*Plant Biosystems*, Vol. 141, No. 1, March 2007, pp. 40 – 50

Taylor & Francis
Taylor & Francis Group

# The *Chrysopogono grylli-Nerietum oleandri* association in Croatia as compared with other *Rubo ulmifolii-Nerion oleandri* communities (*Tamaricetalia*, *Nerio-Tamaricetea*) in the Mediterranean

N. JASPRICA[1], M. RUŠČIĆ[2] & S. KOVAČIĆ[3]

[1]*Institute for Marine and Coastal Research, University of Dubrovnik, Croatia,* [2]*Faculty of Philosophy, University of Split, Croatia, and* [3]*Faculty of Sciences, Department of Botany and Botanical Gardens, University of Zagreb, Croatia*

**Abstract**

A new association, *Chrysopogono grylli-Nerietum oleandri*, situated in the south of Croatia, is proposed. According to its floristic structure, physiognomy and ecology, it belongs to the *Rubo ulmifolii-Nerion oleandri* alliance (*Tamaricetalia*, *Nerio-Tamaricetea*). It is the only association with *Nerium oleander* in Croatia. This community has developed along a temporary watercourse as a vegetation exclave (extrazonal stand) within the climazonal evergreen forest vegetation of the *Oleo-Ceratonion* alliance. The association has a thermophilous character and a large number of companions from the *Quercetalia ilicis* and *Scorzonero-Chrysopogonetalia* communities. This report compares the floristic composition of this association with others of the *Rubo ulmifolii-Nerion oleandri* alliance from other Mediterranean areas. The Croatian association is most similar to the *Spartio-Nerietum oleandri* association from the Ionian side of Calabria (south Italy). The syntaxonomic status of the Montenegrin association *Andropogono distachyi-Nerietum oleandri* was determined, and the status of the stands with *Nerium oleander* is discussed.

**Key words:** Chrysopogono grylli-Nerietum oleandri *ass. nova,* Rubo ulmifolii-Nerion oleandri *associations, Croatia, Adriatic coast, Mediterranean*

## Introduction

*Nerium oleander* L. (Apocynaceae) is native to the Mediterranean basin, North Africa, and Southeast Asia (Tutin et al., 1964 – 1980; Walter & Straka, 1970). More recently, oleander was noted for the Red Sea Basin and Gulf of Aden (Le Houérou, 2003). It is rare in Marmarica (Libya and Egypt) (Le Houérou, 2004) and is found on the Red List of Corsica (Jeanmond & Schlüssel, 2004).

According to Böhling et al. (2002), *Nerium oleander* is a semi-light plant generally found in well-lit places, but also in moderate shade, and in fairly to very hot areas. This weakly sub-oceanic and slightly halo-tolerant species is an indicator of damp sites, as well as those with an intermediate nutrient supply.

*N. oleander*, along with the diverse *Tamarix* species, occupies Mediterranean and Saharan-Arabian riverine and lacustrine dwarf woodlands, scrubs, and permanent tall grass communities temporarily inundated by fresh, brackish, or saline water in infra- to meso-Mediterranean, arid to dry bioclimates (Rivas-Martínez et al., 2002). It grows on the initial soils of river beds, creeks, springs, and temporary pools (Rivas-Martínez et al., 2002) and belongs to the *Nerio-Tamaricetea* class (Braun-Blanquet & Bolòs, 1957). These formations are similar to fairly sparse low forests with shrub layers covering about 60 – 70% of the surface. Various types of herbaceous vegetation, mostly composed of xerophytes, covers areas between the shrubs.

The *Nerio-Tamaricetea* class is represented only by the *Tamaricetalia* order. The *Tamaricetalia* order is characterized by absence of running water during a long period of the year (Rivas-Martínez et al., 2002). Braun-Blanquet and Bolòs (1957) determined the diverse *Tamarix* spp. alongside such species as

Correspondence: N. Jasprica, University of Dubrovnik, Institute for Marine and Coastal Research, PO Box 83, HR-20000 Dubrovnik, Croatia.
Tel.: +385 20 323484. Fax: +385 20 323872. E-mail: nenad.jasprica@unidu.hr

ISSN 1126-3504 print/ISSN 1724-5575 online 
DOI: 10.1080/11263500601153545

*Dittrichia viscosa* (L.) Greuter, *Glycyrrhiza glabra* L., *Equisetum ramosissimum* Desf., *Cynanchum acutum* L., *Salix purpurea* L., and *Vitex agnus-castus* L. as characteristic species of the *Tamaricetalia* order. This group of species, excluding *Vitex agnus-castus*, achieves its optimum in hygrophylic formations, and belongs to another higher syntaxon (Izco et al., 1984).

Braun-Blanquet and Bolòs (1957) included the alliance *Tamaricion africanae* and *Imperato-Erianthion ravennae* from Spain, *Nerion oleandri* from Palestine, and *Tamaricion speciosae* from South Morocco in the *Tamaricetalia* order. Izco et al. (1984) revised the *Tamaricetalia* order on the basis of its physiognomy, floristic composition, ecology and syntaxonomy. These authors believe that order and class characterize the *Tamarix* species, mostly *T. gallica* L. and *T. africana* Poir., are many fewer than those determined by Braun-Blanquet and Bolòs (1957). Additionally, they excluded the *Imperato-Erianthion ravennae* alliance from the *Tamaricetalia* order, which is very close to the *Phragmitetalia*, *Holoschoenetalia*, and *Brachypodietalia phoenicoidis* orders. However, on the Ionian island of Cephalonia, Bolòs et al. (1996) joined the *Imperata cylindrica* grassland community to the *Imperato-Erianthion ravennae* alliance.

More recently, Dimopoulos et al. (2005) included the *Nerium-Tamarix tetranda* community of NW Greece wetlands in the *Nerion oleandri* alliance. *Nerion oleandri* was never in fact described by Eig (1946), but it was mentioned as a *nomen nudum* by Zohary and Orshan (1949), who included *Viticetum agni-casti* and *Nerietum oleandri* within it (cf. Bolòs, 1967). Bolòs (1985) revised this alliance and proposed it as *Rubo ulmifolii-Nerion oleandri* (cf. Cantó et al., 1986), as it differed from other alliances of the *Tamaricetalia* order – *Tamaricion boveniano-canariensis* and *Tamaricion africanae* – which include non-halophytic associations (Izco et al., 1984; Barbagallo et al., 1990). Physiognomically, *Rubo ulmifolii-Nerion oleandri* is characterized by the domination of *Nerium oleander*, considered a differential species of the alliance along with *Rubus ulmifolius* Schott.

Phytosociological research in Croatia has intensified over the past decades, especially for terrestrial vegetation (cf. Nikolić & Topić, 2005). Knowledge of the distribution, variability, ecology, and diversity of most syntaxa, however, is still far from sufficient. In recent investigations no attention has been paid to *Nerio-Tamaricetea* vegetation. Floristic and phytosociological investigations in 2004 and 2005 near the southeastern Adriatic village of Slano (Figure 1) uncovered a new association with *Nerium oleander*: *Chrysopogono grylli-Nerietum oleandri*. It is the only association with oleander in Croatia, and one of two along the eastern Adriatic coast. The present report presents the floristic composition of this association and analyses its syntaxonomic status. It also compares it to associations of the *Rubo ulmifolii-Nerion oleandri* alliance in the wider Mediterranean region.

