The Halophytic Flora of Syria

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Foreword

Halophytes, or salt-tolerant plant species, provide multiple benefits. They play a key role in the ecosystem, protecting habitats, maintaining ecological stability, preventing soil erosion and seawater intrusion into freshwater habitats, and providing food and shelter for a range of fauna. Some halophytes have the potential for commercial-scale production for a variety of uses. Halophytes also represent an important (but so far largely unexploited) source of novel genes to enhance drought and salinity tolerance in crop varieties.

Halophytes have great potential in helping to address the widespread problem of soil salinization. Worldwide, an estimated 10 million ha of arable land is lost every year due to salinization. Salt-affected soils occur in at least 75 countries, occupying more than 20% of the world's irrigated area – and more than half the irrigated land in some countries. Dry regions, where arable land is scarce, are particularly prone to salinization; vast areas of fields are being abandoned due to build-up of salinity in the soil.

This group of plants has the ability to survive salinity, drought and other harsh conditions in both temperate and tropical climates, and in a very wide range of environments from hot deserts to tundra. Several native halophyte species found in Syria have the potential for more widespread use. Some have the ability to survive in very hostile environments; or could be used in the rehabilitation of soils degraded by salinization; or have the potential for commercial cultivation for specific end uses.

This book describes the halophytic flora of Syria. It presents results from a major country-wide survey, including the country's first comprehensive list of native halophytic species. The information will be of interest to the general public, to students of the biological sciences, and to those involved in the management of salt-affected agricultural lands.

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Preface

Halophytes are an important group of plants, and play key roles in the ecosystem. While they have been used by local communities for millennia, their full potential is still untapped. For example, they could be used to assist in the amelioration of saline soil, to rehabilitate degraded ecosystems, or cultivated on a commercial scale for specific end uses. They could be 'mined' for genes conferring salt and drought tolerance, for use in crop breeding programs.

Syria has a unique diversity of halophytic plant species, found in different types of climax vegetation – in naturally occurring *sabkhas* (salt-flats) as well as saline soils and inland and littoral salt marshes. However, only limited published information is available on the status, biology and potential use of these plants. This book attempts to fill this information gap. It presents data collected during country-wide surveys conducted in 2005-06, covering all saline areas in Syria. It provides a provisional list of the halophytes of Syria – the first such list to be published. For each species, it describes characteristics, distribution, habitat, salt tolerance levels and traditional uses.

The halophytic flora of Syria includes about 110 species, belonging to 70 genera and 28 families of flowering plants. Six species were recorded from Syria for the first time during these surveys. This flora can be categorized into nine vegetation associations. The book also identifies several species with potential use in the improvement of saline soils.

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Executive Summary

The halophytic flora of Syria fills a major gap in the botanical literature of the Middle East. It presents the first comprehensive list of the country's halophytic (salt-tolerant) plants – including six species recorded in Syria for the first time. This book aims to serve four functions: to describe the current status of halophytes and their habitats; introduce the reader to halophyte biology and evolutionary adaptations; identify native halophyte species that could help rehabilitate degraded areas (farmland as well as natural ecosystems); and provide a reference for scientists and land management specialists.

Halophytes play key roles in the ecosystem. They have been used by local communities for millennia, but their full potential is still untapped. For example, they could be used in the amelioration of saline soils, to rehabilitate degraded ecosystems, or cultivated on a commercial scale for specific end uses. They could be 'mined' for genes conferring salt and drought tolerance, for use in crop breeding programs.

Syria has a unique diversity of halophytes, found in different types of climax vegetation – in naturally occurring *sabkhas* (salt-flats) as well as saline soils and inland and littoral salt marshes. However, only limited published information is available on the status, biology, and potential use of these plants. To fill this gap, extensive surveys were conducted in 2005-06, covering every major saline areas in the country. This book presents the survey results, together with additional information from often hard-to-find publications.

The book contains two parts. Part 1 is an overview of halophyte biology, describing different types of halophytes and the unique adaptations that enable them to survive in harsh, saline environments. It also discusses salinity and land degradation, including the causes, biophysical processes, and the potential use of halophytes to ameliorate salt-affected soils. Part 2 is a catalog of more than 100 halophyte species found in Syria and elsewhere in the Middle East. It describes the characteristics, distribution, habitat, salt tolerance levels and traditional uses of each species.

Syria has about 110 species of halophytes, belonging to 70 genera and 28 families. They are typically found as 'vegetation associations', where two or three species occur together, sometimes in dense stands, forming the predominant vegetation in an area. The book describes the nine types of vegetation associations found in Syria.

At least 15 species reported in this book could potentially be used for the amelioration of saline soils. Some of these species could also provide forage for sheep and goats, or raw material for the pharmaceutical and foods industries.

Part 1

Halophytic plants: overview, biology and classification of flora

Halocnemum strobilaceum association *at* Al-Mouh *sabkha*

Introduction

Halophytes are plants that can tolerate high levels of salts and/or sodium in soil or in irrigation water; some halophytes even need salts in the growth medium. They can survive salinity, drought and other harsh environmental conditions in both temperate and tropical climates. Halophytes are found in a wide variety of saline habitats from coastal sand dunes, salt marshes and mudflats to inland deserts, salt flats and steppes; and in every climatic zone, from the tropics to tundra.

Halophytes play an important role in protecting habitats and maintaining ecological stability. They provide food and shelter for a great number of animal species, both aquatic and terrestrial. Halophytes also have huge potential to aid agricultural development and habitat restoration in areas affected by salinity.

Figure 1. Major *sabkhas* in Syria

In Syria, halophytes are found in naturally occurring *sabkhas* (salt flats) as well as saline soils and salt marshes in many parts of the country. The larger *sabkhas* in Syria are shown in Figure 1. They include Al-Jaboul lake southeast of Aleppo, Al-Mouh near Palmyra, Al-Hyjanah about 40 km southeast of Damascus, Jyroud about 70 km northeast of Damascus, and the Solonchak depressions in the Al-Kom, Qabajeb and Al-Sukhnah areas as well as at the border between Syria and Iraq (Sankary 1981).

Salinity and land degradation

Salt-induced soil degradation is common in arid and semi-arid areas in many parts of the world, and is particularly serious in irrigated land. Over the last few decades, it has increased steadily in large-scale irrigation schemes in a number of countries. It is now the most common land degradation process in environments where rainfall is too low to maintain a regular percolation of rainwater through the soil and irrigation is done in the absence of a natural or artificial drainage system. Salt-affected soils are found in at least 75 countries and occupy more than 20% of the world's irrigated area (Ghassemi et al. 1995). In some countries, they occur on more than half of the irrigated land (Cheraghi 2004).

Soils in dry areas are particularly prone to salinization. This is because the rate of water evaporation from the soil exceeds the water input from rainfall, allowing salts to accumulate near the surface as the soil dries (Szabolcs 1989). This is likely to increase due to climate change, which will probably cause dry regions to become drier (Dore 2005). The vast tracts of saline soils in dry lands limit the amount and quality of vegetation available for livestock grazing. Accumulation of salts in these soils originates either from the weathering of parent salt-bearing minerals (primary salinity) or from anthropogenic activities involving unsustainable management of land and water resources (secondary salinity). Secondary (human-induced) salinization affects a smaller area than primary salinity (Ghassemi et al. 1995, Oldeman et al. 1991) but is a more serious problem because it mainly affects cropland.

Arable land is scarce in dry regions; yet salinity-affected land is frequently abandoned because amelioration is expensive (Dregne 1995). The problem is aggravated by the low salt tolerance of major agricultural crops (Abrol et al. 1988) compared to wild salt-tolerant plants (halophytes), which are adapted to saline soils (Glenn 1995). Salt build-up is perhaps the largest productivity constraint in irrigated agriculture in the dry areas (Ghassemi et al. 1995). In recent decades, progress has been made in understanding and avoiding practices that lead to soil salinization, and in developing new crops, exploring genetic variation within crops and developing agronomic techniques for the management of salt-affected soils so they remain in production without requiring complete restoration (Lieth and Al-Masson 1993).

Salt-affected soils in Syria

Salt-affected soils cover very large areas in Syria, and are found at different elevations, from the Mediterranean seashore to more than 1000 m in Jyroud sabkha. Most salt-affected areas receive annual precipitation of less than 250 mm, except for the seashore areas, which receive 700-800 mm (Meteorological Department 1977). Human-induced salinization affects about 1.3 million hectares of land in Syria. The major affected areas are irrigated lands in

the Euphrates River Basin, which suffer from severe soil degradation and deterioration of water quality (Abdelkarim 1997, Sarraf 2004).

Natural salt-affected lands, or *sabkhas*, are widespread in Syria. '*Sabkha*' is an Arabic name for a salt-flat that has come into general use as a term following classic research in the United Arab Emirates in the 1960s (Aronson 1985, 1989). *Sabkhas* are flat with saline soil (a thin crust of halite may sometimes be present), and are also subject to periodic flooding. The water and soil of sabkhas are usually highly saline. Consequently, plants and animals have adapted to these conditions. *Sabkhas* are found in many parts of Syria (Fig. 1), and are important habitats for wildlife. The ponds serve as resting areas and a source of food for migrating birds. Many fish and other species are part of these ecosystems. *Sabkha* plants are able to provide a stable environment in areas where less adapted flora cannot survive (Fig. 2).

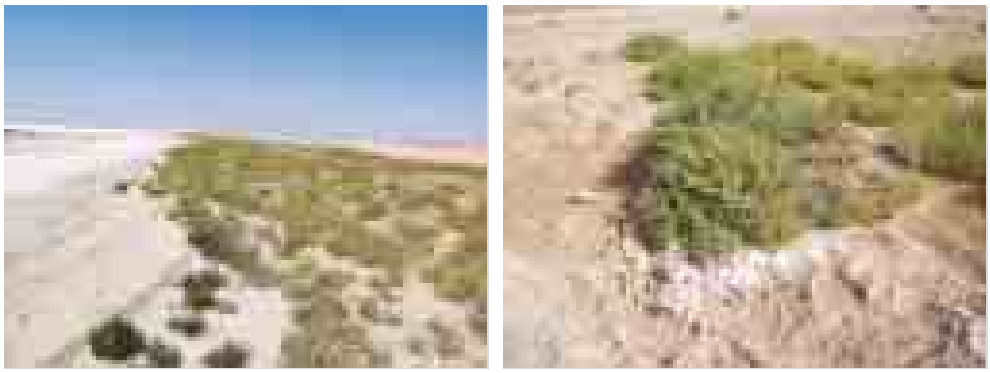

Figure 2. Al-Jaboul (left) and Al-Mouh (right) *sabkhas* in Syria

Human-induced salinization in Syria affects approximately 1.3 million ha. About 60,000 ha of agricultural soils are highly saline and are out of production. Additionally, on about 100,000 ha of irrigated lands in the Syrian part of the Euphrates Basin, production has fallen by 50% because of salinization. About 6000 ha of irrigated land are put out of production each year because of salinization (Abdelkarim 1997).

Halophyte biology: an overview

Introduction

Halophytes are generally defined as rooted seed plants (grasses, succulents, herbs, shrubs and trees) that grow in saline habitats. Most halophytes (as well as salt-tolerant crop cultivars) are deep-rooted perennials that achieve their optimum growth and yield potential at salinity (EC) of 6-20 dS/m, levels at which virtually all modern crops would perish. Some halophytes can grow in coastal regions and in arid inland deserts, where the EC is 45 dS/m (seawater) and above. In recent years, halophyte crops have even been produced, on an experimental basis, using seawater for irrigation (Glenn et al. 1997).

Most halophytes produce salt-free seeds, which require freshwater and temperatures greater than 13°C in order to germinate; but there are exceptions that can germinate at sea water concentrations. As they grow into seedlings and mature, halophytes begin to develop and exhibit salt-tolerance mechanisms.

Categories of halophytes

Depending on their habitat conditions, halophytes have developed different strategies to survive with sometimes very high salt concentration in soil water. They are categorized into obligatory and facultative halophytes depending on their tolerance and demand for sodium salts (Gorychina 1979, Shukla and Chandel 2001). Obligatory halophytes need some salt while facultative halophytes can also grow under freshwater conditions. Other categories of halophytes are:

- Hydro-halophytes that grow in aquatic conditions or on wet soils. Most mangroves such as *Avicennia marina* (Fig. 3) and salt marsh species along coastlines such as *Salicornia europaea* (Fig. 4) and *Arthrocnemum macrostachyum* are hydro-halophytes.
- Xero-halophytes that may grow in habitats where the soil is always saline but where the soil may dry out so much as to cause problems of plant water availability.

Most species found in the *sabkhas* of desert areas are xero-halophytes such as *Tamarix* (Figs. 5 and 6), *Juncus* and *Lemonium* species. Many of them are succulent, for example *Seidlitzia rosmarinus* (Fig. 7).

In general, hydro-halophytic communities tend to generate more biomass than xero-halophytes due to differences in air and soil moisture. Many desert halophytes retain relatively high concentrations of salt, tannins and saponins in their leaves.

Figure 3. *Avicennia marina*

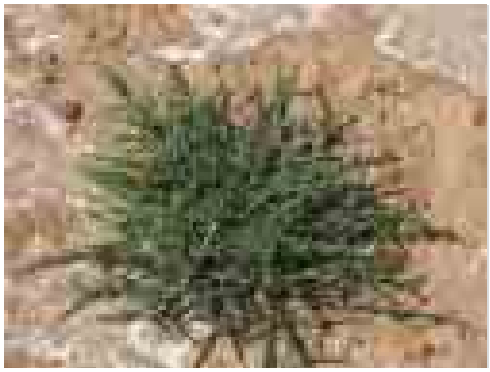

Figure 4. *Salicornia europaea*

Figure 5. *Tamarix mannifera* at Al-Hyjanah *sabkha*

Figure 6. *Tamarix tetragyna* at Al-Mouh *sabkha*. Note the salt excreted from fallen leaves

Figure 7. *Seidlitzia rosmarinus*

Figure 8. Salt crystals on the leaves of *Reaumuria alternifolia*

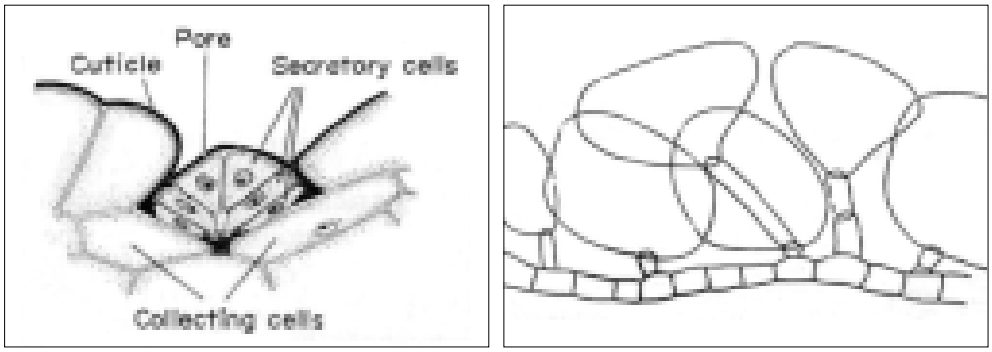

Figure 9. Salt glands in *Tamarix* (left) and *Atriplex* (right). Figure modified from Fahn (1977)

Halophytes can also be categorized based on morphology. One category distinguishes succulent halophytes such as *Seidlitzia rosmarinus, Salicornia europaea, Arthrocnemum glaucum* and others. Halophytes of other categories have salt-secreting trichomes as in some species of *Atriplex* (Fig. 9) on the leaf surface; others excrete the salt with evaporation water, leaving behind visible salt crystals on the leaf surface (Fig. 8). Under lower salinity levels some plants are able to exclude the salts otherwise taken up by the roots.

Different halophytes grow in conditions varying from slightly saline to above-seawater salinity. Their genetic and physiological properties are currently the subject of considerable research.

Salinity thresholds

Salinity thresholds are generally defined as the maximum amount of salt that a plant can tolerate in its root zone without impacting growth (Glenn and Brown 1999). Other important thresholds indicate the highest level of plant salt-tolerance associated with a decline in yield or biomass (usually between 10% and 50%); zero yield thresholds specify levels at which a plant can no longer survive. While some species can thrive in seawater, others cannot tolerate even minimal salt concentrations without significant decline in growth and yield.

Domesticated plants classified as salt-sensitive typically have salinity thresholds of 1-3 dS/m and zero yields at 8-16 dS/m or less, while 'moderately' salt-tolerant plants have thresholds of 5-10 dS/m and zero yields at 16-24 dS/m (Glenn and Brown 1999). The most common method of measuring salinity is to determine the level of electrical conductivity (EC) of the soil and water. Increases in EC values are directly correlated with increases in the concentration of soluble salts or elemental ions, predominantly sodium and chloride. Electrical conductivity is most often expressed in units such as decisiemens per meter (dS/m).

Soil samples (saturated paste extract) are classified as saline when EC values exceed 4 dS/m. Water is considered slightly saline between 0.7 and 2.0 dS/m

and saline at levels above 2 dS/m. Rainwater has a conductivity of 0.02-0.05 dS/m whereas seawater, at the other extreme, averages 45-60 dS/m. Salinity in water is also measured by the mass of its inorganic particulates or total dissolved solids (TDS), expressed as parts per million (ppm) or milligrams per liter (mg/l): less than 1000 ppm is considered fresh or potable, greater than 4000 ppm saline; 35,000-45,000 ppm is the standard for sea water. When comparing EC and TDS measurements, 1 dS/m is roughly equal to 650-700 ppm, and close to 800 ppm at higher levels of salinity.

Salinity thresholds are by no means fixed indexes of salt-tolerance. Rather, they can vary widely with environmental conditions and cultivation techniques that influence the plant's physiological response to increasing salinity. Some important factors to consider when gauging the impact of salts on plant growth and yield are:

- Soil structure and texture (sand/loam/clay), fertility and permeability
- Salt concentration variability within sub-soils and the root zone (vertical soil profile)
- Evapotranspiration rates, plant water requirements and soil infiltration
- Life cycle variability of plant salt-tolerance from germination to maturity
- Environmental and climatic factors: temperature, moisture, light, wind, etc.

Distinguishing features of halophytes

The distinguishing feature of halophytes is osmoregulation – their ability to regulate osmotic imbalances that result from increased salinity (Shukla and Chandel 2001, Gorychina 1979). Whether they require or merely tolerate elevated levels of salt in their environment, halophytes compensate for the high osmotic (low water) potential in soil moisture by increasing the osmotic potential within their cells and tissues. By maintaining high internal salt levels, they are able to avoid many of the associated effects of dehydration such as nutrient deficiencies and specific ion toxicity.

