Diversity of Vascular Flora of Boka Kotorska Bay

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Abstract Boka Kotorska represents a unique geomorphologic object in the southern part of eastern coastline of Adriatic Sea. Due to the interesting orography of this bay (surrounded by high mountains representing special micro-centers of floristic diversity in this part of Europe), climate characteristics and pedological substrate, etc., the area of Boka Kotorska Bay may be considered one of the floristic hotspots of Balkan Peninsula. In spite of many centuries of anthropogenic impact, diversity of vascular flora was preserved to a significant percentage. The overview of diversity of vascular flora at Boka Kotorska is a compilation of extensive studies presented in more than 200 scientific papers. However, it must be stated that studies of flora were not systematic. Certain parts of Boka Kotorska area are characterized

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by excellent level of study and knowledge of floristic diversity, while some other parts are completely neglected and forgotten by researchers. Area of Boka Kotorska includes a high number of *Locus classicus* units. Literature data have shown presence of 49 endemic taxa, mostly from the Mediterranean–Submediterranean range group. The system of national and international conservation recognizes 47 taxa of vascular plants and among them 26 species belong to family Orchidaceae. The traditional landscape improvement and garden design, present for centuries in area of Boka Kotorska, resulted in extraordinary richness in diversity of ligneous flora.

Keywords Endemic taxa, Ornamental plants, Protected species, Vascular flora, Vegetation

Contents

1 Introduction

The geographical position of the Boka Kotorska Bay and its immediate surroundings, with high mountains that surround it represent indeed a remarkable natural object. This area, inhabited from the period of the first traces of human civilization has undoubtedly, due to such development, lost much of its naturalness and authenticity. Traces of ancient settlements in the area of Boka Kotorska dating years before Christ, as well as of those from the beginning of the last millennium, the remains of medieval urban settlements and military fortresses, the presence of old roads, the remains of the old ports, and the very tradition of people living in this area in a continuity of more than a 2000 years are all evidence of that. On the other hand, there is no doubt that the human population, sharing the living area that is naturally surrounded by the sea, on the one side, and high mountains, on the other, found the modus of coexistence which tended to harm the natural entities the least. The fact confirming this is that even today, after such a long time, in the area of the Boka Kotorska Bay there can be found fragments of some ancient natural vegetation including preserved holm oak trees in its natural distribution. Boka Kotorska being located at an altitude of 0–500 m has a Mediterranean climate, and this is the area that in this short review will be observed in terms of vegetation and flora. Although it might at first seems that this is a common Mediterranean coastal rocky

area, the Boka Kotorska Bay conceals in its hidden parts an extraordinarily high diversity of habitat types, which still resist the intense anthropogenic influence that has been present in this area for centuries.

There is no doubt that many researchers of flora could not ignore such a representative natural object. The Boka Kotorska Bay and its cities were visited by many botanists, and there is a several hundred years old tradition of its research. Even though it is evident that there are published data of the area in almost 200 scientific papers, monographs, and reports, it is clear that in most cases, these studies of flora in the area of the Boka Kotorska Bay were partially performed around large settlements. Some parts of the Boka Kotorska Bay are therefore floristically completely uninvestigated and there are almost no any scientific data on the plant species and their habitats. Namely the 114 km of its coastline is not only a strict contact area between the sea and land in the form of rocky, stony, and sandy beaches. Those are the numerous meadows extremely moist, well-preserved fragments of forest stands, steep cliffs and taluses, sections of grassy vegetation on limestone karst, and degradation levels of evergreen Mediterranean forest with all the beautiful wealth of species hiding inside. Of course there are specific coastal habitats such as salt marshes, walls and sides of the old fortifications. It is simply a mosaic of microhabitats which is enriched with a large diversity of vegetation entities and exceptional diversity of plant taxa with special ecological and evolutionary solutions that make this region interesting for different types of botanical research. Almost all types of habitats from the Boka Kotorska Bay have been partially surveyed. This is obvious not only from the numerous scientific publications, but from the very extensive herbarium material as well which is stored in large scientific herbarium collections recognizable by the material from the Balkan Peninsula. Old researchers' herbarium exsiccates, as well as the more recent collected material, hide incredible specimens of rare and endemic taxa, often belonging to the very narrow distribution type. A particular plant species present specificity of this area.

The first floristic researches related to the area of the Boka Kotorska Bay date from the first half of the nineteenth century. Then was for the first time scientifically described the Illyrian endemic species *Petteria ramentacea* (Sieber) C. Presl [1]. The researches continued already in 1827, when *Muzzio Tommasini* arrived in the Boka Kotorska Bay. The researcher sent his material to Padua and Vienna, to the then-known researchers of his time (Visiani, Host) for determination [2]. Tommasini publishes the results of his trips to the Boka Kotorska Bay in 1835 [3], and the researchers who determined his exsiccates later publish new taxa based on the material obtained from this researcher. Because of that, and out of special gratitude, *Muzzio Tommasini* is one of the botanists to whom a special tribute is paid by naming a significant number of taxa after him [2]. There is no doubt that the special mark on the floristic work in the nineteenth century in the region of the Boka Kotorska Bay was left by the Paduan physician and botanist *Roberto Visiani*. Devotedly working on collecting the botanical and herbarium material, as well as analyzing the materials sent to him by other botanists who were his contemporaries, this researcher, the author of the famous work Flora

Dalmatica [4–6] became recognizable for a larger number of taxa some of which are described from the area of the Boka Kotorska Bay (*Seseli globiferum* Vis., *Stachys menthifolia* Vis. et al.). Then there come later works by Visiani [7–9], *Emanuel Weiss* [10, 11], research results of the environment of Kotor [12–15], the Islands of Mamula, and the Cape Oštra [16], as well as the hill Vrmac Tivat [17, 18]. A large number of botanists and many others exploring the environment passed through the Boka Kotorska Bay [19–25] contributing to the research and knowledge of the flora in this area. Academician Vukić Pulević in detail wrote about them and described their work in his books *Montenegro doors of Balkans* [26] and *Botanists and Montenegro* [2].

Many Serbian botanists starting with *Josif Pančić* [27] and *Lujo Adamović* [28–30] explored the area of the Boka Kotorska Bay in their own method and made an outstanding contribution to the knowledge of its flora and vegetation. After World War II, research in this area has been intensified by works presenting results of new floristic data for this area, but they became significant for the broader region as well [31–44]. Fragments of the laurel and chestnut vegetation communities [45], laurel and oleander vegetation communities [46], as well as vegetations of the salt marshes of Tivat [47, 48] were especially studied. Specific habitats such as the remains of ancient fortresses and walls around these sites were researched as well and the findings from these studies became a part of an exceptional corpus of work dedicated to the flora and vegetation of the Boka Kotorska Bay [49].

However, despite the extraordinary botanical materials, we are not able to precisely define the exact number of species that is characteristic for this area. On the one hand, we see that this is an area that has been thoroughly studied, with an exceptional number of references published since the middle of nineteenth century to the present day, with a rich herbarium material stored in the relevant European herbarium collections, whereas, on the other hand, there is no scientifically conducted study of the floristic diversity of the Boka Kotorska Bay. One of the most studiously researched localities is the eastern part of the Boka Kotorska Bay with the hill of Vrmac and the field of Tivat for which there have been recorded 866 taxa at the level of species, subspecies, and lower infraspecific taxa [42]. This study has greatly consolidated the existing knowledge on the floristic diversity of the eastern part of the Boka Kotorska Bay, however, in its own thorough researches it has recorded another 279 taxa that were registered for the first time for the studied area [42]. For the area of the saline marshes of Tivat there have been registered 307 taxa of species, subspecies, and lower taxonomic entities [48], and on the hill of St. Ivan above Kotor alone, which includes a geomorphological unit at the height of only 260 m with the city walls and ramparts, there has been registered 301 taxa at the level of species and subspecies [50]. The estimated number of taxa at the level of species and subspecies for the studied area, excluding the allochthone species that represent a special part of the current floristic list, certainly is over 1000, however, there are no precise data on that.

2 Characteristics of Vegetation in the Boka Kotorska Bay

Based on vegetation papers on the Boka Kotorska Bay, the oldest of which date back to 1900 [28–30, 45–47, 51–54], Prodomus of the plant communities of Montenegro [55], and the natural potential vegetation map [56] in this area have been recorded 15 major plant formations: bushes, maritime pine forests (*Pinus halepensis*) (Fig. 1), black pine forests (*Pinus nigra*), laurel forests (*Laurus nobilis*) (Fig. 2), evergreen oak forests (*Quercus ilex*, *Quercus pseudosuber*, *Quercus coccifera*) (Fig. 3), carob forests (*Ceratonia siliqua*) (Fig. 4), deciduous oak forests, deciduous shrubs (Fig. 5), hedges and fences, pastures and rocky and karstic terrains (Fig. 6), rocks and walls (Fig. 7), seashore (Figs. 8 and 9), ponds and marshes (Fig. 10), weeds, and culture plants (Fig. 11). However, despite a good general overview of the vegetation, a detailed list of vegetation units, their mapping, and analysis of vegetation changes still have not been systematized and compiled.