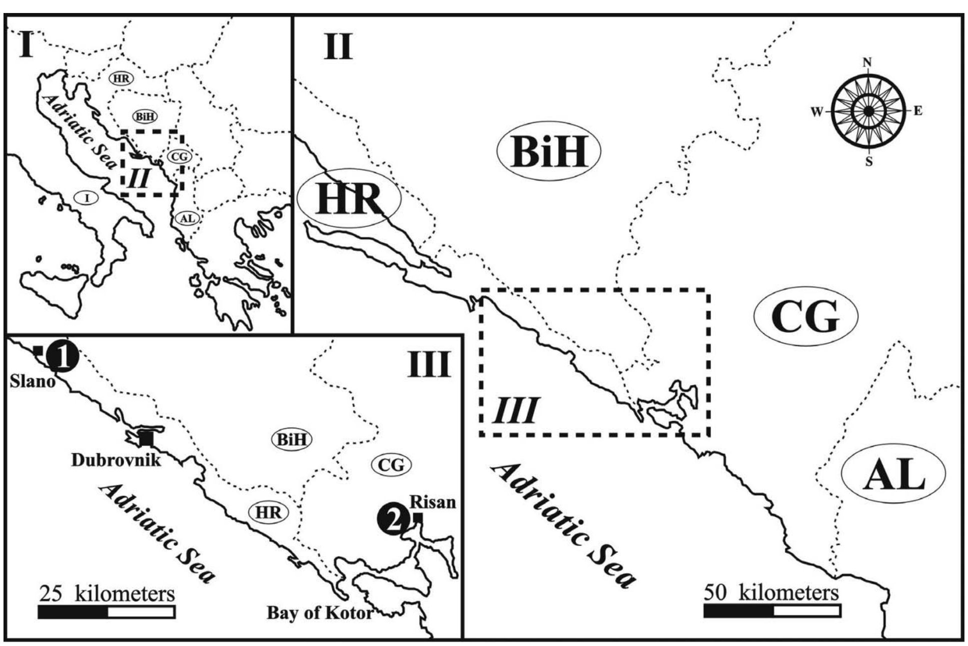


Figure 1. Position of the *Nerium oleander* L. associations on the southeastern Adriatic coast. Key: 1: *Chrysopogono grylli-Nerietum oleandri*; 2: *Andropogono distachyi-Nerietum oleandri*; AL: Albania, BiH: Bosnia and Herzegovina; HR: Croatia; I: Italy; CG: Montenegro; ■: towns or villages).

## Study area

The study area is in southern Croatia, southeast of the village of Slano, about 30 km northwest of Dubrovnik. The central position of the *Nerium oleander* area (42°45′59.24″N; 17°53′24.07″E) occurs along the temporary watercourse known as Ratački Canal. This is formed from a ravine that represents a local depression that collects surface-water drainage. In such karstic regions rainfall seeps into subterranean fissures, but small watercourses may be formed in winter. Geologically, the area consists mostly of Cretaceous and Eocene limestone (Raić & Papeš, 1982). Mediterranean limestone soil (calcicambisol) has developed on this geological formation (Martinović, 2000).

According to the bioclimatic classification of Rivas-Martínez (1993, 1997) and Rivas-Martínez et al. (1999), and the Bioclimatic Map of Europe (Rivas-Martínez et al., 2004a), the study area has a Mediterranean pluviseasonal-oceanic bioclimate, is situated within the lower meso-mediterranean belt, and falls within the lower humid ombroclime (ombrotype). The bioclimatic analysis was made with reference to the nearest meteorological station, namely that of Dubrovnik (data for 1971–2000, Croatian Meteorological and Hydrological Service).

The study area is situated in the Mediterranean Region, Eastern Mediterranean Subregion, Adriatic Province, and Epiro-Dalmatian Sector (Rivas-Martínez et al., 2004b). According to Trinajstić (1995), the area belongs to the vegetation zone of the *Oleo-Ceratonion* alliance. The *Pistacio lentisci-Juniperetum phoeniceae* and *Oleo sylvestris-Euphorbietum dendroidis* are the most common associations in this zone (Jasprica & Kovačić, 2000; Kovačić et al., 2001). Thermophilic evergreen forests of holm oak vegetation (ass. *Fraxino orni-Quercetum ilicis*) are developed fragmentarily over a wider area.

According to the Habitats Directive 92/43 EEC (EEA, 1999), the Government of Croatia has proposed that the European Union ecological network "NATURA 2000" register this area of oleander as a natural habitat of common interest.

## Materials and methods

Collections and field observations based on the approach of the Zürich-Montpellier school (Braun-Blanquet, 1964) were carried out in 2004 and 2005. Nomenclature follows *Flora Europaea* (Tutin et al., 1964–1980, 1993). Biological form was verified in the field and denoted according to categories reported in Pignatti (1982), these being based on the classification of Raunkiaer (1934). Regarding chorological form, reference was also made to Jasprica and Kovačić (1997), as well as to the monographs used for taxonomic nomenclature.

The system of characteristic species and nomenclature of higher taxa (Table I) was derived from Horvat et al. (1974), Mucina (1997), and Rivas-Martínez et al. (2002). Subspecies were treated at the species level only (Table II), as it never can be determined with certainty if different authors recognized subspecies or not. The authors agree with Golub (1994) that taxa below the species level are often unsuitable for syntaxonomic synthesis covering larger territories.

The criteria necessary to define a new syntaxon were used according to the 3rd edition of the International Code of Phytosociological Nomenclature (Weber et al., 2000). Accordingly, the original diagnosis of an association is sufficient only if it contains at least one vegetation relevé. We are aware that the sample of analysed relevés should contain at least 10 vegetation relevés (as recommended by 7A of ICPN), but the *Nerium* stands in Croatia only cover a surface area of 93.4 ha.

A comparison with similar vegetation types (*Rubo ulmifolii-Nerion oleandri*, Table II; see Appendix 1 for data sources and references) was carried out. A total of 56 relevés were collected from the literature on Mediterranean sites in Spain, Italy, Greece, and Montenegro. Data for the Montenegrin association (three relevés) were collected in 2005. Seven relevés were collected in Turkey in October 2005. Altogether, 67 relevés were subjected to cluster analysis and other MDS (multivariate analysis) tools; the resulting table was rearranged slightly manually (Table II). ANOSIM randomization (Clarke & Warwick, 1994) was used to test for significant differences in *Nerium oleander* community structure. The dissimilarity percentage programme (SIMPER, Clarke & Warwick, 1994) was used to identify the species making the greatest contribution to differences between clusters observed in the MDS plot. Statistical analyses were performed using PRIMER v5 software (Clarke & Gorley, 2001).

## Results

Table I presents the floristic composition of the proposed *Chrysopogono grylli-Nerietum oleandri* association. The syntaxonomic scheme of the association is:

Class *Nerio-Tamaricetea* Br.-Bl. & O. Bolòs 1957
- Order *Tamaricetalia africanae* Br.-Bl. & O. Bolòs 1957 em. Izco, Fernández & Molina, 1984
  - Alliance *Rubo ulmifolii-Nerion oleandri* O. Bolòs 1985
    - Association *Chrysopogono grylli-Nerietum oleandri* Jasprica, Ruščić & Kovačić 2007

Table I. *Chrysopogono grylli–Nerietum oleandri* ass. nova.

