

The Vegetation of the Ghadira Nature Reserve

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ABSTRACT

The Ghadira Nature reserve is one of the few salt-marshes still extant in the Maltese Islands. The indigenous vegetation is dominated by halophilic and salt-tolerant species such as *Phragmites australis*, *Inula crithmoides*, *Juncus acutus*, *Juncus subulatus*, *Triglochin barleri*, *Melilotus messanensis*, *Salicornia ramosissima*, *Suaeda maritima*, *Salsola soda* and *Parapholis filiformis*. Management of the reserve has resulted in the introduction of three main categories of plants (a) species from the adjacent dune such as *Elymus farctum*, *Sporobolus arenarius* and *Pancratium maritimum*; (b) species, mainly trees and shrubs, introduced in order to attract birds and (c) halophytic species introduced from other salt-marsh areas in order to protect them from extinction such as *Carex extensa*, *Halimione portulacoides* and a possibly undescribed species as *Limonium*. *Tamarix* species, especially *T. africana* and *Atriplex halimus* were introduced long before the establishment of the reserve but their numbers have been augmented as part of the reserve management policy. Another component of the vegetation is represented by weed species such as *Oxalis pes-caprae* and *Sonchus* cf. *oleraceus*, some of which have greatly increased in abundance.

The aquatic vegetation is represented by four macrophytes: the angiosperm *Ruppia drepanensis* (for which Ghadira is the only known station in the Maltese Islands) and the green algae *Enteromorpha intestinalis*, *Cladophora* sp. and *Ulothrix* sp. The algae occur largely as floating algal mats supporting a characteristic thycoplankton the phytoplanktonic component of which is dominated by diatoms, dinoflagellates and chlorophytes.

Introduction

Saline marshlands are communities which become established on soft substrates inundated and/or permeated by water of high salinity.

Few saline marshlands exist in the Maltese Islands, these are located mainly at the mouths of valley systems e.g. Salini, Birzebbuga, Marsa, St. Julians, Marsalforn (Gozo) or on low-lying

coastal land where sea-water permeates the soil e.g. Ghadira, Ghadira s-Safra, Is-Simar, Marsaxlokk, (Schembri *et al.*, 1987).

All Maltese saline marshes have been greatly modified by human activity, partly for purposes of land reclamation e.g. Marsa or due to their proximity to urban or resort areas e.g. St. Julians, Marsalforn (Gozo), Marsaxlokk, Is-Simar. As a result few localities still support a discrete saline marsh vegetation while in most cases only the persistent appearance of a few saline marsh species such as *Phragmites australis* or *Atriplex prostrata* bely the former existence of a saline marsh community (Lanfranco & Schembri, 1986).

Ghadira is one of the largest saline marshes in the Maltese Islands. The locality is now a Nature Reserve. For details of the former history of Ghadira and events leading to its establishment as a Nature Reserve see Sultana (1990).

Very little literature exists pertaining specifically to the vegetation of Ghadira. This consists entirely of reports leading to the establishment of Ghadira as a Nature reserve (Lanfranco [G], 1967; Savona -Ventura *et al.*, 1980; Axell, 1980; Schembri, 1981; Thake, 1981).

There has been no attempt to study the vegetation in detail beyond the floristic aspect. This paper is the result of a short-term preliminary survey on which a more detailed research programme can be built.

Materials and Methods

The flora growing within the confines of the reserve was investigated during a series of visits