In terms of biogeography the area of the Boka Kotorska Bay belongs to the Mediterranean region, within which, according to the classification by Stevanović [57], we distinguish two subregions: the Euro-Mediterranean and Euro-Submediterranean. In terms of vegetation the first subregion is characterized by formations of evergreen leathery leaves holm oaks and their degradation products, while the second subregion is characterized by thermophilic forests and thickets butcher's broom and hornbeam and their degradation forms. Starting from the coast, depending on the nature of its substrate in the vicinity of water grow different plant communities belonging to *Crithmo-Staticetalia*, *Limonetalia*, *Thero-*

Fig. 1 Maritime pine forests (*P. halepensis*) (Photo by Dmitar Lakušić)

Fig. 2 Laurel (*L. nobilis*) (Photo by Vesna Mačić)

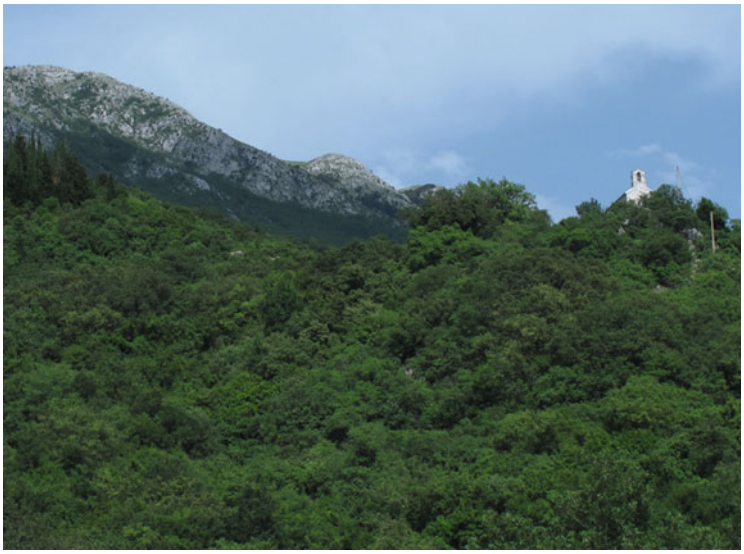

Fig. 3 Evergreen oak forest (*Q. pseudosuber*) (Photo by Vesna Mačić)

Salicornietalia, *Juncetalia maritimi,* and *Phragmitetalia australis*. The rocky coast and sea cliffs are overgrown by sparse vegetation almost entirely consisting of species of the genus *Limonium* (*Limonium cancellatum* and *Limonium anfractum*) and *C. maritimum*, whereas the floristic composition on more distant rocks becomes richer. This type of habitat is included in the NATURA 2000: 1240 Vegetation of the Mediterranean Sea cliffs covered with endemic species of the genus *Limonium*

Fig. 4 Carob forests (*C. siliqua*) (Photo by Vesna Mačić)

Fig. 5 Deciduous shrubs (Photo by Dmitar Lakušić)

[ass. *Crithmo-Limonietum anfracti* (H-ić) Ilijanić; *Plantagini-Staticetum cancellatae* H-ić (1934) 1939].

On the muddy-clay substrate of the Tivat salinas and a part of the Tivat field, on very salty and flooded habitats, there are communities of glassworts ass. *Salicetum herbacea* Jank. et Stev. 1984 and *Arthrocnemum fruticosi* Br.-Bl. 1928 of the order *Thero-Salicornietalia*. They are included in the NATURA 2000 habitat: 1310 – Annual vegetation glasswort (*Salicornia*). In the less saline and wet environments

Fig. 6 Karstic terrains (*Nerium oleander)* (Photo by Dmitar Lakušić)

Fig. 7 Rocks and walls (Photo by Vesna Mačić)

thrives the community of *Limonio-Artemisietum caerulescentis* H-ic (1933) 1934 of the order *Limonetalia*, while in places where there are brackish waters grows the community of *Junco maritimo-Acute* H-ic 1934 from the order of *Juncetalia*. These communities belong to the NATURA 2000 habitat: 1410 – Mediterranean saline

Fig. 8 Seashore (*Crithmum maritimum and Limonium anfractae*) (Photo by Dmitar Lakušić)

Fig. 9 Seashore (Photo by Danijela Stešević)

water fields (*Juncetalia maritimi*) on mud and sand. The community of *Scirpetum maritimi* Br.-Bl. 1934 from the order of *Phragmitetalia* is registered on ponded and brackish locations and this habitat is also included in NATURA 2000: 2190 – Humid dune slacks.

Fig. 10 Ponds and marshes (*Arthrocnemum fruticosum*) (Photo by Dmitar Lakušić)

Fig. 11 Culture plants (Photo by Danijela Stešević)

According to a map of potential vegetation [56] by the very coast of the Boka Kotorska Bay, at an altitude of 300 (500) m.a.s.l. dominated stiff leaved forest vegetation of holm oaks (ass. *Quercetum ilicis adriaprovincialis* Trinajstić 1975). Preserved parts of this community at the end of the 1990s were recorded only in the

southern part of the peninsula of Luštica [42]; however, the intensified anthropogenic influence has decreased their representativeness, and reduced their stands to fragments only. Today, the entire area of the Boka Kotorska Bay, in this high-altitude area and slopes exposed to the south dominate degradation forms of the evergreen holly oak forests, found in thick and impassable macchia (ass. *Orno-Quercetum ilicis* H-ić (1956) 1958; *Orno-Quercetum ilicis myrtetosum* H-ić 1963), garrigue (ass. *Erico-Cistetum cretica* H-ić 1958), and dry fields and rocky pastures (communities of the alliance *Cymbopogo-Brachypodion ramosi* H–ić (1956) 1958). The following NATURA 2000 habitats contribute to a special biological value to the area: fragments of macchia with the dominating juniper *Juniperus phoenicea*, which are recorded in Luštica in the bay of Trašte (5210 – Macchia with Mediterranean junipers (*Juniperus* spp.)) [58], fragments of the preserved communities of laurel (ass. *Lauretum nobilis adriaticum* Lakušić, 1983) in Kostajnica and in Luštica (5230 * High bushes of laurel), xerophile bushy formations characteristic of the thermomediterranean zone in Luštica, which include a very specific relict communities of woody spurge (*Euphorbia dendroides*) – 5330 Thermomediterranean pre-desert shrubs; natural stands of laurel and oleander near Risan (ass. *Andropogono distachyi-Nerietum oleandri* (Jovanović and Vukićević 1978) Jasprica et al. 2007) – 92D0 southern coastal galleries and thickets (*Nerio-Tamaricetea*), and 6220 * Eumediterranean xerophylous grasslands (*Thero-Brachypodietea*).

According to the general vertical zonation the region of evergreen elements shifts to thermophilic deciduous forests and shrubs of fresh *Ostryo-Carpinion orientalis* H-ić 1967. However, on the northern slopes of the Bay this type of vegetation is lowered to the sea, so that there is no evergreen vegetation belt. This unusual phenomenon can be explained by the exposure, proximity of the high mountain ranges, and influence of colder Oromediterranean climate. Thermophilic deciduous vegetation is represented by the following communities: *Rusco-Carpinetum orientalis* Blečić & Lakušić 1966, *Paliuretum adriaticum* H-ić 1958, and *Paliuretum adriaticum carpinetosum orientalis* H-ić 1963. Depending on the degree of degradation, the community of butcher's broom and hornbeam appears either in the form of a forest, or dense or sparse shrub. Communities with Christ's thorn (*Paliurus spina-christi*) are dominated by a more degraded, rocky environment. In the zone of holly oak forests there is ass. *Paliuretum adriaticum typicum*, and in the zone of thermophilic deciduous vegetation we can find a subassociation of *Paliuretum adriaticum – Carpinetosum orientalis* H-ić 1963. The ultimate degradation of bushy formations forms rocky pastures thriving with the bond of *Scorzonero-Chrysopogonetalia* H-ić & Horvat (1956) 1958. The communities of rocky pastures form a part of the network NATURA 2000 habitats (62A0- East Submediterranean dry grasslands *Scorzoneratalia villosae).*

A dendrological specificity of the Boka Kotorska Bay certainly are the chestnut forests (ass. *Lauro-Castanetum sativae* M. Jank. 1966) (Fig. 12), which grow under the direct influence of the Mediterranean climate and sea, which are, thanks to the relief and exposure, protected from excessive insolation and summer droughts. They are registered in Stoliv, Lepetane, in the area above Tivat, Kostanjica between

Fig. 12 Chestnut forests (ass. *Lauro-Castanetum sativae*) (Photo by Vesna Mačić)

Morinj and Kamenari, on Savina. They form a part of the network NATURA 2000 habitats as well (9260 Chestnut forests). Together with the natural stands of laurel and oleander near Risan, halophyte flora and vegetation along the coastline of the Bay of Tivat, flora and vegetation of the peninsula of Vrmac, vegetation on the steep rocks and screes that rise above the sea, in 1979 this type of forests was proposed to be under the measures of protection and rational use [34].

As an azonal vegetation type, vegetation of rocks is except the supralittoral splach zone present on all altitude ranges. It consists of the communities belonging to the following classes: *Adianthetea capilli-veneris* Br.-Bl. 1947 and *Asplenietea rupestris* (H. Meier) Br-Bl. [34]. The total vegetation diversity of the area is contributed by a number of anthropogenic communities in ruderal and cultivated areas.

