Halophyte Plant Diversity, Coastal Habitat Types and Their Conservation Status in Cyprus

M. Öztürk, S. Gucel, A. Guvensen, C. Kadis, and C. Kounnamas

Abstract This chapter focuses on the identification, description and determination of the conservation status of the halophytic plant diversity and the coastal habitat types of Cyprus. The chapter presents the results of a study that was undertaken during 2006–2008 in the coastal zone of Cyprus, which revealed that a total of 457 plant taxa with distinct features are distributed along a 770 km long coastline; 129 being typical halophytes. The taxa dominating the major intact habitats along the coast are *Limonium* spp., *Mesembryanthemum* spp., *Euphorbia paralias, Pancratium maritimum, Eryngium maritimum, Medicago marina, Taraxacum aphrogenes, Otanthus maritimus* and *Cakile maritima.* The saline habitats along the coast and alongside the internationally important salt lakes of Larnaca and Akrotiri (both included in the Ramsar list of Wetlands of International Importance) abound in halophytic taxa like *Salicornia* spp., *Arthrocnemum microstachyum, Suaeda vera, Juncus* spp., *Halimione portulacoides* and *Inula crithmoides*. These salt lakes serve as migration stations for a large number of migratory birds during their route from Europe to Africa and back. Their conservation value is related not only to their function as important bird habitats but also to their significant floristic diversity. The coastal waters of the island give shelter to 197 fish species and various species of crabs, sponges and echinoderms. The Green and the Loggerhead turtles breed regularly on the island's sandy beaches, some of which are strictly protected. The coastal zone has been seriously degraded over the last 25 years. The habitats in this zone face serious degradation problems due to economic, recreational and intensive tourist development. An attempt has been made here to present the information on the life forms and other features of the major plant taxa occuring within the coastal zone. The conservation status of the plant taxa has been identified according to the Red Data Book of the Flora of Cyprus and the criteria set by the IUCN: 6 taxa critically endangered, 12 endangered and 14 vulnerable. Moreover, in the coastal zone of Cyprus 16 habitats types that are included in the Habitats Directive (92/43/EEC) Annex I have been identified out of which 3 are classified as priority ones and need immediate conservation measures. Information on coastal endemics has also been included so that it can be utilised for future effective conservation action.

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1 Introduction

Cyprus is an island lying at a strategic location in the East Mediterranean with an area of 9,250 km^2 and 770 km long coastline, having Turkey in the north, Syria and Lebanon in the west and Egypt in the south. The indented coastline of the island -the third largest in the Mediterranean - is full of cliffy or rocky parts interchanging with small or large sandy or gravelly beaches. It is 240 km long from end to end and 100 km

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wide at its widest point. The name of the island is said to have originated from the Greek word for the Mediterranean Cypress tree or from the Greek name of the henna plant. However, some historians report that the name stems either from the Eteocypriot or Sumerian word for copper (zubar) or for bronze (kubar), because large deposits of copper ore are found in the country. Cyprus has given its name to the classical latin word for copper via overseas trade through the phrase *aes Cyprium*, i.e. metal of Cyprus, later shortened to *Cuprum – Copper*.

The extinction of dwarf hippos and elephants depicts the arrival of first humans (Simmons 2001) on the island. The earliest site of human activity is said to lie in the southern coastal part Aetokremnos. The site shows remains of hunter-gatherers dating back to 10000 BC (Mithen 2005). The remains of the oldest known settlements on the island date from 7000 to 3900 BC around the well preserved neolithic village Khirokitia (Wade 2007; Walton 2004). These remains bear witness to the existence of an ancient civilization which developed along the North and South coasts. Most Chalcolithic settlements (3900–2500 BC) are found in Western Cyprus. One comes across here the oldest water wells in the world dating back to 9,000–10,500 years (BBC 2009).

The data published on the biodiversity of Cyprus reveals that 7, 26 and 357 species of land mammals, amphibians/reptiles and birds, respectively, distribute on the island. The coastal waters abound of various species of crabs, sponges and echinoderma and give shelter to 197 fish species. The largest wild animal that still lives on the island is the Cyprus moufflon (*Ovis aries ophion*), a rare type of wild sheep found only in Cyprus. The sandy beaches on the coastal zone are typical breeding habitats for Green turtle (*Chelonia mydas*) and Loggerhead turtle (*Caretta caretta*). The island is used by millions of birds during their migration from Europe to Africa and back, the main reason being the presence of Larnaca and Akrotiri Salt Lakes. Cyprus is one of the few places on earth where the geological processes and microclimate have played an important role in the development of its habitat diversity and thus the rich biodiversity (BBC 2009).

With its approximately 2000 taxa of flowering plants, it is an extremely interesting island, which make it a botanist's paradise. The island's isolation has allowed an evolution of a strong endemic flora. This richness is further strenghtened by an incorporation of botanical elements from the neighbouring land masses, where 8% of the indigenous plants (145 taxa) are endemics. The aim of this review is to enlighten the environmental threats faced by the coastal zone plant diversity in Cyprus and present information for a geographical/taxonomical/ecological database of European coastal zone plants, thus contributing towards effective conservation action during the future planning programmes. The list of threatening factors has also been compiled.

