	.	.	.	I	Ph
Frangula alnus Mill.		+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	Ph
Oxalis acetosella L.	C	1	2	3	3	3	+	1	1	3	2	2	2	3	2	3	3	+	2	1	1	V	H
Galeopsis tetrahit L.		1	+	1	1	+	1	.	.	+	+	+	1	+	.	+	+	+	+	+	+	V	Th
Symphytum tuberosum L.		.	1	.	.	1	.	1	1	+	.	+	1	2	.	.	2	.	+	.	1	III	G
Hedera helix L.		.	+	+	.	+	.	1	1	.	+	.	.	.	1	+	.	1	+	+	+	III	Ph
Fragaria vesca L.		.	.	.	.	1	.	.	+	.	.	.	.	+	.	+	+	+	+	.	1	III	H
Geum urbanum L.		.	+	+	.	.	+	+	.	.	.	.	+	+	+	.	.	.	.	.	.	II	H

Aegopodium podagraria L.	.	.	.	2	2	+	.	.	.	.	.	.	2	.	.	.	2	.	2	.	II	H
Athyrium filix femina (L.) Roth.	.	.	+	.	+	.	.	.	.	+	.	1	.	.	+	.	.	.	1	+	II	H
Angelica silvestris L.	.	.	.	.	.	.	1	1	.	2	.	.	.	.	1	.	.	+	.	1	II	H
Cerastium silvaticum W.K.	.	.	+	+	+	.	+	.	1	.	.	.	.	.	.	.	.	.	.	.	II	Ch
Festuca gigantea (L.) Vill.	+	.	1	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	II	H
Impatiens noli tangere L.	+	.	2	+	.	.	.	.	1	.	.	.	.	.	.	+	.	.	.	.	II	Th
Platanthera bifolia (L.) Rich.	.	.	.	.	.	+	1	1	.	.	.	.	.	.	.	.	.	.	.	.	I	G
Geranium robertianum L.	.	.	+	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	I	Th
Urtica dioica L.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	2	I	H
Deschampsia caespitosa (L.) Beauv.	+	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	+	.	.	.	I	H
Melampyrum silvaticum L.	.	+	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	+	I	Th
Pulmonaria officinalis L.	.	2	.	.	.	.	1	.	.	.	.	.	.	.	.	.	+	.	.	.	I	H
Veronica chamaedrys L.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	1	.	.	.	.	.	I	H
Moehringia trinervia (L.) Clairv.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	H
Galium aparine L.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	H
Galium palustre L.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	H
Galium silvaticum L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	+	.	I	H
Senecio nemorensis L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	I	H
Hypericum hirsutum L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	2	.	I	H
Cardamine savensis Schulz.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	I	H
Maianthemum bifolium (L.) Schm.	.	.	.	.	.	.	1	.	.	.	.	+	.	.	.	.	.	.	.	.	I	H
Nephrodium spinulosum Stremp.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	H
Ranunculus ficaria L.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	I	G
Millium effusum L.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	I	H
Rubus caesius L.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	I	H
Myosotis scorpyoides L.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	I	H
Lapsana communis L.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	Th
Rumex sanquineus L.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	I	H
Cephalanthera rubra (L.) L.C. Rich.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	G
Torylis anthriscus (L.) Gmel.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	I	

Explantation of abbreviations:
A - Tree layer
B - Shrub layer
C - Ground vegetation layer
+, 1, 2, 3, 4, 5 - Combined assessment of abundance and cover - (Braun-Blanquet 1964)
I - V - Degree of participation
Ph, Ch, H, Th, G - Biological form (Raunkiaer 1905)

relationships and with a preserved forest soil, while those relating to artificial regeneration should be applied in stands where acorn yields are unsatisfactory. In the latter case, silvicultural principles of natural regeneration should be applied, that is, three cuts: the preparatory, seeding and final cut.

Typical forest of pedunculate oak and common hornbeam
Tipična šuma hrasta lužnjaka i običnoga graba
(*Carpino betuli-Quercetum roboris typicum* Rauš 1971)

Site of the phytocoenosis: It develops mostly on re-deposited "swampy" loess, which occurs on micro-elevations and river terraces (Takšić 1970).

The soil is lowland brown, lowland pseudogley and mineral-swampy moderate ogley (semigley). These sites are out of reach of flood water, but in case they reach lower humid micro-elevations, they are usually weak, of short duration, and rare.

Common hornbeam is the best indicator of the state of stagnant water and groundwater, since it tolerates passing floods of short duration, but not stagnant water and high levels of groundwater (Dekanić 1959). Therefore, it occurs only when the water table is 2 to 3 m high, which is the case only on micro-elevations. When a micro-elevation gradually turns into a micro-depression, groundwater levels rise and hornbeam disappears from the floral composition.

The association dominates in the central part of the "Žutica" Unit, which is also the highest point of the relief. The most characteristic complexes are found in the areas around Petica, Vratoč, along the old course of the Lonjica, along the Ćesma on river terraces, around Pleso, and at other points. It covers about 30 % of the total area.

Floral composition and vegetational structure: The floral composition, based on 10 characteristic recordings taken in various parts of the "Žutica", is shown in Table 5. The recordings register 67 species, of which 42 participate with over 20% in the association. It is important to point out that phytocoenological recordings were made during the full growing season from June to September. Depending on weather conditions, this association comes to life at the end of March or the beginning of April. Common hornbeam is the first to break into leaf, maples and hawthorns follow, and pedunculate oak is the last. The reason why this association is the first in the area to enter the leafing stage lies in its position. As it is out of reach of floods, the temperature of the soil is higher than in other places. According to Rauš (1973), the spring aspect in the "Žutica" pedunculate oak forests consists of the following species in the ground layer: *Galanthus nivalis, Leucoium aestivum, Caltha palustris, Symphytum tuberosum, Anemone ranunculoides, Anemone nemorosa, Ranunculus ficaria, Viola reichenbachiana, Oxalis acetosella, Lathyrus vernus, Veronica montana, Veronica chamaedrys, Euphorbia amygdaloides*, and others. The number of species in the association and its floral composition is somewhat different from the recordings, since most of the spring plants later disappear from the floral composition.

In terms of phytocoenology, a typical forest of pedunculate oak and common hornbeam (*Carpino betuli-Quercetum roboris typicum*) represents a clearly defined association whose layers contain all the important constitutive elements.

As seen in Table 5, the tree layer consisting of well-defined dominant and subordinate storeys covers 100% of the area. Old, thick pedunculate oaks prevail, assisted by hornbeams and some maples. Of the species that characterize and distinguish this association from others, pedunculate oak (*Quercus robur*) in the tree layer and common hornbeam (*Carpinus betulus*) in the understorey occur with the highest constancy.

Pedunculate oak is the most important edifier and common hornbeam the subedifier in the tree layers. Diagnostically, they take up the most important place due to their constant presence in the subassociation, which they build completely. These two species occur not only in the tree layer, but also in other layers in the form of young growth and seedlings. The participation of pedunculate oak in the phytocoenosis is very large, and so is its influence on its growth and economic value. In spite of this, pedunculate oak is not nearly as important as common hornbeam for the definition of the association, because it often occurs outside a typical forest, in associations where life conditions are drastically different from those in a forest of pedunculate oak and common hornbeam. A comparison of the presence of common hornbeam in other forest associations of a lowland region reveals its strong links to a mixed forest of pedunculate oak and common hornbeam, because it does not occur in other phytocoenoses, or does so only sporadically. As already mentioned, its growth in other sites is prevented by stagnant surface water or groundwater, which is yet another indication of its exclusive ties to this association.

The shrub layer covers 1 - 5 % of the area, except in recordings 6 and 8, where it covers 20 %. It is made up of cobnut (*Corylus avellana*), common hornbeam (*Carpinus betulus*), spindle tree (*Evonymus europaea*), hawthorn (*Crataegus oxyantha*), and maple (*Acer campestre*), as well as of characteristic species of the alliance, order and family *Querco-Fagetea*. There is a large number of bushes, for example buckthorn (*Rhamnus cathartica*), guelder rose (*Viburnum opulus*), elm (*Ulmus carpinifolia*), and others, which occur frequently, but are not linked to the association.

Depending on individual recordings, the layer of ground vegetation covers wide range of the area (30 to 90 %). Of the species that characterise and distinguish this association from others, those that indicate the specific features of the site are particularly prominent: *Veronica montana* (speedwell), *Quercus robur* (pedunculate oak), *Carex brizoides* (quaking sedge), *Rubus hirtus* (blackberry), *Lysimachia nummularia* (moneywort), and others. A large number of species are linked to the order *Fagetalia* and the alliance *Carpinion betuli*, of which the most important are: *Stellaria holostea*, *Circaea lutetiana* (enchanter's nightshade), *Viola reichenbachiana* (violet), *Galium odoratum* (woodruff), *Lamiastrum galeobdolon* (deadnettle), *Polygonatum multiflorum* (Solomon's seal), *Ajuga reptans* (common bugle), *Brachypodium silvaticum* (bromegrassw), *Anemone nemorosa* (wood anemone) *Asarum europaeum* (wild ginger) and others.

These species are accompanied by a large number of very constant companions, which can be seen from a synthetic table of phytocoenological recordings of the association.

A comparison of floral compositions in 10 recordings from the synthetic table shows some differences among them. So, for example, recording 2 shows an association with species of a distinctly mesophyllic character. Almost all species favouring a more humid terrain are absent, which indicates a very dry site. Recordings 9 and 10 show a slightly more humid variant, with species such as *Ajuga reptans, Veronica chamaedrys*, and particularly *Carex remota, Cerastium silvaticum, Impatiens noli tangere, Lysimachia nummularia, Glechoma hederacea, Carex brizoides, Rumex sanguineus* and *Ranunculus lanuginosus*. Recording 6, with a substantially larger cover of shrub layer and with species such as *Carex brizoides, Rubus caesius* and *Deschampsia caespitosa* in the ground layer, indicate a certain disturbance in the stand.

Comprehensive vegetative research and a comparison with normally developed stands in Lipovljani have shown that the present state of forest vegetation in a typical association of pedunculate oak and common hornbeam in the Management Unit "Žutica" is satisfactory. In other words, the existing composition and arrangement of the storeys and plants ensures the stability of the association, except in some localities where the onset of narrow-leaved ash and black alder, prompted by increased site humidity, has interfered with the progression. The layer of ground vegetation is normal and does not display any signs that can be linked to dieback of pedunculate oak in this subassociation.

Stability of the phytocoenosis: On the basis of the distribution map of forest associations in "Žutica" made by Medvedović (1973-1975) in the course of his research, and the state of the forest in 1997, which was established with research by this author, it can be concluded that hydro-meliorative activities (drainage, flood defence) have had a double effect on these forests. A shortage of water in the sites of lowland forests accelerates progressive succession, as seen in compartments 39a and 168 in the Žalkovo region, where this association has spread into the area previously inhabited by the association of pedunculate oak and great green weed *(Genisto elatae-Quercetum roboris)*. The association of pedunculate oak and common hornbeam also develops better on raised terrains along the river Česma and some other older water courses. On the other hand, a surplus of water causes these forests to shrink in size and give way to forests of more humid sites, such as those of narrow-leaved ash and black alder. The latter have penetrated the sites affected by dieback, despite the association's stability. The result is that compartments 107a, 113b. 119b, 126d, 129a and 129d, including some others, are now inhabited by associations of pedunculate oak and great green weed with common hornbeam (*Genisto elatae-Quercetum roboris carpinetosum betuli*) in place of pedunculate oak and common hornbeam. This is the first step towards the regression of the site and the association. Higher humidity in compartments 28a and b, 34b, 41b, 48a and c, 131a and c, part of 132 and 139a and some others, has favoured the appearance of pedunculate oak and great green weed with quaking sedge (*Genisto ela-*

tae-Quercetum roboris caricetosum remotae), while in compartments 25d, 101a, 103a, 119a, 187b, 188d and some others, it has led to the occurrence of pedunculate oak and great green weed with remote sedge (*Genisto elatae-Quercetum roboris caricetosum remotae*). Extreme examples of waterlogging in the localities marked as associations of pedunculate oak and common hornbeam in the 1975 map are compartments 27d and 72f, which are under ash forest today, and compartments 80b, 88a, 100b, 112b, 113d, and 126c, which are under the forest of black alder. In conclusion, it can be said that on the whole this is a fairly stable association, and that the areas under this association twenty years ago and today are equal in size, although the understoreys in some localities have been aggressively attacked by narrow-leaved ash. These localities include river terraces on micro-elevations within reach of flood water Black alder occurs in parts of forests in which water remains for longer periods after controlled floods have been let in by water management authorities.

Forest of pedunculate oak and common hornbeam with beech
Šuma hrasta lužnjaka i običnoga graba s bukvom
(*Carpino betuli-Quercetum roboris fagetosum* Rauš 1971)

Research so far: Numerous scientists have studied the occurrence of beech in lowland regions ever since the last century. These include Šulek (1866), M. Anić (1942), Fukarek (1954, 1964), Petračić (1955), M. Anić (1966), Rauš (1969, 1975), and many others. Rauš (1971) described the forest of pedunculate oak and hornbeam with beech from a vegetational point as a subassociation with beech.

Distribution of the phytocoenosis: The forest of pedunculate oak and common hornbeam with beech grows in lowland regions of Croatia within a typical forest of pedunculate oak and common hornbeam. Rauš (1971) cites 22 localities in Croatia: three in Pokuplje, eleven in Posavina, six in Podravina, and two in Baranja. In Posavina, the most important areas are Žutica, Lipovljani and Spačva; in Podravina the most important area is Repeš; then the Česma basin, the Pokuplje forests and some regions in Baranja.

Site of the phytocoenosis: It develops exclusively on micro-elevations. The soil is drained but fresh, slightly acid to neutral, of a lowland pseudogley, therefore, similar to that of the association described above.

After examining the terrain, it can be stated that in the Management Unit "Žutica" the forest of pedunculate oak and common hornbeam with beech covers a very small area (slightly over 5 %). It grows on the highest micro-elevations and river terraces completely out of reach of floodwater, and at the highest altitudes in the unit. The majority of beeches are found in the region of Crna Humka (compartments 30, 31, 125, 116), then along the stream Draščina (compartments 104-47), in compartments 107, 112, 117, 118, 124, and in areas leading towards compartments 106-100 and 80-88. Fragments of the forest can also be found in various small areas. Such a sporadic arrangement of vegetation indicates that in the past the entire area was probably densely inhabited by beech, which has been slowly disappearing.

In general, beech occurs in stands either individually or in smaller groups. The trees are fairly thick, of good appearance, and high quality.

Floral composition and vegetational structure: The floral composition is shown in the synthetic Table 5, on the basis of 10 (no. 11-20) phytocoenological recordings from characteristic parts of the association. The recordings show a rich floral composition with 74 species in all, of which 48 participate at a rate of more than 20%. As seen from the Table, the forest of pedunculate oak and common hornbeam with beech *(Carpino betuli-Quercetum roboris fagetosum)* is distinguished by its characteristic floral composition. This forest is a very interesting object of research because its present floral composition and structure is a reflection of numerous secular climatic changes.

The tree layer, with very well developed main and subordinate storeys, covers 90 - 100 % of the area. Pedunculate oak (*Quercus robur*), common hornbeam (*Carpinus betulus*) and beech (*Fagus sylvatica*) are the most constant components. In the mixture with common hornbeam and beech, pedunculate oak grows as well as it does in the mixture with common hornbeam.

In a sociological sense, beech, which distinguishes this association from others in the studied area, is the most important species, followed by common hornbeam and pedunculate oak. In a diagnostic sense, beech and its companions also take up a primary position in the shrub and ground layer.

The shrub layer is not very well developed, and covers 1 - 15 % of the area, with the exception of Recording 10, where it covers 60 %. It is composed of common hornbeam (*Carpinus betulus*), cobnut (*Corylus avellana*), spindle tree (*Euonymus europaea*) and hawthorns (*Crataegus* sp.), as characteristic species of the alliance, order and class *Querco-Fagetea*, and butcher's broom (*Ruscus aculeatus*) and beech (*Fagus sylvatica*) as distinguishing species of the subassociation, together with a smaller number of some other species.

The ground vegetation layer covers 40 - 90 % of the area, with the exception of Recording 1, where it covers 20 %. Its composition is very different from that of a typical forest of pedunculate oak and common hornbeam. Rauš classified this association as a special subassociation on the basis of the following distinguishing species: *Mercurialis perennis, Dentaria bulbifera, Cardamine trifolia, Allium ursinum, Luzula pilosa, Maianthemum bifolium, Anemone hepatica, Ruscus aculeatus, Rubus hirtus, Staphylea pinnata, Crocus banaticus, Galanthus nivalis*, and others. Of these species, the following have been recorded: *Rubus hirtus, Fagus silvatica, Ruscus aculeatus, Luzula pilosa* and *Maianthemum bifolium. Crocus banaticus* and *Galanthus nivalis* are expected to be part of the layer in springtime.

Apart from the already mentioned distinguishing species in the subassociation, the ones most constantly present are also *Veronica montana, Carex brizoides* and *Rubus hirtus*, as well as *Stellaria holostea, Circaea lutetiana, Lamiastrum galeobdolon, Viola reichenbachiana, Galium odoratum, Polygonatum multiflorum, Ajuga reptans, Asarum europaeum*, and others as characteristic species of the alliance, order and class *Querco-Fagetea*.

Along with characteristic and distinguishing species of the class, order, alliance and association, this subassociation also has a large number of constant accompanying species, such as *Oxalis acetosella, Galeopsis tetrahit, Symphytum tuberosum*, and others.

When floral compositions in 10 recordings in the association's synthetic table were compared, it was not possible to establish any significant differences among them. The relatively rich floral compositions are dominated by elements of beech-oak forests (*Querco-Fagetea*). Recording 20 is the only exception, in that the shrub cover is larger and the ground vegetation cover smaller than in other recordings. This is attributed to a partial dieback of oak in this area in the past, which opened the stands and allowed the shrub layer to grow more lusciously as it received more light.

Stability of the phytocoenosis: In terms of forest dieback and stability, the condition in the association is satisfactory. It is thanks to its mixed character (oak, hornbeam, beech) that this association has an advantage over other, more uniform, associations.

By comparing this association's distribution in the old vegetation map (Medvedović 1975) and its present state in the new vegetation map, it can be concluded that the area under the association of pedunculate oak and common hornbeam with beech has expanded, which is certainly the result of natural succession. It can also be partly attributed to a more detailed differentiation of this association from a typical forest of pedunculate oak and common hornbeam.

The forest is regenerated naturally, and our task is to assist it in this direction.

Syndynamics of the phytocoenosis: By studying the climate in the Earth's past, as well as by analyzing pollen in the bogs on the edges of the Pannonian Plain and in central Hungarian mountains, R. Soo and his associates Zolyomi and Kintzler (1940) conclude that beech has been in the plains ever since the Sub-Boreal period (about 2,500 - 800 BC). This means that a mixed forest of pedunculate oak, common hornbeam and beech came into being during secular changes in the climate, and that it used to cover much larger areas in the Pannonian Plain.

Research into vegetational and syndynamic relationships in the forests of Spačva led Rauš (1975) to conclude that in lowland regions, beech has regenerated by self-fertilisation since the Sub-Boreal period. According to his findings, seeds in the past were gradually but constantly being brought into the area from nearby hills and mountains by streams, small rivers, animals, birds and people, which enabled the beech to regenerate continuously. The seeds coming from nearby hills and mountains and the seeds resulting from the fructification of beeches in the plain came into contact and mixed. Later, these two newly-formed populations (originating from the seeds of different provenance), cross-bred and created new, more resistant beech species capable of adapting to different site conditions. It is not surprising, therefore, that beech, being a species of wide ecological amplitude and plasticity, can even be found on the very edge of swamp regions, as is the case in "Žutica". Its hundreds of years of development have helped it to adapt to life conditions in lowland regions. This does not solve all the problems connected with beech and the evolution of vegetation in general. Further systematic-morphological, genetic, biological, ecological and phytocoenological research on the beech and its sites in lowland regions should be conducted in order to arrive at acceptable answers.

Just like the one described earlier, this association has also been affected by biotic (particularly anthropogenic) influences, which have played a significant role in its formation and present appearance.

FOREST OF PEDUNCULATE OAK AND GREAT GREEN WEED
ŠUMA HRASTA LUŽNJAKA I VELIKE ŽUTILOVKE
(*Genisto elatae-Quercetum roboris* Ht. 1938)

Research so far: Different aspects of this association were studied and described by J. Kozarac (1886, 1888), Bech-Mannagetta (1901), I. Horvat (1938, 1949, 1974), Glavač (1960, 1969), Rauš (1968, 1970-1995), and others. It was I. Horvat who set up the foundations of a comprehensive study of pedunculate oak in Posavina (1938). The soundness of his hypotheses is daily confirmed by research in these forests. A big contribution to the study of pedunculate oak forests was made by Glavač, M. Anić, and above all by Rauš.

Distribution of the phytocoenosis: The forest of pedunculate oak and great green weed, the world-renowned "Slavonian forest", covers large areas of lowland terrains. It is found in the valleys of the rivers Sava and Drava and their tributaries. The most valuable forests lie in the basins of the Spačva and the Česma.

This is the best-represented association in the Management Unit "Žutica", covering 30 - 40 % of the area. The largest complexes of this association are found in forest regions of Šumarak, Gospodice, partly Ravneš and Žalkovo, and along the Crna Humka - Carev Bok area. It is not present in swampy areas inhabited by ashes and alders, on micro-elevations in the central part, and along river terraces.

Site of the phytocoenosis: It develops above willows, poplars, black alders and narrow-leaved ashes. The terrain where it appears is several metres above the normal water level. It inhabits sites of flooded micro-depressions from which water, whose depth is about 1 m, retreats during the growing season. The terrain is either periodically covered with floods of short duration, or is outside the scope of floods but is still abundantly fresh. The soil is mineral-swampy, more or less acid, and pseudogley.

Floral composition and vegetational structure: This is the most valuable and best known forest association in Croatia, because its appearance, composition and value are the result of a mixture of diverse drier and more humid vegetational elements. At the transition from a micro-elevation to a micro-depression, common hornbeam and the majority of mesophyllic species of the *Fagetalia* order disappear, and hygrophyllic species of the *Populetalia albae* order, which can tolerate floods and higher groundwater levels, appear.