| No of relevés | 1* | 2 | 3 | 4 | 5 | C |
|---|---|---|---|---|---|---|
| Surface (m$^2$) | 25 | 25 | 25 | 20 | 18 | |
| Altitude (m) | 90 | 93 | 97 | 87 | 84 | |
| Aspect | SW | SW | NE | SW | NE | |
| Slope (°) | 17 | 19 | 15 | 16 | 16 | |
| Vascular plant cover (%) | 80 | 90 | 85 | 85 | 85 | |
| No of species | 22 | 22 | 22 | 20 | 21 | |
| Character-taxa of class, order, alliance and association (Nerio-Tamaricetea, Tamaricetalia, Rubo ulmifolii-Nerion oleandri) | | | | | | |
| ***Nerium oleander*** **L.** | **4.2** | **4.2** | **4.3** | **3.2** | **4.2** | **V** |
| ***Chrysopogon gryllus*** **(L.) Trin.** | **3.5** | **3.5** | **3.4** | **3.2** | **3.2** | **V** |
| *Rubus ulmifolius* Schott | + | + | – | – | +.1 | III |
| *Vitex agnus-castus* L. | – | – | – | – | + | I |
| Companions | | | | | | |
| Quercetalia ilicis, Quercetea ilicis | | | | | | |
| *Phyllirea latifolia* L. | + | 1.1 | + | + | +.1 | V |
| *Pistacia lentiscus* L. | 1.1 | + | – | +.1 | – | III |
| *Olea europaea* L. var. *sylvestris* Brot. | + | 1.1 | – | – | + | III |
| *Arbutus unedo* L. | +.1 | +.1 | – | – | – | II |
| *Juniperus phoenicea* L. | – | – | +.1 | – | +.1 | II |
| Scorzonero-Chrysopogonetalia, Festuco-Brometea | | | | | | |
| *Silene vulgaris* (Moench.) Garcke subsp. *vulgaris* | + | + | + | + | +.1 | V |
| *Teucrium polium* L. | + | + | + | + | + | V |
| *Melica ciliata* L. | + | + | + | + | + | V |
| *Micromeria juliana* (L.) Bentham | + | + | + | + | + | V |
| *Psorolea bituminosa* L. | + | + | + | + | + | V |
| *Helichrysum italicum* (Roth) G. Don f. | + | + | + | + | +.1 | V |
| *Anthyllis vulneraria* L. subsp. *praepropera* (A. Kerner) Bornm. | – | – | +.3 | + | + | III |
| *Koeleria splendens* C. Presl | – | – | +.2 | + | + | III |
| *Carduus micropterus* (Borsbás) Teyber | + | + | – | | | II |
| *Galium corrudaefolium* Vill. | + | + | – | – | – | II |
| Thero-Bracyhpodietalia, Thero-Brachypodietea | | | | | | |
| *Galium divaricatum* Pourret ex Lam. | + | + | + | + | + | V |
| *Brachypodium retusum* (Pers.) Beauv. | 2.1 | 3.2 | – | – | + | III |
| *Centaurea glaberrima* Tausch | – | – | 1.2 | +.1 | +.1 | III |
| *Avena sterilis* L. | – | – | +.1 | + | + | III |
| Cisto-Ericetalia, Erico-Cistetea | | | | | | |
| *Chaerophyllum coloratum* L. | + | + | + | + | + | V |
| *Cistus incanus* L. subsp. *corsicus* (Loisel.) Heywood | +.1 | 1.1 | + | + | – | IV |
| *Erica manipuliflora* Salisb. | +.1 | +.1 | +.1 | – | – | III |
| *Calicotome spinosa* (L.) Link | +.1 | +.1 | – | + | – | III |
| Carthametalia lanati, Artemisietea vulgaris | | | | | | |
| *Dittrichia viscosa* (L.) W. Greuter | + | + | – | + | + | IV |
| Centaureo-Campanuletalia, Asplenietea trichomanis | | | | | | |
| *Sedum ochroleucum* Chaix | – | – | +.3 | + | – | II |

*holotypus.
The indicator species of the association are noted in bold.
Companions only present in one relevé: *Colutea arborescens* L. (Quercetalia pubescentis, Quercetea pubescentis) 3 (+.2); *Hordeum murinum* L. subsp. *leporinum* (Link) Arcangeli. (Chenopodietalia, Chenopidietea) 3 (+.3); *Cheilanthes acrostica* (Balbis) Tod. (Centaureo-Campanuletalia, Asplenietea trichomanis) 3 (+).

*Description of the association*

*Chrysopogono grylli-Nerietum oleandri*, ass. nova hoc loco

NOMENCLATURAL TYPE: relevé 1 in Tab. I (*holotypus*)
DIAGNOSTIC SPECIES: see Tab. I
SITE: Slano, southern Croatia, eastern Adriatic coast
DATE: rel. 1–4 June 16, 2004; rel. 5 June 5, 2005.

This association developed along the temporary watercourse as a vegetation exclave (extrazonal stands) within the climazonal evergreen forest vegetation of the *Oleo-Ceratonion* alliance. The stands are generally small (25–50 m$^2$), but when the association attains optimal development in mid-June the colour of the flowers of the dominant species make them particularly visible. The association is found at altitudes between 84 and 97 m on carbonaceous substrata derived from Cretaceous and Eocene limestone. It generally prefers a

Table II. The *Rubo ulmifolii-Nerion oleandri* associations from some Mediterranean localities.

