Acta Bot. Croat. 55/56, 29 - 40

CODEN: ABCRA 25
ISSN 0365-0588

UDC 581.526.42= 20
Original scientific paper

THE SIGNIFICANCE OF THE SPONTANEOUS VEGETATION IN THE OLD GARDEN OF THE ARBORETUM TRSTENO (CROATIA)

MAJA KOVAČEVIĆ

(Arboretum Trsteno Hrvatske akademije znanosti i umjetnosti, Trsteno)

Received April 28, 1997

This paper deals with research in the tree cover in the Renaissance Gucetic garden, part of the Arboretum Trsteno of the Croatian Academy of Science and Art. The vegetation of the wood complex investigated covers 100% of the surface and four layers can be recognized. The biological spectrum contains 77.7% phanerophytes, 14.0% chamaephytes and 8.3% geophytes. The compositions of the stands investigated are distinguished into cultivated, subspontaneous and spontaneous species. Among spontaneous species, *Laurus nobilis* plays the most significant role and is dominant. In accordance with spontaneous species, belonging to phytosociological units, reference is made to the intermixing of evergreen and deciduous regions of the coast, in the investigated habitat.

Introduction

The pearl of Dubrovnik gardens, the Renaissance garden of Count Gucetic, is today part of the Arboretum Trsteno of the Croatian Academy of Science and Art, and well known as a collection of exotic and spontaneous plant species. It is situated on the Adriatic coast in the village Trsteno, northwest of Dubrovnik (Fig. 1).

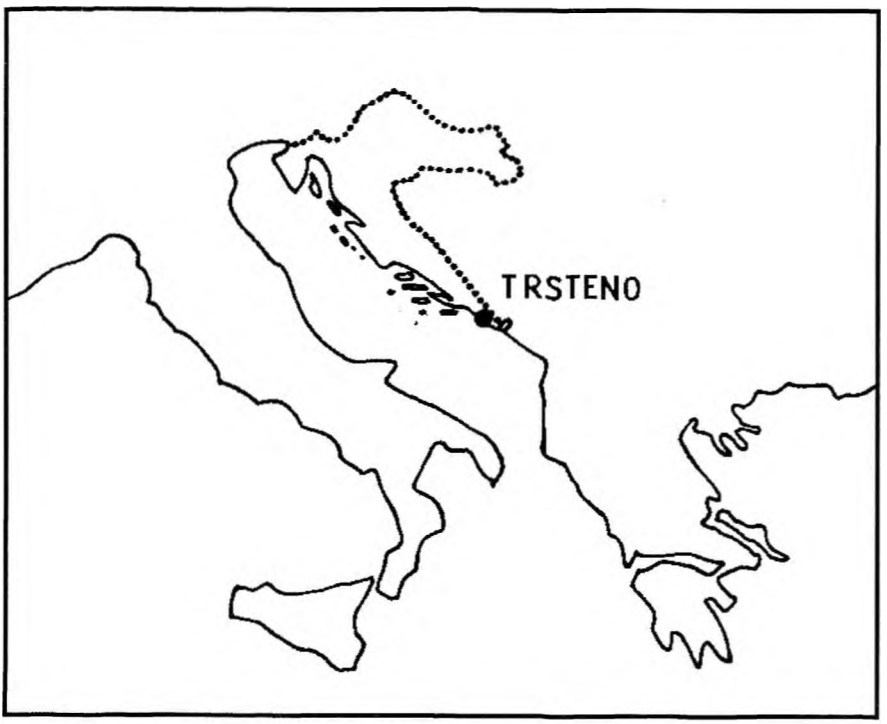


Fig. 1. Geographic position of Trsteno

In accordance with its landscape garden conception, the garden is divided into two parts: parterres with low vegetation and a woody part with high vegetation, composed mainly of a bay-tree grove. The bay-tree grove is a peculiarity of the garden, from both a landscaping and a botanical view. A dense tree complex is composed of elements of spontaneous vegetation with exotic ornamental species arranged individually or in groups. Some of them maintain themselves and tend to spread, making, with the bay-tree, a stage which has an equilibrium of its own without any considerable human intervention.