3 Balkan Endemic Plants in the Flora of Boka Kotorska

The term “endemism” attracted scientists since ancient times and there are many definitions attempting to explain this phenomenon. Knowledge of endemic flora of certain areas may explain its biogeographical history, and the percentage share of

the endemic species in given flora determines the degree of isolation and the age of a given territory [59].

By now there has not been produced a detailed study on the endemic flora of Montenegro. The oldest data on the endemic flora of Montenegro originate from Turill [60], who divided the Balkan Peninsula according to the phytogeographic and floristic terms into 16 districts. For the district of Montenegro he recorded 210 endemic plant taxa. According to the Blečić [61], who cites Turill [60] including the most recent data of the time, in the flora of Montenegro there were recorded 220 Balkan and 20 Montenegro endemic species. According to the Stevanović et al. [62], the Balkan endemic plant taxa in the flora of Montenegro make 223 which is 11.7 % of the total flora of Montenegro. Endemism of the Montenegrin flora cannot be observed without the endemic flora of the Balkan Peninsula, or at least its western part. Flora of the Western Balkans, of the Dinarids to be more precise, central Mediterranean (Adriatic coast) and Submediterranean is characterized by a high percentage of endemism. The largest number of endemic species in the Western Balkans was recorded on high limestone mountains, in canyons and river gorges, as well as on the Dalmatian islands, and, generally speaking, in the coastal (Adriatic) region [63].

A review of the research data on the area of the Boka Kotorska Bay revealed the presence of 49 Balkan endemic plant taxa (Table 1). Balkan endemic plants are, by definition, such plant taxa that are with their distribution restricted to the territory of the Balkan Peninsula [60, 64, 65].

The first described plant taxon in the territory of Montenegro was a plant under the common name Dalmatian Laburnum *Cytisus ramentaceus*, which was later named *Petteria ramentacea* (Fig. 13). It was described by the German botanist *Fr. W. Sieber* 1822 on materials collected in the vicinity of Kotor. It turned out that this "debut" in the flora of Montenegro was also the endemic plant of the Western Balkans. It grows only in karst rocky Dalmatia, Bosnia and Herzegovina, Montenegro, and Albania.

It is not unusual that the first described plant in the flora of Montenegro originated from the area of the Boka Kotorska Bay. The Bay with Paštrovići belonged to the Austro-Hungarian province of Dalmatia in terms of territory and policy in the nineteenth century, and was a place from which "all roads" led to Montenegro as well. It attracted researchers who made some first significant floristic records from Boka Kotorska and its hinterland, Tommasini [3], Bartolommeo [66], and Ebel [67]. One of them, *Roberto Visiani* that had actually never done any botanical researches in Montenegro, made description based on herbarium material that he had received from other botanists, which were a number of new species for the science, such as *Amphoricarpos neumayerianus*, *Lonicera glutinosa*, *Achillea abrotanoides,* and others. *Locus classicus* of these plant species is located on Orjen. From the area of the Boka Kotorska Bay the following are described: *Cytisus tommasinii*, *Seseli globiferum*, *Clinopodium dalmaticum,* and *Stachys menthifolia*. All of the aforementioned plant taxa are Balkan endemic species of wider or narrower distribution (see Table 1). Visiani published these significant

Table 1 Review of the endemic taxa of the vascular flora of Boka Kotorska

Number	Species	Subspecies	Locality	Life form	Floristic elements, chorological group
1.	*Cerastium grandiflorum* Waldst. & Kit.		Kotor, hill of St. Ivan	Ch	SEM
2.	*Cerastium ligusticum* Viv.	Subsp. *trichogynum* (Möschl) P. D. Sell and Whitehead	Peninsula Luštica: village Klinci	Ch	MED–SUBM
3.	*Petrorhagia obcordata* (Margot and Reuter) Greuter & Burdet		Tivat, hill of St. Ivan	T	MED–SUBM
4.	*Dianthus ciliatus* Guss.	Subsp. *dalmaticus* (Čelak.) Hayek	Kotor, hill of St. Ivan	Ch	MED–SUBM
5.	*Consolida uechtritziana* (Pancic ex Huth) Soó		Kotor	T	MED–SUBM
6.	*Erysimum linariifolium* Tausch	Subsp. *linariifolium*	Vrmac	Ch	SEM
7.	*Cardamine rupestris* (O.E. Schultz) K. Malý		Kotor, near Krašići	T/H	MED–SUBM
8.	*Viola suavis* M. Bieb.	Subsp. *austrodalmatica* Mereďa and Hodálová	Zelenika	H	MED–SUBM
9.	*Euphorbia glabriflora* Vis.		Kotor, hill of St. Ivan	Ch	MED–SUBM
10.	*Rhamnus intermedius* Steud. & Hochst.		Luštica, hill of St. Ivan	NP	MED–SUBM
11.	*Rhamnus orbiculata* Bornm.	Subsp. *orbiculata*	Donji Stoliv, Vrmac	NP	MED–SUBM
12.	*Trifolium dalmaticum* Vis.	Subsp. *dalmaticum*	Vrmac, Tivat	T	MED–SUBM
13.	*Trifolium pignantii* Fauché & Chaub.		Vrmac	H	MED–SUBM
14.	*Cytisus tommasinii* Vis	Subsp. *tommasinii*	Vrmac	Ch	SEM
15.	*Petteria ramentacea* (Sieber) C. Presl		Vrmac	NP	MED–SUBM
16.	*Genista sylvestris* Scop.	Subsp. *dalmatica* (Bartl.) Lindb.	Luštica	Ch	MED–SUBM
17.	*Seseli globiferum* Vis.		Hill of St. Ivan	H	MED–SUBM

(continued)

Table 1 (continued)

Number	Species	Subspecies	Locality	Life form	Floristic elements, chorological group
18.	*Chaerophyllum coloratum* L.	Subsp. *coloratum*	Luštica, Vrmac, hill of St. Ivan	T	MED–SUBM
19.	*Limonium dictyophorum* (Tausch) Degen		Pržno	H	MED–SUBM
20.	*Moltkia petraea* (Tratt.) Griseb.		Vrmac, hill of St. Ivan	Ch	MED–SUBM
21.	*Onosma stellulata* Waldst. & Kit.		Vrmac	Ch	SEM
22.	*Teucrium arduinii* L.	Subsp. *arduinii*	Kotor, hill of St. Ivan	Ch	MED–SUBM
23.	*Sideritis romana* L.	Subsp. *purpurea* (Talbot ex Benth.) Heywood	Kotor, Luštica, Vrmac	T	MED–SUBM
24.	*Stachys menthifolia* Vis.	Subsp. *menthifolia*	Kotor, Vrmac, hill of St. Ivan	H	MED–SUBM
25.	*Clinopodium alpinum* (L.) Kuntze	Subsp. *majoranifolium* (Mill.) Govaerts	Kotor, Vrmac, hill of St. Ivan	H	MED–SUBM
26.	*Clinopodium dalmaticum* (Benth.) Bräuchler & Heubl		Kotor, Hill of St. Ivan	Ch	MED–SUBM
27.	*Micromeria kerneri* Murb.		Kotor surroundings	Ch	MED–SUBM
28.	*Satureja horvatii* Šilić	Subsp. *horvatii*	Kotor surroundings	Ch	MED–SUBM
29.	*Satureja subspicata* Bartl. ex Vis.	Subsp. *subspicata*	Hill of St. Ivan above Kotor	Ch	SEM
30.	*Vincetoxicum huteri* Vis. & Ascherson		Luštica, Vrmac, hill of St. Ivan	H	SEM
31.	*Asperula scutellaris* Vis.		Kotor, hill of St. Ivan	Ch	MED–SUBM
32.	*Galium firmum* Tausch		Vrmac, hill of St. Ivan	Ch	MED–SUBM
33.	*Galium procurrens* Ehrend.		Kotor, Vrmac	H	CEUR
34.	*Viburnum maculatum* Pant		Vrmac	NP	CEUR
35.	*Knautia visianii* Szabó		Tivat, Vrmac	H	MED–SUBM

(continued)

Table 1 (continued)

Number	Species	Subspecies	Locality	Life form	Floristic elements, chorological group
36.	*Campanula austroadriatica* D. Lakušić & Kovačić		Kotor, Tivat, Vrmac, Risan	Ch	MED–SUBM
37.	*Edraianthus tenuifolius* (A.DC.) A. DC.		Vrmac	Ch	MED–SUBM
38.	*Tanacetum cinerariifolium* (Trevir.) Sch.Bip.		Vrmac, Luštica, hill of St. Ivan	H	MED–SUBM
39.	*Centaurea glaberrima* Tausch	Subsp. *glaberrima*	Luštica	H	MED–SUBM
40.	*Hieracium baldaccianum* Bald.		Kotor	H	SEM
41.	*Hieracium heterogynum* (Froelich) Gutermann	Subsp. *heterogynum*	Vrmac	H	SEM
42.	*Hieracium heterogynum* (Froelich) Gutermann	Subsp. *pachychaetium* (Nägeli & Peter) Greuter	Kotor	H	SEM P
43.	*Hieracium thapsiformoides* K. Malý		Kotor	H	SEM
44.	*Hieracium tommasinianum* K. Malý	Subsp. *tommasinianum*	Kotor	H	CEUR
45.	*Allium guttatum* Steven	Subsp. *dalmaticum* (A. Kerner ex Janchen) Stearn	Tivat, hill of St. Ivan	G	MED–SUBM
46.	*Fritillaria messanensis* Raf.	Subsp. *gracilis* (Ebel) Rix	Vrmac, hill of St. Ivan	G	JEP
47.	*Crocus dalmaticus* Vis.		Kotor, Luštica, Vrmac	G	MED–SUBM
48.	*Iris pseudopallida* Trinajstić		Kotor, hill of St. Ivan	G	MED–SUBM
49	*Sesleria robusta* Schott & al.	Subsp. *robusta*	Kotor surroundings	H	SEM

findings in his most famous work, "*Flora Dalmatica*" which was printed in three volumes [4–6].