Table 6. - *Tablica 6.*

Association:		*GENISTO ELATAE-QUERCETUM ROBORIS* Ht. 1938			
Subassociation:		*carpinetosum betuli* Glav. 1961	*caricetosum brizoides* Ht. 1938	*caricetosum remotae* Ht. 1938	
Number of recordings:		10	10	10	
Area:		Žutica			
Plot size (m^2):		400	400	400	
		Degree of participation			Biological form
FLORAL COMPOSITION					
Characteristic species of association and alliance (*Alno-Quercion*):					
Quercus robur L.	A	V	V	V	Ph
Alnus glutinosa (L.) Gartn.		IV	V	II	Ph
Fraxinus angustifolia Vahl.		III	II	I	Ph
Ulmus carpinifolia Gled.		.	I	.	Ph
Ulmus carpinifolia Gled.	B	III	IV	III	Ph
Viburnum opulus L.		I	II	I	Ph
Acer tataricum L.		I	I	I	Ph
Sambucus nigra L.		I	I	I	Ph
Alnus glutinosa (L.) Gartn.		.	IV	III	Ph
Genista tinctoria subs. *elata*		.	I	II	Ph
Quercus robur L.		.	I	.	Ph
Quercus robur L.	C	IV	II	III	Ph
Rumex sanquineus L.		IV	III	III	H
Cerastium silvaticum W.K.		III	II	III	Ch
Lycopus europaeus L.		III	IV	III	H
Nephrodium spinulosum Strempel.		II	II	I	H
Impatiens noli tangere L.		III	II	I	Th
Lysimachia nummularia L.		III	III	IV	H
Angelica silvestris L.		II	II	I	H
Cardamine dentaria L.		I	I	I	H
Solanum dulcamara L.		.	III	II	H
Valeriana dioica L.		.	I	I	H
Viburnum opulus L.		I	.	.	Ph
Fraxinus angustifolia Vahl		.	.	I	Ph
Ulmus carpinifolia Gled.		.	.	I	Ph
Acer tataricum L.		.	.	I	Ph
Characteristic species of order (*Populetalia*) and class (*Alno-Populetea*):					
Ulmus laevis Pall.	B	I	.	II	Ph
Rubus ceasius L.		I	.	.	H
Rubus ceasius L.	C	IV	IV	V	H
Glechoma hederacea L.		IV	IV	IV	H

Distinguishing species for individual subassociations:					
Carpinus betulus L.	A	V	II	.	Ph
Acer campestre L.	B	V	III	II	Ph
Crataegus monogyna Jacq.		IV	II	I	Ph
Euonymus europaea L.		III	I	I	Ph
Veronica montana L.	C	IV	II		Ch
Viola reichenbachiana Jor. ex Bor.		IV	I	I	H
Scrophularia nodosa L.		III	.	I	H
Anemone nemorosa L.		II	.		G
Asarum europaeum L.		II	.		H
Ajuga reptans L.		IV	I	I	H
Carex maxima		III	.	.	H
Geum urbanum L.		IV	I	I	H
Oxalis acetosella L.		IV	.	.	H
Frangula alnus Mill.	B	II	V	III	Ph
Carex brizoides L.	C	III	V	.	H
Deshampsia caespitosa (L.) Beaur.		II	V	II	H
Dryopteris filix mas (L.) Sch.		III	IV	I	Th
Fraxinus angustifolia Vahl.	B	I	II	IV	Ph
Carex remota L.	C	IV	II	V	H
Carex strigosa Huds.		II	.	III	H
Leucoium aestivum L.		I	.	III	G
Iris pseudacorus L.		II	III	V	G
Ranunculus repens L.		II	II	IV	H
Lysimachia vulgaris L.		.	III	IV	H
Symphytum officinale L.		.	I	III	H
Carex elata All.		.	.	II	H
Caltha palustris L.		.	.	II	H
Euphorbia palustris L.		.	.	IV	H
Characteristic species of order (*Fagetalia*) and class (*Querco-Fagetea*):					
Acer campestre L.	A	I	I	.	Ph
Crataegus oxyacantha L.	B	IV	III	III	Ph
Prunus spinosa L.		II	II	I	Ph
Pyrus pyraster (L.) Borkh.		II	II	I	Ph
Carpinus betulus L.		IV	III	.	Ph
Corylus avellana L.		II	I	.	Ph
Circaea lutetiana L.	C	V	IV	II	G
Urtica dioica L.		IV	IV	V	H
Aegopodium podagraria L.		II	I	I	H
Humulus lupulus L.		I	II	I	H
Lamiastrum galeobdolon (L.) Ehr. et Pol		II	I	.	Ch
Brachypodium silvaticum (Huds.) R.S.		II	II	.	H
Paris quadrifolia L.		II	I	.	G
Galium odoratum (L.) Scop.		I	I	.	G
Geranium robertianum L.		I	I	.	Th
Stellaria holostea L.		I	I	.	H

Acer campestre L.		I	.	I	Ph
Primula sp.		I	.	.	
Chrysosplenium alternifolium L.		I	.	.	H
Polygonatum multiflorum (L.) All.		I	.	.	G
Ranunculus ficaria L.		I	.	.	G
Vinca minor L.		I	.	.	Ch
Crataegus oxyacantha L.		I	.	.	Ph
Carpinus betulus L.		I	.	.	Ph
Ranunculus lanuginosus L.		I	.	.	H
Sanicula europaea L.		I	.	.	H
Carex silvatica Huds.		.	I	.	H
Arum maculatum L.		.	I	.	G
Other species of wet and flooded sites:					
Salix cinerea L.	B	.	I	I	Ph
Polygonum hydropiper L.	C	IV	IV	III	Th
Myosotis scorpioides L.		III	IV	III	H
Galium palustre L.		III	IV	V	H
Poa palustris L.		II	I	I	H
Peucedanum palustre (L.) Monch.		II	III	III	H
Juncus effusus L.		I	III	III	H
Senecio fluviatilis Wallr.		I	II	I	H
Festuca gigantea (L.) Vill.		I	I	I	H
Lytrum salicaria L.		I	III	II	H
Stachys palustris L.		.	II	III	H
Succisa pratensis Mch.		.	I	I	H
Carex elongata L.		.	II	III	H
Alisma plantago aquiatica L.		.	I	.	H
Frangula alnus Mill.		.	I	.	Ph
Carex riparia Curt.		.	.	I	H
Carex vulpina L.		.	.	I	H
Carex vesicaria L.		.	.	I	H
Roripa amphibia (L.) Bess.		.	.	I	
Mentha aquatica L.		.	.	I	H
Thalictrum sp.		.	.	I	
Stellaria aquiatica		.	.	I	H
Other plants:					
Populus euroamericana	A	I	.	.	Ph
Fraxinus americana		I	.	.	Ph
Rhamnus cathartica L.	B	III	I	III	Ph
Cornus sanquinea L.		.	I	I	Ph
Rosa canina L.		.	I	I	Ph
Fraxinus americana		I	.	.	Ph
Galeopsis tetrahit L.	C	IV	V	III	
Hedera helix L.		II	I	I	Ph
Athyrium filix femina (L.) Roth.		III	III	I	H

Prunella vulgaris L.	I	I	I	H
Pulmonaria officinalis L.	I	I	I	H
Aristolochia clematitis L.	.	I	I	H
Hypericum acutum L.	.	II	I	H
Lychnis flos cuculi L.	.	I	I	H
Bidens tripartitus L.	.	I	I	Th
Agrostis alba L.	.	I	I	H
Stellaria media (L.) Mill.	I	.	II	Ch
Galium aparine L.	II	I	.	H
Ballota nigra L.	I	I	.	
Eupatorium cannabinum L.	I	I	.	H
Moehringia trinervia (L.) Clairv.	I	.	.	
Symphytum tuberosum L.	I	.	.	G
Rhamnus cathartica L.	I	.	.	Ph
Veronica chamaedrys L.	I	.	.	H
Torilis anthriscus (L.) Gmel.	.	I	.	
Galium silvaticum L.	.	I	.	H
Amorpha fruticosa L.	.	.	I	Ph
Solidago sp.	.	.	I	H
Melandrium rubrum Garcke.	.	.	I	H
Tamus communis L.	.	.	I	G

Explantation of abbreviations:
A - Tree layer
B - Shrub layer
C - Ground vegetation layer

Biological range: The biological range of life forms was based on 30 phytocoenological recordings (Table 6). Its structure is as follows: phanorephytes (Ph) 33%, chamaeophytes (Ch) 4%, hemicryptophytes (H) 52%, geophytes (G) 7%, and therophytes (Th) 4%. It can be concluded from the above that it is a hemicrypto-phanerophytic (52 + 33 %) association, with a small participation of geophytes (7%).

Due to a large participation of hemicryptophytes, this association belongs to the Central European region and shows its resistence to winter colds. A considerable share of phanerophytes indicates very warm summers.

Structure of the phytocoenosis: As already said, the basic postulates on vegetational and syndynamic relationships in lowland forests were established by I. Horvat (1963). He wrote: "The Slavonian forest can be divided into three subassociations: *Genisto-Quercetum caricetosum brizoides* Horv., *Genisto-Quercetum caricetosum remotae* Horv., and *Genisto-Quercetum carpinetosum betuli* Glav. The first association contains some acidophyllic species, and is therefore rich in black alders. The Slavonian forest achieves its vegetational-sociological optimum in the second association, while the third one is terminal, that is, a transition towards the

Fagetalia order, which develops as soon as the levels of groundwater or floodwater drop."

M. Anić (1959) and Rauš (1969, 1975) exclude the subassociation *Genisto elatae-Quercetum roboris carpinetosum betuli* from the *Populetalia albae* order, raise it to the rank of an association, divide it into subassociations and place it into the *Fagetalia* order. However, this author has established the subassociation *carpinetum betuli* in the sense in which Glavač described it (1961).

In the current research in the studied area, the following three subassociations were found:

Genisto elatae-Quercetum roboris caricetosum brizoides Ht. 1938

Genisto elatae-Quercetum roboris caricetosum remotae Ht. 1938

Genisto elatae-Quercetum roboris caricetosum betuli Glav. 1961

The fourth subassociation, *Genisto elatae-Quercetum roboris aceretosum tatarici* Rauš 1971 (Forest of pedunculate oak and great green weed with arrow wood), is very interesting and important. However, it is connected to eastern Slavonia and Baranja, and is not the subject of this research.

Syndynamics of the phytocoenosis: The forest of pedunculate oak and great green weed is one step below the forest of pedunculate oak and common hornbeam in the vegetation chain. With a gradual decrease in humidity, this association naturally passes into the latter terminal association. In addition, in the vegetation chain, this association is above the forest of narrow-leaved ash and black alder, which inhabit lower, more humid terrains in which pedunculate oak cannot survive.

Stability of the phytocoenosis: The research carried out in the regions afflicted by large-scale dieback of lowland forests (Kalje, Turopoljski Lug, Pokuplje basin), the data on forest dieback in the Management Unit "Žutica", and the existing condition in the field show that it is precisely this association that has undergone, and is still undergoing, the biggest changes in lowland forest habitats and the most serious dieback of pedunculate oak. Therefore, this association is unfortunately the best indicator of how endangered the forest "Žutica" is. It is in this forest that the worst defoliation, the strongest fungi attacks, and the largest pedunculate oak dieback have been recorded. In the last few decades, anthropogenic activities causing a drop in groundwater levels and an increase in floods have had the most serious impact on the pedunculate oak, which has dramatically changed the typical appearance of this association.

Forest-economic importance: The Management Unit "Žutica", and the whole of Posavina, offer very favourable natural conditions for the growth of these forests. Only man and his harmful actions can cause problems.

As mentioned earlier, the Zagreb School of Forestry stresses the importance of natural regeneration for all forests, and particularly for the forest of pedunculate oak. Natural regeneration is done with the shelterwood method over a rotation period of at least 140 years. Natural regeneration and proper tending activities have resulted in the world-renowned quality of Slavonian oak, relative stability, biological diversity and a preserved genofund. Therefore, everything that relates to a forest of pedunculate oak and common hornbeam also relates to this forest, with some added features. According to Dekanić (1961), shelterwood fellings in pedunculate oak stands growing in micro-depressions (pedunculate oak and great green weed) should favour the regeneration of pedunculate oak, as it is the weakest species in a silvicultural sense. Shelterwood fellings should be carried out in two cuts: a seeding cut and a final one.

Silvicultural and other forest operations should take into account the changes and dieback occurring in the site and the association. Forest experts should adapt their activities to the existing state and deal with each problem in a multidisciplinary manner. This point will be dealt with in more detail in the chapter Discussion.

Forest of pedunculate oak and great green weed with common hornbeam
Šuma hrasta lužnjaka i velike žutilovke s običnim grabom
(Genisto elatae-Quercetum roboris carpinetosum betuli
/Ht. 1938/ Glav. 1961)

Research so far: The most comprehensive research into this subassociation was carried out by V. Glavač (1961). Following the work by J. Kozarac, I. Horvat and other authors, Glavač concluded that forests of pedunculate oak and common hornbeam differ in an ecological, floral, and forest-economic sense, despite their uniform appearance and structure. For this reason, they are divided into two phytocoenoses. One of these phytocoenoses, occurring on elevated and unflooded positions (micro-elevations), was described by Horvat (1938) under the name *Querceto-Carpinetum croaticum* subas. *ruscetosum acuti*. The other, growing in more humid positions, was described for the first time by Glavač (1961) under the name *Querceto-Genistetum elatae* subas. *carpinetosum betuli*, or "humid type of pedunculate oak and common hornbeam forest". Today, the first phytocoenosis represents the forest of pedunculate oak and common hornbeam (*Carpino betuli-Quercetum roboris* Anić 1959), while the second, due to its floral composition and specific developmental conditions, represents the driest variant of the subassociation of pedunculate oak and great green weed *(Genisto elatae-Quercetum roboris carpinetosum betuli* Glav. 1961). In the course of this research, the specific features of the subassociation mentioned by Glavač were also noticed, as well as the specific site conditions, which are reflected in the floral composition. These forest sites can be called "humid micro-elevations".

Distribution of the phytocoenosis: According to Glavač, this phytocoenosis is distributed over large areas in lowland Posavina and Podravina. It sometimes covers large areas in continuous, unbroken units, and sometimes occurs sporadically between dry, non-flooded micro-elevations and swampy, flood-affected areas.

Site of the phytocoenosis: Forests of pedunculate oak and great green weed with hornbeam grow both within and outside flood zones. Those within the flood zone relate to drained areas, which are flooded for short periods. The latter involve much larger areas over flat or slightly raised humid micro-elevations, the so-called humid micro-elevations.

The soils are wet variants of pseudogley in transition towards mineral-swampy soils. In terms of texture, they are clays and loams. The soil permeability is mostly poor. The surface horizons are usually acid, and the supply of nutrients is satisfactory.

This subasscociation, which grows in a mosaic-like pattern over only about 5% of the area in "Žutica", is provided with all the necessary and specific life conditions by the above factors.

Floral composition and vegetational structure: 10 phytocoenological recordings in Table 7 show a very rich and diverse floral composition. I have registered 90 species in all, of which 54 participate at a rate of over 20% in the subassociation.

Its floral composition distinguishes this association from both forests of pedunculate oak and common hornbeam and typical forests of pedunculate oak and great green weed. The tree layer of the former is made up almost exclusively of pedunculate oaks and common hornbeams without any narrow-leaved ashes and black alders, while that of the latter consists almost exclusively of pedunculate oaks, a small percentage of narrow-leaved ashes and black alders, and very few hornbeams. On the other hand, the association in question is characterized by the dominance of pedunculate oaks and hornbeams, and a considerable presence of narrow-leaved ashes, lowland elms, spreading elms and black alders. There are also maples, wild pears and other species. The vitality of trees in the upper storey is very high, but that of hornbeams is low due to excessive humidity. Although the number of hornbeams is high, they lack the dimensions, competitiveness, vitality and generative capability that they have on typical micro-elevations. Their roots are shallow, and the root collars have distinctive root branches above the ground, which is linked to site conditions.

Although the tree layer is sometimes dominated by narrow-leaved ash, on the whole the stand displays its mixed character. The tree cover differs from recording to recording, and ranges between 50 - 90%.

The shrub layer coverage ranges from very low 1% to very high 80%, and points to certain influences on the association which should be studied and described in more detail. It is important to point out that, according to Glavač's description of the association, the shrub layer covers 1 - 3% of the area. A somewhat higher participation of lowland elm (*Ulmus carpinifolia*) and dogwood (*Frangula alnus*) is characteristic of the association and alliance *Alno-Quercion* and the order *Populetalia.* However, the participation of distinguishing species and those of the *Fagetalia* order and *Querco-Fagetea* class is much higher. These include maple (*Acer campestre*), common hornbeam (*Carpinus betulus*), hawthorns (*Crataegus monogyna* and *C. oxyacantha*) and hazel (*Corylus avellana*). The best represented accompanying species is buckthorn (*Rhamnus cathartica).*

The layer of ground vegètation is made up of numerous different species. The average cover is 50 - 100%. Hygrophytes and mesophytes inhabit very small areas in a mosaic-like pattern. *Carex brizoides* and *Carex remota* alternately dominate the layer.

Table 7 shows that this forest type consists of three sociologically and ecologically different groups. The first includes a total of 24 characteristic species of the association of the pedunculate oak floodplain forest (*Genisto elatae-Quercetum roboris*), the alliance of the alder and pedunculate oak forest (*Alno-Quercion roboris* Horv.). and the order of *Populetalia* Br.-Bl. The most numerous are: *Quercus robur, Alnus glutinosa, Fraxinus angustifolia, Ulmus carpinifolia, Carex remota, Glechoma hederacea, Rumex sanquineus, Rubus caesius, Cerastium silvaticum, Lysimachia nummularia, Carex brizoides,* etc. As Glavač claimed that these species had very important phytocoenological significance, he added this forest type to the floodplain forest of pedunculate oak.

The second group consists of distinguishing species of the subassociation and species of the *Querco-Fagetea class.* These species outnumber those of the *Populetalia* order (15 in all). However, the frequency and cover of individual species is much lower. The importance of the group does not lie in the sociological importance of its individual members, but in its characteristic composition. The most important phytocoenological characteristic of the studied type is the relatively high number of types of vegetation. The species that differentiate this subassociation from other subassociations of floodplain forests of pedunculate oak are: *Carpinus betulus, Acer campestre, Euonymus europaea, Veronica montana, Viola reichenbachiana, Scrophularia nodosa, Ajuga reptans, Carex maxima, Polygonatum multiflorum, Lamiastrum galeobdolon, Anemone nemorosa,* and others.

The third group consists of accompanying species, which are mostly found in humid and swampy meadows and forests. These species are: *Polygonum hydropiper, Myosotis scorpioides, Galium palustre, Iris pseudacorus, Ranunculus repens,* and others. The ecological importance of this group testifies to its affiliation to the floodplain forest of pedunculate oak.

As the floral composition is very diverse, each recording should be described in more detail. Recording no. 1 is characterised in the following way: hornbeam is distributed over the whole compartment, and pedunculate oak has declined and has been replaced by Euro-American poplar and American ash. Now poplar is dying, while American ash is almost completely desiccated, which has allowed shrubs to cover large areas. Recording no. 2 shows a similar situation: the EA poplar was introduced in 1968 after the pedunculate oak dieback. Currently, narrow-leaved ash and black alder are penetrating the area. The well-developed shrub layer is dominated by dogwood and spreading elm. The situations in recordings 3, 4, and 5 also show the effects of pedunculate oak dieback, which has degraded typical micro-elevation sites. Currently, the species on micro-elevations are complemented with black alders (recordings no. 3 and 4), and narrow-leaved ashes (recording 5), and a large number of species favouring more humid sites (*Carex brizoides, Carex remota, Glechoma hederacea, Lysimachia nummularia, Polygonum hydropiper, Rumex sanguineus*). Species such as *Deshampsia caespitosa, Rubus cae-*

sius and *Juncus effusus* show a certain degree of site degradation. On the other hand, Recording 6 shows the situation along the river Česma, where the terrain has been gradually elevated by river depositions. Former forests of narrow-leaved ash have been replaced by forests of pedunculate oak and common hornbeam growing at the highest points immediately along the river. The recording shows the forest of pedunculate oak and great green weed with common hornbeam on a slightly lower terrain. Previous research and recordings 7 and 8 show that the site is in progression with a tendency towards a drier site. Recording 7 shows a transition from the subassociation *caricetosum* brizoides to that of *carpinetosum betuli*, while Recording 8 shows a progression from *caricetosum remotae* to *carpinetosum betuli*. In Recording 7 there is still a considerable participation of species of more humid sites, while a characteristic of Recording 8 is well-sized ashes but no ash seedlings or saplings, and good-quality hornbeams and oaks. Mesophyllic and hygrophyllic elements are approximately equal in number. Recording 10 is characterised by a very large cover of quaking sedge (*Carex brizoides)*, which makes it difficult to determine whether this recording belongs to the subassociation with quaking sedge or to that with common hornbeam. This is a general problem with a whole series of similar associations in the studied area. In this case, a large participation of mesophyllic elements from the class *Querco-Fagetea (Corylus avellana, Veronica montana, Galeobdolon luteum, Asarum europaeum, Brachypodium silvaticum, Scrophularia nodosa, Aegopodium podagraria)* indicates a humid micro-elevation.

Syndynamics of the phytocoenosis: As humidity decreases, this subassociation continues the hygrophytic subassociations of the floodplain forests of pedunculate oak (*Genisto elatae-Quercetum roboris caricetosum remotae* and *caricetosum brizoides*). By comparing the map of forest communities in "Žutica" (Medvedović 1975), in which this association was not singled out, and the research of this author from 1997, it can be concluded that the site and vegetation progression from the subassociation *caricetosum brizoides* to that of *carpinetosum betuli* has taken place in compartments 118a and 162c, and from *caricetosum remotae* into *carpinetosum betuli* in compartments 63a, 65a, 154a and 155b. Therefore, this is the driest subassociation of the forest of pedunculate oak and great green weed. As humidity continues to decrease, it is transformed into a dry type of pedunculate oak and common hornbeam forest (*Carpino betuli-Quercetum roboris*), which is characterized by a complete absence of species in the *Querco-Fagetea* class. However, regression processes resulting from plant dieback and terrain waterlogging are also taking place here, so that a typical micro-elevation is being transformed into a humid one (compartments 107a, 113b, 119b, 126d, 129a, etc.). This confirms the observations made on the condition in the recordings described above.

In nature there are no sharp boundaries between these types, so it is sometimes difficult to decide to what association a certain subassociation belongs.

This, and the state shown in the recordings, point to the conclusion that the subassociation in the area of "Žutica" is not of a stable character, but is the result of dieback and consequent changes in the site rather than of natural succession.

Table 7. - *Tablica 7.*

Association:		*GENISTO ELATAE-QUERCETUM ROBORIS* Ht. 1938										
Subassociation:		*carpinetosum betuli* Glav. 1961										Degree of part.
Number of recording:		1	2	3	4	5	6	7	8	9	10	
Area:		Žutica										
Department, compartment:		90b	34b	155b	119b	146a	196b	161c	62a	166b	78a	
Plot size (m^2):		400	400	400	400	400	400	400	400	400	400	
Date:		3.6.97.	2.7.97.	24.6.97.	27.6.97.	24.6.97.	6.6.97.	19.6.97.	4.9.97.	19.6.97.	24.9.97.	
Cover (%):												
Tree layer		70	80	50	90	50	90	90	90	90	70	
Shrub layer		70	80	5	1	40	50	5	20	50	30	
Ground vegetation layer		90	90	90	100	100	60	90	50	50	100	
FLORAL COMPOSITON												
Characteristic species of association and alliance (*Alno-Quercion*):												
Quercus robur L.	A	3	3	1	4	3	4	3	4	4	4	V
Alnus glutinosa (L.) Gartn.		1	1	2	1	.	.	2	.	1	2	IV
Fraxinus angustifolia Vahl		2	1	.	.	2	1	.	3	1	.	III
Ulmus carpinifolia Gled.	B	+	.	.	.	+	+	.	+	1	.	III
Viburnum opulus L.		.	+	.	.	.	+	.	.	.	.	I
Fraxinus angustifolia Vahl		.	.	.	.	.	.	.	.	3	+	I
Acer tataricum L.		.	.	+	.	.	.	+	.	.	.	I
Sambucus nigra L.		.	.	.	.	.	.	+	.	.	.	I
Quercus robur L.	C	+	.	.	1	+	+	1	+	2	+	IV
Carex remota L.		+	.	.	4	3	+	2	1	3	.	IV
Rumex sanquineus L.		+	+	+	+	1	+	.	.	1	.	IV
Carex brizoides L.		2	3	4	1	.	.	4	.	.	4	III
Impatiens noli tangere L.		+	.	.	3	1	2	3	.	.	.	III
Cerastium silvaticum W.K.		.	.	.	+	+	+	.	+	1	.	III
Lysimachia nummularia L.		.	.	+	1	2	.	2	+	1	.	III
Lycopus europaeus L.		+	+	+	1	+	.	.	.	.	.	III

Nephrodium spinulosum Strempel.		+	.	+	.	+	.	+	.	.	.	II
Carex strigosa Huds.		.	.	.	+	.	.	1	+	2	.	II
Angelica silvestris L.		.	.	+	.	+	.	.	.	.	1	II
Cardamine dentaria L.		+	.	.	.	.	+	.	.	.	.	I
Viburnum opulus L.		.	.	.	.	.	.	+	.	+	.	I
Leucoium aestivum L.		.	.	.	.	.	.	.	.	+	.	I
Characteristic species of order (*Populetalia*) and class (*Alno-Populetea*):												
Frangula alnus Mill.	B	.	3	1	.	1	.	+	.	.	.	II
Ulmus laevis Pall.		.	2	.	.	.	.	.	.	.	.	I
Rubus ceasius L.		.	.	.	.	.	+	.	.	.	.	I
Rubus ceasius L.	C	+	+	2	+	+	.	2	1	.	3	IV
Glechoma hederacea L.		1	.	3	1	2	+	3	+	3	.	IV
Distinguishing species and class species (*Querco-Fagetea*):												
Carpinus betulus L.	A	1	2	3	3	2	2	2	2	3	1	V
Acer campestre L.		1	.	.	.	.	+	.	.	.	.	I
Acer campestre L.	B	+	+	+	+	+	1	+	1	+	1	V
Carpinus betulus L.		1	.	+	+	2	+	1	1	2	.	IV
Crataegus monogyna Jacq.		+	+	+	.	1	+	+	1	.	.	IV
Crataegus oxyacantha L.		+	+	+	+	+	+	.	.	+	.	IV
Euonymus europaea L.		.	+	.	.	+	+	.	+	.	+	III
Corylus avellana L.		4	.	.	.	.	.	.	1	.	3	II
Prunus spinosa L.		+	1	.	.	+	.	.	.	.	.	II
Pyrus pyraster (L.) Borkh.		.	1	.	+	.	.	.	.	+	.	II
Circaea lutetiana L.	C	+	1	1	+	+	+	2	1	1	+	V
Veronica montana L.		+	.	.	1	+	1	.	1	+	2	IV
Viola reichenbachiana Jor. ex Boreu.		+	.	+	1	+	+	.	1	+	.	IV
Ajuga reptans L.		1	+	1	2	+	+	1	.	1	.	IV
Urtica dioica L.		.	3	+	.	+	+	.	3	+	1	IV
Scrophularia nodosa L.		+	.	+	+	+	.	.	+	.	+	III
Dryopteris filix mas (L.) Sch.		+	+	1	.	.	.	+	.	1	.	III
Carex maxima		+	4	.	.	+	+	.	.	1	.	III