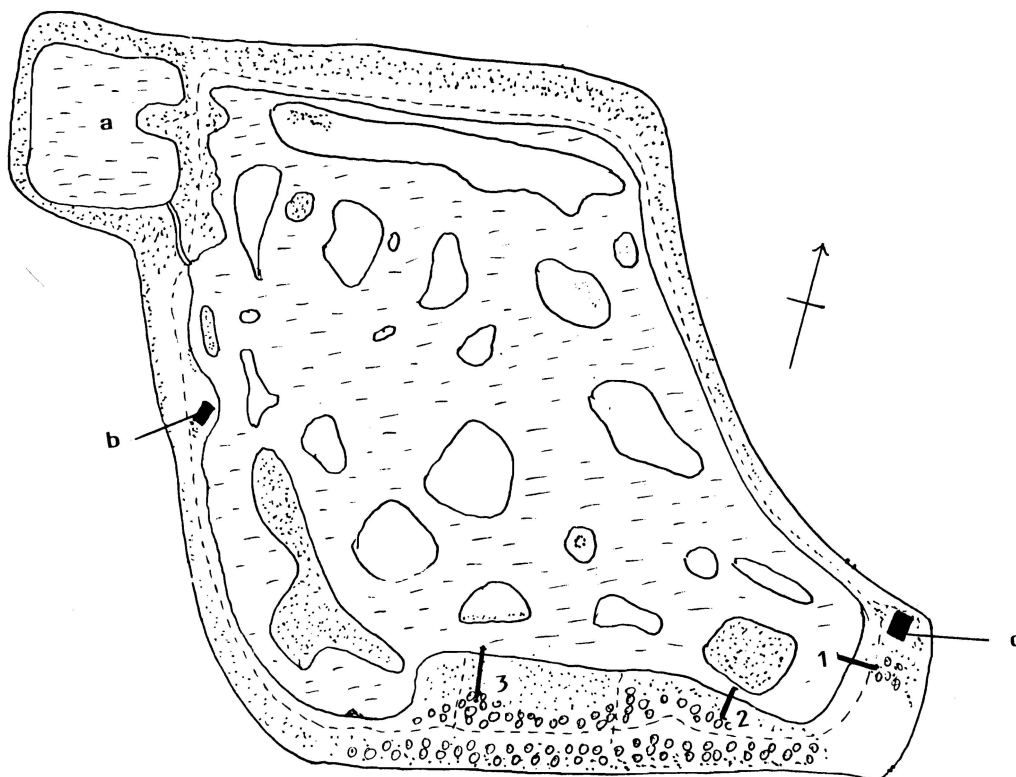


Fig. 1: Plan of Ghadira Reserve showing position of transects 1; 2 & 3 (small circles = *Tamarix* trees; dots = reeds; rushes and low vegetation; dashes = water; broken line = main path; a = reservoir; b = hide; c = resource centre).

