ARTICLES

Mediterranean Botany
ISSNe 2603-9109

EDICIONES COMPLUTENSE

https://dx.doi.org/10.5209/mbot.60833

Plant communities and habitat types in the protected area of Lake Pamvotis (Epirus, Northwestern Greece)

Maria Sarika[1], Anastasia Christopoulou[2,3], Andreas Zikos[2], Dimitrios Kazanis[2] & Ioannis Bazos[2]

Received: 4 July 2018 / Accepted: 13 April 2020 / Published online: 9 September 2020

Abstract. The vegetation of the protected area of Lake Pamvotis (Epirus, NW Greece) was studied and classified into habitat types according to the Council Directive 92/43/EEC. The main vegetation types encountered in the Ioannina Basin and the south-western part of Mt Mitsikeli are: (1) *Quercus coccifera* shrublands, (2) degraded deciduous oak forests, (3) Mediterranean arborescent mattorals with *Juniperus*, (4) Oro-Mediterranean heathlands, (5) willow low open forests, (6) oriental plane woods, (7) plant communities supported by calcareous substrates, (8) aquatic macrophyte assemblages, (9) reed beds and rush meadows. Twenty plant communities belonging to twelve alliances, eleven orders, and ten phytosociological classes were discerned. The *Asplenio ceterach-Aurinietum saxatilae* is described as a new association and the *Eleocharito palustris-Alismatetum lanceolati* is reported for the first time from Greece. Eleven habitat types were identified and their conservation status was assessed. Three habitat types (4090, 8210, 91M0) were in favourable conservation status, while one (5210) is in unfavourable-bad conservation status. The rest are in unfavourable-inadequate conservation status, with several pressures and threats recorded.
Keywords: conservation status assessment; cluster analysis; habitat directory; vegetation classification.

Vegetación y tipos de habitats en el área protegida del lago Pamvotis (Epirus, Noroeste Grecia)

Resumen. La vegetación del área protegida del lago Pamvotis (Epiro, noroeste de Grecia) se ha estudiado y clasificado en tipos de hábitat de acuerdo con la Directiva 92/43/CEE. Los principales tipos de vegetación que se encuentran en la cuenca de Ioannina y la parte sudoeste del monte Mitsikeli son: (1) arbustos de *Quercus coccifera*, (2) bosques de roble caducifolio degradados, (3) matorrales arborescentes mediterráneos con *Juniperus*, (4) brezales oromediterráneos, (5) bosques de sauces bajos abiertos, (6) bosques de *Platanus orientalis*, (7) diversas comunidades vegetales sobre sustratos calcáreos, (8) comunidades de macrófitas acuáticas, (9) cañaverales y juncales. Se distinguieron veinte comunidades de plantas pertenecientes a doce alianzas, once órdenes y diez clases fitosociológicas. *Asplenio ceterach-Aurinietum saxatilae* se describe como una nueva asociación y *Eleocharito palustris-Alismatetum lanceolati* se localiza por primera vez en Grecia. Se identificaron once tipos de hábitat y se evaluó su estado de conservación. Tres tipos de hábitat (4090, 8210, 91M0) estaban en estado de conservación favorable, mientras que uno (5210) está en estado de conservación desfavorable o muy desfavorable. El resto se encuentra en un estado de conservación desfavorable o inadecuado, y se han registrado diferentes amenazas y presiones de tipo antrópico.
Palabras clave: Estudio del estatus de conservación; análisis de grupos; directorio de hábitats; clasificación de la vegetación.

Introduction

The vegetation of Epirus has been inadequately explored, with the majority of the available data focusing on wetland habitats (Barbéro & Quézel, 1976; Georgiadis *et al.*, 1997; Sarika-Hatzinikolaou *et al.*, 2003; Ammanatidou, 2005; Dimopoulos *et al.*, 2005; Sarika *et al.*, 2005; Zogaris *et al.*, 2009; Manolaki & Papastergiadou, 2012). Studies of Ganiatsas (1970), Sarika-Hatzinikolaou *et al.* (2003), Stephanides & Papastergiadou (2007) and Papastergiadou *et al.* (2010) are available for Ioannina basin, while Gerasimidis & Korakis (2006) presented some phytosociological data for Mt Mitsikeli.

The current study provides an inventory of the main vegetation units and the related habitat types within the confines of the protected area of Lake Pamvotis. The dominant plant communities were described and classified into habitat types following the Council Directive 92/43/EEC. A conservation status assessment of the habitat types was performed, based on specific structures and functions, typical species, existing pressures and threats. Identification, mapping, and monitoring of the habitat types took place within areas of the Natura 2000 Network designed as Sites of Community Importance (SCI) and Special Areas of Conservation (SAC) (Dafis *et al.*, 2001).

1 Section of Genetics & Biotechnology, Department of Biology, National and Kapodistrian University of Athens, Panepistimiopolis, 15784 Athens, Greece. Email: msarika@biol.uoa.gr
2 Section of Ecology and Systematics, Department of Biology, National and Kapodistrian University of Athens, Panepistimiopolis, 15784 Athens, Greece.
3 Nicolaus Copernicus University, Institute for the Study, Conservation and Restoration of Cultural Heritage, ul. Sienkiewicza 30/32, 87–100 Toruń, Poland.

Material and Methods

Study area

The study area is located in the Prefecture of Ioannina (Epirus, NW Greece). It occupies the south-western part of Mt. Mitsikeli and almost the entire basin of Ioannina, including the Natura 2000 site Lake Pamvotis (code GR2130005) and partly the site Mt. Mitsikeli (code GR2130008). It stretches over 10 cells of the European Environment Agency (EEA) reference grid of 10x10 km (Figure 1). Ioannina basin has a total length of 35 km along its NNW-SSE axis and a width ranging from 3 to 10 km. It lies in an average elevation of about 480 m asl and is surrounded by high mountains. Mt Mitsikeli forms the north-eastern border of the areawhilst mount Tomaros rises to the west of it. The most distinctive feature of the basin is Lake Pamvotis -a highly eutrophic aquatic ecosystem that has been suffering from long-lasting anthropogenic pressures (Kagalou *et al*., 2008). The hydrologic and trophic state of Lake Pamvotis and its conservation value are described in detail by Kagalou *et al*. (2008) and Chiotelli (2015).

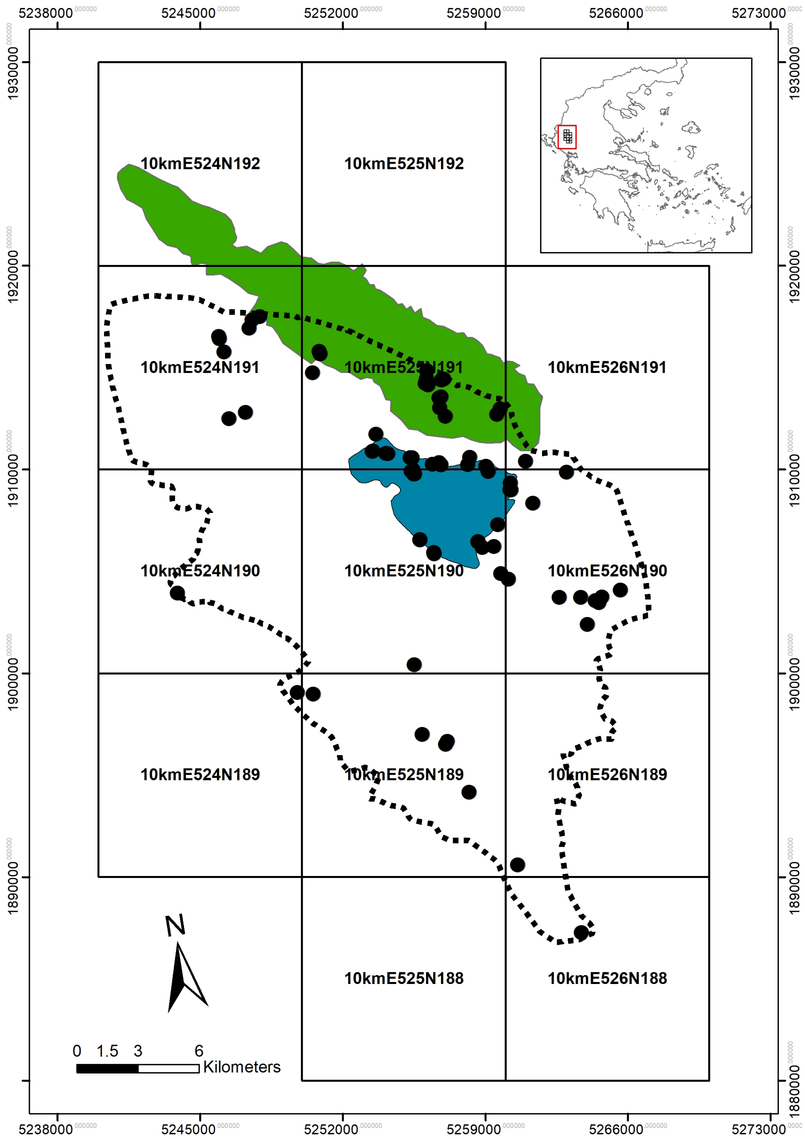

Figure 1. Study area (dashed line), the two Natura 2000 sites: GR2130005 with blue color and GR2130008 with green color, the EEA reference grid 10 x10 km and the positions of the relevés of the current study (black dots).

Human activity has influenced the natural environment of Ioannina basin profoundly as cultivations and pastures have replaced mainly the preexisting vegetation. In the lower part of *Quercetalia pubescenti-petraeae* belt (500–650 m asl) heavily grazed *Quercus coccifera* shrublands expand, while degraded deciduous oak forests can be found within the same belt but in higher elevations (620–900 m asl). Shrubby vegetation of secondary succession dominated by *Juniperus oxycedrus* subsp. *deltoides*, and usually emanates from degraded oak forests, develops at elevations spanning 900 m asl and 1300 m asl (Horvat *et al*., 1974; Raus, 1980; Karagiannakidou-Iatropoulou, 1983; Bergmeier, 1990). At elevations ranging roughly from 1100 m asl to 1700 m asl, oro-Mediterranean heathlands are dominant on the south-western part of Mt Mitsikeli, while beech and fir forests are nowadays present only on north-eastern flanks at elevations up to 1500 m. *Pinus brutia* and *P. nigra* reforestations reforestations, which are scattered at low and moderate elevations were originally planted to control soil erosion in heavily degraded sites.

Data collection

The vegetation study was carried out following the Braun-Blanquet floristic-sociological approach (Westhoff & van der Maarel, 1980; Kent & Coker, 1992). Seventy-two (72) vegetation sample plots (relevés) ranging in size from 4 m^2 to 200 m^2 were recorded from May to October 2015. The choice of stands for sampling was based on uniformity and distinctiveness so that each of the selected stands is typical of the contextual vegetation type in terms of both floristic composition and physiognomy. The selection of sample plots was based on the following general principles: 1) the plot area is homogenous and large enough to represent the floristic composition of the entire stand, 2) the vegetation in the plot area is as far as possible ecologically intact, 3) sampling sites are not in the vicinity of ecotones. The plot sizes used were harmonized with those suggested by Dimopoulos *et al*. (2018) for the monitoring and assessment of habitat types' conservation status on a national level. Our goal was the size and shape of plots to be relatively constant in the stands of the same vegetation type. In each plot, all vascular plants were recorded and their coverage was estimated by using the transformed (9-point) Braun-Blanquet scale (Van der Maarel 1979). These data were used to classify the vegetation units and to identify the habitat types, since the recently proposed revisions of the EUNIS (European Nature Information System) habitat classification system are mainly based on a combination of species occurrence and species cover (Schaminée *et al*., 2019). In addition, data regarding the sampling locality of each plot was recorded as proposed by Tsiripidis *et al*. (2018).

Data analysis

Plant specimens were identified mainly according to Davis (1965–85), Tutin *et al*. (1968–80, 1993), Strid (1986), and Strid & Kit Tan (1991, 1997, 2002). The nomenclature of the taxa follows Dimopoulos *et al*. (2013, 2016). The delimitation of vegetation units (Table 2–7) was made utilizing species groups derived from the Braun-Blanquet tabulation technique. This technique highlights species concentrated to particular relevé clusters (character species) or species delimiting differentiated subtypes within a cluster of closely related relevés (differential species). These groups of differentiating species are considered as diagnostic because their presence in particular relevé clusters separates vegetation into discrete units (Müeller-Dombois 1984; Chytrý *et al*., 2002). Following this concept and using as a guide taxa that prefer specific relevé clusters and are considered as diagnostic of the high-rank syntaxa listed in the EuroVegChecklist (Mucina *et al*., 2016), we classified the separate vegetation units into phytosociological classes, orders, and alliances. The procedure followed for the assessment of diagnostic species is that proposed by Westhoff & van der Maarel (1980). The reader can find a detailed description of how this process was applied to the present study by referring to Sarika (2012). The characteristic species of each class and the nomenclature of the high-rank syntaxa listed in Table 1, as well as of those involved in the text, follow Mucina *et al*. (2016). At the association level, names previously defined according to the formal syntaxonomic code (Weber *et al*., 2000), were adopted.