The outstanding historical values of the garden, and the question whether the bay-tree is a spontaneous species in this locality, provided the incentive for my research into the composition of the plant cover.

Objects and research methods

The investigated area is situated in the middle of the old garden and partially to the west of the entrance. It is covered with high vegetation of bay-tres, oriental hornbeams, Aleppo pines, persimons, and some other exotic

species. The beginning of the arrangement of the garden and the cultivation of this part, took place five hundred years ago, but traces of recent conception are about hundred and fifty years old.

The layer of trees reaches a height of from 8 m to 30 m. The shrubby layer is not densely developed, but the layer of herbaceous undershrubs is rather remarkable. The ground cover layer is dense, and in some places forms carpets. The ground is covered with a thick layer of loose leaves. The vegetation covers 100% of the surface and owing to the high density of the crowns of the evergreen trees the underneath layers are in heavy shadow.

Maintenance of this part of the garden is done by periodic removal of dry trees and those blown down in strong storms. The removal of prickly ivy lianes and sporadic clearing of the bush layer take place in ten year cycles.

In parts of the garden which are less affected by cultivation, and where natural circumstances are balanced, 5 stands were chosen for phytosociological records (Fig. 2). The surface investigated covers 2 800 m^2.

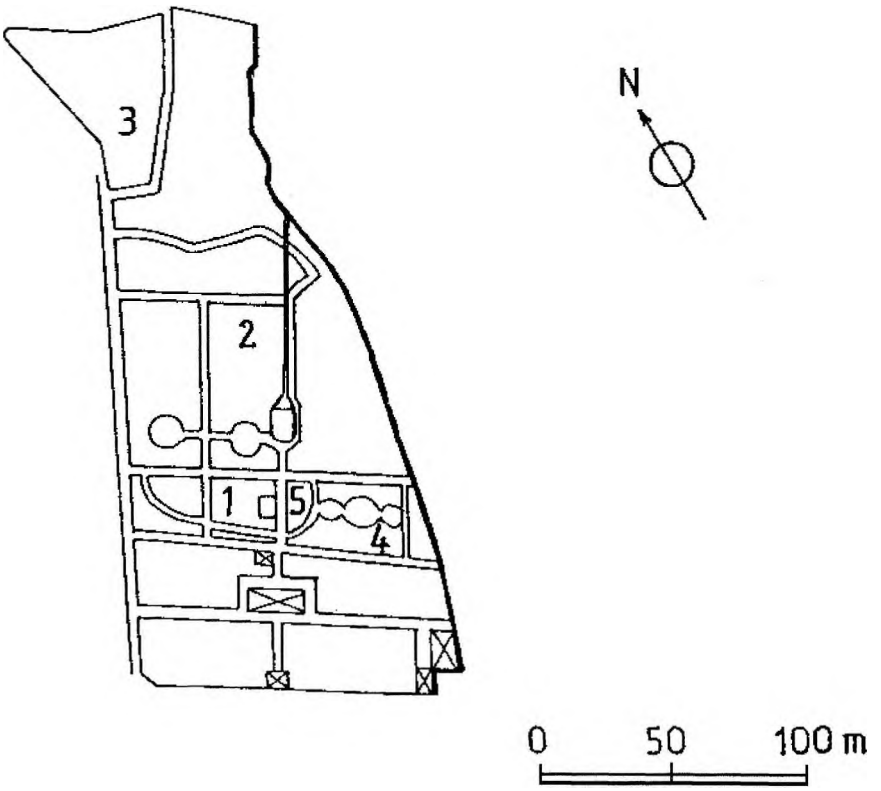


Fig. 2. Plan of the garden with stands investigated

Climatic and edaphic factors of the stands and surrounding vegetation

Trsteno is situated in the southern evergreen district of the east Adriatic eu-Mediterranean zone. The climate is characterized by rather high humidity, rezulting in a relatively decreased manifestation of the dry and hot summer period. With respect to the annual precipitation factor, Gračanin (1952) clasified Trsteno as a warm humid bordering or semihumid climate.