| Association No | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| No of relevés | 8 | 6 | 4 | 6 | 1 | 9 | 2 | 5 | 10 | 8 | 7 |
| No of species | 11 | 13 | 6 | 10 | 8 | 31 | 13 | 55 | 105 | 33 | 23 |
| Character-taxa of class, order, alliance and association | | | | | | | | | | | |
| ***Nerium oleander* L.** | **V** | **V** | – | **V** | **4** | **V** | $1^{4}$ | **V** | **V** | **V** | **V** |
| ***Rubus ulmifolius* Schott** | **IV** | **V** | $4^{2-3}$ | – | **4** | **V** | – | II | IV | V | **II** |
| ***Rubia peregrina* L.** | II | III | – | **V** | – | – | – | – | – | – | – |
| ***Aristolochia rotunda* L.** | – | – | – | – | – | – | **2** | – | – | – | – |
| ***Andropogon distachyos* L.** | – | – | – | – | – | – | – | **II** | – | – | – |
| ***Spartium junceum* L.** | – | – | – | – | – | II | – | – | **V** | **V** | – |
| ***Calicotome villosa* (Poiret) Link** | – | – | – | – | – | – | – | – | **V** | **IV** | – |
| *Vitex agnus-castus* L. | – | – | – | – | – | **IV** | 2 | – | – | IV | IV |
| *Tamarix africana* Poiret | – | – | – | – | 2 | V | – | – | IV | V | – |
| *Tamarix gallica* L. | – | IV | $4^{+}$ | – | – | – | – | – | – | – | – |
| Companions | | | | | | | | | | | |
| *Scirpus holoschoenus* L. | IV | V | $3^{+}$ | V | – | – | – | – | – | – | II |
| *Saccharum ravennae* (L.) Murray | II | III | $2^{+}$ | II | – | – | – | – | – | – | III |
| *Arundo donax* L. | IV | II | – | – | – | – | – | – | – | – | – |
| *Brachypodium phoenicoides* (L.) Roemer & Schultes | II | – | $2^{1}$ | III | – | – | – | – | – | – | – |
| *Equisetum ramosissimum* Desf. | – | IV | – | II | – | – | – | – | – | – | – |
| *Pipthaterum miliaceum* (L.) Cosson | II | III | – | – | – | IV | – | IV | – | II | III |
| *Dittrichia viscosa* (L.) Greuter | III | III | – | – | 2 | II | – | – | – | V | II |
| *Asparagus acutifolius* L. | II | II | – | – | – | II | – | – | III | – | – |
| *Clematis flammula* L. | II | – | – | – | – | – | – | IV | – | – | – |
| *Smilax aspera* L. | – | III | – | – | – | – | – | IV | – | – | – |
| *Pistacia lentiscus* L. | – | – | – | II | – | – | – | – | II | – | – |
| *Clematis vitalba* L. | – | – | – | – | 2 | – | – | – | – | – | – |
| *Arum italicum* Miller | – | – | – | – | – | IV | 2 | – | – | – | – |
| *Vinca herbacea* Waldst. & Kit. | – | – | – | – | – | – | 2 | – | – | – | – |
| *Melica ciliata* L. | – | – | – | – | – | – | – | IV | – | – | – |
| *Dactylis glomerata* L. | – | – | – | – | – | – | – | IV | II | – | – |
| *Carthamus lanatus* L. | – | – | – | – | – | – | – | IV | – | – | – |
| *Asplenium ceterach* L. | – | – | – | – | – | – | – | IV | – | – | – |
| *Hyparrhenia hirta* (L.) Stapf | – | – | – | – | – | – | – | IV | III | – | – |
| *Satureja montana* L. | – | – | – | – | – | – | – | IV | – | – | – |
| *Cynosurus echinatus* L. | – | – | – | – | – | – | – | III | – | – | – |
| *Teucrium polium* L. | – | – | – | – | – | – | – | III | – | – | – |
| *Laurus nobilis* L. | – | – | – | – | – | – | – | III | – | – | – |
| *Punica granatum* L. | – | – | – | – | – | – | – | III | – | – | – |
| *Fraxinus ornus* L. | – | – | – | – | – | – | – | III | – | – | – |
| *Prunus mahaleb* L. | – | – | – | – | – | – | – | III | – | – | – |
| *Centaurium erythraea* Rafn. | – | – | – | – | – | – | – | III | – | – | – |
| *Carpinus orientalis* Miller | – | – | – | – | – | – | – | II | – | – | – |
| *Vitis vinifera* L. | – | – | – | – | – | – | – | II | – | – | – |
| *Ficus carica* L. | – | – | – | – | – | – | – | II | – | – | III |
| *Ruscus aculeatus* L. | – | – | – | – | – | – | – | II | – | – | – |
| *Moltkia petraea* (Tratt.) Griseb. | – | – | – | – | – | – | – | II | – | – | – |
| *Ephedra fragilis* Desf. | – | – | – | – | – | – | – | II | – | – | – |
| *Micromeria parviflora* (Vis.) Reichenb. | – | – | – | – | – | – | – | II | – | – | – |
| *Calamintha nepeta* (L.) Savi | – | – | – | – | – | II | – | III | III | – | – |
| *Helichrysum italicum* (Roth) G. Don f. | – | – | – | – | – | – | – | – | V | II | – |
| *Micromeria greacea* (L.) Bentham ex Reichenb. | – | – | – | – | – | – | – | – | V | – | – |
| *Foeniculum vulgare* Miller | – | – | – | – | – | – | – | – | IV | – | – |
| *Avena barbata* Pott ex Link | – | – | – | – | – | – | – | – | III | – | – |
| *Briza maxima* L. | – | – | – | – | – | – | – | – | III | – | – |
| *Trifolium campestre* Schreber | – | – | – | – | – | – | – | – | III | – | – |
| *Ampelodesmos mauritanica* (Poiret) T. Durand & Schinz | – | – | – | – | – | – | – | – | III | – | – |
| *Psoralea bituminosa* L. | – | – | – | – | – | – | – | – | III | – | – |
| *Carlina corymbosa* L. | – | – | – | – | – | – | – | – | III | – | – |
| *Desmazeria rigida* (L.) Tutin | – | – | – | – | – | – | – | – | III | – | – |
| *Phragmites australis* (Cav.) Trin. ex Steudel | – | – | – | – | – | – | – | – | II | II | – |
| *Dasypyrum villosum* (L.) P. Candargy | – | – | – | – | – | – | – | – | II | – | – |
| *Euphorbia characias* L. | – | – | – | – | – | – | – | – | II | – | II |
| *Eryngium campestre* L. | – | – | – | – | – | – | – | – | II | – | – |

(*continued*)

Table II. (*Continued*).

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Onobrychis caput-galli* (L.) Lam. | – | – | – | – | – | – | – | – | II | – | – |
| *Aira caryophyllea* L. | – | – | – | – | – | – | – | – | II | – | – |
| *Medicago polymorpha* L. | – | – | – | – | – | – | – | – | II | – | – |
| *Vicia villosa* Roth. | – | – | – | – | – | – | – | – | II | – | – |
| *Hypochoeris achyrophorus* L. | – | – | – | – | – | – | – | – | II | – | – |
| *Verbascum sinuatum* L. | – | – | – | – | – | – | – | – | II | – | – |
| *Vulpia ciliata* Dumort. | – | – | – | – | – | – | – | – | II | – | – |
| *Fedia coruncopiae* (L.) Gaertner | – | – | – | – | – | – | – | – | II | – | – |
| *Linum* sp. | – | – | – | – | – | – | – | – | II | – | – |
| *Aegilops geniculata* Roth. | – | – | – | – | – | – | – | – | II | – | – |
| *Allium subhirsutum* L. | – | – | – | – | – | – | – | – | – | II | – |
| *Artemisia campestris* L. | – | – | – | – | – | II | – | – | – | II | – |
| *Cistus monspeliensis* L. | – | – | – | – | – | – | – | – | – | II | – |
| *Cynoglossum creticum* Miller | – | – | – | – | – | II | – | – | – | – | – |
| *Asphodelus aestivus* Brot. | – | – | – | – | – | – | – | – | – | – | III |

For each species the presence class is given in Roman numbers, r: less than 5%; +: 6 – 10%; I: 11 – 20%; II: 21 – 40%; III: 41 – 60%; IV: 61 – 80%; V: 81 – 100%. The association's indicator species are noted in bold. See Appendix 1 for data sources and references.