Exclusion and excretion. Virtually all halophytes are able to exclude sodium and chloride ions from their soluble nutrient uptake. In addition, certain halophytes have feeder roots with an outer protective layer and a waxy inner membrane that effectively filter out salts while allowing water to pass through. The storage or compartmentation of excess salts within certain organs of the plant is another exclusion mechanism (known as intraplant allocation) that predominates at the root level. As a result of stomatal closure and reduced transpiration rates, many halophytes are able to confine excess salts within their extensive root systems and the lower parts of the shoot in order to restrict their translocation to the rest of the plant.

Excretion is the most readily observable self-regulating behavior. This adjustment is often characterized by the secretion of salty sap through epidermal pores, glands and bladders located on the roots, shoots, and leaves (Fig. 9). Intercellular transport mechanisms (pumps) move excess salt ions from surface cells to the outside of the leaf or stem, leaving visible crystal deposits once the water has evaporated (Fig. 8).

Succulence and abscission. Succulence is the ability to retain water, and thus dilute internal salt concentrations, causing leaves and stems to become distended or succulent. Succulents and other halophytes have the capacity to sequester sodium ions in vacuoles (pockets) within the cell by active transport mechanisms and intracellular pumps that help maintain constant salt levels in the cytoplasm. This inhibits ion toxicity and helps maintain cell turgor (rigidity) while slight accumulations of water, potassium, and manufactured organic proteins (proline, mannitol, sucrose and glycine betaine) keep the cell sap from dehydrating and allow metabolic processes to function properly.

Another efficient desalination mechanism is abscission or die-off of the older salt-laden leaves and stems (and the subsequent regrowth of new salt-free ones). Abscission has a similar detoxifying effect, ensuring plant survival through continuous cycles of salt purges.

Economic and environmental benefits

Halophytes have considerable potential economic value. They could be used for rehabilitation of saline soils, to sustain or extend the cultivable life of irrigated farms, and bring vast tracts of marginal or non-arable lands under commercial production (Aronson 1985). Some halophytes have the potential for commercial-scale production for food, fodder and forage, fiber, fuel, green manure, timber and construction materials as well as raw materials for pharmaceutical, industrial, and household products (Schmsutdinov et al. 2000, Aronson 1985). The genetic resources of halophytes are also important for developing more salt-tolerant crops.

In coastal areas, despite limited diversity, halophytes play key roles in preventing soil erosion and seawater intrusion into freshwater habitats, and providing food and shelter for a great number of animal species, both aquatic and terrestrial (Schmsutdinov et al. 2000).

Commercial production. Although many halophytes have long been wild-harvested by indigenous peoples in coastal areas, delta marshlands and arid deserts, serious efforts to domesticate halophytes for commercial production did not begin until the 1960s. Thus far, botanists have identified and categorized over 2000 halophytic species from more than 550 genera in over 100 families. Some of these have the potential for crop production on a commercial scale, to provide food, fodder and forage, fibre and fuel, green manure and other farm inputs, timber and construction materials, as well as raw materials for pharmaceutical, industrial, and household products.

Grains and oil seeds. Halophytes do not generally accumulate salts in their seed, enhancing their potential for immediate use without additional treatment. A number of salt-tolerant plants (*Chenopodium, Distichlis, Pennisetium, Sporobolus, Uniola, Zizania* and *Zostera*) produce large amounts of high-protein seeds that contain amino acids and essential fatty acids, essential vitamins and minerals, and important carbohydrates. Some halophytes can be multipurpose. For example, *Salicornia* is used as a green vegetable; the seed is pressed for its

high quality edible oil; the residual meal provides superior feed for livestock and farmed shrimp/fish; stems and straw can be utilized as cut hay in mixed feeding regimes.

Fodder, forage and green manure. In the past, halophytic grasses, shrubs and trees, containing digestible protein levels comparable to conventional livestock feed, were planted as forage or harvested for fodder. These include grasses (*Kochia, Spartina, Sporobolus* and others), shrubs (*Atriplex, Salsola* and *Suaeda*) and trees (*Luecaena, Prosopis*). Due to the relatively high salt content in their tissue, the potential is greatest when used in mixed feeding regimes. Many halophtyes have also shown promise in the extraction of leaf protein concentrates that are being increasingly used in animal feeds. Some nitrogen-fixing halophytes (*Alhagi, Glycyrrhiza* and *Prosopis*) have been used as cover crops, green manures, mulch and compost (Fegler and Mota-Urbin 1982).

Agro-forestry and conservation. Salt-tolerant shrubs and trees (*Prosopis, Tamarix* and others) can be planted for conservation, stabilization, rehabilitation of degraded environments, and to reverse desertification. They may be harvested for much-needed fuelwood and timber. The replanting of mangrove forests (*Avicennia* and *Rhizophora*) on the tropical coasts represents another immediate low-cost opportunity for both environmental restoration and sustainable commercial production. Mangroves have traditionally been used for fuelwood, charcoal and building materials, but over the last 100 years, their extent has been reduced by half.

Medicinal, industrial and domestic uses. Some halophytes are now being harvested commercially to obtain gums, oils and resins for production of household goods, food processing, and heavy industrial applications. Other halophytes (*Azedarach, Balanites, Calophyllum, Catharanthus, Hippophae* and *Melaleuca*) are well known for their bioactive derivatives and are essential ingredients for pharmaceuticals, agricultural pesticides, traditional medicines and natural cosmetics. Historically, a number of halophytes (*Juncus, Arundo, Scirpus* and *Typha*) have been cultivated and/or wild-harvested for paper-pulp, fiber and other raw materials used in cottage industries and large-scale processing. In addition, a few halophytes (*Beta, Leptochloa* and *Nypa*) are now being considered as renewable sources.

Ornamentals. A diverse group of halophytes, including *Pancratium maritimum, Convolvulus secundes* and *Limonium* species can be used for landscaping and ornamental purposes under saline conditions.

Plant breeding. There is also potential to use halophytes or diversities among and within halophyte species to improve crop production in saline areas. Many of their unique features could be valuable in plant breeding programs. To give one example, *Agropyron junceum* has been used as a source of salt tolerance genes for wheat.

Soil amelioration (phytoremediation). Phytoremediation is the cultivation of plants for the purpose of reducing soil and water contamination by organic and inorganic pollutants. Phytoremediation is often the only effective and economical method of removing or reducing contaminates, particularly for large areas where physical/chemical treatments and leaching are too expensive or unfeasible. A number of halophytic grasses have been proven to be effective in re-vegetating brine-contaminated soils that typically result from gas and oil mining.

Halophytic flora of Syria

Syria has about 110 halophytic species, belonging to 70 genera and 28 families of flowering plants; 37% of those belong to *Chenopodiaceae*. Other well-represented families are *Gramineae* (*Poaceae*), *Compositae*, *Tamaricaceae* and *Plumbaginaceae*. Annual and perennial species account for 69% of the total species. About 38% of the species are Mediterranean floristic elements, 16% are Saharo-Arabian and 12% Irano-Turanian (Al-Oudat 2008).

The climax vegetation on saline soil differs from one location to another, but can be classified under four types (Al-Oudat 2008):

- *Tamarix tetragyna–Halocnemum strobilaceum* association in Al-Mouh *sabkha*
- *Tamarix smyrnensis–Arthrocnemum macrostachyum* association along the Mediterranean seashore
- *Tamarix macrocarpa–Salicornia europaea* association in Al-Jaboul *sabkha*
- *Tamarix mannifera–Juncus maritimus* association in Jyroud *sabkha*.

Halophytic communities in Syria are still poorly understood. This is mainly due to two factors: absence of updated information, and the interest of most botanists and ecologists in the rich flora of other parts of the country, especially the coastal regions. Some information is available on the halophytic flora of Lebanon and Syria (Mouterde 1966, 1970, 1983) but rarely contains details about the habitats. Some information is also available for desert areas in Syria (Rodin 1964, Sankary 1981, Ministry of Land Reclamation and Water Management of the former USSR 1987, Vinogradov and Rodin 1964).

Review of previous studies

In his survey of halophytic vegetation of the Middle East, Zohary (1973) discussed the halophytic communities of Syria with the *Halocnemetea strobilacei* class, which consists of a group of communities confined to interior cool and warm temperate deserts. The characteristic species are fairly numerous: *Salsola* spp, *Seidlitzia rosmarinus*, *Tamarix* spp, *Cornulaca setifera*, *Limonium* spp, *Puccinellia* and others. In inner Syria, a few halophytic plant communities have characteristics very similar to those of *Halocnemetea* found in the eastern part of Damascus. In the center of the Syrian desert, in Es Sukhne, Palmyra and its vicinity, there are a few plant communities consisting of the following species: *Halocnemum strobilaceum, Cornulaca setifera, Suaeda carnosissima, Sphenopus divercayus, Seidlitzia rosmarinus, Atriplex leucoclada, Gypsophila perfoliata, Atriplex stylosa, Limonium palmyrense, Girgensohnia oppositifolia, Salsola inermis, Salsola zenobiae*.

Rodin (1964) classified the halophytic vegetation of the Syrian desert under three categories:

- Saline flats with very high salt content and very sparse vegetation of *Halocnemum strobilaceum*

- Halophytic steppe vegetation dominated by *Aeluropus littoralis*
- Mesohalophytic vegetation in the peripheries of the *sabkhas*; dominated by phreatophytes such as *Tamarix* spp, *Alhagi maurorum*, *Prosopis farcta*, *Cynodon dactylon* and others.

The Ministry of Land Reclamation and Water Management of the former USSR (1987) classified the halophytic vegetation of Syria as a type of *Halocnemum* pasture, dominated by *Halocnemum strobilaceum*, *Frankenia pulverulenta*, *Seidlitzia rosmarinus* and *Tamarix* species. It also mentions small plots of meadow vegetation found on the slopes of saline areas, dominanted by *Aeluropus littorals* and to a lesser extent *Alhagi mourorum*.

Sankary (1981) proposed *Tamarcieto–Aeluropetum* (*Tamarix articulata–Aeluropus littoralis*) as the dominant vegetation on saline soils in Syria. He classified the halophytic vegetation under six associations based on soil salinity levels:
- *Prosopis–Cynodon* (salinity range 2-7 dS/m)
- *Atriplex–Reaumeria* (salinity 4-10 dS/m)
- *Frankenia–Aeluropus* (salinity 10-18 dS/m)
- *Linonium–Suaeda* (salinity > 22 dS/m)
- *Halocnemum–Salicornia* (salinity 30-200 dS/m)
- *Tamarix–Juncus* (flooded soils without consideration of salinity).

The present study

This book seeks to document the current status of the native flora of saline lands in Syria. The study included:
- Reconnaissance of the country's entire saline area through a network of reconnaissance routes
- Geo-botanical survey of the reconnaissance area, with more than 60 observations at different sites. Geo-botanical vegetation types were identified mainly by visual screening in 2005-06. The individual types of vegetation were documented based on (i) records of various stands of each type of vegetation, (ii) uniform composition of dominant and subdominant species.

Classification of vegetation associations in Syria

Halophytic vegetation in Syria can be classified into nine vegetation associations, described below:
- *Tamarix* associations
- Associations of *Halocnemum strobilaceum* and *Halopeplis perfoliata* on muddy salt flats
- Obligatory hygro-halophytic associations in inland and littoral salt marshes
- Hydrophilous euryhalophytic associations (*Arundo*, *Juncus*, *Typha*)
- Hydrohalophytic plant associations (*Ruppia maritima*)
- Halophytic shrub associations on salty and dry soils
- Herbaceous perennial and hemicryptophyte halophytic associations
- Xerohalophytic associations with salt tolerant xerophytes
- Annual halophytic associations

Figure 10. *Tamarix mannifera* association at Al-Hyjanah

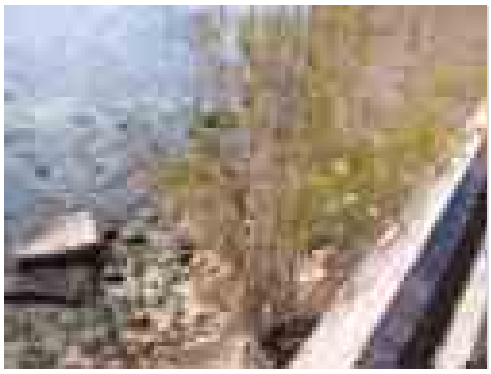

Figure 11. *Tamarix smyrnensis* at the sea-shore

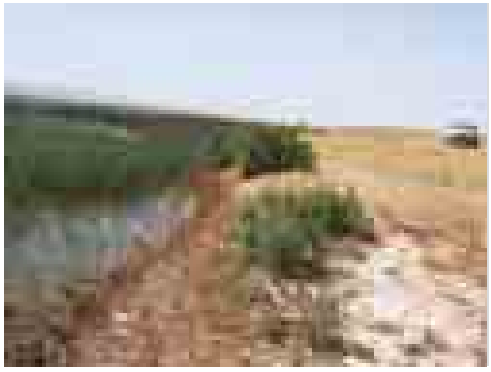

Figure 12. *Tamarix tetragyna* association at Al-Jaboul

Figure 13. *Tamarix macrocarpa* association at Al-Mouh

1. *Tamarix* associations

Tamarix associations are among the most important vegetation units in Syria's saline areas (Fig. 10). These associations are typical of vast areas of saline flats with high salinity and high groundwater level, both inland saline areas and littoral marshes. In most inland sabkhas, *Tamarix* species form forest-like associations as in Al-Mouh *sabkha*, where vegetation density may exceed 60% and soil salinity can reach 70 dS/m. *Tamarix* species are the dominant plants in the first stratum. Low shrubs of *Halocnemum*, *Arthrocnemum* and *Salicornia* form the second stratum, while perennial species of *Limonium*, *Frankenia* and annual and perennial grasses and herbs form the third stratum.

Several *Tamarix* species (Figs. 11-13) occur in a variety of saline habitats, particularly seashore (*T. smyrnensis*), saline and sandy soil (Al-Hyjanah and Jyroud *sabkhas*), estuaries of central depressions, and vast areas of inland saline soils with a relatively high water table (Al-Mouh *sabkha*).

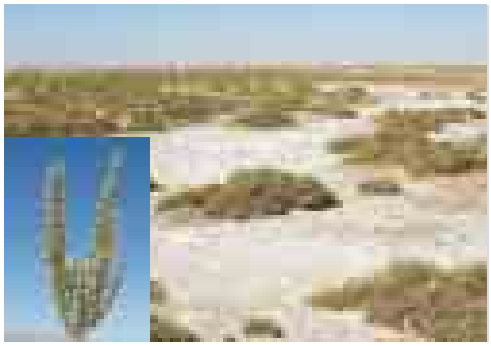

Figure 14. *Halocnemum strobilaceum* association at Al-Mouh

Figure 15. *Halopeplis perfoliata* association at Al-Jaboul

2. *Halocnemum strobilaceum and Halopeplis perfoliata* associations

Associations of *Halocnemum strobilaceum* and *Halopeplis perfoliata* are typical of muddy salt flats (Figs. 14, 15). *Halocnemum strobilaceum* (Fig. 14) is typical of vast areas of saline flats with high salinity (up to 70 dS/m) and high groundwater level. *Halocnemum strobilaceum* and *Halopeplis perfoliata* (Fig. 15) associations are very poor in species diversity and often monodominant. On the peripheries of inland saline areas they form a pioneer halophyte community.

3. Obligatory hygro-halophytic associations

This vegetation type is unique to highly salty and wet soil at the margins of salt lakes and littoral marshes of the Mediterranean Sea. It can be divided into two main subunits: inland salt marshes (Al-Jaboul) dominated by *Salicornia europaea*, (Figs. 16-18) and littoral salt marshes of the Mediterranean seashore dominated by *Arthrocnemum macrostachyum* (Figs. 19, 20).

Figure 16. *Salicornia europaea* association at Al-Jaboul

Figure 17. *Salicornia europaea* association at Al-Jaboul (autumn)

Figure 18. *Salicornia europaea* at vegetative stage

Figure 19. *Arthrocnemum macrostachyum* association at the seashore

Figure 20. *Arthrocnemum macrostachyum* at vegetative stage (seashore)

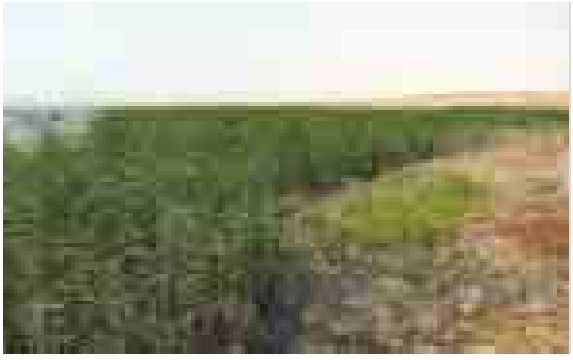

Figure 21. *Arundo donax* association at Al-Jaboul

Figure 22. *Arundo donax* on saline soil at Al-Jaboul

4. Hydrophilous euryhalophytic associations

The vegetation on the margins of saline seashore and moderately saline lakes (Al-Jaboul) and areas with high groundwater (Jyroud *sabkha*) is composed of hydrophilous euryhalophytic species, including mesohalophytes and facultative halophytes. The dominant species are perennials belonging to the genera *Arundo* (Figs. 21, 22), *Juncus* (Figs. 23, 24), and *Typha* (Fig. 25). Both salinity and floodwaters affect the vegetation of this type. The species found in this type of vegetation have a wide range of salt tolerance. For example *Arundo donax* is euryhalophytic, growing on the banks of freshwater bodies and also in highly saline wetlands (Fig. 21). Some varieties of *Arundo donax*, on the other hand, are typical halophytic varieties adapted to extremely saline habitats (Fig. 22). One of the most important subunits within this type is *Juncus acutus*.