The twenty year average of meteorological mesurements in Trsteno from 1970 to 1990 (Kovačević 1994) shows that the mean air temperature in spring is 17.2°C and mean precipitation is 81 mm, the summer mean air temperature is 22.6°C, and the mean precipitation 72 mm, the autumn mean air temperature is 12.9°C, and the mean precipitation 147 mm, and the winter mean air temperature is 9.1°C, and the medium precipitation 130 mm (Fig. 3).

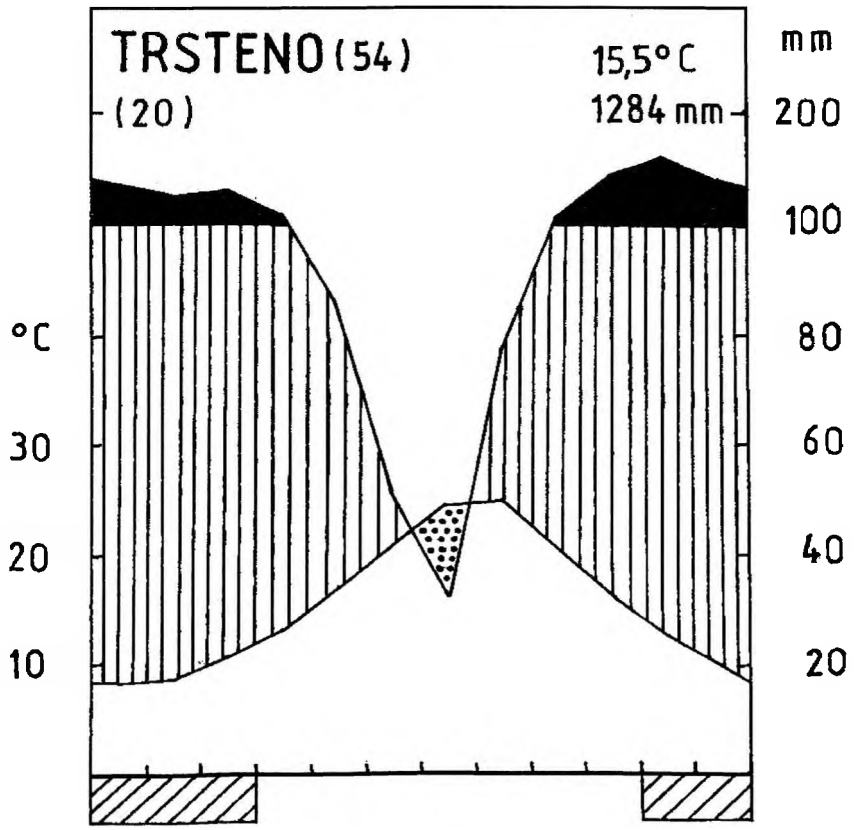
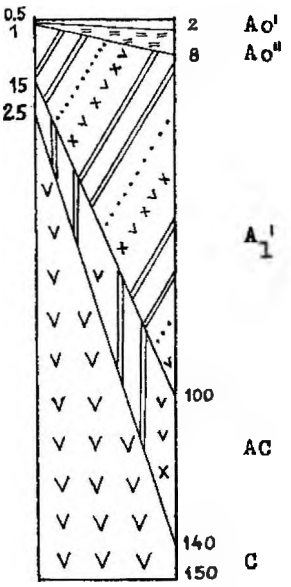


Fig. 3. Climatic diagram (after Walter) of the Trsteno Meteorologic Station for the 20 year period 1970-1990.

In the old part of the garden, the bay-tree grove lies on brown carbonate soil which developed on the geological substrate of flysch. According to the soil investigation of G r a č a n i n (1952) this soil is colored dark-brown, and with respects to texture it is clay loam with scattered rock particles, slightly to moderately skeletoid. The soil structure is characterized by aggregates bigger then 5 mm. Water and air capacity are moderate. The soil is weakly alkaline, with pH values lying between 7.1 and 7.3. The surface layer is rather rich in humus while the deeper layers are poor in it. The characteristic of this soil is its high lime content, which surpasses 50% (Fig. 4).