Lamiastrum galeobdolon (L.) Ehr. et Pol.	3	+	.	.	.	+	.	.	.	3	II
Brachypodium silvaticum (Huds.) R.S.	+	.	.	.	.	.	.	.	1	2	II
Anemone nemorosa L.	+	+	.	.	.	1	.	.	.	.	II
Asarum europaeum L.	1	2	.	.	.	.	.	.	.	1	II
Paris quadrifolia L.	+	+	.	.	.	.	.	+	.	.	II
Aegopodium podagraria L.	.	.	+	.	.	.	.	3	.	1	II
Galium odoratum L.	1	.	.	1	.	.	.	.	.	.	I
Primula sp.	.	.	.	.	.	+	.	1	.	.	I
Acer campestre L.	.	.	.	.	.	.	+	.	+	.	I
Stellaria holostea L.	1	.	.	.	.	.	.	.	.	1	I
Sanicula europaea L.	.	.	.	.	+	.	.	.	.	.	I
Chrysosplenium alternifolium L.	+	.	.	.	.	.	.	.	.	.	I
Polygonatum multiflorum (L.) All.	+	.	.	.	.	.	.	.	.	.	I
Ranunculus ficaria L.	+	.	.	.	.	.	.	.	.	.	I
Vinca minor L.	.	.	.	.	.	+	.	.	.	.	I
Crataegus oxyacantha L.	.	.	.	.	.	.	.	.	+	.	I
Humulus lupulus L.	.	.	+	.	.	.	.	.	.	.	I
Geranium robertianum L.	.	2	.	.	.	.	.	.	.	.	I
Carpinus betulus L.	.	.	.	1	.	.	.	.	.	.	I
Ranunculus lanuginosus L.	.	+	.	.	.	.	.	.	.	.	I
Species of wet and flooded sites:											
Polygonum hydropiper L. C	.	.	2	+	2	.	1	+	+	+	IV
Myosotis scorpioides L.	.	+	+	1	+	.	+	.	1	.	III
Galium palustre L.	.	1	+	+	+	.	1	.	.	.	III
Iris pseudacorus L.	+	+	.	.	+	.	.	.	+	+	II
Ranunculus repens L.	+	.	+	.	+	.	.	+	.	.	II
Deshampsia caespitosa (L.) Beaur.	+	.	2	.	3	.	.	.	.	.	II
Poa palustris L.	.	.	+	.	+	.	1	.	.	.	II
Peucedanum palustre (L.) Monch.	.	+	.	+	+	.	.	.	.	.	II
Lytrum salicaria L.	.	.	+	.	+	.	.	.	.	.	I
Juncus effusus L.	.	.	+	.	1	.	.	.	.	.	I
Senecio fluviatilis Wallr.	.	+	+	.	.	.	.	.	.	.	I

Festuca gigantea (L.) Vill.		+	.	.	.	.	.	.	.	.	.	I
Other species:												
Populus euroamericana	A	1	.	.	.	.	.	.	.	.	.	I
Fraxinus americana		+	.	.	.	.	.	.	.	.	.	I
Rhamnus cathartica L.	B	.	1	.	.	+	2	.	1	+	.	III
Fraxinus americana		+	.	.	.	.	.	.	.	.	.	I
Galeopsis tetrahit L.	C	+	+	1	+	+	+	.	+	1	.	IV
Oxalis acetosella L.		+	+	1	2	+	.	3	.	.	1	IV
Athyrium filix femina (L.) Roth.		+	+	.	.	.	+	1	.	.	+	III
Galium aparine L.		2	.	.	.	.	1	.	.	.	+	II
Hedera helix L.		.	.	.	.	.	+	.	1	.	+	II
Moehringia trinervia (L.) Clairv.		.	.	+	.	.	+	.	.	.	.	I
Symphytum tuberosum L.		1	.	.	.	.	.	.	.	.	.	I
Prunella vulgaris L.		.	.	.	.	.	+	.	.	.	.	I
Rhamnus cathartica L.		.	.	.	.	.	.	.	.	+	.	I
Ballota nigra L.		.	.	1	.	.	.	.	.	.	.	I
Veronica chamaedrys L.		.	.	+	.	.	.	.	.	.	.	I
Stellaria media (L.) Mill.		.	.	.	+	.	.	.	.	.	.	I
Pulmonaria officinalis L.		.	1	.	.	.	.	.	.	.	.	I
Eupatorium cannnabinum L.		.	+	.	.	.	.	.	.	.	.	I

Exenplation of abbreviations:
A - Tree layer
B - Shrub layer
C - Ground vegetation layer

+, 1, 2, 3, 4, 5 - Combined assessment of abundance and cover (Braun-Blanquet 1964)

Stability of the phytocoenosis: Vukelić and Rauš (1993) wrote about the association of pedunculate oak and great green weed with common hornbeam in Turopoljski Lug: "In points in which the subassociation borders with other die-back-affected associations, individual trees and even small groups of trees growing on the borderline, are not spared. They are also declining." According to the current observations in the Management Unit of "Žutica", the association is fairly loose and dynamic, despite its mixed composition, which is the result of constant changes in site conditions.

Forest of pedunculate oak and great green weed with quaking sedge
Šuma hrasta lužnjaka i velike žutilovke s drhtavim šašem
(*Genisto elatae-Quercetum roboris caricetosum brizoides* Ht. 1938)

Research so far: The subassociation, first described by I. Horvat in 1938, was found in the area of Draganički and Šašinovečki Lug. Various other localities of these forests were studied by a number of other researchers.

Distribution of the phytocoenosis: The subassociation is distributed in western regions of the Croatian lowlands (the Pokuplje basin, Česma, Žutica, Lipovljani, and others). Research into the lowland forests of Croatia, especially by Rauš, showed that, going eastwards, this subassociation gradually recedes and completely disappears before Slavonski Brod.

Site of the phytocoenosis: This subassociation occurs in a slightly higher region of micro-elevations and on a transition towards the forest of pedunculate oak and hornbeam. Groundwater levels are lower here, and flooding with surface water, if it takes place, is shorter than in the subassociation with remote sedge (caricetosum remotae). The soils are slightly more acid pseudogleys and mineral-swampy compact clays and loams.

In the area under study, the subassociation occurs most frequently along micro-elevations in the central part, and covers about 10% of the total area of the Management Unit.

Floral composition and vegetational structure: Phytocoenological features of the subassociation Genisto elatae-Quercetum roboris caricetosum brizoides are shown in 10 of the most characteristic recordings in Table 8. A total of 88 species are mentioned, of which 50 participate at a rate of over 20 % in the area.

The tree layer, with a 60 - 90% coverage, is dominated by pedunculate oak with additions of black alder, narrow-leaved ash, and lowland elm, which are characteristic species of the *Alno-Quercion* association and alliance, and common hornbeam and wild pear as the species of the *Fagetalia* order and *Querco-Fagetea* class. The percentage of black alder in the composition is particularly large in coupes and young stands.

The shrub layer is rich in species and covers a large range: from 5% to 60%. It is composed mainly of *Alnus glutinosa*, *Ulmus carpinifolia*, *Fraxinus angustifolia*, *Genista tinctoria* ssp. *elata* and *Viburnum opulus* as characteristic species of the

Alno-Quercion association and alliance, *Frangula alnus* as a characteristic species of the *Populetalia* order and *Alno-Populetalia* class, and *Crataegus oxyacantha* and *Crataegus monogyna*, *Acer campestre*, *Carpinus betulus* and *Prunus spinosa* as characteristic species of the *Fagetalia* order and *Querco-Fagetea* class.

The ground vegetation covers 80 - 100% of the area, except in Recording 6, where it covers 50%. It is especially luscious in the spring and early summer, when the forest is abundantly humid. The humidity factor is reflected in the whole constitution of the association. The ground layer is dominated by *Carex brizoides*, *Deschampsia caespitosa* and *Dryopteris filix* mas as distinguishing species of the subassociation, and *Lycopus europaeus*, *Solanum dulcamara*, *Rumex sanquineus*, *Lysimachia nummularia* and *Nephrodium spinulosum* as characteristic species of the association and alliance *Alno-Quercion*. Of charácteristic species belonging to the order *Populetalia* and the class *Alno-Populetalia*, especially prominent are *Rubus caesius* and *Glechoma hederacea*, of those characterising the *Fagetalia* order and *Querco-Fagetea* class there are *Circaea lutetiana* and *Urtica dioica*, while the accompanying species are *Myosotis scorpioides*, *Galium palustre*, *Geleopsis tetrahit*, *Polygonatum hydropiper*, *Juncus effusus*, *Iris pseudacorus*, *Lysimachia vulgaris* and *Peucedanum palustre*.

A significant presence of acidophyllic elements (*Carex brizoides*, *Deschampsia caespitosa*, *Polytrichum attenuatum* in the moss layer and others) indicates that the subassociation grows on somewhat more acid soils, because these elements do not occur in other typical subassociations of the Slavonian forest. In some places, quaking sedge covers up to 100% of the area, which is a typical feature of this subassociation.

As the recordings show a large variety of plant species, a detailed analysis has been made of each. The recordings, particularly Recording 9, show typical features of this association. In all recordings, except in No. 10, there is a significantly larger participation of black alder and doogwood, as well as of species favouring fresher sites. This is particularly true of Recording 4, which shows the following species: *Lycopus europaeus*, *Polygonum palustre*, *Ranunculus repens*, *Juncus effusus*, *Lysimachia nummularia*, *Peucedanum palustre*, *Myosotis scorpioides*, *Carex remota*, *Poa palustris*, and *Lytrum salicaria*. This is a transition between the subassociation in question and the subassociation with remote sedge (*caricetosum remotae*). On the other hand, the already mentioned Recording 10 is a slightly drier variant, and represents a transition towards the subassociation with common hornbeam (carpinetosum betuli), which is evident by a large quantity of narrow-leaved ashes, common hornbeams and hazels in the tree and shrub layers, and hygrophyllic and mesophyllic elements in the ground vegetation.

It is important to note that these recordings show not only a typical subassociation of *caricetosum brizoides*, but also a non-typical one in a number of compartments, as well as transitions between these two associations. This is largely due to changes in the site and the dieback of pedunculate oak. These compartments and changes will be described in the sub-chapter Stability of the phytocoenosis.

Table 8. - *Tablica 8.*

Association:		*GENISTO ELATAE-QUERCETUM ROBORIS* Ht. 1938									
Subassociation:		*caricetosum brizoides* Ht. 1938									Degree of part.
Number of recording:		1	2	3	4	5	6	7	8	9	10	
Area:		Žutica									
Department, compartment:		144a	127a	161d	168a	145a	125e	32a	44a	115a	41d	
Plot size (m^2):		400	400	400	400	400	400	400	400	400	400	
Date:		3.6.97.	3.6.97.	19.6.97.	19.6.97.	24.6.97.	26.6.97.	2.7.97.	26.8.97.	27.8.97	11.9.97	
Cover (%):												
Tree layer		70	80	70	80	60	80	60	70	70	90	
Shrub layer		30	30	40	20	5	60	40	50	10	60	
Ground vegetation layer		100	100	100	100	100	50	100	80	100	95	
FLORAL COMPOSITON												
Characteristic species of the association and alliance (*Alno-Quercion*):												
Quercus robur L.	A	3	4	4	4	4	4	4	4	4	4	V
Alnus glutinosa (L.) Gartn.		2	3	+	3	2	2	.	+	1	+	V
Fraxinus angustifolia Vahl		.	.	+	+	.	+	.	.	.	2	II
Ulmus carpinifolia Gled.		+	.	.	.	.	.	.	.	.	1	I
Alnus glutinosa (L.) Gartn.	B	+	1	1	2	.	2	2	2	.	.	IV
Ulmus carpinifolia Gled.		+	.	1	+	.	+	1	+	.	1	IV
Fraxinus angustifolia Vahl.		.	.	+	.	.	+	.	1	.	+	II
Viburnum opulus L.		.	.	.	.	.	+	+	.	.	+	II
Genista tinctoria ssp. *elata* Wend.		.	.	.	.	.	.	+	+	.	.	I
Sambucus nigra L.		.	.	+	.	.	.	.	.	.	.	I
Quercus robur L.		.	.	.	.	.	.	.	+	.	.	I
Acer tataricum L.		.	.	.	.	+	.	.	.	.	.	I
Lycopus europaeus L.	C	.	+	.	2	1	2	+	2	.	+	IV
Solanum dulcamara L.		.	+	+	.	.	2	.	+	+	.	III
Rumex sanquineus L.		.	.	+	+	+	.	+	+	+	.	III
Lysimachia nummularia L.		.	+	.	2	+	.	.	.	1	2	III

Nephrodium spinulosum Strempel.		1	1	.	.	1	.	.	.	+	.	II
Impatiens noli tangere L.		.	2	2	1	2	.	.	.	.	.	II
Quercus robur L.		.	+	.	.	.	.	.	3	.	+	II
Carex remota L.		.	.	.	2	.	.	.	+	.	1	II
Angelica silvestris L.		.	.	.	2	.	.	1	.	.	+	II
Cerastium silvaticum W.K.		.	.	.	.	+	.	+	+	.	.	II
Valeriana dioica L.		.	.	.	.	.	.	.	2	1	.	I
Cardamine dentaria L.		.	.	.	.	.	+	.	.	.	.	I
Characteristic species of the order and class (*Alno-Populetea*):												
Rubus caesius L.	C	3	+	1	.	+	+	.	+	+	1	IV
Glechoma hederacea L.		.	+	+	.	3	.	1	2	1	3	IV
Frangula alnus Mill.		.	.	.	.	.	.	.	.	.	+	I
Distinguishing species of the subassociation:												
Frangula alnus Mill.	B	2	3	1	1	+	3	1	2	2	1	V
Carex brizoides L.	C	5	4	4	2	3	2	5	3	5	3	V
Deshampsia caespitosa (L.) Beaur.		1	1	.	4	3	+	3	4	3	1	V
Galeopsis tetrahit L.		2	1	1	1	2	.	2	+	1	1	V
Dryopteris filix mas (L.) Sch.		+	.	+	+	+	.	+	+	.	+	IV
Characteristic species of the order and class (*Querco-Fagtea*):												
Carpinus betulus L.	A	.	2	.	.	.	.	.	.	+	2	II
Acer campestre L.		.	.	.	.	.	.	.	.	.	+	I
Crataegus oxyacantha L.	B	+	.	+	.	.	1	+	.	+	.	III
Acer campestre L.		+	.	1	+	.	+	+	.	.	.	III
Carpinus betulus L.		+	+	.	.	.	.	+	+	.	+	III
Prunus spinosa L.		.	.	.	.	.	1	+	.	.	.	II
Crataegus monogyna Jacq.		.	.	.	.	.	1	+	.	.	+	II
Pyrus pyraster (L.) Borkh.		.	+	.	.	.	1	+	.	.	+	II
Euonymus europaea L.		+	.	.	.	.	.	.	.	.	+	I
Corylus avellana L.		2	.	.	.	.	.	.	.	.	3	I
Circaea lutetiana L.	C	1	+	.	.	1	.	2	1	1	+	IV

Urtica dioica L.		.	.	+	+	+	.	+	+	2	+	IV
Brachypodium silvaticum (Huds.) R.S.		.	.	.	.	.	.	+	+	+	+	II
Humulus lupulus L.		.	.	+	.	1	.	.	.	+	.	II
Veronica montana L.		+	.	.	.	.	.	+	.	.	+	II
Aegopodium podagraria L.		.	.	.	.	+	3	.	.	.	.	I
Ajuga reptans L.		.	+	.	.	.	.	.	.	.	1	I
Geranium robertianum L.		.	.	.	.	.	.	+	.	.	.	I
Viola reichenbachiana (L.) Jor. ex Boreu.		.	.	.	.	.	.	.	.	.	+	I
Carex silvatica Huds.		.	.	.	.	.	.	.	.	.	+	I
Galium odoratum (L.) Scop.		.	.	.	.	.	.	.	.	.	+	I
Lamiastrum galeobdolon (L.) Ehr. et Pol.		.	+	.	.	.	.	.	.	.	.	I
Arum maculatum L.		+	.	.	.	.	.	.	.	.	.	I
Paris quadrifolia L.		+	.	.	.	.	.	.	.	.	.	I
Stellaria holostea L.		.	.	.	.	.	.	.	.	+	.	I
Other species of wet and flooded sites:												
Salix cinerea L.	B	.	.	.	.	.	.	+	.	.	.	I
Myosotis scorpioides L.	C	.	+	+	2	1	+	+	1	+	.	IV
Galium palustre L.		.	+	+	1	+	2	+	.	.	+	IV
Polygonum hydropiper L.		.	.	2	3	2	.	+	+	1	1	IV
Juncus effusus L.		.	.	+	1	+	+	+	.	.	.	III
Iris pseudacorus L.		.	+	.	.	.	+	+	+	.	+	III
Lysimachia vulgaris L.		.	+	.	+	1	2	+	+	.	.	III
Peucedanum palustre (L.) Monch.		.	+	.	1	1	1	1	1	.	.	III
Lytrum salicaria L.		.	.	.	+	2	2	+	+	+	.	III
Senecio fluviatilis Wallr.		.	.	.	.	+	.	+	.	+	.	II
Stachys palustris L.		.	.	.	.	.	+	.	1	+	.	II
Carex elongata L.		.	2	+	.	.	3	.	.	.	.	II
Ranunculus repens L.		.	.	.	.	1	.	.	1	.	+	II
Poa palustris L.		.	.	.	+	.	.	.	.	+	.	I
Festuca gigantea (L.) Vill.		.	+	.	.	.	.	.	.	.	+	I
Alisma plantago aguiatica L.		.	.	.	.	+	.	.	.	.	+	I
Symphytum officinale L.		.	.	.	.	.	.	+	.	.	.	I

Succisa pratensis Mch.		.	.	1	.	.	.	.	.	.	.	I
Other species:												
Rhamnus cathartica L.	B	.	.	.	.	.	.	.	+	+	.	I
Cornus sanquinea L.		.	.	.	.	.	.	.	.	.	1	I
Rosa canina L.		.	+	.	.	.	.	.	.	.	.	I
Athyrium filix femina (L.) Roth.	C	+	.	1	.	.	.	+	+	1	1	III
Hypericum acutum L.		.	.	.	+	.	.	+	.	+	+	II
Eupatorium cannabinum L.		.	.	.	.	.	.	+	.	1	.	I
Lychnis flos cuculi L.		.	+	+	.	.	.	.	.	.	.	I
Geum urbanum L.		.	.	+	.	+	.	.	.	.	.	I
Bidens tripartitus L.		.	.	.	.	.	.	.	+	.	+	I
Prunella vulgaris L.		.	.	.	.	.	.	.	+	.	+	I
Senecio rivularis (W.K.) D.C.		.	.	.	.	.	.	+	.	.	.	I
Galium silvaticum L.		.	.	.	+	.	.	.	.	.	.	I
Ballota nigra L.		2	.	.	.	.	.	.	.	.	.	I
Pulmonaria officinalis L.		.	.	.	.	.	.	.	.	.	1	I
Galium aparine L.		.	.	.	.	.	.	.	.	.	+	I
Hedera helix L.		.	.	.	.	.	.	.	.	.	+	I
Agrostis alba L.		.	.	2	.	.	.	.	.	.	.	I
Aristolochia clematitis L.		.	.	.	.	.	.	.	.	.	+	I
Torilis anthriscus (L.) Gmel.		.	.	.	.	.	.	.	.	.	+	I

Explanation of abbreviations:
A -Tree layer, B - Shrub layer, C -Ground vegetation layer

+, 1, 2, 3, 4, 5 -Combined assessment of abundance and cover (Braun-Blanquet 1964)

Syndynamics of the phytocoenosis: The progression of site conditions has allowed the association to gradually pass into a slightly drier subassociation with common hornbeam, with some mesophyllic elements of forests of pedunculate oak and common hornbeam. The subassociation with remote sedge (*Genisto elatae-Quercetum roboris caricetosum remotae*) grows in more humid sites.

Stability of the phytocoenosis: By comparing the present arrangement of vegetation with that described by Medvedović (1975), it could be said that the subassociation is in regression in its larger part, which is the consequence of pedunculate oak dieback and waterlogging of the terrain. So, the forest of black alder has replaced the forest of pedunculate oak and great green weed with quaking sedge in departments and compartments 70c and d, 111d, 117b, 140b and 141b. Similarly, compartments 33b, 58b, e, and f are now covered with a forest of narrow-leaved ash, and compartments 130a and b, 134, 136e and d, 149, 150 and 168 with the subassociation with remote sedge.

In compartments 28a and b, 34b, 41b, 48a and c, 131a and c, 132 and 139, there are regression processes in favour of the subassociation with quaking sedge. This is the consequence of pedunculate oak dieback and terrain waterlogging, and the subsequent entrance of black alder and narrow-leaved ash into the site of pedunculate oak and common hornbeam.

Site progression has taken place in very small areas in compartments 118a and 162c, where *Genisto elatae-Quercetum roboris carpinetosum* betuli has replaced *Genisto elatae-Quercetum roboris caricetosum brizoides*, and in compartments 35b and 168, which are currently inhabited by *Carpino betuli-Quercetum roboris*.

A survey of all compartments shows that quaking sedge (*Carex brizoides*) is intensively invading hornbeam sites on micro-elevations, an indication that some sites are too humid for this species, and it is therefore moving to drier ones. Pedunculate oak dieback is noticeable, and the subassociation is in the regression stage. In some smaller areas, black alder and narrow-leaved ash have entered all stand layers.

Consequently, along with a large participation of plants of humid sites, there is a number of species such as *Frangula alnus*, *Salix cinerea*, *Juncus effusus*, *Peucedanum palustre*, *Cirsium palustre* and others, while mesophyllic elements are disappearing. They all show a tendency towards a wet and waterlogged biotop.

Good-quality hornbeam and a number of mesophyllic elements from the forest of pedunculate oak and common hornbeam occur in a small area.

Based on his research of forest vegetation in dieback-affected plots in "Žutica", the analyses of floral recordings in the period 1969 - 1973, and a comparison with a typical condition in Lipovljani, Rauš concluded that the forest of pedunculate oak and great green weed with quaking sedge was in a relatively stable condition, and did not show any disorders in its development and composition that might have been the consequence of low-intensity dieback of pedunculate oak. According to Rauš, the subassociation was then in a state of progression.

On the other hand, some other dieback-afflicted areas show a much more serious condition of this subassociation. On the basis of research done in Turopoljski Lug (1993), Vukelić and Rauš concluded that it was the most unstable association undergoing the biggest changes.

Forest of pedunculate oak and great green weed with remote sedge
Šuma hrasta lužnjaka i velike žutilovke s rastavljenim šašem
(*Genisto elatae-Quercetum roboris caricetosum remotae* Ht. 1938)

Research so far: Horvat (1938) was the first to describe the subassociation, while Rauš later dealt with its synecological-vegetational features in depth (1970, 1973, 1975, 1980).

Distribution of the phytocoenosis: The Slavonian forest, or the forest of pedunculate oak and great green weed with remote sedge, stretches in a mosaic-like pattern in the lowland part of Croatia along the principal rivers of Sava, Drava and their tributaries. It is distributed in Pokuplje along the river Odra, in Posavina and Podravina, and in Central Croatia.

The association is well represented in the studied area (about 25%), and the largest complexes are Šumarak, Gospođice, Ravneš, and areas stretching from compartments 52 to 75 in the northern part, and from 169 to 195 in the southern part.

Site of the phytocoenosis: It grows on mineral-swampy, moderately distinct soil, of slightly acid to practically neutral reaction.

The groundwater level remains rather high over the whole year (1 - 3 m). According to Dekanić (1959), the groundwater level in the spring and autumn is high and exceeds the soil surface. Water stagnates on the surface for a very long period (June, July), or until it evaporates, as the soil is not permeable. The water comes from precipitation, which remains on impermeable soils, and from river floods. The association is usually flooded once or twice a year.

The terrain altitude ranges from 95 to 97 m, which, together with the micro-relief, plays an important role in the growth of this asociation, since groundwater levels depend on these two factors.

Floral composition and vegetation structure: The floral composition of the association is shown in Table 9, on the basis of 10 phytocoenological recordings. A total of 89 species is shown, of which 41 participate in the association at a rate of over 20 %.

The tree layer, in which the pedunculate oak is the main tree species, covers 50 - 90% of the area. It occurs in all plots and regularly dominates the subassociation, while black alders and narrow-leaved ashes occur is smaller numbers. It should be stressed that these are characteristic species of the association and alliance *Alno-Quercion*. Compared to typically developed stands in Lipovljani, where the tree layer coverage is 80 - 90%, the stands in the Management Unit "Žutica" display some disorders.

The shrub layer covers 30 - 80% of the area and is not equally developed in all recordings. The predominant species is narrow-leaved ash, which indicates two things: a transition towards a wetter site, and a gradual invasion of narrow-leaved ash (*Fraxinus angustifolia*) and black alder (*Alnus glutinosa*) into such sites. Other species present in larger numbers are lowland elm (*Ulmus carpinifolia*) and spreading elm (*Ulmus laevis*), also characteristic of the association and alliance *Alno-Quercion*, and hawthorn (*Crataegus oxyacantha*) and maple (*Acer campestre*) as characteristic species of the order *Fagetalia* and class *Querco-Fagetea*. Buckthorn (*Rhamnus cathartica*) is the most important accompanying species.

There is also a large number of *Genista tinctoria* ssp.*elata*, a characteristic species of the association.

The ground layer, taking between 50 to 100% of the area, features the following most important characteristic species of the association and alliance *Alno-Quercion*: pedunculate oak (*Quercus robur*), remote sedge (*Carex remota*), moneywort (*Lysimachia nummularia*), summer snowflake (*Leucoium aestivum*), gypsywort (*Lycopus europaeus*), wood dock (*Rumex sanguineus*), *Carex elongata*, mouse-ear (*Cerastium silvaticum*) and *Carex strigosa*.