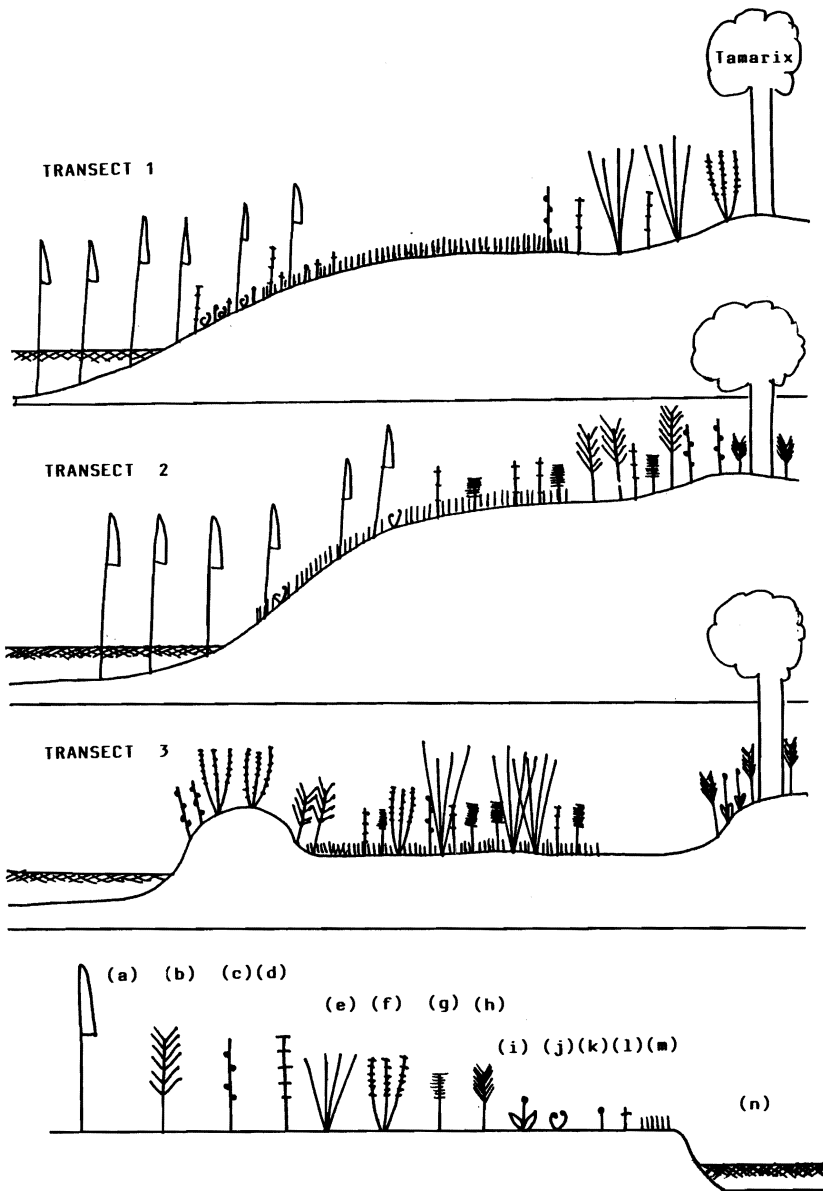


Fig. 2: Three representative transects. Baseline for transects 1 and 2=4 metres, that for transect 3=5 metres. Key to symbols: (a) = *Phragmites australis*, (b) = *Sporobolus arenarius*, (c) = *Melilotus messanensis*, (d) = *Salicornia ramosissima*, (e) = *Juncus acutus*, (f) = *Inula crithmoides*, (g) = *Suaeda maritima*, (h) = *Bromus rigidus*, (i) = *Aethiorhiza bulbosa*, (j) = *Parapholis incurva*, (k) = *Salsola soda* (seedlings), (l) = *Juncus hybridus*, (m) = *Parapholis filiformis*, (n) = algal mats (*Cladophora* with some *Ulothrix*). In transect 1 the following species were also present in the *Tamarix* undergrowth: *Sonchus oleraceus*, *Oxalis pes-caprae*, *Elymus farctus* and *Sporobolus arenarius*.

undertaken in the spring of 1988. Every species seen was recorded and its frequency and habitat noted. A complete list of the species is given in the appendix. Representative transects were taken (Figs. 1, 2). The aquatic vegetation was also noted. Water samples were taken from different parts of the site in order to examine the microbiota. Literature records were consulted (Sommier & Caruana Gatto, 1915; Borg; 1927; Borg, 1936; Lanfranco, 1967) as well as unpublished records by the author. Physico-chemical data used as a background for this study is based on Hili *et al.* (1990).

Non-Submerged Plant Life

The species growing within the confines of the reserve may be categorised as follows:

- A. *Indigenous element*: Plants typical of saline marshlands and which also existed in the locality prior to the commencement of management activities. This component may be divided into three categories.
- (i) Species which, at least in the Maltese Islands, are confined to saline marshlands. The most characteristic are *Salicornia ramosissima*, *Triglochin barleri*, *Parapholis filiformis*, *Suaeda maritima*, *Juncus acutus* and *Melilotus messanensis*.
 - (ii) Species which also occur in other types of saline habitats. Examples are *Inula crithmoides*, *Salsola soda* and *Parapholis incurva*.
 - (iii) Salt-tolerant species which also occur in non-saline habitats but which, in the Maltese Islands, often reach their best development in saline conditions — not necessarily because of a predilection for saline substrates but more likely as a result of reduced competition by salt-intolerant species. Some of these also occur in freshwater marshlands. Examples are *Phragmites australis* and *Juncus subulatus*.
 - (iv) species which are equally common in saline & non-saline substrates such as *Lotus ormithopodioides* and *Medicago polymorpha*.
- B. *Introduced species*: This component includes those species which become established as a result of habitat disturbance (i.e. weed species) and those which have been introduced deliberately as part of the reserve management policy. The following categories can be recognised:
- (i) Weed species, many of which occur in a variety of anthropic habitats. While most were also present prior to the establishment of the reserve, many have increased in extent as a result of the works carried out on the site in order to render it more attractive to bird life. Characteristic species are *Sonchus oleraceus*, *Bromus diandrus* and *Oxalis pes-caprae*.
 - (ii) Species introduced from the adjacent dune community such as *Elymus farctus*, *Sporobolus arenarius* and *Pencratium maritimum*. Some of these are also part of the original vegetation where the reserve abuts on to the dune community.
 - (iii) Species introduced in order to attract birds. These consist chiefly of indigenous and archeophytic trees and shrubs such as *Ceratonia siliqua*, *Myoporum tetrandrum* and *Punica granatum*.
 - (iv) Halophytes introduced from other saline marshlands in order to protect them from possible extinction in their original sites. Examples are *Carex extensa* which was rescued from a nearby marsh which was destroyed when the Mellieħa bypass was under construction; *Halimione portulacoides* and a possibly undescribed species or subspecies of *Limonium* rescued from Ras iċ-Ċagħaq at Delimara where there was