Figure 23. *Juncus acutus* association at the seashore

Figure 24. *Juncus maritimus* association at Jyroud

Figure 25. *Typha latifolia* association at Al-Mouh

Figure 26. *Ruppia maritima* association at Al-Jaboul

Figure 27. *Ceratophyllum demersum* association at Al-Jaboul

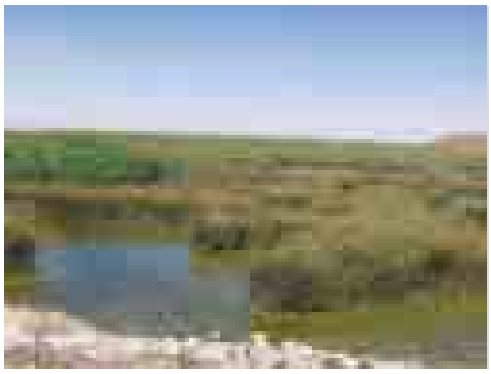

Figure 28. *Ruppia maritima* with *Arundo* and *Scirpus* associations at Al-Jaboul

Figure 29. *Seidlitzia rosmarinus* association at Al-Mouh

Figure 30. *Nitraria retusa* association at Jyroud

5. Hydrohalophytic plant associations

Ruppia maritima and *Ceratophyllum demersum* (Figs. 26, 27) are characteristic components of aquatic plant associations in the marshes along inland salt lakes (Al-Jaboul). *Ruppia* is associated with *Arundo donax* and *Scirpus littoralis* in Al-Jaboul Lake (Fig. 28).

6. Halophytic shrub associations on salty and dry soils

The plant associations in this group are represented by *Seidlitzia rosmarinus*, *Reaumuria alternifolia* (Al-Mouh) and *Nitraria retusa* (Jyroud) (Figs. 29, 30).

7. Herbaceous perennial and hemicryptophyte halophytic associations

Mosaic stands of herbaceous perennial and hemicryptophyte halophytic species are found in most saline areas in Syria. These species play an important role in the vegetation of saline habitats, and can be divided into three categories:

(i) Seashore perennials (Figs. 31-34) such as *Eryngium maritimum, Euphorbia paralias, Hyparrhenia hirta, Medicago marina, Lotus corniculatus, Halimione portulacoides* and *Limonium species*.

(ii) Inland perennials such as *Aeluropus lagopoides* (Fig. 35), *Peganum harmala, Atriplex leucoclada, Convolvulus lineatus, Astragalus squarrosus* (Fig. 36), *Glycyrrhiza glabra, Limonium palmyrense* (Fig. 37), *Sedlitzia rosmarinus* (Fig. 29), and *Anabasis* species.

(iii) Species found in both regions such as *Suaeda fruticosa*, *Frankenia* species (Fig. 38), *Cynodon dactylon, Aeluropus littoralis* (Fig. 39) and others.

8. Xerohalophytic associations with salt-tolerant xerophytes

The Syrian *sabkhas* are surrounded by dry steppes, with transitional types occurring between steppes and the saline soil habitats. Xerohalophytic associations with salt-tolerant xerophytes mostly cover such habitats. Associations of *Anabasis articulata* (Fig. 40), *A. articulata, Haloxylon articulatum, Chenolia arabica, Prosopis farcta* (Fig. 41) and Alhagi maurorum (Fig. 42) are more common in xerophytic associations. Some species of *Salsola, Seidlitzia, Reaumeria, Zygophyllum fabago* (Fig. 43), *Zilla spinosa* and some salt-tolerant xerophytes colonize in such conditions.

9. Annual halophytic associations

Annual species, as with other plant associations, are important in saline habitats. The annuals occurring in saline areas can divided into two categories:

(i) Spring halophytic therophytes such as *Aizoon hispanicum, Beta maritima* (Fig. 44), *Sphenopus divercatus*, *Polypogon monospelienis, Matthiola tricuspidata* (Fig. 45) and *Cakile maritima* (Fig. 46).

(ii) Late summer annual halophytes such as *Salsola kali* and *S. volkensii* (Figs. 47, 48).

Provisional list of halophytes of Syria

Table 1 is a provisional list of the halophytes of Syria. This list, the first published to date, was developed following field trips to all the saline regions in Syria during 2005-06. The main criteria applied in the field studies were the absence of a species from non-saline habitats, and the measurement of electrical conductivity (EC) of the soil.

Nomenclature follows various sources, mostly studies of the flora of Lebanon and Syria (Mouterde 1966, 1970, 1983), Palestine (Zohary and Feinbrun-Dothan 1966, 1972, 1978, 1986), Saudi Arabia (Mandaville 1990), Kuwait (Shuaib 1995) and Syria (Sankary 1981).

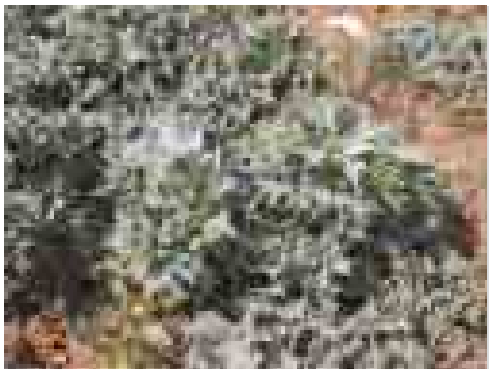

Figure 31. *Eryngium maritimum* at the seashore

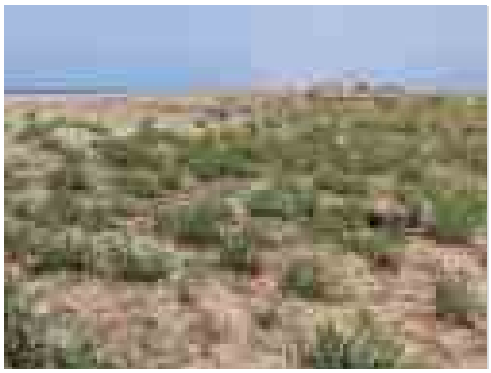

Figure 32. *Euphorbia paralias* association at the seashore

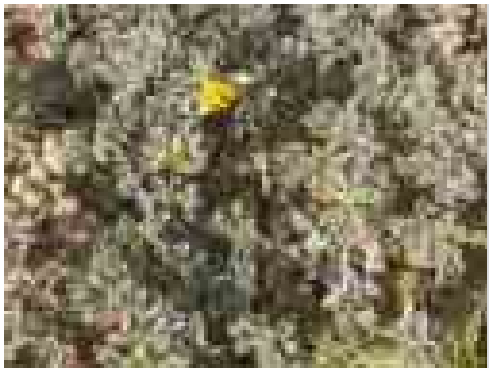

Figure 33. *Medicago marina* at the seashore

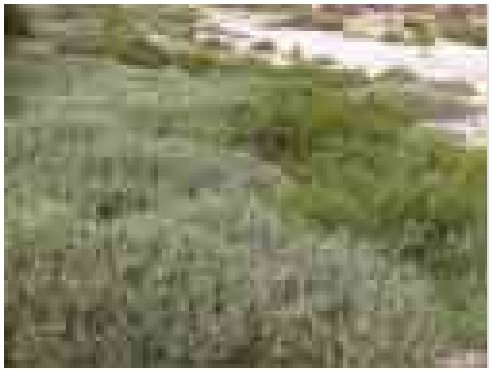

Figure 34. Association of *Halimione portulacoides* (left) and *Arthrocnemum macrostachyum* (right) at the seashore

Figure 35. *Aeluropus lagopoides* association at Al-Jaboul

Figure 36. *Astragalus squarrosus* at Al-Hyjanah

Figure 37. *Limonium palmyrense* association at Al-Mouh

Figure 38. *Frankenia pulverulenta* at Al-Jaboul

Figure 39. *Aeluropus littoralis* association at Al-Mouh

Figure 40. *Anabasis articulata* association at Jyroud

Figure 41. *Prosopis farcta* association at Al-Jaboul

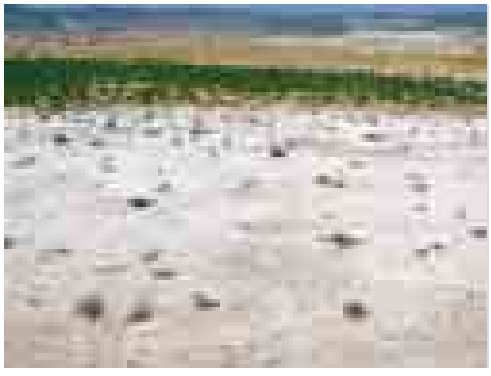

Figure 42. *Alhagi maurorum* association at Al-Jaboul

Figure 43. *Zygophyllum fabago* association at Jyroud

Figure 44. *Beta vulgaris maritima* at the seashore

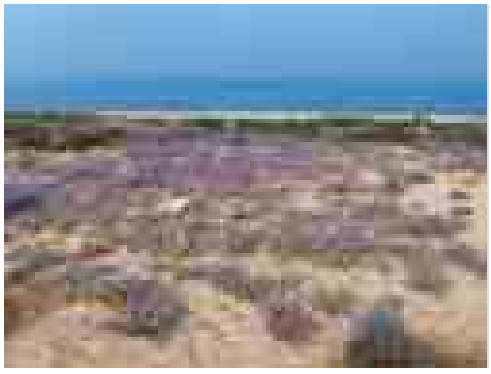

Figure 45. *Matthiola tricuspidata* association at the seashore

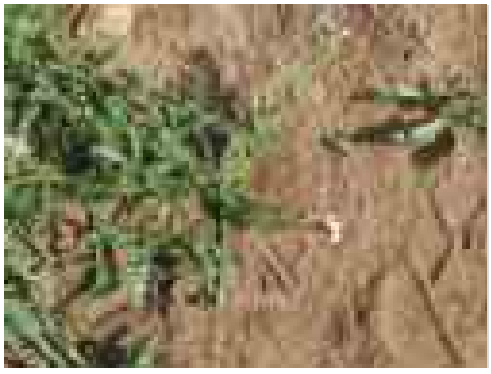

Figure 46. *Cakile maritima* at the seashore

Figure 47. *Salsola volkensii* at Al-Jaboul

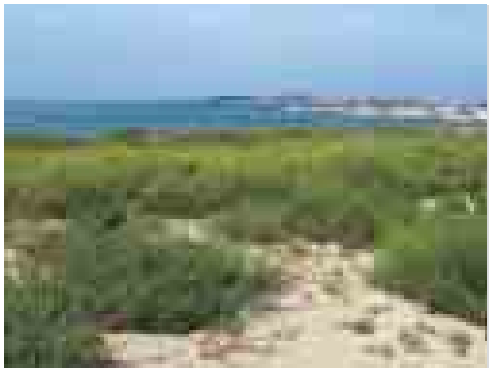

Figure 48. *Salsola kali* association at the seashore

Based on the list in Table 1, the following conclusions can be summarized:

- The flora of saline soils contains about 110 halophytic and salt-tolerant species, belonging to 70 genera and 28 families of flowering plants.
- About 37% of the species belong to *Chenopodiaceae*. Other well represented families are *Graminiae* (*Poaceae*), *Compositeae, Tamaricaceae* and *Plumbaginaceae*.
- Genera with high numbers of halophytic and salt-tolerant species are *Salsola, Suaeda, Tamarix, Limonium, Arthrocnemum, Juncus* and *Scirpus*.
- Annual and perennial species are predominant, accounting for 69% of the species.
- About 38% of the species are Mediterranean floristic elements, 16% are Saharo-Arabian and 12% are Irano-Turanian.
- Six species were recorded from Syria for the first time: *Arthrocnemum fruticosum, Halopeplis perfoliata, Suaeda vera, Aellenia autrani, Juncus arabicus* and *Solanum elaeagnifolium*.

In Syria, as elsewhere, natural halophytic vegetation is rapidly being destroyed. In most areas that have been studied, degradation of vegetation cover leads to desertification and salinization, as seen in Jyroud, Al- Mouh, Hyjanah and Al-Jaboul *sabkhas*. There is also invasion by weedy species. The most widespread of these species are *Alhagi maurorum* and *Prospis farcta*. Other species such as *Anabasis haussknechtii, Salsola* species and some annual halophytes are more or less restricted to degraded lands.

Potentially useful halophyte species

There are several native species that might be useful for the improvement of saline soils. We recommend further studies on the ecology and possible use of the following species:

Tamarix tetragyna
Beta maritima
Suaeda fruticosa
Salicornia europaea
Arthrocnemum fruticosum
Atriplex leucoclada
Arthrocnemum macrostachyum
Halocnemum strobilaceum
Halimione portulacoides
Seidlitzia rosmarinus
Inula crithmoides
Scirpus littoralis
Nitraria retusa
Zygophyllum fabago
Limonium angustifolium.

Table 1. Native halophytic species of Syria

Family and Species	Local name	Life form*	Geographical region	Salinity**
Amaryllidaceae	الفصيلة النرجسية	-	-	-
Pancratium maritimum L.	نرجس البحر	Perennial	M	Tolerates maritime exposure
Aizoaceae	الفصيلة الآيزونية	-	-	
Aizoon hispanicum L.	الغاسول(حدق)	Annual	SA	> 10 dS/m
Mesembryanthemum forsskalei Hochst. ex Boiss	ملاّح ، غاسول	Annual	S	Up to 20 dS/m
Mesembryanthemum nodiflorum L.	ملاّح، مليح، غاسول	Annual	M, ES, SA	Up to 28 dS/m
Capparaceae	الفصيلة القبارية	-	-	-
Capparis spinosa L	القبار – الشفلح	Shrub	M	Up to 14 dS/m
Caryophyllaceae	الفصيلة القرنفلية	-	-	-
Gypsophila anatolica Boiss. et Helder. (Syn. G. *perfoliata* L.***)	جبسوفيلا أناضولية	Perennial	IT	Up to 10 dS/m
Ceratophyllaceae	فصيلة قرنيات الورق	-	-	-
Ceratophyllum demersum L.	حامول الماء	Perennial	Cosmopolitan	> 10 dS/m
Chenopodiaceae	الفصيلة السرمقية	-	-	-
Aellenia glauca (Bieb) Allen. ssp.*lancifolia* (Boiss.) Allen. (syn.*Halothamnus glaucus* (M.Bieb.) Botsch. ***)	العجواء	Perennial	IT	Up to 20 dS/m
Aellenia autrani (Post) Zoh.	العجواء	Annual	IT	Up to 10 dS/m
Anabasis articulata (Forsk.)Moq.	الشنان آرتيكولاتا	Shrub	SA	Up to 10 dS/m
Anabasis haussknechtii Bge. (Syn. *A.syriaca* Iljin.)	الشنان السوري	Perennial	IT	Up to 10 dS/m
Arthrocnemum fruticosum (L.) Moq.(Syn. *Sarcocornia fruticosa* (L.) A.J. Scott.***)	اشنان (قلام)	Shrubby perennial	M	> 56 dS/m
Arthrocnemum glaucum (Del.) Ung-Sternb.	شوع	Shrubby perennial	M	> 56 dS/m

Table 1. (continued)

Family and Species	Local name	Life form*	Geographical region	Salinity**
Arthrocnemum macrostachyum (Moric.) Moris et Del.	اشنان	Shrub	M, SA	> 56 dS/m
Atriplex halimus L.	القطف الملحي	Shrub	M, SA	Up to 56 dS/m
Atriplex leucoclada Boiss.	الرغل– القطف	Perennial	SA	Up to 30 dS/m
Atriplex hastata L. (Syn. *Atriplex prostrata* Boucher ex DC.***)	الرغل– القطف	Annual	ES, IT, M	Up to 20 dS/m
Atriplex rosea L.	الرغل الوردي	Annual	M	Up to 20 dS/m
Atriplex stylosa Viv.	الرغل– القطف	Dwarf shrub	SA	Up to 20 dS/m
Atriplex littoralis L.	الرغل الشاطئي	Annual	M, ES	Up to 20 dS/m
Bassia hyssopifolia (Pall.) Kuntze.	اللياء	Annual	M, IT	Up to 14 dS/m
Bassia muricata (L.) Aschers	اللياء	Annual	SA, IT	Up to 14 dS/m
Beta vulgaris L. ssp. *maritima* (L.) Batt.	الشوندر البري	Perennial (annual)	M, ES, IT	Up to 28 dS/m
Chenopodium album L.	رجل البطة (السرمق)	Annual	Pluri-regional	Up to 8 dS/m
Chenopodium murale L.	رجل البطة (السرمق)	Annual	Pluri-regional	Up to 8 dS/m
Chenopodium rubrum L.	رمرام –زربيخ	Annual	Pluri-regional	Up to 20 dS/m
Chenolea arabica Boiss.	الفلفلة	Dwarf-shrub	SA	Up to 20 dS/m
Girgensohnia oppositifolia Pall	الشويكة	Annual	IT	Up to 10 dS/m
Halimione portulacoides (L.) Aellen. (Syn. *Atriplex portulacoides* L.***)	القطف البحري	Shrubby perennial	ES, M, IT	Up to 56 dS/m
Halocnemum strobilaceum (Pall.) Bieb.	الثليث (الحمض)	Dwarf shrub	M, IT, SA	> 56 dS/m
Halopeplis amplexicaulis (Vahl.) Ung- Sternb.	البلبل (العدو)	Annual	M	> 56 dS/m
Halopeplis perfoliata (Forsk.) Aschers. et Sch.	الخرزة (خرايز)	Shrublet	-	> 56 dS/m

Table 1. (continued)

Family and Species	Local name	Life form*	Geographical region	Salinity**
Haloxylon articulatum (Gav) Bge. (Syn. *Hammada scoparia* (Pomel) Iljin.)	الرمث	Shrub	SA, IT	Up to 10 dS/m
Salicornia europaea L. (syn. *S. herbacea* L.)	اشنان –حرض– القلي	Annual	M, ES	> 56 dS/m
Salsola crassa Bieb.	النداوى	Annual	IT	Up to 20 dS/m
Salsola jordanicola Eig.	الخذراف الأردني	Annual	SA	Up to 12 dS/m
Salsola kali L	الحرض الشائك– حرض	Annual	Pluri-regional	Up to 17 dS/m
Salsola tetrandra Forsk.	العرد	Dwarf shrub	SA	16 to 20 dS/m
Salsola volkensii Asch. et Schweinf.	الخذراف	Annual	M	Up to 20 dS/m
Schanginia baccata (Forssk) Moq. (syn. *Suaeda aegyptica* (Hasselq.)Zoh.)	السواد	Annual	SA	Up to 14 dS/m
Seidlitzia rosmarinus (Ehr.) Bge.	العنظوان	Shrub	SA	> 20 dS/m
Suaeda asphaltica Boiss.	السويدة	Shrub	SA	Up to 40 dS/m
Suaeda fruticosa (L.) Forssk. (Syn. *Suaeda vera* Forsk. ex.J.F.Gmel.***)	السويدة	Shrub	S	Up to56 dS/m
Suaeda vera Forsk. ex J. F. Gmel.	السويدة	Shrub	M, SA	Up to56 dS/m
Suaeda vermiculata Forssk ex J.F. Gmel.	السويدة	Half-shrub	SA	Up to56 dS/m
Suaeda carnosissima Post.	السويدة	Annual	Endemic	Up to56 dS/m
Cistaceae	الفصيلة القستوسية	-	-	-
Helianthemum lippii (L.) Dum. Cours.	زهرة الشمس	Dwarf shrub	SA	10 (15) dS/m
Compositae	الفصيلة المركبة	-	-	-
Achillea fragrantissima (Forssk.) Sch.	القيصوم– بعيثران	Chamaephyte	SA, IT	> 10 dS/m
Centaurea postii Boiss.	المرار	Perennial	M	14-20 dS/m