A_0' 1-2 cm thick layer of loose leaves

A_0'' Black coloured horizon of humus, granular structure made of smaller and larger crumbs. Roots spread densely ramifying. At the dept of 8 cm it transits to

A_1' Brown coloured horizon mainly of crumbly structure, slightly skeletoid. Under 30 cm the soil becomes lighter in colour A_1''. At the depth of about 80 cm it transits to

AC Yellowish-white weathered flysch.

C Hard laminate flysch.

Reaction to $CaCO_3$ is positive in the whole profile.

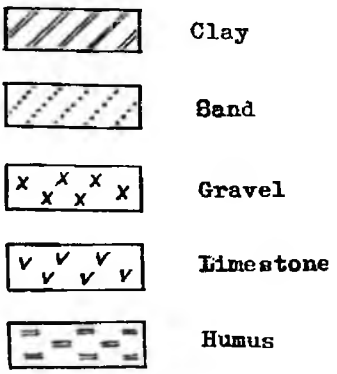


Fig. 4. The morphology of the soil profile in the old garden of the Arboretum Trsteno (after G r a c a n i n 1952)

The surrounding vegetation consists of parterress garden plantations, the nursery and olive tree groves inside the Arboretum. More distant, there are private gardens, orchards and olive tree groves in the village of Trsteno. The vegetation surrounding the village is to a lesser extent influenced by human activities. The coastal belt is made of macchia, a transition stage of the climax community *Orno-Quercetum ilicis*, and of Aleppo pine forest on the base of previous olive groves and vineyards. The vegetation of the colline hinterland of Trsteno partially belongs to garigues of the *Cisto-Ericion* alliance and partially to the retrograde stage of *Carpinetum orientalis* association.

Results

The floristic composition of the woody part of the garden is shown in Table 1. The groundwork was phytosociological research into five stands whose locations are visible in Fig. 2. So as better to represent the data they are worked out separately for each layer. Furthermore, all the species are arranged in three groups: cultivated species planted here, spontaneous species and subspontaneous species growing up from the seed by itself. Along with the name of the species, the degree of their vitality and the symbol of the life form are also given.

Stand 5 in its physiognomy apparently represents a peculiarity of the garden. In composition it shows few species, but they form a very dense cover. The tree layer is composed chiefly of *Laurus nobilis* and the shrub layer of *Trachycarpus fortunei,* kept permanently at the shrub stage because of reduced light intensity. The development of such a dense cover of shrubby palms is favored by continued watering of the soil by water from a fountain flowing through a little channel across the middle of this stand.

On stands 2 and 3, situated north of the middle part of the garden, besides *Laurus nobilis* some older trees of cultivated species grow in the tree layer.

In the shrub layer, cultivated species grow sparsely, but very considerable shading hinders their growth, as is visible from the degree of their vitality determined.

All stands are characterized by a thick layer of loose leaves and by a ground layer composed chiefly of *Hedera helix* and seedlings of different species (Table 1).

From Table 2, which shows the biological spectra of the stands investigated, it is strikingly that life-form types are reduced almost exclusively to the phanerophytes. This is caused by anthropogenic influence which tends to maintain this vegetation, and by the specific conditions of high shading, which selects the species in the lower layers.