The most important distinguishing species of the subassociation are remote sedge (*Carex remota*), yellow flag (*Iris pseudacorus*), tufted sedge (*Carex elata*), marsh marigold (*Caltha palustris*), broad-leaved ragwort (*Senecio fluviatilis*), greater pond sedge (*Carex riparia*), *Carex strigosa*, summer snowflake (*Leucoium aestivum*), creeping buttercup (*Ranunculus repens*), common comfrey (*Symphytum officinalis*) and others.

Common nettle (*Urtica dioica*) as a characteristic species of the *Fagetalia* order and *Querco-Fagetea* class is also prominent.

Galium palustre, *Polyganum hydropiper*, *Myosotis scorpioides*, *Juncus effusus*, *Peucedanum palustre*, *Carex elongata*, *Lysimachia vulgaris*, *Euphorbia palustris* and other accompanying species with a high degree of constancy indicate increased humidity. Furthermore, these species connect this subassociation with other described associations of similar sites and similar compositions.

Therefore, the layer of ground vegetation is distinguished by a wealth of plants of the *Populetalia* order and of accompanying species covering large parts of the forest, which is an indication that this is the most humid subassociation of forests of pedunculate oak and great green weed.

On the basis of detailed analyses of individual phytocoenological recordings, it can be concluded that an aggressive onset of narrow-leaved ash and black alder has been enabled by the newly formed (swampy) conditions. With their number and fast growth, these species are suppressing the pedunculate oak. Due to increased humidity, oak regenerates poorly, while older trees die prematurely. Narrow-leaved ash and black alder have taken dominance either in the tree layer or the shrub layer. The result is that in some recordings, such as 1, 2, 3, 4, and 5, the stands are monodominant, while in some others the narrow-leaved ash and black alder occur both in the shrub and in the tree layer.

The process of water logging is especially visible in Recordings 3, 4 and 5, where narrow-leaved ash and black alder are accompanied by a large number of the following species: *Amorpha fruticosa*, *Carex elata*, *Carex vesicaria*, *Roripa amphybia*, *Deshampsia caespitosa*, *Polygonum hydropiper*, *Carex elongata*, and others. According to Ellenberg (1979), Oberdorfer (1983) Zolyomi and others (1967), the auto-ecological characteristics of these species confirm that they belong to very wet and flooded sites and do not occur in drier habitats. Except for *Deshampsia caespitosa* and *Carex elongata*, all these species require full light or semi-light, which also indicates changes in the sites and structural factors of the association.

The most typical recording of the association is Recording 5, while Recording 10 represents the driest variant of the subassociation, with species such as *Viola reichenbachiana*, *Circaea lutetiana*, *Stellaria media*, *Geum urbanum*, and *Urtica dioica*.

Table 9. - *Tablica 9.*

Association:		*GENISTO ELATAE-QUERCETUM ROBORIS* Ht. 1938										
Subassociation:		*caricetosum remotae* Ht. 1938										Degree of part.
Number of recording:		1	2	3	4	5	6	7	8	9	10	
Area:		Žutica										
Department, compartment:		188d	181b	135d	24a	75c	119a	191a	84a	9c	56c	
Plot size (m^2):		400	400	400	400	400	400	400	400	400	400	
Date:		16.6.97.	17.6.97	24.6.97.	3.7.97.	27.8.97.	27.6.97	16.6.97	1.7.97.	2.7.97.	26.8.97.	
Cover (%):												
Tree layer		70	80	50	70	80	80	90	50	90	80	
Shrub layer		70	60	30	70	40	50	60	50	80	50	
Ground vegetation layer		90	100	100	80	100	80	90	100	70	50	

FLORAL COMPOSITON

Characteristic species of the association and alliance (*Alno-Quercion*):

Quercus robur L.	A	4	5	3	4	5	4	4	3	4	5	V
Alnus glutinosa (L.) Gartn.		.	.	.	.	.	2	+	1	.	+	II
Fraxinus angustifolia Vahl		.	.	.	.	.	.	2	.	2	.	I
Alnus glutinosa (L.) Gartn.	B	.	+	2	+	.	2	1	1	.	.	III
Ulmus carpinifolia Gled.		2	1	.	1	1	.	2	.	.	1	III
Genista elata Wend.		.	3	+	.	3	.	.	.	5	.	II
Acer tataricum L.		.	.	.	.	.	.	1	.	.	.	I
Sambucus nigra L.		.	.	.	.	.	.	.	1	.	.	I
Viburnum opulus L.		.	.	.	.	.	.	.	.	.	+	I
Lysimachia nummularia L.	C	+	.	+	+	.	+	1	1	+	1	IV
Quercus robur L.		2	2	.	2	1	.	1	.	2	.	III
Lycopus europaeus L.		.	+	.	2	1	1	+	1	.	.	III
Rumex sanquineus L.		1	1	.	+	.	.	+	1	1	.	III
Cerastium silvaticum W.K.		+	+	.	+	.	.	+	.	+	.	III
Solanum dulcamara L.		.	.	.	+	.	1	.	1	.	.	II

Impatiens noli tangere L.		+	.	.	.	.	.	2	.	.	.	I
Nephrodium spinulosum Strempel.		.	.	.	.	.	.	.	.	.	+	I
Fraxinus angustifolia Vahl.		.	.	.	.	.	.	1	.	.	.	I
Angelica silvestris L.		.	.	1	.	.	.	.	.	.	.	I
Valeriana dioica L.		.	.	.	.	2	.	.	.	.	.	I
Cardamine dentaria L.		.	.	.	+	.	+	.	.	.	.	I
Ulmus carpinifolia Gled.		.	.	.	.	.	.	2	.	.	.	I
Acer tataricum L.		.	.	.	.	.	.	+	.	.	.	I
Characteristic species of the order and class (*Alno-Populatea*):												
Frangula alnus Mill.	B	+	+	1	.	.	+	+	.	.	.	III
Ulmus laevis Pall.		.	.	.	+	.	1	.	1	+	.	II
Rubus caesius L.	C	1	1	1	1	+	+	+	3	1	1	V
Glechoma hederacea L.		+	1	.	1	2	.	4	2	.	+	IV
Distinguishing species of the subassociation:												
Fraxinus angustifolia Vahl.	B	3	1	1	3	+	2	2	.	1	.	IV
Carex remota L.	C	3	2	2	3	+	1	1	3	2	2	V
Iris pseudacorus L.		2	1	+	1	+	2	+	2	.	+	V
Ranunculus repens L.		2	3	+	3	2	.	.	2	2	.	IV
Lysimachia vulgaris L.		2	3	1	1	.	+	.	+	1	.	IV
Euphorbia palustris L.		1	+	+	.	.	1	1	+	1	.	IV
Carex strigosa Huds.		3	.	.	1	.	.	3	.	3	1	III
Symphytum officinale L.		.	1	.	1	+	1	.	3	.	.	III
Leucoium aestivum L.		.	1	+	+	.	1	.	.	2	.	III
Carex elata All.		.	3	3	.	4	.	.	.	.	.	II
Caltha palustris L.		2	.	.	.	.	1	+	.	.	.	II
Characteristic species of the order and class (*Querco-Fagetea*):												
Crataegus oxyacantha L.	B	.	.	.	2	.	.	+	2	+	+	III
Acer campestre L.		1	.	.	+	.	.	+	1	.	.	II
Prunus spinosa L.		+	.	.	.	.	+	.	.	.	.	I

Crataegus monogyna Jacq.		.	.	.	.	.	.	.	1	.	.	I
Pyrus pyraster (L.) Borkh.		.	.	.	+	.	.	.	1	.	.	I
Euonymus europaea L.		.	.	.	.	.	.	.	.	.	+	I
Urtica dioica L.	C	+	+	+	1	+	2	+	2	.	1	V
Circaea lutetiana L.		.	.	.	2	+	.	2	.	.	1	II
Ajuga reptans L.		1	.	+	.	.	.	.	.	.	.	I
Dryopteris filix mas (L.) Sch.		+	.	.	.	.	1	.	.	.	.	I
Humulus lupulus L.		.	.	.	.	.	.	.	1	.	.	I
Aegopodium podagraria L.		.	.	.	.	.	.	.	.	+	.	I
Viola reichenbachiana Jor. ex Boreu.		.	.	.	.	.	.	.	.	.	+	I
Scrophularia nodosa L.		.	.	.	.	.	.	+	.	.	.	I
Acer campestre L.		.	.	.	.	.	.	+	.	.	.	I
Euonymus europaea L.		.	.	.	+	.	.	.	.	.	.	I
Other species of wet and flooded sites:												
Salix cinerea L.	B	.	+	.	.	.	.	.	.	.	.	I
Galium palustre L.	C	1	2	+	1	+	1	2	2	1	+	V
Carex elongata L.		.	3	3	.	.	4	.	3	+	.	III
Peucedanum palustre (L.) Monch.		+	.	1	.	+	1	2	.	+	.	III
Myosotis scorpioides L.		1	1	.	+	.	.	2	1	.	.	III
Polygonum hydropiper L.		.	+	1	.	+	.	.	2	3	.	III
Juncus effusus L.		+	+	.	.	+	.	+	+	.	.	III
Stachys palustris L.		.	.	.	1	1	1	.	2	1	.	III
Deshampsia caespitosa (L.) Beaur.		.	.	4	.	.	.	+	+	2	.	II
Senecio fluviatilis Wallr.		+	.	+	.	.	.	.	.	1	.	II
Lytrum salicaria L.		.	.	.	+	1	+	.	.	.	.	II
Carex vulpina L.		+	.	2	.	.	.	.	.	.	.	I
Carex vesicaria L.		.	2	2	.	.	.	.	.	.	.	I
Roripa amphibia (L.) Bess.		.	3	.	.	.	.	.	.	1	.	I
Carex riparia Curt.		.	.	.	.	.	.	2	.	.	.	I
Succisa pratensis Mch.		.	.	.	.	1	.	.	.	.	.	I
Mentha aquatica L.		.	.	.	.	+	.	.	.	1	.	I

Poa palustris L.		.	.	.	.	.	+	.	.	.	.	I
Festuca gigantea (L.) Vill.		.	.	.	+	.	.	.	.	.	.	I
Stellaria aquatica		.	.	.	.	.	.	+	.	.	.	I
Other species:												
Rhamnus cathartica L.	B	1	.	+	1	.	.	+	2	.	3	III
Amorpha fruticosa L.		.	3	+	.	.	.	.	.	.	.	I
Galeopsis tetrahit L.	C	+	1	.	.	.	+	+	+	.	+	III
Stellaria media (L.) Vill.		.	.	.	+	.	.	+	.	.	+	II
Geum urbanum L.		.	.	.	.	.	.	.	2	.	+	I
Athyrium filix femina (L.) Roth.		.	.	.	.	.	.	+	+	.	.	I
Hedera helix L.		.	.	.	+	.	.	.	.	.	+	I
Agrostis alba L.		3	1	.	.	.	.	.	.	.	.	I
Solidago sp.		.	3	.	.	1	.	.	.	.	.	I
Hypericum acutum L.		+	.	.	.	.	.	.	.	.	.	I
Lychnis flos cuculi L.		.	.	.	.	.	.	+	.	.	.	I
Thalictrum sp.		.	.	+	.	.	.	.	.	.	.	I
Bidens tripartitus L.		.	.	.	.	+	.	.	.	.	.	I
Prunella vulgaris L.		.	.	.	.	.	.	.	.	+	.	I
Pulmonaria officinalis L.		.	.	.	.	.	.	1	.	.	.	I
Melandrium rubrum (Weigel.) Garcke.		.	.	.	.	.	.	+	.	.	.	I
Aristolochia clematitis L.		.	.	.	.	.	.	+	.	.	.	I
Cornus sanquinea L.		.	.	.	.	.	.	+	.	.	.	I
Tamus communis L.		.	.	+	.	.	.	.	.	.	.	I
Rosa canina L.		.	.	.	.	.	.	.	+	.	.	I

Explanation of abbreviations:
A - Tree layer, B - Shrub layer,
C -Ground vegetation layer
+, 1, 2, 3, 4, 5 - Combined assessment of abundance and cover (Braun-Blanquet 1964)

Syndynamics of the phytocoenosis: I. Horvat (1938) considered this subassociation a typical forest of the Slavonian plain. In a vertical sense, it occurs slightly below the forest of pedunculate oak and great green weed with quaking sedge. The forest of narrow-leaved ash (*Leucoio-Fraxinetum angustifoliae* Glav. 1959) is more humid than the forest of pedunculate oak and great green weed, and one follows the other towards a more humid site.

Stability of the phytocoenosis: According to research (Rauš 1980), this subassociation in the Management Unit "Žutica" is in a state of regression, because its stability has been greatly disturbed by the dieback of lowland elm, followed by an abrupt and mass dieback of pedunculate oak. The ground layer is very rich, which means that an excessive quantity of light passes through rarefied, broken, canopies - the result of permanent dieback of pedunculate oak (preceded by that of lowland elm) in the subassociation.

Too much light in the stand allows weed vegetation to grow very fast, which, combined with abundant humidity, contributes to water logging of the terrain. Stability will have to be restored with silvicultural and draining measures.

Black alder and narrow-leaved ash fill in the empty places and thus help stabilise these stands.

An analysis of the phytocoenological recordings, and a comparison of distribution maps of the "Žutica" forest associations (Medvedović 1975) and the present condition show that swamping processes are still taking place. Compartments 54a and b; 78 (north), 92b and c, 132, 134, and 154c are now inhabited by forests of black alder in place of the earlier association of pedunculate oak and great green weed with remote sedge. A similar phenomenon has occurred in compartments 15, 20, 56b, 61b, 62b, 64f, 164b, 194c, and 196a, now inhabited by forests of narrow-leaved ash. A certain degree of regression resulting from dieback is visible in compartments 130a and b, 134, 136e and d, 149, 150, and 168, where the subassociation *caricetosum remotae* has replaced that of *caricetosum brizoides*. However, the subassociation *caricetosum remotae* is showing a tendency to expand at the expense of other associations in the Unit. The same is happening in compartments 25d, 37 (a part), 83a, 101a, 103a, 119a, 187b, and 188d, where site regression is even greater, because the association of pedunculate oak and common hornbeam has been replaced by the association of pedunculate oak and great green weed with remote sedge.

Certain progression is only visible in compartments 63a, 65a, 154a, and 155b, where *Genisto elatae-Quercetum roboris caricetosum remotae* has been replaced by *Genisto elatae-Quercetum roboris carpinetosum betuli*, and in compartment 37a and parts of compartments 62 and 65, which are now inhabited by *Carpino betuli-Quercetum roboris*.

In can be concluded that the biggest vegetative and ecological changes have occurred, and are still occurring, mainly in this subassociation. The association is unstable, and digressions from floral compositions and structures of normally developed stands are frequent. The size of the area under this association has not changed, which is connected with what has been said above, but very serious regression processes are visible in the entire Management Unit "Žutica".

In order to establish the causes of pedunculate oak dieback, Dekanić (1962) conducted research on the water regime in the forest "Žutica". He found that the water regime in the forest of pedunculate oak and great green weed with remote sedge was highly unfavourable. Among other negative impacts of dams, roads and canals, there are also disturbances in the rhizosphere.

Research in other localities affected by pedunculate oak dieback, such as Kalje, Turopoljski Lug and the Pokuplje Basin, also show visible changes in the phytocoenological structure, which indicate stagnant water and excessive humidity of the biotop (Vukelić et al. 1997).

THE FOREST OF BLACK ALDER WITH ALDER BUCKTHORN
ŠUMA CRNE JOHE S TRUŠLJIKOM
(*Frangulo-Alnetum glutinosae* Rauš 1968)

Research so far: Although it covers a much smaller area than the above described associations, the forest of black alder with alder buckthorn is an interesting and important association of the lowland region in Croatia. Horvat (1938, 1963), Glavač (1960, 1962), Fukarek (1963) and Rauš (1968, 1971) studied the forest of black alder from different viewpoints, but Rauš was the first to describe this association in Posavina.

Horvat (1938) described the forest of black alder in Croatia under the name *Carici brizoides-Alnetum glutinosae*. Later (1963), he went on to describe alder forests on peat and humus-gleyic soils of Podravina under the name *Carici elongatae-Alnetum glutinosae* (W. Koch) Tx. et Bodeux. According to Horvat, the latter association has the character of a relic, and has survived since the glacial period in the sites in which oscillations of groundwater represent fundamental factors in the growth of the association.

Distribution of the phytocoenosis: According to research so far, the forest of black alder and alder buckthorn is found in Podravina, Podunavlje, Pokuplje and the entire region of Croatian Posavina, where it occurs in smaller areas in a mosaic-like pattern. Some research (Erdeši 1971) shows that black alder is disappearing from the region of lower Posavina, and has almost completely gone from Podunavlje.

Typical stands of black alder with alder buckthorn cover slightly over 5% of the entire area of the "Žutica". Larger stands are situated in the northern part, while elsewhere they occur fragmentarily in micro-depressions.

Site of the phytocoenosis: The forest of black alder with alder buckthorn is arranged in a mosaic pattern over a specific relief and in specific relief conditions. It usually occurs in old riverbeds and depressions, and less frequently in swamps, where the pioneering role of black alder has come to its full expression. When conditions are favourable, it inhabits old riverbeds and after several generations forms a normal forest soil and conditions for the growth and development of other tree species.

The association occurs exclusively on eugley soils, or on their sub types, epigley and amphigley, although it is slightly better represented on amphigley. It is rich in nitrogen and has a slightly acid reaction.

The phytocoenosis is subjected to long-lasting surface water about 20 to 70 cm in depth (sometimes more), which often indicates soil completely saturated with water.

Floral composition and vegetative structure: The floral composition, based on 10 phytocoenological recordings from various parts of the "Žutica", is shown in Table 10. A total of 79 species have been registered, of which 34 participate at a rate of over 20%.

The tree layer covers 30% of the area in Recording 3, and almost 90% in Recording 10. Of the characteristic species belonging to the association and alliance *Alno-Quercion*, black alder (*Alnus glutinosa*) is the most constant, while other tree species are almost non-existent, apart from a sporadic occurrence of narrow-leaved ash (*Fraxinus angustifolia*).

Stagnant surface water is responsible for the fact that black alder develops special conical roots, giving these forests an unusual aspect. Mud collecting around these cones forms soil, which enables black alder to vegetate despite stagnant surface water, since a part of its roots is above the water. Other tree species do not possess this ability. However, there are stands whose appearance does not correspond to this typical picture. These are the ones in which both the site and the association are at a higher level of development, so the humidity is lower, and the cones gradually disappear, although the floral composition is the same.

It is interesting that the phytocoenosis disposes of large quantities of organic matter through leaves and other waste material, which leads to a gradual progression of site conditions.

The coverage of the shrub layer ranges from 5 to 30%, with the exception of Recording 9, where it reaches 50%. This may be caused by conditions in the site hostile to the development of most trees and shrubs, and by the fact that black alder, when fully canopied, almost entirely shades the soil. Besides black alder, the shrub layer consists only of alder buckthorn (*Frangula alnus*) and grey willow (*Salix cinerea*) as characteristic species of the association and alliance *Alno-Quercion*, to which it belongs primarily in the diagnostic sense. Buckthorn (*Rhamnus cathartica*) is the only accompanying species that participates in the stand to a larger degree. It is characteristic that almost all shrubs, except grey willows, develop on the cones of black alder trees.

The layer of ground vegetation covers 90 - 100% of the area (the recordings show a range between 7 and 70%). *Carex riparia*, *Peudecanum palustre*, *Nephrodium spinulosum*, *Solanum dulcamara*, *Galuim palustre*, *Iris pseudacorus* and others are characteristic species of the association and alliance *Alno-Quercetum*. Of other species of wet and flooded sites, there is a slightly higher participation of *Myosotis scorpioides*, *Polygonum hydropiper* and *Euphorbia palustris*, and of accompanying species there are *Urtica dioica*, *Galeopsis tetrahit*, *Circaea lutetiana*, *Eupatorium cannabinum* and some others.

In most cases, two storeys (sinusions) can be distinguished in the layer of ground vegetation, of which one (mesophytic) grows on the already mentioned conical roots of black alders, that is, on the soil connected to the alder root system. This sinusion is made up of *Nephrodium spinulosum*, *Glechoma hederacea*, *Solanum dulcamara*, *Rubus caesius*, *Urtica dioica*, *Galium palustre*, *Circaea lutetiana*, and a smaller number of some other species.

The other sinusion (hygrophytic) of the ground vegetation occurs on the soil itself, between the cones of black alder, and is made up of distinct hygrophytes. Of characteristic species of the association and alliance, special mention should be made of *Carex riparia*, *Peucedanum palustre*, *Carex elongata*, *Lysimachia vulgaris* and *Lycopus europaeus*, while of accompanying species there are *Iris pseudacorus*, *Carex vesicaria*, *Sparganium erectum*, *Polygonum hydropiper*, *Lythrum salicaria*, *Stachys palustris*, and many others.

A detailed analysis of the recordings and the history of dieback in the Management Unit "Žutica" have led to the conclusion that the stands of black alder are in progression. Some stands are the result of site and association progression, while others originate from dieback of pedunculate oak and lowland elm and the associated water logging of the terrain, in other words, from regression processes. Recordings 1 and 2 are examples of waterlogged terrain with hygrophyllic vegetation in the place where the association of *Carpino betuli-Quercetum* roboris existed prior to pedunculate oak dieback. They are all characterised by poorly stocked stands, very hard conditions for the development of vegetation, the prevalence of swampy sedges, and the formation of cones.

Similar conditions are seen in Recordings 4, 5 and 6, where water remains on the surface over the whole year. Such specific ecological conditions have caused groups of black alders to grow on elevated cones, and often to develop from stumps. The poor-quality trunks are relatively low, have weak crowns, and are often forky.

Very well developed black alders are seen in Recording 7, and especially in Recording 8. Unlike previous recordings, these are not in the initial, but in the optimal stage of the development of black alder forests. The terminal stage is largely shown in Recording 9, with species such as *Quercus robur*, *Crataegus oxyantha* and *C. monogyna*, *Acer campestre*, *Corylus avellana*, *Ulmus carpinifolia*, *Cornus sanquinea*, *Carex remota*, *Carex brizoides*, *Cerastium silvaticum* and *Geum urbanum*. All these are mesophyllic elements of oak forests that indicate a transition of the association of black alder with alder buckthorn into a drier association of pedunculate oak and great green weed with remote sedge. A characteristic of this recording is a large participation of American ash (*Fraxinus americana*), brought into this site by man, probably as a consequence of certain changes in the site. However, as in other parts of the Management Unit "Žutica", in this one too, autochthonous elements prevail, so the American ash will gradually disappear from the floral composition.