To classify the dataset and to identify differences among vegetation types, we used the two-way indicator species analysis (TWINSPAN) (Hill, 1979). TWINSPAN pseudospecies cut levels for species abundances were set to 0 and 25% cover, while only three division levels were applied, to avoid resulting in groups with a small number of relevés (Sarika *et al*., 2018). Subsequently, different division levels were accepted, resulting in nine groups characterized by the presence or absence of 12 indicator species (Hill & Šmilauer, 2005).

Visualization and interpretation of classification results were performed using non-metric multidimensional scaling (NMDS), based on the Bray-Curtis dissimilarity index. The ordination analysis was performed using the 'vegan' package and the function ordispider (Oksanen *et al*., 2019) in R statistical software platform (R Core Team, 2017). Function *ordispider* draws a 'spider' diagram showing each ordinated element connected to the respective group centroid (Oksanen *et al*., 2019).

The interpretation of habitat types was mainly achieved through the concept of indicator species (diagnostic, constant, dominant), following the phytosociological approach (Schaminée *et al*., 2019). Many of the diagnostic species that differentiate the vegetation of the study area into discrete units and species that are constantly present in these units (constant species) are listed as *indicator species* of particular habitat types of the EUNIS classification system (Schaminée *et al*., 2013, 2014, 2019).

A crosswalk between EUNIS habitat types and the recognized alliances of the EuroVegChecklist was used as a means of identifying habitat types for which certified lists of indicator species have not yet been published. Nowadays, changes and revisions in EUNIS (Schaminée *et al*. 2012, 2014, 2019) and the development of the EuroVegChecklist hierarchical syntaxonomic system (Mucina *et al*., 2016) permit a valid crosswalk between alliances and the EUNIS habitat types and vice versa. The correspondence of the habitat types found in the study area with the MAES (Mapping and Assessment of Ecosystems and their Services) ecosystem categories and types (Maes *et al*., 2018) is presented in Table S1 (Supplementary Material), according to the typology proposed by Kokkoris *et al*. (2018). Habitat type names and codes are also listed in Table S2 (Supplementary Material).

Table 1. A crosswalk between syntaxa and various habitat typologies. EUNIS: EUNIS Habitat Classification (Davies *et al*., 2004; Schaminée *et al*., 2019); Annex: Habitat types of Annex I of the Council Directive 92/43/EEC; NI: Habitat types of national interest

	EUNIS	Annex	NI
Quercetea pubescentis			
Quercetalia pubescenti-petraeae			
Quercion confertae	T19-[G17a], S51-[F51]	91M0, 5210	
Huetio cynapioidis-Quercetum frainetto			
Quercus pubescens community			
Juniperus oxycedrus subsp. *deltoides-Quercus coccifera* community			
Juniperus oxycedrus subsp. *deltoides* community			
Quercetea ilicis			
Quercetalia ilicis			
Arbuto andrachnes-Quercion cocciferae	T21-[G21]		934A
Quercus coccifera community			
Daphno-Festucetea			
Daphno-Festucetalia			
Astragalo angustifolii-Seslerion coerulantis	S75-[F74c]	4090	
Astragalus angustifolius community			
Asplenietea trichomanis			
Onosmetalia frutescentis			
Campanulion versicoloris	H3.2	8210	
Asplenio ceterach-Aurinietum saxatilae			
Drypidetea spinose			
Drypidetalia spinosae			
Silenion caesiae	H2.6	8140	
Drypis spinosa community			
Salicetea purpureae			
Salicetalia purpureae			
Salicion albae	T11-[G11]	92A0	
Salicetum albo-fragilis			
Alno glutinosae-Populetea albae			
Populetalia albae			
Platanion orientalis	T14-[G13]	92C0	
Platanus orientalis-Junglans regia community			
Potamogetonetea			
Potamogetonetalia			
Potamogetonion	C1.3	3150	
Stuckenia pectinata community			
Nymphaeion albae	C1.3	3150	
Nymphaeetum albo-lutae			
Nymphaeetum minoris			
Nymphoidetum peltatae			
Phragmito-Mgnocaricetea			
Phragmitetalia			
Phragmition communis	D5.1		72A0
Phragmitetum communis			
Typhetum angustifoliae			
Scirpetum lacustris			
Oenanthetalia aquaticae			
Eleocharito palustris-Sagittarion sagittifoliae	D5.1		72A0
Eleocharito palustris-Alismatetum lanceolati			
Bolboschoenus maritimus community			
Molinio-Arrhenatheretea			
Filipendulo ulmariae-Lotetalia uliginosi			
Mentho longifoliae-Juncion inflexi	R36-[E34b]		72B0
Juncus inflexus-Juncus effusus community			

Habitat coding follows Davies *et al*. (2004), Schaminée *et al*. (2019), and the Interpretation Manual of EU Habitat types (Anon., 2013), whereas habitat types of national interest follow Dafis *et al*. (2001). For the assessment of habitat types' conservation status, both European (Evans & Arvela, 2011) and national guidelines (Kotzageorgis *et al*., 2014; Dimopoulos *et al*., 2018; Tsiripidis *et al*., 2018) have been considered, as proposed by Evans & Arvela (2011) and adopted for Greece (Chrysopolitou *et al*., 2014), at a local or regional scale (e.g., sampling plot level or Natura 2000 site level). The term conservation degree should be used for the conservation status assessment, while at national or biogeographical scale the term conservation status. This differentiation is essential (Kokkoris *et al*., 2018; Tsiripidis *et al*., 2018) and in the current work, the term conservation degree is used both for the assessment of habitat conservation status at the sample plot level (relevés) and for the overall assessment in the Natura 2000 site and the study area. The methodology used follows the procedure developed within the national monitoring project of habitat types for the standardization of the conservation status assessment methods (Dimopoulos *et al*., 2018; Tsiripidis *et al*., 2018). In brief, assessment of the conservation degree of each habitat type started at the plot level, with a minimum number of 5 relevés per habitat type, unless this was not possible due to limited habitat size. For each habitat type, different field sheets prepared for the national monitoring project have been used (Dimopoulos *et al*., 2018). These field sheets include specific variables-criteria for the assessment of conservation status of each habitat type such as structure and functions (including typical species), assessment of trend and future status of the habitats' structures and functions based on observed pressures and threats alongside their intensity, as well as the presence of positive impacts (Kallimanis *et al*., 2017; Tsiripidis *et al*., 2018).

Regarding pressures and threats, we followed the methods proposed by Evans & Arvela (2011), and we used the common list for all EU countries and habitat types available on the web page of the European Environment Agency. To upscale the assessment of the conservation degree from the sample plot level to the Natura 2000 site and then to the study area, we followed the upscaling procedure suggested by Dimopoulos *et al*. (2018), in which assessment of conservation degree is also performed at the EEA reference grid 10 x 10 km cell level, as an intermediate step. In more detail, for the assessment of the conservation degree of each habitat type, the 75–25 rule was applied (Chrysopolitou *et al*., 2014; Dimopoulos *et al*., 2018). For calculating the area covered by each habitat type the vegetation map of the responsibility area of the Management Body was used, as this was updated and modified by the results of the current study.

Results and Discussion

Vegetation classification system

The NMDS revealed nine groups of relevés (Figure 2). Eleven relevés from an average elevation of more than 1000 m asl (up to 1700 m asl) that refer to *Drypidetea spinosae*, *Daphno-Festucetea,* and *Quercetea pubescentis*, form the group 1. Twelve relevés from moderate elevations (500–900 m asl) assigned to the classes *Quercetea pubescentis* and *Quercetea ilicis* constitute the group 2. Six relevés form the third group representing the chasmophytic vegetation on rocky cliffs (class *Asplenietea trichomanis*) of middle and upper slopes of the study area. Twenty-two relevés from wetland and aquatic habitats assigned to the classes *Phragmito-Magnocaricetea*, *Molinio-Arrhenatheretea* and *Potamogetonetea* comprise group 4. However, three relevés also belonging to *Potamogetonetea* form group 5. These were recorded in open water exposed to wind and wave action, in contrast to those of group 4, which were selected in more sheltered localities. Likewise, two relevés of *Phragmito-Magnocaricetea* recorded in a temporarily flooded depression form group 6. Group 7 includes four relevés associated with *Salicetea purpureae*. Group 8, with three relevés, represents *Alno glutinosae-Populetea albae*. *Salicetea purpureae* and *Alno glutinosae-Populetea albae* related to riparian habitats were separated into two different groups, since those belonging to the *Alno-Populetea albae* are rich in species related to drier environmental conditions. Finally, one relevé dominated by *Stuckenia pectinata* remains isolated in the diagram (Group 9). This relevé represents the only stand with submerged macrophytes sampled, due to the rarity of this vegetation type within the study area and, to a lesser extent, to accessibility difficulties.

The classification analysis revealed ten associations and ten communities not assigned to the formal rank. The identified vegetation units belong to twelve alliances, eleven orders, and ten phytosociological classes. The complete syntaxonomic scheme is presented in Table 1. A description of plant communities is provided below within the contexts of the highest syntaxonomic units (classes). It is associated with the name and the code of the corresponding habitat type, according to Annex I of the Habitat Directive92/43/EEC or Dafis *et al*. (2001).

The coordinates given for each relevés in the following tables are according to European Terrestrial Reference System (ETRS89).

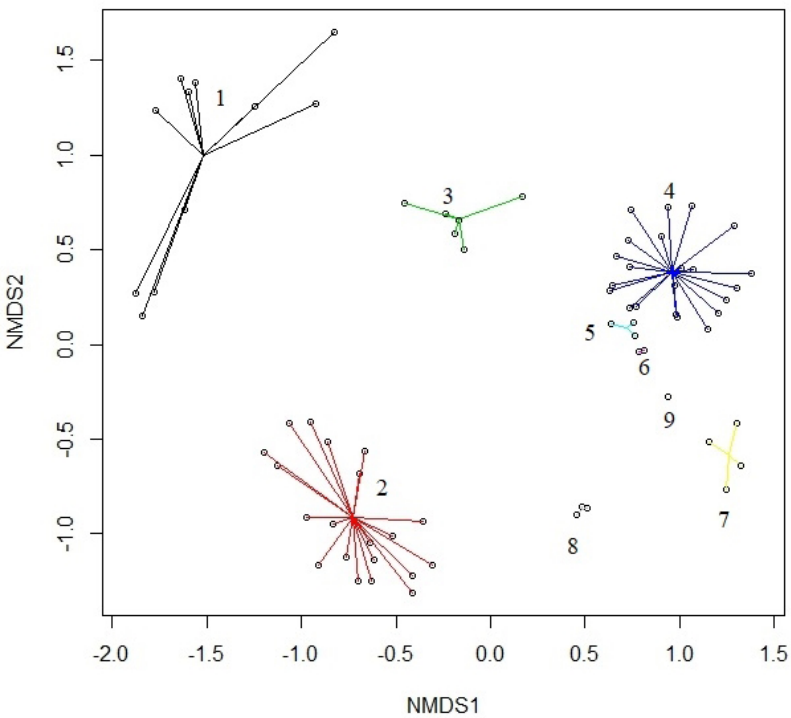

Figure 2. Non-metric multidimensional scaling (NMDS) using Bray-Curtis dissimilarity and ordispider function. In brackets the habitat type. Group 1: 11 rel. (5210, 4090, 8140); group 2: 20 rel. (91M0, 934A); group 3: 6 rel. (8210); group 4: 22 rel. (3150, 72A0, 72B0); group 5: 3 rel. (3150); group 6: 2 rel. (72A0); group 7: 4 (92A0); group 8: 3 rel. (92C0); group 9: 1 rel. (3150).

Quercetea pubescentis

Natura 2000 habitat type*:* 91M0 "Pannonian-Balkanic-turkey oak-sessile oak forests"

Degraded deciduous oak forests dominated mostly by *Quercus frainetto* were recorded in the upper-elevation section of the *Quercetalia pubescenti-petraeae* belt (Table 2, rel. 1–6). The floristic composition of these forests suggests the classification of this brushwood in the *Huetio cynapioidis-Quercetum frainetto* described by Bergmeier & Dimopoulos (2008). This vegetation type is differentiated by undergrowth of *Juniperus oxycedrus, Quercus coccifera*, *Q. pubescens* and other woody species resilient to browsing.

Table 2. *Huetio cynapioidis-Quercetum frainetto* (rel. 1–6), *Quercus pubescens* comm. (rel. 7), *Quercus coccifera* comm. (rel. 8–17). All relevés are part of group 2 (Figure 2).