a small but important marsh, now obliterated as a result of works in connection with the new power station. All of the introduced species have survived but, so far, there is no sign of propagation.

Two species deserving special mention are *Atriplex halimus* and *Tamarix africana*. Both are perhaps indigenous to the site but both have also been extensively planted. As indigenous species *Atriplex halimus* belongs to category A(ii) while *Tamarix africana* belongs to category A(iii) above.

Vegetation Structure

Part of the marshland perimeter is fringed with *Tamarix africana* which supports an undergrowth dominated by grasses, especially *Bromus rigidus* but also by other types of plants such as *Inula crithmoides* and *Aethiorhiza bulbosa*. Where the marsh abuts on the dune, species such as *Elymus farctus* and *Sporobolus arenarius* also occur. Weed species, especially *Sonchus oleraceus* and *Oxalis pes-caprae* are abundant.

Clearings among *Tamarix* trees, especially along the south border are occupied by dense mats of *Triglochin barrelieri*, often mixed with *Melilotus messanensis* and *Parapholis filiformis*.

Closer to the water's edge, dominant species are *Parapholis filiformis* and *Salicornia ramosissima* accompanied by *Suaeda maritima* all of which are annuals.

At the water's fringe is a population of *Phragmites australis* which is partly submerged during the wet season when the water level is high. This *Phragmites* belt is backed by a dense population of *Juncus subulatus* (a species which is also common in some freshwater marshes).

In late spring the receding waters permit germination of annual species such as *Salsola soda* (which reaches maximum development in summer), *Juncus hybridus* and *Parapholis incurva*.

On more permanent substrates there are populations of *Juncus acutus* and *Inula crithmoides*.

Submerged Vegetation

A. The Macroflora. Four species of submerged macroscopic plants were encountered during the present investigation. The only angiosperm was *Ruppia drepanensis*, a taxon of uncertain status which is endemic in the Mediterranean (Maire, 1952). Ghadira is the only locality in the Maltese Islands where it is known to occur (Lanfranco, 1989). It grows in the main pool and in the reservoir but in greatly reduced quantity when compared to its abundance prior to the establishment of the reserve. The remaining three species are green algae. *Enteromorpha intestinalis* occurs mainly in the ditch. The main pool supports large populations of a *Cladophora* species which, in places, is accompanied by an *Ulothrix* species. Unpublished records by the author dating to the sixties and early seventies indicate the presence of a species of *Vaucheria* (Division: Xanthophyta) which was not encountered during the present study.

B. The Microflora. Most parts of the pool support a rich micro-flora. Much of the material examined during this study is unidentified but it is still possible to indicate some of the major microfloristic components. In the ditch the most characteristic species were diatoms such as *Nitzschia longissima* and species of *Achnantes*, and *Pleurosigma* (s.l.). Also abundant was the green monad *Pyramimonas*. Most abundant of the Cyanobacteria was a species of *Phormidium*. These were accompanied by numerous ciliates which included species of *Aspidiska*, *Lacrymaria*, *Vorticella* and *Vaginicola* and by microfauna especially gastrotrichs, rotifers, ostracods and cyclopoid copepods.