Table 10. - *Tablica 10.*

												Degree of part.	Biological form
Association:		*FRANGULO-ALNETUM GLUTINOSAE* Rauš 1968											
Subassociation:		*typicum* Rauš 1971											
Number of recording:		1	2	3	4	5	6	7	8	9	10		
Area:		Žutica											
Department, compartment:		125d	112b	154c	197a	82d	95b	90c	44b	91a	114c		
Plot size (m^2):		400	400	400	400	400	400	400	400	400	400		
Date:		26.6.97.	27.6.97.	20.6.97.	6.6.97.	1.7.97.	1.7.97.	23.9.97.	27.8.97.	3.6.97.	27.8.97		
Cover (%):													
Tree layer		40	40	30	60	40	50	80	80	70	90		
Shrub layer		30	5	10	15	20	10	10	5	50	5		
Ground vegetation layer		100	90	100	100	100	100	70	100	100	90		
FLORAL COMPOSITON													
Characteristic species of the association and alliance (*Alno-Quercion*):													
Alnus glutinosa Gartn.	A	3	3	3	3	3	3	4	5	2	5	V	Ph
Fraxinus angustifolia Vahl		.	.	.	1	.	.	.	.	1	.	I	Ph
Frangula alnus Mill.	B	2	+	1	1	1	2	+	+	3	1	V	Ph
Salix cinerea L.		+	.	1	1	2	.	1	+	+	.	IV	Ph
Alnus glutinosa Gartn.		1	1	+	.	.	1	1	1	.	.	III	Ph
Sambucus nigra L.		.	.	.	.	1	.	+	.	.	.	I	Ph
Rubus caesius L.		.	.	.	+	.	.	.	.	+	.	I	H
Fraxinus angustifolia Vahl.		.	.	.	.	.	.	.	.	+	.	I	Ph
Viburnum opulus L.		.	.	.	.	.	.	.	.	+	.	I	Ph
Carex riparia Curt.	C	3	2	4	4	4	4	3	2	4	3	V	H
Peucedanum palustre (L.) Monch.		3	2	+	+	1	1	1	1	1	1	V	H
Nephrodium spinulosum (Mill.) Stemp.		2	.	+	2	1	2	2	+	1	1	V	H
Solanum dulcamara L.		3	3	1	2	.	2	2	+	+	1	V	H
Galium palustre L.		2	2	+	1	.	1	1	1	+	.1	V	H
Iris pseudacorus L.		.	3	.	.	+	1	+	+	+	2	IV	G
Carex vesicaria L.		3	.	4	3	3	3	.	2	.	.	III	H
Carex elongata L.		1	2	1	.	.	.	.	2	2	3	III	H
Lysimachia vulgaris L.		1	+	+	.	.	2	1	+	.	.	III	H
Rubus caesius L.		1	.	+	.	1	+	.	+	.	+	III	H
Sparganium erectum L.		3	3	1	.	1	2	.	1	.	.	III	H

Stachys palustris L.		+	1	.	.	.	1	+	+	.	+	III	H
Allisma plantago aquatica L.		.	1	.	.	+	.	.	.	.	.	I	H
Sium latifolium L.		.	1	.	.	.	.	.	.	.	.	I	H
Other species of wet and flooded sites:													
Myosotis scorpioides L.	C	.	.	1	+	2	1	+	.	.	+	III	H
Polygonum hidropiper L.		:	+	+	.	2	.	.	2	.	2	III	Th
Euphorbia palustris L.		1	+	.	.	1	.	.	.	+	.	II	H
Leucoium aestivum L.		.	1	+	+	.	.	.	.	+	.	II	G
Carex elata All.		2	.	.	4	.	.	3	+	.	.	II	H
Roripa amphibia (L.) Bess.		2	.	.	1	.	.	+	+	.	.	II	
Cardamine dentata L.		.	+	.	+	.	.	.	.	.	+	II	H
Lythrum salicaria L.		. .	.	+	.	.	.	+	.	.	+	II	H
Caltha palustris L.		.	.	.	.	1	.	.	.	3	.	I	H
Deshampsia caespitosa (L.) Beaur.		.	.	.	.	.	.	.	.	1	2	I	H
Mentha aquatica L.		.	.	3	.	1	.	.	.	.	.	I	H
Rumex sanquineus L.		.	.	.	.	+	.	.	.	.	+	I	H
Lemna trilusca L.		.	+	.	+	.	.	.	.	.	.	I	H
Hottonia palustris L.		2	3	.	.	.	.	.	.	.	.	I	H
Ranunculus repens L.		.	.	.	.	1	.	.	.	.	+	I	H
Lemna minor L.		.	+	.	.	.	.	.	.	.	.	I	H
Symphytum officinale L.		.	+	.	.	.	.	.	.	.	.	I	H
Festuca gigantea (L.) Vill.		.	.	.	.	+	.	.	.	.	.	I	H
Juncus effusus L.		.	.	.	.	.	.	.	.	.	+	I	H
Senecio aquatica Huds.		.	.	.	.	1	.	.	.	.	.	I	H
Other species:													
Fraxinus americana	A	.	.	.	.	.	.	.	.	3	.	I	Ph
Quercus robur L.		.	.	.	.	.	.	.	.	1	.	I	Ph
Rhamnus cathartica L.	B	.	.	.	+	+	+	.	.	.	.	II	Ph
Quercus robur L.		.	.	.	.	+	.	.	.	+	.	I	Ph
Crataegus oxyacantha L.		.	.	.	.	.	.	.	.	+	+	I	Ph
Prunus spinosa L.		.	.	.	.	+	.	.	.	.	+	I	Ph
Fraxinus americana		.	.	.	.	.	.	.	.	2	.	I	Ph
Cornus sanquinea L.		.	.	.	.	.	.	.	.	+	.	I	Ph
Acer campestre L.		.	.	.	.	.	.	.	.	+	.	I	Ph
Corylus avellana L.		.	.	.	.	.	.	.	.	+	.	I	Ph
Crataegus monogyna Jacq.		.	.	.	.	.	.	.	.	+	.	I	Ph

Ulmus carpinifolia Gled.		.	.	.	.	.	.	.	.	+	.	I	Ph
Ulmus laevis Pall.		.	.	.	.	.	.	.	.	+	.	I	Ph
Pyrus pyraster (L.) Borkh.		.	.	.	.	.	.	.	.	+	.	I	Ph
Acer tataricum L.		.	.	.	+	.	.	.	.	.	.	I	Ph
Urtica dioica L.	C	+	1	+	2	2	+	2	.	.	1	IV	H
Galeopsis tetrahit L.		+	+	+	.	2	+	+	3	.	.	IV	Th
Circaea lutetiana L.		.	.	+	1	+	+	.	.	+	+	III	G
Lycopus europaeus L.		+	1	.	.	1	.	1	+	.	+	III	H
Eupatorium cannabinum L.		+	+	.	.	+	+	+	.	.	.	III	H
Aegopodium podagraria L.		.	.	+	.	1	.	.	.	.	+	II	H
Glechoma hederacea L.		.	.	.	.	1	.	+	.	.	1	II	Ch
Bidens tripartitus L.		.	.	.	.	.	.	+	3	.	2	II	Th
Galium silvaticum L.		.	.	.	.	.	+	+	+	.	.	II	H
Vitis silvestris Gmel.		.	.	2	.	.	.	.	.	+	.	I	
Impatiens noli tangere L.		.	.	.	.	+	.	.	.	+	.	I	Th
Lychnis flos cuculi L.		.	.	.	+	.	.	.	.	+	.	I	H
Humulus lupulus L.		.	.	+	.	1	.	.	.	.	.	I	H
Carex remota L.		.	.	.	.	.	.	.	.	+	.	I	H
Lysimachia nummularia L.		.	.	.	.	.	.	.	.	+	.	I	H
Carex brizoides L.		.	.	.	.	.	.	.	.	1	.	I	H
Cerastium silvaticum W.K.		.	.	.	.	.	.	.	.	+	.	I	Ch
Geum urbanum L.		.	.	.	.	.	.	.	.	+	.	I	H
Galium odoratum (L.) Scop.		.	.	.	+	.	.	.	.	.	.	I	G
Polygonatum multiflorum (L.) All.		.	.	.	+	.	.	.	.	.	.	I	G
Aristolochia clematitis L.		.	.	.	.	2	.	.	.	.	.	I	H
Moehringia trinervia (L.) Clairv.		.	.	.	.	+	.	.	.	.	.	I	
Melandrium rubrum Roehl.		.	.	.	.	.	.	.	+	.	.	I	H
Athyrium filix femina (L.) Roth.		.	.	.	.	.	.	.	.	.	2	I	H
Angelica silvestris L.		.	.	.	.	.	.	.	.	.	+	I	H

Explanation of abbreviations:
A - Tree layer
B - Shrub layer
C - Ground vegetation layer
+, 1, 2, 3, 4, 5 - Combined assessment of abundance and cover (Braun-Blanquet 1964)

Biological range: Biological forms according to Ranunkiaer (1905) on the basis of 10 phytocoenological recordings (Table 10) show the following structure in the association: phanerophytes (Ph) 29%, chamaephytes (Ch) 3%, hemicryptophytes (H) 57%, geophytes (G) 6%, and therophytes (Th) 5%, which means that the association of black alder with alder buckthorn is a distinctly hemicrypto-phanerophytic (57 - 29%) association.

Distribution of the phytocoenosis: Due to the fact that these associations occur both in drained sites (river terraces) and in extremely swampy sites (depressions), the basic association *Frangulo-Alnetum glutinosae* (Rauš 1968) is divided into two subassociations: the subassociation *typicum* (Rauš 1971), and the subassociation *ulmetosum laevis* (Rauš 1971). Both these associations are present in the lowland region of Croatia.

Syndynamics of the phytocoenosis: The syndynamic development of the forest of black alder with alder buckthorn is very interesting, primarily owing to the pioneering and meliorative role the black alder plays in the lowland region of Croatia. There are three stages in its development: in the initial stage, which begins in former river courses, only ground vegetation of sedges and other similar species develops, followed by grey willow, white willow, fragile willow, alder buckthorn, white poplar, narrow-leaved ash and black alder on micro-elevations.

The optimal stage of the forest development is marked by black alder originating from seeds and stumps, with or without conical roots. There are also some narrow-leaved ashes and spreading elms.

The terminal stage contains black alder, which gradually disappears and gives place to pedunculate oak. Some sporadic maples and common hornbeams also occur.

In the Management Unit "Žutica", forests of black alder are in various stages of development. Forests growing on micro-elevations along the existing canals and dried riverbeds are in the initial stage. On a slightly more elevated terrain the sinusion of cones with swampy vegetation and bushes (*Salix cinerea, Frangula alnus*) gradually disappears, to be replaced by pure forests of black alder (optimal stage). The boundary of the terminal stage is more difficult to determine due to a successive development in which alder abruptly penetrates the sites of pedunculate oak. In certain small places in the central part of the Management Unit, alder even penetrates hornbeam sites.

Stability of the phytocoenosis: By carrying out meliorative treatments and fellings, man has been influencing the development of forests of black alder for a very long time.

The consequence of man's activities and of specific ecological conditions in which forests of black alder grow is the following phenomenon: in the Management Unit "Žutica" black alder has spread from old riverbeds and canals onto surfaces covered with stagnant water remaining there after floods and heavy rains. In addition, the disappearance of pedunculate oak has meant the disappearance of a "pump" whose role was to take away large quantities of water from the soil. The result was a worsened hydrological regime, a change in the microclimate, and a deterioration of biological components in the soil. Since black alder is the only species capable of tolerating such extremely humid conditions, it quickly invaded these localities. Narrow-leaved ash occurs in less humid localities.

The large-scale expansion of black alder is also noticeable in the association *Genisto elatae-Quercetum roboris*, as well as in individual places on micro-elevations.

Black alder also grows along oil wells, which is not surprising since as a pioneering species it can more or less tolerate such unfavourable life conditions. However, extremely adverse conditions, such as oil slicks, cause its degradation and dieback.

A comparison between the distribution of forest vegetation in the Management Unit "Žutica" (Medvedović 1975) and the present state shows that black alder has aggressively penetrated into the site of pedunculate oak in compartments 54a and b, 78 (north), 92b and c, 132, 134 and 154c, and replaced the previous forest of pedunculate oak and great green weed with remote sedge, and in compartments 70c and d, 111d, 117b, 140b and 141b, previously inhabited by the forest of pedunculate oak and great green weed with remote sedge. Very drastic dieback of pedunculate oak, combined with the water logging of the terrain, has enabled black alder to inhabit micro-elevations in compartments 80b, 88a, 100b, 112b, 113d, 125 and 126c, where it has replaced the previous forest of pedunculate oak and common hornbeam.

Black alder has also spread over previously uninhabited areas in compartments 96, 97 and 124, and along the majority of oil wells. Progression has also taken place in compartments 84, 86 and 121a, where the forest of black alder with alder buckthorn has been replaced by the forest of pedunculate oak and great green weed with remote sedge, and in compartments 82a and c, and 90b, which are now inhabited by forests of pedunculate oak and great green weed with common hornbeam. However, this is open to question, since, under disturbed site conditions and dieback, black alder spreads into the site of common hornbeam much more readily than common hornbeam inhabits the site of black alder.

Forest-economic characteristics: Similar to narrow-leaved ash, black alder also displays a tendency to expand quickly into areas which are either desiccated or are in the process of desiccation. It is a promising species and should be given more attention. Its properties will be fully utilised when pedunculate oak forests desiccate and decline, and black alder takes up the place of the necessary "third" species in pedunculate oak forests. The development of black alder forests should be assisted with silvicultural measures. Together with pedunculate oak and narrow-leaved ash, black alder should remain the basic species to be introduced into desiccating and declining stands (Matić 1989). In degraded sites, pedunculate oak should be obtained indirectly by introducing pioneering tree species, particularly narrow-leaved ashes, black alders, willows and poplars.

More will be said about silvicultural measures in normally developed forests of black alder in the section on the forests of narrow-leaved ash, because the principles are almost the same. The rotation of black alder forests is a minimum of 60 years, and 30 years with coppice forests.

FOREST OF NARROW-LEAVED ASH WITH SUMMER SNOWFLAKE ŠUMA POLJSKOGA JASENA S KASNIM DRIJEMOVCEM (*Leucoio-Fraxinetum angustifoliae* Glav. 1959)

Research so far: The first to describe the forest of narrow-leaved ash with summer snowflake in Croatia was Glavač (1959), who also divided it into two subassociations: *typicum* and *alnetosum glutinosae* (1962), which was adopted by other researchers of forest vegetation in lowland regions in Croatia (Horvat, Rauš). The exceptions are E. Vukičević (1959) and Erdeši (1971), who considered such phytocoenoses facies or subassociations of forests of pedunculate oak and great green weed in their most humid sites.

Distribution of the phytocoenosis: The forest of narrow-leaved ash with summer snowflake inhabits the clayey alluvial terrain of the Croatian Posavina from Sisak to Spačva. The largest and the most beautiful of these forests are located in Lipovljani in Posavina, in Javička Greda near Jasenovac and in Kamare near Novska.

Site of the phytocoenosis: A typical forest of narrow-leaved ash is especially beautifully developed in the southern part of the studied area, where the river Česma joins the river Lonja (the lowest terrain), but it does not cover large areas. Flood tides beginning at this point extend into the interior towards Veliko and Málo Polje. In the lowest points, narrow-leaved ashes display circles left by floodwater and ice at heights of up to 2 m. Narrow-leaved ash is a monodominant species here, the trunks are curved, many trees have been blown down, and the shrub and ground layers are almost non-existent. It occurs in the area of willows and initial vegetation in general, and represents the initial stage in the development of ash forests (according to Glavač 1959). In the southernmost and north-western areas, the association is complemented with black alder and pedunculate oak, while the shrub and ground layers are much better developed. Since hydrological conditions are more favourable here than in a typical subassociation, trees have much better heights and forms. Apart from black alder, there are also *Frangula alnus*, *Nephrodium spinulosum*, *Peucedanum palustre*, and others. The forest of narrow-leaved ash is in its optimal and terminal stage of development here.

The most important factors in the development of the association are the relief and the related stagnant and groundwater. The association occurs exclusively on eugley soil, that is, on its sub-types epigley and amphigley (occurring more frequently on the former). The terrain is uneven, and the soils can be neutral to acid. The association is exposed to long-lasting surface water and high groundwater.

In terms of orography, the phytocoenosis inhabits depressions of different kinds (bogs and recessions).

Floral composition and vegetative structure: The floral composition of the association is shown in Table 11 with five recordings from a typical subassociation, and five recordings from a subassociation with black alder. A total of 65 species has been recorded in the former, and 58 species in the latter.

The tree layer covers 50 - 90% of the area, and is made up of narrow-leaved ashes in the dominant storey, with an occasional appearance of lowland elms, ashes and pedunculate oaks. The tree layer in the subassociation with black alder covers 50 - 80% of the association's area, and is characterised by a fairly large participation of black alder.

The shrub layer is rather poor, and covers 1 - 40% of the area in a typical subassociation (Recording 4 is an exception, as the coverage there is 70%), and 1 - 10% in a subassociation with black alder (Recording 9 - 30%). It is mostly made up of narrow-leaved ash, spreading elm (*Ulmus laevis*), dyers' greenweed (*Genista tinctoria* ssp. *elata*) grey willow (*Salix cinerea*) and lowland elm (*Ulmus carpinifolia*) as the characteristic species of the alliance and order *Populetalia*, and hawthorn (*Crataegus oxyantha*) of accompanying species. The situation is the same in both associations, while black alder (*Alnus glutinosa*) and alder buckthorn (*Frangula alnus*) are distinguishing species for the second subassociation.

In a typical forest of narrow-leaved ash with summer snowflake, the ground layer covers 70 - 100% of the area, with the exception of Recording 5, where the coverage is only 10%. In the subassociation with black alder, the coverage is 90 - 100%. As characteristic and distinguishing species of the association, both subassociations contain common-marsh bedstraw (*Galium palustre*), bladder-sedge (*Carex vesicaria*), greater pond sedge (*Carex riparia*), tufted sedge (*Carex elata*), summer snowflake (*Leucoium aestivum*), and *Cardamine dentata*. Bladder-sedge is better represented in the subassociation with black alder, while summer snowflake and *Cardamine dentata* are better represented in the subassociation *typicum*. As characteristic species of the alliance and order *Populetalia*, both subassociations are rich in gipsywort (*Lycopus europaeus*), yellow loosestrife (*Lysimachia vulgaris*), dewberry (*Rubus caesius*), yellow flag (*Iris pseudacorus*), marsh woundwort (*Stachys palustris*), wood dock (*Rumex sanguineus*), remote sedge (*Carex remota*) and others. In the subassociation *alnetosum glutinosae* the participation of remote sedge is considerably smaller than in the subassociation *typicum*.

Of other species of wet and flooded sites, the most numerous in both subassociations are *Polygonum hydropiper*, spurge (*Euphorbia palustris*), and purple loosestrife (*Lythrum salicaria*). In the subassociation typicum there is also sedge (*Carex vulpina*), giant fescue (*Festuca gigantea*), and tufted hair-grass (*Deschampsia caespitosa*). Of distinguishing species which divide the subassociation alnetosum glutinosae from typicum, the most numerous are common nettle (*Urtica dioica*), milk parsley (*Peucedanum palustre*), common hemp nettle (*Galeopsis tetrahit*), water forget-me-not (*Myosotis scorpioides*), bittersweet (*Solanum dulcamara*), Nephrodium spinulosum, marsh marigold (*Caltha palustris*), and soft rush (*Juncus effusus*).

A detailed analysis of individual phytocoenological recordings, combined with knowledge of the conditions in the terrain and changes in the past, show that Recording 1 represents a young ash forest. The conditions for the development of forest vegetation here are very hard, so that narrow-leaved ash is a mono-dominant species of very bad appearance (curved), while the shrub layer is very poorly developed. Recording 2 refers to the terrain which represents the initial stage in the development of narrow-leaved ash forests. The stand is characterised by a very poor appearance with badly curved ash trees and a poverty of species (*Leucoium aestivum*, *Polygonum hydropiper*, moss), but the recording itself represents a transition into the optimal stage, which is fully shown in Recording 3. Here, the ash is taller, straight and of good quality, and there is a much larger variety of species in all layers.

Recording 4 represents a typical example of a terminal stage in the development of forests of narrow-leaved ash and summer snowflake, as described by Glavač (1959). Apart from narrow-leaved ash, the tree layer displays pedunculate oak, the shrub layer is characterised by Genisto elatae, and the ground vegetation abounds in hygrophyllic species with occasional tufts of remote sedge (*Carex remota*). It is a perfect indicator of decreased humidity and a transition towards the association of pedunculate oak and great green weed with remote sedge (*Genisto elatae-Quercetum roboris caricetosum remotae*).

Recording 5 shows the area affected by pedunculate oak dieback. The terrain is waterlogged, and consequently the earlier association of pedunculate oak and great green weed with remote sedge has been replaced by the association of narrow-leaved ash and summer snowflake. A number of elements remaining from forests of pedunculate oak are further indicators of the case: *Acer campestre*, *Crataegus oxyantha*, *Euonymus europaea*, *Ulmus carpinifolia*, *Carex remota*, *Rubus caesius*, *Cerastium silvaticum*, *Stellaria media*. *Glechoma hederacea*, and others.

Recording 6 shows a characteristic subassociation with black alder, where the participation of narrow-leaved ash reaches 70% and black alder 30%. Species differentiating this subassociation from a typical forest of narrow-leaved ash with summer snowflake are also present: *Myosotis scorpioides*, *Solanum dulcamara*, *Caltha palustris*, *Urtica dioica*, *Peucedanum palustre* and *Nephrodium spinulosum*. Recording 7 is similar, except that the participation of alder is somewhat higher, while Recording 8 is characterised by the fact that it was made in the area where pedunculate oak has desiccated. The desiccation was followed by the introduction of EA poplar cultures, which were suppressed by narrow-leaved ash and black alder some thirty years later, as these were the only pioneering species capable of surviving in such a badly devastated site.

In contrast, Recordings 9 and 10 represent the driest variant of this subassociation with species such as *Quercus robur*, *Acer campestre*, *Crataegus oxyantha*, *Carex remota* and others, and indicate the progression of the site towards a forest of pedunculate oak and great green weed with remote sedge.

Table 11. - *Tablica 11.*

Association:		*LEUCOIO-FRAXINETUM ANGUSTIFOLIAE* Glavač 1959										Degree of part.	Biological form
Subassociation:		*typicum* Glavač 1959					*alnetosum glutinosae* Glavač 1959						
Number of recording:		1	2	3	4	5	6	7	8	9	10		
Area:		Žutica											
Department, compartment:		9a	194a	61b	198a	56b	160b	167c	129c	69a	77a		
Plot size (m^2):		400	400	400	400	400	400	400	400	400	400		
Date:		2.7.97.	6.6.97.	4.9.97.	4.6.97.	26.8.97.	17.6.97.	20.6.97.	26.6.97.	27.8.97	23.9.97.		
Cover (%):													
Tree layer		90	60	50	70	80	50	70	50	70	80		
Shrub layer		1	5	20	70	40	10	1	10	30	10		
Ground vegetation layer		70	100	90	100	10	90	90	100	90	90		
FLORAL COMPOSITON													
Characteristic and distinguishing species of the association:													
Fraxinus angustifolia Vahl	A	5	4	4	4	4	3	4	4	4	4	V	Ph
Fraxinus angustifolia Vahl	B	.	+	1	+	.	+	+	1	2	1	IV	Ph
Galium palustre L.	C	2	2	1	+	+	1	1	1	+	1	V	H
Carex vesicaria L.		2	1	1	+	.	4	3	2	2	4	V	H
Carex elata All.		2	+	3	2	.	.	3	3	2	2	IV	H
Carex riparia Curt.		.	+	4	1	.	4	.	.	1	3	III	H
Leucoium aestivum L.		3	2	.	2	.	+	+	.	.	.	III	G
Cardamine dentata L.		1	+	+	.	.	.	.	.	.	+	II	H
Characteristic and distinguishing species of the alliance and order (*Populetalia*):													
Quercus robur L.	A	.	.	.	+	.	.	.	.	.	+	I	Ph
Ulmus laevis Pall.	B	.	+	1	.	+	1	.	.	+	.	III	Ph
Genista tinc. ssp. *elata* A. et G.		+	+	.	4	.	+	.	.	.	.	II	Ph
Salix cinerea L.		.	.	1	+	.	.	.	1	.	+	II	Ph
Ulmus carpinifolia Gled.		.	.	.	+	.	.	.	+	.	.	I	Ph
Populus alba L.		+	.	.	.	.	.	.	.	.	.	I	Ph

Quercus robur L.		.	.	+	.	.	.	.	.	.	.	I	Ph
Lycopus europaeus L.	C	1	.	1	+	.	+	+	1	+	2	IV	H
Lysimachia vulgaris L.		+	+	1	1	.	.	+	+	+	1	IV	H
Rubus caesius L.		+	+	1	1	+	.	+	.	2	.	IV	H
Iris pseudacorus L.		+	2	.	+	.	+	+	1	+	+	IV	G
Stachys palustris L.		2	1	.	+	.	.	+	1	+	1	IV	H
Rumex sanquineus L.		+	1	.	+	.	+	1	+	.	.	III	H
Carex remota L.		3	+	.	+	+	.	.	.	1	.	III	H
Carex elongata L.		1	.	.	1	.	2	.	1	.	.	II	H
Quercus robur L.		.	.	.	+	+	.	.	.	+	.	II	Ph
Valeriana dioica L.		.	.	2	.	+	.	.	.	1	+	II	H
Glechoma hederacea L.		.	.	+	.	1	.	+	.	3	.	II	Ch
Ulmus carpinifolia Gled.		.	.	.	.	1	.	.	.	.	.	I	Ph
Viburnum opulus L.		.	.	+	.	.	.	.	.	.	.	I	Ph

Distinguishing species of the subassociation *alnetosum glutinosae*:

Alnus glutinosa Gartn.	A	.	.	.	.	.	+	1	1	2	3	III	Ph
Alnus glutinosa Gartn.	B	.	.	1	.	.	1	+	1	.	+	III	Ph
Frangula alnus Mill.		.	.	.	+	.	.	.	+	.	1	II	Ph
Urtica dioica L.	C	.	.	1	.	1	2	2	+	1	1	IV	H
Peucedanum palustre (L.) Monch.		+	.	.	+	.	1	1	3	.	2	III	H
Galeopsis tetrahit L.		.	.	.	.	+	+	+	+	.	+	III	Th
Solanum dulcamara L.		.	.	1	.	.	1	1	.	1	.	II	H
Humulus lupulus L.		.	.	.	.	.	+	+	+	.	.	II	H
Nephrodium spinulosum (Mill.) Stemp.		.	.	+	.	.	+	+	+	.	.	II	H
Caltha palustris L.		.	.	+	.	.	3	1	.	.	.	II	H
Juncus effusus L.		.	.	.	.	.	.	+	+	+	.	II	H
Myosotis scorpioides L.		.	.	.	.	.	+	1	+	.	+	II	H
Lysimachia nummularia L.		.	.	.	.	.	.	1	.	+	.	I	H
Impatiens noli tangere L.		.	.	.	.	.	.	1	+	.	.	I	Th
Athyrium filix femina (L.) Roth.		.	.	.	.	.	.	+	+	.	.	I	H
Circaea lutetiana L.		.	.	.	.	.	.	.	+	+	.	I	G
Frangula alnus Mill.		.	.	.	.	.	+	.	.	.	.	I	Ph