Altitude (m asl)	670	640	626	648	633	770		906	644	524	500	860	900	634	948	654	530	805	
Exposure	282	240	40	240	20	145		230	50	52	256	203	167	267	75	297	177	245	
Plot size (m²)	200	200	200	200	200	200		200	200	200	200	200	200	200	200	200	200	200	
Slope (º)	20	15	35	15	30	30		40	3	35	35	40	10	5	20	10	30	65	
Total cover (%)	95	100	100	85	100	95		95	100	40	95	95	80	100	100	70	90	90	
Species N.	13	9	18	19	14	16		20	13	20	15	26	17	7	8	26	12	13	
Relevé N.	1	2	3	4	5	6		7	8	9	10	11	12	13	14	15	16	17	
Quercus frainetto	5	5	5	4	3	4	V	.	.	.	.	.	.	.	.	.	.	.	.
Quercus pubescens	.	.	.	3	3	2b	III	4	1	+	+	+	.	.	.	.	.	.	II
Quercus coccifera	3	1	2a	3	5	4	V	2b	4	3	5	5	4	5	5	4	4	5	V
Characteristics of *Carpino-Fagetea*																			
Brachypodium sylvaticum	1	1	1	2b	.	2a	V	+	2a	.	.	+	2a	.	2m	.	.	.	III
Hedera helix	3		2m	2a	+	.	IV	.	+	.	.	+	.	+	.	2b	+	.	III
Luzula forsteri	2m	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.
Aremonia agrimonoides	.	.	+	.	.	r	II	+	.	.	.	.	.	.	.	.	.	.	.
Melica uniflora	.	.	.	.	.	.	.	.	.	.	.	2m	.	.	.	.	.	.	I
Characteristics of *Quercetea pubescentis*																			
Ruscus aculeatus	1	2a	+	.	+	1	V	+	3	+	2a	1	r	2a	.	+	+	.	IV
Juniperus oxycedrus subsp. *deltoides*	+	.	1	.	.	1	III	+	.	.	.	+	.	.	.	.	+	3	I

Cornus mas	.	.	.	r	1	+	III	+	.	.	.	.	.	.	.	.	.	.	.
Acer monspessulanum	.	.	.	+	.	+	I	.	.	.	.	.	.	.	.	.	.	.	.
Cyclamen hederifolium	.	2m	+	.	.	.	I	.	+	.	.	.	.	+	.	.	.	.	I
Phillyrea latifolia	.	.	.	.	.	1	I	.	.	.	.	+	.	.	.	.	.	.	I
Helleborus odorus subsp. *cyclophyllus*	+	.	.	.	.	.	I	.	.	.	.	+	.	.	.	.	.	.	I
Fraxinus ornus	.	.	.	.	.	.	.	.	.	1	1	+	.	.	.	r	.	.	II
Colutea arborescens	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	I
Galium laconicum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carpinus orientalis	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	I
Hippocrepis emerus subsp. *emeroides*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	I
Pistacia terebinthus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	I
Characteristics of *Quercetea ilicis*																			
Asparagus acutifolius	+	.	.	+	+	.	III	+	+	2a	1	+	.	.	+	2a	+	.	III
Veronica chamaedrys	.	.	+	.	.	2m	II	2m	.	.	.	+	.	.	.	.	.	.	I
Asplenium onopteris	+	.	+	.	+	.	III	+	.	.	.	+	.	.	.	.	.	.	I
Clematis flammula	.	.	.	.	.	.	.	.	.	2a	.	.	.	.	.	.	.	.	I
Helictotrichon convolutum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	2b	I
Characteristics of *Ononido-Rosmarinetea*																			
Phlomis fruticosa	.	.	.	.	.	.	.	.	.	1	.	.	+		1	1	2b	.	III
Teucrium capitatum	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	+	I
Micromeria juliana	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	I
Cistus creticus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	I
Companions																			
Crataegus monogyna	.	+	.	.	+	.	II	.	+	.	+	.	+	.	.	+	.	.	III
Rosa sp.	+	+	.	+	1	2a	V	+	+	.	.	.	.	+	.	.	.	+	II
Pteridium aquilinum	+	.	+	.	+	+	IV	.	.	.	.	.	.	.	.	.	.	.	I
Trifolium ochroleucon	.	.	+	.	.	.	I	+	.	.	.	.	.	.	.	.	.	.	I
Potentilla micrantha	.	.	.	.	+	.	I	2m	.	.	.	.	.	.	.	.	.	.	I
Poa trivialis	.	.	.	.	+	.	I	+	.	.	.	.	.	.	.	.	.	.	I
Dioscorea communis	.	.	.	.	.	+	I	.	.	.		+	.	.	.	.	.	.	I
Vicia villosa	.	.	.	+	.	.	I	.	.	+	.	.	.	.	.	1	.	.	I
Geum urbanum	.	.	.	+	.	.	I	.	+	.	2m	.	.	.	.	.	.	.	I
Rubus sp.	.	.	.	.	1	1	II	.	.	2a	.	.	.	+	+	.	.	.	II
Asplenium trichomanes	.	.	+	.	.	.	I	.	.	.	.	+	.	.	.	.		+	I
Asplenium ceterach	.	.	+	.	.	.	I	.	.	.	+	+	.	.	.	.	+	+	II
Dactylis glomerata	.	.	+	+	.	.	II	.	.	2m	+	+	.	.	.	2m	.	.	II
Geranium robertianum	.	.	+	.	.	.	I	.	.	.	.	+	.	.	.	.	+	.	I
Achnatherum bromoides	.	1	.	.	.	.	I	+	.	.	.	.	.	.	.	.	.	.	I
Sanguisorba minor	.	.	.	+	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.
Euphorbia myrsinites	.	.	.	+	.	.	I	.	.	.	.	.	+	.	+	+	.	.	II
Campanula spatulata	.	.	.	.	.	.	.	2m	.	.	.	.	.	.	.	+	.	.	I
Clinopodium vulgare	.	.		.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	I
Silene italica	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	I
Digitalis laevigata subsp. *graeca*	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	I
Clematis vitalba	.	.	.	.	.	.	.	.	.	.	.	+	.	+	1	+	+	.	III
Eryngium campestre	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	+	.	.	I
Trifolium angustifolium	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	I
Geranium lucidum	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	1	.	.	I

Other species: *Prunus* sp.+ in 1; *Helleborus* sp. and *Dorycnium* sp. + in 3; *Carlina corymbosa*, *Daucus carota*, *Leontodon tuberosus*, *Trifolium* sp.+ in 4; *Sedum* sp. and *Lonicera* sp. + in 7; *Prospero autumnale* and *Crocus* sp. + in 8; *Hordeum bulbosum* 2a, *Sonchus oleraceus* r, *Acanthus spinosus, Opopanax hispidus*, *Digitalis laevigata* subsp. *graeca* + in 9; *Torilis leptophylla, Rhagadiolus stellatus* + in 10; *Melittis melissophyllum* subsp. *albida*, *Carex spicata*, *Lamium* sp. + in 11; *Convolvulus elegantissimus*, *Chrysopogon gryllus*, *Melica ciliata*, *Sternbergia* sp., *Colchicum* sp., *Crocus* sp. + in 12; *Sambucus ebulus* + in 14; *Geranium rotundifolium* and *Viola odorata* 2m, *Anisantha sterilis*, *Aetheorhiza bulbosa*, *Briza maxima* and *Johrenia distans* + in 15; *Galium* sp. and *Arum* sp. + in 16; *Saxifraga* sp., *Satureja montana* and *Luzula* sp. + in 17.

Localities: datum ETRS89 in all tables (see Figure 1). 1: 20.970572, 39.611305; 2: 20.960356, 39.600; 3: 20.968506, 39.609038; 4: 20.731244, 39.639984; 5: 20.773068, 39.71344; 6: 20.959945, 39.668481; 7: 20.829529, 39.736086; 8: 20.70736, 39.658708; 9: 20.782929, 39.71511; 10: 20.872664, 39.557658; 11: 20.829097, 39.737363; 12: 20.934137, 39.465041; 13: 20.903223, 39.498882; 14: 20.791595, 39.588699; 15: 20.915385, 39.628111; 16: 20.914847, 39.676297; 17: 20.793447, 39.755332.

Vegetation stands dominated by *Quercus pubescens* were also sporadically observed. Their floristic composition was characterised not only by the dominance of *Q. pubescens* in the tree layer, but also by the vigorous presence of *Quercus coccifera* in the shrub layer (Table 2, rel. 7). This fact reveals a gradual replacement of the *Quercus pubescens* community by a partly evergreen shrubland vegetation type (pseudomaquis). The *Quercus pubescens* forests are floristically related to the *Quercetea pubescenti*s.

Natura 2000 habitat type: 5210 "Mediterranean arborescent matorral with *Juniperus* spp."

Juniperus oxycedrus subsp. *deltoides* dominated stands are widely distributed in the west and south sides of Mt. Mitsikeli. This vegetation was diversified into two types: one growing on moderate elevations (500–800 m asl), characterised by the constant presence of *Quercus coccifera* (Table 3, rel. 1–2) and another one ascending to higher elevations (1200–1270 m), represented by monospecific formations of *Juniperus oxycedrus* subsp. *deltoides* rich in species of the classes *Festuco-Brometea* and *Daphno-Festucetea* (Table 2, rel. 3–6). The *Juniperus oxycedrus*-*Quercus coccifera* stands were poor in species of the *Quercetea pubescentis* and are very weakly related to this class. However, it is widely accepted that the *Juniperus oxycedrus*-*Quercus coccifera* community, frequently reported from Greece (Raus, 1980; Karagiannakidou-Iatropoulou, 1983; Bergmeier, 1990; Chasapis *et al*., 2004; Fotiadis, 2004), belongs to the order *Quercetalia pubescenti-petraeae*, even though the presence of character species of the abovementioned syntaxa is often very limited.

Table 3. *Juniperus oxycedrus* subsp. *deltoides* comm. (rel. 1–6), *Astragalus angustifolius* comm. (rel. 7–11).

Altitude (m asl)	810	635	491	1270	1200	1220		1656	1678	1560	1500	1451	
Exposure	190	205	175	103	234	245		350	220	285	193	205	
Plot size (m²)	50	50	50	50	50	50		16	16	16	16	16	
Slope (º)	20	15	45	30	25	30		10	30	40	20	45	
Total cover (%)	60	70	70	60	60	70		90	85	100	80	100	
Species N.	18	15	17	27	30	31		20	18	20	22	18	
Group (Figure 2)	2	2	2	1	1	1		1	1	1	1	1	
Relevé N.	1	2	3	4	5	6		7	8	9	10	11	
Juniperus oxycedrus subsp. *deltoides*	3	4	4	4	4	4	V	.	.	.	.	+	I
Astragalus angustifolius s.l.	.	.	.	.	.	.	.	3	3	4	3	2a	V
Festuca varia s.l.	.	.	.	.	.	.	.	3	3	3	2b	2b	V
Characteristics of *Quercetea ilicis*													
Quercus coccifera	2b	2b	.	.	.	.	III	.	.	.	.	.	
Asparagus acutifolius	+	+	2a	.	.	.	III	.	.	.	.	.	.
Helictotrichon convolutum	.	2a	.	1	.	2a	III	.	.	.	.	.	.
Characteristics of *Quercetea pubescentis*													
Fraxinus ornus	.	+	.	.	.	.	I	.	.	.	.	.	.
Galium laconicum	.	.	.	.	.	.	.	.	.	+	.	.	I
Helleborus odorus subsp. *cyclophyllus*	.	.	.	+	+	+	III	.	.	.	.	.	.
Celtis australis	.	.	1	.	.	.	I	.	.	.	.	.	.
Characteristics of *Ononido-Rosmarinetea*													
Phlomis fruticosa	2a	1	1	+	+	1	V	.	.	.	.	.	.
Characteristics of *Daphno-Fetucetea*													
Rosa pulverulenta	.	.	.	+	1	+	III	.	.	.	.	.	.
Poa thessala	.	.	.	.	.	.	.	.	.	+	.	.	I
Thymus longicaulis	.	.	.	2a	+	.	II	2a	2b	+	.	2a	IV
Campanula spatulata	+	.	.	+	.	.	II	.	.	+	.	.	I
Characteristics of *Drypidetea spinosae*													
Euphorbia myrsinites	+	+	.	+	+	+	V	+	+	+	1	+	V
Characteristics of *Festuco-Brometea*													
Eryngium amethystinum	.	.	.	1	+	+	III	2a	1	2a	1	+	V
Melica ciliata	.	+	+	2a	1	+	V	.	.	.	.	.	.
Minuartia verna	.	.	.	.	.	.	.	+	1	+	+	.	IV
Alyssum montanum	.	.	.	.	.	.	.	+	+	.	.	.	II
Sanguisorba minor	.	.	.	2m	+	+	III	.	.	.	.	+	I
Satureja montana	.	.	.	1	1	2a	III	.	.	.	+	1	II
Teucrium chamaedrys	.	.	.	.	2a	1	II	+	.	.	.	1	II
Anthyllis vulneraria	.	.	.	.	2m	2m	II	.	.	.	.	.	.
Brachypodium pinnatum	.	.	.	+	2m	2m	III	.	.	.	.	.	.