In the main pool one of the dominant species is an unidentified coccoid alga, also abundant were diatom species of *Achnantes*, *Navicula* (s.l.) and *Cocconeis* (this last epiphytic on

Cladophora). Blue-green algae were represented by species of *Spirulina* and *Chroococcus* while green algae were represented by species of *Pyramimonas* and (?) *Coelastrum*. Bacteria, notably spirochaetes, were abundant in the rotting algal mats. In summer there is an extensive development of pink halobacteria.

The reservoir does not support an abundant phytoplankton. The main species were an unidentified chlamydomonad and dinoflagellates, notably *Procoentrum micans* and a species of *Gymnodinium*. A species of *Cosmarium* (Desmidiaceae) was also noted.

Discussion

The modification carried out on the Ghadira site in connection with its conversion into a bird reserve have caused at least one major change in the nature of the habitat. In the pre-modification stage, Ghadira supported a large, rather shallow pool which invariably dried up in summer while now there is a permanent water body — although the water level fluctuates widely throughout the year (Hili *et al.*, 1990). It is thus the aquatic biota which have been most profoundly affected by these changes. The principal change observed is the decline in the population of *Ruppia drepanensis*. This is regrettable in view of the rarity of this species. It is possible that this species favours waters which dry up periodically but, more likely, the main reason for its decline is the great increase in the population of a species of *Cladophora*. Prior to the changes undertaken on the site, the only macroscopic alga noted was a species of *Vaucheria* (not recorded in the present investigation). The waters of Ghadira tend to become heavily eutrophic from late spring through summer, a phenomenon which, again, is mainly due to the great proliferation of the *Cladophora* which depletes the oxygen supply of the pool and dies off. In fact, during the hot months, much of the *Cladophora*, especially in the shallower parts, would be dead and in a state of putrefaction. An extensive development of pink halobacteria forms on these dead algal mats. The situation is relieved in the wet season when the pool is replenished by rain water.

There are no records of the microbiota of Ghadira prior to this investigation. A remarkable characteristic is the co-existence, especially in the reservoir, of species with saltwater and freshwater affinities, e.g. *Cosmarium* sp. (freshwater) and *Procoentrum micans* (saltwater).

Fewer qualitative changes seem to have occurred in the non-submerged vegetation. The floristic composition of the site is reasonably well documented in the standard floras (Sommier & Caruana Gatto, 1915; Borg, 1927) and the list given by Lanfranco [G] (1967) as well as numerous unpublished records by the author. A survey of the pool area was carried out in April 1974 as part of training in field work for pupils of the Hamrun Boys Secondary School, and supervised by the author. No species encountered during that survey has disappeared from the pool area except for the weed species *Urtica pilulifera*, which has also nearly disappeared from all over the Maltese Islands. The main change is the considerable proliferation of weed species, especially *Sonchus oleraceus*, to be expected given the considerable disturbance undergone by the site; as well as the deliberate introduction of new species as noted above.

Two rare species which were recorded from the pool area of Ghadira have disappeared. *Chondrilla juncea* occurred in the area at least till the mid-1920's (Borg, 1927) but which is now confined - in very reduced numbers - to the area occupied by the Danish village outside the boundary of the reserve. *Crypsis aculeata* was recorded by Borg (1935) as plentiful. Neither of the above mentioned species has been seen in the pool area since the mid-1960s.

APPENDIX

Annotated List of Species

Hereunder are enumerated the plant species the presence of which (past or present) within the confines of the reserve has been verified by the author. This list is based on observations made during the present study and the information derived from the fieldwork carried out in 1974 by students of the then Hamrun Boys Secondary School under the author's supervision. The flora of the pool area before and after the modifications leading to the establishment of the reserve can thus be compared. Little use has been made of literature records since most of these do not specify from which part of Ghadira the records originate. The dune habitat just outside the confines of the reserve carries a very different flora and many literature records refer to this latter habitat.