2 Geology, Hydrology, Soils and Climate

Geomorphologically, the island is characterised by the ophiolitic complex of large Troodos mountain range displaying a variable relief with a predominance of slopes and rounded peaks as well as prevalence of vertical cliffs, steep slopes, gorges and deep gullies. It covers most of the southern and western parts of the island and accounts for roughly half of its area. The highest peak is Mount Olympus (1952 m above sea level), located in the center of this range. The small Kyrenia mountain range extends along the northern coastline. Both are dominating the central Mesaoria plain. There are six districts in the country (IPI 2007); Nicosia (Lefkosia-Lefkosa), Famagusta (Ammochostos-Gazimagusa), Kyrenia (Keryneia-Girne), Larnaca (Larnaka-Larnaka/Iskele), Limassol (Lemesos-/Leymosun) and Paphos (Pafos/Bafos-Baf/Gazibaf) (Fig. 1). The country is traversed by rivers and small and large streams, the largest being Pediaios, Gialias and Serrachis which rise from Troodos. The significant natural salt lakes of Larnaca and Akrotiri accummulate large volumes of water. There are also smaller lagoons like Paralimni and Galateia-Mehmetcik. The largest water reservoirs are Kouris and Asprokremmos, the former being at the homonymous river with a capacity of 115 million m^3 and the later on the Xeros river with a capacity of 51 million m^3. The indented coastline is full of small or extensive cliffy or rocky parts interchanging with small or large sandy or gravely beaches (Pantelas et al. 2003).

The area of arable land of the island is approximately 15% and the irrigated land is about 400 $km^{2.}$ For the purposes of this study soil samples collected randomly and analysed at a soil laboratory in 2008.

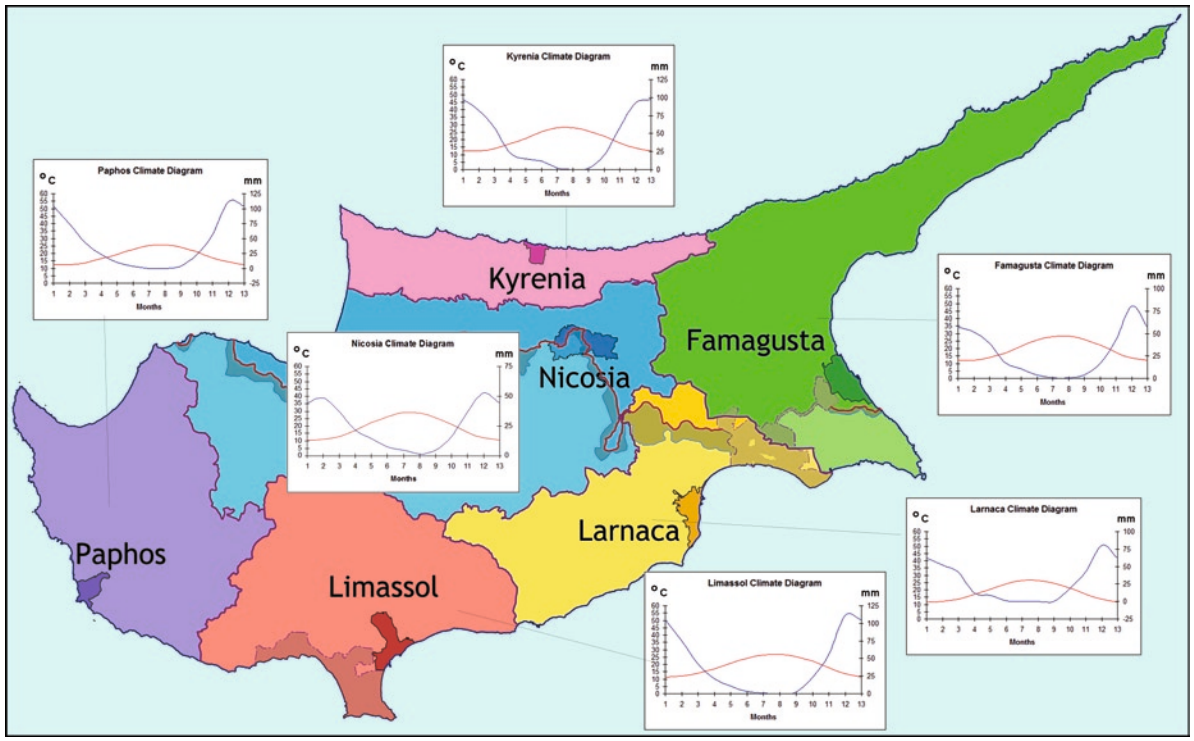

Fig. 1 Map of Cyprus with districts and their climate diagrams

The results obtained showed that the water potential of soils around coastal zone varies between 26.42–61.9%. The pH was found to be between 7.1 and 8.9. The texture is mainly sandy, soluble salts vary between 0.01 and 2.56%, organic matter from trace level to 1.94%, $CaCO_3$ between 22.2 and 52.5%, cation exchange capacity between 1.63–50 me/100 gr and Sodium between 50 and 6,300 ppm.