Other species of wet and flooded sites:													
Polygonum hidropiper L.	C	2	4	+	1	.	+	1	+	+	.	IV	Th
Euphorbia palustris L.		1	+	+	+	.	+	.	1	.	3	IV	H
Lytrum salicaria L.		+	.	+	+	.	1	.	1	.	.	III	H
Ranunculus repens L.		1	+	+	1	.	+	1	.	.	.	III	H
Carex vulpina L.		1	2	.	.	.	.	.	.	.	.	I	H
Alisma plantago aquatica L.		.	.	.	+	.	1	.	.	.	.	I	H
Festuca gigantea (L.) Vill.		.	2	.	+	.	.	.	.	.	.	I	H
Deschampsia caespitosa (L.) Beaur.		1	+	.	.	.	.	.	.	.	.	I	H
Oenanthe fistulosa L.		.	+	+	.	.	.	.	.	.	.	I	H
Succisa pratensis Mch.		.	.	1	.	.	.	.	.	.	+	I	H
Mentha aquatica L.		1	.	.	.	.	.	.	.	.	.	I	H
Roripa amphibia (L.) Bess.		.	2	.	.	.	.	.	.	.	.	I	
Senecio aquatica Huds.		.	+	.	.	.	.	.	.	.	.	I	H
Thalictrum flavum L.		.	+	.	.	.	.	.	.	.	.	I	
Poa palustris L.		+	.	.	.	.	.	.	.	.	.	I	H
Symphytum officinale L.		.	.	.	.	.	.	.	2	.	.	I	H
Accompanying species:													
Acer campestre L.	A	.	.	.	.	1	.	.	.	.	.	I	Ph
Crataegus oxyacantha L.	B	.	.	1	.	3	.	+	.	+	.	II	Ph
Rhamnus cathartica L.		.	.	+	.	.	.	.	.	2	.	I	Ph
Pyrus pyraster (L.) Borkh.		.	.	+	.	.	.	.	.	.	+	I	Ph
Acer tataricum L.		.	.	.	+	.	1	.	.	.	.	I	Ph
Acer campestre L.		.	.	.	.	1	.	.	.	+	.	I	Ph
Fraxinus americana		.	.	.	1	.	.	.	.	.	.	I	Ph
Euonymus europaea L.		.	.	.	.	+	.	.	.	.	.	I	Ph
Amorpha fruticosa L.		.	+	.	.	.	.	.	.	.	.	I	Ph
Aegopodium podagraria L.	C	1	.	.	.	.	.	.	+	.	.	I	H
Galeopsis speciosa Mill.		.	.	1	.	+	.	.	.	.	.	I	Th
Stellaria media (L.) Mill.		.	.	.	.	+	+	.	.	.	.	I	Ch
Melandrium rubrum Roehl.		.	.	+	.	.	.	.	.	.	+	I	H

Lychnis flos cuculi L.	.	.	.	+	.	.	.	.	.	.	I	H
Milium effusum L.	.	+	.	.	.	.	.	.	.	.	I	H
Hedera helix L.	.	.	.	.	+	.	.	.	.	.	I	Ph
Brachypodium silvaticum (Huds.) R.S.	.	.	.	.	+	.	.	.	.	.	I	H
Acer campestre L.	.	.	.	.	+	.	.	.	.	.	I	Ph
Rhamnus cathartica L.	.	.	.	.	+	.	.	.	.	.	I	Ph
Cerastium silvaticum W.K.	.	.	.	.	+	.	.	.	.	.	I	Ch
Geum urbanum L.	.	.	.	.	.	.	+	.	.	.	I	H
Angelica silvestris L.	.	.	.	.	.	.	.	+	.	.	I	H
Filipendula ulmaria (L.) Maxim.	.	.	.	.	.	.	.	.	1	.	I	H
Ajuga reptans L.	.	.	.	.	.	.	.	.	.	+	I	H
Galium silvaticum L.	.	.	.	.	.	.	.	.	.	+	I	H

Explanation of abbreviations:
A - Tree layer
B - Shrub layer
C - Ground vegetation layer
+, 1, 2, 3, 4, 5 - Combined assessment of abundance and cover (Braun-Blanquet 1964)

Biological range: The biological range of biological (living) forms according to Ranunkiaer (1905) from 10 phytocoenological recordings (Table 11) show the following relationship of plant species: phanerophytes (Ph) 33%, chamaephytes (Ch) 4%, hemicryptophytes (H) 55%, geophytes (G) 4%, therophytes (Th) 5%. Such a structure points to a distinctly hemicrypto-phanerophytic (55 + 33%) association.

Division of the phytocoenosis: Glavač (1959) divides the association into two subassociations: *typicum* - in a flooded zone, and *alnetosum glutinosae* (forest of narrow-leaved ash and black alder with summer snowflake) - in depressions out of a flood zone or on its edges, and in relief depressions under the strong influence of groundwater.

Syndynamics of the phytocoenosis: According to research by this author, the forest of narrow-leaved ash with summer snowflake in "Žutica" is in all stages of development (from initial to terminal - according to Glavač 1959). Narrow-leaved ash itself also occurs in all kinds of stands inhabiting different forms of micro-relief (from swamps to micro-elevations). As humidity in the site decreases, the association allows a drier association of pedunculate oak and great green weed remote sedge to take its place. Under more humid conditions, not even narrow-leaved ash survives, and the site is taken by the initial vegetation of willows and various swampy plants.

Stability of the phytocoenosis: Due to a disturbed rhythm of floods and a waterlogged terrain intersected with roads, the association shows a tendency to expand into lower positions inhabited by the association of pedunculate oak and great green weed. Narrow-leaved ash shows outstanding aggression in conquering more humid sites, producing an ample seed crop, and spreading its seed fast by water and wind. A comparison of the current state with that described by Medvedović (1975) shows that the forest of narrow-leaved ash has expanded into compartments 15, 20, 56b, 61b, 62b, 64f, 164b, 194c, 195c, and 196a, which were previously inhabited by forests of pedunculate oak and great green weed with remote sedge, and into compartments 33b and 58b, e, and f, previously inhabited by the forest of pedunculate oak and great green weed with quaking sedge. The full extent of regression is seen in compartments 27d and 72f, where an ash forest has replaced the earlier forest of pedunculate oak and common hornbeam after the pedunculate oak desiccated and ecological conditions changed. Apart from these changes in the associations themselves, the onset of narrow-leaved ash and the accompanying elements is visible in many localities.

Besides a complex in the southern and south-western region, there are also several initial areas of a successive character, resulting from the water let into the Management Unit "Žutica" by the water authorities. This association is expected to expand in the future.

Likewise, the seed of narrow-leaved ash is successfully invading clearings and forming young ash stands within complexes of lowland forests (Matić 1981). This can be seen in many places in "Žutica", particularly in the north-west and south part of the Management Unit.

Under normal conditions, the processes of vegetation succession lead towards the transition of a forest of narrow-leaved ash into a less humid forest of pedunculate oak and great green weed with remote sedge. In the Unit under study this is a very rare occurrence, and can only be seen in compartments 23b and 75a. Progression is visible along river courses, where deposits of materials have elevated the terrain and decreased humidity. Elements of oak forests are gradually suppressing hygrophyllic elements of ash forests, thus forming associations occupying a higher place in a succession series *Leucoio-Fraxinetum angustifoliae* → *Genisto elatae-Quercetum roboris* → *Carpino betuli-Quercetum roboris*.

Forest-economic characteristics: The importance of narrow-leaved ash should be emphasised from several standpoints. It is important as a pioneering species, and succeeds in unfavourable, mostly swampy conditions where other species cannot grow and where it has no competition. Furthermore, when stands of pedunculate oak in the association *Genisto elatae-Quercetum roboris* desiccate and the biotop changes and becomes waterlogged, ash represents an indispensable species in the restoration of desiccated stands. In the first stage, together with black alder, it takes the main role until conditions for the return of pedunculate oak are established. This was proved in the restoration of the forests Kalje, Turopoljski Lug, the forests in Pokuplje, and others. Finally, ash is a highly appreciated economic species, which periodically achieves the same price as pedunculate oak.

In the natural regeneration of narrow-leaved ash stands (Dekanić, 1961), shelterwood felling is done in two cuts (seeding and final), as ash is the most heliophyllic species. The minimal rotation period is 80 years.

OTHER ASSOCIATIONS
OSTALE ZAJEDNICE

Apart from the above mentioned and described associations, there are initially developed associations of willows in the south-west of "Žutica". These are stands of white willow (*Salix alba*), goat willow (*Salix caprea*) and grey willow (*Salix cinerea*). The conditions for the development of forest vegetation in these localities are very hard, as the terrain is mainly covered with almost impenetrable high sedges, while bushes of goat willow and grey willow are sporadically dispersed in small groups. White willow grows in the form of trees, but its numbers are low. Small groups of white willow are also sporadically arranged over the area. The following species occur in the ground vegetation: *Carex riparia*, *Carex vesicaria*, *Carex elata*, *Polygonum hydropiper*, *Lysimachia vulgaris*, *Leucoium aestivum*, *Iris pseudocorus*, *Stachys palustris*, *Euphorbia palustris*, and others, mostly swampy species, indicating high humidity in the site. This is not surprising, since the area is under the strong influence of flood and groundwater.

Unlike cultures of spruce (*Picea abies*) and Weymouth pine (*Pinus strobus*) which inhabit very small areas in the "Žutica", artificially raised cultures of Euro-American poplars (*Populus* x *euroamericana*) are much more numerous, for example in compartments 42a, 49c, 131b, 133, 137a, 138b, 173c, 182c, 183b, 193b, and others. They were raised primarily in order to restore the area after pedunculate oak dieback (most were established in 1968). Recordings from compartments 42a, 49c, 114c and 137b show that Euro-American poplars are enriched with a large participation of black alder (*Alnus glutinosa*) in the tree layer, while alder buckthorn (*Frangula alnus*) occurs in the shrub layer. *Carex vesicaria*, *Carex elata*, *Peucedanum palustre*, *Deschampsia caespitosa*, *Urtica dioica*, *Polygonum hydropiper*, *Juncus effusus*, *Lycopus europaeus*, *Lytrum salicaria*, *Myosotis scorpioides*, *Lysimachia vulgaris*, *Galeopsis tetrahit*, *Stachys palustris*, *Iris pseudacorus*, *Glechoma hederacea* and *Galium palustre* appear in the ground layer. This is indication of the return of autochthonous vegetation, above all, of black alder and its accompaniments, as pioneering species capable of surviving in changed site conditions (water logging, full light). Unless new disturbances take place, this slow progression is expected to continue towards autochthonous natural vegetation, from black alder towards pedunculate oak.

DISCUSSION
RASPRAVA

FACTORS OF DESTABILIZATION IN THE "ŽUTICA" ECOSYSTEM
ČIMBENICI DESTABILIZACIJE EKOSUSTAVA ŽUTICA

The forest of "Žutica" represents an ecosystem which has dramatically changed its natural appearance and stability primarily owing to man's activity. Regions of lowland forests in Croatia are currently under strong human influence; however, this influence is nowhere so pronounced as in "Žutica".

The forests of Central Posavina were primeval forests as late as the 18th century. Virtually untouched by man, these forests were not affected by any human influence, so they retained a perfect ecological balance.

The original influence of man on the ecosystems in the "Žutica" forests was limited to his exploiting them by cutting, using more elevated positions for building houses and settlements, and keeping livestock in forests and in fields.

The first major shock for these forests came when man's extensive activities disrupted the balance between the biocoenosis and the site. As pedunculate oakwood achieved outstanding values on the European market, almost every virgin forest in Posavina was cut down. Large-scale felling caused the climate and the hydrological conditions in the forests and their surroundings to change. The microclimate and macroclimate changed, and humidity increased. The negative influence of man increased by his favouring pedunculate oak and establishing its monocultures. Since this monoculture could not achieve a biological balance, it was prone to frequent attacks by harmful insects. Repeated defoliation, combined with mildew and floods during the growing period, led to tree and stand dieback.

In 1930, dieback of lowland elm caused by Dutch Elm disease assumed epidemic proportions. The disappearance of elm from the understorey resulted in a changed climate: there was more light, the forests became warmer and drier, and the ecological balance was disturbed even more.

At the end of the 19th and the beginning of the 20th century, regulations of the water regimes of the Sava, Lonja and Česma took place. These hydro-improvement treatments, continuing until the present day, have had a highly damaging impact on the "Žutica" forest ecosystem. The river courses of the Sava, Česma and Lonja have been regulated, the Lonja-Strug canal and the Deanovec canal dug; the Lonjsko Polje drained, a retention at a height of 98.4 m above sea level made, and agricultural land around the forest ammeliorated. All this has disturbed water relations in the forest. Groundwater levels have dropped and floods are either absent or reach the forest at an unsuitable time, that is, when water management authorities let the water into the forest. Combined with other negative factors, this has resulted in forest dieback and regression processes, both in the plant communities and in the site.

Dry periods during the growing season are becoming more frequent. As a result, there is either a shortage of water, or more frequently, a surplus of water. Again, the main culprit is man. In order to exploit oil from "Žutica", man has built as many as 76 km of hard roads through the forest, most of them without adequate draining systems. The resulting "slots" trap the water, so it cannot retreat as it does under a normal regime. The trapped water remains until it evaporates, which leads to water logging of the terrain. The consequences are a lack of oxygen in the soil, decreased microbiological activity, and a decline in vegetation not adapted to these new conditions.

It is very important to mention that the area of the forest "Žutica" has been very intensively exploited for oil since 1964. A highly complex system of exploitation with as many as 289 oil wells has been erected in large clearings. These wells are connected with roads for motor vehicles and underground oil and water transport systems. Two central buildings of INA-Naftaplin have also been built in the area. These facilities have broken up the stands in the "Žutica" and exposed them to adverse external influences, thus leading to general dieback. The most pronounced cases of dieback are precisely around the oil wells. Another problem is that old oil pipes often burst and the oil spills into the forest, while restoration of the damage is inadequate and untimely. The soil becomes polluted, and roots and useful fauna cannot carry out their function. This causes the physiological weakening and desiccation of trees.

A further highly negative impact on the forest communities is exerted by the river Sava and its tributaries, which are badly polluted with toxic mechanical waste, unhumified faecal matter, large amounts of chemical waste, acids and various other toxic substances.

The situation is further aggravated by polluted air (SO_2, NOx, heavy metals and other materials) whose origin is difficult to ascertain. A part undoubtedly comes from industrial centres (Zagreb, Sisak, Kutina), a part relates to car traffic (immediate vicinity of the motorway), while a considerable part is brought to the area from distant European industrial regions by air currents.

Felling activities carried out after dieback also destroy the structure of stands and further influence the forest climate.

Apart from all these abiotic factors, biotic ones also play an important role. In the beginning of forest research, these were considered primary factors of forest decline. Today, however, they are regarded to have a secondary role: a weakened tree resistance allows harmful entomofauna, above all gypsy moths and plant diseases (mildew), to attack.

The ground vegetation along the river Lonja is badly damaged by cattle (pigs, cows and horses), and the soil is trodden down or routed up.

In conclusion, the forest of "Žutica" is a very complex ecosystem marked by a multitude of various factors and their combinations. This contributes to the complexity of the problem of desiccation, since the effect of harmful factors is mostly synergistic.

THE HISTORY OF DESICCATION IN THE MANAGEMENT UNIT "ŽUTICA"
POVIJEST SUŠENJA ŠUMA U GOSPODARSKOJ JEDINICI ŽUTICA

The first instances of dieback in "Žutica" occurred in 1910. Since then, desiccation intensity has been changing, but the first particularly strong occurrences of dieback took place between 1924 and 1927.

The problem of oak dieback was dealt with in the "Forest Paper" as early as 1878, but it did not worry forest experts of the time until a catastrophic dieback of Žutica" in 1925 took place. According to Nenadić, the dieback was of such pro - portions that it was regarded as the biggest national economic catastrophe of the time. The wood mass of dead oaks in 1924 alone was about 50,000 m^3, and the situation grew even worse the following year. Different researchers gave different reasons for the occurrence, but what it known is that in that year the flood coincided with defoliation. The same situation was repeated in the spring of 1965 and 1966. In the short period of 1966 - 1973, about 300,000 m^3 of wood mass desiccated. Total dieback occurred almost exclusively in micro-depressions where water remained for longer periods. Stronger instances of desiccation on micro-elevations were only sporadic, and occurred only on small elevations situated in the middle of a low terrain. Despite the fact that stagnant water did not remain there long, a high level of groundwater, reaching almost to the soil surface, had almost the same effect on the area browsed clean by cattle. According to an analysis carried out in 1968, between 1958 and 1968 a total of 244,900 m^3 of pedunculate oak desiccated. During the half-period 1968 - 1977, a further 69,660 m^3 of dead oak trees were cut down, which amounted to a total of 314,560 m^3 for a 20-year period. Such catastrophic dieback in a relatively small area had never happened before, and initiated a detailed study of this problem.

PRESENT CONDITION IN THE "ŽUTICA" ECOSYSTEM
SADAŠNJE STANJE EKOSUSTAVA ŽUTICA

The intensity of dieback is lower today, but the desiccation process, above all of pedunculate oak, is still continuing. The consequences of earlier disastrous dieback cases are still felt today, so that the proportion of sanitary fellings in the period 1988 - 1995 amounted to 25,259 m^3, or 13.8%. At present, this is a very unstable ecosystem that requires careful handling and the application of silvicultural treatments aimed at restoring its lost ecological balance.

Each change in the intensity and dynamics of wetting (surplus or shortage of water) causes changes in the forest ecosystem. This is largely reflected in desiccation, as is the case here. Conditions causing catastrophic dieback have an impact on young, middle-aged, mature and old stands. The intensity of dieback is higher in older stands.

In order to assess the present condition of forests, the phytocoenology of all communities in the Management Unit "Žutica" was recorded in detail, and special attention was given to the consequences of pedunculate oak dieback in the last thirty years. The condition was compared with research by Rauš (1967 - 1973, 1980) and with Medvedović's vegetation map of the "Žutica" on a scale 1 : 50,000, also dating from 1975. The results of pedological research, as well as those of research into lowland forests in the areas affected by pedunculate oak dieback (Kalje, Turopoljski Lug, Pokuplje Basin), were also used.

From a phytocoenological standpoint, the condition is regarded normal when no significant changes in site conditions and in the structure of forest associations have occurred in the last thirty years, or when a progressive successive change towards a climatozonal association has taken place. In this respect, the presence of various successive processes linked primarily to anthropogenic (stressful) influences has been established.

The Forest of pedunculate oak and common hornbeam (*Carpino betuli-Quercetum roboris*) is relatively the most stable association of pedunculate oak in Croatia. In the last thirty years, its total surface area in "Žutica" has slightly increased. This is the result of progression, that is, of the syndynamic development of more humid associations, which has occasionally been accelerated by a drop in the groundwater level caused by hydro-meliorative activities (the best example is the locality of Žalkovo). The total area in progression is slightly over 300 ha; however, this association, too, was subjected to regression processes. Almost 60 ha of the association's sites are currently inhabited by black alder or narrow-leaved ash, and as many as 200 ha by forests of pedunculate oak and great green weed (80 ha is the subassociation with quaking sedge, and 120 ha is the subassociation with remote sedge).

It should be stressed that the association of pedunculate oak and common hornbeam, being a terminal association in the development of forest vegetation of lowland Croatian regions, proved to be stable and resistant to dieback in other localities affected by pedunculate oak dieback (Kalje, Turopoljski Lug, Pokuplje Basin). This stable character was also confirmed by research in "Žutica" (Rauš 1980).

For the first time in this region, an association of pedunculate oak and great green weed with common hornbeam, or the so-called humid micro-elevation, was established in an area of about 150 ha. Of this, about 100 ha were the result of progression in the areas previously inhabited by the described subassociations of the association with quaking sedge and remote sedge. However, about 50 ha were established as a consequence of regression processes in the association of pedunculate oak and common hornbeam.

The biggest changes, regardless of whether they related to positive or negative succession, took place in the association of pedunculate oak and great green weed (*Genisto elatae-Quercetum roboris*). About 50 ha of the subassociation with quaking sedge (*caricetosum brizoides*) are inhabited by the forest of black alder, about 30 ha by a forest of narrow-leaved ash, while over 120 ha are covered by a more humid subassociation with remote sedge.

Site progression is visible on a very small area of about 40 ha (20 ha has turned into a subassociation with common hornbeam and about 20 ha into an association of pedunculate oak and common hornbeam). Therefore, this subassociation has considerably decreased its area.

Its floral composition has also undergone changes, so that an increased participation of plants of humid terrain is complemented with *Frangula alnus*, *Salix cinerea*, *Juncus effusus*, *Peucedanum palustre*, *Cirsium palustre* and others, while mesophyllic elements are gradually disappearing. All this indicates that the biotop is now waterlogged.

Rauš, studying the forest vegetation of "Žutica" in the period 1969 - 1973, confirmed that the forest of pedunculate oak and great green weed with quaking sedge was in a relatively stable condition and did not show any disturbances in its development and floral composition connected to small-scale pedunculate oak dieback. According to him, the subassociation was then in a state of progression.

However, research in other localities of pedunculate oak dieback shows almost identical results to those found and described in "Žutica" by this author, where serious consequences of stress and indiscriminate sites are visible. Floral compositions and the physiognomy and structure of stands have completely lost their character of typically developed subassociations in many places. Non-typical plants indicating a waterlogged biotop are dominant.

A more humid subassociation with remote sedge (*caricetosum remotae*) has also undergone considerable changes. Regression was recorded in as many as fifteen departments or compartments (about 200 ha), and the site was invaded by more humid associations, of which 70 ha by the association of black alder, and 130 ha by the association of narrow-leaved ash. Currently, slightly over 50 ha are still under the association of pedunculate oak and great green weed with common hornbeam, while about 130 ha are under the association of pedunculate oak and common hornbeam; however, these are progression processes.

On the other hand, the area of this association has increased at the expense of the association of pedunculate oak and common hornbeam, mostly owing to increased terrain humidity and related regression processes. Slightly more than 120 ha are taken by this association, and about 120 ha by the association of pedunculate oak and great green weed with quaking sedge. In addition, as a consequence of the mainly natural succession of associations and their transition into drier ones, this subassociation has expanded over a further 80 ha of the previous forest of black alder and over about 50 ha of the previous forest of narrow-leaved ash.

All this indicates very intensive changes despite the fact that the association has more or less retained its surface area of thirty years ago.

On the basis of his research in "Žutica" (1980), Rauš concluded that this subassociation was in regression, because its stability was largely disturbed by the dieback of lowland elm, followed by the sudden and mass dieback of pedunculate oak. Such conditions led to the development of ample weed vegetation, a surplus of stagnant water and water logging of the terrain.

This situation, although on a smaller scale, is confirmed by current research. Today, regression processes in the subassociation with quaking sedge are somewhat larger, which coincides with the results of vegetation research in Kalje, Turopoljski Lug and the Pokuplje basin.

In the meantime, pioneering species of black alder and narrow-leaved ash have filled bare land and empty areas left after dieback, which has had a positive effect on the gradual stabilisation of these stands.

Thus, the total area under the association of black alder with alder buckthorn (*Frangulo-Alnetum glutinosae*) has been enlarged by about 80 ha in relation to 1975, (Medvedović). However, this was rather difficult to establish, since black alder grows very intensively around the majority of the 289 oil wells existing in the area, developing the association of black alder with alder buckthorn. Therefore, it can be concluded that the size of the area under this association is much larger than mentioned above. Next, some 25 ha refers to the entrance of black alder into the previously bare land, while the second expansion of black alder relates to regression processes in the site and stands in "Žutica". Black alder took over 70 ha of the area which, according to Medvedović (1975), was under the association of pedunculate oak and great green weed with remote sedge, and 40 ha under the association of pedunculate oak and common hornbeam.

However, changes in site conditions and the progression of vegetation caused black alder to diminish by almost 80 ha in favour of the association of pedunculate oak and great green weed with remote sedge, by 50 ha in favour of the association of pedunculate oak and great green weed with quaking sedge, and by about 30 ha in favour of the association of pedunculate oak and great green weed with common hornbeam.

The results of the current research were compared with the situation in 1975 (Medvedović). It can be seen shown that the penetration of narrow-leaved ash and the related association of narrow-leaved ash and summer snowflake (*Leucoio-Fraxinetum angustifoliae*) into the previously bare land and the area inhabited by other associations is even stronger than was the case with black alder. The negative factors mentioned earlier have led to pedunculate oak dieback and caused abrupt changes in ecological site conditions, which have resulted in more humid conditions and the possibility of narrow-leaved ash, being a pioneering, fast-growing species with light seed, expanding into smaller or bigger areas under different associations. These include swampy areas, micro-depressions and micro-elevations.

The same pattern emerges as with black alder: the higher the terrain and the drier the association, the weaker the onset of narrow-leaved ash. Thus, the association of narrow-leaved ash with summer snowflake covers over 120 ha of the land previously inhabited by the association of pedunculate oak and great green weed with remote sedge. About 30 ha of the sites belonging to the association of pedunculate oak and great green weed with quaking sedge, and 15 ha of the sites of the association of pedunculate oak and common hornbeam are covered by forests of narrow-leaved ash.

All these forests of narrow-leaved ash were formed through regression processes. A normal site progression and a transition of forests of narrow-leaved ash into drier associations occurred over only 70 ha. The association of narrow-leaved ash with summer snowflake passed into the association of pedunculate oak and great green weed with remote sedge on 50 ha, and the association of pedunculate oak and common hornbeam on about 20 ha. It should be stressed that over 100 ha of the previously bare soils are now covered with forests of narrow-leaved ash with summer snowflake in various stages of development. These forests were created either naturally, or with the help of man (by planting seedlings), but they are mostly in the initial stage that frequently passes into the optimal one.