Some other endemic plants such as *Viburnum maculatum* (Vrmac near Kotor, [68]), *Vincetoxicum huteri* (on the road from Risan towards Crkvice, [21]) (Fig. 14),

Fig. 13 *Petteria ramentacea* (Sieber). (Photo by Snežana Vuksanović)

Fig. 14 *Vincetoxicum hutteri* Vis. and Ascherson. C. Presl (Photo by Danijela Stešević)

Rhamnus orbiculatus (Kotorska župa, [13]), and *Galium proccurens* [69] have also been described from the area of Boka Kotorska Bay.

After the World War II Montenegro local botanists and botanists from the neighboring countries explore the flora. We are going to mention the Bosnian-Herzegovinian botanists Čedomil Šilić who described the new species of endemic heather *Satureja horvatii* on the material collected on the mountain of Orjen (Kabao–Subra) [70]. This plant was also recorded in the vicinity of Kotor (Table 1). In recent years, thanks to molecular analysis, certain plant families, and/or groups have been revised and some new to science endemic species from the area of the Boka Kotorska have been described, like *Viola suavis* subsp. *austrodalmatica* [71], *Cardamine rupestris* [72], and *Campanula austroadriatica* [73].

Table 1 presents the 49 Balkan endemic plant species and subspecies that were recorded in the flora of Boka Kotorska. The taxonomic status of the endemic plants is given in accordance with the existing bibliographic sources [64, 74–80] and electronic databases [81–84]. Locality, life form and areal group are given for each taxon. Meusel [85–88] method was used to define the areal (chorological) groups, as well as their appropriate classification, which is according to Tomović et al. [65] modified and adapted for the territory of Montenegro. Taxa are listed in the following chorological groups: the MED–SUBM (Mediterranean–Submediterranean); SEM (South European mountain); and CEUR (Central European). Taxon classification in terms of life form is done by the system Raunkiaer [89], which was revised by Mueller-Dombois and Ellenberg [90] and elaborated by Stevanović [88]. Taxa are classified as follows: nanophanerophytes (NP), chamaephytes (Ch), hemicryptophytes (H), geophytes (G), and therophytes (T).

The chorological structure of the endemic flora of Boka Kotorska showed that it is the largest Mediterranean–Submediterranean group with 34 taxa, followed by 12 taxa belong to the South European mountain group and only three taxa belong to the central European one. In the biological spectrum of flora chamaephytes are the most numerous with 18 taxa, followed by hemicryptophytes with one taxon less, i.e. 17, therophytes numbering six taxa and geophytes and nanophanerophytes each having four taxa.

The immediate and strong Mediterranean influence caused the largest number of endemic taxa of Boka Kotorska to belong Mediterranean–Submediterranean areal group. Members of this group inhabit xerophilous and thermophilic communities which make a significant share of the habitats in Boka Kotorska. In addition, a strong anthropogenic influence that leads to the spread of secondary vegetation types (rocky habitats, xerophilous grass communities, and various forms of shrubs), at the expense of the potentially forest and shrub types of habitats, contributes to the increasing number of endemic taxa belonging to the Mediterranean–Submediterranean chorological group [59]. Southern Europe mountain group that is represented with 12 taxa is characteristic of the high mountainous type of endemism. A relatively small number of endemic taxa belong to it and they inhabit the slopes of Vrmac and the slopes of the hill of St. Ivan. Given that the coastal mountains of Lovćen and Orjen immediately rise over Boka Kotorska, which are considered centers of high mountain endemism in the Balkans and in Europe [57], it

is not surprising that some orophytes found refuge on the northern slopes of the hill in Boka. The Central European areal group is represented with only three taxa inhabiting the broad leaf forests and mesophilic pastures of the central and western Balkans. Their contribution is, therefore, insignificant in the total number of the endemic flora of Boka Kotorska.

Life forms of the plants reflect the basic features of habitats as well as the continuity of weather changes on it and they are the result of the adjustment process during the evolution of the species [91]. Chamaephytes are the most numerous life form in the biological spectrum of endemic flora of Boka Kotorska. Endemic dwarf shrubs in the Boka Kotorska usually inhabit cracks of the thermophilic limestone cliffs and rocky areas. Plants that live in such habitats have by the rule slower growth and they are resistant to drought [92]. Hemicryptophytes represent the most numerous life form in the temperate zone and in the Balkan Peninsula, and we therefore expect their large distribution in the endemic flora of Boka Kotorska. The life form of therophytes in the endemic flora mainly belongs to the plants that predominantly inhabit the Mediterranean region. Therophytes inhabit the less productive habitats such as dry meadows and rocky places where they are exposed to drought or habitats that are under strong anthropogenic influence. Geophytes life form belongs to the plants that inhabit the Mediterranean and Submediterranean thermophilic and xerophilous habitats. Nanophanerophytes are represented by four species in the endemic flora of Boka Kotorska, which is expected, considering that there are not many Balkan endemic taxa among the bushy plants.

4 Protected and Rare Species of Vascular Plants in the Flora of Boka Kotorska Bay

According to the available studies and our own field data there are 47 species of national and/or international protection status, which are grouped into 15 families in the area of Boka Kotorska (Table 2). In accordance with ancient research data there are two more species in Boka that are protected in Montenegro: *Pancratium maritimum* L. (Trašte [16, 93]) and *Echinophora spinosa* L. (Trašte [16], Tivat [18]. The above-mentioned species have not been reported in Boka for more than a century, and we believe that they are extinct in this area due to urbanization.

Two species – *Galanthus nivalis* L. and *Ruscus aculeatus* L., which have numerous populations in Montenegro, they are listed in the ANNEX V Habitat Directive. Furthermore 27 recorded taxa have been listed by the CITES convention.

National legislation protects 46 species, whereby is the category of endangered defined only for *Polygonum maritimum* (IUCN category VU, B2ab Criteria (iii, v) (Fig. 15) [94]. Taxa of the Orchidecaeae family are protected in Montenegro, so that the greatest number of protected species (26) in Boka Kotorska belong to this family. Some of these species have a wide distribution and a number of populations in the Mediterranean and Submediterranean area of Montenegro, like *Orchis morio*

Table 2 Review of taxa of the vascular flora of Boka Kotorska with the corresponding level of protection

Taxon	National status of protection[a]	International status of protection
Polygonaceae		
Polygonum maritimum L.	+	
Chenopodiaceae		
Salicornia europaea L.	+	
Salicornia fruticosa (L.) A. J. Scott.	+	
Salsoda kali L.	+	
Salsola soda L.	+	
Caryophyllaceae		
Spergularia salina J. Presl & C. Presl	+	
Brassicaceae		
Cakile maritima Scop.	+	
Euphorbiaceae		
Euphorbia paralias L.	+	
Rhamnaceae		
Rhamnus intermedius Steudel & Hochst	+	
Apiaceae		
*Chaerophyllum coloratum*L.	+	
Eryngium maritimum L.	+	
Primulaceae		
*Cyclamen hederifolium*Aiton.	+	
Cyclamen repandum Sm.	+	
Plumbaginaceae		
Limonium angustifolium Tausch	+	
Asclepiadaceae		
Vincetoxicum huteri Vis. & Ascherson	+	
Lamiaceae		
Micromeria kerneri Murb.	+	
Satureja inodora Host.	+	
Asteraceae		
Aster tripolium L.	+	
Centaurea glaberrima Tausch.	+	
Posidoniaceae		
Posidonia oceanica (L.) Delile	+	
Zosteraceae		
Zostera marina L.	+	
Zostera noltii Hornem.	+	
Liliaceae		
Ruscus aculeatus L.		Anex V Habitat Directive

(continued)

Table 2 (continued)

Taxon	National status of protection[a]	International status of protection
Amaryllidaceae		
Galanthus nivalis L.	+	CITES; Anex V Habitat Directive
Orchidaceae		
Anacamptis pyramidalis (L.) Rich.	+	CITES
Epipactis microphylla (Ehrh.) Swartz	+	CITES
Dactylorhiza saccifera (Brongn.) Soó	+	CITES
Ophrys apifera Hudson	+	CITES
Ophrys araneola Rchb.	+	CITES
Ophrys bertolonii Moretti (Fig. 16)	+	CITES
Ophrys bombyliflora Link	+	CITES
Ophrys holosericea (Burm.) Greuter	+	CITES
Ophrys reinholdii Spruner ex Fleischm	+	CITES
Ophrys scolopax Cav. subsp. *cornuta* (Steven) Camus	+	CITES
Ophrys sphegodes Miller subsp. *montenegrina* H. Baumann & Künkele	+	CITES
Ophrys sphegodes Miller subsp. *sphegodes*	+	CITES
Orchis coriophora L.	+	CITES
Orchis laxiflora Lam.	+	CITES
Orchis morio L. supsp. *morio*	+	CITES
Orchis morio L. supsp. *albanica*	+	CITES
Orchis pauciflora Ten.	+	CITES
Orchis quadripunctata Cirillo ex Ten.	+	CITES
Orchis simia Lam.	+	CITES
Orchis tridentata Scop.	+	CITES
Platanthera bifolia (L.) Rich.	+	CITES
Serapias cordigera L.	+	CITES
Serapias lingua L.	+	CITES
Serapias vomeraceae (Burm.) Briq.subsp. *laxiflora* (Soó) Göltz & Reichard	+	CITES
Serapias vomeraceae (Burm.) Briq.subsp. *vomeraceae*	+	CITES
Spiranthes spiralis (L.) Chevall.	+	CITES

[a]National status of protection is given in accordance with the document "Decision on the protection of certain animal and plant species" (Decision published in Official Gazette MNE No 76/06 of 12th December 2006)

L., for example. However, there are some that have been reported only in Boka Kotorska and only on one locality: *Ophrys bombyliflora* Link (Muo above Kotor: [4]) *Ophrys reinholdii* Spruner ex Fleischm (Mrkovi in Boka Kotorska: [40]). We do not have any information on the population size of these rare orchids.