Table 1. (continued)

Family and Species	Local name	Life form*	Geographical region	Salinity**
Inula crithmoides L.	راسن(حطب زيتي)	Shrub	M	Up to 56 dS/m
Inula viscosa (L.) Ait. (Syn. *Dittrichia viscosa* (L.) Greuter***)	الطيون	Chamaephyte	M	Up to 10 dS/m
Xanthium strumarium L.	اللزيق	Annual	Borealo-Tropical	Up to 20 dS/m
Convolvulaceae	الفصيلة اللبلابية	-	-	-
Convolvulus lineatus L.	اللبلاب	Perennial	ES, M, IT	8 (10) dS/m
Cressa cretica L.	ندوة	Perennial	M, IT	Up to 42 dS/m
Ipomoea stolonifera (Cyr.) J.F.	المدادة البحرية	Perennial	M	Tolerates maritime exposure
Cruciferae	الفصيلة الصليبية	-	-	-
Cakile maritima Scop.	رشاد البحر(قاقلي)	Annual	M, ES	18 dS/m
Malcolmia grandiflora (Bge.) Kuntze. (Syn. *Strigosella grandiflora* (Bge.) Botsch.	السليح (الأسليح)	Annual	M, IT	Up to 14 dS/m
Matthiola tricospidata (L.) R.Br.	المنثور	Annual	M	10 (15) dS/m
Cyperaceae	الفصيلة السعدية	-	-	-
Scirpus holoschoenus L. (Syn. *Scirpoides holoschoenus* (L.)Sojak. ***)	أسل الخب(ديس)	Perennial	M, IT	Up to 20 dS/m
Scirpus Littoralis Schrad. (Syn. *Schoenoplectus subulatus* (Vahl) Lye.***)	أسل الخب(ديس)أسل	Perennial	M. IT	Up to 56 dS/m
Scirpus maritimus L. (Syn. *Bolboschoenus maritimus* (L.) Palla. ***)	الخب(ديس)	Perennial	Pluriregional	> 56 dS/m
Euphorbiaceae	فصيلة الحلاب	-	-	-
Euphorbia paralias L.	الحلاب	Half-shrub	M	Up to 20 dS/m

Table 1. (continued)

Family and Species	Local name	Life form*	Geographical region	Salinity**
Frankeniaceae	الفصيلة الفرانكينية	-	-	-
Frankenia hirsuta L. var. *hispida* (D.C.) Boiss	الحمرة	Perennial	M, ES	> 20 dS/m
Frankenia intermedia. D.C.	الحمرة	Sub-shrub	M, IT	> 20 dS/m
Frankenia pulverulenta L.	الحمرة	Annual	ES, M, IT	> 20 dS/m
Gramineae	الفصيلة النجيلية	-	-	-
Aeluropus lagopoides (L.) Trin.ex Thwaites.	العكرش القصير	Perennial	SA, IT	Up to 56 dS/m
Aeluropus littoralis (Gouan) Parl.	العكرش– المليح	Perennial	M, IT	Up to 56 dS/m
Agropyron junceum (L.) Beauv. (Syn: *Elytrigia juncea* (L.) Nevski subsp. *juncea* ***)	سفون – سيفون	Perennial	M	Tolerates maritime exposure
Ammophila arenaria (L.) Link.	قصب الرمال	Perennial	M	Up to 20 dS/m
Arundo donax L.	الزل –القصب	Perennial	M, IT, ES	10(40) dS/m
Cynodon dactylon (L.) Pers.	النجيل – شرش الانجيل	Perennial	Borealo-Tropical.	Up to 10 dS/m
Hyparrhenia hirta (L.) Stapf.	الحمرور	Perennial	M, IT, SA	Up to 20 dS/m
Polypogon monspeliensis (L.) Desf.	ذيل القط	Annual	M, IT, SA	Up to 15 dS/m
Pucccinellia distans (L.) Parl.	بوكسينيلا	Perennial	M, IT	Up to 56 dS/m
Sphenopus divaricatus (Gouan) Reichb.	حشيشة تدمر	Annual	M, IT, SA	20-25 dS/m
Sporobolus arenarius (Goun) Duv-Jouve.	مالحي	Perennial	M	Up to 56 dS/m
Juncaceae	فصيلة الأسل	-	-	-
Juncus acutus L.	سمّار–أسل– بوط	Perennial	M, IT	Up to 56 dS/m
Juncus arabicus (Aschers and Bunhenou) Adamson	الأسل– سمّار الحصر	Perennial	IT, SA	Up to 56 dS/m
Juncus maritimus Lam.	الأسل – السمّار	Perennial	ES, M	> 56 dS/m

Table 1. (continued)

Family and Species	Local name	Life form*	Geographical region	Salinity**
***Leguminosae* (*Fabaceae*)**	الفصيلة البقولية	-	-	-
Alhagi maurorum Medik	العاقول – شوك الجمل	Perennial	IT	> 10 dS/m
Astragalus squarrosus Bunge.	القتاد الملحي	Shrub	IT	Up to 14 dS/m
Glycyrrhiza glabra L.	عرق السوس	Perennial	M, ES, IT	Up to 10 (14) dS/m
Lotus corniculatus L.	قرن الغزال	Perennial	ES, M, IT	10-12 dS/m
Medicago litoralis Rhode ex Loisel.	النفل الشاطئي	Annual	M	Up to 20 dS/m
Medicago marina L.	النفل البحري	Perennial	M	Up to 20 dS/m
Mimosaceae	الفصيلة المستحية	-	-	-
Acacia cyanophylla Lindley (Syn. *A.saligna* (Labill.) H. Wandl.	السنط الأزرق	Tree	Australian	9-33 (56) dS/m
Prosopis farcta (Banks et Sol.) Macbride (Syn. *Lagonychium farctum*)	الخرينيبة– الغاف	Shrub	IT	Up to 12 dS/m
Plantaginaceae	فصيلة لسان الحمل	-		
Plantago coronopus L.	الربل	Annual	M, IT, SA	Up to 30 (40) dS/m
Plantago maritima L.	الربل البحري	Perennial	M	Up to 30 (40) dS/m
Plumbaginaceae	الفصيلة البلومباغية	-	-	
Limonium angustifolium (Tausch) Degen.	الأريال	Perennial	M	Up to 56 dS/m
Limonium palmyrense (Post) Dinsm.	الأريال التدمري	Perennial	M	Up to 20 dS/m
Limonium sieberi (Boiss.) O. Kuntze.	الأريال	Perennial	M	Up to 56 dS/m
Limonium virgatum (Wild) Four.	الأريال	Perennial	M	Up to 56 dS/m

Table 1. (continued)

Family and Species	Local name	Life form*	Geographical region	Salinity**
Polygonaceae	الفصيلة البطباطية	-	-	-
Polygonum maritimum L.	البطباط البحري	Perennial	M	Up to 20 dS/m
Ruppiaceae	الفصيلة الروبية	-	-	-
Ruppia maritima L.	الحزلول	Perennial	Tropical America	> 10 dS/m
Solanaceae	الفصيلة الباذنجانية	-	-	-
Solanum elaeagnifolium Cav.	باذنجان بري	Perennial	North America	Up to 10 dS/m
Tamaricaceae	فصيلة الطرفة	-	-	-
Reaumuria alternifolia (Lab.) Grande.	الملوح – الملاح	Dwarf shrub	IT	Up to 20 dS/m
Tamarix macrocarpa (ehrenb.)Bge.	الطرفة– الأثل – العبل	Tree	SA, S	Up to 56 dS/m
Tamarix mannifera (Ehrenb.) Bge. (Syn. *T. nilotica* (Ehrenb.) Bge.***)	الطرفة– الأثل – العبل	Tree	M	Up to 56 dS/m
Tamarix smyrnensis Bge.	الطرفة– الأثل – العبل	Tree	M	Up to 56 dS/m
Tamarix tetragyna Ehrenb.	الطرفة– الأثل – العبل	Tree	M, SA	Up to 56 dS/m
Thymelaeaceae	فصيلة المازريون	-	-	-
Stellera lessertii (Wickstr) Boiss. (Syn. *Thymelaea*)	ستيليرا	Shrub	M, IT	-14 dS/m10
Thyphaceae	الفصيلة التيفية	-	-	-
Typha latifolia L.	الحلفا (التيفا)	Perennial	Borealo-Tropical	10-37 dS/m
***Umbelliferae* (*Apiaceae*)**	الفصيلة الخيمية	-	-	-
Eryngium maritimum L.	قرصعنّة بحرية	Perennial	M	Up to 15 dS/m

Table 1. (continued)

Family and Species	Local name	Life form*	Geographical region	Salinity**
Zygophyllaceae	الفصيلة القلابية	-	-	-
Nitraria retusa (Forssk.) Asch.	الغرقد	Shrub	SA	Up to 56 dS/m
Peganum harmala L.	الحرمل	Perennial	IT, SA	Up to 8-10 dS/m
Zygophyllum fabago L.	القلاب	Perennial	IT	Up to 14 dS/m
Verbenaceae	فصيلة رعي الحمام	-	-	-
Phyla nodiflora (L.) Greene.	الفيلا	Perennial	M, IT, Tropical	Tolerates maritime exposure

* M = Mediterranean, IT = Irano-Turanian, SA = Saharo-Arabian, S = Sudanian, ES = Euro-Siberian
** Electrical conductivity (EC) of the soil was measured during the study
*** Synonymous nomenclature as listed at http://www.ars-grin.gov/cgi-bin/npgs/html/tax_search.pl

Part 2

A Catalog of the Major Native Halophyte Species in Syria

Halopeplis perfoliata in Al-Jaboul

Pancratium maritimum L.

Family: *Amaryllidaceae*
Local name: Narjys al-Bahr نرجس البحر، زنبق البحر (القعبل)
Common name: Sea daffodil

Figure 49. Flowers of *Pancratium maritimum*

Figure 50. *Pancratium maritimum* grows on sandy soils

Distribution:	*Pancratium maritimum* (Fig. 49) is distributed at the seashore near Tartous. It is a rare species in Syria and must be protected.
Description:	Plant 50-70 cm. Bulb subglobose, usually 5-7 cm in diameter, deeply sunk, with a long neck. Leaves subsynanthous, 1-2.5 (-3) cm broad, erect, broadly lorate, slightly twisted, glaucous, about as long as scape. Flowers fragrant, 2-8 to a spathe. Perianth 8-15 cm; tube longer than limb; segments oblong-lanceolate, with a narrow green mid-stripe on outside; teeth of corona 12, triangular, acute. Seeds hydrochorous. Flowers August-October. Leaves appear shortly after flowers.
Salt tolerance:	Tolerates seashore conditions and maritime exposure.
Habitat:	Psammophile (Fig. 49, 50), grows on sandy areas along the seashore.
Uses:	Used as an ornamental plant because of its elegant flowers and strong sweet scent that can carry a considerable distance. Ideal for seaside and sandy terrain. Seeds and cooked bulbs can be eaten (Tanaka 1976), but fresh bulbs are poisonous. *P. maritimum* contains more than 16 alkaloids. The main alkaloids are haemanthamine in the leaves and bulbs, and galanthane in the roots (Berkov et al. 2004). *P. maritimum* has medicinal properties: antifeedant, emetic, hypotensine, purgative and pesticide. It also has psychoactive properties.

Aizoon hispanicum L.

Family: *Aizoaceae*
Local name: Al-Ghasool, Ghasool الغاسول (حدق)
Common name: Purslane, Aizoon

Figure 51. *Aizoon hispanicum* at flowering stage, Al-Jaboul

Figure 52. Flowers of *Aizoon hispanicum*

Distribution:	*Aizoon hispanicum* (Figs. 51, 52) grows in saline soil in Al-Mouh, Maskaneh and Al-Jaboul *sabkhas*, and on the seashore.
Description:	Annual, papillose, rather fleshy, 5-20 cm. Stems ascending to erect, dichasially branched. Leaves up to 4(-5) × 1cm, more or less opposite, mostly sessile, oblong-lanceolate to almost linear, obtuse. Flowers 1.2-1.7 cm, short-pedicelled, green. Perianth somewhat fleshy, 5-cleft into lanceolate to ovate about 1.5 cm long segments, green outside, whitish within. Capsule dehiscing when moistened, broadly ovoid-subconical, flattened at apex. Seeds about 1 mm, reniform, brown. Flowers February-May.
Salt tolerance:	*Aizoon hispanicum* is considered a halophyte species (Aronson 1989).
Habitat:	Xerophyte, occurs in arid habitats (Aronson 1989). Prefers neutral and alkaline soils but can grow in saline soil.
Uses:	Leaves and stems are used raw or cooked (Phillips and Rix 1995), can be used as a spinach substitute. Leaves have an acid flavor; they are thick and succulent with a slightly salty tang (Facciola 1990). Plant ash yields soda which is used in making soap and glass.

Mesembryanthemum forsskalei Hochst. ex Boiss.

Family: *Aizoaceae*
Local name: Mallah, Ghasul (طرطير)، غاسول ، ملاّح
Common name: Slender leaf ice plant

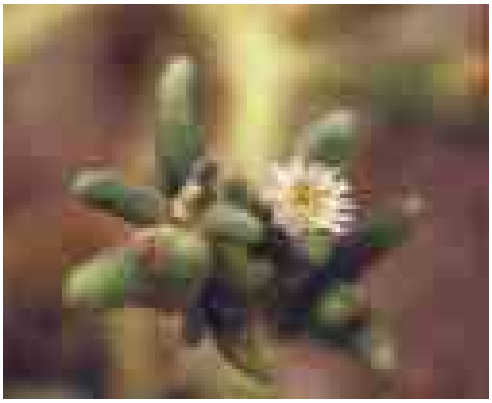

Figure 53. *Mesembryanthemum forsskalei* at flowering stage

Distribution:	*Mesembryanthemum forsskalei* (Fig. 53) occurs in dry saline soil and at the seashore.
Description:	Annual papillose, fleshy herb, 10-25 cm. Stems short, erect to ascending, simple or branching from base, often spreading. Leaves up to 5 × 0.8-1.2 cm, thick opposite, sessile, very fleshy, terete-conical, the upper ones decurrent. Flowers axillary. Pedicels shorter than calyx. Calyx with subequal conical lobes. Petals white-cream, longer than calyx. Capsule 1.2-1.5 cm. Flowers March-May.
Salt tolerance:	Xerophyte, salt-tolerant plant (Aronson 1989).
Habitat and uses:	Similar to *Mesembryanthemum nodiflorum*.

Mesembryanthemum nodiflorum L.

Family: *Aizoaceae*
Local name: Mallah, Ghasul ملاّح، مليح، غاسول
Common name: Egyptian fig-marigold; Slender leaf ice plant

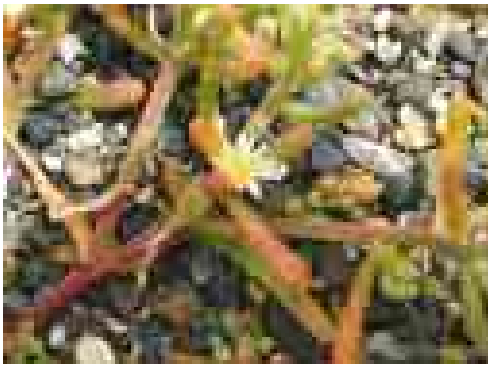

Figure 54. *Mesembryanthemum nodiflorum* at flowering stage

Distribution:	*Mesembryanthemum nodiflorum* (Fig. 54) is found in dry saline soils in the desert and along the Mediterranean seashore.
Description:	Annual, minutely-papillose, fleshy low herb. Stems generally ascending, 10-15 cm, moderately branching. Leaves up to 4 × 0.4 cm, the lower opposite, the upper alternate, sessile, linear to semiterete, sparingly ciliate at margins. Flowers axillary, almost sessile. Calyx up to 1 cm, with unequal, linear lobes. Petals almost filiform, white-cream, shorter than calyx. Stigmas 5, sessile. Capsule small, 0.7-1 cm. Flowers March-June. The leaves are covered in bladder cells, giving the plant glistening appearance.
Salt tolerance:	Can tolerate at least 50% of sea water. Occurs in salt marshes and under xeric conditions (Aronson 1989, MacDonald and Barbour 1974).
Habitat:	Found on wide range of soil types, from sandy to loamy and clay soils. Can tolerate nutritionally-poor and saline soils. *Mesembryanthemum* accumulates salt throughout its life, in a gradient from the roots to the shoots, with the highest accumulation in the epidermal bladder cells (Adams et al. 1998). After death the salt leaches from the decaying plant into the surrounding soil. This increases the soil salinity and prevents other less salt-tolerant species from growing. Root growth is retarded under salinity, indicating that under heavy salinity, water uptake by the root system is not essential for plant survival at the late developmental stage (Kholodova et al. 2002).

Uses:	*Mesembryanthemum* is poisonous and can cause oxalate toxicity in remnants. Acute signs of toxicity are associated with hypocalcemia and chronic ingestion can lead to renal failure (Jacob and Peet 1989). The crushed leaves can be used as soap substitute. In folk medicine the leaf juice is used to sooth inflammation of the mucous membranes of the respiratory or urinary system, to treat painful or difficult urination and involuntary urination. The fresh juice has been used to treat water retention, painful urination and lung inflammation (Foster et al. 2002). Leaves are used in the treatment of ascites, dysentery and liver and kidney diseases (Chopra et al. 1986). Roots and leaves of some *Mesembryanthemum* species are still chewed and smoked by inhabitants of the Karroo in South Africa, for stimulating and narcotic (but not hallucinogenic) purposes.

Capparis spinosa L.