The climate is typical mediterranean with average daytime temperature lying around 32°C from June to September, 16°C from December to February and 25°C in the other 5 months. Rainfall is common in winter and precipitation in the form of snow occurs from January to March on the mountain peaks (Fig. 1).

3 Plant Diversity

Cyprus was known as the "Green Island" because most of it was covered with forests. Over time, this forest vegetation has been destroyed, mainly due to human activities, such as expansion of cultivations and human settlements, misuse and over exploitation, intensive grazing, fires and recently, climatic change. The varied microclimate and geology of the island has resulted in a great variety of habitats, which together with its isolation and location near the big neighbouring land masses has contributed a lot to its rich biodiversity. These factors have allowed the evolution of strong endemic flora which makes it an extremely interesting place for botanists (Gucel and Yildiz 2008). Nearly 8% (145 taxa) of the indigenous plants are endemics. The earliest systematic studies on the island were carried out by Sibthorp (1758–1796), Hawkins (1758–1841) and Bauer (1760–1826), and were followed by many others (cf. Yildiz and Gucel 2006). However, detailed studies were undertaken by Meikle (1977, 1985) who compiled the collected data in two volumes. He was followed by a large number of local investigators (Alziar 1985; Alziar and Guittonneau 2004; Alziar and Christodoulou 2006a, b; Christodoulou 2003; Christodoulou 2006a, b; Christodoulou and Hadjikyriakou 2006; Christodoulou et al. 2006; Chrtek and Slavik 1993; Costa et al. 1984a, b; Della and Iatrou 1995; Della 1994, 1996; Georgiades 1994; Georgiades and Hadjikyriakou 1993; Gucel and Yildiz 2008; Hadjichambis and Della 2007; Hadjichambis et al. 2003a, b, c; 2004; Hadjikyriakou et al. 1996; Hadjikyriakou et al. 2003; Hadjikyriakou and

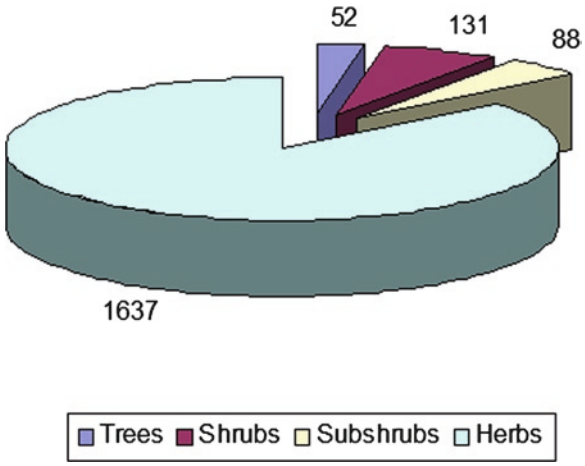

Fig. 2 Number of indigenous plant taxa in Cyprus

Alziar 2006; Hadjikyriakou 2009; Hand 2000, 2001, 2004, 2006; Hand and Hadjikyriakou 2009; Iacovou et al. 1995; Kephalas 2005, 2006a, b; Pantelas et al. 1997; Tsintides et al. 2007; Yildiz and Gucel 2006). The number of indigenous plant taxa recorded until now from Cyprus exceeds 1900 (Fig. 2).

The plant cover in general is composed of Forest, Maquis, Garrigue and Phrygana, accounting for 42.3% of the total land area and other high forests found on the Troodos and Pentadaktylos mountain ranges and along the coast of the Akamas peninsula in the west, the Akrotiri peninsula in the south, Cape Gkreko in the southeast, the Karpasia peninsula in the east, as well as along the northern coasts make up the 43.8%. These include species very common in the Mediterranean basin like *Pinus brutia* and *P. nigra* ssp. *pallasiana* accompanied by species like *Juniperus phoenicea, J. foetidissima, Olea europaea, Ceratonia siliqua, Arbutus andrachne, Myrtus communis, Rhus coriaria, Pistacia lentiscus, P. terebinthus, Berberis cretica, Sorbus aria* ssp. *cretica, Rosa chionistrae, Cotoneaster racemiflorus* var. *nummularia, Smilax aspera* and *Cistus* species. The most important are the natural forests of *Cedrus brevifolia* and *Quercus infectoria* ssp. *veneris*. The common broadleaved species are *Platanus orientalis, Alnus orientalis, Salix alba, Nerium oleander, Arundo donax, Laurus nobilis* and *Rubus sanctus*. The forests of the *Cupressus sempervirens* occur on mountainous areas, chiefly on limestone and marls and rarely on igneous formations. The most common shrubs are *Ziziphus lotus,Crataegus azarolus, Sarcopoterium spinosum* and *Thymus capitatus*.