Fig. 15 *Polygonum maritimum* L. (Photo by Snežana Vuksanović)

Fig. 16 *Ophrys bertolonii* Moretti (Photo by Snežana Vuksanović)

In addition to the protected species, it is important to mention the ones that are not protected, but that are very rare. They were recorded in Montenegro only in Boka Kotorska, on one or two localities. These are: *Aeluropus litoralis* (Gown) Parl. (Tivat saline fields [42, 47]; St. Ivan above Kotor [42]), *Aira caryophyllea* L. (Vrmac [42]), *Ajuga iva* (L.) Schreber (road Krtole – Luštica [95], Miriša [42]), *Andrachne telephioides* L. (Luštica [96]), *Anogramma leptophylla* (L.) Link (Rose, Vrmac [16]), *Anthemis ruthenica* Bieb. (Lastva near Tivat [97]), *Asplenium petrarchae* (Guerin) DC. (Kotor [98]), *Bupleurum tenuissimum* L. (Tivat fields, saline field *Consolida incana* (ED Clarke) Munz ([10], *Daphne gnidium* L. (near Kotor [4]), *Elymus elongatus* (Host) Runemark (Tivat saline fields: [47], Tivat

saline fields [42]), *Eryngium creticum* Lam. (Muo, Dobrota [16]), *Fumana arabica* (L.) Spach (Trinity bay Trašte [16]), *Lamium hybridum* Vill. (Lepetane, Stoliv [42]), *Lavatera punctata* All. (Vrmac [25]), *Linaria chalepensis* (L.) Miller (Boka Kotorska [16]), *Lotus cytisoides* L. (Mamula, vicinity of Kotor [16]), *Medicago coronata* (L.) Bartal. (Vrmac [3]), *Medicago tuberculata* (Retz.) Willd. (Boka Kotorska: [16]), *Narcissus papyraceus* (Gornja Lastva: [42]), *Orobanche hederae* Duby (Lepetane [42]), *Orobanche lavandulacea* Reichenb. (St. Ivan above Kotor [16]), *Orobanche ramosa* L. (St. Ivan above Kotor [16]), *Orobanche sanguinea* C. Presl. (Near Kotor [16]), *Parapholis filiformis* (Roth) C. E. Hubbard, *Plantago maritima* L. (Tivat saline fields [47, 48]), *Plumbago auriculata* Lam. (Tivat, Ostrvo cveća [96]), *Potentilla sterilis* (L.) Garcke (Prčanj and Stoliv [6], Meljine and Vrmac [16]), *Puccinellia festuciformis* (Host) Parl. (Tivat saline fields [42, 47, 48]), *Rumex confertus* Willd. (Lepetane [42]), *Ruppia cirrhoza* (Petagna) Grande (Kotor [21], Tivat saline fields [47]), *Santolina chamaecyparissus* L. (between Škaljari and Kotor [16]), *Scandix australis* L. (Kotor [11]), *Schoenoplectus litoralis* (Schrad.) Palla (Tivatske salt pans [47]), *Sedum rubens* L. (Zelenika [10]) *Sedum stellatum* L. (Kostanjica the Gulf Morinj [99], *Senecio leucanthemifolius* Poir. (Kotor [5]), *Silene bupleuroides* L. (Škaljari [3]), *Spergularia media* (L.) C. Presl (environment Kotor [23]) *Triglochin maritima* L. (saline fields in the Bay of Tivat [32], Tivat bay, the saline fields [47]), *Vicia articulata* Hornem (Muo, Prčanj [3]).

It is particularly interesting to mention the orchid *Neotinea maculata* (Desf.) Stearn, which is in Montenegro recorded only on two localities in Boka: Spilica near Kotor [100] and at Činovica hill at the foot of the peninsula of Vrmac [42]. This is one of the two species that are identified representatives of Orchidaceae family in Montenegro, which is not protected by the national legislation, despite the fact that it is very rare.

5 The Decorative Flora of the Boka Kotorska Bay

Several millennia coexistence of man and nature in the area of Boka Kotorska reflected on man's relationship with nature as its primordial environment. Respect for nature is reflected in the tradition and culture of living of the people who have been inhabiting these areas for centuries. For these reasons, and in particular, bearing in mind the tradition of enriching the living space with the natural surroundings, the settlements in the area of Boka Kotorska from ancient times have been having parks, gardens, and green areas. Cultivating these areas was made easier by the fact that sailing as a recognizable occupation of the inhabitants of Boka Kotorska, often followed the tradition of bringing seedlings of rare species of trees that enriched the already recognizable beautifully landscaped gardens and parks. Area of Boka Kotorska did not bypass the traditional enrichment of dendroflora from the period of the Roman civilization, and particularly in the eighteenth and nineteenth centuries. At that time, the introduction of species into Europe from distant places was intense. The impression of a raised awareness of the

importance of cultivation of the ambient areas is complemented by extraordinarily nicely and cleanly decorated squares, ancient tree-lined boulevards, and in particular extremely well-designed gardens and parks in the courtyards of the monastery buildings. Private gardens and yards of residential buildings and houses are nonetheless beautifully designed. One of the equally important arboreal properties in the area of Boka are exceptionally well designed and decorated the old city cemeteries, where there can also be found outstanding examples of rare species originating from distant countries. On the other hand, the residents of Boka Kotorska with equal care nourished the fragments of natural arboreal properties in their environment. Appreciating the importance of the forest vegetation in the preservation of the natural surroundings and healthy environment, over the older towns one can easily find fragments of the preserved natural stands that have survived over the millennium anthropogenic pressure.

The fact that the dendroflora of the Boka Kotorska Bay is enriched with a significant number of species, intensive work on the renovation of gardens, parks, alleys, and avenues provoked the interest of researchers to thoroughly treat this segment floristic diversity as well. Although the city cadastres have records of the qualitative composition of the landscaped urban areas, there undoubtedly lies a true treasure of decorative dendroflora in the diversity of species that have been planted somewhere in the hidden corners of the private properties and gardens. In the second half of twentieth century, particularly in the late 1960s and early 1970s several studies were conducted which were important for the understanding of the decorative flora of Boka Kotorska. First of all those are the studies referring to the landscaping of the Montenegrin beaches, and then the analyses of the potential natural and decorative dendroflora in the horticultural landscaping of the coastal area of Montenegro [101, 102]. But the real studies thoroughly researching the species that are used for landscaping parks and avenues, alleys, and gardens, as well as their relationship with the nearby dendroflora and special descriptions of the ambient areas in the area of the Boka Kotorska Bay were made especially for the outer part of the bay and the surroundings of Herceg Novi [52] and the inner part of the bay [53, 103]. Unfortunately, to date, these are the only botanical reports on the dendroflora of Boka Kotorska.

Climatic characteristics of the area and pedological substrate have facilitated the breeding of many species of plants for ages, especially the so-called southern species. Even today we may notice remnants of the once developed complexes for breeding of the certain species in Boka Kotorska, although they do not constitute the primary activity and occupation of the inhabitants of Kotor today. Olives have been the main characteristic of the farming in this area from the ancient times (*Olea europaea* L.), the evidence of which is found in the remains of old olive trees all over the area of the Bay area. Intensive planting of olive trees in the area of the bay originates from the period when the Boka Kotorska was under the government of the Venetian Republic. The success in planting depended in certain parts on the very configuration of the field, but they generally planted up to 500 m.a.s.l. The largest areas were on the peninsula of Luštica, where, according to the available data, prior to World War II there were planted about 90,000 trees [52]. Besides

olives, some smaller fig plantings can be found in the area of Boka Kotorska as well (*Ficus carica* L.) vines, different kinds of fruit trees and species with drupes. Finally, private gardens and yards in residential areas and along roads are rich in smaller citrus plantations forming small orangeries. Apart from their economic value, they undoubtedly extremely contribute to the enrichment of environmental scenery and complement the Mediterranean landscape. These are mainly *Citrus aurantium* L., *C. medica* L., and *C. nobilis* Lour., which are having today's a huge number of hybrids and varieties.