In conclusion, all this confirms that over 700 ha of the most interesting and valuable forests of pedunculate oak underwent intensive and abrupt external and internal influences during dieback some thirty years ago. The principal tree species desiccated, the site conditions and forest communities changed, and a negative succession of forest vegetation took place. In order to obtain the final picture and a complete syndynamic development in "Žutica", the results should be complemented with those of pedological research.

The results of all research have been used to draw up a vegetation map on a scale 1:25,000 of forest associations in the Management Unit "Žutica". The mapping was based on the instructions from the "Manual of typological research and vegetation mapping" (Horvat et al. 1950). A total of eight vegetative units (associations and subassociations) was presented, including the association of pedunculate oak and great green weed with common hornbeam for the first time in this area.

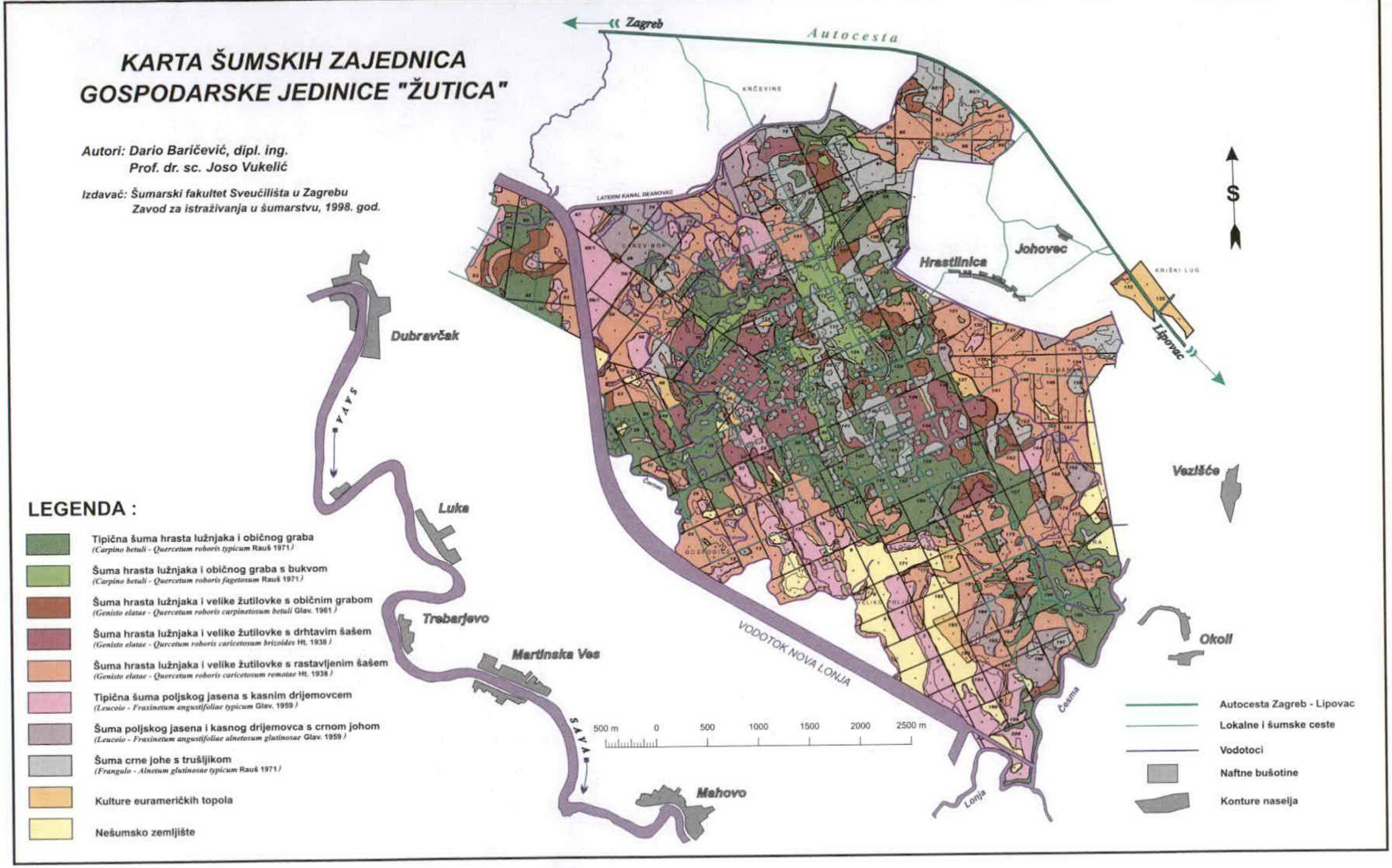


Figure 2. Map of forest associations in the Management Unit "Žutica"

The phytocoenological map shows the real state of forest phytocoenoses in the studied area, as well as the development dynamics of vegetation. It can be used as a starting point in planning and carrying out all the activities within the ecosystem (management, tending and other tasks). Next, it can also be used in climatological, pedological, economic, management and other research.

In general, it is hard to predict the direction of vegetation development in the studied area. It mostly depends on man's influence on the ecosystem. Degradation processes should be stopped with various meliorative and silvicultural measures. Natural principles should be followed, taking into account each case as it is. Areas under more humid associations are expected to expand, especially in the south, south-west and north-west part of the Management Unit under the forest of narrow-leaved ash, and in the north-east area of black alder forests around oil wells and in "slots". However, despite the considerable negative influence of various factors on the ecosystem, natural succession and the development of forest associations will continue their normal course in many places, that is, there will be a change from more humid towards drier associations.

SILVICULTURAL TREATMENTS IN STANDS WITH DAMAGED STRUCTURES AND SITES
UZGOJNI POSTUPCI U STRUKTURNO I STANIŠNO OŠTEĆENIM SASTOJINAMA

The ecosystem of the Management Unit "Žutica" has largely altered its natural appearance, and is in various stages of site and association degradation. As a result, the situation in the area of the Management Unit is highly varied in terms of conditions in forest associations. Therefore, in choosing proper silvicultural procedures, the existing situation should be taken into account. The Management Unit has a variety of forms. There are degraded flat areas with stagnant surface water, non-forested areas thickly covered with weeds, stands in one of the stages of degradation (thicket, brushwood), low silvicultural forms or coppices, and areas where natural or artificial regeneration with pedunculate oak have failed, and are consequently waterlogged or covered with weeds and subject to the succession of pioneering species. On the other hand, there are bigger or smaller areas with unbroken horizontal and vertical structures of good appearance and well-preserved soil, and areas where regeneration with pedunculate oak has been very successful.

Before these stands are regenerated and reconstructed, a thorough review of the area should be made, and a detailed forest management plan made, prescribing silvicultural treatments for each particular case.

Next, all accessible causes of degradation should be eliminated, and degraded areas put into progression by first restoring the most threatened areas, and then those with a lower degree of degradation. The preservation of forest soil from degradation should be given priority in establishing the sequence of treatments.

In applying silvicultural procedures to stands with damaged structures and sites, we should follow the principles set down by Matić (1989), Matić & Skenderović (1993), Matić et al. (1994), Matić (1996), Matić et al (1996), which have proved successful in other areas afflicted with similar ecological disturbances (Kalje, Turopoljski Lug, the Pokuplje basin).

Old oak stands in the central part of "Žutica", which have retained their coherence, adequate growing stock, mixture ratio and other structural and site properties, should be further tended and supported for the production of wood mass and use of trees as natural water pumps, and for gradual natural regeneration. Other healthy stands should also be tended and formed into coherent smaller or bigger stands, which will continue their production under new conditions in the soil.

Stands should also be regenerated in compartments 64a, 70b, 107a, 113b, 119b, 126d, 131c, 179b and others, where desiccation has reduced the growing stock by over 30%, leaving incoherently covered areas, but site conditions have not changed so much as to prevent the survival of pedunculate oak seedlings. Along with natural regeneration with the existing and newly formed young growth of the principal tree species, artificial regeneration should also be applied by introducing acorns or seedlings of pedunculate oak on the principle of shelterwood felling.

Natural and artificial regeneration, combined with the shelterwood method in small areas or circles should be the main principle of regenerating these stands.

In compartments 25d, 37, 63a, 103a, 104d, 122b, 155b and others, the desiccation of pedunculate oak and elm occurred in larger proportions, so that groups of oaks alternate with groups of ashes and alders, there are bigger or smaller gaps, and the forest cover has been halved. However, the remaining trees have good chances of survival, so these stands should be restocked with black alder or narrow-leaved ash. In this manner, the continuity of the still immature pedunculate oak stand will be ensured by establishing a stand of pioneering species which will protect the soil, form storeys, maintain a favourable stand climate, and gain good increment.

In areas with a higher degree of degradation, such as compartments 27d, 36b, 63a, 72f, 104b, 179e, 187b and some others, causes of degradation should first be eliminated from the terrain. In these compartments, conditions for the development of vegetation are very difficult. They are mostly covered with pedunculate oak stands heavily afflicted by large-scale desiccation. The ecological balance is disturbed, the canopy is permanently broken in many places, the terrain is waterlogged, the shrubs are thick and rich, and narrow-leaved ashes and black alders are appearing. In some extreme cases (for example, in compartment 117), even black alders are desiccating, leaving only weed-covered areas. Prior to planting such areas with pioneering species, weeds should be destroyed by mechanical means. Black alder, narrow-leaved ash and other pioneering tree species should be planted, bearing in mind the conditions in every site and the ecological requirements of each particular tree species. In order to prepare the site for planting pioneering tree species, it is necessary to drain the surface by digging shallow canals or vents in places where water stagnates in artificially formed "slots".

In degraded sites, pedunculate oak should be obtained indirectly by introducing pioneering tree species, especially narrow-leaved ashes, black alders, willows, poplars and others. It should be stressed that pedunculate oak is not and cannot be a pioneering tree species (Matić 1996), because it does not tolerate degraded soil.

In 1970, Professor Dekanić began an experiment in "Žutica" (compartment 114) aimed at determining the most favourable tree species and methods of regeneration in devastated areas resulting from pedunculate oak dieback. The results show that it is practically very difficult, if not almost impossible, to immediately regenerate degraded areas with autochthonous tree species, except for black alder. Black alders, white willows and Euro-American poplars can be used as pioneering, or transitional tree species, which will, in combination with silvicultural and other measures, form conditions for the arrival of more valuable tree species. Further research in these same experimental plots after twenty years (Oršanić, Matić, Anić 1996), confirmed that pedunculate oak was not suitable for planting in dieback-affected areas. Black alder, narrow-leaved ash, poplar and white willow are recommended. The best quality of trees and wood mass were achieved in the cultures of black alder and Euro-American poplar, clone I-154. It should be pointed out that a period of 25 years is not long enough for pioneering species to play their meliorative role.

To sum up, we could say that the measures applied to forests are aimed at maintaining the biological balance in the ecosystem. Each member of the community, from the living world in the soil to the dominant trees and every site factor, should be paid due attention. Judging by the situation so far, it is clear that better-organised and stronger forestry policy is needed in relation to the co-users of the same area, first of all the water management and the oil industry. Forestry experts are the most knowledgeable about forest ecosystems, and without their say when important decisions related to interventions into the ecosystem are made, little progress can be made.

CONCLUSIONS
ZAKLJUČCI

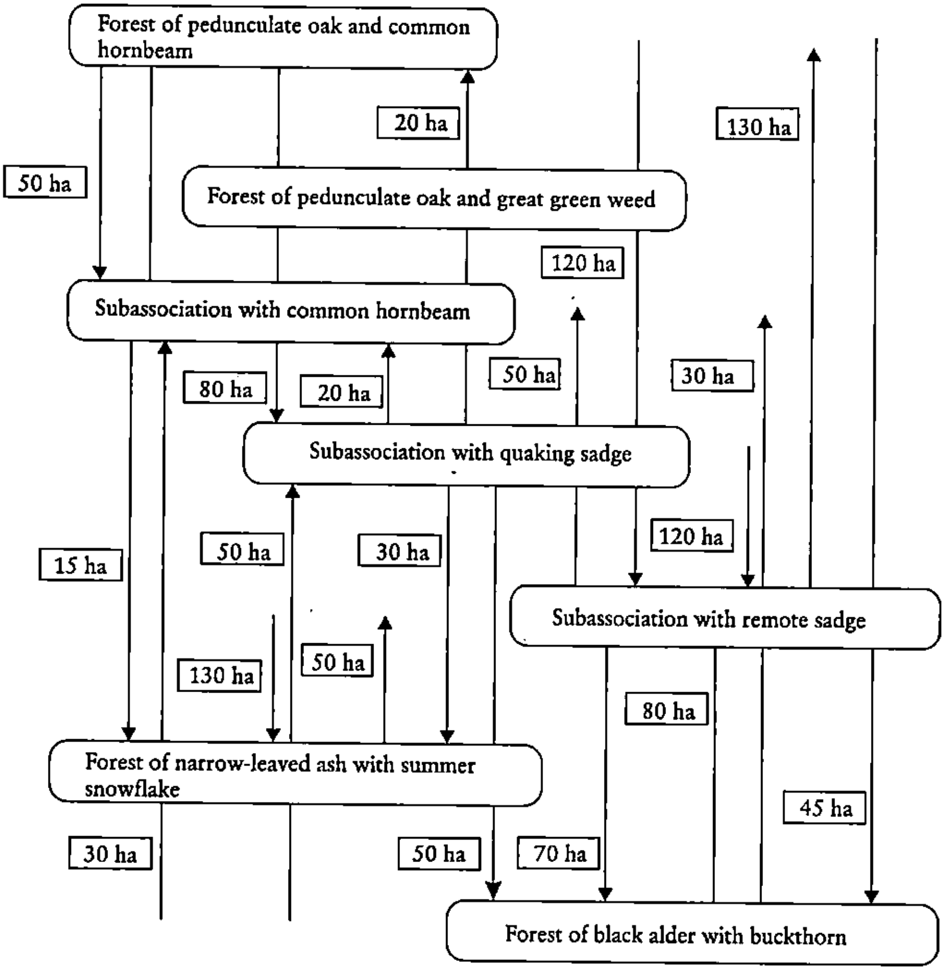
1. The author established and described eight forest associations over an area of 5,107 ha, of which the association of pedunculate oak and great green weed with common hornbeam was described for the first time in this area. A disturbed ecosystem was detected in most of them.

   The systematic position of the studied and described communities is as follows:

Class: *Querco-Fagetea* Br.-Bl. et Vlieg. 1937
Order: *Fagetalia sylvaticae* Pawl. 1928
Alliance: *Carpinion betuli* Ht. 1956
Association: *Carpino betuli-Quercetum roboris* (Anić 1959) emend. Rauš 1969
Subass: *typicum* Rauš 1971
Subass: *fagetosum* Rauš 1971

Class: *Alno-Populetea* Fk. et Fb. 1964
Order: *Populetalia albae* Br.-Bl. 1931
Alliance: *Alno-Quercion roboris* Ht. 1938
Association: *Genisto elatae-Quercetum roboris* Ht. 1938
Subass: *caricetosum remotae* Ht. 1938
Subass: *caricetosum brizoides* Ht. 1938
Subass: *carpinetosum betuli* Glav. 1961
Association: *Frangulo-Alnetum glutinosae* Rauš 1968
Subass: *typicum* Rauš 1971
Association: *Leucoio-Fraxinetum angustifoliae* Glav. 1959
Subass: *typicum* Glav. 1959
Subass: *alnetosum glutinosae* Glav. 1959

2. The first instances of dieback in these forests occurred in 1910, and have continued with higher or lower intensity until today. At present, the desiccation intensity is lower, but the participation of sanitary fellings in the period 1988 - 1995 was 13.8%, or 25,259 m^3.
3. The causes of aberrations from normal forest associations of lowland regions, as well as of the overall destabilization of the "Žutica" forest ecosystem, have a synergistic nature. The principal causes include badly conducted regulations of waterways and melioration, and the related drop in groundwater levels and changes in the natural rhythm of floods, as well as the terrain being turned into waterlogged "slots" by a network of hard roads with inadequate draining systems. Normal relations among synecological factors have been disturbed, leading to changes in the participation of principal tree species, floral compositions and forest associations, as well as to the instability of forest stands and other problems.
4. The progression and regression scheme of forest associations in the studied area in the last twenty-five years is as follows:



5. All this confirms that over 700 ha of the most interesting and valuable forests of pedunculate oak suffered very intensive and abrupt external and internal influences during dieback some thirty years ago. The principal tree species desiccated, the site conditions and forest associations changed, and a negative succession of forest vegetation took place. The final picture and complete syndynamic development can only be obtained in correlation with pedological and other research in "Žutica".
6. A vegetation map of forest associations in the Management Unit "Žutica" on a scale 1:25,000 was drawn up on the basis of phytocoenological and other research. The map, providing the real situation in the forest phytocoenoses of the studied area and pointing to the dynamics of vegetation development, can serve as a starting point for planning and carrying out

various activities within the ecosystem (tending, management, and other tasks).

In general, it is difficult to predict the future development of vegetation in the studied area as it mostly depends on the influence of man on the ecosystem. Areas under more humid associations are expected to continue expanding, particularly in the south, south-west, and north-west part of the Unit inhabited by forests of narrow-leaved ash, and in the north-east part under forests of black alder, mainly in the "slots" and around oil wells. However, despite the large negative influence of various factors on the ecosystem, natural succession and the development of forest associations in many places will continue their normal course, that is, will go from more humid to drier associations.

7. The biological spectrum of life forms according to Ranunkiaer (1905) shows that all the associations in the studied area are hemicryptophytic-phanerophytic. This places them into the Central European region, shows their resistance to winter colds, and indicates very warm summers.
8. The processes of degradation can be stopped, and sites and associations put into their normal condition and progression, only by applying a multidisciplinary approach.
9. The silvicultural principles set down by Matić (1989), Matić and Skenderović (1993), Matić *et al.* (1994), Matić (1996), Matić *et al.* (1996) should be applied to treat the damaged structures and stands in the forest of "Žutica". These principles have proved very successful in other areas affected by similar ecological disturbances (Kalje, Turopoljski Lug, the Pokuplje basin).
10. The field monitoring of water movement on and in the soil with piezometers (permanent monitoring), already conducted in some other lowland ecosystems, is the best way of arriving at exact data on the water regime in the forest. It is also one of the principal indicators for managing forest ecosystems of lowland regions. With regard to significant changes and desiccation caused mainly by changes in the water regime, this system should also be introduced into the area of "Žutica".
11. Man and his activities in the field of water management and the oil industry have always been the main destabilising factor in the "Žutica" ecosystem. Better-organised and stronger forestry policy is needed in relation to other co-users of the same area. Forestry experts are those who know best about forest ecosystems, and without their equal participation in important decisions relating to treatments in the ecosystem, little progress can be made.

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EKOLOŠKO-VEGETACIJSKE ZNAČAJKE ŠUME ŽUTICA

SAŽETAK

Nizinska šumska područja u Hrvatskoj u drugoj su polovici ovoga stoljeća pod jakim meliorativnim, tehnološkim i drugim antropogenim utjecajima, što je u jednom sinergističkom djelovanju izazvalo mjestimične promjene i nestabilnosti šumskih ekosustava. Ti su utjecaji uzrokovali u pojedinim dijelovima savskoga toka u zapadnom dijelu Hrvatske značajno sušenje šuma, a u drugim područjima različite sindinamske promjene vezane uz povlačenje ili pak širenje pojedinih vrsta drveća ili šumskih zajednica.

U tom je smislu poglavito značajna šuma Žutica, u kojoj se promijenio normalan odnos sinekoloških čimbenika, što je imalo za posljedicu promjenu udjela glavnih vrsta drveća, flornoga sastava i pridolaska šumskih zajednica, nestabilnost šumskih sastojina i drugo. Zbog toga je šuma Žutica vrijedan i zanimljiv objekt znanstvenih vegetacijskih istraživanja.

Žutica je šumski kompleks između autoceste Zagreb – Lipovac na sjeveru, rijeke Save na jugu, rijeke Lonje na zapadu i rijeke Česme na istoku.

Ukupna površina gospodarske jedinice iznosi 6 116, 68 ha, od čega je obraslo šumskim sastojinama 5 107,41 ha, a neobraslo i neplodno 1 009,27 ha.

U tri godine istraživačkoga rada završen je fitocenološki opis, snimanje, sistematizacija i kartiranje šume Žutice. Osim toga, uspoređeno je sadašnje stanje sa stanjem ovih šuma u prošlosti (Dekanić 1962, Medvedović 1975, Rauš 1980) i s rezultatima istraživanja nizinskih šuma u kojima se suši hrast lužnjak (Kalje, Turopoljski lug, Pokuplje).

Šuma Žutica predstavlja ekosustav koji je djelovanjem čovjeka uvelike promijenio svoj prirodni izgled i prirodnu stabilnost.

Šume srednje Posavine još su u 18. stoljeću bile prašume, gotovo netaknute od čovjeka, ritam njihova razvoja nije bio ničim ometan te je u njima vladala savršena ekološka ravnoteža.

Izravni utjecaj čovjeka u ekosustav Žutice svodio se prošlih razdoblja na iskorištavanje šuma sječom, boravak na povišenijim dijelovima te držanje stoke u šumi i na poljima.

No, prvi veći šok za ove šume nastao je čovjekovim naglim zahvatima koji su unijeli nesklad u ravnotežu biocenoza – stanište. Zbog vrijednosti lužnjakova drva na europskom tržištu u 19. stoljeću posječene su gotovo sve nekadašnje prašume u Posavini. Velike sječe izazvale su promjenu klime i hidroloških prilika u šumama i njihovoj okolici. Promijenila se mikroklima i makroklima te se povećala vlažnost. Negativni se utjecaj čovjeka nastavio forsiranjem hrasta lužnjaka i stvaranjem monokultura hrasta lužnjaka. U monokulturama nije uspostavljena biološka ravnoteža pa su šumu češće napadali štetni kukci. Ponovljeni golobrst te pepelnica, zajedno s poplavama tijekom vegetacijskoga razdoblja izazvali su sušenje stabala i sastojina.

Godine 1930. započelo je i epidemijsko ugibanje nizinskoga brijesta koje uzrokuje holandska bolest. Nestankom brijesta iz podstojne etaže promijenila se klima, u šumi je postalo svjetlije, toplije i suše, što je još više poremetilo ekološku ravnotežu.

Do početka 20. stoljeća veliki su prostori u Posavini bili izloženi poplavama, no hidrotehnički zahvati tijekom ovoga stoljeća uvelike su smanjili poplavne površine.

Već od kraja 19. stoljeća pa do danas planiraju se i provode veliki radovi na uređenju vodnih režima naših rijeka. Zbog toga su se promijenili vodni odnosi u staništu šume, snizila se razina podzemne vode, poplave ili izostaju ili poplavna voda dolazi u šumu u nepogodno vrijeme, tj. kada je vodoprivreda pušta u šumu. Sve je to, uz druge negativne čimbenike, utjecalo na slabljenje otpornosti pojedinih stabala, sušenje šuma i na regresijske procese i biljnih zajednica i staništa.

Čovjek je za svoje potrebe izgradio velik broj tvrdih cesta i nasipa kroz šumske ekosustave u GJ Žutica, koji nažalost uglavnom nemaju adekvatno riješene propuste za vodu, pa se teren kazetira, a voda koja dođe na određeno područje ne može se povući kao kod normalnoga režima, već ostaje zarobljena dok ne ispari, zbog čega se zemljište zamočvaruje. Na taj se način stanište degradira, nestaje kisika u tlu, smanjuju se mikrobiološke aktivnosti i propada vegetacija neprilagođena na takve uvjete.

Utjecaj je čovjeka na GJ Žutica i režim njezinih voda velik, pa je u vodoprivrednim planovima dobila ulogu retencijskoga prostora za visoke vode rijeke Save, Česme i Lonje, te je tako u potpunosti, osim predjela Žalkovo, okružena novim riječnim tokovima i nasipima. Nažalost sve to nije usklađeno s prirodnim odnosima pa su nastali vrlo veliki poremećaji ekosustava.

Vrlo je važno istaknuti da je Žutica pojačano eksploatirano naftno područje još od 1964. godine. Razvijen je složeni sustav ekploatacije sa čak 289 naftnih bušotina na velikim čistim proplancima, povezanim putovima za motorna vozila s proširenim stazama za podzemni odvod nafte i dovod vode te s dva velika središnja objekta INA-Naftaplina. Ti su, za šumu strani objekti razbili kompaktnost šume Žutice, čime su sastojine razbijene i izložene nepovoljnim vanjskim utjecajima, što je uzrokovalo i ubrzalo opće sušenje. Moramo naglasiti da su danas najbolje vidljiva sušenja upravo oko naftnih postrojenja. Veliku štetu čini pucanje dotrajalih naftovoda i izlijevanje nafte, uz neadekvatnu sanaciju. Tlo se onečišćuje, onemogućava se funkcija korijenja i korisne faune u tlu, što pak izaziva fiziološko slabljenje i odumiranje stabala.

