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The Flora and Vegetation of the Acheron Delta (W Greece) Aiming at Nature Conservation

By

Theodoros GEORGIADIS*), Panayotis DIMOPOULOS*) and
Georgios DIMITRELLOS*)

With 2 Figures

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Summary

GEORGIADIS Th., DIMOPOULOS P. & DIMITRELLOS G. 1997. The Flora and Vegetation of the Acheron Delta (W Greece) Aiming at Nature Conservation. – *Phyton* (Horn, Austria) 37 (1): 31-60, 2 figures. – English with German summary.

The Acheron Delta is a coastal wetland of Western Greece which has remained unexplored from a floristic and vegetational point of view. The flora of the investigated area consists of 415 taxa belonging to 89 families and 280 genera, 395 of the listed taxa are reported for the first time, three taxa are reported for the first time from Epiros and one taxon is a new record for the Western Greek mainland. From chorological analysis of the flora the predominance of Mediterranean elements (52.2 %) and the high percentage of widespread taxa (45.1 %) are evident. The life-form spectrum shows, that Therophytes are predominant (32.8 %). The proportion of the Hemicryptophytes is noteworthy (24.6 %) and the high percentages of Phanerophytes (15.4 %), and especially Hydrophytes (13.7 %), must also be emphasized. The vegetation mosaic of Acheron Delta is mapped and analytically described at the plant association level. A syntaxonomic arrangement of the plant communities is also given. The human impact on the vegetation during the last 35 years is recorded on the basis of the area covered by the different vegetation types in 1960 and 1995. The total loss of natural habitats within 35 years is 163.8 ha. Conservation and restoration proposals for this ecologically significant wetland are made in the framework of a sustainable management plan.

Zusammenfassung

GEORGIADIS Th., DIMOPOULOS P. & DIMITRELLOS G. 1997. Flora und Vegetation des Acheron-Deltas (W-Griechenland) im Hinblick auf Ziele des Naturschutzes. – *Phyton*

*) Prof. Dr. Th. GEORGIADIS, Dr. P. DIMOPOULOS, G. DIMITRELLOS, University of Patras, Department of Biology, Division of Plant Biology, Laboratory of Plant Ecology, 265 00 Patras, Greece.

(Horn, Austria) 37 (1): 31–60, 2 Abbildungen. – Englisch mit deutscher Zusammenfassung.

Das Acheron-Delta ist ein Feuchtgebiet an der griechischen Westküste, das floristisch und vegetationskundlich bisher unerforscht blieb. Für die Flora des untersuchten Gebietes konnten 415 Arten aus 89 Familien und 280 Gattungen notiert werden. Fast alle dieser Arten (395) sind Erstmeldungen, drei davon Erstfunde für Epiros, eine Art ist neu für das westgriechische Festland. Die chorologische Analyse der Flora erbrachte eine Dominanz des mediterranen Elements (52.2 %) und einen hohen Prozentsatz weit verbreiteter Arten (45.1 %). Das Lebensformenspektrum zeigt, daß Therophyten vorherrschen (32.8 %), der Anteil der Hemikryptophyten (24.6 %) ist bemerkenswert, aber auch die hohen Prozentanteile von Phanerophyten (15.4 %) und Hydrophyten (13.7 %) sollen hervorgehoben werden. Das Vegetationsmosaik ist in Abbildung 2 dargestellt. Der Beschreibung der Vegetationseinheiten auf Assoziationsniveau ist eine syntaxonomische Übersicht vorangestellt. Die Veränderungen der Vegetationsverteilung aufgrund menschlicher Eingriffe während der vergangenen 35 Jahre werden durch Vergleich der Flächenanteile der Vegetationstypen in den Jahren 1960 und 1995 dokumentiert. Der Rückgang naturnaher Vegetationseinheiten innerhalb von 35 Jahren beträgt 163,8 ha. Im Rahmen eines nachhaltigen Managementplans werden Verbesserungen für das ökologisch bedeutende Feuchtgebiet vorgeschlagen.

1. Introduction

Acheron Delta belongs to the western chain of Greek wetlands along the coast of the Ionian Sea, which includes extensive deltas and lagoons in the gulfs of Kyparissiakos, Patraikos and Amvrakikos, and the intermediate group which includes the Akarnanian lakes and marshes and the lakes of Epiros (Fig. 1). In recent years the wetlands of Western Greece, which all have high ecological value, have suffered significantly from human activities and, according to PSILOVIKOS 1992, the "ratio of extant to extinct wetlands in the western chain is 1.25 with a significant loss of wetlands having occurred in the south".

Although ecological projects are being carried out throughout the Greek wetlands, the lack of satisfactory information and research on their floristic composition and vegetation structure (with the exception of some of the 'RAMSAR' sites) must be pointed out. Wetlands of Western Greece which seem to be well-explored from a floristic and vegetational point of view are: the Acheloos Delta, the lagoons of Messolongi-Aitolikon, Amvrakikos Gulf and the Louros-Arachthos Delta, as well as the Strofilia coastal area (WOLFF 1968, SZLJ 1981, SZLJ 1983, GEORGIADIS & al. 1990).

In the framework of a research project concerning "Ecological impacts of agricultural activities, conservation and management on the wetlands of Kalamas, Acheron and Kalodiki", the authors had the opportunity to study the flora and vegetation of the Acheron Delta which has suffered much from human activities during the last 35 years.

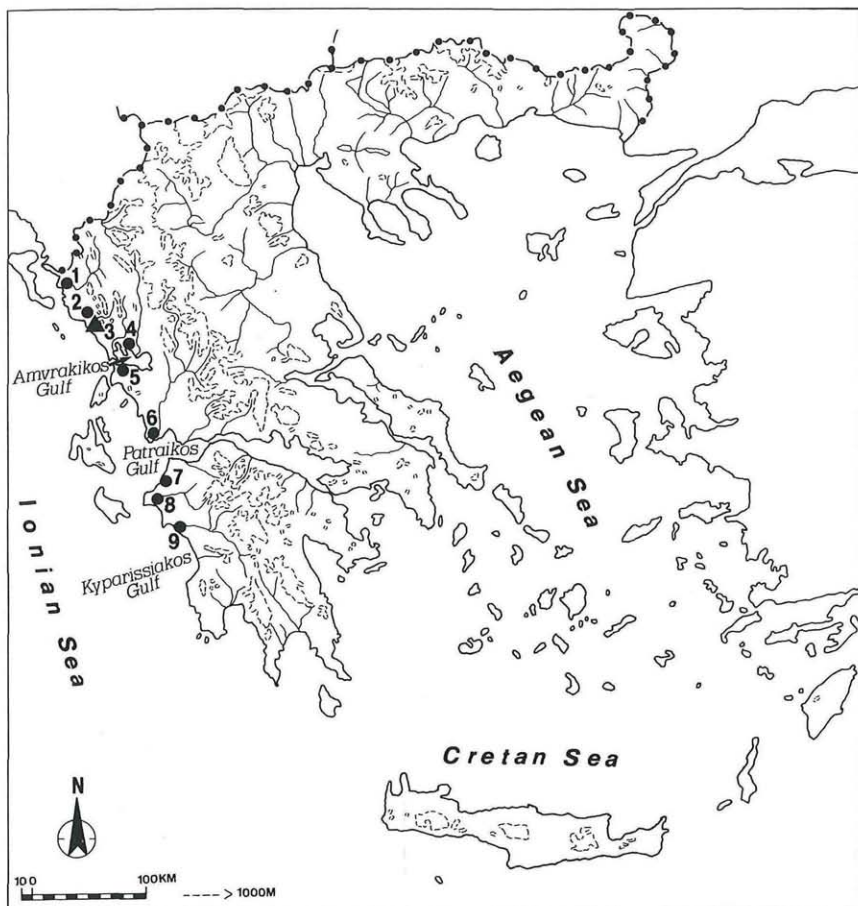


Fig. 1. The main wetlands of the western Greek wetland chain. 1: Kalamas Delta; 2: Kalodiki Fen; 3: Acheron Delta; 4: Louros-Arachthos Delta and Amvrakikos Gulf; 5: Lakes of Vulkaria and Saltini; 6: Acheloos Delta, lagoons of Messolongi-Aitolikon and estuaries of Evinos river; 7: Strofilia coastal area; 8: Pineios Delta; 9: Alfeios Delta.

The inventory of the natural potential of the Acheron Delta on the basis of its flora and vegetation constitutes an important means for planning effective conservation measures through management practices adapted to harmonize with the natural environment.

2. Study Area

2.1. Geography – Geomorphology

The Acheron Delta is located in the southwestern part of Epiros between the cities of Parga and Preveza. It belongs to the lobate morphody-

namic delta type (PSILOVIKOS 1992) and lies between 39°14'N and 20°30'E. The size of the investigated area is 1630 ha. From a geological point of view, the delta plain consists of recent alluvial deposits (quaternary deposits of torrential origin), while on the W-exposed rocky coasts and hills, the substrate consists of limestones and dolomites.

From a geomorphological point of view, the plain of Acheron Delta is considered to be a tectonic basin filled in with extensive layers of alluvial deposits carried by the River Acheron. This basin continues eastwards and borders the cultivated land of Mesopotamos village, while the other borders are surrounded by steep calcareous hills. On the western side there are two openings between the hills (Phanari and Odyssea altitude of the pure marshy land ranges from 0 to 0.3 m, or is even negative in restricted bays) and the River Acheron flows through the first opening in the N-Ionian Sea.

The whole area is flat or with a very low gradient. The areas, and increases towards the cultivated land (where it ranges from 1 to 5 m) close to the village of Mesopotamos. The form of relief occurring in the lower marsh areas is concave, while in the surrounding hills it is convex and a strongly inclined relief is predominant (PAPAMICHOS & al. 1994).