Companions with only class lower than II: Association 2. *Brachypodium phoenicoides* (L.) Roemer & Schultes (I); Association 3. Companions only in one relevé *Arundo donax* L. ($1^+$); Association 4. *Arundo donax* L. (I), *Rhamnus lycoides* L. (I), *Asparagus stipularis* Forskal (I); Association 5. Companions with cover lower than 2: *Brachypodium silvaticum* (Hudson) Beauv. (1), *Crataegus monogyna* Jacq. (1), *Carex pendula* Hudson (1); Association 6. *Calicotome villosa* (Poiret) Link (I), *Scirpus holoschoenus* L. (I), *Phragmites asutralis* (Cav.) Trin ex Steudel (I), *Briza maxima* L. (I), *Allium subhirsutum* L. (I), *Daucus carota* L. (I), *Rosa sempervirens* L. (I), *Pyrus amygdaliformis* Vill. (I), *Geranium rotundifolium* L. (I), *Pimpinella peregrina* L. (I), *Carduus pycnocephalus* L. (I), *Dracunculus vulgaris* Schott (I), *Pistacia lentiscus* L. (I), *Osyris alba* L. (I), *Oenanthe pimpinelloides* L. (I), *Galactites tomentosa* Moench. (I), *Knautia integrifolia* (L.) Bertol. (I), *Rosmarinus officinalis* L. (I), *Prasium majus* L. (I); Association 7. Companions only in one relevé *Pipthaterum miliaceum* (L.) Cosson ($1^1$) *Arundo donax* L. (1), *Brachypodium sylvaticum* (Hudson) Beauv. (1), *Myrtus communis* L.(1), *Oxalis pes-caprae* L.($1^1$), *Rubus X assurgens* (1), *Symphytum bulbosum* L.(1), *Tamus communis* L.(1); Association 8. *Hypericum perforatum* L. (I), *Micromeria juliana* (L.) Bentham ex Reichenb. (I), *Asplenium trichomanes* L. (I), *Sedum ochroleucum* Chaix (I), *Dichanthium ishaemum* (L.) Roberty (I), *Quercus pubescens* Villd. (I), *Acer monspessulanum* L. (I), *Celtis australis* L. (I), *Paliurus spina-christi* Miller (I), *Crataegus monogyna* Jacq. (I), *Ligustrum vulgare* L. (I), *Rhamnus orbiculatus* Bornm. (I), *Pistacia terebinthus* L. (I), *Euonymus europaeus* L. (I), *Osyris alba* L. (+), *Asparagus acutifolius* L. (I), *Cephalaria leucantha* (L.) Roemer & Schultes (I), *Briza maxima* L. (I), *Sesleria autumnalis* (Scop.) F. W. Schultz (+), *Psoralea bituminosa* L. (+), *Dasypyrum villosum* (L.) P. Candargy (+), *Verbascum macrurum* Ten. (+), *Digitalis ferruginea* L. (+), *Parietaria judaica* L. (+), *Petrorhagia saxifraga* (L.) Link (r), *Sideritis romana* L. (r), *Peucedanum longifolium* Waldst. & Kit. (r), *Scrophularia heterophylla* Willd. (r); Association 9. *Dittrichia viscosa* (L.) Greuter (I), *Centranthus ruber* (L.) DC. (I), *Scrophularia canina* L. (I), *Euphorbia rigida* Bieb. (I), *Equisetum ramosissimum* Desf. (I), *Daucus carota* L. (I), *Pipthaterum miliaceum* (L.) Cosson (I), *Artemisia arborescens* (L.) Cosson (I), *Salix purpurea* L. (I), *Populus nigra* L. (I), *Platanus orientalis* L. (I), and other 60 species with presence in one and/or two relevés; Association 10. *Foeniculum vulgare* Miller (I), *Ampelodesmus mauritanica* (Poiret) T. Durand & Schinz (I), *Oxalis pes-caprae* L. (I), *Convolvulus althaeoides* L. (I), *Clematis vitalba* L. (I), *Asparagus acutifolius* L. (I), *Briza maxima* L. (I), *Euphorbia dendroides* L. (I), *Lathyrus clymemum* L. (I), *Crepis vesicaria* L. (I), *Phlomis fruticosa* L. (I), *Sixalix atropurpurea* (L.) Greuter & Burdet (I), *Pinus halepensis* Miller (I), *Scrophularia canina* L. (I), *Daphne gnidium* L. (I), *Saccharum ravennae* (L.) Murray (I), *Daucus carota* L. (I), *Pistacia lentiscus* L. (I), *Osyris alba* L. (I), *Calamintha nepeta* (L.) Savi (I); Association 11. *Carlina corymbosa* L. (I), *Capparis spinosa* L. (I), *Arum italicum* Miller (I), *Nicotiana glauca* Graham (I), *Avena sterilis* L. (r), *Dasypyrum villosum* (L.) P. Candargy (r), *Lagurus ovatus* L. (r), *Carthamus lanatus* L. (r), *Sorghum halepense* (L.) Pers. (r), *Verbena officinalis* L. (r), *Digitaria sanguinalis* Scop. (r), *Glycyrrhiza echinata* L. (r), *Gypsophila perfoliata* L. (r).

southern aspect and a slope of 15 – 20°. This association is similar to fairly sparse low forests with shrub layers covering 80 – 90% of the surface. The habitats are not exposed to disturbances.

The association comprised a total of 32 species (Table I). The number of species per relevé was 20 – 22, and 11 species displayed the greatest presence (V). *Nerium oleander* dominated. *Chrysopogon gryllus* (L.) Trin. was an abundant and constant species. *Rubus ulmifolius* – a characteristic species of *Rubo ulmifolii-Nerion oleandri* – appeared within this association with relatively high frequency (III) and low cover. Among characteristic species of the *Tamaricetalia* order, *Vitex agnus-castus* had the lowest frequency and cover.

A larger number of companions (28) were present in the association (Table I). Of these, 37% were phanerophytes and 34% hemicryptophytes. Most of the species (78%) belonged to Mediterranean floral elements, mostly circum-Mediterranean plants (56%). Most of the companions were treated as characteristic species of the *Quercetalia ilicis* and *Scorzonero-Chrysopogonetalia* communities.

Table II compares the proposed Croatian association with the other five associations of the *Rubo ulmifolii-Nerion oleandri* alliance from 11 sites around the Mediterranean region.

*Nerium oleander* and *Rubus ulmifolius* had high constancy in almost all Mediterranean associations (Table II). On the contrary, species of the *Tamaricetalia* order – *Vitex agnus-castus*, *Tamarix gallica* and

*T. africana* – generally had low constancy and cover in the *Rubo ulmifolii-Nerion oleandri* associations, except in the *Rubo ulmifolii-Nerietum oleandri viticetosum agni-casti* from Calabria (south Italy). All character-species of the particular association generally had a high constancy and cover. The number of species per association ranged from six in the *Rubo ulmifolii-Nerietum oleandri* (Spain) to 105 in the *Spartio-Nerietum oleandri* (Sicily).

MDS ordination showed two groups of significantly different assemblages of the *Rubo ulmifolii-Nerion oleandri* alliance (ANOSIM, $p < 0.001$, Figure 2). Spanish associations (Figure 2, group A) are distinctly different from those in Calabria, Croatia, and Turkey (Figure 2, group B). Associations from Greece (No 7), Montenegro (No 8), and Sicily (No 9) were completely separate from these.

The Croatian association was most similar to the *Spartio-Nerietum oleandri* association from Calabria (Table II, No. 10, similarity 45%). According to SIMPER analysis, among character-species of the alliance, order, and class, *Vitex agnus-castus*, *Tamarix gallica*, and *T. africana* contributed most to variance among associations. Of companions, those making the largest contribution included *Scirpus holoschoenus* L., *Saccharum ravenae* (L.) Murray, *Arundo donax* L., *Brachypodium phoenicoides* (L.) Roem. et Schult., and *Equisetum ramossisimum*.

## Discussion

The present investigation revealed the presence of a thermophilous association of *Nerio-Tamaricetea*

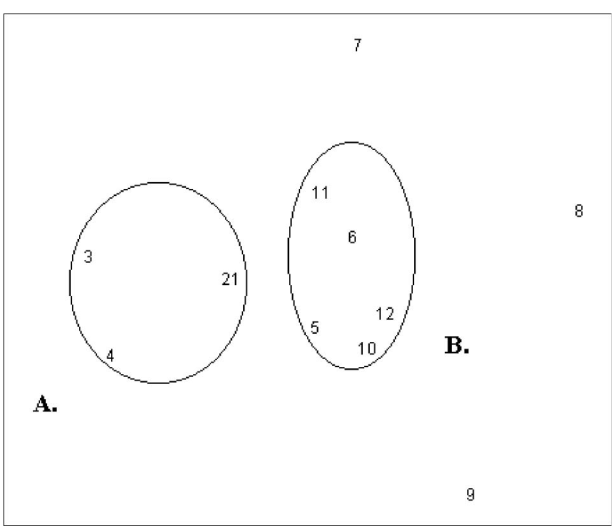


Figure 2. Two-dimensional configuration (non-metric multidimensional scaling ordination) of the *Nerium oleander* associations (species abundance data, stress value = 0.11). Symbols A and B refer to the two groups of significantly different *Rubo ulmifolii-Nerion oleandri* associations (ANOSIM, $p < 0.001$). Numbers indicate associations (see Appendix 1 for list of *Rubo ulmifolii-Nerion oleandri* associations, Croatian association = 12).

vegetation in southern Croatia. The proposed Croatian association, *Chrysopogono grylli-Nerietum oleandri*, is significantly different both floristically and ecologically from the hygrophilic oleander associations described up to now in the Mediterranean (cf. Izco et al., 1984; Biondi et al., 1994; Dimopoulos et al., 2005). On the other hand, the association is very distant from climazonal communities and could be treated as a separate formation. These agree with recommendations of Bolòs (1985) who placed all thermophilous oleander stands within the *Rubo ulmifolii-Nerion oleandri* alliance. The study has demonstrated the presence of associations of this alliance in nearly the whole Mediterranean region.