Number of stand examined	1	2	3	4	5
Date	5. IX 1996.	9. IX. 1996.	9. IX. 1996.	9. IX. 1996.	5. IX 1996.
HERBACEOUS LAYER					
Subspontaneous species					
Trachycarpus fortunei (Hook) H. Wendl. -◎- P	2.1	1.1			4.1
Celtis australis L. - ○- P		1.1	1.1	+.1	
Pittosporum tobira (Thunb.) Ait. - ○- P	+.1	1.1			
Juglans regia L. - ○- P	+.1				
Ficus carica L. - ○- P	+.1				
Robinia pseudoacacia L. - ○- P				+.1	
Sorbus domestica L. - ○- P		1.1			
Ligustrum lucidum Ait. - ○- P		+.1			
Spontaneous species					
Ruscus aculeatus L. - ●- Ch	5.4	1.2	2.2	4.3	3.2
Laurus nobilis L. - ●- P	1.2	2.2	1.1	1.1	1.1
Rubia peregrina L. - ●- Ch	+.2	+.1	1.2	+.2	+
Viburnum tinus L. - ○- P	1.1	1.1	1.1		
Orobanche hederae Duby - ●- G		1.1	1.1	1.1	
Fraxinus ornus L. - ○- P	+.1		1.1		
Limodorum abortivum L. Sw. - ●- G		1.1			
Phillyrea media L. - ○- P		+.1			
Asparagus acutifolius L. -◉- Ch			+.2		
Rhamnus alaternus L. - ○- P			+.1		
GROUND LAYER					
Cultivated species					
Vinca minor L. - ● Ch				+.3	2.4
Vinca major L. - ●- Ch				1.2	
Spontaneous species					
Hedera helix L. - ●- P	3.4	2.3	4.4	3.4	3.4
SEEDLINGS					
Subspontaneous species					
Trachycarpus fortunei (Hook) H. Wendl. - P	1.1	1.1	+.1	1.1	1.1
Celtis australis L. - P	+.1	+.1		+.1	
Robinia pseudoacacia L. - P	+.1			+.1	
Pittosporum tobira (Thunb.) Ait. - P	+.1				
Sorbus domestica L. - P		+.1			
Juglans regia L. - P		+			
Spontaneous species					
Laurus nobilis L. - *P*	1.1	1.1	1.1	2.1	1.1
Fraxinus ornus L. - P	+.1		+.1	+.1	
Viburnum tinus L. - P		1.1	1.1		
Quercus pubescens Willd. - P	+.1				
Asparagus acutifolius L. - Ch			+.1		

Degrees of vitality

● Well developed, regularly completing the life cycle.
◉ Strong and increasing but usually not completing the life cycle.
◎ Feeble but spreading, never completing the life cycle.
○ Occasionally germinating but not increasing.

In the floristic composition of the stands three groups may be distinguished: cultivated species (exotes), spontaneous and subspontaneous species. Most numerous is the group of spontaneous species.

Table 2. Biological spectrum of the stands investigated

Biological spectrum	P	Ch	G	Σ
Number of species	28	5	3	36
%	77.7	14.0	8.3	100

The vegetation covering the examined part of the garden has a considerable anthropogenic origin and species growing spontaneously (Table 3) point to the connection between the deciduous and the evergreen coastal area. In the same geographical region, two associations appear: the *Carpinetum orientalis croaticum lauretosum* subassociation and the *Orno-Quercetum ilicis* association facies *Laurus nobilis,* developed within boundaries of the eu-Mediterranean zone (H o r v a t i c 1963). They are dominant in the vegetation cover surrounding Trsteno, but are divided into the narrow coastal belt and the colline belt of hinterland. The boundary between these two communities descends towards the sea coast because of the peculiar local ecological conditions (the inclination is about 0°, deep soil, abundance of water). Coming into contact, their boundaries become indistinct and they merge into one another. This leads to the recognition of *Laurus nobilis,* present in both of the communities, as a spontaneous species in this area. The high degree of vitality of *Laurus,* the dense crown cover and the largest number of seedlings also point to its spontaneous presence here.

Among spontaneous species, *Quercus pubescens* and *Carpinus orientalis* are the most significant trees, and their dimensions are similar to those of cultivated trees about hundred to a hundred and forty years old. Species like *Fraxinus ornus, Pistacia terebinthus, Smilax aspera, Ruscus aculeatus* and *Hedera helix* show a very high vitality.

Cultivated species planted and growing in the bush layer such as *Euonymus japonica, Pittosporum tobira* and *Prunus laurocerasus* have vanished in many locations. The few that have survived show a very low vitality, cosed in the shadow of the dense crowns of *Laurus* trees.