Family: *Capparidaceae*
Local name: Kabbar, Shaffalah, Lassaf القبار، الشفلح، اللصف
Common name: Common Caper-bush

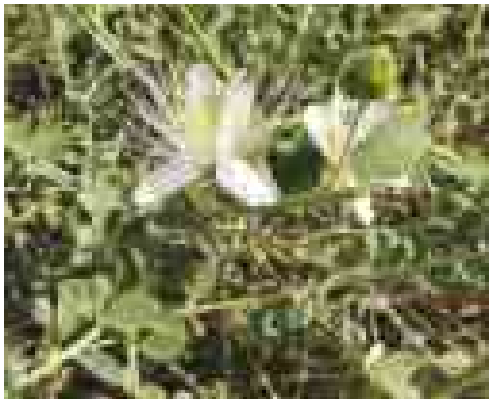

Figure 55. *Capparis spinosa* at flowering stage

Figure 56. Flowers and flower buds of *Capparis spinosa*

Figure 57. Fruits of *Capparis spinosa*

Distribution:	*Capparis spinosa* (Fig. 55) is widely distributed on slopes and gravel soils. Grows in Al-Mouh and Jyroud sabkhas.
Description:	Spiny, scrambling semi-shrub with long, decumbent branches. Leaves alternate or sub-opposite, long. Petiole ovate, 1-4 cm. Flower buds more or less symmetrical. Flowers axillary, solitary, showy, white or pale pink. Fruit berry 3-4 cm, dehiscing by valves, seed numerous. Flowers July-October.
Salt tolerance:	Salt-tolerant plant (Aronson 1989). Grows in Al-Mouh on soils with salinity of 14 dS/m.
Uses:	Caper is grazed by camels and sometimes by goats. The flower buds (Fig. 56), and sometimes the young fruits (Fig. 57) are cured with vinegar and salt. Picked capers have acrid tart and pungent taste with a lemony tang. The new aerial parts of *Capparis* contain 11.9% protein, 1.9% fat, 31.6% fiber, 7.5% ash and 48.2% NFE (ACSAD 1979).
Medicinal uses:	Caper contains flavonoids (rutin, glucocapparin and sinigrin), pentosans, rutic and pectic acids. Methyl glycerinates upon enzymatic action produce isothiocyanate which give it its pungency (Rodrigo et al. 1992, Sincich 2002, Uhl 2000). Used as a detergent and as an anti-rheumatic, diuretic, laxative, expectorant analgesic and tonic. Mostly used for treating muscular and joint pains, enlargement of spleen, paralysis, toothache, ear ache, and to improve capillary function. Also effective against dermatophytes (Rodrigo et al. 1992, Uhl 2000). Capers contain considerable amounts of the anti-oxidant bioflavinoid rutin.
Note:	Due to the importance of caper in medicine and the possibility of establishing a caper industry, consideration should be given to local cultivation of *Capparis spinosa*.

Gypsophila anatolica Boiss. et Heldr. (Syn. *G. perfoliata* L.)

Family: *Caryopphyllaceae*
Local name: Gypsophila جبسوفيلا (شرش الحلاوة)
Common name: Gypsophila

Figure 58. *Gypsophila anatolica* at flowering stage

Distribution:	*Gypsophila anatolica* (Fig. 58) is widely distributed in Jyroud and Al-Khatonia *sabkhas*, rarely in Al-Mouh and Al-Hyjanah.
Description:	Perennial, glabrous herb, 30-80 cm. tall. Stems erect, branched. Leaves 3-5 nerved, oblong, oblong- lanceolate, sessile and slightly connate at base. Inflorescences divaricately branched, many flowered. Petal white-pink. Flowres May-July.
Salt tolerance:	Salt-tolerant species. Grows on sandy soil with salinity up to 10-12 dS/m. Often associated with *Aeluropus, Atriplex* and *Zygophyllum* species.
Habitat:	Psammophile, grows on sandy saline soil.
Uses:	The roots and vegetative parts are rich in saponins, so sheep and goats do not eat it. In folk medicine the infusion is used as an expectorant and diuretic. Roots are used to treat dysentery, diarrhea and stomach ulcers, and as an analgesic, antipyretic, anti-inflammatory and insecticidal.

Ceratophyllum demersum L.

Family: *Ceratophyllaceae*
Local name: Hamul el Mayeh حامول الماء
Common name: Hornworth, Coontail

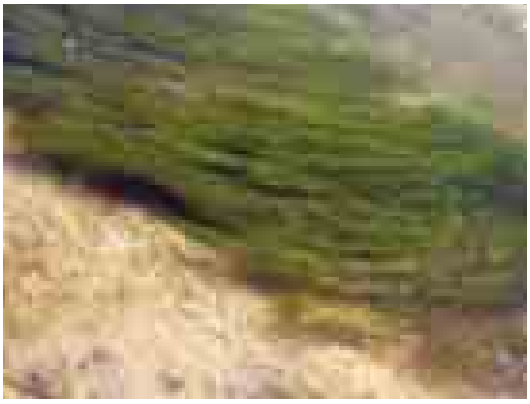

Figure 59. *Ceratophyllum demersum* at Al-Jaboul

Distribution:	*Ceratophyllum demersum* (Fig. 59) is distributed in Al- Jaboul lake. It will grow in both still and flowing water.
Description:	Perennial, submerged, rather stiff herb. Stems slender, branching, glabrous, 20-100 cm or longer. Leaves 1-2 cm, 4-12 in a whorl, filiform, once to twice divided dichotomously into 2-4 segments; segments dark green, linear, with irregular, short, dense, erect teeth. Flowers almost sessile. Staminate flowers with mostly 12 petals, 3-denticulate at apex; stamens 10-16, crowded. Pistillate flowers with 9-10 teplas; ovary longovoid, style very long, awl-shaped. Fruit up to 5 mm, ovoid, black, rough or somewhat warty, stiff, with 2 spines at base and with persistent style as long as or longer than nutlet. Flowers June-August.
Salt tolerance:	Salt-tolerant, grows in some sites of Al-Jaboul lake where water salinity is more than 10-15 dS/m.
Habitat:	Found in ponds, lakes, and quiet streams, may be able to invade a wider variety of habitats. Found over a wide depth range. Shade-adapted, and can form a dense canopy in deep water.
Uses:	*Ceratophyllum* can be used as measure of water pollution as it can contain trace metals such as cadmium and lead. It can also be successfully used for heavy metal removal. A dense bed of *Ceratophyllum* can remove up to 0.1g N per square metre per day during the early growth stage. Chemical compounds isolated from *Ceratophyllum* have been shown to inhibit the growth of Phytoplankton and Cyanobacteria (NIWA 2005a,b,c).

Aellenia autrani (Post) Zoh. (Syn. *Halothamnus glaucus* (M.Bieb.) Botsch.)

Family: *Chenopodiaceae*
Local name: Al-Ajwaa العجواء
Common name: (Aellenia)

Figure 60. *Aellenia autrani* at the beginning of flowering stage

Distribution:	*Aelenia autrani* (Fig. 60) is widely distributed at the boundaries of Al-Jaboul and Al-Hyjanah *sabkhas.*
Description:	Annual, pubescent, rarely glabrous, 20-50 cm. Stems erect; branches spreading from base. Stem leaves usually 8 × 3 mm, sessile, lanceolate, somewhat auriculate at base; the lower 1-2.5 cm, early deciduous, the floral ones (bracts) persistent. Bracteoles 3-6 mm, orbicular, obtuse to acute, green, puberulent. Flowers solitary along branches, forming leafy spikes. Fruiting perianth (0.6) 1-1.2 (-1.5) cm in diameter (including wings); lobes ovate, obtuse, connivent, with orbicular-wings. Flowers July-September. Varies widely in indumentum (from glabrous to densely hairy) and size of leaves (Zohary and Feinbrun-Dothan 1966).
Salt tolerance:	(Aronson 1989) considers *Aellenia* species salt-tolerant. Grows in soil with salinity of more than 10 dS/m.
Habitat:	*Aellenia* species are distributed in stony and gypsaceous ground, and on loess soils. Found in alluvial soils in Al-Jaboul, together with *Seidlizia rosmarinus* at Al-Mouh.
Uses:	*Aellenia* species are of medium palatability especially at early vegetative stage. They are eaten by sheep, goats and especially camels. The dry aerial parts contain 16-18% protein, and 24-26% fiber (Sankary 1982).

Aellenia glauca (Bieb) Allen. ssp.*lancifolia* (Boiss) Allen. (syn.*Halothamnus glaucus* (M.Bieb.) Botsch.)

Family: *Chenopodiaceae*
Local name: Al-Ajwaa العجواء
Common name: (Aellenia)

Figure 61. *Aellenia glauca* at fruiting stage

Distribution:	*Aellenia glauca* (Fig. 61) is distributed at the boundaries of Al-Jaboul, Al-Mouh and Al-Hyjanah *sabkhas.*
Description:	Perennial, glabrous-green, 30-60 cm. Stems erect, woody at base, branching mostly in upper part. Branches angulate. Leaves 0.5-4 × 0.2-0.5 cm, succulent, more or less clasping-decurrent, lanceolate to subulate; the floral ones linear-lanceolate, persisting after flowering. Bracteoles succulent, triangular, acute. Flowers in leafy spike-like inflorescences. Flowering perianth with membranous, triangular, acute lobes (0.5) 0.8-1 cm; lobes of fruiting perianth indurated, connivent, with orbicular-obovate, 5-7 mm long wings. Flowers April-July.
Salt tolerance:	Salt-tolerant species, grows in alluvial soils at Al-Jaboul and Al-Hyjanna. At some sites, grows in soils with salinity of 14-20 dS/m.
Habitat and uses:	Similar to *Aellenia autrani.*

Anabasis articulata (Forsk.) Moq.

Family: *Chenopodiaceae*
Local name: Eshnan شنان
Common name: Berry bearing glasswort

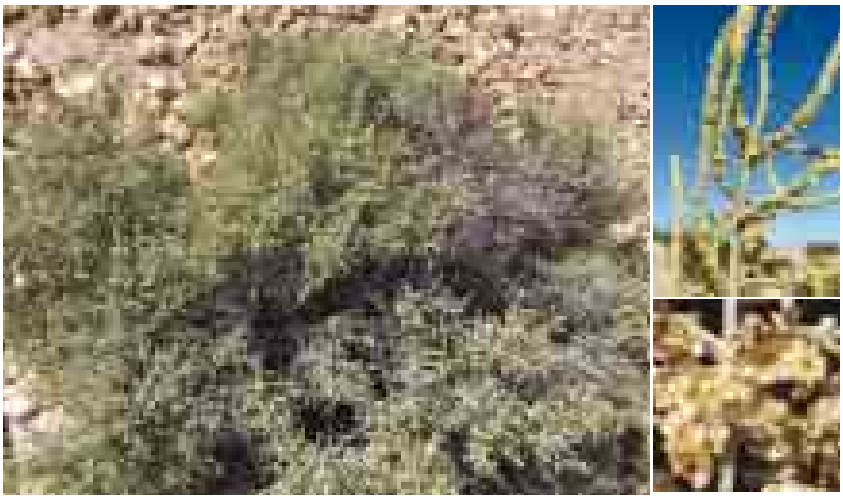

Figure 62. *Anabasis articulata* at flowering stage. Inset: flowers and fruits

Distribution:	*Anabasis articulata* (Fig. 62) is widely distributed in Syrian desert. Common at the outer boundaries of Al-Mouh, Jyroud, Hyjanah and other *sabkhas.*
Description:	Dwarf-shrub (chamaephyte), 30-60 cm. Stems woody to half their length or more, erect or tortuous. Branches opposite, with more or less equal internodes, brittle, the older ones with split and peeling bark. Leaves reduced to a short, 2-lobed cupule, villose within. Flowers up to 5 mm, solitary, opposite, the upper arranged in spikes at ends of branches. Perianth segments membranous. Stamens 5, long-exserted; staminodal lobes thick, orbicular-obovate, papillose. Ovary papillose; stigmas thick, papillose. Fruiting perianth membranous; wings 5, nearly equal, 5-7 mm. Long, ovate-orbicular, striate, white or pink. Utricle erect, free. Seeds vertical. Flowers October-November, frequently December-January.
Salt tolerance:	Salt-tolerant plant (Aronson 1989), has been found in soils with salinity up to 10 dS/m.
Habitat:	Highly xerophyte plant, survives in very arid areas. A characteristic desert species, common in the Sahara desert. Grows in a variety of locations, sand, gravel, and chalk slopes. Salt tolerant and grows vigorously in salt affected soils (Fig. 63).

Notes:	*Anabasis* species have tap roots that extend to 3 m. They also have surface roots that develop dense hairs in spring. The hairs utilize the moisture of surface soil and die after the soil surface layers dry. *Anabasis* species sprout from the root crown the above ground portions of the plant is cut. They have succulent stems that contain water-storing parenchyma cells. Most photosynthesis is done by the succulent stems.

Figure 63. *Anabasis articulata – Seidlitzia rosmarinus* community, Al-Mouh

Uses:	*Anabasis* is a poisonous plant, and contains alkaloids: anabasine, lupinine, aphyllyne, oxyaphyllidine, and anabasamine (Sincich 2002). In autumn, the concentration of alkaloids decreases, and the plant becomes edible for animals, especially camels. The anabasine alkaloid closely resembles nicotine, and is used as an insecticide. *Anabasis* is used in folk medicine to treat wounds and skin diseases of animals. Methyl-anabasine, a derivative of anabasine, has an invigorating effect on respiration centers. *Anabasis* species are used for fuel; they also contain potassium and are therefore used as a detergent. The dry aerial parts of *Anabasis articulata* contain 8.5% protein, 2.5% fat, 54.8 fiber, 26.1% ash, and 17% NFE (ACSAD 1979).

Anabasis haussknechtii Bge. (Syn. *A. syriaca* Iljin.)

Family: *Chenopodiaceae*
Local name: Syrian eshnan الشنان السوري
Common name: Berry bearing glasswort

Figure 64. *Anabasis haussknechtii* at flowering stage

Figure 65. *Anabasis haussknechtii* at fruiting stage

Figure 66. Community of *Anabasis* in Jyroud

Distribution:	*Anabasis haussknechtii* (Figs. 64, 65) is widely distributed at the boundaries of *sabkhas*, especially Al-Mouh and Jyroud (Fig. 66).
Description:	Glabrous perennial (hemicryptophyte), white-glaucous to green-greyish, 20-50 cm. Stems woody in lower part, sparsely branching, mainly from base. Branches long, herbaceous, fleshy, with long joints, erect or ascending. Leaves reduced to a short cupule with 2 triangular, acute lobes. Inflorescences much branched, often forming a panicle of many spikes, each with 5-20 joints. Flowers solitary, opposite at each node. Perianth segments oblong-obovate. Stamens more or less exserted. Fruiting perianth with 3 ascending wings at lower part; wings up to 6 × 5-9 mm, somewhat unequal, semiorbicular-reniform, entire or somewhat crenate. Utricle erect, free, membranous, included. Seeds vertical; embryo spirally coiled. Flowers September-December.
Salt tolerance:	Salt tolerant plant (Aronson 1989).
Habitat and uses:	Similar to *Anabasis articulata*.

Arthrocnemum fruticosum (L.) Moq.
(Syn. *Sarcocornia fruticosa* (L.) A.J. Scott)

Family: *Chenopodiaceae*
Local name: Eshnan اشنان (قلام)
Common name: Glasswort

Figure 67. *Arthrocunemum fruticosum* at Al-Jaboul

Figure 68. *Arthrocnemum fruticosum* at Al-Jaboul

Distribution:	*Arthrounemum fruticosum* (Fig. 67) is widely distributed in Al-Jaboul, also found in the Mediterranean area.
Description:	Shrubby, glabrous, glaucous perennial, 30-100 cm. Stems ascending to erect, woody below, more or less decussately branched, rarely rooting at base; joints cylindrical, 0.6-1.5 cm. Leaves about 2 mm, membranous-margined, forming a copular sheath. Spikes cylindrical, terminal and lateral. Flowers in threes in adjacent cells of the floral cavity. Perianth of middle flower obscurely pentagonous or trapezoidal at top. Seeds grey, covered with small, thick conical protuberances. Flowers June-September (November).
Salt tolerance:	Tolerates salinities above seawater levels, grows on Mediterranean seawater at Asqalan, where salnity is 56 dS/m (Aronson 1989).
Uses:	Potential as an ornamental shrub (Fig. 68). Very similar to *A. macrostachyum*; they occur in mixed stands. Uses similar to *A. macrostachyum*.

Arthrocnemum glaucum (Del.) Ung-Sternb.

Family: *Chenopodiaceae*
Local name: Shua شوع
Common name: Glasswort

Figure 69. *Arthrocnemum glaucum* at flowering stage

Figure 70. *Arthrocnemum glaucum* at Al-Jaboul. Note the salt on the soil surface

Figure 71. *Arthrocnemum fruticosum* and *A. glaucum* in very saline soil at Al-Jaboul

Distribution:	*Arthrocnemum glaucum* (Figs. 69, 70) is found at Al-Jaboul *sabkha.*
Description:	Glabrous, succulent shrub, 20-50 cm high with ascending to decumbent branches sometimes rooting in contract with the ground. Leaves virtually absent, reduced to minute, opposite, connate lobes 1 mm or less long, forming a cupule at each joint. Flowers minute, in terminal spikes in opposed groups of 3 at the nodes, partially exserted within connate bracts from an undivided cavity, the central flower of each triad slightly larger. The dispersal unit is the group of connate bracts of each flower, somewhat quadrangular, wedge-shaped at base, with the seed loosely held below. Seeds ovoid, somewhat compressed, 1.5 mm long, testa dark brown to black and somewhat shining, with a hard, muriculate surface. Flowers June-September.
Salt tolerance:	Tolerates salinities above seawater levels, grows on soils with salinity > 60 dS/m, where salt forms a thin layer on the soil surface (Fig. 71).
Habitat and uses:	Similar to *A. macrostachyum*.

Arthrocnemum macrostachyum (Moric.) Moris et Delphonte.