Vrlo negativan utjecaj na šumske zajednice imaju i zatrovane i onečišćene vode rijeke Save i njezinih pritoka, u koje se slijeva mehanički otpad, nehumificirane fekalije, velika masa kemijskoga otpada, kiseline te razne druge otrovne supstancije.

Šuma je uz to sve više opterećena onečišćenim zrakom (SO_2, NO_x, teški metali i dr.), čije je porijeklo teško utvrditi. No, sigurno jedan dio potječe iz naših industrijskih središta (Zagreb, Sisak, Kutina), dio se odnosi na automobilski promet (neposredna blizina autoceste), dok značajan dio otpada na daljinski transport onečišćenoga zraka, koji zračnim strujanjima dolazi do naše zemlje iz udaljenijih europskih industrijskih područja.

Zasigurno se i sječom nakon znatnih sušenja narušava struktura sastojina, što utječe na promjenu šumske klime.

Uza sve spomenute abiotske čimbenike ne treba isključiti ni biotske, koji su se u prvo vrijeme istraživanja smatrali primarnim čimbenicima propadanja šuma, dok u današnje vrijeme prema većini autora imaju sekundarnu ulogu.

Iz svega izrečenoga može se reći da je šuma Žutica jedan vrlo složen ekosustav uvjetovan mnoštvom raznolikih čimbenika te njihovim kombinacijama, tako da je i problem sušenja vrlo kompleksan, posebno znajući da je djelovanje štetnih čimbenika uglavnom sinergetičko.

Sušenje je u šumi Žutici prvi put uočeno 1910. godine. Otada do danas nekada je veće, nekada manje. Prvo je osobito jako sušenje bilo od 1924. do 1927. godine.

Obujam hrastovih sušaca samo u 1924. godini iznosio je oko 50 000 m^3, a stanje se sljedeće godine još i pogoršalo. Uzroci tomu su prema pojedinim istraživačima različiti, ali se zna da je tih godina poplava koincidirala s defolijacijom, kao što se to dogodilo i u proljeće 1965. i 1966. godine. U kratkom razdoblju od 1966. do 1973. godine posušilo se oko 300 000 m^3 drveta. Potpuna su sušenja gotovo isključivo nastala u nizama gdje se voda duže zadržavala. Na gredama je jačeg sušenja bilo samo mjestimično. Takvo katastrofalno sušenje na relativno maloj površini nije se nikada ranije dogodilo te je bilo povodom da se istraživanja ovoga problema nakon dugoga vremena ponovno pojačaju.

Danas je sušenje slabije, ali i dalje traje sušenje ponajprije hrasta lužnjaka, a uvelike se osjećaju i posljedice prijašnjih katastrofalnih sušenja, tako da je udio sanitarnih sječa od 1988. do 1995. godine 13,8 %, što iznosi 25 259 m^3. Možemo reći da je ovo sada jedan vrlo labilan ekosustav kojim je potrebno vrlo pažljivo gospodariti težeći uzgojnim postupcima koji će ekosustav dovesti u što veću ekološku ravnotežu.

Svaka promjena u jačini i dinamici vlaženja u svezi sa suviškom ili manjkom vode izaziva i promjene u šumskom ekosustavu. One se najčešće, kako je to i ovdje slučaj, očituju u sušenju. Uvjeti koji izazivaju katastrofalno sušenje djeluju na mlade, srednjodobne, starije i stare sastojine, s tim da se starije sastojine više suše.

Na obrasloj površini od 5 107 ha utvrđeno je i opisano 8 šumskih zajednica, od kojih je zajednica hrasta lužnjaka i velike žutilovke s običnim grabom (*Genisto elatae-Quercetum roboris carpinetosum betuli* Glav. 1961) prvi put opisana na ovome području.

Sistematski položaj istraženih i opisanih zajednica je sljedeći:

Razred: *Querco-Fagetea* Br.-Bl. et Vlieg. 1937
red: *Fagetalia sylvaticae* Pawl. 1928
sveza: *Carpinion betuli* Ht. 1956
as.: *Carpino betuli-Quercetum roboris* (Anić 1959) emend. Rauš 1969
subas.: *typicum* Rauš 1971
subas.: *fagetosum* Rauš 1971

Razred: *Alno-Populetea* Fk. et Fb. 1964
red: *Populetalia albae* Br.-Bl. 1931
sveza: *Alno-Quercion roboris* Ht. 1938
as.: *Genisto elatae-Quercetum roboris* Ht. 1938
subas.: *caricetosum remotae* Ht. 1938
subas.: *caricetosum brizoides* Ht. 1938
subas.: *carpinetosum betuli* Glav. 1961
as.: *Frangulo-Alnetum glutinosae* Rauš 1968
subas.: *typicum* Rauš 1971
as.: *Leucoio-Fraxinetum angustifoliae* Glav. 1959
subas.: *typicum* Glav. 1959
subas.: *alnetosum glutinosae* Glav. 1959

Prisutne su još inicijalne vegetacije vrba i šaševa te kulture euroameričkih topola (*Populus* x *euramericana*) u koje ulaze prirodne, pionirske vrste poljski jasen i crna joha, kao i na vrlo maloj površini kulture smreke (*Picea abies*) i borovca (*Pinus strobus*).

Biološki spektar životnih oblika po Ranunkiaeru (1905) pokazuje da su sve zajednice istraživanoga područja hemikriptofitsko-fanerofitske, što opredjeljuje ove zajednice u srednjoeuropsku oblast, pokazuje njihovu otpornost protiv zimske hladnoće te indicira vrlo toplo ljeto.

S fitocenološkoga gledišta normalnim smatramo stanje kada u tridesetak godina nema značajnih promjena u stanišnim uvjetima i građi šumskih zajednica ili kada je pak došlo do progresivnoga sukcesivnoga pomaka u smjeru klimatskozonalne zajednice nekoga područja.

Analiza vlastitih fitocenoloških snimaka te usporedba karte rasprostiranja šumskih zajednica u GJ Žutica (Medvedović 1975) i današnjega stanja pokazuje da je šuma hrasta lužnjaka i običnoga graba, relativno najstabilnija zajednica hrasta lužnjaka u Hrvatskoj, u proteklih trideset godina donekle povećala svoju ukupnu površinu. To je rezultat progresije, tj. sindinamskoga razvitka vlažnijih zajednica, koji je na pojedinim lokalitetima ubrzan sniženjem razine podzemnih voda zbog hidromelioracijskih radova (najljepši je primjer lokalitet Žalkovo). Ukupna površina na kojoj se događala i događa progresija nešto je preko 300 ha, no unatoč tomu i ova je zajednica bila podložna regresivnim procesima. Gotovo na 60 ha staništa ove zajednice danas su sastojine crne johe ili poljskoga jasena, a čak na 200 ha šuma hrasta lužnjaka i velike žutilovke (80 ha subasocijacija s drhtavim šašem i 120 ha subasocijacija s rastavljenim šašem).

Važno je napomenuti da se zajednica hrasta lužnjaka i običnoga graba na drugim lokalitetima sušenja hrasta lužnjaka (Kalje, Turopoljski lug, Pokuplje), kao terminalna zajednica u razvoju šumske vegetacije nizinskoga područja Hrvatske, pokazala stabilnom i otpornom na sušenje, a to su stabilno stanje pokazala i istraživanja u Žutici (Rauš 1980).

Na površini od oko 150 ha prvi je put na ovom području izdvojena i zajednica hrasta lužnjaka i velike žutilovke s običnim grabom ili tzv. vlažna greda. Od toga je oko 100 ha nastalo kao posljedica progresije na površinama gdje su prije bile opisane subasocijacije ove zajednice s drhtavim šašem i s rastavljenim šašem. No, oko 50 ha nastalo je kao posljedica regresijskih procesa u zajednici hrasta lužnjaka i običnoga graba.

Najveće promjene, bilo da se radi o pozitivnoj ili negativnoj sukcesiji, doživjela je zajednica hrasta lužnjaka i velike žutilovke s drhtavim šašem. Tako na staništu ove subasocijacije danas na više od 50 ha imamo šumu crne johe, na 30 ha šumu poljskoga jasena, dok je na više od 120 ha danas vlažnija subasocijacija s rastavljenim šašem.

Pregledom svih ovih odjela mogu reći da na istraživanom području drhtavi šaš (*Carex brizoides*) sve intenzivnije ulazi na grede u stanište graba gdje ga ima više nego u tipski opisanoj šumi, što upućuje na zaključak da mu je na pojedinim mjestima previše vlažno te da traži suša staništa. Sušenje hrasta lužnjaka dosta je primjetno, a subasocijacija je također izložena regresiji. Na manjim površinama vidljiv je prodor crne johe i poljskoga jasena u svim slojevima.

Progresija se staništa primjećuje na mnogo manjoj površini, i to na približno 40 ha (20 ha je prešlo u subasocijaciju s običnim grabom i oko 20 ha u zajednicu hrasta lužnjaka i običnoga graba) pa je ova subasocijacija znatnije smanjena po svojoj površini.

U njezinu flornom sastavu također su uočljive promjene pa uz povećani udio biljaka vlažnih terena rastu: *Frangula alnus, Salix cinerea, Juncus effusus, Peucedanum palustre, Cirsium palustre* i dr., dok mezofilni elementi polako iščezavaju. Sve to upućuje na zamočvarenost biotopa koji nije bio takav.

Važno je napomenuti da je Rauš, istražujući šumsku vegetaciju GJ Žutica u razdoblju od 1969. do 1973. godine, ustvrdio da se šuma hrasta lužnjaka i velike žutilovke s drhtavim šašem nalazi u relativno stabilnom stanju i da ne pokazuje nikakve poremećaje u razvoju i flornom sastavu vezano uz sušenje hrasta lužnjaka, koje je bilo neznatno. Subasocijacija se po njemu u GJ Žutica tada nalazila u progresiji.

S druge strane, istraživanja na ostalim lokalitetima sušenja hrasta lužnjaka pokazuju rezultate koji su gotovo istovjetni stanju koje sam zatekao i opisao u GJ Žutica. Dakle, zbog stresa i neizdiferenciranosti staništa nastaju teške posljedice. Florni sastav sastojina, njegova fizionomija i struktura na mnogim lokalitetima potpuno su izgubili karakter tipski razvijene subasocijacije, a prevladavaju netipične biljke koje indiciraju zamočvarenost biotopa.

Druga, vlažnija subasocijacija s rastavljenim šašem (*caricetosum remotae*) doživjela je također veće promjene, tako da je čak u petnaest odjela ili odsjeka (oko 200 ha) zabilježena regresija pa su stanište ove zajednice zauzele vlažnije zajednice, i to na 70 ha zajednica crne johe i 130 ha zajednica poljskoga jasena. Danas je još nešto više od 50 ha pod zajednicom hrasta lužnjaka i velike žutilovke s običnim grabom i oko 130 ha pod zajednicom hrasta lužnjaka i običnoga graba, no ovdje se radi o progresijskim procesima.

S druge strane, površina se ove zajednice povećala uglavnom zbog povećane vlažnosti terena i s tim povezanim regresijskim procesima, i to na račun zajednice hrasta lužnjaka i običnoga graba na nešto preko 120 ha i zajednice hrasta lužnjaka i velike žutilovke s drhtavim šašem na oko 120 ha. Nadalje, kao posljedica uglavnom prirodne sukcesije zajednica i prijelaza u suše zajednice, ova se subasocijacija proširila na još 80 ha bivše šume crne johe i oko 50 ha bivše šume poljskoga jasena.

Sve to govori o vrlo velikim promjenama unatoč tomu što je ova zajednica više-manje zadržala površinu od prije tridesetak godina.

Još je Dekanić (1962) proveo istraživanja vodnoga režima u šumi Žutici radi utvrđivanja uzroka sušenja hrasta lužnjaka. Pri tom je utvrdio da je u šumi hrasta lužnjaka i velike žutilovke s rastavljenim šašem nepovoljan vodni režim. Podaci pokazuju da je u sastojini, uz ostalo, došlo do poremećaja u zoni rizosfere nakon izgradnje nasipa, cesta i kanala.

Prema Raušević istraživanjima (1980) gospodarske jedinice Žutica ova se subasocijacija nalazila u stanju regresije, jer je stabilnost subasocijacije uvelike poremećena prvobitno sušenjem nizinskoga brijesta, a potom naglim i masovnim sušenjem hrasta lužnjaka. Takvi su uvjeti omogućili nagli razvoj korovne vegetacije i višak stagnirajuće vode pa se teren zamočvaruje.

To i današnja istraživanja potvrđuju, no u manjem opsegu nego prije. Danas je nešto veća regresija u subasocijaciji s drhtavim šašem, što koindicira s rezultatima istraživanja vegetacije s područja Kalja, Turopoljskoga luga i iz Pokuplja.

U međuvremenu su pionirske vrste crna joha i poljski jasen popunili dio praznina nastalih sušenjem i dio neobrasloga zemljišta, što je pozitivno utjecalo na postupnu stabilizaciju ovih sastojina.

Kao posljedicu toga te specifičnih ekoloških uvjeta u kojima se razvija šuma crne johe, danas u GJ Žutica imamo pojavu da se crna joha širi iz korita starih vodotoka i kanala na površine gdje stoji voda, koja se u manjim ili većim kazetama zadržava nakon poplava i većih oborina. Također je nestajanjem hrasta lužnjaka nestala i "crpka" koja je crpila velike količine vode iz tla. To je izazvalo pogoršanje hidrološkoga režima, izmjenu mikroklime i pogoršanje bioloških komponenata tla. Na tim i takvim lokalitetima naglo se širi crna joha kao jedina vrsta koja se može održati u tako ekstremno vlažnim uvjetima, dok na nešto manje vlažnim lokalitetima dolazi i poljski jasen.

Tako se ukupna površina pod zajednicom crne johe s trušljikom (*Frangulo-Alnetum glutinosae*) u odnosu na 1975. god. (Medvedović) povećala za oko 80 ha, što je vrlo teško odrediti jer se crna joha dosta intenzivno razvija oko velike većine naftnih bušotina, pa možemo zaključiti da je povećanje površina pod ovom zajednicom mnogo veće. Nadalje, nekih 25 ha otpada na prodor crne johe na ranije neobraslo zemljište, dok se drugo širenje crne johe odnosi na regresijske procese u staništu i sastojinama GJ Žutica. Tako je crna joha zauzela 70 ha površina koje su prema Medvedoviću (1975) bile pod zajednicom hrasta lužnjaka s velikom žutilovkom i rastavljenim šašem i 40 ha pod zajednicom hrasta lužnjaka i običnoga graba.

S druge strane, površine pod crnom johom su se smanjile gotovo 80 ha u korist zajednice hrasta lužnjaka i velike žutilovke s rastavljenim šašem, 50 ha u korist zajednice hrasta lužnjaka i velike žutilovke s drhtavim šašem te oko 30 ha u korist zajednice hrasta lužnjaka i velike žutilovke s običnim grabom kao posljedica promijenjenih stanišnih uvjeta i progresije vegetacije.

Prema vlastitim istraživanjima te usporedbom sa stanjem iz 1975. god. (Medvedović) može se zaključiti da je prodor poljskoga jasena i s tim povezano zajednice poljskoga jasena s kasnim drijemovcem (*Leucoio-Fraxinetum angustifoliae*), kako na prije neobraslo zemljište tako i na područje rasprostranjenosti drugih zajednica, još snažniji nego što je to bio slučaj kod crne johe. Zbog nabrojenih negativnih čimbenika najprije se osušio hrast lužnjak te su se dosta naglo promijenili ekološki uvjeti staništa pa je ono većinom postalo vlažnije i tako pogodno za širenje poljskoga jasena, kao pionirske, brzorastuće vrste lakoga sjemena, na veće ili manje površine pojedinih zajednica, od bare, preko nize, pa sve do grede.

I ovdje vrijedi ista zakonitost kao kod crne johe: što je teren viši i zajednica suša, to je prodor poljskoga jasena slabiji. Tako na čak više od 120 ha bivšega staništa zajednice hrasta lužnjaka i velike žutilovke s rastavljenim šašem danas uspijeva zajednica poljskoga jasena s kasnim drijemovcem, nadalje na oko 30 ha staništa zajednice hrasta lužnjaka i velike žutilovke s drhtavim šašem i 15 ha staništa zajednice hrasta lužnjaka i običnoga graba sada raste šuma poljskoga jasena.

Normalna progresija staništa i prelazak šuma poljskoga jasena u suše zajednice prisutna je samo na oko 70 ha, i to prelaskom zajednice poljskoga jasena s kasnim drijemovcem u zajednicu hrasta lužnjaka i velike žutilovke s rastavljenim šašem na približno 50 ha te zajednicu hrasta lužnjaka i običnoga graba na oko 20 ha. Važno je napomenuti da je i preko 100 ha bivšega neobrasloga zemljišta, bilo prirodnim putem, bilo uz pomoć čovjeka (sadnja sadnica), danas obraslo šumom poljskoga jasena s kasnim drijemovcem u raznim fazama razvitka. No, najčešće je to inicijalna faza koja na mnogim mjestima prelazi u optimalnu.

Većinom kao posljedica sušenja hrasta lužnjaka te sanacije posušenih površina (uglavnom 1968. god.) podignute su kulture euroameričkih topola (*Populus* x *euroamericana*), npr. odjeli 42a, 49c, 131b, 133, 137a, 138b, 173c, 182c, 183b, 193b i dr., u kojima se danas uz euroameričke topole u sloju drveća s velikim udjelom javlja crna joha (*Alnus glutinosa*), a u sloju grmlja trušljika (*Frangula alnus*). U sloju prizemnoga rašća najveći udio imaju: *Carex vesicaria, Carex elata, Peucedanum palustre, Deshampsia ceaspitosa, Urtica dioica, Polygonum hydropiper, Juncus effusus, Lycopus europaeus, Lytrum salicaria, Myosotis scorpioides, Lysimachia vulgaris, Galeopsis tetrahit, Stachys palustris, Iris pseudacorus, Glechoma hederacea* i *Galium palustre*. Sve to upućuje na povratak autohtone vegetacije, u prvom redu crne johe i njezinih pratilica, kao pionirske vrste koja može opstati u tako promijenjenim stanišnim uvjetima (zamočvarenost, puno svjetlosti). Treba očekivati da će se, ako ne dođe do novih poremećaja, ova polagana progresija nastaviti i dalje k autohtonoj prirodnoj vegetaciji, od crne johe prema hrastu lužnjaku.

Zaključno se može reći da sve to potvrđuje da je više od 700 ha nama najzanimljivijih i najvrednijih šuma hrasta lužnjaka u vrijeme sušenja prije tridesetak godina pretrpjelo vrlo intenzivne i nagle vanjske i unutarnje utjecaje. U njima su se osušile glavne vrste drveća, promijenile su se stanišne prilike i šumske zajednice te je nastala negativna sukcesija šumske vegetacije.

Na osnovi fitocenoloških i drugih istraživanja izrađena je vegetacijska karta šumskih zajednica gospodarske jedinice Žutica u mjerilu 1: 25 000. Ona prikazuje stvarno stanje areala šumskih fitocenoza istraživanoga područja te pokazuje dinamiku razvoja vegetacije ovoga područja i može poslužiti kao dobra osnova za planiranje i izvođenje svih radova u ekosustavu (uzgoj, uređivanje i dr.).

No, općenito je teško reći u kojemu će smjeru ići dalji razvitak vegetacije istraživanoga područja, što većinom ovisi o djelovanju nas samih na ekosustav. Može se očekivati da će se površine pod vlažnijim zajednicama i dalje povećavati, posebno u južnom, jugozapadnom i sjeverozapadnom dijelu gospodarske jedinice šume poljskoga jasena te u sjeveroistočnom dijelu, na mnogim mjestima gdje je teren kazetiran i oko bušotina šume crne johe. No, usprkos velikom negativnom utjecaju raznih čimbenika na ekosustav prirodna sukcesija i razvitak šumskih zajednica na mnogim će mjestima ići normalnim putem, tj. od vlažnijih zajednica prema sušim.

U uzgoju se u strukturno i stanišno oštećenim sastojinama GJ Žutica možemo pridržavati načela koja su odredili Matić (1989, 1996), Matić i Skenderović (1993), Matić i dr. (1994, 1996) i koja su se pokazala uspješnim na drugim područjima u kojima je došlo do sličnih ekoloških poremećaja (Kalje, Turopoljski lug, Pokuplje).

Tako stare hrastove sastojine središnjega dijela GJ Žutica, koje su zadržale suvislost, primjernu drvnu zalihu, omjer smjese i druga strukturna i stanišna svojstva, treba i dalje uzgajati i podržavati radi proizvodnje drva i radi korištenja stabala kao prirodnih crpki za vodu te radi postupnoga prirodnoga pomlađivanja. Potrebno je također pristupiti njezi i formiranju ostalih neosušenih sastojina u suvisle manje ili veće sastojine koje će u novim uvjetima u tlu nastaviti proizvodnju.

U odjelima 64a, 70b, 107a, 113b, 119b, 126d, 131c, 179b i drugim, gdje je sušenje smanjilo drvnu zalihu preko 30 % i gdje su nakon toga ostale nesuvislo obrasle površine, no stanišni uvjeti se nisu promijenili u tolikoj mjeri da pomladak hrasta lužnjaka ne bi mogao opstati, potrebno je pristupiti obnovi sastojina. Uz prirodnu obnovu postojećim i novonastalim pomlatkom glavne vrste drveća treba primijeniti umjetnu obnovu unošenjem žira ili sadnica hrasta lužnjaka po načelima oplodnih sječa.

Prirodno i umjetno pomlađivanje uz oplodne sječe na malim površinama ili krugovima treba i u ovoj situaciji biti glavno načelo obnove ovih sastojina.

U odjelima 25d, 37, 63a, 103a, 104d, 122d, 149b, 155b te drugim, gdje je bilo nešto veće sušenje lužnjaka i brijesta pa se sada skupine hrasta smjenjuju sa skupinama urasloga jasena i johe te većim ili manjim plješinama, a obrast se smanjio do polovice ili neznatno niže, no stabla koja su ostala imaju povoljan izgled za dalji opstanak, potrebno je podsaditi takve sastojine crnom johom ili poljskim jasenom. Na taj ćemo način osigurati kontinuitet još nezrele lužnjakove sastojine uz formiranje sastojine pionirskih vrsta koja će štititi tlo, razviti slojeve, održavati povoljnu sastojinsku klimu i koja će dobro priraščivati.

Na površinama koje su u još većem stupnju degradirane, kao što su to odjeli 27d, 36h, 38b, 63a, 72f, 93a, 104b, 179e, 187b i neki drugi, potrebno je prvo na terenu ukloniti uzroke degradacije. U tim su odjelima vrlo teški uvjeti za razvitak vegetacije. To su većinom lužnjakove sastojine pogođene velikim sušenjem, narušena je ekološka ravnoteža, na mnogim mjestima trajno je prekinut sklop, teren je zamočvaren, bujno je razvijeno grmlje, urašta poljski jasen i crna joha, dok se u ekstremnim slučajevima suši i crna joha (npr. odjel 117), pa imamo samo zakorovljene površine. Na takvim površinama treba saditi pionirske vrste drveća uz prethodnu mehaničku pripremu staništa uništavanjem korova. Potrebno je saditi crnu johu, poljski jasen i ostale pionirske vrste drveća, imajući na umu uvjete koji vladaju na konkretnom staništu i ekološke zahtjeve pojedine vrste. Površinska odvodnja kopanjem plitkih kanala sisavaca ili izrada propusta na mjestima stagniranja vode u umjetno stvorenim kazetama preduvjet je pripremi staništa i sadnji pionirskih vrsta drveća.

Na degradiranim staništima do lužnjaka treba doći posredno unošenjem u ta staništa pionirskih vrsta drveća, posebno poljskoga jasena, crne johe, vrba, topola i drugih. Važno je naglasiti i to da hrast lužnjak nije i ne može biti pionirska vrsta drveća (Matić 1996), jer ne prihvaća degradirano tlo za svoj razvoj.

Samo multidisciplinaran pristup rješavanju ovoga i sličnih problema može zaustaviti degradaciju staništa i zajednica te ih dovesti u normalno stanje i progresiju.

Terensko praćenje kretanja vode na tlu i u tlu pijezometrima (trajni monitoring), koje se provodi u nekim drugim nizinskim ekosustavima, najbolji je način dolaska do točnih podataka vodnoga režima u šumi, a to je ujedno i jedan od glavnih pokazatelja za gospodarenje šumskim ekosustavima nizinskoga područja pa ga je potrebno uvesti i u šumu Žuticu zbog velikih promjena i sušenja koja su uglavnom uvjetovana promjenama vodnoga režima.

Najsnažniji čimbenik destabilizacije ekosustava Žutice bio je i ostao čovjek, ponajprije djelovanjem preko vodoprivrede i naftne industrije. Potrebna je puno organiziranija i snažnija šumarska politika u odnosu na sudjelitelje istoga prostora. Šumarski su stručnjaci najbolji poznavatelji šumskih ekosustava i bez njihova jednakopravnoga sudjelovanja u donošenju važnih odluka, u svezi s ovakvim i sličnim velikim zadiranjima u ekosustav, nikakva napretka ne može biti.

Ključne riječi: Žutica, sinekološko-vegetacijsko istraživanje, šumske zajednice, narušeni ekosustavi, sinergizam, vegetacijska karta, multidisciplinarno istaraživanje