A group of species that are constituents of the bush layer and also occur among seedlings, has an ornithochor connection with the vegetation of near and distant areas. The bay-tree grove is the dwelling place of some species of birds: blackbird *(Turdus merula),* robin *(Erithacus rubra),* wren *(Troglodytes troglodytes),* some species of tits (*Parus* sp.), hawfinch *(Coccosthraustes coccosthraustes),* golden oriole *(Oriolus oriolus),* nuthatch *(Sitta europaea).* They play a role of primary importance in the dispersal of plant species:

Viburnum tinus, Ligustrum lucidum, Sorbus domestica, Ficus carica, Eriobotrya japonica, Trachycarpus fortunei, Asparagus acutifolius, Pittosporum tobira, Ruscus aculeatus, Rubia peregrina, Celtis australis and some others. Rodents play a smaller part in dispersal and they represented here by squirrels, rats and dormice, disseminating fruits of the species *Juglans regia, Quercus pubescens, Sorbus domestica, Trachycarpus fortunei, Eriobotrya japonica.*

Table 3. Spontaneous species classified on the basis of the differentiation of plant communities

ORNO - QUERCETUM ILICIS fac. *Laurus nobilis*	*CARPINETUM ORIENTALIS CROATICUM* *lauretosum*
Characteristic species of the Class ***QUERCETEA ILICIS*** *Asparagus acutifolius* *Pistacia terebinthus* *Rubia peregrina* *Ruscus aculeatus* Characteristic species of the Alliance ***QUERCION ILICIS*** *Phillyrea angustifolia* *Smilax aspera* Characteristic species of the Assoc. ***ORNO-QUERCETUM ILICIS*** *Rhamnus alaternus* *Viburnum tinus* Differential companion species according to Ass. ***Quercetum galloprovinciale*** *Carpinus orientalis* *Fraxinus ornus* *Laurus nobilis* *Tamus communis*	Characteristic species of the Class ***QUERCO-FAGETEA*** *Orobanche hederae* *Tamus communis* Characteristic species of the Order ***QUERCETALIA PUBESCENTIS*** *Quercus pubescens* Characteristic species of the Alliance ***OSTRYO-CARPINION ORIENTALIS*** *Fraxinus orientalis* Characteristic species of the Assoc. ***CARPINETUM ORIENTALIS CROATICUM*** *Carpinus orientalis* Differential species of the Association ***CARPINETUM ORIENTALIS CROATICUM*** *Asparagus acutifolius* *Pistacia terebinthus* *Ruscus aculeatus* Differential species of the Subassociation ***CARPINETUM ORIENTALIS CROATICUM lauretosum*** *Laurus nobilis* *Rhamnus alaternus* *Smilax aspera* *Viburnum tinus*

High, old trees of cultivated, ornamental species of *Pinus halepensis, Cupressus sempervirens, Tilia americana, Diospyros virginiana* are situated individually or in groups within the *Laurus* complex. They were planted in the second half of the last century and at the beginning of this, when *Laurus* was cut to enable the growth of young cultivated trees.

Conclusion

This paper is concerned with research into the wood cover in the middle part of the Renaissance Gučetić garden, part of the Arboretum Trsteno of the Croatian Academy of Science and Art. Five stands have been chosen with a total surface of 2 800 m^2 not very much affected by cultivation activities, and lying on brown carbonate soil developed on the geological substrate of flysch, in the region of a warm and humid climate. The vegetation of the investigated wood complex (Table 1) covers 100% of surface, and four layers can be recognized.

The biological spectrum (Table 2) shows that the biggest shares are taken by phanerophytes - 77.7%, chamaephytes - 14.0% and geophytes - 8.3%. Such a peculiar biological spectrum structure is due to human cultivation and maintenance of the garden. Also, the high shadow in the under layers is a limiting ecological factor on life form diversity.