Family: *Chenopodiaceae*
Local name: Echnan اشنان
Common name: Glasswort

Figure 72. *Arthrocnemum macrostachyum* at the seashore

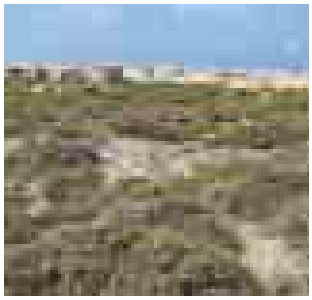

Figure 73. *Arthrocnemum macrostachyum* community at the seashore

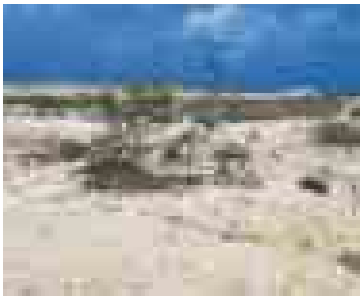

Figure 74. *Tamarix-Arthrocnemum* community at the seashore

Distribution:	*Arthrocnemum macrostachyum* (Fig. 72) is widely distributed on the seashore, especially in salt marshes. Occupies large stretches in the Mediterranean littorals, where it is dominant in *Arthrocnemum* communities (Fig. 73), and co-dominant in *Tamarix-Arthrocnemum* communities (Fig. 74).
Description:	Succulent, glabrous, glaucous much branched shrub, 0.3-1 m. Branches erect to ascending, succulent, cylindrical, the lower ones often rooting at base, jointed; joints cylindrical or club-shaped. Leaves (free part of cupules) very short. Flowering branches erect, ending in thick, cylindrical, obtuse spikes, 3-6 × 0.3-0.4 cm. Flowers in threes, free protruding from the undivided cavity to up to one third the length of joint. Perianth 2-4 mm, 3-dentate, obpyramidal. Pericap membranous. Seeds about 1 mm, black, shining, covered with short papillae. Flowers May-September.
Salt tolerance:	Tolerate salinities greater than seawater levels and up to 90 dS/m. Grows in Mediterranean seawater at Asqalan (Aronson 1985, 1989).
Habitat:	*Arthrocnemum* species are very resistant to salt in moist soils, and their growth is enhanced by NaCl, which makes them typical to salt marshes and salt zones. They needs moist soils and can withstand sporadic flooding, and also tolerate drought (Wayse 1972).
Uses:	*Arthrocnemum* species are potentially ornamental shrubs (Fig. 30). Good soil stabilizer, eaten by camels. Plant extract showed hypoglycaemic effects (Shabana et al. 1990). The ash of *Arthrocnemum* species is used in making soap and glass.

Atriplex L.

Family: *Chenopodiaceae*
Local name: Al-Raghel, Al-Qataf الرغل، القطف
Common name: Saltbush

Description:	*Atriplex* species are perennial or annual herbs or shrubs, mostly with farinose or vesiculose indumentum. Leaves alternate or rarely opposite, sessile or petiolate, flat, green or greyish-green or mealy-white. Flowers unisexual (plants monoecious or dioecious), arranged in terminal or axillary cluters forming spike-like or paniculate inflorescences. Staminate flowers with 5-, rarely 3-parted perianth; stamens 5 or rarely 3, free or connate at base into a ring. Pistillate flowers usually in axillary clusters or solitary or also in spike-like or paniculate inflorescences, often without perianth, but with 2 herbaceous, membranous or leathery bracteoles (valves). Fruit utricle enclosed in 2 valves (bracteoles); pericarp membranous, free or slightly adhering to the vertical seed. Seeds erect or pendulous. Variable and widely distributed genus, includes many desert and seashore species and halophytes. Many species are salt-tolerant and their name is derived from an ancient Latin name, which means saltbush. Most species of *Atriplex* retain salt in their leaves, which makes them of great use in areas affected by soil salinity. About 120 species, mainly in deserts, saline and waste places, in both temperate and warm regions of the Old and New World. Australia is one of the larger centres of this genus (Zohary and Feinbrun-Dothan 1966). The most important salt-tolerant species of *Atriplex* in Syria are: *A. halimus* L., *A. hastata* L., *A. leucoclada* Boiss., *A. littoralis* L., *A. rosea* L. And *A. stylosa* Viv.
Notes:	The root system is mostly a taproot and lateral roots occupying the upper soil layer. Where soils allow, the taproot often extends more than 3 m. Most *Atriplex* species are silvery-green, silvery, or even white in appearance due to the presences of special vesiculated trichomes covering the surface of the leaves (Fig. 47) The trichomes have terminal, spherical cells in which the salt, extracted from leaf tissues, is sequestered.

Atriplex halimus L.

Family: *Chenopodiaceae*
Local name: Al-Qataf Al-Malhi القطف الملحي
Common name: Saltbush

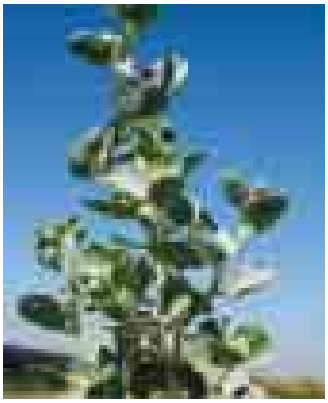

Figure 75. *Atriplex halimus* at vegetative stage

Figure 76. *Atriplex halimus* at the shore of Al-Jaboul

Distribution:	*Atriplex halimus* (Figs. 75, 76) is found in El-Hamme (southwest Syria), at many sites of Al-Jaboul *sabkha* (rare), and at the seashore in Lataqia (Mouterde 1966, 1970, 1983).
Description:	Shrub with vesicular hairs, about 1-2 m. Stems erect, much branched, woody, terete or angular, whitish. Leaves 1-6 × 0.5-4 cm, alternate, sometimes opposite below, ovate to ovate- rhombic to triangular, sometimes cuneate or hastate at base, entire or obsoletely repand-lobed or dentate, silvery-white, without prominent nerves, the upper narrower, lanceolate; petiole 0.3-1.2 cm. Flower clusters densely spicate; spikes in terminal, almost leafless panicles. Staminate flowers inconspicuous, with 5 membranous petals, generally at top of cluster. Pistillate flowers at base of cluster, with valves 4-5 mm. long and broad, not stipitate, scarcely united at base, orbicular or semiorbicular or reniform to short-cuneate at base, entire or dentate, smooth or reticulate but not tuberculate. Seeds 1-2 mm in diameter, vertical, lenticular, dark brown. Flowers April-October.
Salt tolerance:	Tolerates full-strength seawater and salinities up to 56 dS/m. Can tolerate seawater exposure, grows in Mediterranean seawater at Asqalan (Aronson 1989).
Habitat:	Xerophyte, occurs in arid areas, tends to grow in areas of high salinity. Tolerates temperature as low as -5 to -10ºC. Can be damaged by severe frost but soon recovers.

Uses:	Highly palatable. Sheep, goats and camels eat it year-round. Dry aerial parts contain: 18.4% protein, 2.4% fat, 13.2% fiber, 23.6% ash and 42.2% NFE (ACSAD 1979). The leaves have a good salty flavour; go well in salads or can be cooked like spinach. Leaves retain their salty flavour even when growing in non-salty soils. Excellent natural nutritional supplement, rich in vitamins C, A and D, and minerals such boron and chromium which are known to have a role in appetite control. May prove useful in the treatment of type 2 diabetes due to its chromium content.

Atriplex hastata L.
(Syn. *Atriplex prostrata* Boucher ex DC)

Family: *Chenopodiaceae*
Local name: Al-Raghel, Al-Qatuf الرغل– القطف
Common name: Hastate Orach

Figure 77. *Atriplex hastata* at vegetative stage. Left: flowers

Distribution:	*Atriplex hastata* (Fig. 77) is found in Al-Jaboul and other *sabkhas.*
Description:	Annual, 30-100 cm, green or scurfy-canescent, glabrescent or glabrous. Stems branching, often erect ascending. Leaves mostly alternate, triangular-hastate to deltoid, sometimes cuneate or cordate at base, entire or slightly sinuate, the lower up to 10 × 7 cm, the upper lanceolate-hastate to lanceolate-linear, acute-mucronate. Flowers in axillary or terminal clusters forming long spikes or panicles; pistillate flowers at the base, staminate at the top of each cluster. Valves of pistillate flowers 1-4 × 1-3 mm, triangular-deltoid to elliptical-deltoid or lanceolate, entire or repand-dentate, connate below middle, with smooth or tuberculate surface. Seeds vertical, lenticular, 1-2.5 mm in diameter, dark brown. Flowers June-November.
Salt tolerance and uses:	Similar to *A. leucoclada*

Atriplex leucoclada Boiss.

Family: *Chenopodiaceae*
Local name: Al-Raghel, Al-Qatuf الرغل– القطف
Common name: Wild Orache

Figure 78. *Atriplex leucoclada* at vegetative stage. Left: fruits

Distribution:	*Atriplex leucoclada* (Fig. 78) is widely distributed in arid regions. Grows at the boundaries of Al-Mouh *sabkha*. Also grows in soil with salinity up to 14 dS/m at Al-Jaboul and Al-Mouh *sabkhas*; also in Mediterranean seawater in Asqalan (Aronson 1989).
Description:	Perennial herb with woody base or half-shrub, mealy-canescent, 30-100 cm. Stems prostrate to erect. Leaves 0.8-3 × 0.2-2.5 cm, triangular-deltoid, cuneate or truncate or hastate at base, acuminate at apex, sinuate-dentate; lower leaves short-petioled, upper mostly sessile. Flowers in terminal and axillary infloescences; the terminal of mixed staminate and pistillate flower clusters, spike-like or paniculate; the axillary of pistillate flowers only, solitary or in groups. Staminate perianth membranous. Valves of solitary pistillate flowers 3-6 × 2-6 mm (in fruit), campanulate, upper part of valve free, 3-5-toothed or -lobed, mostly without tubercles; valves of spicate pistillate flowers with well developed tubercles, deltoid, 3-5-lobed, each of the lateral lobes 2-4-toothed, terminal lobe longer than lateral ones. Stigmas free to base. Pericarp membranous. Seeds 2 mm across, dark brown. Flowers March-October.
Salt tolerance:	Most *Atriplex* species are drought-resistant and can survive salinities up to 30-35 dS/m (salt tolerance varies between different populations). *A. hastata* and *A. stylosa* are found in Al-Jaboul where the soil forms a crust and the salinity of the upper layer (0-20 cm) exceeds 30 dS/m.
Uses:	*Atriplex* species are highly palatable. Leaves have 12-22% protein content oand regenerate well after grazing. The aerial parts of *A. leucoclada* contain 16.8% protein, 0.9% fat, 22.4% fiber, 15.8% ash and 44.2% FNE (ACSAD, 1979). Leaves are used as a spinach substitute; they have a bland flavour and are often mixed with stronger tasting leaves (Bown 1995, Launert 1981). Seeds, harvested when just ripe, are effective as a laxative (Grieve 1984).

Atriplex littoralis L.

Family: *Chenopodiaceae*
Local name: Al-Raghel, Al-Qataf الرغل الشاطئي – القطف
Common name: Littoral orache

Figure 79. *Atriplex littoralis* at flowering stage

Distribution:	*Atriplex littoralis* (Fig. 79) is widely distributed in saline soils at the seashore.
Description:	Annual, green, up to 100 cm. Stem erect, simple or branching. Leaves membranceous, alternate, petiolate, linear-lanceolate, entire-sinuate. Flowers arranged in paniculate inflorescences. Bracteoles sessile, triangulare, entire, or with 1-3 teeth at base. Flowers May-October.
Salt tolerance and uses:	Similar to *A. leucoclada.*

Atriplex rosea L.

Family: *Chenopodiaceae*
Local name: Al-Raghel, Al-Qataf الرغل الوردي، القطف
Common name: Saltbush

Figure 80. *Atriplex rosea* at vegetative stage. Left: fruits

Distribution:	*Atriplex rosea* (Fig. 80) is widely distributed in waste lands and around refuse heaps. It grows at the boundaries of *sabkhas.*
Description:	Annual, 30-80 cm. Stems leafy, erect or ascending, divaricately much branched, more or less mealy and canescent, later indurated. Leaves up to 6×3 cm, triangular-deltoid to ovate-rhombic, unequally sinuate or dentate; upper leaves ovate-oblong. Clusters axillary, forming leafy racemes, sometimes leafless at ends of branches, 2-20-flowered; upper clusters of staminate flowers together with some pistillate ones, the lower ones of pistillate flower only. Fruiting valves 0.4-1 cm, leathery, whitish, triangular-deltoid or rhombic, somewhat cuneate and indurated at base, irregularly toothed-lobed. Pericarp membranous. Seeds 1.5-3 mm in diameter, lenticular, dark brown, smooth, shining. Flowers June-October.
Salt tolerance and uses:	Similar to *A. leucoclada.*

Atriplex stylosa Viv.

Family: *Chenopodiaceae*
Local name: Al-Raghel, Al-Qataf الرغل– القطف
Common name: Saltbush

Figure 81. *Atriplex stylosa* at fruiting stage

Distribution:	*Atriplex stylosa* (Fig. 81) is widely distributed in arid regions. It grows at the boundaries of Al-Mouh and Al-Jaboul *sabkhas.*
Description:	Dwarf shrub, papillose mealy-canescent, 10-30 cm. Stems numerous, erect or ascending, branching, leafy, terete, white. Leaves (0.5-) 2-4×0.5-1 cm, sessile, oblong to oblong-linear, rarely ovate to orbicular, somewhat tapering at base, obtuse, entire or sinuate-repand, the upper ones linear, acute. Flowers arranaged in clusters of two kinds: those mixed of pisillate and staminate flowers from terminal spike-like or branched inflorescences; those consisting of pistillate flowers only are crowded in the leaf axils. Fruiting valves up to 5-7×3-5 mm, free up to middle, deltoid or triangular to rhombic-cuneate at base. Seeds about 1.5 mm. In diam., brownish. Flowers March-May (August).
Salt tolerance and uses:	Similar to *Atriplex leucoclada.*

Bassia hyssopifolia (Pall.) Kuntze.

Family: *Chenopodiaceae*
Local name: Al-Lia`a اللياء
Common name: Five-hook bassia

Figure 82. *Bassia hyssopifolia* at vegetative and fruiting stages

Distribution:	*Bassia hyssopifolia* (Fig. 82) is found at the periphery of Al- Hyjanah *sabkha.*
Description:	Annual, much branched, 20-70 cm tall, villose, erect or decumbent. Leaf blade oblancelate to linear, 0.8-2 cm × 1-3 mm, densely villous on surfaces, base cuneate, apex obtuse or acute. Flowers usually 2 or 3 arranged in dense spikes on upper part of branches. Perianth 5- lobed, segments reffexed at apex. Flowers July-September.
Salt tolerance and uses:	Similar to *B. muricata*.

Bassia muricata (L.) Aschers.

Family: *Bassia muricata (L.)* Aschers.
Local name: Al-Lia`a اللياء
Common name: Bassia

Figure 83. *Bassia muricata* at fruiting stage

Distribution:	*Bassia muricata* (Fig. 83) is widely distributed in Al-Mouh *sabkha.*
Description:	Annual, densely villose, 10-50 cm. Stems usually many, erect or decumbent, branching from base, indurated in lower part. Leaves 0.5-1.5×0.1-0.2 cm, linear-lanceolate to oblanceolate, densely hairy. Flowers in clusters subtended oblong bracts and forming loose, leafy spikes; each cluster consisting of 1 pistillate and 1-2 hermaphrodite flowers. Perianth of 5 petals connate to middle. Fruiting perianth becoming indurated, teplas furnished with a 3-4 mm long spine, 2 to 3 times as long as fruit, rarely shorter or scarcely longer, spreading, needle-shaped, yellow. Seeds 1 mm across, discoid, greenish-grey. Flowers February-June.
Salt tolerance:	*Bassia* species tolerates brackish to saline conditions (Duncan 1974). *Bassia muricata* grows in Al-Mouh sabkha together with *Frankenia* and *Seidlitzia*, in areas with soil salinity > 14 dS/m.
Habitat:	*Bassia* species grows in saline-alkaline sites, in steppe and desert.
Uses:	*Bassia* species are poisonous, containing sabonins. Toxic to sheep, can be a threat to other livestock (James et al. 1967). The dry aerial parts contain up to 21.5% protein, 2.4% fat 19.7% fibre, 19.2% ash, and 37.2% NFE, while dry seeds contain 20-27% protein, 8.8-16.0% fat, and 3.4- 9.4% ash (Duke and Ayensu 1985). The aerial parts of Bassia muricata contain flavonoid glycosides (Quercetin) (Kamel et al. 2001). Used as an antifungal (Stuart 1995). Leaves and fruits are cardiotonic and diuretic (Duke and Ayensu 1985). Seeds are used to treat skin infections such as eczema and scabies (WHO 1998, Yeung 1985).

Beta vulgaris L. subsp. *maritima* (L.) Batt.

Family: *Chenopodiaceae*
Local name: Shawander barii شوندر بري
Common name: Sea beet

Figure 84. Branch of *Beta vulgaris maritima* at flowering stage

Figure 85. *Beta vulgaris maritima* at the seashore

Distribution:	*Beta vulgaris* (Figs. 84-85) is widely distributed at seashore (Tartous and Lattakia). It grows in muddy maritime marshes, tolerates exposure.
Description:	Annual to perennial, glabrous or sometimes hirsute, 20-100 cm. Stems decumbent to erect branched and leafy, rather stout, furrowed, sometimes colored. Leaves mostly up to 12×6 cm, petiolate, dark green to reddish; radical leaves frequently rosulate, ovate, cuneate to somewhat cordate, obtuse; cauline leaves rhombic- oblong to lanceolate-linear. Flowering clusters (1-) 2-4 flowered, arranged in long, slender, more or less interrupted spikes. Perianth lobes 2-5 mm, as long as or longer than diameter of fruit, often incurved, more or less keeled, especially in fruit. Flowers March-June. Subsp. *maritima*: perennial, rarely annual, glabrous or loosely pilose, branching from base. Perianth lobes about 2 mm, not or only rarely incurved, rarely cartilaginous at base, short-triangular at apex, slightly keeled or without keel. Clusters 1-2 (-3)-flowered, in rather dense spikes, leafy to top or leafless at apex.
Salt tolerance:	Some populations occur in saline environments, and can tolerate up to 28 dS/m (Aronson 1989), especially after the seedling stage. It has been trialed at Asqalan on dilution of Mediterranean seawater.
Habitat:	*Beta vulgaris* originated in the salty lands surrounding the Mediterranean sea. Prefers sandy and gravely soils, and can grow in heavy (loamy and clay) moist soil; can also grow in very alkaline and saline soils.

Uses:	Palatable and may be used as fodder. The leaves are eaten; and are quite close in taste to spinach (Simons 1977). Long history of folk medicinal use, reportedly for tumours: decoction prepared from seed, juice of vegetative plant parts. The juice is used to treat ulcers, the decoction is used as a purgative to treat haemorrhoids. Leaves and roots are used as an emmenagogue, and are effective in treatment of feline ascariasis (Pastyshenkov 1990). *Beta vulgaris* contains soluble fibers, which can helps normalize systolic blood pressure, reduce blood triglycerides, and improve the ratio of good (HDL) to bad (LDL) cholesterol (Pastyshenkov 1990).