The flora includes a comparatively high proportion of endemic plants counting to about 145. Some of the most eminent among these are *Bosea cypria*; one of the three species of the genus Bosea occurring in the world; *Cedrus brevifolia;* one of the four cedar species occurring in the world; *Tulipa cypria, Crocus cyprius, C. hartmannianus* and *Quercus alnifolia.*

Another important constituent of the indigenous flora of Cyprus are the typical plants of the Eastern Mediterranean like *Pinguicula crystallina, Cyprinia gracilis* (a monotypic genus named after Cyprus), *Colchicum troodi, Glaudosciadium cordifolium,* and *Euphorbia thompsonii*. The halophytic vegetation is of special interest and high conservation value (Guvensen and Öztürk 2003: Guvensen et al. 2006; Öztürk et al. 2006a, b). This type of vegetation flourishes on saline habitats along the coast and around the Larnaca and Akrotiri salt lakes. Characteristic species of these habitats are *Salicornia* spp., *Arthrocnemum microstachyum, Suaeda vera, Juncus* spp., *Halimione portulacoides* and *Inula crithmoides*.

The coastal vegetation is restricted along a 150 m wide narrow belt, where the dominant plants are *Limonium* spp., *Mesembryanthemum* spp., *Euphorbia paralias, Pancratium maritimum, Eryngium maritimum, Medicago marina, Taraxacum aphrogenes, Otanthus maritimus*, *Cakile maritima*, *Crithmum maritimum* and *Matthiola tricuspidata* (Gehu et al. 2000; Uslu 1998, 2001). The wetland vegetation that colonizes areas of the salt lakes, river mouths and other marshy places consists of *Arthrocnemum macrostachyum, Salicornia fruticosa, S. europaea, Halocnemum strobilaceum, Phragmites australis* and other species. The dominating halophytic taxa, their ecological features and a list of the families with the highest number of taxa are presented in Table 1 and Fig. 3.

The families with the highest number of taxa are given in Fig. 3. Out of a total of 129 taxa, *Poaceae* has the highest number. The families with lower taxa are; Apiaceae (5), Caryophyllaceae (5), Juncaceae (5), Brassicaceae (4), Gentianaceae (4), Liliaceae (4), Aizoiaceae (3), Convolvulaceae (2), Euphorbiaceae (3), Papaveraceae (2), Tamaricaceae (3), Frankeniaceae (2), Plantaginaceae (2), Agavaceae (1), Amaryllidaceae (1), Apocynaceae (1), Geraniaceae (1), Illecebraceae (1), Juncaginaceae (1), Linaceae (1), Neuradaceae (1), Orobanchaceae (1), Polygonaceae (1), Zannichelliaceae (1), Zygophyllaceae (1).

Table 1 List of halophytes and their ecological features

Families	Taxa	Life Form	Ecotype	Altitude (m above sea-level)	Flowering Time
Aizoaceae	*Aizoon hispanicum* L.	T	PH	0–70	3–5
	Mesembryanthemum crystallinum L.	C	X	SL	3–5
	Mesembryanthemum nodiflorum L.	C	X	SL	3–5
Agavaceae	*Agave sisalana* Perrine ex Engelm.	C	X	SL	8
Amaryllidaceae	*Pancratium maritimum* L.	C	PH	SL	8–10
Apiaceae	*Crithmum maritimum* L.	C	X	SL	4–7
	Cachyrs scabra (Fenzl) Meikle	CH	PH	SL-30	4–6
	Eryngium maritimum L.	C	PH	SL	6–8
	Ferulago syriaca Boiss.	CH	X	150–300	5–6
	Pseudorlaya pumila (L.) Graunde	T	X	SL	3–6
Apocynaceae	*Trachomitum venetum* (L.) Woodson	C	PH	SL	6–8
Asteraceae	*Achillea cretica* L.	CH	X	15–150	4–7
	Achillea maritima (L.) Ehrend. & Y.P. Guo ssp. *maritima*	CH	PH	SL	6–8
	Aetheorhiza bulbosa (L.) Cass.	C	X	0–400	4–6
	Ambrosia maritima L.	CH	X	SL	7–12
	Chlamydophora tridentata (Delile) Less.	T	HG	0–300	2–5
	Helichrysum conglobatum (Viv.) Steud.	CH	X	0–700	3–5
	Inula crithmoides L.	CH	HG	SL	6–8
	Launea resedifolia (L.) O.Kuntze	CH	X	SL	3–5
	Reichardia picroides (L.)Roth	H	X	SL-30	2–11
	Taraxacum aphrogenes Meikle	H	X	SL	10–12
Brassicaceae	*Cakile maritima* Scop.	T	PH	SL	2–7
	Enarthrocarpus arcuatus Labill.	T	X	SL-30	3–5
	Malcolmia nana (DC.) Boiss. var. *glabra* Meikle	T	PH	SL	3
	Matthiola tricuspidata (L.) R. Br.	T	PH	SL	2–5
Caryophyllaceae	*Silene colorata* Poiret var. *decumbens* (Bjv.) Rohrb.	T	X	0–800	3–6
	Silene discolor Sibth. et Sm.	T	PH	SL	3–5
	Silene kotschyi Boiss. var. *maritima* Boiss.	T	PH	SL	6–7
	Spergularia bocconii (Scheele) Aschers. et Graebn.	T	X	0–760	2–6
	Spergularia marina (L.) Griseb.	T	XH	SL	3–6
Chenopodiaceae	*Arthrocnemum macrostachyum* (Moric.) C. Koch	CH	HA	SL	5–7
	Arthrocnemum perenne (Miller) Moss	CH	HA	SL	4–7
	Atriplex halimus L.	CH	XH	0–150	7–10
	Atriplex patula L.	T	X	SL	5–7
	Atriplex prostrata Boucher ex DC.	T	X	SL	7–10
	Bassia hirsuta (L.) Ascherson	T	X	SL	7–9