2.2. Bioclimate and Soil Conditions

On the basis of EMBERGER'S (1955) pluviothermic coefficient ($Q = 157.8$), the studied area belongs to the humid Mediterranean bioclimatic zone with mild winters almost free of frost and snow. The climatic data was supplied by the meteorological stations of Preveza and Kerkira. According to the BAGNOULS & GAUSSEN (1952) xerothermic index ($X_m = 75.5$), the area can be included in the intense Meso-Mediterranean character of the Mediterranean bioclimate. The dry period lasts from early May to late August (GEORGIADIS 1994).

Although the topography of the delta is regular and almost flat, the observed altitudinal micro-differences caused by the sedimentary deposits have important effects on the drainage and degree of soil hydromorphy. In general, along the banks of the River Acheron and at the eastern side of the Acheron Delta, the soils are hydromorphic and more water-logged.

Based on soil analyses from different vegetation types (PAPAMICHOS & al. 1994), the following soil units have been distinguished according to the FAO-UNESCO (1997) soil classification system:

a) Calcaric Fluvisols: On cultivated land far from the sea consisting of recent alluvial deposits with a calcareous horizon up to a depth of at least 50 cm.

b) Chromic Luvisols: On the surrounding calcareous rocky hills of hard limestones and dolomites.

c) Saline, Alkaline, Saline-Alkaline Gleyic Fluvisols: Hydromorphic alluvial soils rich in soluble salts or exchangeable Na^+ , or in soluble salts and exchangeable Na^+ respectively.

d) Eutric Histosols: Organic soils rich in semi-decomposed organic material.

3. Materials and Methods

The study is based on the results of field work carried out at intervals between May 1993 and September 1994. Collections of plant material (ca. 1000 specimens) were made during different seasons of the year from all the representative biotopes covered by different vegetation types. Herbarium specimens are deposited at UPA (University of Patras). The species list is based on the authors collections and field observations. The collection sites have been numbered A1–A12 and a description of their ecological characteristics is given (Fig. 2). The collection numbers used in this study range from 7355 to 7959.

Species identification was made according to Flora Europaea (TUTIN & al. 1964–1980) and the Flora of Turkey (DAVIS 1965–1988). As a rule, the nomenclature follows Flora Europaea (TUTIN & al. 1964–1980) and Med-Checklist (GREUTER & al. 1984–1989) where available. Syntaxonomic nomenclature follows HORVAT, GLAVAC & ELLENBERG 1974, BARBERO & QUEZEL 1976, GEHU & al. 1986, QUEZEL & al. 1992 and JULVE 1993 and therefore often does not confirm with the Code of Phytosociological Nomenclature 2nd edition (BARKMAN & al. 1986).

The chorological types are identified as in Flora d'Italia (PIGNATTI 1982). RAUNKIAER'S system (1934) was followed for ranking the terrestrial taxa into life-form categories and the production of a life-form spectrum, while life-forms of higher aquatic plants are classified according to HUTCHINSON 1975.

The vegetation of the Acheron Delta was surveyed using the BRAUN-BLANQUET phytosociological approach (BRAUN-BLANQUET 1964, WESTHOFF & VAN DER MAAREL 1978). The vegetation mapping was based on data obtained by surveying aerial photographs (taken in 1984) and verification in the field according to the present vegetation pattern (Fig. 2). For the inventory of environmental changes originating from human activities, a series of aerial photographs (1960, 1984) were analyzed. In order to calculate the areas covered by the recognized vegetation types, a planimeter was used on the vegetation map of the studied area.

4. Results

4.1. Flora

As a result of our field work, 415 taxa from 89 families and 280 genera, are recorded from the Acheron Delta. The majority of these taxa are new

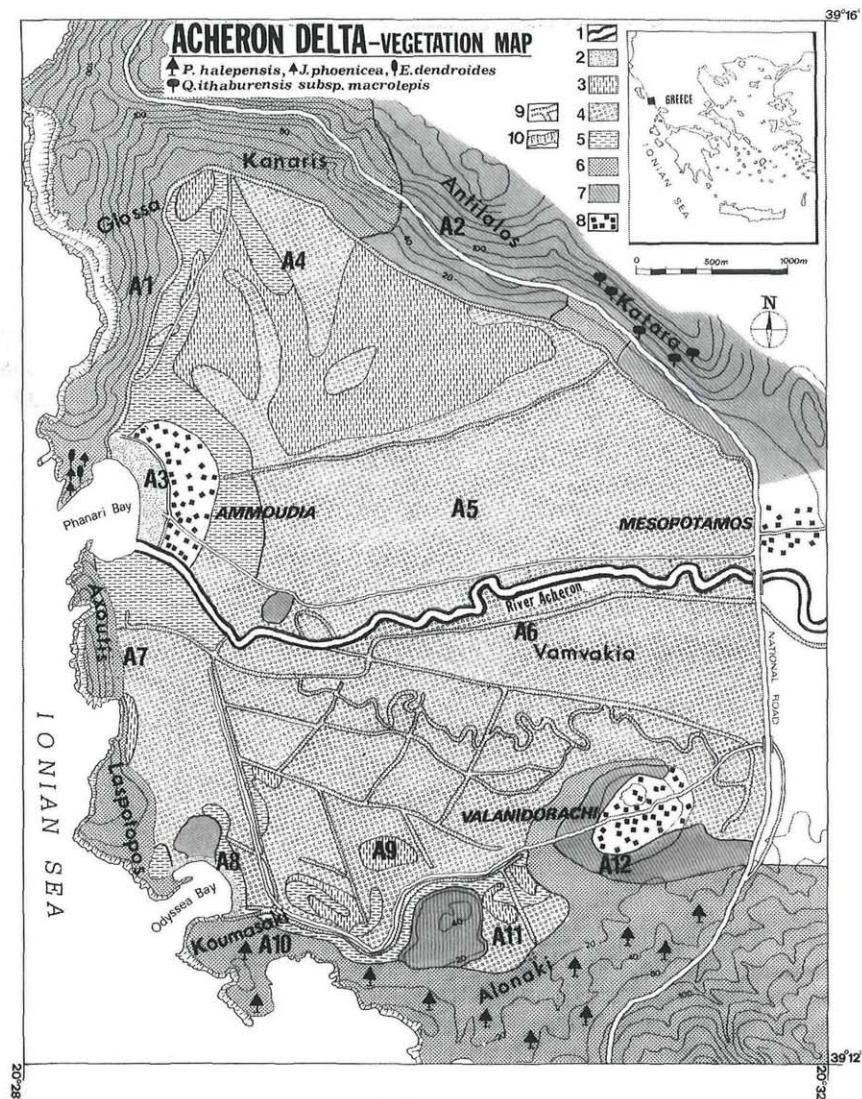


Fig. 2. Vegetation map of the Acheron Delta (present situation). 1: Riparian vegetation; 2: Ammophilous vegetation; 3: Scrub with *Tamarix parviflora*, aquatic vegetation (emergent herbaceous, floating-leaved and submerged vegetation); 4: Cultivated land; 5: Halophytic vegetation and vegetation of brackish marshes; 6: Macchia vegetation; 7: Phrygana vegetation, 8: settlements, 9: Ditches, 10: Rocky coast, ▲: *Pinus halepensis*-forests.

Description of the collection sites

A1: Glossa; Macchia vegetation, scrub with *Euphorbia dendroides*, rocky coasts; Hard limestones; Soil pH: 7.0–7.6; Altitude: 0–170 m.

records since ECONOMIDOU 1981 included only 20 species from the Acheron Delta plain.

Regarding the life-form spectrum of the delta flora in Table 1, it appears that the proportion of Therophytes (32.8 %) is higher than that of other life-forms, while the proportion of Hemicryptophytes (24.6 %) is noteworthy. The percentages of Therophytes and Hemicryptophytes are in accordance with the Mediterranean character of the flora of this wetland as well as the intense Meso-Mediterranean character of the Mediterranean bioclimate.

The remarkably high percentages of Phanerophytes (15.4 %) and especially Hydrophytes (13.7 %), must also be emphasized. From the 57 aquatic species (Hydrophytes), 53 taxa belong to the Rhizophytes (Emerged or Hyperhydate macrophytes, 44 taxa; Floating-Leaved, 1 taxon; Submerged, 8 taxa) and 4 taxa to the Pleustophytes. The Hyperhydate macrophytes of Acheron Delta can be further classified into four subcategories as follows: graminids (22 taxa), herbids (20 taxa), sagittarids (1 taxon), ipomeids (1 taxon), while the Floating-Leaved can be separated into one subcategory: natopotamids (1 taxon). The Submerged Rhizophytes can be divided into the following three subcategories: myriophyllids

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- A2: Kanaris – Antilalos – Katara; Macchia, phrygana vegetation, open forest stands with *Quercus ithaburens* subsp. *macrolepis*; Hard limestone rocks and dolomites; Soil pH: 7.0–7.4; Altitude: 10–315 m.
 - A3: Close to the village of Ammoudia; Sandy beaches and rocky escarpments, reed vegetation, artificial stands with *Eucalyptus* sp. and *Populus nigra* on the sandy beach with a herb layer consisting of ammophilous species.
 - A4: NW part of Acheron Delta; Wet meadows with *Juncus* spp., belt of reed vegetation along the irrigation ditches, Tamarisk thickets, cultivated land; Soils often flooded.
 - A5: N-NW part of Acheron Delta; Cultivated land, wet meadows with *Juncus* spp.
 - A6: Wider area of Vamvakia; Cultivated land, riparian vegetation, ditches, roadsides, phrygana vegetation; Altitude: 10–60 m.
 - A7: Wider area of Axoutis and Laspotopos; Macchia vegetation, rocky coasts, scrubs with *Tamarix* sp. and reed thickets, salt marshes, wet meadows with *Juncus* spp.; Altitude: 0–100 m.
 - A8: Odyssea Bay; Sandy beaches, Macchia vegetation, salt marshes, wet meadows with *Juncus* spp., cultivated land; Altitude: 0–10 m.
 - A9: East of Odyssea Bay; Cultivated land, scrubs with *Tamarix* sp. and reed vegetation, wet meadows with *Juncus* spp.
 - A10: Koumasaki; Macchia vegetation and forests with *Pinus halepensis*, narrow zones of wet meadows dominated by *Juncus* spp.; Altitude: 0–53 m.
 - A11: Wider area of Alonaki; Macchia vegetation, naturally regenerated habitats with *Pinus halepensis*, phrygana vegetation, scrub with *Tamarix* sp.; Altitude: 0–54 m.
 - A12: Valanidorachi; Phrygana and macchia vegetation, cultivated land; Altitude: 10–70 m.