Chenolea arabica Boiss.

Family: *Chenopodiaceae*
Local name: Fulfula الفلفة
Common name: Arab bassia

Figure 86. *Chenolea arabica* at vegetative stage. Left: flower

Distribution:	*Chenolea arabica* (Fig. 86) is widely distributed in Al-Hyjanah *sabkha* in sandy saline soils, it also grows at the margins of Al-Mouh and Al-Hyjana.
Description:	Woolly-canescent dwarf shrub, 10-40 cm. Stems woody at base; branches prostrate to ascending. Leaves 0.5-1 × 0.1-0.2 cm, sessile, oblong-linear to oblong, obtuse, puberulent, floral leaves subglabrous. Flower clusters forming dense, leafy, 5-10 cm long spikes. Flowers hermaphrodite. Perianth about 3 mm, woolly, with 5 hemispherical, obtuse lobes. Style divided into 2 filiform stigmas. Utricle about 3 mm, included in the unchanaged but closed perianth. Flowers March-May.
Salt tolerance:	Salt-tolerant (Aronson 1989). Found at sites with soil salinity > 10 dS/m, and sometimes > 14 dS/m.
Habitat:	Xerophyte, occurs in arid environments, especially on gypsiferous soils. It is considered to be an indicator of gysiferous soils.
Uses:	Medium palatability, eaten by sheep, goats and camels.

Chenopodium album L.

Family: *Chenopodiaceae*
Local name: Rejel el-Batta رجل البطة (السرمق)
Common name: Fat hen

Figure 87. *Chenopodium album* at flowering stage

Distribution:	*Chenopodium album* (Fig. 87) is widely distributed in fields, gardens, and waste areas.
Description:	Annual, more or less mealy, whitish, grey or greenish, 30-80 cm, highly polymorphic. Stems erect, branched, rather rigid, and sometimes reddish. Leaves 1-7 × 0.3-4 cm, petiolate, the middle and lower ones rhombic, ovate or often oblong or lanceolate, the upper oblong-lanceolate to linear, cuneate, rarely subhastate, dentate-sinuate, the uppermost and rarely all leaves almost entire, with mealy under-surface. Flower clusters densely crowded and arranged in paniculately branched, elongated inflorescences, leafy in lower part. Teplas 5, keeled, hooded, scarious-margined, mealy, greenish, enclosing fruit. Seeds about 1.5 mm in diameter, lenticular, obtusely margined, smooth or very finely furrowed, blackish. Flowers May-November.
Salt tolerance:	Salt-tolerant (Fegler and Mota-Urbin 1982) and widely distributed at seashore and peripheries of *sabkhas.*
Habitat:	Grows in field, gardens and waste areas.

Uses:	Formerly cultivated as a bread plant because of its highly nutritious seeds. High vitamin C content, used for salads; also used in medicine (see *Chenopodium rubrum*) (Zohary and Feinbrun-Dothan 1966, 1972, 1978, 1986). Seeds contain 18% protein, 8% fat, 69% carbohydrate, and 20% fiber (Duke and Ayensu 1985). Aerial parts contain 20.5% protein 4.2% fat, 19.9% fiber, 20.0% ash and 35.4% NFE (ACSAD 1979). Leaves are used as anthelmintic, antiphlogistic, antirheumatic, and as a mild laxative (Foster and Duke 1990, Manandhar 2002, Stuart 1995). Infusion used to treat rheumatism (Moerman 1998). Poultice applied to treat bug bites, sunstroke, rheumatic joints and swollen feet. A decoction is used for carious teeth (Duke and Ayensu 1985). A green dye is obtained from young shoots. The crushed roots are a mild soap substitute (Coon 1975).

Chenopodium murale L.

Family: *Chenopodiaceae*
Local name: Ramram, Zarbykh رمرام، زربيخ
Common name: Nettle leaf goosefoot

Figure 88. *Chenopodium murale* at flowering stage

Distribution:	*Chenopodium murale* (Fig. 88) is widely distributed along roadsides, at waste places, refuse heaps and irrigated fields.
Description:	Annual, green, sparingly mealy, 25-70 cm. Stems ascending to erect, generally branching, more or less angular and thickened at base. Leaves 1-7 × 0.5- 4 cm, petiolate, rhombic-ovate to rhombic-oblong, cuneate, acute to acuminate at apex, irregularly, unequally and acutely serrate-dentate, glabrous or somewhat mealy, mainly on lower surface. Inflorescences axillary and terminal, paniculate, divaricately branched, with dense or loose clusters. Flowers hermaphrodite. Tepals 5, green, bluntly keeled, more or less enclosing fruit. Pericarp membranous, hardly separable from seed. Seeds 1-1.5 mm, in diameter, lenticlar, acutely keeled at margin, minutely pitted, black. Flowers February- September.
Salt tolerance:	Salt-tolerant (Fegler and Mota-Urbin 1982).
Uses:	See *C. album* and *C. rubrum.*

Chenopodium rubrum L.

Family: *Chenopodiaceae*
Local name: Rejel el-Batta رجل البطة (السرمق)
Common name: Coast-blight, Goosefoot

Figure 89. *Chenopodium rubrum* at flowering stage at Al-Jaboul

Distribution:	*Chenopodium rubrum* (Fig. 89) is found at Al-Jaboul *sabkha.*
Description:	Annual, glabrous or nearly glabrous, usually reddish, 15-80 cm. Stems prostrate to erect, simple or branched, angular. Leaves up to 9×7 cm, long-petioled, much varying in size and shape, rhombic, ovate or triangular to lanceolate, more or less acute or acuminate, obscurely 3-lobed, sinuate-dentate, the uppermost often entire. Flower clusters crowded in branched, axillary or terminal, generally leafless inflorescences. Terminal flower of each glomerule with 3-5 almost free, strongly incurved teplas and horizontal seeds; other flowers with 2-3 membranous tepals connate almost to middle, 1-2 stamens and vertical seeds. Seeds about 1 mm in diameter, minutely pitted to nearly smooth, brown-black. Flowers March-August.
Salt tolerance:	Salt-tolerant (Fegler and Mota-Urbin 1982, Duncan 1974). Most populations in Al-Jaboul grow in soil of salinity 10 dS/m, some populations withstand up to 20 dS/m.
Habitat:	Most species of *Chenopodium* prefer loamy and clay soils and can grow in very alkaline soils. They require moist soil but can tolerate drought.

Uses:	*Chenopodium* seeds are a favorite bird food and can be used for poultry. The seeds have high contents of protein (> 12%), vitamins and minerals, suggesting potential for cultivation on unproductive land. Seeds are ground into powder and used with cereal flours to make bread and pastries (Kunkel 1984, Tanaka 1976). Seeds should be soaked in water overnight and rinsed before being used in order to remove any saponins. Leaves and seeds of all *Chenopodium* species are more or less edible. However, many species contain small quantities of saponins; as well as oxalic acid, which in large quantities can lock up food nutrients. Despite this, they are nutritious vegetables when consumed in reasonable quantities (Bown 1995). Leaves are used raw (should be eaten in small quantities) or cooked as spinach (Facciola 1990). Golden-green dyes can be obtained from the whole plant (Grae 1974).

Girgensohnia oppositiflora Pall.

Family: *Chenopodiaceae*
Local name: Al-Syeikah الشويكة
Common name: Girgensohnia

Figure 90. *Girgensohnia oppositiflora* at flowering stage

Distribution:	*Girgensohnia* (Fig. 90) is distributed in the peripheries of Al-Mouh, Al-Hyjanah and Jyroud *sabkhas.*
Description:	Scabrous-puberulent annual, 20-40 cm. Stems ascending to erect, much branching, indurated, somewhat woody at base. Leaves usually 0.5-1 × 0.1-0.3 cm, opposite, recurved, linear-subulate, somewhat connate and dilated at base, mucronate-spinulose at apex, with membranous, ciliate margins; axils frequently bearing short branches or buds. Flowers opposite in short rather dense spikes. Perianth segments free almost to base, oblong-ovate, somewhat acute, and hairy. Fruiting perianth with 3 unequal, triangular to orbicular, entire or denticulate wings. Seeds 1-2 mm, ovoid to oblong-ovoid. Flowers June-August.
Salt tolerance:	Salt tolerant. Grows on soils with salinity not exceeding 10 dS/m.
Habitat:	Found in arid environments, mainly on saline soils. Sheep, goats and camels graze it after drying.
Uses:	Sheep, goats and camels graze dried plants.

Halimione portulacoides (L.) Aellen. (Syn. *Atriplex portulacoides* L.)

Family: *Chenopodiaceae*
Local name: Al-Qattyf el-Bahrii القطف البحري، السرمق البحري
Common name: Sea purslane

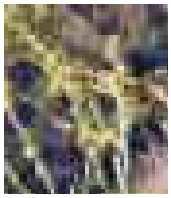

Figure 91. *Halimione portulacoides* at flowering stage. Left: flowers

Figure 92. *Halimione* plant growing 1 m from the seashore. Note the succulent leaves, and growth of new leaves to replace old ones

Distribution:	*Halimione portulacoides* (Figs. 91-92) is widely distributed along the seashore. It is a typical halophyte plant that grows on salt soils of the littorals.
Description:	Shrubby perennial, more or less mealy, glabrescent, 40-100 cm. Stems procumbent, indurated below. Branches ascending striate to angular. Leaves rather fleshy, 1-6×0.3-1.5 cm, opposite, short-petioled, oblong- elliptical to linear-lanceolate, tapering-cuneate at base, slightly acuminate to obtuse or aciculate at apex, grey- green. Flower clusters arranged in loose or dense, terminal and axillary spikes, forming paniculate inflorescences. Bracteoles 3-4 mm, obdeltoid-cuneate, 3-lobed with middle lobe equal to or smaller than lateral ones, green-caescent. Seeds about 1.5 mm in diameter. Flowers June-November.
Salt tolerance:	Typical halophyte. Tolerates salinities up to 56 dS/m, and grows in Mediterranean seawater at Asqalan (Aronson 1989).
Habitat:	Prefers sandy and loamy soils, and can grow in nutritionally poor soils. Requires moist or wet soils, and can tolerate maritime exposure. The leaves are covered with dense hairs which can store salts, thereby preventing excess salt intake. Dead hairs and salt on the leaf surface reflect solar radiation, reducing received heat and limiting transpiration (Adam 1990). When the leaves get so covered with salt that they no longer function they fall and new ones grow.
Uses:	Can be used as fodder and as an ornamental plant. Leaves are also used as salt or cooked as potherb (Facciola 1990).

Halocnemum strobilaceum (Pall.) Bieb.

Family: *Chenopodiaceae*
Local name: Al-Thaleeth الثليث (حمض)
Common name: Halocnemum

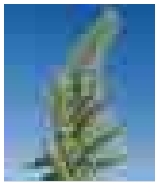

Figure 93. *Halocnemum strobilaceum* at flowering stage. Left: flowers

Figure 94. Association of *Tamarix-Halocnemum* at Al-Mouh

Distribution:	*Halocnemum strobilaceum* (Fig. 93) is widely distributed Al-Mouh, Jyroud, Al-Jaboul and other *sabkhas*. The vegetation at Al-Mouh and Jyroud is dominated by *Tamarix-Halocnemum* association, with *H. strobilaceum* occupying up to 60% of the area.
Description:	Glabrous, fleshy dwarf shrub, 20-50 cm. Stems ascending to erect, much branched. Branches with short, thick, cylindrical to club-shaped internodes, ending with 2, about 1 mm long, obovate, more or less obtuse, scarious-margined leaves, connate at base, often subtending short, sterile, globular, bud-like branches, with 4 rows of very short, rounded, sessile leaves, broader than long. Bracts of flower clusters reniform to orbicular shed after flowering. Spikes lateral and terminal, sessile, opposite, cone-like or globular to oblong. Perianth about 1.5 mm. Seeds about 0.5-1 mm, compressed, brown, smooth to minutely tuberculate. Flowers May-September.
Salt tolerance:	Very resistant to salt; grows in damp salt soil (salinity > 90 dS/m), tolerates salinities above seawater levels.
Habitat:	A plant of saline and marshy areas. Grows in damp salt soils, particularly in areas where water has just receded. A typical semi-shrub, forms rounded clumps (Fig. 94).
Uses:	Grazed by sheep and camels, but Bedouins believe that overfeeding on this plant causes lung disease in camels. Four coumarins (coumarin, hydroxy-3-methylcoumarin, oreoselone, and heraclenin where isolated from the aerial part of *Halocnemum strobilaceum* (Miftakhova et al. 2001). Aerial plant parts contain 6.9% protein, 2.15% fat, 17% fiber, 40.1% ash and 33.83% NFE (El Shaer et al. 1991).

Halopeplis amplexicaulis (Vahl.) Ung- Sternb.

Family: *Chenopodiaceae*
Local name: Bolbul البلبل (عدو)
Common name: Halopeplis

Figure 95. *Halopeplis amplexicaulis* at flowering stage

Figure 96. *Halopeplis amplexicaulis* occurs in some sites where other halophytes cannot grow

Distribution:	*Halopeplis amplexicaulis* (Fig. 95) is distributed in saline depressions of Al-Mouh, Jyroud, and Al- Jaboul *sabkhas*. At some sites, it forms pure communities.
Description:	Glaucous, glabrous annual, 10-30 cm. Stems thin, branching from base, often indurated below. Branches procumbent to ascending, whitish not jointed. Leaves about 3 mm, alternate, clasping, almost globular or semiglobular, obtuse, with rudimentary blades. Flower clusters in short (0.5-1.5 cm), lateral and terminal, alternate, sessile, dense, oblong spikes. Bracts fleshy, ovate-orbicular, acute or acuminate. Flowers connate. Stamen 1. Seeds about 0.5 mm, with cylindrical papillae on back. Flowers May-August.
Salt tolerance:	Hydro-halophyte plant. Tolerates salinity higher than seawater, and up to 90 dS/m; grows at some sites where other halophytes cannot grow (Fig. 96).
Habitat:	Forms swards, often mono species, in mud areas of Al-Mouh. Highly salt-tolerant. Dense plant communities of *Halopeplis*, with notably brown-red fleshy leaves, dominant in the centre of Al-Mouh Sabkha, where other halophyte species cannot grow, with the exception of *H. strobilaceum*.
Uses:	Potential as an ornamental shrub. The ashes yield soda which is used in making soap and glass.

Halopeplis perfoliata Forsk.

Family: *Chenopodiaceae*
Local name: Khurzah (Khurrayz) الخرزة (خرايز)
Common name: Halopeplis

Figure 97. *Halopeplis perfoliata* at vegetative stage

Figure 98. *Halopeplis perfoliata* grows in highly saline soil (Al-Jaboul)

Distribution:	*Halopeplis perfoliata* (Fig. 97) is found in saline depressions of Al-Jaboul and Al-Mouh *sabkhas.*
Description:	Glabrous, juicy-succulent shrublet, erect or ascending, 20-40 cm high. Leaves very succulent, subglobular or pyriform, perfoliate, giving the stems a swollen, jointed appearance. Flowers in dense terminal spikes. Some or all the plant, particulary the inflorescence, often is strongly red-colored in the succulent parts. Flowers June-August
Salt tolerance:	Hydro-halophyte plant, tolerates salinities up to 42 dS/m. Found in muddy sites at Al-Jaboul (Fig. 98) and Al-Mouh.
Habitat:	Hydrohalophyte, occurs in wet areas. Grows in marshes at the coast or in mud in *sabkhas*.
Uses:	Similar to *H. amplexicaulis*.

Haloxylon articulatum (Cav) Bge. (Syn. *Hammada scoparia*).

Family: *Chenopodiaceae*
Local name: Al-Rameth الرمث
Common name: Rimth

Figure 99. *Haloxylon articulatum* at flowering stage

Distribution:	*Haloxylon articulatum* (Fig. 99) is widely distributed in the Syrian desert. It is common at the peripheries of Al-Mouh, Jyroud, Hyjana and other *sabkhas.*
Description:	Glabrous semi-shrub, 20–40 cm. Stems erect, woody, intricately branched; all branches fleshy, grey or grey-brown later turning black. Leaves reduced to minute triangular scales. Inflorescences mostly consisting of short, spike-like, flowering branches. Flowers usually solitary, with 2 bracteoles. Fruit (including wings) 4–6 mm in diameter. Wings almost equal. Flowers September-October.
Salt tolerance:	Salt-tolerant by (Aronson 1989). Some species of Haloxylon tolerate salinities of 8 dS/m; *H. articulatum* was trialed at Asqalan, on diluted Mediterranean seawater (Aronson 1989). It grows at Al-Mouh in soil with salinity 10 dS/m.
Habitat:	Xerophyte, occurs in arid areas. Prefers sandy and loamy soils, and can grow in nutritionally poor soils, also in very alkaline and saline soils.
Uses:	Low palatability, eaten by sheep and goats in spring (sometimes) and winter (moderately). Extensive root system and is used for stabilizing sandy soils (Usher 1974). Dry aerial plant parts contain 18.7% protein, 3.6% fat, 20% fiber, 17% ash and 40.7% NFE (Sankary 1981-1982), but percentages vary at different growth stages. Bedouins use the plant to treat skin diseases and animal psora.

Salicornia europaea L. (Syn. *S. herbacea* L.).