In the whole area, especially in the coastal region, on the promenades along the sea, in parks, in a private gardens, etc., there are palm trees as a distinctive element of decoration of the Mediterranean cities. Certainly, the most frequent palm is the canary date palm *Phoenix canariensis* Hort ex Chabaud, while in the parks by the height stands out the *Washingtonia filifera* (Linden ex André) H. Wendl. There are also often two kinds of palmettos *Chamaerops humilis* L. (otherwise autochthonous in the Western Mediterranean and North Africa), as well as *Trachycarpus excelsa* Wendl. which can grow high up to 15 m. Although rarely, the coconut palm *Cocos australis* Mart has also been planted in the Boka Kotorska Bay. But these are rare specimens that are not especially noticeable. Among the less common representatives of the family of palm trees that are grown in the area of the Boka Kotorska Bay, there are also specimens of *Sabal palmetto* (Ealter) Loddo. ex Schult. et Schult.f. and *Livistona chinensis* (Jacq.) R.Br. ex Mart. Besides the palm trees the succulent representatives of the genus *Agave* are often grown, the species which also occurs naturally in the rocky parts of the coast and steep rocky sides facing the sea can reach extremely old age. Representatives of the genus *Yucca* may also be found, which likewise conquer the space outside the landscaped areas. Along the roads there is the cactus *Opuntia ficus-indica* (L.) Mill. which is considered to be domesticated species, although it is an allochthonous representative that became domesticated and spontaneously spread to natural habitats.

Based on studies from the second half of twentieth century there are more than 100 species of dendroflora [52, 103] in the area of the Boka Kotorska Bay. As the more recent data have not been synthesized yet and can be found exclusively in the local tree cadastres, we assume that this number is significantly higher. The fact that today many other species are used in the landscape architecture, and that they are included in the processes of afforestation and landscaping of the parks and avenues of trees (*Lagerstroemia indica* L., Lythraceae or *Rhazia stricta* Decne., Apocynaceae), justifies our assumption that the 50 years old data are different now.

The decorative flora of the Boka Kotorska, there are many known plant species of Gymnosperms group. This primarily includes *Cycas revoluta* Thunb. as well as some other representatives of this primitive group of plants, e.g., *Dioon edule* Lindl. There is also the inevitable ginkgo tree *Ginkgo biloba* L., which in its own, recognizable way contributes the dynamics of landscaped areas. The use of coniferous species in planting and landscape architecture is common in the area of the Boka Kotorska Bay. Around and in particular over the cities there are plantations of autochthon conifers among which dominates the black pine (*P. nigra* F. Arnold) in combination with many other species including pine (*P. heldreichii* Christ)

[103]. However, one of the most planted conifers certainly is the *P. halepensis* Mill., along with *P. brutia* Ten., P. *pinaster* Ait. pine nuts, and *P. pinea* L., which is often found in single-species, and rarely in small groups. Cypress *Cupressus sempervirens* L. is often grown, but it is often spontaneously present in the preserved fragments of natural or semi-natural stands. In the area of the Boka Kotorska Bay it occurs in varieties var. *horizontalis* (Mill.) Loudon and var. *pyramidalis* (O. Targ. Tozz.) Nyman. The most frequently planted are the representatives of *Cedrus deodara* (Roxb. Ex D.Don) G.Don, *Abies cephalonica* Loudon, *Picea pungens* Engelm., *Calocedrus decurrens* (Torr.) Florin, *Chamaecyparis pisifera* (Siebold et Zucc.) Endl., *Cryptomeria japonica* (Thunb. ex Lf) D.Don, and many others. As a real rarity, most often planted in private gardens of the towns of Boka, are the two species of Patagonian firs, i.e., *Araucaria araucana* (Molina) K. Koch and *A. columnaris* (G. Forst) Hook.

Enormous treasure of species, being the main cause of the distinctive colorfulness of the Mediterranean plants, gives us a large range of species of woody dicotyledonous representatives. First of all these are the forms of decorative species of *Magnolia grandiflora* L. (Fig. 17) and *M. x soulangeana* Soul.-Bod. frequent species in the tree-lined avenues. There are also recognizable camellias *Camellia japonica* L. (Fig. 18) However, what makes the entire coast of the Boka Kotorska Bay in the early spring months recognizable is *Acacia dealbata* Link. that is found growing both spontaneously and in the orchards and gardens. Families of legumes a favorite in the Mediterranean as the cultivated species of trees. There are therefore several species of the Mimosaceae families in the area of the Boka Kotorska Bay; together with the species of the genus Acacia, *A. retinoides* Schltdl and

Fig. 17 *Magnolia grandiflora* L. in garden. (Photo by Vesna Mačić)

Fig. 18 *Camellia japonica* L. (Photo by Vesna Mačić)

A. floribunda (Vent.) Willd., *Albizia julibrissin* Durazzo., there is carob from the family of Cesalpinaceae – *C. siliqua* L., as well as the ornamental species of *Cercis siliquastrum* L., *Gleditsia triacanthos* L. and *Caesalpinia gilliesii* (Hook.) D. Dietrare. As one of the most common ornamental species planted along the entire Montenegrin coast, and thus in the Boka Kotorska Bay as well, the Chinese species of *Pittosporum tobira* Ait. is especially grown. This species covers a wide area and it often found as a standalone tree or plant that successfully tolerates pruning and is used as a hedge. Rare are the representatives of the *Casuarina equisetifolia* L. species, originating from Australia as well as banana trees.

There is no doubt that the centuries-long tradition of decorating gardens, yards, parks, and squares with greenery led to the fact that today we can find in the area of the Boka Kotorska Bay some examples of extremely rare tropical plants. However, as the tradition of bringing seedlings of rare plants and herbs by the sailors has nowadays almost entirely disappeared, the preservation of this wealth in diversity is one of the main tasks of the local administration. By this we mean the preservation of arboreal sites of the landscaped areas.

6 Conclusions

Area of Boka Kotorska is undeniably one of diversity hotspots for flora of Montenegro and Balkan Peninsula. Although exposed to many centuries of anthropogenic pressure, flora of Boka Kotorska managed to significantly preserve its natural character due to presence of primary habitats – numerous microhabitats with conserved elements of natural vegetation. The peculiar character of this flora is evidenced by rich results of botanical studies performed in this area during a long period of time. The qualitative composition of flora in area of Boka Kotorska sparked considerable interest, leading to a vast amount of data collected in

numerous publications, particularly in the 19th and the first half of twentieth century. Unfortunately, the floristic studies in area of Boka Kotorska were not performed in any systematic manner, and data pertain only to certain isolated localities or individual floristic data. The data in detailed floristic studies of several regions (Vrmac, Brdo Sv.Ivan, parts of Luštica, Tivatsko polje etc.) are not sufficient for creating an all-including overview of floristic diversity, which is only glimpsed during the survey of literature data.

This overview of floristic diversity of Boka Kotorska is a compilation of existing results collected by numerous researchers, including the authors of this paper. The collected data on presence of endemic taxa at species and subspecies level indicate an interesting florogenesis of this area. The placement of endemic taxa in appropriate chorological groups clearly shows that these are not exclusively endemics of Mediterranean–Submediterranean chorological type, as there is also a significant presence of representatives of South European-mountain chorological group, in spite of significantly lower altitudes in the area. The quality of endemic flora of Boka Kotorska is obviously significantly influenced by high mountain massifs which are part of mountain systems of Western Balkans.

The list of species placed under the appropriate conservation system has multiple implications: it supports the recorded prominent floristic diversity, as in addition to species included in European and World lists (species of Orchidaceae and species from the CITES list) it also abounds in representatives not included in these lists. On the other hand, this area shows an unusual richness in microhabitats. The list is characterized by representatives preferring different habitats and vegetation units. And finally, the list of taxa under the appropriate protection regime still reflects the significant anthropogenic pressure imposed on this area for many centuries. This is particularly evident in taxa recorded in this area in the past but lacking any newer records.

Diversity of flora of ligneous plants at Boka Kotorska includes both autochthonous species and a significant number of species introduced for needs of landscaping design, including parks, streets, public areas, and private gardens. The ancient tradition of bringing plants from distant journeys was unfortunately partially continued even after such journeys became uncommon. In spite of this, the modern decorative flora in the area of Boka Kotorska may be considered particularly rich. In addition to usual decorative tree species, parks, and arboretums may also host extremely rare and valuable individuals of South American, African and Asian species.

The researchers in fields of flora and conservation biology are presented with an overview of floristic richness of a unique natural object. In the immediate future it is necessary to involve the research potential from Montenegro in order to study the area of Boka Kotorska from the floristic standpoint as soon as possible. It would lead to valid quantitative representation of flora and all its potentials. On the other hand, fast and intensive urbanization in the coastal area is the leading threat to survival of preserved microhabitats, which, as we concluded earlier, are the main pillars of the pronounced floristic diversity of Boka Kotorska. Therefore activities

on detection, marking and conservation of these localities are priority tasks for the national environmental conservation service.