The floristic and ecological characterization of this new association is in line with the biological and chorological spectra. Phanerophytes and hemicryptophytes generally prevailed, which is consistent with most other associations of the alliance. The character-species of the association, *Chrysopogon gryllus*, was recorded for the first time in the *Nerio-Tamaricetea* vegetation. It has a wide ecological amplitude and appears in many dry grassland communities in the Balkans (Ilijanić & Topić, 1989). *Vitex agnus-castus* was the only character-species of the *Tamaricetalia* order in the Croatian association. It is common in South Adriatic freshwater wetlands where it constitutes the thermophilous scrub communities (Lovrić, 1993; Jasprica & Carić, 2002).

Herbaceous plants of the *Thero-Brachypodietea* are diverse in the *Rubo ulmifolii-Nerion oleandri* associations, frequently including abundant xerophytic grasses (*Brachypodium retusum* (Pers.) Beauv., *Andropogon distachyos* L., *Hyparrhenia hirta* (L.) Stapf., *Dactylis glomerata* L., etc.), especially in the associations from Croatia, Montenegro, and Sicily.

Despite their proximity, however, the *Chrysopogono grylli-Nerietum oleandri* association from Croatia and *Andropogono distachyi-Nerietum oleandri* from Montenegro showed some interesting differences in their structure. This may be explained by the local rainfall regime. The Montenegrin association grows within the *Ostryo-Carpinion orientalis* alliance (*Quercetea pubescentis*), at the very foot of Mount Orjen, which has the highest precipitation (4,774 mm) in the Dinaric Alps (Horvat et al., 1974). Unfortunately, owing to lack of reliable data, a comparison of Croatian and Montenegrin sites by the Rivas-Martínez bioclimatic parameters was not possible. Regarding syntaxonomy, the status of the Montenegrin association never has been determined. We thus classified the association in the alliance *Rubo ulmifolii-Nerion oleandri* and the class *Nerio-Tamaricetea*.

The above analysis shows that two main groups can be distinguished within the *Rubo ulmifolii-Nerion oleandri* alliance: (1) Spanish associations (mostly *Rubo ulmifolii-Nerietum oleandri*) with abundant hygrophylic species from other higher syntaxa (e.g. *Scirpus holoschoenus*, *Saccharum ravennae*, *Arundo donax*, etc.) and (2) associations from Calabria, Croatia and Turkey.

Spanish associations appear in more humid air and edaphic conditions. This is supported by floristic analysis (see Table II). Regarding diversity, the *Rubo ulmifolii-Nerietum oleandri* (Spain) and *Aristolochio rotundae-Nerietum oleandri* (Greece) associations are species-poor and contain hygrophytes and ruderals. These associations usually are attached to hygrophylic communities of *Populetalia albae* in Greece (Krause et al., 1963; Bolòs et al., 1996) or *Salicetalia purpureae* in southern Italy (Biondi et al., 1994).

A common characteristic of the all associations of the *Rubo ulmifolii-Nerion oleandri* alliance is a great number of companions from different syntaxa. SIMPER analysis indicated that the difference between the associations could be largely ascribed to the frequency and cover of companions. This fact may explain the position of the *Rubo ulmifolii-Nerietum oleandri* from Calabria and Turkey (Figure 2; Nos 5, 6 and 11) together with the more thermophilous *Spartio-Nerietum oleandri* from Calabria and *Chrysopogono grylli-Nerietum oleandri* from Croatia. Some companions (*Pipthaterum miliaceum* (L.) Cosson, *Dittrichia viscosa*, *Asparagus acutifolius* L., *Arum italicum* Miller, etc.) were common for these associations, but not recorded in the Spanish associations.

Despite the difference in biogeographic position and bioclimates (*sensu* Rivas-Martínez et al., 2004a,b), the Croatian community is closely related to the *Spartio-Nerietum oleandri* from Calabria. Both are very rich in the same companions and associated with the *Oleo-Ceratonion* maquis. This may suggest their subordination to another class of vegetation. All these facts suggest a need for a more detailed ecological investigation of these rare associations, and perhaps a thorough revision of their syntaxonomic status.

It seems plausible that the community of *Nerium oleander* assimilated an earlier community (Grime, 2001). According to Adamović (1909, 1911), oleander stands from this part of Croatia were extensive at the beginning of the 20th Century, but we have no data on their composition.

Finally, if we consider the statements of Mayr (2002), the Croatian association *Chrysopogono grylli-Nerietum oleandri* may be defined as a 'geographic race' of *Spartio-Nerietum oleandri*. These two associations may thus be considered as geographical groups of associations that tend to differ from each other in terms of mean differences and, sometimes, even in specific single characteristics. Rivas-Martínez's classification (2005) of typological units of dynamic phytosociology (sigmeta) may be useful in recognizing the series of associations defined on the most important ecological and geographical levels (biogeography, bioclimatic plane, edaphic factors, etc.).

The present findings contribute essential baseline information that should aid in future evaluations of the state of *Nerium oleander* stands along the Adriatic coast, both in Croatia and Montenegro. Stands with oleander are sporadic in this area and, owing to heightened coastal development, perhaps in the process of becoming extinct. They nevertheless are an important part of the region's natural heritage in need of conservation measures to ensure their survival. Management plans must ensure that all forms of land are used in a sustainable way. Those included as protected areas in the "NATURA 2000" network, in fact, must be protected according to international obligation.

## Acknowledgements

The authors thank colleagues Prof Vukić Pulević and Zlatko Bulić from Montenegro for providing us with the literature data and the opportunity to investigate the Montenegrin *Nerium* stands in 2005. Thanks also are extended to the Croatian Meteorological and Hydrological Service and Dr Marjana Gajić-Čapka for their contributions to the manuscript.

## References

Adamović L. 1909. Die Vegetationsverhältnisse der Balkanländer:(Mösische Länder): umfassend Serbien, Altserbien, Bulgarien, Ostrumelien, Nordthrakien und Nordmazedonien. In: Engler A, Drude O, editors. Die Vegetation der Erde, 12, Leipzig, Germany.

Adamović L. 1911. Die Pflanzenwelt Dalmatiens. Von Dr. Werner Klinkhardt Verlag, Leipzig, Germany.

Alcaráz FJ. 1982. Contribución al estudio fitosociológico y fitotopográfico del cuadrante NE de la provincia de Murcia (SE de España). PhD Thesis. Inéd Fac. Ciencias. University of Murcia, Spain.

Barbagallo C, Brullo S, Furnari F. 1990. La vegetazione alofila palustre della Tunisia. Boll Acc Gioenia Sci Nat Catania 23:581 – 652.

Biondi E, Ballelli S, Allegrezza M, Taffetani F, Francalancia C. 1994. La vegetazione delle "fiumare" del versante ionico lucano-calabrese. Fitosociologia 27:51 – 66.

Böhling N, Greuter W, Raus T. 2002. Zeigerwerte der Gefäßpflanzen der Südägäis (Griechenland). Braun-Blanquetia 32:3 – 108.