(continued)

Table 1 (continued)

Families	Taxa	Life Form	Ecotype	Altitude (m above sea-level)	Flowering Time
	Beta vulgaris L. ssp. *maritima* (L.) Arcangeli	T	X	0–150	2–5
	Halimione portulacoides (L.) Aellen.	CH	HA	SL	6–10
	Halocnemum strobilaceum (Pall.) Bieb.	CH	HA	SL	8–10
	Halopeplis amplexicaulis (Vahl.) Ung.-Sternb. ex Ces.	T	HA	SL	7–9
	Salicornia europaea L.	T	HA	SL	5–10
	Salicornia fruticosa L.	CH	HA	SL	9–11
	Salsola inermis Forssk.	T	XH	0–150	9–11
	Salsola kali L.	T	PH	SL	5–9
	Salsola soda L.	T	PH	SL	5–9
	Suaeda aegyptiaca (Hasselq.) Zohary	CH	HA	SL	8–10
	Suaeda maritima (L.) Dumort.	T	HA	SL	8–10
	Suaeda vera Forssk.	CH	HA	0–30	10–5
Convolvulaceae	*Cressa cretica* L.	H	XH	SL	6–10
	Ipomoea imperati (Vahl) Griseb.	H	P	SL	7–11
Cyperaceae	*Bolboschoenus maritimus* (L.) Palla	C	HG	0–1500	4–9
	Carex divisa Huds.	C	HG	0–1700	3–5
	Carex extensa Good.	H	HG	SL	6–8
	Carex flacca Schreber ssp. *serrulata* (Bir.) Greuter	C	HG	0–1675	3–9
	Cyperus capitatus Vand.	C	HG	SL	2–5
	Eleocharis palustris (L.) Roem. & Schult.	C	HG	0–1500	3–6
	Isolepis cernua (Vahl) Roem. & Schult.	T	HG	SL-250	4–5
	Scirpoides holoschoenus L.	C	HG	0–1900	4–9
	Scirpus lacustris L. ssp. *tabernaemontani* (C.C.Gmel.) Syme	C	H	SL-1300	3–6
	Schoenoplectus litoralis (Schrad.) Palla	C	HG	SL	4–7
	Schoenus nigricans L.	H	HG	0–500	3–7
Euphorbiaceae	*Euphorbia paralias* L.	CH	PH	SL	2–11
	Euphorbia peplis L.	T	PH	SL	5–7
	Euphorbia terracina L.	CH	PH	0–300	2–6
Fabaceae	*Acacia saligna* (Labill.) Wendl. fil.	P	HG	0–100	4–7
	Alhagi maurorum Medik var. *Turcorum*	CH	PH	SL	6–8
	Argyrolobium uniflorum Jaub. & Spach	CH	X	SL	3–4
	Coronilla repanda (Poir.) Guss. ssp. *repanda*	T	PH	SL	2–4
	Lotus halophilus Boiss et Spruner	T	PH	SL	3–4
	Medicago littoralis Rohde ex Loisel. var. *littoralis*	T	X	0–200	3–5
	Medicago marina L.	H	PH	SL	2–4
	Ononis diffusa Ten.	T	PH	SL	3–6

Frankeniaceae	*Frankenia hirsuta* L. var. *hispida* (DC.) Boiss.	CH	PH	SL	4–10
	Frankenia pulverulenta L.	T	PH	0–200	4–10
Gentianaceae	*Blackstonia perfoliata* (L.) Hudson	T	HG	0–700	6–7
	Centaurium tenuiflorum (Hoffmanns. & Link) Fritsch	T	HG	0–800	6–8
	Centaurium maritimum (L.) Fritsch	T	X	SL-400	4–5
	Centaurium erythraea Rafn. ssp. *rhodense* (Boiss. et Reut.) Melderis	T	HG	0–1065	5–7
Geraniaceae	*Erodium crassifolium* L'Her.	CH	HG	SL	3–5
Illecebraceae	*Paronychia argentea* Lam.	H	PH	0–1500	12–7
Juncaceae	*Juncus acutus* L.	C	HG	0–1150	3–5
	Juncus heldreichianus Marsson ex Parl.	C	HG	0–1800	4–8
	Juncus littoralis C.A. Mey.	C	HG	0–150	4–6
	Juncus maritimus Lam.	C	HG	SL	7–8
	Juncus rigidus Desf.	C	HG	0–150	6–8
Juncaginaceae	*Triglochin bulbosa* L.	C	HG	SL	3–5
Liliaceae	*Allium curtum* Boiss. & Gaillard	C	PH	0–30	4–5
	Allium trifoliatum	C	XH	0–300	3–5
	Asparagus stipularis Forssk.	C	X	0–700	3–6
	Asphodelus tenuifolius Cav.	T	X	SL	3–4
Linaceae	*Linum maritimum* L.	H	HG	SL	5–10
Neuradaceae	*Neurada procumbens* L.	T	P	SL	3–6
Orobanchaceae	*Cistanche helypaea* (L.) P. Coutinho	H	HA	SL	3–5
Papaveraceae	*Glaucium flavum* Crantz	H	X	SL	5–7
	Hypecoum procumbens L.	T	X	0–300	3–6
Plantaginaceae	*Plantago coronopus* L. ssp. *commutata* (Guss.) Pilger	T	PH	0–800	2–7
	Plantago maritima L. ssp. *crassifolia*	T	PH	0–150	3–10
Plumbaginaceae	**Limonium albidum* (Guss.) Pignatti ssp. *cyprium* Meikle	H	X	SL	6–11
	Limonium echioides (L.) Mill. ssp. *echioides*	T	HA	0–230	4–6
	Limonium echioides (L.) Mill. ssp. *exaristatum*	T	HA	0–200	4–7
	Limonium meyeri (Boiss.) O.Kuntze	T	HA	SL	7–10
	Limonium mucronulatum (H. Lindb. fil.) Greuter&Burdet	H	HA	SL	6–9
	Limonium sinuatum (L.) Mill.	H	HA	SL	3–7
	Limonium virgatum (Willd.) Fourr.	H	HA	0–160	5–8