Table 1
Life-form spectrum of the flora of Acheron Delta.

Life forms		Number of taxa		%
Therophytes		136		32.8
Th. scapose	131		31.57	
Th. reptant	4		0.96	
Th. rosulate	1		0.24	
Hemicryptophytes		102		24.8
H. scapose	76		18.32	
H. caespitose	13		3.13	
H. rosulate	7	1.69		
H. scandent	2		0.48	
H. reptant	4		0.96	
Chamaephytes		24		5.8
Ch. fruticose	3		0.72	
Ch. suffruticose	18		4.34	
Ch. succulent	2		0.48	
Ch. reptant	1		0.24	
Geophytes		32		7.7
G. bulbose	14		3.37	
G. rhizomatose	17		4.10	
G. radicose	1		0.24	
Phanerophytes		64		15.4
Mega- Phanerophytes	16		3.86	
Nano- Phanerophytes	48		11.56	
Hydrophytes		57		13.7
<i>Pleustophytes</i>				
Acro- Pleustophytes				
Hydrocharids	1		0.24	
Lemnids	1		0.24	
Meso- Pleustophytes				
Ceratophyllids	2		0.48	
<i>Rhizophytes</i>				
Hyperhydrides				
Graminids	22		5.31	
Herbids	20		4.82	
Sagittarids	1		0.24	
Ipomeids	1		0.24	
Floating-leaved				
Natopotamids	1		0.24	
Submerged				
Myriophyllids	3		0.72	
Magnopotamids	1		0.24	
Parvopotamids	4		0.96	

Table 2
Chorological spectrum of the flora of Acheron Delta.

Chorological group	Number of taxa	Percentage %
I. Widely distributed	186	45.1
Cosmopolitan	26	6.31
Subcosmopolitan	41	9.95
Paleotemperate	28	6.80
Eurasian	24	5.83
Circumboreal	12	2.91
European	28	6.80
Euroasian	7	1.70
Paleosubtropical	15	3.64
African	2	0.48
American	3	0.73
II. Mediterranean	215	52.2
Steno-Mediterranean	85	20.63
Euri-Mediterranean	130	31.55
III. Balkan	11	2.7
Endemics	10	2.43
Subendemics	1	0.24

(3 taxa), magnopotamids (1 taxon) and parvopotamids (4 taxa) and the Pleustophytes belong to the following three subcategories: hydrocharids (1 taxon), lemniids (1 taxon) and ceratophyllids (2 taxa). The other life-form categories, namely of Geophytes and Chamaephytes are present in much lower percentages (Table 1).

For the chorological analysis 412 taxa were taken into consideration (since there are 2 cultivated species: *Avena sativa*, *Pyrus communis* and 1 species of doubtful origin: *Vitis vinifera*). From this analysis the four chorological groups given in Table 2 have been distinguished and the following ascertainties have been made:

a. The Mediterranean group is dominant and comprises 215 taxa (52.2 %), of which 85 are Steno-Mediterranean and 130 are Euri-Mediterranean elements.

b. The group of Widespread taxa which includes a great number of geoelements (Cosmopolitan, Subcosmopolitan, Temperate, Eurasian, Tropical, etc.) constitutes the second group represented by 186 taxa (45.1 %).

c. The group of Balkan elements with a small percentage (2.7 %), add to the chorological composition of the delta.

4.2. Vegetation

The plant communities present in the vegetation complex of the Acheron Delta belong to the following types: ammophilous-ammonitro-

philous vegetation, vegetation of salt marshes, freshwater and brackish marshes, riparian forests, aquatic, macchia and phrygana vegetation, and remnants of *Quercus ithaburensis* subsp. *macrolepis* deciduous oak forest. The vegetation pattern is presented in Fig. 2. The syntaxonomic assignment of the plant communities is given in the following scheme:

Crithmo-Staticetea BR.-BL. 1974

Crithmo-Staticetalia MOLINIER 1934

Crithmo-Staticion MOLINIER 1934

Ammophiletea BR.-BL. & R. TX. 1943

Ammophiletalia BR.-BL. (1931)1943

Agropyron juncei (R. TX. 1945 in BR.-BL. & R. TX. 1952) GÉHU, RIV.-MART. & R. TX. 1972 in GÉHU & al. 1984

Sporobolo arenarii-Agropyretum juncei (BR.-BL. 1933) GÉHU, RIV.-MART. & R. TX. 1972 in GÉHU & al. 1984

Euphorbio terracinae Silenetum nicaeensis LAVRENTIADES 1964

Cakiletea maritimae R. TX. & PREISING 1950

Euphorbietalia peplis R. TX. 1950

Euphorbion peplis R. TX. 1950

Salsolo kali-Xanthietum strumarium OBERD. & R. TX. 1950

Thero-Salicornietea strictae (R. TX. 1954) R. TX. & OBERD. 1958

Thero-Salicornietalia strictae (R. TX. 1954) R. TX. & OBERD. 1958

Thero-Salicornion strictae (BR.-BL. 1933) R. TX. 1954

Salicornietum europaeae R. TX. 1974

Juncetea maritimi BR.-BL. 1952

Juncetalia maritimi BR.-BL. 1952

Juncion maritimi BR.-BL. 1952

Juncetum maritimo-acuti HORVATÍĆ 1934

Lemnetea minoris (R. TX. 1955) SCHWABE-BRAUN & R. TX. 1981

Lemnetalia minoris (R. TX. 1955) SCHWABE-BRAUN & R. TX. 1981

Lemnon minoris (OBERD. 1957) MÜLLER & GÖRS 1960

Lemno-Azolletum filiculoides BR.-BL. 1952

Ceratophylletea demersi DEN HARTOG & SEGAL 1964

Ceratophylletalia demersi DEN HARTOG & SEGAL 1964

Ceratophyllion demersi DEN HARTOG & SEGAL 1964

Ceratophylletum demersi DEN HARTOG & SEGAL 1964

Potametea pectinati KLIKA 1941

Potametalia pectinati W. KOCH 1926 corr. OBERD. 1979

Potamion pectinati W. KOCH 1926 em. OBERD. 1957

Potametum pectinati CARSTENSEN 1955

Hydrocharition morsus ranae RÜBEL 1933

Hydrocharitetum morsus-ranae VAN LANGENDONCK 1935

Nasturtietea officinalis ZOHARY 1973

Nasturtio-Glycerietalia PIGN. 1953

Glycerio-Sparganion BR.-BL. & SISSINGH 1942

Nasturtietum officinalis SEIBERT 1962

Phragmitetea R. TX. & PREISING 1942

Phragmitetalia W. KOCH 1926

Phragmiton communis W. KOCH 1926

Phragmitetum communis SCHWALE 1939

Quercu Fagetea BR.-BL. & Vlieger 1937

Populetales BR.-BL. 1931

Salicion albae SÓO 1940

Salicetum albae KÁRPÁTI 1962

Quercetea ilicis BR.-BL. 1947

Quercetalia ilicis BR.-BL. 1947

Oleo-Ceratonion BR.-BL. 1947

Oleo-Lentiscetum aegaeicum LUDWIG, KRAUSE & SEIDEL 1963

Pinetosum halepensis BARBERO & QUEZEL 1976

Juniperetosum phoeniceae BARBERO & QUEZEL 1976

Quercetosum cocciferae BARBERO & QUEZEL 1976

Cisto – Micromerietea OBERD. 1954

Cisto-Micromerietalia OBERD. 1954

Hyperico empetrifolii-Micromerion graecae BARBERO & QUEZEL 1989

4.2.1 Ammophilous – Ammonitrophilous Vegetation

The beach landscape and the associated psammophytic vegetation are encountered only in the locations of Odyssea Bay and Ammoudia and cover only 10.5 ha of the Acheron Delta. No special vegetation diversity is observed since only very narrow and small sandy areas exist (average width 30–35 m) in the study area. However, the following two ammophilous and one ammonitrophilous plant associations have been distinguished: *Euphorbio terracinae-Sileneum nicaeensis*, *Sporobolo-Elymetum farcti* and *Salsolo kali-Xanthietum strumarium*. These associations are characterized and dominated by the following species of the Classes Ammophiletea and Cakiletea maritimae: *Silene colorata*, *Euphorbia terracina*, *Medicago marina*, *Elymus farctus* (= *Agropyron junceum*), *Pancratium maritimum*, *Sporobolus pungens*, *Eryngium maritimum*, *Otanthus maritimus*, *Salsola kali*, *Xanthium strumarium*, etc.