Bolòs O de. 1967. Comunidades vegetales de las comarcas próximas al litoral comprendidas entre los rios Llobregat ySegura. Mam Real Acad Cien Artes Barcelona 38: 3 – 280.

Bolòs O de. 1985. A proposit de les comunitats de *Nerium oleander*. Collect Bot (Barcelona) 16:227 – 228.

Bolòs O de, Masalles RM, Ninot JM, Vigo J. 1996. A survey on the vegetation of Cephalonia (Ionian islands). Phytocoenologia 26:81 – 123.

Braun-Blanquet J. 1964. Pflanzensoziologie. Grundzüge der Vegetationskunde. 3. New York, USA: Springer-Verlag.

Braun-Blanquet J, Bolòs O de. 1957. Les groupements végétaux du bassin moyen de l'Ebre et leur dynamisme. Anales Estac Exp Aula Dei 5:1 – 266.

Brullo S, Spampinato G. 1990. La vegetazione dei corsi d'acqua della Sicilia. Boll Acc Gioenia Sci Nat Catania 23: 119 – 252.

Brullo S, Spampinato G. 1997. Indagine fitosociologica sulle ripisilve della Calabria (Italia meridionale). Lazaroa 18:105 – 151.

Cantó P, Laorga S, Belmonte D. 1986. Vegetación y catálogo florístico del Peñón de Ifach (Penyal d' Ifac) (Alicante, España). Opusc Bot Pharm Complut 3:3 – 86.

Clarke KR, Gorley RN. 2001. Primer v5: User manual/tutorial. Plymouth, UK: PRIMER-E Ltd.

Clarke KR, Warwick RM. 1994. Change in marine communities: an approach to statistical analysis and interpretation. Plymouth, UK: Plymouth Marine Laboratory.

Dimopoulos P, Sykora K, Gilissen C, Wiecherink D, Georgiadis T. 2005. Vegetation ecology of Kalodiki Fen (NW Greece). Biologia, Bratislava 60:69 – 82.

EEA (European Environment Agency) 1999. Natura 2000. Mediterranean Region. Reference lists of habitat types and species present in the region. ETC/NC, Paris, France.

Eig A. 1946. Synopsis of the Phytosociological units of the Palestine. Palest J Bot 3:4.

Figuerola R. 1983. Estudio de la vegetación y flora de las Sierras Martés y Ave. PhD Thesis. Inéd Fac. Farmacia. University of Valencia (Mecanografiado), Spain.

Golub VB. 1994. Class *Asteretea tripolium* on the territory of the former USSR and Mongolia. Folia Geobot Phytotax 29: 15 – 54.

Grime JP. 2001. Plant strategies, vegetation processes, and ecosystem properties. 2nd edition. Chichester, UK: John Wiley & Sons Ltd.

Horvat I, Glavač V, Ellenberg H. 1974. Vegetation Südosteuropas. Stuttgart, Germany: Gustav Fischer Verlag.

Ilijanić Lj, Topić J. 1989. On the sociology of *Chrysopogon gryllus* in Yugoslavia. Acta Bot Croat 48:75 – 82.

Izco J, Fernández F, Molina A. 1984. El orden *Tamaricetalia* Br. Bl. & O. Bolòs 1957 y su ampliación con los tarayales hiperhalófilos. Doc Phytosoc 8:377 – 389.

Jasprica N, Carić M. 2002. Vegetation of the natural park of Hutovo Blato (Neretva river delta, Bosnia and Herzegovina). Biologia, Bratislava 57:505 – 516.

Jasprica N, Kovačić S. 1997. Vascular flora of the central part of Pelješac peninsula. Nat Croat 6:349 – 456.

Jasprica N, Kovačić S. 2000. Florističke i vegetacijske značajke Stona i okolice [Floristic and vegetation characteristics of the Ston area]. Dubrovnik (Matica hrvatska) 1 – 2:199 – 214.

Jeanmond D, Schlüssel A, editors. 2004. Notes and contributions on Corsican flora, XX. Candollea 59:65 – 94.

Jovanović B, Vukičević E. 1978. Fitocenoza sa oleanderom (*Nerium oleander* L.) kod Risna u Boki Kotorskoj [Communities with *Nerium oleander* L. near Risan, Bay of Kotor]. Radovi sa Simpozija "Stanje, zaštita i unapređenje čovjekove sredine u Crnoj Gori", Oct 6 – 8, 1976, Herceg-Novi. pp 381 – 390.

Kovačić S, Jasprica N, Ruščić M. 2001. Floristic characteristics of Phoenician juniper macchia (ass. *Pistacio lentisci-Juniperetum phoeniceae* Trinajstić 1987) in Central and Southern Dalmatia (Croatia). Nat Croat 10:73 – 81.

Krause W, Ludwig W, Seidel F. 1963. Zur Kenntnis der Flora und Vegetation auf Serpentinstandorten des Balkans. 6. Vegetationsstudien in der Umgebung von Mantoudi (Euböa). Bot Jb 82:337 – 403.

Le Houérou HN. 2003. Bioclimatology and phytogeography of the Red Sea Basin and Aden Gulf, with particular reference to highland evergreen sclerophylls and lowland halophytes. Arid Land Res Manag 17:177 – 256.

Le Houérou HN. 2004. Plant diversity in Marmarica (Libya and Egypt): a catalogue of the vascular plants reported with their biology, distribution, frequency, usage, economic potential, habitat and main ecological features, with an extensive bibliography. Candollea 59:259 – 308.

Lovrić AŽ. 1993. Dry coastal ecosystem of Croatia and Yugoslavia. In: van der Maarel E, editor. Ecosystems of the world 2A. Dry coastal ecosystems. Polar regions and Europe. Amsterdam, The Netherlands: Elsevier. pp 391 – 420.

Martinović J. 2000. Tla u Hrvatskoj [Soils in Croatia]. Ministry of Environmental Protection, Physical Planning and Construction, Zagreb, Croatia.

Mayr E. 2002. The biology of race and the concept of equality. Daedalus 131:89 – 94.

Mucina L. 1997. Conspectus of classes of European vegetation. Folia Geobot. Phytotax. 32:117 – 172.

Nikolić T, Topić J, editors. 2005. Red Book of vascular flora of the Republic of Croatia. Categories EX, RE, CR, EN and VU. Ministry of Culture, State Institute for Nature Protection, Zagreb, Croatia.

Peris JB. 1983. Estudio sobre la flora y la vegetación de las sierras de Boquerón y Palomera. PhD Thesis. Inéd Fac. Farmacia. University of Valencia, Spain.

Pignatti S. 1982. Flora d'Italia, 1 – 3. Bologna, Italy: Edagricole.

Raić V, Papeš J. 1982. Osnovna geološka karta 1:100000, List Ston [Geological map, Ston area]. Institut za geološka istraživanja, Zagreb, Croatia.

Raunkiaer C. 1934. The life forms of plants and statistical plant geography. Oxford, UK: Clarendon Press.

Rivas-Martínez S. 1993. Bases para una nueva clasificación Bioclimática de la Tierra. Folia Bot Matritensis 10:1 – 23.

Rivas-Martínez S. 1997. Syntaxonomical synopsis of the potential natural plant communities of North America, I. Itinera Geobot 10:5 – 148.

Rivas-Martínez S. 2005. Notions on dynamic-catenal phytosociology as a basis of landscape science. Plant Biosyst 139:135 – 144.

Rivas-Martínez S, Sánchez-Mata D, Costa M. 1999. North American boreal and western temperate vegetation (Syntaxonomical synopsis of the potential natural plant communities of North America, II). Itinera Geobot 12:5 – 316.