Chrysopogon gryllus	1	.	.		.	.	I	.	.	.	.	.	.
Draba lasiocarpa	.	.	.	.	.	.	.	.	+	.	.	.	I
Herniaria incana	.	.	.	.	.	.	.	.	.	.	+	.	I
Muscari neglectum	.	.	.	.	.	.	.	.	.	.	+	.	I
Stipa pulcherrima	1	.	.	.	+	+	III	.	.	.	r	+	II
Achnatherum bromoides	2m	+	.	.	.	.	II	.	.	.	.	.	.
Companions													
Dactylis glomerata	+	.	+	.	+	.	III	.	.	.	.	.	.
Teucrium capitatum	.	.	+	+	.	+	III	.	.	.	.	.	.
Trifolium campestre	+	.	+	.	+	.	III	.	.	.	.	.	.
Lotus corniculatus	.	.	.	.	.	.	.	+	.	1	.	.	II
Scabiosa tenuis	.	.	.	+	.	+	II	.	.	.	.	.	.
Medicago lupulina	.	.	.	+	+		II	.	.	.	.	.	.
Hypericum rumeliacum	.	.	.	+	.	+	II	.	.	.	.	.	.
Minuartia attica	.	+	.	+	.	+	III	.	.	.	.	.	.
Prunus cocomilia	.	.	.	+	+	+	III	.	.	.	.	.	.
Leontodon crispus	.	.	.	+	+	+	III	.	.	.	.	.	.
Silene viridiflora	.	.	.	+	.		I	.	.	.	.	1	I
Orlaya daucoides	2m			+	.	+	III	.	.	.	.	.	.
Phleum pratense	.	.	.	+	.	+	II	.	.	.	.	.	.
Crucianella sp.	.	.	.	+	.	+	II	.	.	.	.	.	.
Petrorhagia saxifraga	.	.	.	.	+	+	II	.	.	.	.	.	.
Eryngium campestre	.	.	.	.	+	+	II	.	.	.	.	.	.
Trifolium angustifolium	+	+	.	.	+	.	III	.	.	.	.	.	.
Trifolium scabrum	2m	+	.	.	.	+	III	.	.	.	.	.	.
Bupleurum flavum	2m	+	.	.	.	.	II	.	.	.	.	.	.
Sedum urvillei	.	.	.	.	.	.	.	1	+	+	2m	.	IV
Acinos alpinus	.	.	.	.	.	.	.	2a	.	+	.	+	III
Anthemis arvensis	.	.	.	.	.	.	.	+	+	+	.	.	III
Sedum rubens	.	.	.	.	.	.	.	+	+	.	2m	.	III
Trisetum flavescens	.	.	.	.	.	.	.	+	+	.	.	2b	III
Centaurea lacerata	.	.	.	.	.	.	.	+	+	1	1	.	IV
Filago germanica	.	.	.	.	.	.	.	.	+	+	.	.	II
Scandix australis	.	.	.	.	.	.	.	.	+	.	+	.	II
Cruciata laevipes	.	.	.	.	.	.	.	.	+	2m	.	.	II
Cerastium glomeratum	.	.	.	.	.	.	.	.	+	+	.	.	II
Crepis neglecta	.	.	.	.	.	.	.	.	.	+	2m	.	II

Other species: *Stachys germanica, Xeranthemum* sp. + in 1; *Carex* sp. + in 2; *Aurinia saxatilis* subsp. *orientalis* 2m, *Bromus sterilis* 2a, *Bellardia trixago*, *Briza maxima*, *Euphorbia peplus* r, *Geranium robertianum, Knautia integrifolia* +, in 3; *Dasypyrum villosum* 2m, *Clematis vitalba*, *Helianthemum salicifolium* + in 4; *Ajuga chamaepitys*, *Catapodium rigidum*, *Phleum* sp., *Sideritis montana*, *Sedum amplexicaule* subsp. *tenuifolium*, *Trifolium stellatum* + in 5; *Cynosurus effusus*, *Dianthus* sp., *Pulicaria* sp., *Sideritis raeseri* + in 6; *Armeria canescens*, *Asperula aristata*, *Plantago argentea*, *Galium verum*, *Trifolium physodes* + in 7; *Centaurea epirota* + in 8; *Cuscuta* sp., *Trifolium arvense* + in 9; *Allium flavum*, *Arabis glabra*, *Galium setaceum* subsp. *decaisne*, *Petrorhagia prolifera*, *Veronica arvensis*, *Verbascum* sp. +, *Poa bulbosa* 2m, in 10; *Rosa* sp. +, *Sedum acre* 2m in 11.

Localities: datum ETRS89 (see Figure 1). 1: 20.937622, 39.675924; 2: 20.791277, 39.751862; 3: 20.888735, 39.680758; 4: 20.893531, 39.709219; 5: 20.893006, 39.704817; 6: 20.895624, 39.700726; 7: 20.897522, 39.717265; 8: 20.89617, 39.716965; 9: 20.888665, 39.721972; 10: 20.887756, 39.718452; 11: 20.927276, 39.700612.

Although the *Juniperus oxycedrus* subsp. *deltoides* monodominant community is scarcely studied, Horvat *et al*. (1974) mention its secondary nature, while Davies *et al*. (2004) note that it mostly results from the degradation of broad-leaved evergreen or thermophilous deciduous forests. If we adopt the notion that a thermophilous deciduous forest of the alliance *Quercion confertae* preexisted in the study area in the sites nowadays colonized by the *Juniperus oxycedrus* subsp. *deltoides stands*, as often asserted in the literature for such communities (Horvat *et al*., 1974; Raus, 1980; Karagiannakidou-Iatropoulou, 1983; Bergmeier, 1990), we can include these stands in the *Quercion confertae* alliance.

Quercetea ilicis

Habitat type of national interest: 934A "Greek *Quercus coccifera* woods"

Quercus coccifera shrublands expand in the lower part of *Quercetalia pubescenti-petraeae* belt. The height of *Q. coccifera* individuals was in most cases not more than five meters (average height: 4.5 m). In dense stands, *Asparagus acutifolius* was the only characteristic species of the *Quercetea ilicis* (Table 2, rel. 8–17). Species of the *Quercetea pubescentis* recorded in a great number of the sample plots, separate the community into a semi-deciduous and an evergreen variant. This affirms previous reports that *Q. coccifera* shrublands in Greece and other adjacent Mediterranean regions are frequently associated with thermophillous deciduous trees such as *Quercus pubescens* and *Fraxinus ornus* (Raus, 1980; Bergmeier, 1990; Jasprica *et al*., 2015).

Vegetation types of the alliance *Arbuto andrachnes-Quercion cocciferae* recently reported from the Marmara region and the Aegean coast of Turkey (Bergmeier *et al*., 2018) resemble either the semi-evergreen (Table 2, rel. 8–13) or the evergreen variant (Table 2, rel. 14–17) of *Quercus coccifera* community spreading in the study area. We think both the abovementioned variants possibly belong to the alliance *Arbuto andrachnes-Quercion cocciferae* in which the evergreen mesic kermes oak forests of the Eastern Mediterranean are included. More information concerning *Quercus coccifera* communities across the Mediterranean region can be found in Tsiourlis *et al*. (2009) and Jasprica *et al*. (2016).

Daphno-Festucetea

Natura 2000 habitat type: 4090 "Endemic oro-Mediterranean heaths with gorse"

Astragalus angustifolius-dominated stands were found on Mt. Mitsikeli at or above tree line, spanning an elevation range 1450–1700 m asl (Table 3, rel. 7–11). A taxon belonging to the *Festuca varia* (sensu lato) group was constantly and abundantly present in these stands. *Festuca varia* s.l. is a complex taxonomically group, perhaps in a need of revision (Strid & Kit Tan, 1991) since all the characters used to describe the microspecies distinguished by Markgraf-Dannenberg (1976, 1980) show a wide overlapping (Strid & Kit Tan, 1991; Strid 2016). Mucina *et al*. (2016) consider that this group, which is reported to occur in Greece (Strid & Kit Tan, 1991), is represented in the *Daphno-Festucetea* communities most probably (and in most cases) by the species *Festuca cyllenica*, while less frequently the species *F. graeca*, *F. penzesii* and *F. kozanensis* might also occur. The material collected from the investigated sample plots was identified as *Festuca* cf. *cyllenica*, which is also in accordance with the two species of the group (*F. cyllenica*, *F. graeca*) reported from the area (Dimopoulos *et al*., 2013). This vegetation type is already reported from Mt. Mitsikeli under the name *Astragalus angustifolius* community (Gerasimidis & Korakis, 2006), which potentially belongs to the *Fagetalia* belt and has probably replaced degraded *Fagu*s or *Abies* forests. Since Mt. Mitsikeli consists mainly of limestone (Papadopoulou-Vrynioti *et al*., 2015), we consider the *Astragalus angustifolius* stands as an expression of the alliance *Astragalo angustifolii-Seslerion coerulantis*, which spreads on calcareous substrates (Mucina *et al*., 2016).

Asplenietea trichomanis

Natura 2000 habitat type: 8210 "Calcareous rocky slopes with chasmophytic vegetation"

A floristically homogenous vegetation unit that occurs on middle and upper slopes of cliffs between 600-1400 m asl is described here for the first time as the new association *Asplenio ceterach-Aurinietum saxatilae ass. nova hoc loco* (Table 3, rel. 1–7, *holotypus*: rel. 2; characteristic taxa: *Asplenium ceterach* and *Aurinia saxatilis* subsp. *orientalis*). It is a thermo-mesomediterranean chasmophytic vegetation type that develops sparsely on limestone rock crevices. The diagnostic taxa of this association, grow on slopes with an inclination between 70° and 90°, covering only a small percentage of the investigated sample plot surface (>5–25%). In the seven sample plots selected as representative of this vegetation type, 39 taxa were found, while the average number of taxa per sample was 11. Diagnostic taxa of the association are: *Asplenium ceterach*, *Aurinia saxatilis* subsp. *orientalis*, *Centranthus ruber* subsp. *sibthorpii*, *Campanula versicolor*, *Sedum dasyphyllum* subsp. *dasyphyllum* and *Sedum hispanicum*. Although some diagnostic taxa of this association had higher coverage percentage than that of *Asplenium ceterach* and *Aurinia saxatilis*, the last two were chosen as nominal taxa since they were consistently present in all the investigated stands.

The chasmophytic vegetation of limestone cliffs that occurs at low to moderate elevations (up to 1500 m asl), belongs to the order *Onosmetalia frutescentis* (Dimopoulos *et al*., 1997; Mucina *et al*., 2016), which is represented in Greece by the alliance *Campanulion versicoloris*.

Drypidetea spinosae

Natura 2000 habitat type: 8140 "Eastern Mediterranean screes"

The communities of montane limestone scree habitats in Greece are well separated from the rock-cliff *Asplenietea trichomanis* vegetation and are classified into the order *Drypitetalia spinosae*, which is characterised by the predominance of Balkan chorotypes (Dimopoulos *et al*., 1997). A community dominated by *Drypis spinosa* was found on Mt. Mitsikeli. Apart from *Drypis spinosa,* no other species of the *Drypidetea spinosae* was present in our relevés (Table 4, rel. 8–9). The *Silenion caesiae* is the most widespread alliance of the order *Drypidetalia spinosae* in Greece, comprising calcareous scree communities which are distributed all over the mountain ranges of mainland (Dimopoulos *et al*., 1997).

Table 4. *Asplenio ceterach-Aurinietum saxatilae ass. nova* (rel. 1–7), *Drypis spinosa comm.* (rel. 8–9).