As for the succession of vegetation from the seashore to the interior of the delta, differences are observed between the two above-mentioned sandy beaches. As a result of human interference, in Ammoudia beach an obscure zonation of the ammophilous vegetation is observed. This is because of the sparsely vegetated or totally bare sandy zone with a width of 10 to 30 m behind the partially washed-flat. *Euphorbio terracinae-Sileneum nicaeensis* and *Sporobolo-Elymetum farcti* develop in combination with ammonitrophilous species of *Salsolo kali-Xanthietum strumarium*, up to an artificial zone with *Eucalyptus* sp. and *Populus nigra*. In Odyssea bay however, after the bare sandy zone, a flat to gently inclined sandy belt covered by ammophilous-ammonitrophilous species with a low degree of cover-abundance exists. This zone is then succeeded by sand-dunes of 1–2 m in height, colonized by dense macchia vegetation dominated by *Juniperus phoenicea* (2–3 m height) and characterized by the following

species: *Pistacia lentiscus* (1.5–2 m), *Quercus coccifera* (0.7–1.3 m), *Asparagus acutifolius*, *Ruscus aculeatus*, *Smilax aspera*, *Phillyrea latifolia*. The transition inland continues with an extensive zone of halophytes (within the salt marshes) and another zone of brackish marshes with *Juncus* spp.

4.2.2 Rocky Vegetation

The rocky coasts of the studied wetland exist in the lower parts of the hills occurring in the estuaries of the River Acheron. These rocky formations, sprayed by the salty mist of surf waves, are colonized by a narrow pure (littoral) zone of halophytes characterized by a low number of salt tolerant species of the xero-halophytic *Crithmo maritimi*-*Limonietales* *pseudominuti* MOLINIER 1934 communities with a low cover-abundance degree, such as: *Crithmum maritimum*, *Limonium vulgare*, *Brassica cretica* subsp. *aegea* and *Capparis spinosa*. In the sublittoral belt (on the upper part of the calcareous hill slopes), sclerophyllous phytocoenoses are abundant.

4.2.3 Halophytic Vegetation

As a result of human impacts, the halophytic plant communities of the Acheron Delta show a low degree of diversity and occupy only small fragmented areas. The zonation of vegetation from the seashore inland, distinguishable in relatively undisturbed halophytic habitats (annual, perennial halophytic communities, transitional zone from saline to brackish soils), does not occur in the Acheron Delta. The vegetation zones recognized on its salt marsh-stands in the investigated wetland are:

a. A flooded, flat muddy zone directly influenced by the sea and covered by the therophytic pioneer halophytic association of *Salicornietum europaeae*.

b. A transitional zone towards the cultivated land (in some places higher than the sea-level) covered by brackish marshes of *Juncetalia maritimi* where halophytic and semi-halophytic species participate in the herb layer.

The *Salicornietum europaeae* appears uniform throughout the localities of its occurrence, since the dominant and usually the only species is *Salicornia europaea* which forms a carpet-like layer. It constitutes a characteristic pioneer plant association colonizing flat, flooded salty soils, with an average cover of about 80–90% in dense patches. In Odyssea Bay the structure of this association which colonizes interior habitats behind the psammophytic zone, is enriched by the following species with lower frequency of occurrence and coverage: *Halimione portulacoides*, *Cressa cretica*, *Cotula coronopifolia*, *Arthrocnemum macrostachyum* (= *A. glaucum*), *Plantago coronopus*, *Hordeum marinum* etc.

Depending on the microrelief (small concave hollows lower than the sea-level) various halophytes participate in the herb layer of the transitional rush belt communities, important among them are: *Sarcocornia fruticosa*, *Salicornia europaea*, *Arthrocnemum macrostachyum*, *Juncus bufonius*, *Inula crithmoides*, *Triglochin bulbosa*, *Limonium vulgare*, *Pholiurus incurvatus*, *Parapholis filiformis*, *Cotula coronopifolia*, *Plantago coronopus*.

4.2.4 Vegetation of Brackish Marshes

In the brackish marshes of the delta, plant associations of marginal points with species of *Juncus* occur in the transitional zone from the recent marine deposits to the silty-clay, semi-terrestrial brackish soils. These habitats have been created by the inflow of freshwater into former saltmarsh locations due to the construction of irrigation ditches.

The predominant plant association which covers a large area of brackish soils in the Acheron Delta is the *Juncetum maritimo-acuti*, which is characterized by the dominance of rigid tussocks of *Juncus maritimus* and *J. acutus*. The other species participating in this association are: *Aster tripolium* subsp. *pannonicus*, *Samolus valerandi*, *Plantago major*, *Inula crithmoides*, *Calystegia sepium*, *Atriplex prostrata*, *Juncus effusus* etc.

This association occurs either along the bank of the irrigation ditches in the northern and south-western parts of the delta, where it occupies a zone 5–20 m in width, or on inland stands following a zone of reed thickets. In flat habitats east of Ammoudia beach which are flooded until May, the species composition of the wet meadow association is enriched with the following species: *Ranunculus trichophyllus*, *Scirpus maritimus*, *Scirpus lacustris* subsp. *tabernaemontani*, *S. litoralis*, *Salicornia europaea*, *Sarcocornia perennis*, *Triglochin bulbosa*, *Juncus bufonius*, *Ranunculus sardous*, *Holcus lanatus* etc.

4.2.5 Aquatic Vegetation

The following associations of aquatic vegetation (floating-leaved, submerged and emergent herbaceous vegetation) of the Acheron Delta participate in the formation of a more or less zonal arrangement parallel to the margins of the marshes, ditches and sections of the slow-flowing river:

a. The *Lemno-Azolletum filiculoides* is exclusively characterized by the dominance of *Azolla filiculoides* and occurs in relatively protected places of the ditches of the delta where the water is very slow-flowing or totally stagnant. Water depth ranges from 0.2–1 m. Further characteristic species are *Myriophyllum spicatum*, *Ceratophyllum demersum* and *Hydrocharis morsus-ranae*.

b. The *Hydrocharitetum morsus-ranae* prevails in open stagnant or slow-flowing water shaded by reed thickets. More often it occurs within

ditches at the southern and the northern parts of the Acheron Delta. In the structure of this association, apart from the dominant taxon which is the pleustophyte *Hydrocharis morsus-ranae*, a small number of species which characterize other aquatic associations in contact with *Hydrocharitetum* such as *Phragmites australis*, *Myriophyllum spicatum* and *Ceratophyllum demersum* also occur.

c. The *Ceratophylletum demersi* occurring in small shallow ponds and ditches with stagnant eutrophic water is almost exclusively composed of *Ceratophyllum demersum* and only in a few cases does *Myriophyllum spicatum* participate in its structure.

d. The *Potametum pectinati* mainly occurs in places close to the estuaries of the River Acheron which are characterized by slow-flowing water. However, it also occurs less frequently in ditches, stagnant mesotrophic or eutrophic water, and generally in locations with human influence. Apart from *Potamogeton pectinatus*, which is the physiognomically dominant species of this association, other taxa occurring with much lower frequency are *Myriophyllum spicatum* and *Ceratophyllum spicatum*.

e. *Nasturtietum officinalis* is a syntaxon of impressive appearance observed especially within the ditches of the northern and southern part of the Acheron Delta and forming great floating colonies. It is characterized by hemicryptophytes and the dominant species is the hyperhydric herb *Nasturtium officinale*. The floating colonies of this association surround the reed belts.

f. Dense and extensive reed communities develop on muddy soils along the banks of the ditches. They occur in high numbers in the southern part and also the northern part of the delta. The *Phragmitetum communis* is physiognomically characterized by *Phragmites australis* which grows in dense thickets in the freshwater of the ditches and ponds along the banks of the River Acheron and its tributaries. The most frequently occurring taxa in this species-poor association are: *Oenanthe aquatica*, *Veronica anagallis-aquatica*, *Typha latifolia*, *T. angustifolia*, etc. Beside this species-poor facies the more species-rich association of *Scirpo-Phragmitetum* develops in small, closed shallow ponds in the delta. The following taxa participate in its floristic composition: *Phragmites australis*, *Scirpus lacustris* subsp. *tabernaemontani*, *Sparganium erectum*, *Veronica anagallis-aquatica*, *Lythrum junceum*, *Typha angustifolia*, *T. latifolia*, *Mentha longifolia*, *Butomus umbellatus*, *Solanum dulcamara*, *Alisma plantago-aquatica* and *Veronica beccabunga* etc.

4.2.6 Scrubs with *Tamarix parviflora*

Dense scrubs (mean height 3–4 m) with *Tamarix parviflora* exist in various habitats of the northern part of the Acheron Delta and cover large areas. On account of the wide ecological amplitude of *Tamarix* sp. (places

surrounded by ditches, around bogs and close to cultivated land, namely on soils periodically flooded by freshwater, salt and brackish water, as well as on non-flooded areas) these thickets can be classified into three types with the following characteristics:

a. Dense bushes of *Tamarix parviflora* (pure stands), characterized by a poor flora in the openings.

b. Woodland with *Tamarix parviflora* in close vicinity to reed communities and cultivated land. Depending on the dominant species (*Phragmites australis* and *Tamarix parviflora*) it forms mosaic vegetation patterns in various places within the Tamarisk zone, in combination with nitrophilous species such as *Galactites tomentosa*, *Cynara cardunculus*, *Scolymus hispanicus* and *Urtica dioica* and hygrophilous species such as: *Oenanthe fistulosa*, *Lythrum junceum*, *Rumex conglomeratus*, *Epilobium hirsutum* etc. In some places within the periphery of the Tamarisk zone, the characteristic species of the association *Juncetum maritimo - acuti* (*Juncus maritimus* and *J. acutus*) are sparsely distributed.

c. On concave micro-elevations of the Tamarisk zone various obligatory halophytes form on salty soils well-developed halophytic patches within areas free of vegetation. They occur especially in biotopes where a high frequency of natural regeneration of *Tamarix parviflora* is observed. The halophytic species composition constitutes a special facies of the empty spaces within the Tamarisk belt.