(continued)

Table 1 (continued)

Families	Taxa	Life Form	Ecotype	Altitude (m above sea-level)	Flowering Time
Poaceae	*Ammophila arenaria* (L.) Link	C	PH	SL	5–7
	Arundo donax L.	C	HG	0–600	6–10
	Aeluropus lagopoides (L.) Trin.	C	PH	0–160	4–7
	Aeluropus littoralis (Gouan) Parl.	C	PH	SL	4–7
	Brachypodium distachyon (L.) P. Beauv.	T	X	0–400	3–6
	Bromus madritensis L.	T	X	0–1000	3–7
	Catapodium marinum (L.) *C.E.* Hubb.	T	PH	0–100	4
	Elymus farctus (Viv.) Runemark ssp. *farctus* var. *farctus*	C	PH	SL	6–8
	Hordeum marinum Hudson	T	PH	0–100	5–6
	Imperata cylindirica L.	C	PH	0–300	4–6
	Lagurus ovatus L.	T	PH	0–50	4–6
	Parapholis incurva (L.) C.E. Hubb.	T	HG	SL	4–5
	Parapholis marginata Runemark	T	HG	0–230	4–5
	Phragmites australis (Cav.) Trin. ex Steudel	H	HG	0–1500	8–10
	Polypogon maritimus Willd.	T	PH	0–150	5–6
	Sporobolus virginicus (L.) Kunth.	C	PH	SL	6–9
	Trachynia distachya (L.) Link.	T	PH	0–1500	3–5
	Triplachne nitens (Guss.) Link	T	P	SL	4
	Vulpia brevis Boiss & Kotschy	T	PH	SL	3–4
Polygonaceae	*Polygonum maritimum* L.	H	PH	SL	6–11
Tamaricaceae	*Tamarix smyrnensis* Bunge	P	HA	0–1000	4–8
	Tamarix tetragyna Ehrenb.	P	HA	0–300	2–4
	Tamarix tetrandra Pall. ex M. Bieb.	P	HA	0–1300	5
Zannichelliaceae	*Zannichellia palustris* L.	T	HG	0–1500	3–6
Zygophyllaceae	*Zygophyllum album* L.	CH	XH	SL	3–5

Life Forms: *C* = Cryptophytes, *CH* = Chamaephytes, *H* = Hemicryptophytes, *P* = Phanerophytes, *T* = Therophytes
Ecological Types: *HA* = Halophyte, *HG* = Hygrohalophytes, *PH* = Psammohalophytes, *X* = Xerophyte, *XH* = Xerohalophytes
* Endemic
SL = Sea-level
Flowering Time: Month 1 is January and month 12 is December