Altitude (m asl)	591	465	620	476	811	489	1376		1287	1323	
Exposure	39	160	167	18	120	210	172		186	275	
Plot size (m²)	25	25	25	25	25	25	25		50	50	
Slope (º)	85	80	90	90	70	80	90		30	45	
Total cover (%)	20	50	25	30	40	20	10		15	10	
Group (Figure 2)	3	3	3	3	3	3	1		1	1	
Species N.	8	11	11	9	13	9	16		11	11	
Relevé N.	1	2	3	4	5	6	7		8	9	
Asplenium ceterach	1	+	+	+	2b	1	r	V	.	.	.
Aurinia saxatilis subsp. *orientalis*	1	2a	+	1	+	r	.	V	.	.	.
Drypis spinosa									2a	1	V
Characteristics of *Asplenietea trichomanis*											
Centranthus ruber subsp. *sibthorpii*	r	2a	2a	.	.	.	.	II	.	.	.
Campanula versicolor	.	.	1	2a	+	.	1	III	.	.	.
Sedum dasyphyllum		2a	+	+	.	.	.	III	.	.	.
Sedum hispanicum		1	.	+	2m	1	.	III	.	.	.
Characteristics of *Drypidetea spinosae*											
Euphorbia myrsinites	+	+	r	.	+	+	.	IV	.	.	.
Characteristics of *Festuco-Brometea*											
Satureja montana	.	.	.	.	+	.	2a	II	.	+	III
Teucrium chamaedrys	.	.	.	.	.	.	.	.	1	+	V
Sanguisorba minor	.	.	.	.	.	.	.	.	.	+	III
Draba lasiocarpa	.	.	.	.	.	.	r	I	.	.	.
Melica ciliata	.	.	+	.	.	.	.	I	+	+	V
Hypericum rumeliacum	.	.	r	.	.	.	.	I	.	.	.
Characteristics of *Daphno-Festucetea*											
Cerastium candidissimum	+	.	.	.	.	.	.	I	.	.	.
Carum graecum	.	.	+	.	.	.	.	I	.	.	.
Carduus tmoleus	.	.	.	.	.	.	.	.	r	.	III
Minuartia attica	.	.	.	.	.	.	r	I	.	.	.
Astragalus angustifolius	.	.	.	.	.	.	.	.	.	+	III
Companions											
Micromeria juliana	1	1	.	.	2a	r	+	IV	.	.	.
Sedum acre	1	.	.	.	1	.	+	III	.	.	.
Scrophularia heterophylla	1	.	.	+	1	.	.	III	.	.	.
Sedum album	.	.	.	+	1		.	II	.	.	.
Umbilicus rupestris	.	+	.	+		+	.	III	.	.	.
Parietaria judaica		+	.	.	.	+	.	II	.	.	.
Sedum rubens	.	.	.	.	.	1	.	I	+	+	V
Galium sp.	.	.	.	.	.	.	+	I	+	.	III
Achillea holosericea	.	.	.	.	.	.	r	I	.	r	III
Convolvulus arvensis	.	.	.	.	+	.	.	I	1	.	III

Other taxa: *Verbascum* sp., *Minuartia* sp. + in 2; *Sedum sediforme* +, *Silene* sp. 2a in 3; *Dryopteris* sp. + in 4; *Petrorhagia saxifraga* +, *Trisetum flavescens* + in 5; *Ephedra foeminea* 1 in 6; *Melica minuta* +, *Poa bulbosa* r, *Silene viridiflora* +, *Helictotrichon convolutum* 1, *Leontodon hispidus* +, *Malcolmia* sp.+, *Asyneuma limonifolium* subsp. *limonifolium* r in 7; *Malcolmia orsiniana* +, *Nepeta spruneri* +, *Leontodon crispus* +, *Crepis dioscoridis* + in 8; *Centaurea lacerata* +, *Bromus/Anisantha* sp. +, *Festuca* cf. *cyllenica* + in 9.

Localities: datum ETRS89 (see Figure 1). 1: 20.919176, 39.625156; 2: 20.904675, 39.678073, *holotypus ass.*; 3: 20.823831, 39.728239; 4: 20.913442, 39.640364; 5: 20.797934, 39.756273; 6: 20.873563, 39.677381; 7: 20.886658, 39.716563; 8: 20.894727, 39.709537; 9: 20.924979, 39.698316.

Salicetea purpureae

Natura 2000 habitat type: 92A0 "*Salix alba* and *Populus alba* galleries"

Associations dominated by the arborescent species *Salix alba* and *S. fragilis* are elements of the riverine vegetation in Greece (Zaimes *et al*., 2010). However, the distribution of *S. fragilis* in Greece is not fully known because it is often confused with *S. rubens*, probably a hybrid of *S. alba* and *S. fragilis* (Dimopoulos *et al*., 2013). In all the willow stands sampled, two *Salix* species were co-dominant. Observing the texture of buds, as well as the morphology and texture (glabrous or sericeous) of young and mature leaves in the field, we were able to distinguish the species *S. alba* and *S. fragilis*. The association *Salicetum albo-fragilis* is the unique representative of the alliance *Salicion albae* (Table 5, rel. 1–4). There are few records of this vegetation type in Greece up to present (Georgiadis *et al*., 1997; Karagianni *et al*., 2008; Sarika *et al*., 2018).

Table 5. *Salicetum albo-fragilis* (rel. 1–4), *Platanus orientalis-Juglans regia* comm. (rel. 5–7).

Altitude (m asl)	460	469	470	462		470	585	527	
Plot size (m^2)	200	200	200	200		200	200	200	
Total cover (%)	85	100	90	100		100	100	80	
Group (Figure 2)	7	7	7	7		8	8	8	
Species N.	19	18	18	16		13	17	16	
Relevé N.	1	2	3	4		5	6	7	
Salix alba	3	2a	3	2b	V	.	.	.	.
Salix fragilis	2b	4	3	3	V	.	.	.	.
Platanus orientalis	.	.	.	.	.	5	5	5	V
Juglans regia	.	.	+	2a	III	1	2a	2a	V
Characteristics of *Alno glutinosae-Populetea albae*									
Galium aparine	2a	+	+	.	IV	.	.	+	II
Populus alba	1	.	.	.	II	.	.	.	.
Sambucus nigra	.	1	1	2a	IV	1	.	.	II
Humulus lupulus	.	2a	2b	.	III	.	.	.	.
Clematis vitalba	.	1	.	.	II	.	1	.	II
Rubus caesius	.	.	2a	1	III	.	.	.	.
Melissa officinalis subsp. *altissima*	.	.	.	.	.	.	+	2a	IV
Hedera helix	.	.	.	.	.	4	2b	2b	V
Characteristics of *Epilobietea angustifolii*									
Urtica dioica	3	+	3	2m	V	.	+	.	II
Calystegia sepium	+	2m	.	+	IV	.	.	.	.
Sambucus ebulus	.	2m	2m	.	III	.	.	.	.
Epilobium hirsutum	.	+	.	.	II	.	.	.	.
Conium maculatum	.	.	.	2m	II	.	.	.	.
Geum urbanum	.	.	.	.		.	+	+	IV
Characteristics of *Crataego-Prunetea*									
Prunus cocomilia	1	2a	1	.	IV	.	.	.	.
Corylus avellana	.	.	+	.	II	r	r	r	V
Rubus sp.	.	.	.	.	.	1	1	3	V
Cornus sanguinea subsp. *australis*	.	.	.	3	II	.	.	.	.
Crataegus monogyna	.	.	.	.	.	+	.	+	IV
Characteristics of *Phragmito-Magnocaricetea*									
Phragmites australis	+	.	2a	.	III	.	.	.	.
Iris pseudacorus	.	.	.	+	II	.	.	.	.
Cicuta virosa	r	.	.	.	II	.	.	.	.
Lycopus europaeus	.	+	.	.	II	.	.	.	.
Helosciadium nodiflorum	.	.	.	2m	II	.	.	.	.
Equisetum fluviatile	.	.	+	.	II	.	.	.	.
Characteristics of *Quercetea pubescentis*									
Cornus mas	.	.	1	.	II	.	.	.	.
Ruscus aculeatus	.	.	.	.	.	2b	+	.	IV
Helleborus odorus subsp. *cyclophyllus*	.	.	.	.	.	.	r	+	IV
Clinopodium vulgare	.	.	.	.	.	.	.	+	II
Celtis australis	.	.	.	1	II	.	.	+	II
Companions									
Anisantha sterilis	2a	.	2m	.	III	.	.	.	.
Dactylis glomerata	+	.	.	.	II	.	.	+	II
Brachypodium sylvaticum	.	.	.	.	.	r	+	+	V

Other species: *Malva* sp. +, *Ailanthus altissima* 1, *Carduus pycnocephalus* r, *Rumex conglomerates* 1, *Alyssum* sp. 1, *Avena barbata* +, *Sonchus oleraceus* r, *Poa trivialis* + in 1; *Persicaria lapathifolia* subsp. *lapathifolia* +, *Equisetum palustre* +, *Holcus lanatus* subsp. *lanatus* +, *Veronica arvensis* +, *Xanthiun strumarium* r in 2; *Rumex palustris*, *Helianthus laetiflorus*, *Mentha* sp. 2m in 3; *Geranium dissectum* +, *Galium* sp. 2m, *Silybum marianum* r in 4; *Ulmus* sp. r, *Arum* sp.+, *Quercus* sp. r, *Orobanche* sp. r in 5; *Ficus carica* r, *Castanea sativa* +, *Melica minuta* +, *Polystichum setiferum* +, *Equisetum ramosissimum* r in 6; *Prunella vulgaris* +, *Juncus inflexus* + in 7.

Localities: datum ETRS89 (see Figure 1). 1: 20.872771, 39.684849; 2: 20.91734, 39.649755; 3: 20.906728, 39.640693; 4: 20.775198, 39.742994; 5: 20.938559, 39.656943; 6: 20.966583, 39.610114; 7: 20.958691, 39.61247.

Alno glutinosae-Populetea albae
Natura 2000 habitat type: 92C0 “Oriental plane woods (*Platanion orientalis*)”

Platanus orientalis-dominated stands occur throughout the ravines and streams of Ioannina basin. They are frequently highly disturbed by human activities such as waste disposal, water drilling, and streamflow regulation. Besides the dominant *P. orientalis*, *Junglans regia* was significantly present in the tree layer (Table 5, rel. 5–7). Karetsos (2002) cites similar *Platanus orientalis*-*Junglans regia* community, annotating that it resembles the *Junglando-Platanetum orientalis typicum*, which is mentioned by Horvat *et al*. (1974) from the former Yugoslavia. Later on, Fotiadis (2004) records similar *Platanus orientalis*-*Junglans regia* combinations from the mountains Beles and Krusia, which he attributes to the *Junglando*-*Platanetum orientalis*, highlighting the intense anthropogenic pressure that this association suffers. The stands reported by Karetsos (2002) and Fotiadis (2004) and those found by us have several species in common with the *Junglando-Platanetum orientalis* typicum and probably represent a local form of it. However, due to the significant geographic distance between Greece and the former Yugoslavian regions and the lack of intermediate sampling stations, we adopt Karetsos’ approach (2002) that all the representatives of this vegetation type in Greece must be registered as a simple community.

Potamogetonetea
Natura 2000 habitat type: 3150 “Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition*-type vegetation”

The macrophyte vegetation of the *Potamogetonetea* class that is linked to freshwater aquatic and wetland habitats of Ioannina basin has been thoroughly studied in the past (Sarika-Hatzinikolaou *et al.*, 2003). Field observations within the framework of the present study verified that most of the communities of this class recorded in the past are still present in the study area, although their distribution and abundance have been significantly reduced. Furthermore, Stephanides & Papastergiadou (2007) mention that species composition and distribution pattern of the submerged and floating-leaf vegetation have been considerably altered in Lake Pamvotis during the last decades. Some communities of the abovementioned class already known from the area were recorded anew and are cited in the present study (Table 6, rel. 1–7).

Table 6. *Nymphoidetum peltatae* (rel. 1–3), *Nymphaeetum albo-lutae* (rel. 4–5), *Nymphaeetum minoris* (rel. 6), *Stuckenia pectinata* comm. (rel. 7).

Altitude (m asl)	463	463	456		463	459		460	463
Plot size (m^2)	16	16	4		10	15		4	4
Total cover (%)	80	80	70		85	90		90	80
Group (Figure 2)	5	5	5		4	4		4	9
Species N.	1	3	3		2	4		3	4
Relevé N.	1	2	3		4	5		6	7
Nymphoides peltata	5	4	3	V	.	.	.	.	.
Nuphar lutea	.	.	.	.	5	5	V	.	.
Nymphaea alba	.	.	.	.	.	r	III	5	.
Stuckenia pectinata	.	.	.	.	.	.	.	.	5
Characteristics of *Potamogetonetea*									
Myriophyllum spicatum	.	.	.	.	.	.	.	.	2a
Potamogeton crispus	.	.	.	.	.	.	.	.	+
Character taxa of *Lemnetea*									
Ceratophyllum demersum	.	.	.		.	.		.	2m
Spirodela polyrhiza	.	2m	.	II	.	.		.	.
Characteristics of *Phragmito-Magnocaricetea*									
Phragmites australis	.	.	+	II	r	r	V	.	
Sparganium erectum	.	.	.	.	.	r	III	.	
Veronica beccabunga	.	2m	.	II	.	.	.	+	
Eleocharis palustris	.	+	.	II	.	.	.	.	
Mentha aquatica	.	.	r	II	.	.		.	.
Typha angustifolia	.	.	.	.	.	.	.	+	

Other species: *Cyperus capitatus* + in 2; *Paspalum distichum* + in 7.
Localities: datum ETRS89 (see Figure 1). 1: 20.915717, 39.673759; 2: 20.92749, 39.667274; 3: 20.872042, 39.648182; 4: 20.873575, 39.684459; 5: 20.77357, 39.749132; 6: 20.85913, 39.562386; 7: 20.860358, 39.687969.

Phragmito-Magnocaricetea
Habitat type of national interest: 72A0 “Reed thickets”

All previously reported reed-bed communities of the *Phragmito-Magnocaricetea* (Sarika-Hatzinikolaou *et al.*, 2003) are still present in the study area. Some of them were recorded anew (Table 7, rel. 1–8, 11–15), while the *Bolboschoenus maritimus* community (Table 7, rel. 9–10) and the association *Eleocharito palustris-Alismatetum lanceolati* (Table 8, rel. 5–6) were documented for the first time.