The syntaxonomic assignment of the communities with *Tamarix parviflora* proved problematic and is thus not given in the present contribution.

4.2.7 Riparian Vegetation

Typical gallery forests occur along the River Acheron, although the width of this natural zone has been much reduced during the last 35 years (to less than 5 m in some places). This is because of the demand for more arable land on these fertile soils and hence the extension of cultivation at the expense of the natural riparian forest habitats. The *Salicetum albae* along the River Acheron is characterized by the following tree species: *Salix alba*, *S. fragilis*, *Alnus glutinosa*, *Ulmus minor*, *Platanus orientalis* and various climbers as *Periploca graeca*, *Tamus communis*, *Humulus lupulus*, *Hedera helix*, *Calystegia sepium*, *Clematis vitalba*, *Clematis flammula* etc.

Additionally, on account of the close vicinity of the riparian vegetation to arable land and human influences (grazing in the undergrowth of these riparian forests), various nitrophilous species such as *Rubus ulmifolius*, *Epilobium angustifolium*, *Conyza canadensis*, *Silybum marianum*, *Urtica dioica* etc. have been observed.

4.2.8 Surrounding Vegetation

Within the vegetation covering the surrounding hills of the Acheron Delta the following plant communities occur:

a. Well-structured forests with *Pinus halepensis*, developing on the Koumasaki and Alonaki hills at the southern parts of the delta area (Fig. 2). These are characterized by a high percentage of natural regeneration of the dominant tree species and the following main floristic composition: tree layer (*Pinus halepensis*, *Olea europaea* subsp. *oleaster*, *Phillyrea latifolia*), shrub layer (*Pistacia lentiscus*, *Quercus coccifera*, *Calicotome villosa*, *Anthyllis hermanniae*, *Sarcopoterium spinosum*, *Asparagus acutifolius*), herb layer with a moderate to high species diversity, and the following most frequently occurring taxa: *Brachypodium retusum*, *Prasium majus*, *Tamus communis*, *Clematis vitalba*, *Dactylis glomerata* and *Stipa bromoides*.

b. Scrubs with *Juniperus phoenicea* and *Euphorbia dendroides*. Mixed scrub communities occur on rocky soils of moderate to high inclination on the hills of the NW edges of the delta (Fig. 2), at altitudes ranging from 100–150 m. The physiognomically dominant species are *Juniperus phoenicea* and *Euphorbia dendroides* with a mean cover percentage of 40–70 % in combination with *Pistacia lentiscus* (50–60 % mean cover). Other participant species are: *Quercus coccifera* (mean cover degree 25–30 %), *Pistacia lentiscus*, *Rubia peregrina*, *Urginea maritima*, *Allium subhirsutum*, *Teucrium chamaedrys*, *Prasium majus*, *Myrtus communis* etc.

c. Macchia vegetation with *Quercus coccifera* and phrygana with *Phlomis fruticosa*. The typical occurrence of the closed arborescent macchia presents a very limited distribution in delta (small fragmented patches), a homogenous floristic composition and different facies depending on the parent rock material, relief, altitude and distance from the sea. The main facies in the studied area are characterized by the following dominant species: *Quercus coccifera*, *Phillyrea latifolia* and *Pistacia lentiscus*. Apart from the dominant taxa, the following species also participate in the species composition: *Hippocrepis (Coronilla) emerus* subsp. *emeroides*, *Myrtus communis*, *Lonicera etrusca*, *Brachypodium sylvaticum* subsp. *sylvaticum*, *Prasium majus*, *Crepis fraasii*, *Rubia peregrina*, *Asparagus acutifolius* etc.

In the phrygana communities with *Phlomis fruticosa* which grow on the hills NE of the delta (Antilalos, Katara) the following taxa occur: *Phagnalon graecum*, *Satureja juliana*, *Osyris alba*, *Asphodelus aestivus*, *Calicotome villosa*, *Teucrium chamaedrys*, *Urginea maritima* and *Quercus coccifera* (low frequency of occurrence in its suffruticose form) together with a great diversity of other herb species: *Bituminaria bituminosa*, *Rhagadiolus stellatus*, *Acanthus spinosus*, *Crepis rubra*, *Lathyrus aphaca* etc. The recognized phrygana communities represent a degraded stage of the *Quercus coccifera* scrubland as became obvious from the vegetation study

of two plots of close proximity on the N-NE hilly slopes. One plot is characterized by dense macchie vegetation of *Quercus coccifera*, while in the second, which was recently burnt, a more or less typical phrygana structure has already established. The phrygana vegetation can be syntaxonomically assigned to the Alliance *Hyperico empetrifolii* – *Micromerion graecae*. For its distinction at the plant association level, more phytosociological relevées are needed.

d. Woodland with *Quercus ithaburensis* subsp. *macrolepis*. The open, sparsely arranged remnant forest stands with *Quercus ithaburensis* subsp. *macrolepis* colonize the eroded calcareous slopes of the hills NE of the delta. These stands represent degraded stages of extensive deciduous forests which formerly covered the area. Intense human pressure (fires, grazing, clearing) have lead to their present, degraded state. However, these forest stands are impressive and enhance the landscape of the whole delta from an aesthetic point of view. They are characterized by the following species: *Quercus ithaburensis* subsp. *macrolepis*, *Dictamnus albus*, *Paliurus spina-christi*, *Quercus coccifera*, *Osyris alba*, *Ruscus aculeatus*, *Phlomis futilcosa*, *Smilax aspera*, *Cercis siliquastrum*, *Pistacia terebinthus* and many herb species. The exact syntaxonomic assignment of this community is not yet possible, since further phytosociological relevées are necessary for the description of a new association.

4.3. Vegetation Changes

The analysis of a series of aerial photographs (1960, 1984) and verification in the field according to the present vegetation pattern, showed a substantial regression and loss of natural habitats in the Acheron Delta. In 1960, natural habitats (A, B, C, D, E, G in Table 3) covered 44.2 % of the total area (1630 ha) while by 1995 they covered 34.1 %, mainly due to the extension of agricultural land facilitated by the construction of an irrigation and drainage network during the 1960's. The total loss of natural habitats within 35 years is 163.8 ha. The modification of the natural vegetation to more or less degraded vegetation types is analysed and illustrated in table 3. One positive fact worth noting is that the present agricultural land has been fragmented into more and smaller fields which are separated by hedges of natural vegetation.

The main human influences acting on the natural habitats of the Acheron Delta during the last 35 years having causing qualitative (degradation) and quantitative (destruction) alterations of its ecological characteristics are the following: irrigation and drainage networks, extension of agricultural land and intensive monocultures, clearing of the riparian forest-vegetation, the tamarisk bush and reed vegetation, unwise use of agricultural chemicals, fire and grazing. A decline of forest and scrub communities in the surrounding hills has been noted with an increase of

Table 3

Vegetation changes (in ha) in Acheron Delta (1960-1995).

A: Sand-dune vegetation, B: Salt marsh vegetation & Rush belt, C: Reed and Tamarisk belt, D: Riparian belt, E: Cultivated land, F: Macchia vegetation, G: Phrygana vegetation, H: Other land uses (roads, ditches, hamlets, etc). Positive percentage of change (+), Negative percentage of change (-).

Year	A	B	C	D	E	F	G	H
1960	12.5	153.3	266.0	160.0	832.2	109.5	19	77.5
1995	10.5	111.0	197.0	120.0	989.0	80	38	84.5
Changes of area in ha	-2	-42.3	-69	-40	+156.8	-29.5	+19	7.0
Percentage change	16 (-)	27.6 (-)	25.9 (-)	25 (-)	18.8 (+)	26.9 (-)	100 (+)	9 (+)

phrygana from 19 ha to 38 ha and a decrease of macchia vegetation from 109.5 ha to 80 ha.

5. Discussion

In spite of the fact that the Acheron Delta has suffered considerable degradation and/or destruction of its natural habitat types (vegetation syntaxa), it still retains high ecological value.

The floristic richness of this coastal wetland (415 taxa) is considered to be quite significant, especially if we take into consideration data concerning larger delta and other coastal areas, such as Acheloos Delta with 346 taxa (SZLIJ 1983), Louros-Arachthos Delta with 295 taxa (SZLIJ 1981), Kalamas Delta with 400 taxa (GEORGIADIS 1994), Evros Delta with 350 taxa (BABALONAS 1981, BABALONAS 1986), and the Strofilia coastal area with 450 taxa (GEORGIADIS & al. 1990). However, it must be pointed out that research on the wetland flora of Greece has been much neglected until now, resulting in an unsatisfactory level of floristic knowledge of the Greek wetlands. Moreover, the existing floristic studies have hardly done any justice to the various wetlands and are thus unable to present a real picture of the Greek flora. Although these data are considered significant they are currently insufficient to allow the comparison of the surface of each coastal and delta area with its floristic diversity. It has also been pointed out by HELIOTIS 1988 and VERHOEVEN 1992, that the information on vegetation types and plant species of the wetlands of Greece, is far from complete, thus it is impossible to indicate their most characteristic botanical values with any precision.

The relatively high number of aquatic macrophytes (57 taxa) adding to the biological spectrum of the flora of the Acheron Delta with a percentage of 13.7% of the total flora, is indicative of the ecological status of the

partly well-conserved natural potential of the wetland. Moreover, taking into consideration the wetland species (species which according to VERHOEVEN 1992 spend only part of their lifecycle in an aqueous environment or are only partially submerged) and the fully aquatic species also occurring in Acheron Delta, the total number of species runs to 75 (18%). The wetland character of the flora of Acheron Delta could increase with the application of a rational sustainable management plan.