Key to symbols:

A = confined to saline marshes; B = growing mainly on a variety of saline substrates; C = dune species; D = frequent also on non-saline substrates; E = weed species; F = planted in quantity; G = planted in limited quantity; H = marked decrease at Ghadira Reserve site since 1974; I = marked increase in Ghadira Reserve site since 1974; J = very rare in Maltese Islands; K = extinct from Ghadira Reserve site; L = endangered species introduced as a protection measure; S = submerged hydrophyte

A. VASCULAR PLANTS

(I) Gymnosperms		family: FABACEAE	
<i>Pinus halepensis</i> Miller	G	<i>Astragalus baeticus</i> L.	E
		<i>Ceratonia siliqua</i> L.	G
		<i>Cercis siliquastrum</i> L.	G
		<i>Lotus ormithopodioides</i> L.	D
		<i>Medicago littoralis</i> Rohde ex Loiseleur	D
(II) Dicotyledons		<i>Medicago polymorpha</i> L.	D,E
family: APIACEAE (= UMBELLIFERAE)		<i>Melilotus messanensis</i> (L.) Allioni	A
<i>Foeniculum vulgare</i> Miller	D, E	<i>Psoralea bituminosa</i> L.	D
family: ARALIACEAE		family: FRANKENIACEAE	
<i>Hedera helix</i> L.	G	<i>Frankenia hirsuta</i> L.	B
family: ASTERACEAE (= COMPOSITAE)		<i>Frankenia pulverulenta</i> L.	B,H
<i>Aethionhiza bulbosa</i> (L.) Cassini	D	family: LAURACEAE	
<i>Bellis annua</i> L.	D,H	<i>Laurus nobilis</i> L.	G
<i>Centaurea nicaensis</i> Allioni	D,H	family: MALVACEAE	
<i>Chondrilla juncea</i> L.	A, J, K	<i>Lavatera arborea</i> L.	B,E
<i>Chrysanthemum coronarium</i> L.	E	<i>Lavatera cretica</i> L.	D, E
<i>Galactites tomentosa</i> Moench	E, I	<i>Malva silvestris</i> L.	D, E
<i>Inula crithmoides</i> L.	B	family: MORACEAE	
<i>Reichardia picroides</i> (L.) Roth	D	<i>Morus alba</i> L.	G
<i>Sonchus oleraceus</i> L.	E, I	family: MYOPORIACEAE	
<i>Urospermum picroides</i> (L.) Scopoli ex F.W. Schmidt	E, I	<i>Myoporum tetrandrum</i> (Labillardiere) Domin	G
family: CACTACEAE		family: OLEACEAE	
<i>Opuntia ficus-indica</i> (L.) Miller	G	<i>Fraxinus angustifolia</i> Vahl	G
family: CARYOPHYLLACEAE		<i>Olea europaea</i> L.	G
<i>Silene colorata</i> Poiret	D	family: OROBANCHACEAE	
<i>Spergularia bocconei</i> (Scheele) Ascherson & Graebner	D,E	<i>Orobanche pubescens</i> D'Urville	D
family: CHENOPODIACEAE		family: OXALIDACEAE	
<i>Atriplex halimus</i> L.	B,F	<i>Oxalis pes-caprae</i> L.	E
<i>Atriplex prostrata</i> Boucher ex DC.	B,E	family: PITTOSPORACEAE	
<i>Beta maritima</i> (L.) Arcangeli	D,E	<i>Pittosporum tobira</i> (Thunberg) Aiton fil.	G
<i>Halimione portulacoides</i> (L.) Aellen	A,L	family: PLUMBAGINACEAE	
<i>Salicornia ramossissima</i> J. Woods	A	<i>Limonium</i> sp. aff. <i>L. virgatum</i> (Willdenow) Fourreau	A, L
<i>Salsola soda</i> L.	B	family: POLYGONACEAE	
<i>Suaeda maritima</i> (L.) Dumortier	A	<i>Rumex buchecephalophorus</i> L.	D
family: CONVULVULACEAE		family: PRIMULACEAE	
<i>Cressa cretica</i> L.	A, H	<i>Anagallis arvensis</i> L.	D,E, I
family: EUPHORBIACEAE		family: PUNICACEAE	
<i>Euphorbia pinea</i> L.	D		
<i>Euphorbia terracina</i> L.	C		