Table 7. *Phragmitetum communis* (rel. 1–8), *Bolboschoenus maritimus* comm. (rel. 9–10), *Typhetum angustifoliae* (rel. 11–14), *Scirpetum lacustris* (rel. 15).

									C1			C2					C3	
Altitude (m asl)	465	465	465	465	465	465	468	465		465	465		462	465	465	443		472
Plot size (m²)	16	16	16	16	16	16	16	16		16	16		16	16	16	16		16
Total cover (%)	100	100	100	100	100	100	90	100		100	100		100	90	90	100		80
Group (Figure2)	4	4	4	4	4	4	4	4		4	4		4	4	4	4		4
Species N.	9	14	4	4	2	12	1	10		4	14		8	3	6	9		6
Relevé N.	1	2	3	4	5	6	7	8		9	10		11	12	13	14		15
Phragmites australis	5	3	5	5	5	5	5	5	V	.	.		.	.	r	1	III	.
Bolboschoenus maritimus	.	.	.	.	.	.	.	2m	I	5	2b	V	2b	.	.	.	II	.
Typha angustifolia	.	.	.	.	.	+	.	.	.	.	1	III	5	5	4	5	V	1
Schoenoplectus lacustris	.	2m	.	.	.	.	.	.	I	.	.	.	.	.	.	+	II	5
Characteristics of *Epilobietea angustifolii*																		
Epilobium hirsutum	1	1	1	.	.	.	.	.	II	.	1	III	.	.	1	.	II	.
Calystegia sepium	2m	.	.	2m	.	+	.	2a	III	.	2m	III	+	.	+	+	IV	.
Pulicaria dysenterica	.	r	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.
Urtica dioica	.	.	.	.	.	+	.	.	I	.	.	.	r	.	.	.	II	.
Characteristics of *Phragmito-Magnocaricetea*																		
Mentha aquatica	.	2a	.	.	.	r	.	2b	II	.	3	III	r	.	+	1	IV	.
Butomus umbellatus	.	r	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.
Alisma plantago-aquatica	+	r	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.
Typha domingensis	.	2m	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.
Sparganium erectum	.	2m	.	.	r	.	.	.	II	.	1	III	.	.	1	+	III	.
Lycopus europaeus	.	+	.	.	.	.	.	+	II		+	III	.	.	.	.	.	2m
Eleocharis palustris	.	r	.	.	.	.	.	.	I	2a	.	III	.	.	.	.	.	.
Solanum dulcamara	.	.	2a	1	.	.	.	.	II	.	.	.	.	+	.	.	II	.
Cicuta virosa	.	.	2a	1	.	.	.	.	II	.	.	.	.	.	.	.	.	.
Iris pseudacorus	.	.	.	.	.	2m	.	.	I	.	.	.	r	.	.	.	II	.
Cyperus longus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	II	1
Veronica beccabunga	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	II	.
Lythrum salicaria	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	II	.
Alisma lanceolatum	.	.	.	.	.	.	.	.	.	r	1	V	.	.	.	.	.	r
Galium elongatum	.	.	.	.	.	.	.	1	I	.	r	III	.	.	.	.	.	.
Characteristics of *Molinio-Arrhenatheretea*																		
Stachys palustris	2m	.	.	.	.	.	.	.	I	.	.		.	+	.	.	II	.
Carex otrubae	r	.	.	.	.	.	.	r	II	.	3	III	.	.	.	.	.	.
Rumex conglomeratus	.	1	.	.	.	.	.	1	II	.	+	III	.	.	.	.	.	.
Rorippa sylvestris	.	+	.	.	.	.	.	1	II	.	1	III	.	.	.	.	.	.
Poa trivialis	.	+	.	.	.	+	.	.	II	.	r	III	.	.	.	.	.	.
Galium debile	.	.	.	.	.	2m	.	.	I	.	.	.	.	.	.	.	.	.
Verbena officinalis	.	.	.	.	.	r	.	.	I	.	.	.	.	.	.	.	.	.
Oenanthe fistulosa	.	.	.	.	.	.	.	1	.	.	1	III	.	.	.	.	.	.
Carex hirta	.	.	.	.	.	.	.	.	.	+	.	III	.	.	.	.	.	.
Juncus inflexus	.	.	.	.	.	.	.	.	.	.	+	III	.	.	.	.	.	.
Scirpoides holoschoenus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	II	.
Companions																		
Lemna trisulca	2a	.	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.
Riccia fluitans	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1

Other species: *Hydrocharis morsus-ranae* + in 1; *Cirsium vulgare* r, *Vinca major*, *Nuphar lutea* + in 6; *Ranunculus marginatus* + in 7; *Lemna minor* 2m in 15.

Localities: datum ETRS89 (see Figure 1). 1: 20.852225, 39.69; 2: 20.873713, 39.684704; 3: 20.873619, 39.684519; 4: 20.87229, 39.678724; 5: 20.884722, 39.680556; 6: 20.889651, 39.6796; 7: 20.773428, 39.75021; 8: 20.90491, 39.643612; 9: 20.879148, 39.640993; 10: 20.904767, 39.643529; 11: 20.926709, 39.664354; 12: 20.859281, 39.688189; 13: 20.878988, 39.64172; 14: 20.872096, 39.648062; 15: 20.859618, 39.593523.

The *Bolboschoenus*-dominated vegetation, mainly reported from coastal regions of Europe, also occurs in a variety of inland freshwater and saline habitats (Hroudová *et al*., 2009). Although *Bolboschoenus maritimus* communities are rather frequent in coastal saline ecosystems of Greece (Wolff, 1968; Gradstein & Smittenberg, 1977; Babalonas, 1979; Georgiadis *et al*., 1990; Karagianni *et al*., 2008; Sarika, 2012), up to date few records from inland freshwater wetlands exist (Zotos, 2006; Dimopoulos *et al*., 2005; Pirini *et al*., 2011).

Almost monospecific *Alisma lanceolatum* stands were found in the south-central region of Ioannina basin, in a seasonally flooded depression. Hrivnák *et al*. (2015) report that communities dominated by *Alisma lanceolatum* are relatively poorly documented in Central Europe and that their appearance is directly correlated to the water level fluctuation during a given year, an opinion which is also adopted here. *Alisma lanceolatum* is frequently reported from Greece however, data concerning vegetation units dominated by this species are not available up to date. The community found in Ioannina basin is floristically impoverished (Table 8, rel. 5–6), but the presence of *Butomus umbellatus* and *Eleocharis palustris* strengthens the conviction that the investigated stands are correlated to the *Eleocharito palustris*-*Sagittarion sagittifoliae alliance* (Hroudová *et al*., 2009). Additionally, our field observations agree with the statements of Hrivnák *et al*. (2015) regarding habitat preference and frequency of occurrence of the association *Eleocharito palustris*-*Alismatetum lanceolati*, which has not been reported from Greece up to present. However, Hrivnák *et al*. (2015) cite that it can be expected in regions with intensively drought summer because the development of “strong wetland competitors” is discouraged under these circumstances.

Table 8. *Juncus inflexus*-*Juncus effusus* comm. (rel. 1–4), *Eleocharito palustris*-*Alismatetum lanceolati* (rel. 5–6).

Altitude (m asl)	495	463	463	460		482	482	
Plot size (m²)	16	16	16	16		16	16	
Total cover (%)	100	100	80	50		85	90	
Group (Figure 2)	4	4	4	4		6	6	
Species N.	11	9	8	6		5	4	
Relevé N.	1	2	3	4		5	6	
Juncus inflexus	1	5	3	.	IV	.	.	.
Juncus effusus subsp. *effusus*	.	+	2b	3	IV	.	.	.
Alisma lanceolatum	.	.	.	.		4	4	V
Characteristics of *Molinio-Arrhenatheretea*								
Pulicaria dysenterica	2a	.	.	.	II	.	.	.
Teucrium scordium subsp. *scordioides*	+	.	.	.	II	.	.	.
Rumex conglomeratus	+	1	+	.	IV	r	.	III
Potentilla reptans	.	+	1	+	IV	.	.	.
Carex hirta	.	.	2m	r	III	.	.	.
Carex otrubae	.	.	+	.	II	.	.	.
Agrostis stolonifera	.	.	.	2a	II	.	.	.
Characteristics of *Phragmito-Magnocaricetea*								
Mentha aquatica	.	2a	+	.	III	.	.	.
Lycopus europaeus	.	2b	.	.	II	.	.	.
Iris pseudacorus	.	+	.	.	II	.	.	.
Lythrum salicaria	3	.	.	.	II	.	.	.
Cyperus longus	3	.	.	+	III	.	.	.
Calystegia sepium	2a	.	.	.	II	.	.	.
Butomus umbellatus	.	.	.	.	.	+	+	V
Eleocharis palustris	.	.	.	.	.	r	r	V
Companions								
Cirsium creticum	+	r	.	.	III	.	.	.
Cynodon dactylon	.	3	+		III	.	.	.
Xanthium strumarium	.	.	.	.	.	r	r	V

Other species: *Equisetum arvense* 2b, *Festuca arundinacea*, *Hypericum* sp. + in 1; *Rumex pulcher* 1 in 4.

Localities: datum ETRS89 (see Figure 1). 1: 20.946547, 39.613976; 2: 20.927308, 39.664128; 3: 20.879094, 39.641077; 4: 20.855008, 39.697272; 5: 20.871453, 39.556554; 6: 20.851863, 39.690026.

Molinio-Arrhenatheretea

Habitat type of national interest: 72B0 “Rush meadows”

Rush meadow vegetation dominated by *Juncus inflexus* and *Juncus effusus* develops sporadically behind the reed bed zone of Lake Pamvotis on soils waterlogged for less than half of the year. Penas *et al*. (2017) mention that *Juncus inflexus*, *Juncus effusus* and *Mentha aquatica* are among the characteristic species of the *Mentho longifoliae-Juncion inflexi* alliance assigned to the order *Filipendulo ulmariae-Lotetalia uliginosi*. Several types of wet grasslands occur within the Natura 2000 network of Greece (Kakouros *et al*., 2013). Among them, the rush meadows are considered as a habitat type of national interest (habitat type 72B0). We think that the *Juncus inflexus-Juncus effusus* community, which is reported here for the first time from Epirus (Table 8, rel. 1–4), belongs to this habitat type. Wet meadow communities reported from Greece (eg. Karagianni *et al*., 2008; Grigoriadis *et al*., 2009) are often assigned to the habitat type 6420 ("Mediterranean tall humid grasslands of the *Molinio-Holoschoenion*") of Annex I of the EU Habitats Directive. However, in our case, such a correlation could not be justified as both the floristic composition of the investigated relevés and the local environmental conditions (freshwater-fed meadows) do not refer to the *Molinio-Holoschoenion*. On the contrary, most of the species evaluated as diagnostic of *Juncus inflexus-Juncus effusus* community within the framework of the present study are included among the indicator species of the EUNIS habitat type R36, [E34b] "moist or wet mesotrophic to eutrophic pasture", with which the alliance *Mentho longifoliae-Juncion inflexi* is associated.

Habitat types: classification system and pressures affecting the conservation status

Both the EUNIS indicator species found in the study area and the crosswalk between the recognized alliances of the EuroVegChecklist and the EUNIS habitat types allowed the interpretation and classification of the habitat types. Twelve alliances were assigned to eleven of the EUNIS habitat types, eight of which are related to habitats of Annex I (Habitats Directive 92/43/EEC) and three to habitats of national (Greece) interest (Table 1).

Following the distribution categories, responsibility criteria and threats of the Natura 2000 habitats of Greece proposed by Dimopoulos *et al*. (2006), six of the recorded habitat types (4090, 5210, 8210, 934A, 92A0, 92C0) are of high and two (72A0, 8140) of medium monitoring importance. Only one habitat type (3150) has a scattered distribution in Greece, while the rest are widespread or abundant.