From the species list, the presence of the following taxa must be outlined:

- *Cotula coronopifolia* is a xenophyte with a very limited occurrence. It is currently known in Greece from Mesologion delta area in Western Sterea Ellas (Aetoloakarnania), Strofilia coastal area (Kotichi lagoon, Lania and Prokopos lakes) and the port of Killini opposite the island of Zakynthos on the NW coasts of Peloponnisos (HANSEN 1986, KOUMPLI-SOVANTZI 1986, GEORGIADIS & al. 1990, KOUMPLI-SOVANTZI 1991). This first record of *C. coronopifolia* from Epiros extends its northerly known distribution range.

- *Azolla filiculoides* is a small aquatic free-floating fern widely distributed in Europe which, according to present knowledge, is only distributed in Greece in Lake Trichonis of Aetoloakarnania (KOUMPLI-SOVANTZI 1989), the Rivers Loudias, Axios and Richios (Rendina), and the Lakes Volvi and Kerkini of Northern Greece, and River Kalamas and Lake Pamvotis of Epiros (TSAKIRI & al. 1994, SARIKA-HATZINIKOLAOU & al. 1993). The first record of this, most probably, rarely collected species from an intermediate wetland (Acheron Delta) between the wetlands of Aetoloakarnania (Lake Trichonis) and Epiros (Kalamas Delta) contributes to the knowledge of its distribution range in Greece.

- *Brassica cretica* subsp. *aegea*: A chasmophyte distributed in Greece (Aegean Islands, Thrace, Macedonia, Attica, Evvia, Ionian Islands), SW Anatolia and Israel (SNOGERUP & al. 1990), is its first record from Epiros and generally from the wider area of Western mainland Greece.

- *Dictamnus albus*: A species reported as rare in the Greek flora, occurring on calcareous rocky soils of limited mountainous areas of Thessalia, Sterea Ellas, Peloponnisos and Macedonia (HALÁCSY 1901). It is its first report from Western Sterea Ellas and the surrounding hills of the coastal areas of Epiros.

- *Lippia nodiflora*: An adventive species, according to existing information (KOUMPLI-SOVANTZI 1983, HALÁCSY 1902, 1908, 1912), distributed in Thrace, Sterea Ellas, Aetoloakarnania (Lakes of Ozeros, Lysimachia, Trichonis), Peloponnisos, Ionian Islands, Aegean Islands and Crete. It is reported for the first time from Epiros.

From the results of the vegetation analysis and description, it is obvious that the Acheron Delta is a mosaic of many different wetland habitat

types, such as freshwater, salt and brackish marshes and riparian and sand-dune communities, in various combinations of spatial arrangement. It is an heterogeneous wetland with small-scale spatial variation, that constitutes a particularly suitable habitat for many vertebrate species (especially birds, amphibians and mammals), as these often require more than one structural vegetation type for their various life functions. The ecological importance of this wetland on the basis of the above mentioned floristic and vegetational data, is further supported by the high number of vertebrates recorded in the estuary ecosystems and the surrounding vegetation (19 fish, 5 amphibians, 20 reptiles, 18 mammals and 85 bird species) (DIMOPOULOS & al. 1994).

The diversity of the habitats of the wetland vegetation of Acheron, based on the number of recognized syntaxonomic units within the major vegetation types, decreases in the following order: aquatic communities (submerged, 3; floating, 3; emergent, 2), ammophilous-ammonitrophilous communities (3), halophytic communities (1), brackish marsh communities (1) and scrubs with *Tamarix parviflora* (1).

The plant communities recognized within the Acheron Delta ecosystems are characterized by different degrees of human impact (estimated on the basis of the representation of their structure and groups of indicator species). These habitats can be arranged from the most to the least influenced as follows: reed and tamarisk vegetation, riparian vegetation, vegetation of brackish marshes, ammophilous vegetation, aquatic vegetation, and leastly, halophytic vegetation. The alluvial river forests, of which only a small and degraded stretch remains, are still strongly threatened by logging and grazing.

Acheron Delta is an important coastal wetland that must be directly protected and measures must be taken to ensure the conservation and restoration of its natural ecosystems. The basic steps of a proposed sustainable management and conservation plan are the outlined below:

a. Extension of the riparian zone to a minimum width of 30–50 m by planting species such as *Salix alba*, *Alnus glutinosa* and *Populus alba*.

b. Restoration of the impoverished aquatic plant communities (saline and freshwater marshes) and sand-dune formations, either by the reintroduction of native species from the studied area, or preferably by the application of protection measures for these sensitive habitats in order for natural succession of the vegetation to be established.

c. Tree planting on the surrounding hills NE of the Acheron Delta with *Quercus ithaburensis* subsp. *macrolepis*, at first in places still characterized by the presence of relatively fertile soils and later over the remaining area according to soil improvement.

d. Abandoning cultivation in places of close proximity to natural plant communities, characterized by soils of high salinity and humidity (soils of

low agricultural productivity), with the aim of not affecting the natural succession of salt and brackish-marsh vegetation and the scrub vegetation with *Tamarix* sp. and reed thickets.

e. Incorporation of the Acheron Delta into the EC Regulation 2078/92 concerning methods of agricultural production in harmony with the conservation and restoration of the natural environment and ecological management of agriculture.

f. Control of tourism and urban development in ecologically significant and sensitive habitats.

g. Control of grazing not only within the delta plain of Acheron, but also in the drainage basin of the River Acheron.

h. Delimitation of protection zones including all areas covered with natural vegetation within the wetland area, as well as the surrounding vegetation which constitutes an integral component of the coastal wetland ecosystems, and also cultivated land located close to natural vegetation, which in some cases has already been abandoned.

An inventory of the biodiversity of the wetlands of Greece is the only effective means for planning rational sustainable conservation and management plans for their natural environment. With the assistance of EU regulations it is possible to reach an agreement with the local population, since they constitute the most important factor for the application of protection and management measures, and thus for active protection.

6. Plant list

A1–A12 refers to the collecting sites shown in Fig. 2. The numbers in brackets are herbarium collection numbers, obs. = observed, without herbarium species.

Pteridophyta

Azollaceae

Azolla filiculoides – A11(7369).

Equisetaceae

Equisetum palustre – A6(7392),

A11(7400).

E. ramosissimum – A4(7471), A6(7504).

E. telmateia – A11(7512).

Polypodiaceae

Asplenium ceterach – A1(7510),

A7(7532).

A. trichomanes subsp. *inexpectans* –

A1(7555), A2(7569).

Pteridium aquilinum – A2(7370),

A11(obs.).

Gymnospermae

Cupressaceae

Juniperus phoenicea – A1(7472),

A10(obs.).

Ephedraceae

Ephedra fragilis – A1(7505), A2(7486),

A7(obs.).

Pinaceae

Pinus halepensis – A10(7581),

A11(obs.).

Dicotyledones

Acanthaceae

Acanthus spinosus – A2(7393),

A6(7374).

Amaranthaceae

Amaranthus albus – A5(7691),

A9(7644).

Anacardiaceae

Cotinus coggygria – A1(7506).

Pistacia lentiscus – A1(7371), A7(obs.).

P. terebinthus subsp. *terebinthus* –

A2(7449), A12(obs.).

Apocynaceae

Nerium oleander – A2(7523).

Araliaceae

Hedera helix – A1(7401), A6(obs.).

Aristolochiaceae

Aristolochia rotunda – A1(7385),
A8(7511).

Asclepidiaceae

Cynanchum acutum – A4(7473).

Periploca graeca – A7(74513).

Vincetoxicum hirundinaria subsp. *hirundinaria* – A1(7650), A7(7544).

Betulaceae

Alnus glutinosa – A6(7450).

Boraginaceae

Alkanna orientalis – A2(7372).

A. tinctoria subsp. *tinctoria* – A4(7514),
A3(7700).

Cerinthe major – A7(7474).

Cynoglossum creticum – A7(7507).

C. officinale – A7(7741).

Echium italicum – A6(7647).

E. plantagineum – A6(7397).

Lithospermum purpureocaeruleum –
A7(7475).

Butomaceae

Butomus umbellatus – A4(7515),
A8(7722).

Campanulaceae

Campanula ramosissima – A2(7373),
A6(7649).

C. spatulata subsp. *spruneriana* –
A7(7533), A10(7584).

C. versicolor – A2(7487), A7(obs.).

Solenopsis laurentia – A7(7918).

Cannabaceae

Humulus lupulus – A6(7476).

Capparaceae

Capparis spinosa – A7(7757).

Caprifoliaceae

Lonicera etrusca – A7(7386).

Sambucus ebulus – A5(7692).

Caryophyllaceae

Arenaria serpyllifolia – A1(7451),
A8(7703).

Cerastium glomeratum – A4(7508).

Petrorhagia velutina – A1(7516).

P. obcordata subsp. *epirotica* –
A7(7534).

P. saxifraga – A1(7761).

Silene colorata subsp. *colorata* –
A3(7723).

S. sedoides – A3(7923), A8(7940).

Spergularia bocconii – A7(7402).

Ceratophyllaceae

Ceratophyllum demersum subsp. *demersum* – A4(7477), A9(7759).

C. submersum – A4(7601), A9(7760).

Chenopodiaceae

Arthrocnemum macrostachyum –
A7(7452).

Atriplex prostrata – A4(7375).

A. portulacoides – A4(7448).

Salicornia europaea – A4(7625).

Salsola kali subsp. *kali* – A3(7586),
A8(7774).