<i>Punica granatum</i> L.	G	<i>Hordeum marinum</i> Hudson	B
family: RHAMNACEAE		<i>Lagurus ovatus</i> L.	D
<i>Rhamnus oleoides</i> L.	G	<i>Lolium rigidum</i> Gaudin	D,E
family: ROSACEAE		<i>Parapholis filiformis</i> (Roth) C.E. Hubbard	A
<i>Eriobotrya japonica</i> (Thunberg) Lindley	G	<i>Parapholis incurva</i> (L.) C.E. Hubbard	B
<i>Rubus ulmifolius</i> Schott	G	<i>Parapholis marginata</i> Runemark	B
family: SALICACEAE		<i>Phalaris minor</i> Retzius	D,E
<i>Populus alba</i> L.	G	<i>Phalaris paradoxa</i> L.	
family: SOLANACEAE		<i>Phragmites australis</i> (Cavanilles) Trinius ex	
<i>Solanum nigrum</i> L.	E, I	Steudel	E
family: TAMARICACEAE		<i>Piptatherum miliaceum</i> (L.) Cosson	D,E
<i>Tamarix africana</i> Poiret	B,F	<i>Polypogon monspeliensis</i> (L.) Desfontaine	D
<i>Tamarix gallica</i> L.	G	<i>Sporobolus arenarius</i> Duval-Jouve	C
<i>Tamarix parviflora</i> DC.	G	family: RUPPIACEAE	
family: URTICACEAE		<i>Ruppia drepanensis</i> Tineo	H,J,M
<i>Urtica pilulifera</i> L.	E,K		
family: VERBENACEAE		B. ALGAE	
<i>Lantana camara</i> L.	G	(i) Chlorophyta (s.l.)	
<i>Vitex agnus-castus</i> L.	B, G	<i>Cladophora</i> sp.	I
		<i>Coelastrum</i> (?) sp.	
(iii) Monocotyledons		<i>Cosmarium</i> sp.	
family: AMARYLLIDACEAE		<i>Enteromorpha intestinalis</i> (L.) Link	
<i>Pancreatum maritimum</i> L.	C,F	<i>Pyramimonas</i> sp.	
family: CYPERACEAE		<i>Ulothrix</i> sp.	
<i>Carex extensa</i> Goodenough	A, L		
family: IRIDACEAE		(ii) Xanthophyta	
<i>Gladiolus italicus</i> Miller	D,E	<i>Vaucheria</i> sp.	H
family: JUNCACEAE			
<i>Juncus acutus</i> L.		(iii) Bacillariophyta (diatoms)	
<i>Juncus hybridus</i> Brotero	D	<i>Achnantes</i> sp.	
<i>Juncus subulatus</i> Forskaal	B	<i>Cocconeis</i> sp.	
family: JUNCAGINACEAE		<i>Navicula</i> sp.	
<i>Triglochin barrelieri</i> Loiseleur	A	<i>Nitzschia longissima</i> Ralfs	
family: LILIACEAE		<i>Pleurosigma</i> (s.l.) sp.	
<i>Ornithogalum arabicum</i> L.	D,I		
family: POACEAE (= GRAMINEAE)		(iv) Pyrrophyta (Dinoflagellates)	
<i>Avena barbata</i> Pott ex Link	D,E	<i>Gymnodinium</i> sp.	
<i>Avena sterilis</i> L.	D,E, I	<i>Prorocentrum micans</i> Ehrenberg	
<i>Bromus diandrus</i> Roth	D,E		
<i>Bromus madritensis</i> L.	D,E,I	(v) Cyanobacteria (blue-green algae)	
<i>Bromus rigidus</i> Roth	B	<i>Chroococcus</i> sp.	
<i>Crypsis aculeata</i> (L.) Aiton	A,J,K	<i>Phormidium</i> sp.	
<i>Elymus farctus</i> (Viviani) Runemark ex Melderis	C,F	<i>Spirulina</i> sp.	
<i>Festuca arundinacea</i> Schreber	D		
<i>Horedeum leporinum</i> Link	D,E		

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