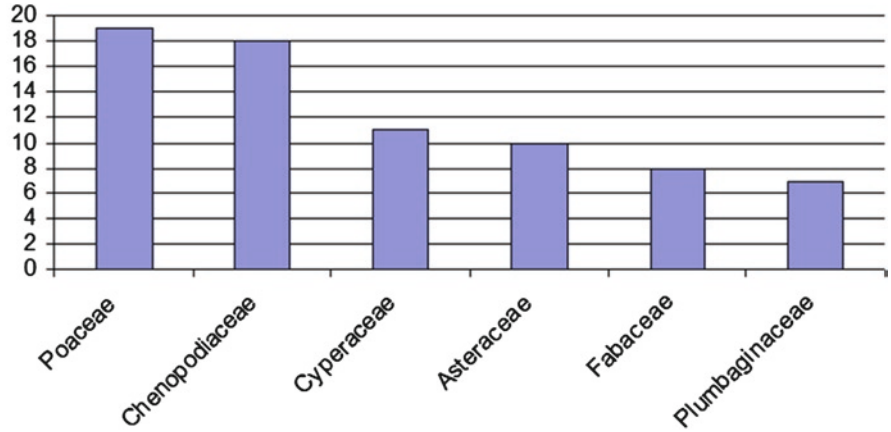

Fig. 3 Families with the highest number of taxa

4 Endemic, Rare and Threatened Plants of Cyprus

Biodiversity in Cyprus is threatened by a number of factors, the principal ones being the expansion of built-up areas, tourism development, heavy tourist use of sandy coasts, trampling of beaches with machinery installation of tourism infrastructure, sand removal, habitat degradation, recreation activities, stochastic events, demographic changes, fires, deforestations, agricultural activities, agricultural expansion, overgrazing, road maintenance, off-road driving, invasion by exotic species like *Acacia saligna*, changes in water balance, drought, habitat degradation and loss, changes in land use, drying out of watercourses and climatic change (Fig. 4a).

A Red Data List for the Cyprus flora compiled by Tsintides et al. (2007) indicates that about 300 plant species are threatened and need immediate protection measures. In this list *Achillea cretica* (Fig. 4b) was recorded as vulnerable (Table 2), but no mention was made for *Pancratium maritimum* (Fig. 4c) and *Trachomitum venetum* (Fig. 4d) which, in our opinion, should be included in the list as endangered species.

Approximately 145 taxa are endemics and some of these are very rare. Twenty-three endemic and other native plants are listed in Appendix I of the Convention for the Conservation of the European Wild Life and the Natural Habitats (Council of Europe 2000) and they are charactewrised as strictly protected. 18 species (16 endemics and 2 other native plants) are of community importance and are listed in Appendices II & IV of the European "Habitats Directive" (92/43/EEC), which provides for the conservation of species through the conservation of their habitats (Council of Europe 1992). It is noted that Appendix II includes the threatened animal and plant species of European Union interest, whose conservation requires the designation of special areas of conservation, while Appendix IV includes animals and plants of European Union interest in need of strict protection. Also, 51 species are included in *the Red List of the Threatened Plants* prepared by IUCN (Walter and Gillett 1998). Moreover, six endemic plants of Cyprus are included in the IUCN & SSC - Species Survival Commission edition " *The Top 50 Plants of the Mediterranean Islands*" which presents fifty of the most threatened plant taxa of the Mediterranean (Montmollin and Strahm 2005). The above information indicades that a significant number of endemic and other plants on the island are part of world's natural heritage.

The situation on the coastal habitats in the country is not different. During the studies carried out between 2006–2008 along 770 km long coastal zone, a total of 457 taxa were found in this area. Out of these plant taxa, 129 halophytic taxa were surveyed at length and their life forms, ecological types, altitudinal distribution and phenology were recorded. The conservation status of 32 of these species is described according to the Red Data Book of the Flora of Cyprus (Tsintides et al. 2007), which evaluates the conservation status of the Cyprus flora based on the criteria set by the International Union for Conservation of Nature (IUCN 2003); 6 were found to be critically endangerd, 12 endangered and 14 vulnerable (Table 2, Fig. 5).

Regarding the habitats diversity observed within the coastal zone, a total of 16 habitat types were

Fig. 4 Land degradation along the coast-Bafra (**a**), *Achillea cretica*-Vulnerable species (**b**), *Pancratium maritimum*-Endangered species (**c**), *Trachomitum venetum*-Endangered species (**d**)

Table 2 Conservation status of the Halophytes of Cyprus

Latin name	Threatened category: IUCN Criteria (IUCN 2003)
Achillea cretica	VU: D2
A. maritima subsp. *maritima*	VU: A4C
Aizoon hispanicum	EN: D1
Ambrosia maritima	CR: B1 ab (i–v) + 2ab(i–v); C2a(i); D1
Ammophila arenaria	EN: B1ab(iii,v) + 2ab(iii,v)
Argyrolobium uniflorum	CR: B1ab(iii,v) + 2ab(iii,v)
Cachyrs scabra	EN: B1ab(iii,v) + 2ab(iii,v)
Centaurium maritimum	EN: B1ab(iii) + 2ab(iii)
Cistanche phelypaea	CR:D1
Coronilla repanda subsp. *repanda*	VU: D2
Enarthrocarpus arcuatus	VU:D2
Erodium crassifolium	VU:D2
Euphorbia paralias	EN:A4ac
Ferulago syriaca	VU:D2
Ipomoea imperati	EN:C2a(i)
Isolepis cernua	EN:D1
Juncus littoralis	VU:D2
Juncus maritimus	VU: D1+2
Limonium mucronulatum	CR: B1ab(iii,v) + 2ab(iii,v); C2a(ii)
Linum maritimum	VU:D2
Malcolmia nana var. *glabra*	CR: B1ab(iii,iv) + 2ab(iii,iv); C2a(ii)
Mesembryanthemum crystallinum	VU:D2
Neurada procumbens	EN:B1ab(iii,v) + 2ab(iii,iv)
Ononis diffusa	EN:B1ab(iii,v) + 2ab(iii,v)
Reichardia picroides	VU:D1+2
Salsola soda	VU:D1+2
Scirpus lacustris ssp. *tabernaemontani*	EN:D1
Silene kotschyi var. *maritima*	EN:B1ab(iii,v) + 2ab(iii,v)
Suaeda aegyptiaca	EN:B1ab(iii,v) + 2ab(iii,v)
Taraxacum aphrogenes	VU:B1ab(iii,v) + 2ab(iii,v)
Triplachne nitens	VU:C2a(i)
Vulpia brevis	CR:B1ab(i–v) + 2ab(i–v)