Sarcocornia fruticosa – A5(7693).

Cistaceae

Cistus creticus subsp. *creticus* –
A1(7509), A7(obs.).

C. monspeliensis – A10(7626).

C. salviifolius – A10(7781).

Fumana arabica – A7(7404).

Helianthemum nummularium subsp.
nummularium – A1(7899), A7(7535).

Compositae

Anthemis arvensis subsp. *arvensis* –
A1(7453), A2(7570).

A. arvensis subsp. *incrassata* –
A2(7669), A7(7536).

A. tinctoria – A1(7948), A4(7955).

Aster tripolium subsp. *pannonicus* –
A4(7517).

Bellis annua – A4(7518), A6(7790).

Carduus pycnocephalus – A5(7479),
A4(7624).

Carlina corymbosa subsp. *graeca* –
A7(7403).

C. frigida – A2(7663).

Carthamus dentatus – A11(7387).

C. lanatus – A12(7803).

Centaurea calcitrapa – A4(7478).

C. solstitialis – A5(7814).

Chamomilla recutita – A4(7613).

Cichorium intybus – A7(7929),
A10(7583).

- Conyza bonariensis* – A4(7602), A6(7786).
C. canadensis – A4(7376).
Cotula coronopifolia – A8(7633).
Crepis foetida subsp. *commutata* – A7(7388).
C. fraasii – A1(7771), A2(7665).
C. rubra – A1(7454), A7(7816).
Cynara cardunculus – A6(7628).
Dittrichia viscosa – A2(7673).
Echinops sphaerocephalus subsp. *sphaerocephalus* – A2(7390).
Evax pygmaea – A7(7537).
Galactites tomentosa – A2(7488).
Hedypnois cretica – A6(7396).
Hyoseris scabra – A1(7932), A7(7538).
Hypochoeris achyrophorus – A7(7828).
H. cretensis – A7(7405).
Inula crithmoides – A6(7646).
Lactuca saligna – A4(7654).
L. serriola – A4(7957).
Leontodon crispus subsp. *crispus* – A1(7389), A2(7677).
Notobasis syriaca – A6(7801).
Onopordum illyricum – A2(7377), A6(7802).
Otanthus maritimus – A3(7592), A8(7778).
Pallenis spinosa – A2(7571), A7(7827).
Picnomon acarna – A12(7805).
Picris echioides – A4(7793), A11(7835).
P. altissima – A1(7924), A7(7539).
Phagnalon graecum – A1(7958).
Pulicaria dysenterica – A4(7603).
P. odora – A4(7752), A6(7800).
Reichardia picroides – A1(7641), A7(7825).
Rhagadiolus stellatus – A3(7378), A7(7540), A12(7804).
Scolymus hispanicus – A1(7764), A11(7834).
Senecio bicolor – A4(7922).
S. vulgaris – A1(7379), A11(7855).
Silybum marianum – A7(7937), A4(obs.).
Sonchus asper subsp. *asper* – A2(7480).
S. oleraceus – A6(7391).
Tussilago farfara – A6(7798).
Urospermum picroides – A7(7541).
Xanthium spinosum – A6(7794).
X. strumarium – A3(7589), A6(7394).
Convolvulaceae
Calystegia sepium – A7(7406), A6(7395).
Convolvulus althaeoides – A2(7572).
C. arvensis – A1(7636), A12(7806).
C. elegantissimus – A2(7672).
Cressa cretica – A8(7519).
Cornaceae
Cornus mas – A6(7796).
C. sanguinea – A6(7651).
Corylaceae
Carpinus orientalis – A7(7542).
Ostrya carpinifolia – A2(7489).
Cruciferae
Arabis hirsuta – A2(7381).
A. sagittata – A2(7678), A11(7832).
Brassica cretica subsp. *aegea* – A7(7455).
Cakile maritima – A3(7593).
Capsella bursa-pastoris – A5(7380).
Clypeola jonthlaspi – A2(7481), A11(7842).
Malcolmia graeca – A7(7543), A2(7858).
Matthiola sinuata – A7(7824).
Nasturtium officinale – A4(7604), A8(7777).
Sinapis alba subsp. *alba* – A5(7382), A6(7797).
Sisymbrium officinale – A6(7520), A4(7694).
Cucurbitaceae
Bryonia alba – A6(7789).
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Dipsacus fullonum – A4(7652), A11(7856).
Knautia integrifolia – A4(7656), A6(7417), A11(7849).
Ericaceae
Arbutus unedo – A7(7826).
Euphorbiaceae
Euphorbia dendroides – A1(7768).
E. exigua – A11(7921), A4(7618).
E. helioscopia – A3(7599), A8(7742).
E. peplis – A3(7598), A9(7892).
E. terracina – A3(7704), A4(7872).

Fabaceae

- Anthyllis hermanniae* – A2(7383),
A7(7545).
Astragalus hamosus – A1(7773),
A2(7456).
Bituminaria bituminosa – A2(7577),
A4(obs.).
Calicotome villosa – A2(7398), A7(obs.).
Cercis siliquastrum – A2(7482).
Coronilla scorpioides – A4(7698),
A11(7841).
Dorycnium herbaceum – A2(7399),
A4(7876).
D. hirsutum – A2(7490), A7(7407).
D. rectum – A6(7630).
Galega officinalis – A6(7521).
Hippocrepis emerus subsp. *emeroides* –
A2(7864), A7(7546).
Hymenocarpus circinnatus – A4(7609),
A8(7780).
Lathyrus aphaca – A2(7671),
A12(7813).
Lotus corniculatus – A2(7690),
A10(7582).
Medicago littoralis – A3(7933).
M. lupulina – A7(7547), A1(7643).
M. marina – A3(7705), A8(7635).
M. orbicularis – A3(7588), A4(7614).
M. polymorpha – A3(7384), A9(7645).
M. truncatula – A4(7925).
Ononis reclinata – A1(7938).
O. spinosa – A2(obs.), A6(7491).
O. viscosa (s.l.) – A4(7493).
Scorpiurus muricatus – A4(7659),
A8(7710).
Spartium junceum – A2(obs.),
A7(7408).
Trifolium angustifolium – A7(7548),
A4(7753).
T. aureum – A4(7607).
T. campestre – A2(7492), A11(7831).
T. lappaceum – A2(7676), A9(7725).
T. physodes – A2(7679).
T. resupinatum – A1(7927), A2(7457).
T. scabrum – A3(7594), A2(7483).
T. stellatum – A1(7928), A12(7810).
Trigonella balansae – A2(7891).
Vicia parviflora – A4(7642).

V. sativa subsp. *nigra* – A2(7494).

Fagaceae

- Quercus coccifera* – A1(755 6), A7(obs.),
A12(obs.).
Q. ithaburensis subsp. *macrolepis* –
A2(7731).

Gentianaceae

- Blackstonia acuminata* – A4(7620),
A9(7723).
Centaurium erythraea subsp. *erythraea*
– A4(7458), A8(7557).
C. pulchellum – A9(7936).
C. spicatum – A1(7945).
C. tenuiflorum – A4(7930).

Geraniaceae

- Erodium cicutarium* – A4(7495),
A12(7809).
E. malacoides – A2(7920).
Geranium columbinum – A4(7941).
Guttiferae
Hypericum spruneri – A2(7686),
A4(7619).

Haloragaceae

- Myriophyllum spicatum* – A4(7655).

Labiatae

- Coridothymus capitatus* – A2(7409),
A12(7459).
Marrubium vulgare – A4(7877).
Mentha longifolia – A4(7748),
A11(7840).
M. pulegium – A4(7884), A8(7713).
Phlomis fruticosa – A1(obs.), A2(7484),
A7(obs.).
Prasium majus – A2(7682), A7(7550).
Prunella vulgaris – A4(7883), A9(7724).
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S. virgata – A4(7875).
Satureja juliana – A1(7558), A7(7549).
S. nepeta – A8(7776).
Stachys germanica subsp. *heldreichii* –
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S. mollissima – A1(7949).
S. palustris – A6(7648).
S. spinulosa – A1(7770).
Teucrium chamaedrys – A2(7675),
A7(7823).
T. capitatum – A1(7767), A2(7662).
T. flavum – A7(7551).

T. scordium subsp. *scordioides* – ECON-
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Lauraceae

Laurus nobilis – A2(7410), A7(obs.).

Linaceae

Linum bienne – A7(7822), A4(7878).

L. pubescens – A3(7587), A9(7744).

L. strictum subsp. *strictum* – A8(7709),
A7(7900).

Lythraceae

Lythrum junceum – A4(7460),
A6(7631).

Malvaceae

Abutilon theophrasti – A9(7729).

Althaea officinalis – A2(7485),
A6(7522).

Lavatera punctata – A2(7861).

Malva sylvestris – A2(7411), A4(7611).

Moraceae

Ficus carica – A2(7666), A7(obs.).

Myrtaceae

Myrtus communis – A2(7574), A7(obs.).

Oleaceae

Ligustrum vulgare – A7(7821).

Olea europea subsp. *oleaster* – A1(obs.),
A2(obs.), A11(obs.).

Phillyrea latifolia – A7(obs.), A11(obs.).

Onagraceae

Epilobium angustifolium – A4(7657),
A6(7799).

E. hirsutum – A6(7524), A11(7830).

Plantaginaceae

Plantago afra – A4(7496).

P. arenaria – A4(7893).

P. bellardii – A3(7912).

P. coronopus subsp. *coronopus* –
A4(7608).

P. crassifolia – A8(7712), A3(7706).

P. lagopus – A3(7595), A4(7874).

P. lanceolata – A4(7880), A7(7743).

P. major subsp. *major* – A7(7552),
A6(7795).

Platanaceae

Platanus orientalis – A6(obs.).