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References

1. Sieber FW (1822) Neue und seltene Gewächse. Flora Regensburg 5(1):241–248
2. Pulević V (2006) Botanists and Montenegro. Natural History Museum of Montenegro, special edition, vol 2, edit. Vizi, O. Natural History Museum of Montenegro, Podgorica, p 458
3. Tommasini M (1835) Botanische Wanderungen im Kreise von Cattaro. Flora (Regensb) 2:1–59
4. Visiani R (1842) Flora Dalmatica, vol 1. F. Hofmeister, Lipsiae
5. Visiani R (1847) Flora Dalmatica, vol 2. F. Hofmeister, Lipsiae
6. Visiani R (1850–1852) Flora Dalmatica, vol 3. F. Hofmeister, Lipsiae
7. Visiani R (1872) Florae dalmaticae supplementum. Mem Inst Veneto 16:1–189
8. Visiani R (1877) Florae dalmaticae supplementum alterum, adjectis plantis in Bosnia, Hercegovina et Montenegro crescentibus. Pars I. Mem Inst Veneto 20
9. Visiani R (1882) Florae dalmaticae supplementum alterum, adjectis plantis in Bosnia, Hercegovina et Montenegro crescentibus. Pars II. Mem Inst Veneto 21
10. Weiss E (1866) Floristisches aus Istrien, Dalmatien und Albanien. Verh Zool-Bot Ges, Wien 16:571–584
11. Weiss E (1867) Floristisches aus Istrien, Dalmatien und Albanien, I, II. Verh Zool-Bot Ges 17:753–762
12. Čelakovský L (1885) *Dianthus dalmaticus* sp. Nova (*S.ciliatus* var. *cymosus*Vis.). Öesterr Bot Zeitschr 35:189–194
13. Bornmüller J (1887) *Rhamnus orbiculata* Bornm. n. sp. Öesterr Bot Zeitschr 37:225–227
14. Bornmuller J (1889) Beitrag zur Flora Dalmatiens. Öesterr Bot Zeitschr 39:333–337
15. Lindberg H (1906) Verzeichnis der auf einer Reise in Oesterreich-Ungarn im Mai und Juni 1905 gesammelten Gefasspflanzen. Finsk Vetensk Soc Forhandl 43(13):1–128
16. Studniczka C (1890) Beitrage zur Flora Süddalmatien. Verh Zool Bot Ges 40:55–84
17. Hirc D (1911) Iz bilinskoga svijeta Dalmacije. III. Oko Bokeljskog zaliva. Glas Hrv Prir Duštva, Zagreb 24(1):33–52
18. Hirc D (1912) Iz bilinskoga svijeta Dalmacije. Glas Hrv Prir Društva, Zagreb 24(2-3):94–109
19. Biasoletto B (1841) Relazione del viaggio fatto nella primavera dell'anno 1838 dalla Maesta del Re Federico Augusto di Sassonia. Trieste
20. Ebel W (1842) Bericht ueber eine Reise in Montenegro. Monatsber Verh Ges 132–141
21. Ascherson P (1869) Beitrag zur Flora Dalmatien. Öesterr Bot Zeitschr 19:65–71
22. Kerner A (1872) Zur flora von Dalmatien. Croatien und Ungarn. Öesterr Bot Zeitschr 23:23–67
23. Pantocsek J (1874) Adnotationes ad Floram et Faunam Hercegovinae, Crnagorae et Dalmatiae. Verhandlungen des Vereines FürNaturkunde in Presburg 2:1–143
24. Veselý J (1890) Ein Ausflug in die Krivošije und auf den Orjen. Gart-Zeit 15:383–388
25. Baldacci A (1894) Contributo alla conoscenza della flora Dalmata, Montenegrina, Albanese. Epirota e Greca Nuovo Gior Bot Ital 1(2):90–103
26. Pulević V, Vincek D (1991) Crna Gora vrata Balkana, putopisi i zapisi evropskih botaničara. Obod, Cetinje

27. Pančić J (1874) Botanische Bereisung von Montenegro im Jahre 1873. Öesterr Bot Zeitschr 24:82–85
28. Adamović L (1900) Zimzeleni pojas Jadranskog primorja. Glas SANU, Beograd 61(23)
29. Adamović L (1911) Biljnogeografske formacije zimzelenog pojasa Dalmacije, Hercegovine i Crne Gore. Rad, JAZU, Zagreb 188(50):1–54
30. Adamović L (1911) Die Pflanzenwelt Dalmatiens. Leipzig
31. Šmarda J (1968) Vysledky biogeografickych cest do Jugoslavie v letech 1964-1967. Československa Akademie Ved – Geograficky UStav v Brne
32. Pulević V (1973) Prilog flori Crne Gore. Glasn Republ Zav Zašt Prir–Prirod Muz, Titograd 6:77–83
33. Pulević V (1977) Prilog poznavanju taksonomije i horologije Crocus tommasinianus Herbert (Iridaceae). Polj Šum, Titograd 23(1):53–60
34. Pulević V (1979) O flori i vegetaciji Boke Kotorske i po trebi njihove zaštite. Boka (Herceg Novi) 10(2):209–220
35. Pulević V (1982) Zaštita flore i vegetacije u Crnog Gori. MANU, Odel Biol Med Nauka, Prilozi, Skopje 3(1):109–124
36. Pulević V (1983) Zaštićene biljne vrste u SR Crnoj Gori. Glas Rep Zavoda Zašt Prir Titograd 16:33–54
37. Pulević V (1984) Euphorbia prostrata Aiton, nova adventivna vrsta u flori Jugoslavije. Drugi kongres o korovima, Osijek 113–117
38. Trinajstić I (1974) Prilog poznavanju horologije neofita Tagetes minutes L. na području Jugoslavije. Acta Bot Croat 33:231–235
39. Obradović M (1985) Endemske biljke roda *Campanula* (zvončići) u flori Herceg-Novog i okoline. Boka 17:437–443
40. Parolly G (1992) Die Orchideenflora Montenegros. Mitt Bl Arbeitskr Heim Orch Baden-Wurt 24(2):141–391
41. Parolly G (1995) Ergaenzunfen zur Flora von Montenegro. Wildenowia 25:57–74
42. Karaman V (1997) Flora istočnog dela Bokokotorskog zaliva. Magistarski rad, Biološki fakultet, Univerzitet u Beogradu
43. Budak PV, Mačić LJV, Mačić KLJ, Anačkov G (2001) Endemic species in flora of St. Ivan hill in the vicinity of the city of Kotor (Montenegro, Yugoslavia). Endemske biljke u flori brda Sv. Ivan u okolini Kotora. (Crna Gora, Jugoslavija). Zbornik Matice Srpske Prirodne Nauke 101:85–94
44. Stešević D (2005) Biljni svijet Grblja, Monografija »Grbalj kroz vjekove«. Grbalj, p 673–694. ISBN: 86-86761-00-X
45. Janković M (1966) *Lauro-Castanetum sativae* M. Jank., nova termofilna i eumediteranska zajednica pitomog kestena i lovora u Boki kotorskoj. Arhiv bioloških nauka 18(1):9–10
46. Jovanović B, Vukićević E (1976) Fitocenoza sa oleandrom (*Nerium oleander* L.) kod Risna u Boki Kotorskoj. Referat na Simpozijumu zaštite čovjekove sredine, Herceg Novi
47. Janković MM, Stevanović V (1983) Prilog poznavanju slatinske vegetacije Boke Kotorske. Zbornik Roberta Visianija Šibenčanina, Muzej grada Šibenika 10:377–396
48. Čađenović N (2007) Flora starih Tivatskih Solana (Crna Gora) - komparativna analiza flore, procjena diverziteta, značaj njihove konverzacije, diplomski rad. PMF, Novi Sad
49. Jovanović S, Stevanović V (1995) Mural flora of the old fortress of the south Adriatic coast (Montenegro). VIII OPTIMA meeting, abstracts, Seville, p 87
50. Budak V, Mačić V, Mačić LJ, Anačkov G (2000) Flora brda Sv Ivan u okolini Kotora. Zbornik radova o flori jugoistočne Srbije i susjednih područja. Abstract
51. Grebeščikov OS (1960) The vegetation of the Kotor Bay seaboard (Crna Gora, Yugoslavia) and some comparative studies with the Caucasia seabord of the Black Sea. Bjuletten M.va Isp, Prirodi. Otd Biologiji 65(6):99–108
52. Popović D, Sterniša A (1971) Flora i vegetacija hercegnovskog područja s posebnim osvrtom na parkovsko bilje. Skupština opštine Herceg Novi i Turistički savez Boke Kotorske, Herceg Novi