Rivas-Martínez S, Díaz TE, Fernández-González F, Izco J, Loidi J, Lousã M, et al. 2002. Vascular plant communities of Spain and Portugal addenda to the syntaxonomical checklist of 2001. Itinera Geobot 15:5 – 922.

Rivas-Martínez S, Penas A, Díaz TE. 2004a. Bioclimatic Map of Europe, Bioclimates. Cartographic Service. University of León, Spain.

Rivas-Martínez S, Penas A, Díaz TE. 2004b. Biogeographic Map of Europe. Cartographic Service. University of León, Spain.

Trinajstić I. 1995. Plantgeographical division of forest vegetation of Croatia. Ann Forest 20:37 – 66.

Tutin TG, Heywood VH, Burges NA, Moore DM, Valentine DH, Walters SM, et al., editors. 1964 – 1980. Flora Europaea 1 – 5. Cambridge, UK: Cambridge University Press.

Tutin TG, Burges NA, Chater AO, Edmondson JR, Heywood VH, Moore DM, et al., editors. 1993. Flora Europaea. II. Cambridge, UK: Cambridge University Press.

Walter H, Straka H. 1970. Arealkunde. Floristicchhistorische Geobotanik (Einführung in die Phytologie III, 2, 2. Aufl.), Stuttgart, Germany: Verlag Eugen Ulmer.
Weber HE, Moravec J, Theurillat JP. 2000. International code of phytosociological nomenclature, 3rd edition. J Veg Sci 11: 739–768.
Zohary M, Orshan G. 1949. Structure and ecology of the vegetation in Dead Sea Region of Palestine. Palest J Bot 4:177–206.

**Appendix 1**

List of the *Rubo ulmifolii-Nerion oleandri* associations and locations where relevés have been made (see Table II).

Association 1. *Rubo ulmifolii-Nerietum oleandri* (Bolòs 1967; 8 rels, the Llobregat and Segura rivers, south Spain).
Association 2. *Rubo ulmifolii-Nerietum oleandri* (Peris 1983; Tab. 49, rel. 1–6, Sierra del Boquerón, Sierra la Palomera, south Spain).
Association 3. *Rubo ulmifolii-Nerietum oleandri* (Figuerola 1983; Tab. 40, rel. 1–4, Sierra Martés, Sierra Ave, south Spain).
Association 4. *Rubio longifoliae-Nerietum oleandri* (Alcaráz 1982; Tab. 83, rel. 1–6, NE of Murcia, south Spain).
Association 5. *Rubo ulmifolii-Nerietum oleandri* (Brullo & Spampinato 1997; Tab. 11, rel. 1, South of Calabria, south Italy).
Association 6. *Rubo ulmifolii-Nerietum oleandri* subass. *viticetosum agni-casti* (Biondi et al. 1994; Tab. 5, rel. 1–9, The Trionto River and near the town of Amendolara, the Ionian Lucan-Calabrian versant, south Italy).
Association 7. *Aristolochio rotundae–Nerietum oleandri* (Bolòs et al. 1996; Tab. 8, rel. 1–2, Katelios, Island of Cephalonia, Greece).
Association 8. *Andropogono distachyi-Nerietum oleandri* (Jovanović & Vukičević 1978; Tab. 1, rel. 1–2, rel. 3–5 our own data collected on 15th October 2005, near willage of Risan, Kotor Bay, Montenegro, South Adriatic).
Association 9. *Spartio-Nerietum oleandri* (Brullo & Spampinato 1990; Tab. 13, rel. 1–10, eastern Sicily, Italy).
Association 10. *Spartio-Nerietum oleandri* (Biondi et al. 1994, Tab. 5, rel. 1–2, Calabria, south Italy; Brullo & Spampinato 1997; Tab. 10, rel. 1–6, Calabria, south Italy).
Association 11. *Rubo ulmifolii-Nerietum oleandri* (rel. 1–4, Pamukkale, Province of Denizli, south-west of Anatolian Peninsula, 24th October 2005; rel. 5–7, village of Doğanbey, the National Park of Dilek Peninsula, the Büyük Menderes delta, Province of Muğla, 29th October 2005, Aegean region of Turkey).

**Appendix 2**

Syntaxonomic scheme of the *Rubo ulmifolii-Nerion oleandri* associations (in alphabetical order).

*Nerio-Tamaricetea* Br.-Bl. & O. Bolòs 1957
*Tamaricetalia africanae* Br.-Bl. & O. Bolòs 1957 em. Izco et al. 1984
*Rubo ulmifolii-Nerion oleandri* O. Bolòs 1985
*Andropogono distachyi-Nerietum oleandri* (Jovanović & Vukičević, 1978) Jasprica et al. 2007 stat. nov.
*Aristolochio rotundae–Nerietum oleandri* Bolòs et al. 1996
*Chrysopogono grylli-Nerietum oleandri* Jasprica et al. 2007 ass. nova
*Rubio longifoliae-Nerietum oleandri* Alcaráz 1982
*Rubo ulmifolii-Nerietum oleandri* O. Bolòs 1965
*Rubo ulmifolii-Nerietum oleandri viticetosum agni-casti* Biondi et al. 1994
*Spartio-Nerietum oleandri* Brullo & Spampinato 1990

**Appendix 3**

Syntaxonomic units mentioned in the text, but not in the scheme (in alphabetical order).

*Asplenietea trichomanis* Br.-Bl. em. nom. Oberd. 1977
*Brachypodietalia phoenicoidis* (Br.-Bl. 1931) Molinier 1934
*Centaureo-Campanuletalia* Trinajstić 1980
*Chenopodietalia* Br.-Bl. in Br.-Bl., Gajewski, Wraber & Walas 1936
*Chenopodietea* Br.-Bl. in Br.-Bl., Roussine & Nègre 1952
*Cisto-Ericetalia* Horvatić 1958
*Erico-Cistetea* Trinajstić 1985
*Festuco-Brometea* Br.-Bl. & R. Tx. 1943 ex Klika & Hadač 1944
*Fraxino orni-Quercetum ilicis* Horvatić (1956) 1958
*Holoschoenetalia* Br.-Bl. (1931) 1937
*Imperato-Erianthion ravennae* Br.-Bl. & O. Bolòs 1957
*Nerium oleander-Tamarix tetranda* community Krause, Ludwig & Seidel 1963
*Oleo-Ceratonion* Br.-Bl. 1936
*Oleo sylvestris-Euphorbietum dendroidis* Trinajstić (1973) 1984
*Ostryo-Carpinion orientalis* Horvat 1959

*Phragmitetalia australis* (W. Koch) R. Tx. & Preisg. 1942
*Pistacio lentisci-Juniperetum phoeniceae* Trinajstić 1987
*Populetalia albae* Br.-Bl. 1931
*Quercetalia ilicis* Br.-Bl. 1936
*Quercetalia pubescentis* Br.-Bl. (1931) 1940
*Quercetea ilicis* Br.-Bl. 1947
*Quercetea pubescentis* Doing-Kraft ex Scamoni & Passarge 1959
*Salicetalia purpureae* Moor 1958
*Scorzonero-Chrysopogonetalia* Horvat & Horvatić 1956
*Tamaricion africanae* Br.-Bl. & O. Bolòs 1957
*Tamaricion boveniano-canariensis* Izco, Fernández & Molina 1984
*Tamaricion speciosae* Br.-Bl. & O. Bolòs 1957
*Thero-Bracyhpodietalia* Br.-Bl. (1931) 1936
*Thero-Brachypodietea* Br.-Bl. 1947