Plumbaginaceae

Limonium narbonense – A8(7634),
A7(7758).

Polygonaceae

Polygonum maritimum – A3(7916).

P. salicifolia – A6(7917), A4(7942).

Rumex conglomeratus – A4(7497),
A11(7839).

R. pulcher (s.l.) – A6(7525).

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Portulaca oleracea subsp. *oleracea* –
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Primulaceae

Anagallis arvensis – A2(7419),
A6(7629).

Samolus valerandi – A4(7699).

Ranunculaceae

Clematis flammula – A6(7416),
A7(7441).

C. vitalba – A6(7527).

Consolida ajacis – A7(7462), A12(7811).

Delphinium peregrinum – A2(7871),
A7(7553).

Ranunculus baudotii – ECONOMIDOU
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Ranunculus bulbosus subsp. *aleae* –
A4(7894).

R. muricatus – A4(7913).

R. sardous – A4(7442).

R. trichophyllus subsp. *trichophyllus* –
A4(7498).

Rhamnaceae

Paliurus spina-christi – A2(7683),
A11(obs.).

Rhamnus alaternus subsp. *alaternus* –
A2(7863), A7(obs.).

Rosaceae

Agrimonia eupatoria – A2(7687),
A4(7653).

Crataegus monogyna – A2(7444),
A7(7554).

Potentilla reptans – A2(7870),
A9(7727).

Pyrus amygdaliformis – A2(7866),
A12(7813).

P. communis – A2(obs.).

Rosa sempervirens – A6(7443),
A11(7829).

Rubus ulmifolius – A6(7526),
A11(7843).

Sanguisorba minor subsp. *muricata* –
A1(7637), A2(7901).

- Sarcopoterium spinosum* – A2(7868), A12(7808).
- Rubiaceae**
- Crucianella angustifolia* – A7(7445), A10(7585).
- Galium aparine* – A6(7792).
- G. palustre* – A4(7749).
- G. verum* – A1(7560), A7(7820).
- Rubia peregrina* – A7(7463), A8(7715).
- Sherardia arvensis* – A2(7689), A11(7838).
- Rutaceae**
- Dictamnus albus* – A2(7440).
- Salicaceae**
- Populus alba* – A6(7466).
- P. nigra* – A6(7529).
- Salix alba* – A6(7528), A11(7850).
- S. amplexicaulis* – A6(7468), A11(7853).
- S. elaeagnos* – A6(7943).
- S. fragilis* – A6(7467), A7(7847).
- Santalaceae**
- Osyris alba* – A2(7439).
- Scrophulariaceae**
- Misopates orontium* – A4(7449).
- Scrophularia canina* – A2(7667), A7(7851).
- Verbascum blattaria* – A4(7658).
- V. sinuatum* – A3(7446), A7(7844).
- Veronica anagallis-aquatica* – A6(7412), A11(7854).
- V. arvensis* – A1(7926), A10(7934).
- V. beccabunga* – A4(7615), A7(7885).
- Kickxia commutata* subsp. *graeca* – A7(7819).
- Solanaceae**
- Datura stramonium* – A4(7612).
- Physalis philadelphica* – A9(7500).
- Solanum dulcamara* – A7(7561).
- S. nigrum* – A8(7711), A11(7837).
- Tamaricaceae**
- Tamarix parviflora* – A4(7879), A9(7728).
- Ulmaceae**
- Celtis australis* – A2(7664).
- Ulmus minor* – A6(7531), A11(obs.).
- Umbelliferae**
- Apium nodiflorum* – A4(7469), A11(7846).
- Bupleurum glumaceum* – A1(7896), A10(7902).
- Crithmum maritimum* – A1(7947), A3(7414).
- Daucus carota* – A4(7464), A11(7851).
- D. guttatus* – A3(7591).
- Eryngium amethystinum* – A1(7765).
- E. campestre* – A1(7438).
- E. maritimum* – A3(7596).
- Foeniculum vulgare* – A6(7501).
- Oenanthe aquatica* – A7(7447), A6(7895).
- O. fistulosa* – A4(7600).
- Opopanax hispidus* – A7(7562).
- Orlaya daucoides* – A2(7867).
- O. daucorlaya* – A3(7590), A4(7621).
- Sanicula europaea* – A4(7606), A7(7413).
- Scaligeria napiformis* – A7(7563).
- Smyrniolum rotundifolium* – A2(7573), A7(7848).
- Tordylium apulum* – A4(7881), A6(7791).
- Torilis arvensis* subsp. *arvensis* – A4(7670), A6(7530), A11(7845).
- T. nodosa* – A7(7818).
- Urticaceae**
- Parietaria officinalis* – A2(7684), A7(7833).
- Urtica dioica* – A2(7860), A4(7750).
- Urtica pilulifera* – A4(7470).
- Valerianaceae**
- Centranthus ruber* – A2(7674), A7(7836).
- Verbenaceae**
- Lippia nodiflora* – A4(7660).
- Verbena officinalis* – A6(7502), A8(7632).
- Vitex agnus* – castus – A2(7668), A7(7817).
- Vitaceae**
- Vitis vinifera* subsp. *sylvestris* – A6(7465).
- Zygophyllaceae**
- Tribulus terrestris* – A5(7437).
- Monocotyledones**
- Alismataceae**
- Alisma plantago-aquatica* – A7(7564).

*Amaryllidaceae**Pancratium maritimum* – A3(7415).*Araceae**Arum italicum* – A1(7640), A6(7503).*A. maculatum* – A2(7681), A5(7815).*Cyperaceae**Carex flacca* subsp. *serrulata* –

A4(7886), A9(7730).

Cyperus longus – A4(7695), A9(7903).*Eleocharis palustris* – A4(7418),

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Scirpus cernuus – A4(7696), A8(7716).*S. holoschoenus* – A3(7701).*S. lacustris* subsp. *tabernaemontani* –

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S. litoralis – A4(7882), A8(7708).*S. maritimus* – A4(7873), A8(7714).*Dioscoreaceae**Tamus communis* – A1(7904), A6(7788),

A10(obs.).

*Gramineae**Aeluropus littoralis* – A8(7898).*Aira elegantissima* – A1(7772).*Alopecurus creticus* – A7(7566).*Avena sativa* – A6(7436).*A. sterilis* subsp. *ludoviciana* –

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A2(7919).

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Briza maxima – A2(7435).*B. media* – A10(7782), A2(7755).*B. minor* – A11(7905).*Bromus hordeaceus* subsp. *molliformis*

– A4(7745).

B. madritensis – A3(7597), A4(7734).*B. rigidus* – A3(7914).*B. sterilis* – A3(7707), A10(7939).*Crypsis aculeata* – A8(7887).*Cynodon dactylon* – A4(762 2), A8(obs.),

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Cynosurus echinatus – A4(7756),

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Echinaria capitata – A1(7433).*Elymus farctus* – A3(7783), A8(7946).*E. pycnanthus* – A3(7702), A7(7565),

A8(7906).

E. pungens subsp. *campestris* –

A4(7355).

Festuca arundinacea – A4(7357).*Holcus lanatus* – A7(7568), A4(7907).*Hordeum bulbosum* – A1(7639).*H. hysrix* – A2(7434).*H. marinum* subsp. *leporinum* –

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H. murinum – A10(7431).*Hypparhenia hirta* – A2(7575),

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Lagurus ovatus – A3(7737), A8(7779).*Lolium rigidum* – A4(7954), A6(7931).*Melica ciliata* – A2(7430), A10(obs.).*Parapholis filiformis* – A10(7733),

A3(7360), A3(7361).

P. incurva – A8(7719).*Phalaris minor* – A5(7739).*Phragmites australis* – A4(7623),

A7(obs.), A11(obs.).

Piptatherum miliaceum subsp. *milia-**ceum* – A7(7889), A1(7747).*Poa trivialis* subsp. *sylvicola* –

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Polypogon monspeliensis – A4(7421),

A8(7908).

P. viridis – A7(7567).*Saccharum ravennae* – A (7732).*Sorghum halepense* – A8(7717),

A2(7736).

Sporobolus pungens – A8(7754).*Stipa bromoides* – A4(7784), A10(7935).*Hydrocharitaceae**Hydrocharis morsus-ranae* – A4(7420),

A9(7888).

*Iridaceae**Gladiolus illyricus* – A1(7769).*Romulea linairesii* subsp. *graeca* –

A4(7638).

*Juncaceae**Juncus acutus* – A4(7697), A8(7721),

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- J. articulatus* – A4(7950), A8(7951).
J. bufonius – A8(7952).
J. effusus – A4(7956).
J. maritimus – A4(7751), A8(7718).
Juncaginaceae
Triglochin bulbosa – A8(7775).
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Allium ampeloprasum – A7(7428).
A. guttatum subsp. *sardoum* – A2(7688), A5(7909).
A. subhirsutum – A1(7762), A2(7859).
A. trifoliatum – A3(7423).
A. vineale – A1(7910), A11(7915).
Asparagus acutifolius – A2(7862), A10(7627), A1(obs.).
Asphodelus aestivus – A2(7869), A11(obs.).
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Orchis laxiflora – A4(7422).
Serapias vomeracea subsp. *vomeracea* – A1(7766).
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Potamogeton crispus – A4(7424), A9(7910).
P. natans – A4(7426).
P. pectinatus – A4(7425).
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Ruppia maritima – A3(7787), A8(7942).
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Typha angustifolia – A8(7720), A9(7726).
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Autor(en)/Author(s): Georgiadis Theodoros, Dimopoulos Panayotis
Panayotis, Dimitrellos Georgios

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