53. Đakonović F (1977) Ekološke karakteristike priobalnog dela unutrašnjeg Bokokotorskog zaliva. Glasn Šum Fak-Jubilarni broj Beograd 52:221–224
54. Jovanović B, Vukićević E, Đakonović F (1979) Exploration of current and potential natural vegetation in the evaluation of countryside. Boka 10(2):165–172
55. Blečić V, Lakušić R (1976) Prodromus biljnih zajednica Crne Gore. Glasnik republičkog zavoda za zaštitu prirode i prirodnjačkog muzeja u Titogradu 9:57–98
56. Fukarek P, Jovanović B (ed) (1983) Karta prirodne potencijalne vegetacije SFR Jugoslavije. Naucno vece vegetacijske karte Jugoslavije, Univerzitet Kiril i Metodije, Skopje
57. Stevanović V (1995) Biogeografska podela teritorije Jugoslavije u Stevanović V, Vasić V, uredn., Biodiverzitet Jugoslavije sa pregledom vrsta od međunarodnog značaja. Ekolibri, Biološki fakultet, Beograd 117–127
58. Petrović D, Hadžiablahović S, Vuksanović S, Mačić V, Lakušić D (2012) Catalogue of habitat types of EU importance of Montenegro, Podgorica. Beograd, Zagreb
59. Tomović G (2007) Phytogeographical reference, distribution and diversity centres of the Balkan endemic flora in Serbia. PhD thesis, University of Belgrade, Belgrade
60. Turrill WB (1929) The plant life of the Balkan peninsula. A phytogeographical study. Clarendon, Oxford, p 49
61. Blečić V (1958) O nekim karakteristikama flore i vegetacije Crne Gore. Zaštita Prirode 13:1–6
62. Stevanović V, Jovanović S, Lakušić D, Niketić M (1995) Diverzitet vaskularne flore Jugoslavije sa pregledomvrsta od međunarodnog značaja. In: Stevanović V, Vasić V (eds) Biodiverzitet Jugoslavije sa pregledom vrsta od međunarodnog značaja. Ecolibri, Biološkifakultet, Beograd, p 183–217
63. Lubarda B, Stupar V, Milanović Đ, Stevanović V (2014) Chorological characterization and distribution of the Balkanendemic vascular flora in Bosnia and Herzegovina. Bot Serbica 38:167–184
64. Strid A, Tan K (eds) (1997) Flora Hellenica, vol 1. Koeltz Scientific Books, Königstein, p 547
65. Tomović G, Niketić M, Lakušić D, Ranđelović V, Stevanović V (2014) Balkan endemic plants in Central Serbia and Kosovo regions: distribution patterns, ecological characteristics and centres of diversity. Bot J Linn Soc 176:173–202
66. Bartolommeo B (1841) Relazione del viaggio fatto nella primavera dell'anno 1838 Della Maesta del re Federico Augusto di Sassonia nell'Istria, Dalmazia e Montenegro
67. Ebel W (1844) Zwölf Tage in Montenegro (und ein Blick auf Dalmatien) IV. J. H. Bon, Königsberg, p 176
68. Pantocsek J (1873) Plantae novae quas aestate anni 1872 per Hercegovinam etMontenegro collexit et descripsit. Öesterr Bot Zeitschr 23(1):4–6; 23(3):79–81; 23(9):265–268
69. Ehrendorfer F, Ančev M (1975) *Galium procurrens*, a new diploid relic species of the G. sylvaticum-group from Balkan Peninsula. Plant Syst Evol 124:1–6
70. Šilić Č (1974) Conspectus generum *Satureja* L, *Calamintha* Moench, *Micromeria* Bentham, *Acinos* Moench et *Clinopodium* L florae Jugoslaviae. Glasnik Muzeja Bosne i Hercegovine 13:106–128
71. Mereďa PJR, Hodálová I, Kučera J, Zozomová-Lihová J, Letz RD, Slovák M (2011) Genetic and morphological variation in *Viola suavis* s.l. (Violaceae) in the western Balkan Peninsula: two endemic subspecies revealed. Syst Biodivers 9(3):211–231
72. Kučera J, Marhold K, Lihová J (2010) *Cardamine maritima* group (Brassicaceae) in the amphi-Adriatic area: a hotspot of species diversity revealed by DNA sequences and morphological variation. Taxon 59(1):148–164
73. Lakušić D, Liber Z, Nikolić T, Surina B, Kovačić S, Bogdanović S, Stefanović S (2013) Molecular phylogeny of the *Campanula pyramidalis* species complex (Campanulaceae) inferred from chloroplast and nuclear non-coding sequences and its taxonomic implications. Taxon 62(3):505–524
74. Greuter W, Burdet HM, Long G (eds) (1984–1989) Med-checklist, vols 1, 3, 4. Conservatoire et Jardin botaniques de la Ville de Gèneve Med-Checklist Trust of OPTIMA, Geneva

75. Jalas J, Suominen J (eds) (1972–1994) Atlas Florae Europaeae. Distribution of vascular plants in Europe, vols 1–10. Committee for Mapping the Flora of Europe & Societas Biologica Fennica Vanamo, Helsinki
76. Jalas J, Suominen J, Lampinen R (eds) (1996) Atlas Florae Europaeae. Distribution of vascular plants in Europe, vol 11. Committee for Mapping the Flora of Europe & Societas Biologica Fennica Vanamo, Helsinki
77. Jalas J, Suominen J, Lampinen R, Kurtto A (eds) (1999) Atlas Florae Europaeae. Distribution of vascular plants in Europe, vol 12. Committee for Mapping the Flora of Europe & Societas Biologica FennicaVanamo, Helsinki
78. Kurtto A, Lampinen R, Junikka L (eds) (2004) Atlas Florae Europaeae. Distribution of vascular plants in Europe, vol 13. Committee for Mapping the Flora of Europe & Societas Biologica Fennica Vanamo, Helsinki
79. Kurtto A, Fröhner SE, Lampinen R (eds) (2007) Atlas Florae Europaeae. Distribution of vascular plants in Europe, vol 14. Committee for Mapping the Flora of Europe & Societas Biologica Fennica Vanamo, Helsinki
80. Tutin TG, Heywood VH, Burges NA, Moore DM, Valentine DH, Walters SM, Webb DA (eds) (1964–1980) Flora Europaea, vols 1–5. Cambridge University Press, Cambridge
81. Euro+Med (2006) Euro+Med Plant Base—the information resource for Euro-Mediterranean plant diversity. http://ww2.bgbm.org/EuroPlusMed/. Accessed 28 Apr 2016
82. International Organization for Plant Information (2016) Authorized WWW server page. In: Wilson K (ed). http://plantnet.rbgsyd.nsw.gov.au/iopi/iopihome.htm. Accessed 20 Apr 2016
83. The International Plant Names Index (2012) http://www.ipni.org. Accessed 27 Apr 2016
84. The Plant List (2013) Version 1.1. Published on the Internet. http://www.theplantlist.org/. Accessed 26 Apr 2016
85. Meusel H, Jäger E, Weinert E (1965) Comparative horology of the Central European flora 1. Gustav Fischer, Jena
86. Meusel H, Jäger E, Weinert E (1978) Comparative horology of the Central European flora 2. Gustav Fischer, Jena
87. Meusel H, Jäger E (1992) Comparative horology of the Central European flora 3. Karten, Liter. Register. Gustav Fischer, German, Jena, Stuttgart, New York
88. Stevanović V (1992) Floristička podela teritorije Srbije sa pregledom viših horiona i odgovarajućih flornih elemenata. In: Sarić MR (ed) Flora Srbije, vol 1. Srpska akademija nauka, Belgrade, pp 47–56
89. Raunkiaer C (1934) The life forms of plants and statistical plant geography. Clarendon, London
90. Mueller-Dombois D, Ellenberg H (1974) Aims and methods of vegetation ecology. Wiley, New York
91. Stevanović B, Janković M (2001) Ekologija biljaka sa osnovama fiziološke ekologije biljaka. NNK International, Belgrade
92. Larson DW, Matthes U, Kelly PE (2000) Cliff ecology: pattern and process in cliff ecosystems. Cambridge University Press, Cambridge
93. Berger R (1914) Beitrage zur Kenntnis der Flora von Suddalmatien und der angrezenden Herzegowina. Allgem Bot Zeitschr 20:11–16
94. Petrović D, Stešević D (2010) Materials for the red book of vascular flora of Montenegro (second contribution). Biologica Nyssana 1(1–2):27–34
95. Pulević V, Bulić Z (1990) Novosti iz flore Crne Gore. Bilten Društva ekologa Bosne i Hercegovine B(5):85–88
96. Lakušić B, Lakušić D (2004) Rasprostranjenje vrsta roda *Teucrium* L. (Lamiaceae) u Crnoj Gori. Glasnik Republičkog Zavoda Zaštite prirode 27–28:51–70
97. Aalto M, Hamet-Ahti L, Rauuhijarvi R, Suominen J, Taarna L, Uotila M, Uotila P, Vitikainen O (1972) Jugoslavian retki 11.-25. VI 1971 (Botanical excursion to western Yugoslavia in 11.25. VI. 1971, including a list of the collected vascular plants). Helsingin yliopiston kasvimuseon monisteita 5

98. Berger R (1913) Beitrage zur Kenntnis der Flora von Suddalmatien und der angrezenden Herzegowina. Allgem Bot Zeitschr 19:177–182
99. Stevanović V (1996) Zvezdasti bobovnik (*Sedum stellatum* L., Crassulaceae) – nova vrsta za floru Jugoslavije. Ekologija 31(2):79–82
100. Rohlena J (1923) Additamenta ad floram dalmaticam. Preslia 2:98–102
101. Sterniša A (1970) Hortikulturni problem Crnogorskog primorja. Hortikultura 1
102. Bunuševac T, Vukićević E, Mijanović O, Sterniša A, Djakonović F (1979) Dekorativne biljke Bokokotorskog zaliva i njihov značaj u turizmu. Boka 10(2):125–141
103. Đakonović F (1978) Dendroflora priobalnog dela unutrašnjeg Bokokotorskog zaliva. The Dendroflora of the interior coastal part of the Boka Kotorska Gulf. Glasnik Republičkog Zavoda Zaštite Prirode-Prirodnjačkog Muzeja 11:99–132