The stands investigated are composed of cultivated, spontaneous and subspontaneous species. Among the spontaneous species *Laurus nobilis* plays the most significant role and is pronouncedly dominant over all the other species. It is recognized as a differential species of the *Carpinetum orientalis croaticum lauretosum* subassociation and as a differential companion species of the *Orno-Quercetum ilicis* association facies *Laurus nobilis*. In accordance with the belonging of spontaneous species to phytosociological units (Table 3), the intermixing of the evergreen and deciduous regions of the coast in the investigated habitats is pointed to.

References

Braun - Blanquet, J., 1965: Plant Sociology. New York/London

Glavač, V., 1963: Sur le dinamisme et de la succesion de la végétation dans le parc a essai de la S.I.G.M.A. Acta Bot. Croat. *22*, 175-188.

Gračanin, Z., 1952: Pedološka studija Arboretuma Trsteno. Prir. istraž. JAZU *25*, 227-262.

Horvat, I., 1949: Nauka o biljnim zajednicama. Zagreb.

Horvat, I., V. Glavač, H. Ellenberg, 1974: Vegetation Südosteuropas. Stuttgart.

Horvatić, S., 1958: Tipološko raščlanjenje primorske vegetacije gariga i borovih šuma. Acta Bot. Croat. *17*, 7-92.

Horvatić, S., 1960: Prilozi poznavanju vegetacije južnohrvatskog primorja (Prethodni izvještaj o istraživanjima u god 1959.) Ljetopis JAZU *66*.

Horvatić, S., 1963: Biljnogeografski položaj i raščlanjenje našeg Primorja u svjetlu suvremenih fitocenoloških istraživanja. Acta Bot. Croat. *22*, 27-75.

Kovačević, M., 1994: Delectus seminum 1995-1996. Arboretum Trsteno HAZU

Matković, P., 1973: Hortikulturno-estetska valorizacija i upotreba lovorika - Laurus nobilis L. - u vrtnoj arhitekturi primorja. Hortikultura *1*, 14-17.

Weaver, J., F. Clements, 1938: Plant Ecology. New York/London.

S A Ž E T A K

ZNAČAJ SAMONIKLE VEGETACIJE U STAROM PERIVOJU ARBORETUMA TRSTENO (HRVATSKA)

Maja Kovačević

(Arboretum Trsteno Hrvatske akademije znanosti i umjetnosti, Trsteno)

U ovom radu prikazano je istraživanje šumskog vegetacijskog pokrova u srednjem dijelu renesansnoga Gučetićevog perivoja, danas dijela Arboretuma Trsteno Hrvatske akademije znanosti i umjetnosti. Izabrano je pet lokaliteta u ukupnoj površini od 2 800 m^2, koji su najmanje utjecani aktivnostima parkovne kultivacije, a leže na smeđem karbonatnom tlu koje se razvilo na geološkom supstratu fliša u području tople humidne klime.

Vegetacija istraživanog šumskog kompleksa pokriva 100% površine i mogu se razlučiti četiri sloja. Biološki spektar čini 77,7% fanerofita, 14,0% hamefita i 8,3% geofita.

U sastavu istraživanih staništa izdvajaju se skupine kultiviranih, subspontanih i spontanih vrsta. Malobrojne jedinke kultiviranih vrsta uglavnom su stara i velika stabla. Među subspontanim vrstama *Trachycarpus fortunei* je najbrojnija. Razlog zamjetno velikom broju subspontanih vrsta je njihov zoohorni način rasprostranjivanja. Među spontanim vrstama, ***Laurus nobilis*** zbog visokog stupnja svoje nazočnosti ima značajnu ulogu i on je dominantan nad svim ostalim vrstama. On se javlja kao diferencijalna vrsta subasocijacije *Carpinetum orientalis croaticum* ***lauretosum*** i kao diferencijalna pratilica asocijacije *Orno-Quercetum ilicis* facijes ***Laurus nobilis***. Prema pripadnosti spontanih vrsta vegetacijskim jedinicama, istraživane sastojine ukazuju na povezanost tj. na pojavu miješanja zimzelenog i listopadnog područja primorja na istraživanim lokalitetima.

Mr. sc. Maja Kovačević

Arboretum Trsteno HAZU

HR - 20233 Trsteno, Hrvatska (Croatia)