The conservation status assessment of the habitat types revealed that three (4090, 8210, 91M0) of the recorded habitat types are in favourable (FV) conservation status, seven (8140, 934A, 92A0, 92C0, 3150, 72A0, 72B0) are in unfavourable-inadequate (U1) conservation status, and only one (5210) is in unfavourable-bad (U2) conservation status (Figure 3). The main pressures and threats affecting the conservation status of the identified habitats are discussed below:

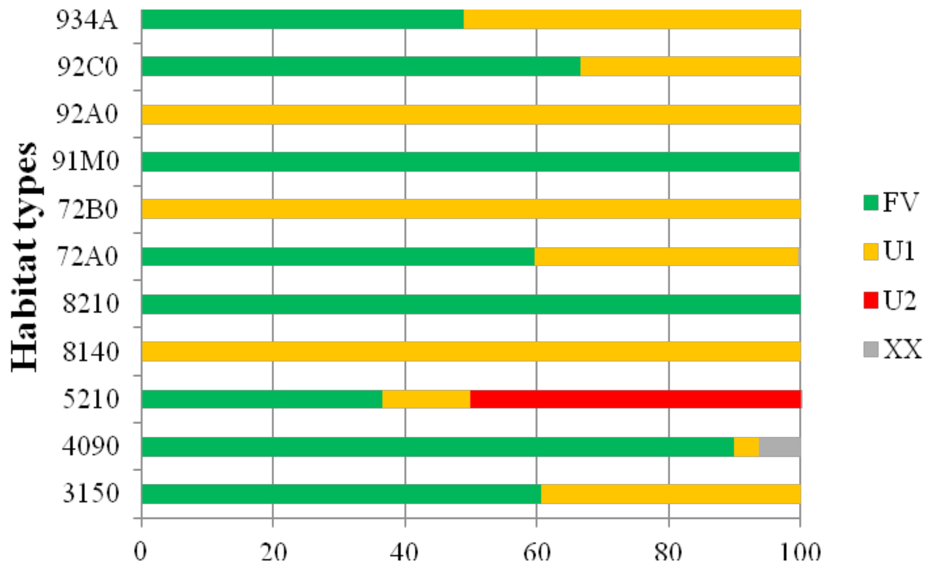

Figure 3. Percentage of the relevés according to their conservation status assessment for each habitat type; FV: Favourable, U1:Unfavourable–Inadequate, U2: Unfavourable–Bad and XX: unknown.

1. Pressures and threats affecting the habitats with favourable (FV) conservation status

Partial habitat loss is the most common threat both for the chasmophytic vegetation (8210) and the deciduous oak forests (91M0). Gerasimidis *et al*. (2009) note that human inhabitation and pastoral activities were the most crucial interferences which caused the substitution of deciduous oak forests that once thrived in low and middle elevations of the study area by shrublands. The oro-mediterranean heaths with gorse (4090) are mostly threatened through the lack of interventions such as grazing, fire, and logging, disturbances, which according to Janssen *et al.* (2016), favour the dominance of this habitat type against forest ones.

2. Pressures and threats affecting the habitats with unfavourable-inadequate (U1) conservation status

Intense grazing, land-use change, habitat fragmentation, water regime alterations, urbanization and eutrophication were assessed as the most frequent pressures that threaten the respective habitats. For the montane limestone scree vegetation (8140) and the *Quercus coccifera* woods (934A) grazing, land-use change and habitat fragmentation seem to be of utmost importance.

Drainage practices (water drilling, streamflow regulation, etc.) highly disturb and degrade the oriental plane woods (92C0) and the willow low open galleries (92A0). Infection by the invasive fungal species *Ceratocystis platani*, usually leads to the death of the infected plane trees (Ocasio-Morales *et al*., 2007). Several long-lasting anthropogenic interferences (Sarika-Hatzinikolaou, 1999; Stephanides & Papastergiadou, 2007) reduce dramatically the submerged macrophyte vegetation (3150) of the study area. According to Stephanides & Papastergiadou (2007), the direct restocking of Lake Pamvotis with benthivorous (*Cyprinus carpio*) and herbivorous (*Ctenopharyngodon idella*) carps, as well as the high eutrophication levels, were the most decisive factors for the massive reduction of submerged vegetation during the last thirty years. This view is also adopted here. The significant degradation observed in some of the investigated reed bed stands (72A0) can be mainly attributed to the eutrophication effects and, to a lesser extent, to various management practices applied for several purposes. Eutrophication damages reed beds (De Nie, 1987), and it is well documented that in Lake Pamvotis, nutrients are still sufficiently high to maintain eutrophic conditions (Alexakis *et al*., 2013). The rush meadows (72B0) that exist in few localities along the lake shores and in surrounding wet microenvironments are remnants of this formerly widespread vegetation type. Land-use changes and hydromorphologic alterations are crucial for the loss of waterlogged meadows in the Ioannina basin region (Alexakis *et al*., 2013).

3. Pressures and threats affecting the habitat with unfavourable-bad (U2) conservation status.

The arborescent matorral with *Juniperus oxycedrus* subsp. *deltoides* were assessed as U2, mainly due to grazing, land-use change, and habitat fragmentation. It is presumed that this vegetation type is in a state of recovery since vigorous regeneration is observed, as a result the decreasing grazing intensity. As stated before, these stands are often the result of degradation of broadleaved evergreen or thermophilous deciduous forests, and we assume that due to the decrease of grazing pressure, the stands have gained in size and in the long term the return of thermophilous forests cannot be ruled out. It would be interesting to reassess this habitat type in a few years, having the current results as a reference.

Acknowledgments

This research was carried out under the project: "Species and Habitat types Monitoring" for the Management Body of Lake Pamvotis, with contractor the Union Companies of "D. Argyropoulos and Associates O.E. - Adens S.A.". We would like to thank the staff of the Management Body for the overall assistance and George Seintis for his participation in the field work. Additional thanks to two anonymous reviewers for their valuable comments on an earlier version of the manuscript.

References

Alexakis, D., Kagalou, I. & Tsakiris, G. 2013. Assessment of pressures and impacts on surface water bodies of the Mediterranean. Case study: Pamvotis Lake, Greece. Environ. Earth Sci. 70 (2): 687–698.

Ammanatidou, D. 2005. Analysis and evaluation of a traditional cultural landscape as a basis for its conservation management. A case study in Vikos-Aoos National Park-Greece. Ph.D. Thesis, Albert-Ludwigs Univ. Freiburg.

Anonymous. 2013. Interpretation manual of European Union habitats. EUR 28. Eur. Comm., DG Environ., Brussels.

Babalonas, D. 1979. Phytosociological study of the vegetation of Evros Delta. Ph.D. Thesis, Aristotle Univ. Thessaloniki.

Barbéro, M. & Quézel, P. 1976. Les groupements forestiers de Grèce Centro-Méridionale. Ecol. Mediter. 2: 1–86.

Bergmeier, E. 1990. Wälder und Gebüsche des Niederen Olymp (Kato Olimbos, NO-Thessalien). Ein Beitrag zur systematischen und orographischen Vegetationsgliederung Griechenlands. Phytocoenologia 18: 161–342.

Bergmeier, E. & Dimopoulos, P. 2008. Identifying plant communities of thermophilous deciduous forest in Greece: Species composition, distribution, ecology and syntaxonomy. Plant Biosyst. 142: 228–254.

Bergmeier, E., Walentowski, H. & Güngöröğlu, C. 2018. Turkish forest habitat types - An annotated conspectus based on the EU Habitats Directive with suggestions for an upgrade. In: Güngöröğlu, C. (Ed.). Practicability of the EU Natura 2000 concept in the forested areas of Turkey. Pp. 134–292. Turkey For. Ass., Ankara.

Chasapis, M., Karagiannakidou, V. & Theodoropoulos, K. 2004. Phytosociological research of Quercus coccifera L. pseudomaquis on Mount Chortiatis, northern Greece. Israel J. Plant Sci. 52: 357–381.

Chiotelli, E. 2015. Evaluation of the effects of irrigation and drainage practices on the landscape of Lake Pamvotis, Ioannina: implications for landscape management in the context of sustainability. Agric. Agric. Sci. Proc. 4: 201–210.

Chrysopolitou, V., Apostolakis, A., Kotzageorgis, G., Defingou, M., Gioutlakis, M., Hatziiordanou, L. & Hadjicharalambous, H. 2014. Deliverable B7. Methodology on data compilation for evaluating the habitat and species status, from cell level to Natura network and national level. 2nd edition. YPEKA, Athens.

Chytrý, M., Tichý, L., Holt, J. & Botta-Dukát, Z. 2002. Determination of diagnostic species with statistical fidelity measures. J. Veg. Sci. 13: 79–90.

Dafis, S., Papastergiadou, E., Lazaridou, E. & Tsiafouli, M. 2001. Technical manual of identification, description and mapping of Greek habitat types. Greek Biotope-Wetland Center (EKBY), Thessaloniki.

Davies, C.E., Moss, D. & Hill, M.O. 2004. EUNIS habitat classification revised 2004. Eur. Environ. Agency, Copenhagen.

Davis, P.H. (Ed.). 1965–1985. Flora of Turkey and the East Aegean islands. Vols. 1–9. Edinburgh Univ. Press, Edinburgh.

De Nie, H.W. 1987. The decrease in aquatic vegetation in Europe and its consequences for fish populations. EIFAC/CECPI Occ. Pap. 19: 1–52.

Dimopoulos, P., Bergmeier, E. & Fischer, P. 2006. Natura 2000 Habitat Types of Greece evaluated in the light of distribution, threat and responsibility. Proc. Roy. Irish Acad. 106B(3): 175–187.

Dimopoulos, P., Raus, T., Bergmeier, E., Constantinidis, Th., Kokkini, S., Strid, A. & Tzanoudakis, D. 2013. Vascular plants of Greece: An annotated checklist. Bot. Gart. Bot. Mus. Berlin-Dahlem & Hell. Bot. Soc., Berlin.

Dimopoulos, P., Raus, T., Bergmeier, E., Constantinidis, Th., Iatrou, G., Kokkini, S., Strid, A. & Tzanoudakis, D. 2016. Vascular plants of Greece: An annotated checklist. Supplement. Willdenowia 46: 301–347.

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

Dimopoulos, P., Sýkora, K., Mucina, L. & Georgiadis, T. 1997. The high-rank syntaxa of the rock-cliff and scree of the mainland Greece and Crete. Fol. Geobot. Phytotax. 32: 313–334.

Dimopoulos, P., Tsiripidis, I., Xystrakis, F., Kallimanis, A. & Panitsa, M. 2018. Methodology for monitoring and conservation status assessment of the habitat types in Greece. Nat. Ctn. Env. Sust. Dev., Athens.

Evans, D. & Arvela, M. 2011. Assessment and reporting under Article 17 of the Habitats Directive. Explanatory Notes & Guidelines for the period 2007–2012. Final Draft, July 2011. Eur. Top. Cent. Biol. Div., Paris.

Fotiadis, G. 2004. Forest phytosociological units of the Greek part of mount Beles and of Krousia mountains. Ph.D. Thesis. Univ. Thessaloniki.

Ganiatsas, K. 1970. Flora and vegetation of the Lake of Ioannina. Ipir. Estia 217–218: 1–20.

Georgiadis, T., Economidou, E. & Christodoulakis, D. 1990. Flora and vegetation of the Strofilia coastal area (NW Peloponnesos-Greece). Phyton (Horn, Austria) 30: 15–36.

Georgiadis, T., Dimopoulos, P. & Dimitrelos, G. 1997. The flora and vegetation of the Acheron delta (W Greece) aiming at nature conservation. Phyton (Horn, Austria) 37: 31–60.

Gerasimidis, A. & Korakis, G. 2006. The vegetation of mountainous rangeland areas at Mount Mitsikeli. In: Platis, P., Sfouggaris, A, Papachristou, Th. & Tsiontsis, A. (Eds.). Proc. 4th Panhellenic Rangeland Congr., 10–12 November 2004. Pp. 183–191. Volos, Greece.

Gerasimidis, A. & Korakis, G. 2009. Contribution to the study of the flora of Mount Mitsikeli, NW Greece. Flora Mediter. 19: 161–184.

Gerasimidis, A., Panajiotidis, S., Fotiadis, G. & Korakis, G. 2009. Review of the Late Quaternary vegetation history of Epirus (NW Greece). Phytol. Balcan. 15: 29–37.

Gradstein, S.R. & Smittenberg, J.H. 1977. The hydrophilous vegetation of western Crete. Vegetatio 34: 65–86.

Grigoriadis, N., Panagopoulos, A., Meliadis, L., Spyroglou, G, & Stathaki, S. 2009. Habitat and hydrological-hydrochemical characteristics of the Agras wetland (Northern Greece). Plant Biosyst. 143(1): 162–172.

Hill, M.O. 1979. TWINSPAN. A Fortran program for arranging multivariate data in an ordered two-way table by classification of the individuals and attributes. Cornell Univ. Ithaca, New York.

Hill, M.O. & Šmilauer, P. 2005. TWINSPAN for Windows version 2.3. Ctn. Ecol. Hydrol., Univ. South Bohemia, České Budějovice.

Horvat, I., Glavač, V. & Ellenberg, H. 1974. Vegetation Südosteuropas. G. Fischer, Stuttgart.

Hrivnák, R., Slezák, M., Šumberová, K. & Hroudová, Z. 2015. A new marsh plant community of Eleocharito palustris-Alismatetum lanceolati (Eleocharito palustris-Sagittarion sagittifoliae alliance) in Slovakia. Acta Soc. Bot. Polonia 84: 311–319.

Hroudová, Z., Hrivnák, R. & Chytrý, M. 2009. Classification of inland Bolboschoenus-dominated vegetation in Central Europe. Phytocoenologia 39: 205–215.