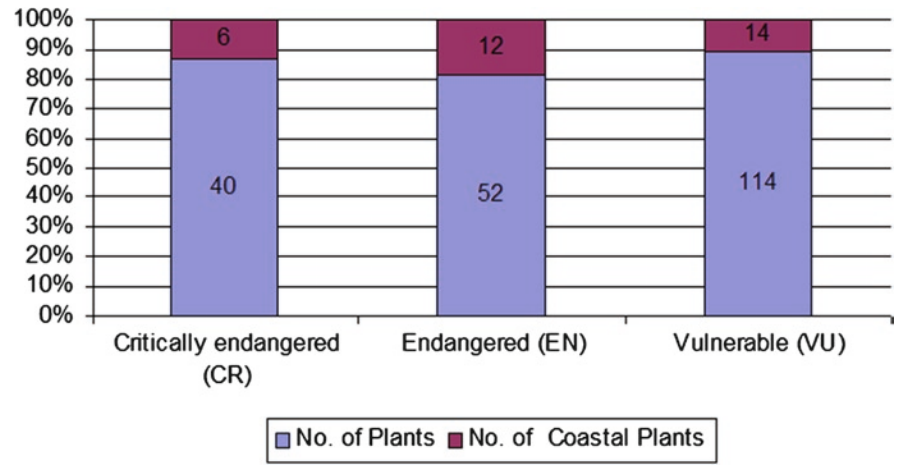

Fig. 5 Percentage of endangered coastal plants among endangered plants of Cyprus

Table 3 Description of habitats

No	Code Name	Importance
1	1110 Sandbanks which are slightly covered by sea water all the time	HD I
2	1140 Mudflats and sandflats not covered by seawater at low tide	HD I
3	1150 Coastal lagoons	HD I*
4	1210 Annual vegetation of drift lines	HD I
5	1240 Vegetated sea cliffs of the Mediterranean coasts with endemic *Limonium* spp.	HD I
6	1310 Salicornia and other annuals colonising mud and sand	HD I
7	1410 Mediterranean salt meadows (Juncetalia maritimi)	HD I
8	1420 Mediterranean and thermo-Atlantic halophius scrubs (Arthrocnemetalia fructicosae)	HD I
9	1430 Halo-nitrophilous scrubs (Pegano-Salsoletea)	HD I
10	1510 Mediterranean salt steppes (*Limonietalia*)	HD I*
11	2110 Embryonic shifting dunes	HD I
12	2190 Humid dune slacks	HD I
13	2230 Malcolmietalia dune grasslands	HD I
14	2240 Brachypodietalia dune grasslands with annuals	HD I
15	2250 Coastal dunes with Juniperus spp.	HD I*
16	2260 Cisto-Lavendulatalia dune sclerophyllous scrubs	HD I

classified as habitat types of the Annex I of the Habitats Directive, according to the Interpretation Manual of European Union Habitats - EUR 25. Out of these habitats, three were found to be priority ones (Table 3). It is noted that Annex I includes the natural habitat types of European Union interest, whose conservation requires the designation of special areas of conservation. As priority habitat types are defined the natural habitat types in danger of disappearance, which are present on the EU territory and for the conservation of which the EU has particular responsibility in view of the proportion of their natural range which falls within its territory.

Code_Name: Included in Annex I of Directive 92/43/EEC, HD I – included in Annex I, HD I* – priority habitat of Annex I.

In the ecological survey of coastal shores, dunes and cliffs in Europe, under the title "Dry Coastal Ecosystems of the World" a lot of information has been presented on the occurrence of endemic littoral plant species (van der Maarel 1996). An evaluation of this data as well as other detailed surveys together with present studies were used for an evaluation of the coastal zone plant diversity in Cyprus.

This evaluation includes plant taxa from salt marshes, tidal flats and saline waters i.e. lagoons. Although species like *Ammophila arenaria* and *Hippophae rhamnoides* ssp. *maritima* and *Puccinellia maritima* are important for the dunes and salt marshes, many coastal species have limited role in the composition and structure of littoral plant communities. Moreover, many species dominating coastal zone habitats do not belong to

these habitats at all such as *Phragmites australis*, *Salix* spp., *Juniperus* and *Quercus* species.

5 Conclusion

We do not always realize how relatively small the areas occupied by coastal ecosystems are and how vulnerable the coastal flora is. We hope that this survey will prove helpful in the preservation of coastal zone plant diversity and habitats. The coastal ecosystems harbour numerous littoral plant taxa of which the majority can be considered endemics in a strict sense. For most of these species their future existence seems to very uncertain, since initiatives to protect rare and threatened coastal species are insufficient. The data presented here will serve as a reference source to build up a detailed database for littoral plant diversity in Cyprus.

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