Janssen, J.A.M., Rodwell, J.S., Garcia Criado, M., Gubbay, S., Haynes, T., Nieto, A., Sanders, N., Landucci, F., Loidi, J., Ssymank, A., Tahvanainen, T., Valderrabano, M., Acosta, A., Aronsson, M., Arts, G., Altorre, F., Bergmeier, E., Bijlsma, R.-J., Bioret, F., Bită-Nicolae, C., Biurrun, I., Calix, M., Capelo, J., Čarni, A., Chytrý, M., Dengler, J., Dimopoulos, P., Essi, F., Gardfjeil, H., Gigante, D., Giusso del Galdo, G., Hajek, M., Jansen, F., Jansen, J., Kapfer, J., Mickolajczak, A., Molina, J.A., Molnár, Z., Paternoster, D., Piernik, A., Poulin, B., Renaux, B., Schaminée, J.H.J., Šumberová, K., Toivonen, H., Tonteri, T., Tsiripidis, I., Tzonev, R. & Valachovič, M. 2016. European red list of habitats. Part 2. Terrestrial and freshwater habitats. Publ. Office Eur. Union, Luxembourg.

Jasprica, N., Škvorc, Ž., Dolina, K., Ruščić, M., Kovačić, S. & Franjić, J. 2015. Composition and ecology of the Quercus coccifera L. communities along the eastern Adriatic coast (NE Mediterranean). Plant Biosyst. 150: 1140–1155.

Jasprica, N., Škvorc, Ž. & Milović, M. 2016. A phytosociological analysis of the Quercus coccifera L. stands in south Albania (NE Mediterranean). Hacquetia 15(1): 49–65.

Kagalou, I., Papastergiadou, E. & Leonardos, I. 2008. Long term changes in the eutrophication process in a shallow Mediterranean lake ecosystem of W. Greece: Response after the reduction of external load. J. Environ. Manag. 87: 497–506.

Kakouros, P., Chouvardas, D. & Papanastasis, V.P. 2013. Landscape composition of rangelands within the Natura 2000 habitat network in Greece. In: Vrahnakis, M., Kyriazopoulos, A.P., Chouvardas, D. & Fotiadis, G. (Eds.). Dry grasslands of Europe: Grazing and ecosystem services. Proc. 9th Eur. Dry Grassland Meeting (EDGM), Prespa, Greece. 19–23 May 2012. Pp. 157–162. Hell. Range Pasture Soc. (HERPAS), Thessaloniki.

Kallimanis, A.S., Panitsa, M., Dimopoulos, P. 2017. Quality of non-expert citizen science data collected for habitat type conservation status assessment in Natura 2000 protected areas. Sci. Rep. 7: 8873.

Karagiannakidou-Iatropoulou, V. 1983. Site research in Querco-Fagetea class of the Chortiatis mountain range. Ph.D. Thesis. Univ. Thessaloniki.

Karagianni, P., Tiniakou, A. & Georgiadis, Th. 2008. A distribution model of habitat types along the rivers of W. Greece: A case-study. Fresen. Environ. Bull. 17: 713–721.

Karetsos, G.K., 2002. Ecological and vegetation study of Iti mountain. Ph.D. Thesis. Univ. Patras.

Kent, M. & Coker, P. 1992. Vegetation description and analysis: a practical approach. CRC Press, Boca Raton. Belhaven Press, London.

Kokkoris, I., Dimopoulos, P., Xystrakis, F. & Tsiripidis, I. 2018. National scale ecosystem condition assessment with emphasis on forest types in Greece. One Ecosyst. 3: e25434.

Kotzageorgis, G., Mantzavelas, A., Hadjicharalambous, E., Defingou, M., Gioutlakis, M., Papagrigoriou, S., Alexandridou, E. (Eds.). 2014. Deliverable C1: Written guidelines to 8 Joint Ventures and administrative bodies of protected areas. YPAPEN, Athens.

Maes, J., Teller. A., Erhard, M., Grizzetti, B., Barredo, J., Paracchini, M., Condé, S., Somma, F., Orgiazzi, A., Jones, A., Zulian, A., Vallecilo, S., Petersen, J., Marquardt, D., Kovačević, V., Abdul Malak, D., Marin, A., Czúcz, B., Mauri, A., Löffler, P., Bastrup-Birk, A., Biala, K., Christiansen, T. & Werner, B. 2018. Mapping and assessment of ecosystems and their services: An analytical framework for ecosystem condition. Publ. Office Eur. Union, Luxembourg.

Manolaki, P. & Papastergiadou, E. 2012. Responses of aquatic macrophyte assemblages to nutrient enrichment in a lowland river basin of western Greece. Plant Biosyst. 146: 1064–1077.

Markgraf-Dannenberg, I. 1976. Die Gattung Festuca in Griechenland. Ver. Geobot. 56: 92–182.

Markgraf-Dannenberg, I. 1980 Festuca L. In: Tutin, T.G. *et al.* (Eds.). Flora Europaea, vol. 2. Pp. 191–218. Cambridge Univ. Press, Cambridge.

Mucina, L, Bültmann, H., Dierßen, K., Theurillat, J.-P., Raus, T., Čarni, A., Šumberová, K.,Willner, W., Dengler, J., Gavilán García, R., Chytrý, M., Hájek, M., Di Pietro, R., Iakushenko, D., Pallas, J., Daniëls, F.J.A., Bergmeier, E., Guerra, A.S., Ermakov, N., Valachovič, M., Schaminée, J.H.J., Lysenko, T., Didukh, Y.P., Pignatti, S., Rodwell, J.S., Capelo, J., Weber, H.E., Solomeshch, A., Dimopoulos, P., Aguiar, C., Hennekens, S.M. & Tichý, L. 2016. Vegetation of Europe: hierarchical floristic classification system of vascular plant, bryophyte, lichen, and algal communities. Appl. Veg. Sci. 19 (Suppl. 1): 3–264.

Müeller-Dombois, D. 1984. Classification and mapping of plant communities: a review with emphasis on tropical vegetation. In: Woodwell, G.M. (Ed.): The role of the terrestrial vegetation in the global carbon cycle: Measurement by remote sensing. Pp. 21–88. John Willey & Sons, New York.

Ocasio-Morales, R.G., Tsopelas, P. & Harrington, T.C. 2007. Origin of Ceratocystis platani on native Platanus orientalis in Greece and its impact on natural forests. Plant Dis. 91: 901–904.

Oksanen, J., Blanchet, F.G., Friendly, M., Kindt, R., Legendre, P., McGlinn, D., Minchin, P.R., O'Hara, R.B., Simpson, G.L., Solymos, P., Stevens, M.H.H., Szoecs, E. & Wagner, H. 2019. vegan: Community Ecology Package. R package version 2.5–5.

Papadopoulou-Vrynioti, K., Mertzanis, A., Vryniotis, D., Vassiliades, E. & Karakitsios, V. 2015. The contribution of karstic rocks to soil quality, Ioannina plain (Epirus, Hellas). J. Geochem. Explor. 154: 224–237.

Papastergiadou, E., Kagalou, I., Stefanidis, K., Retalis, A. & Leonardos, I. 2010. Effects of anthropogenic influences on the trophic state, land uses and aquatic vegetation in a shallow Mediterranean lake: Implications for restoration. Water Resour. Manag. 24: 415–435.

Penas, A., del Río, S., Herrero, L. & Ladero, M. 2017. The Duero Basin. In: Loidi, J. (Ed.). The vegetation of the Iberian Peninsula Plant and Vegetation, vol 12. Pp. 396–438. Springer, Cham.

Pirini, Ch., Karagiannakidou, V. & Charitonidis, S. 2011. Abundance, diversity and distribution of macrophyte communities in neighbouring lakes of different trophic states in North-Central Greece. Arch. Biol. Sci. Belgrade 63: 763–774.

R Core Team 2017. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org.

Raus, T. 1980. Die Vegetation Ostthessaliens (Griechenland). III. Querco-Fagetea und azonale Gehölzgesellschaften. Bot. Jahrb. Syst. 101: 313–361.

Sarika, M. 2012. Flora and vegetation of some coastal ecosystems of Sterea Ellas and eastern continental Greece. Lazaroa 33: 65–99.

Sarika, M., Christopoulou, A., Zervou, S. & Zikos, A. 2018. Vegetation units of wetland and terrestrial habitats: the case study of Spercheios River and Maliakos Gulf (Sterea Ellas, Greece), a Natura 2000 site. Hacquetia 17(2): 189–220.

Sarika, M., Dimopoulos, P. & Yannitsaros, A. 2005. Contribution to the knowledge of the wetland flora and vegetation of Amvrakikos Gulf, W Greece. Willdenowia 35: 69–85.

Sarika-Hatzinikolaou, M. 1999. Floristic and phytosociological study of aquatic ecosystems of Epirus (NW Greece). PhD Thesis. Nat. Kapodistrian Univ. Athens.

Sarika-Hatzinikolaou, M., Yannitsaros, A. & Babalonas, D. 2003. The macrophytic vegetation of seven aquatic ecosystems of Epirus (NW Greece). Phytocoenologia 33: 93–151.
Schaminée, J.H.J., Chytrý, M., Hennekens, S.M., Mucina, L., Rodwell, J.S. & Tichý, L. 2012. Development of vegetation syntaxa crosswalks to EUNIS habitat classification and related data sets. Eur. Environ. Agency. Alterra, Wageningen.
Schaminée, J.H.J., Chytrý, M., Hennekens, S.M., Janssen, J.A.M., Jiménez-Alfaro, B., Knollová, I., Mucina, L., Rodwell, J.S., Tichý, L. & data-providers 2014. Vegetation analysis and distribution maps for EUNIS habitats. Eur. Environ. Agency. Alterra, Wageningen.
Schaminée, J.H.J., Chytrý, M., Hennekens, S.M., Jiménez-Alfaro, B., Mucina, L., Rodwell, J.S. & data contributors 2013. Review of EUNIS forest habitat classification. Eur. Environ. Agency. Alterra, Wageningen.
Schaminée, J.H.J., Chytrý, M., Hennekens, S.M., Janssen, J.A.M., Knollová, I., Rodwell, J.S., Tichý, L. 2019. Updated crosswalk of the revised EUNIS Habitat Classification with the European vegetation classification and indicator species for the EUNIS grassland, shrubland and forest types. Eur. Environ. Agency. Alterra, Wageningen.
Stephanides, K. & Papastergiadou, E. 2007. Aquatic vegetation and related environment in a shallow urban lake of Greece. Belg. J. Bot. 140(1): 25–38.
Strid, A. (Ed.). 1986. Mountain Flora of Greece. Volume 1. Cambridge Univ. Press, Cambridge.
Strid, A. 2016. Atlas of the Aegean Flora 1. Bot. Gard. & Bot. Mus. Berlin-Dahlem, Berlin.
Strid, A. & Kit Tan (Eds.). 1991. Mountain Flora of Greece. Volume 2. Edinburgh Univ. Press, Edinburgh.
Strid, A. & Kit Tan (Eds.). 1997. Flora Hellenica. Volume 1. Koeltz Publ., Königstein.
Strid, A. & Kit Tan (Eds.). 2002. Flora Hellenica. Volume 2. Gantner Publ., Ruggell.
Tsiourlis, G., Konstantinidis, P. & Xofis, P. 2009. Syntaxonomy and synecology of Quercus coccifera Mediterranean shrublands in Greece. J. Plant Biol. 52: 433–447.
Tsiripidis, I., Xystrakis, F., Kallimanis, A., Panitsa, M. & Dimopoulos, P. 2018. A bottom–up approach for the conservation status assessment of structure and functions of habitat types. Rend. Lincei-Sci. Fis. 29(2): 267–282.
Tutin, T.G. & als. (Eds.). 1964–1993. Flora Europaea. Cambridge Univ. Press, Cambridge.
Van der Maarel, E. 1979. Transformation of cover-abundance values in phytosociology and its effects in community similarity. Vegetatio 39 (2): 97–114.
Weber, H.E., Moravec, J. & Theurillat, J.-P. 2000. International Code of Phytosociological Nomenclature. 3rd edition. J. Veg. Sci. 11: 739–768.
Westhoff, V. & van der Maarel, E. 1980. The Braun-Blanquet approach. In: Whittaker, R. H. (Ed.). Classification of plant communities. Pp. 287–399. W Junk, The Hague.
Wolff, W.J. 1968. The halophilous vegetation of the lagoons of Mesolonghi, Greece. Vegetatio 16: 95–134.
Zaimes, G.N., Iakovoglou, V., Emmanouloudis, D. & Goumaridis, D. 2010. Riparian areas of Greece: Their definition and characteristics. J. Engin. Sci. Technol. Rev. 3(1): 176–183.
Zogaris, S., Chatzinikolaou, Y. & Dimopoulos, P. 2009. Assessing environmental degradation of montane riparian zones in Greece. J. Environ. Biol. 30: 719–726.
Zotos, A. 2006. Flora, vegetation and management proposals of wet meadows and reed thickets of the lakes Trichonida and Lysimachia (W. Greece). PhD Thesis. Univ. Ioannina, Agrinio.

Supplementary Material

Table S1. Correspondence of the habitat types found in the study area with the MAES ecosystem categories and types.
Table S2. The names and the codes of the EUNIS and Natura 2000 Habitat types.