Family: *Chenopodiaceae*
Local name: Qalli (kharzah) القلي، (خرزة)
Common name: Glasswort

Figure 100. *Salicornia europaea* at vegetative stage

Figure 101. *Salicornia europaea* at flowering stage. Inset: flowers

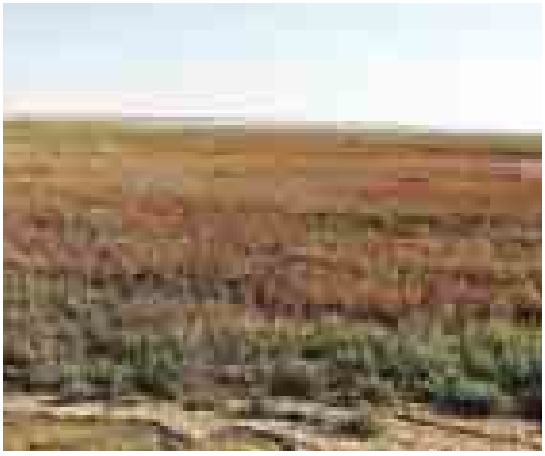

Figure 102. Pure community of *Salicornia europaea* at Al-Jaboul

Distribution:	*Salicornia europaea* (Fig. 100) is widely distributed in sabkhas.
Description:	Annual, glabrous, 15-40 cm. Stems indurated at base, procumbent to erect, more or less decussately and divaricately branched. Branches light green, rarely scarlet. Leaves about 1.5 mm, membranous-margined. Spikes cylindrical, slightly tapering at top. Flowers in groups (cymes) of 3, arranged in the 3-celled floral cavity; middle flower projecting above lateral ones. Perianth of middle flower obovoid-rhomboidal. Stamen mostly 1. Styles and /or stigmas 2. Seeds ovoid, with short hairs, more or less hooked at apex. Flowers August- November. During spring and summer *S. europaea* is green in color, turning to red at flowering stage and fall (Fig. 101).
Salt tolerance:	Can tolerate salinities greater than seawater (35,000 ppm) (Aronson 1989).
Habitat:	Hydrohalophyte species, grows in most coastal marine environments and *sabkhas* throughout the world, from warm tropical to cold zones. Prefers saline soils and sometimes forms pure communities (Fig. 102). Requires moist soils and can tolerate maritime exposure. The dry air of inland areas causes the plant to wilt even when well irrigated.
Uses:	Perhaps the most promising of all halophytes currently under commercial cultivation (Fegler and Mota-Urbina 1982). Can be cultivated in saline areas and used for fodder or for its high-quality oil suitable for human consumption. Oil yield 30%, higher than many oilseed crops. Traditionally burned for soda ash used in glass and soap making. Commercial cultivars of *Salicornia* have demonstrated seed yields of 2-3 t/ha, biomass production of 20 tons/ha. The oil has high protein, fatty acid composition similar to safflower (Anwar. et at. 2002, Facciola 1990), with a nutty taste and the texture of olive oil. When mixed with traditional fodder, the residual meal makes an excellent feed supplement. Can be eaten as a green vegetable raw or pickled, commands a high price in gourmet food markets in Europe and USA. Many Salicornia species can be irrigated with wastewater (effluent) from aquaculture operations and have demonstrated the ability to detoxify contaminated soils, in particular those with high levels of inorganic selenate. Some varieties of *Salicornia* are being cultivated in the deserts of India; where value-added by-products are being test-marketed (Fegler and Mota-Urbina 1982).
Notes:	*Salicornia* species exhibit many adaptations to saline environments (Adam 1990). Photosynthesis is performed by the stems. The stems are segmented. If one part of the plant dies, other parts can survive. The stem has an abundance of water-storing parenchyma. The vascular tissues are deeply situated, far removed from the stem surface where most evaporation occurs.

Salsola crassa Bieb.

Family: *Chenopodiaceae*
Local name: Al-Nadawy النداوي
Common name: Saltwort

Figure 103. *Salsola crassa* at flowering stage

Figure 104. *Salsola crassa* grows between the phytogenic mounds formed by *Halocnemum strobilaceum*

Distribution:	*Salsola crassa* (Fig. 103) is found in Al-Mouh, Jyroud and to a lesser extent Al-Jaboul *sabkhas.*
Description:	Annual, pubescent-tomentose, grayish or whitish, 25-50 cm. Stems erect, rigid, much branched. Branches alternate, except the lowermost. Cauline leaves 0.6-2.5 cm, mostly alternate, fleshy, narrowly linear, half-clasping. Bracts leaf-like, short, broadly ovate, more or less cuspidate. Flowers axillary, solitary. Perianth segments ovate, hairy. Anthers with short appendages. Fruiting perianth about 1.5 cm. in diam, lobes broadly triangular; wings 0.8-1 cm, broad, semiorbicular, brownish-purple. Flowers July-September.
Salt tolerance:	Locally common on high saline soil especially at Al-Mouh (salinity > 20dS/m). It grows in Al-Mouh in a community of *Halocnemum strobilaceum* (Fig. 104).
Uses:	Low palatability, grazed by camels.

Salsola jordanicola Eig.

Family: *Chenopodiaceae*
Local name: Al-Khydraf الخدراف الأردني
Common name: Jordan saltwort

Figure 105. *Salsola jordanicola* at fruiting stage

Distribution:	*Salsola jordanicola* (Fig. 105) is widely distributed in the desert, also found in peripheries of *sabkhas.*
Description:	Annual, white-mealy, papillose, pilose to villose, 15-40 cm, lower parts glabrous with age. Stems ascending to erect, rigid, much branched into dense, slender twigs. Leaves 1-2 cm, soon deciduous, alternate, linear, dilated at base, densely papillose or villose. Bracts short, broadly ovate-triangular, often persistent; bracteoles as long as bracts, 3-3.5 mm, broad, orbicular, white-margined, mostly persistent. Flowers mostly solitary, forming spike-like inflorescences. Perianth segments 2-3 × 1-2 mm, ovate more or less hooded and apiculate. Anthers with short appendages. Stigmas 2, unequal. Fruiting perianth 0.8-1.2 cm in diameter (including wings); wings broadly obovate-suborbicular. Flowers June-October.
Salt tolerance:	Salt-tolerant species. Widely distributed on soil with salinity up to 10-12 dS/m.
Uses:	Low palatability, grazed by sheep, goats and camels.

Salsola kali L.

Family: *Chenopodiaceae*
Local name: Hyredh shaik حُرض شائك، حُرض القلي
Common name: Russian thistle, Prickly saltwort

Figure 106. *Salsola kali* at flowering stage

Figure 107. *Salsola kali* grows at the seashore. Note the thick, short leaves

Figure 108. *Salsola kali* forms a dense community at the seashore

Distribution:	*Salsola kali* (Fig. 106) is distributed in sandy shores, and waste areas. It is highly polymorphic.
Description:	Annual, succulent, hispid-puberulent to scabrous or glabrescent, 20-80 cm. Stems decumbent or ascending, divaricately branched, especially at base, obtusely angular. Leaves 0.6-3 × (0.1-) 0.2-0.3 cm, the lower usually opposite, the upper alternate, fleshy, semiterete, linear-subulate, rarely filiform, somewhat clasping at base, mucronate-spiny. Bracts and bracteoles somewhat longer than perianth, oblong-ovate to triangular, spiny- tipped, keeled. Flowers hermaphrodite, 1-3 in an axil, forming loose and leafy spikes. Perianth segments 3-4 mm, free, membranous, oblong, subacute or obtuse. Fruiting perianth 0.4-1 cm across (including wings); wings obovate to reniform, striate, sometimes much reduced. Seeds horizontal, turbinate-subspherical. Flowers July-October.
Salt tolerance:	Does not grow in highly saline soil (seawater), but tolerates more than 10,000 ppm (17 dS/m). Found at many sites that are exposed to seawater. Plants growing in sandy-saline soil at the seashore have short, thick leaves (Fig. 107).
Habitat:	Prefers neutral and alkaline soils, can grow in very alkaline and saline soils, tolerates maritime exposure (Fig. 108). Salt- and drought-tolerant.
Uses:	Traditionally burned to produce soda ash for soap and glass manufacture. Being considered as a desert fuel crop which can be pressed into logs when dry. Young bushy plants used as forage, with potential biomass yields of 10 t/ha. Medium palatability, grazed by sheep and goats from early spring until flowering, when sharp spines form. The plant contains up to 5% oxalic acid, which may cause toxicity in grazing animals, but young plants are a good fodder source, as long as they are not too high in nitrites or oxalic acid. The plant may contain 0.2% alkaloids, among them salsolidine and salsoline (List and Horhammer 1969-1979). Aerial plant parts contain 12.3% protein, 1.8% fat, 31.7% fiber, 15.2% ash and 39% NFE (Miller 1958). Dry seeds contain 40.5% protein and 27% fat (Duke and Atchley 1984). The juice of the fresh plant is an excellent diuretic (Grieve 1984); the plant is used as a cathartic, diuretic, emmenagogue, stimulant and vermifuge (Launert 1981). In folk medicine, used to treat dropsy and excerscences. Salsoline, one of the constituents of the plant, has been used to regulate blood pressure (Launert 1981).

Salsola tetrandra Forsk.

Family: *Chenopodiaceae*
Local name: Al-Arad العرد
Common name: Saltwort

Figure 109. *Salsola tetrandra* at flowering stage

Figure 110. *Salsola tetrandra* forms a community characterizing the halophytic zonation (Jyroud)

Distribution:	*Salsola tetrandra* (Fig. 109) is widely distributed in Jyroud *sabkha* on sandy-saline soil.
Description:	Dwarf shrub, more or less white and crisp villose-tomentose, 15-50 cm or more. Stems woody, with many tortuous, opposite and alternate branches. Leaves small, about 2 mm, opposite, scaly and fleshy, ovate-triangular, densely imprecated along the tetragonous-cylindrical flowering branchlets; leaf axils hairy. Bracteoles leaf-like, ovate, concave. Flowers hermaphrodite and unisexual, solitary, in dense, catkin-like spikes. Staminate flowers with 4 more or less free segments, villose outside; stamens 4, alternating with 4 tubercle-like staminodes. Hermaphrodite flowers rare, 5-merous, with 5 segments, developing short dorsal wings at maturity; stamens 5. Seeds horizontal. Flowers March-November.
Salt tolerance:	Salt-tolerant (Aronson. 1985). Found in Jyroud *sabkha* together with *Halocnemum strobelaceum* and *Juncus maritimus*, in soil of salinity > 16 dS/m, sometimes > 20 dS/m.
Habitat:	One of the few desert xero-halophytic shrubs that tolerate extreme drought and salinity. It is the dominant plants at some sites in Jyroud and forms communities characterizing the halophytic zonation complex (Fig. 110).
Uses:	Low palatability, grazed by camels. Good soil stabilizer.

Salsola volkensii Schweinf.

Family: *Chenopodiaceae*
Local name: Al-Khydraf الخدراف
Common name: Saltwort

Figure 111. *Salsola volkensii* at beginning of flowering stage. Inset: fruits

Figure 112. *Salsola volkensii* grows vigorously in many sites at Al-Jaboul

Distribution:	*Salsola volkensii* (Figs. 111, 112) is widely distributed in saline soil at Al-Jaboul *sabkha*, and grows in the periphery of Al-Mous and Jyroud *sabkhas.*
Description:	Annual, glaucous, more or less villose with articulate hairs, not mealy, 10-50 cm. Stems erect, indurated, much branched. Leaves 3-8 ×1-2 mm, alternate, fleshy, semiterete or linear, dilated at base, hairy. Bracts fleshy, more or less orbicular; bracteoles as long as or longer than bracts, more or less fleshy, orbicular, concave. Flowers solitary, in loose or dense spikes. Perianth segments connivent, oblong-lanceolate to ovate, acute, villose. Fruiting perianth 5-8 mm in diameter (including wings); wings broadly obovate, imbricated. Flowers July-September.
Salt tolerance:	Tolerate salinities up to 20dS/m.
Habitat:	Xerophyte, occurs in dry areas. Grows vigorously in many sites of Al-Jaboul, forming dense communities (Fig. 112).
Uses:	High palatability, grazed by sheep, goats and camels.

Schanginia baccata (Forssk) Moq. (Syn. *Suaeda aegyptica* (Hasselq.) Zoh.)

Family: *Chenopodiaceae*
Local name: Sawaad السواد
Common name: Schanginia

Figure 113. *Schanginia baccata* at flowering stage. Right: flowers

Distribution:	*Schanginia baccata* (Fig. 113) is found at Al-Mouh *sabkha.*
Description:	Annual herb or low shrub, densely leafy, soft succulent, glabrous, glaucous or some what mealy, 20-60 cm high, stems erect and decumbent. Leaves very succulent, teretish linear cylindrical or somewhat flattened. Flowers in leafy spikes. Perianth about 3 mm long or more, with lobes becoming inflated, spongy-baccate. Flowers September-October.
Salt tolerance:	Tolerates salt marsh conditions. Grows in soils with salinity 14 dS/m.
Habitat:	Hydro-halophyte. Grows in saline soils and marshes, often as a weed in desert oases.
Uses:	See *Suaeda*.

Seidlitzia rosmarinus Bge. ex Boiss.

Family: *Chenopodiaceae*
Local name: Al-Anthawan العنظوان
Common name: Seidlitzia

Figure 114. *Seidlitzia rosmarinus* at fruiting stage

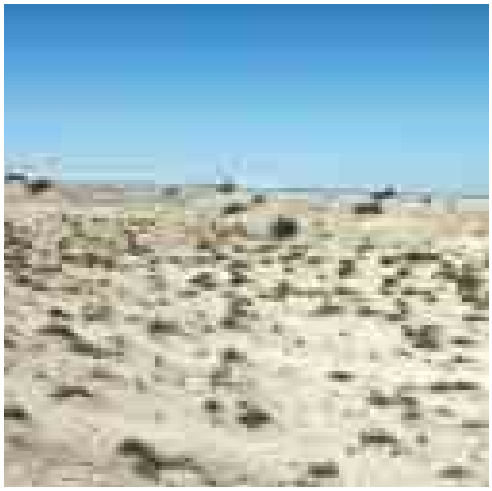

Figure 115. Community of *Tamarix tetragyna* – *Seidlitzia rosmarinus* at Al-Mouh

Distribution:	*Seidlitzia rosmarinus* (Fig. 114) is widely distributed at Al-Mouh *sabkha*, forming dense communities at many sites (Fig. 115). It also grows in communities of *Halocnemum strobilaceum.*
Description:	Glabrous low shrub, up to 60 cm. Stems branched, lower internodes longer than upper. Branches whitish, glossy. Leaves 0.5-3 cm, fleshy, thickening towards apex. Clusters 2-3 (-5)-flowered, opposite, in fleecy leaf axils. Perianth lobes obtuse. Fruit 0.5-1.2 cm broad (including wings). Flowers August-September.
Salt tolerance:	Succulent halophyte, tolerates salinities > 20 dS/m. (Burkova et al. 2002) found that salt tolerance in *Seidlitzia* was due to changes in its osmoregulatory system and to the localizing of salt ions in vacuoles (the central vacuole of leaf cells, and small cytoplasmic vacuoles of leaf and root cells).
Habitat:	A xerophyte species, occurs on salt-gypsiferous and sandy-loamy soils.
Uses:	Low palatability, but is well grazed by camels. The dry aerial plant parts contain 6.8% proteins, 21% fiber and 39% ash (Sankary 1981). Bedouins use it as soap. The seeds contain alkaloids.

Suaeda L.

Family: *Chenopodiaceae*
Local name: Al-Suwaydah السويدة
Common name: Suaeda

Distribution:	*Suaeda* species are widely distributed in seashore and saline soils in arid lands. Most species are halophytes. Some species as *S. fruticosa* are cosmopolitan and occur in many parts of the world.
Description:	Annual or perennial herbs, or shrubs, with succulent, mostly alternate leaves. Flowers usually bisexual, solitary or clustered in the axils, forming leafy spikes. Perianth 5-lobed. Stamens 5. Ovary free from the perianth or adante to it, with 2-5 stigmas. Fruit a utricle with seed horizontal or vertical. The most important species of *Suaeda* found in saline environments in Syria are *S. asphaltica* Boiss., *S. carnosissima* Post., *S. fruticosa* (L.) Forssk., *S. vera* Forsk. ex J.F. Gmel. and *S. vermiculata* Forssk ex J.F. Gmel.

Suaeda fruticosa (L.) Forssk.
(Syn. *Suaeda vera* Forsk. ex. J.F.Gmel.)

Family: *Chenopodiaceae*
Local name: Al-Suwaydah السويدة
Common name: Sea-blight

Figure 116. *Suaeda fruticosa* at flowering stage.
Right: flowers

Distribution:	*Suaeda fruticosa* (Fig. 116) is found at Al-Jaboul and Al-Mouh *sabkhas* and at the seashore.
Description:	Shrubs, more or less glabrous, 40-100 cm. Stems woody, much branched. Young branches scabrous- puberulent. Leaves 0.4-2.5 (-3) × 0.05-0.15 cm, more or less sessile, fleshy, terete, rarely semiterete, straight or arcuate, often deflexed. Clusters axillary, mostly 3-5- flowered, arranged in rather dense, leafy spikes which together from loose, paniculate inflorescences. Bracts leaf-like but smaller than leaves, longer than flowers, short-petioled, oblong-linear; bracteoles shorter than flowers, membranous. Flowers1-2 mm, hermaphrodite. Perianth segments ovate, concave, obtuse and incurved at tip, connate in lower part. Stigmas 3, filiform. Seeds usually vertical, smooth and glossy. Flowers September-May.

Salt tolerance:	Most Suaeda species are salt-tolerant. Some (*S. fruticosa*, *S. vera*, *S. vermiculata* and others) tolerate full strength seawater (56 dS/m) and grow on Mediterranean seawater at Asqalan (Aronson 1989). *S. palaestina* can tolerate salinities up to 79 dS/m (Aronson 1989).
Habitat:	Most *Suaeda* species prefer loamy and sandy soils. They grow in saline soils, waste lands, and upper edges of estuaries, beaches, and *Sabkhas* in arid areas.
Uses:	*Suaeda* species are of medium palatability, and are grazed by sheep and goats. *S. fruticosa*, with the lowest ash and silica levels, is one of the most palatable. The aerial plant parts of *S. fruticosa* contain 12.1% protein, 5% fat, 30.1% fiber, 14.2% ash and 38.6% NFE. Those of *S. tetrandr*a contain 6.77% protein, 2.41% fat, 34.2% fiber, 20.1% ash and 20.52% NFE (Abd el Rahman 1996, El Shaer 1995). The young leaves of most species are eaten raw or cooked (Kunkel 1984, Tanaka 1976). Leaves have a pleasant salty flavor and can be used in salad in small quantities. Leaves are often mixed with other vegetables in order to reduce their saltiness. The seeds are rich in high quality oil (Aronson 1989). Ongoing studies are investigating the commercial potential oil seed production from a number of *Saueda* species including *S. fruticosa*. The leaves of some species, especially *S. fruticosa*, are used as a poultice to treat ophthalmia; and when infused in water, as an emetic (Chopra et al. 1986). Tea made from the roots is taken to relieve cold symptoms (Fegler and Mose 1985). The aqueous extract of *S. fruticosa* is used as a hypoglycaemic, and has ben shown to reduce total cholesterol by 50% (Bannani-Khabchi et al. 1999). The Seri Indians used the stems and leaves of *S. fruticosa* to make a black dye. The aerial parts of *Suaeda* species are rich in potassium and often burned as a source of potash for making soap and glass (Grieve 1984). Some species, especially *S. fruticosa*, are used in India and Pakistan for sand dune stabilization and land reclamation.

Suaeda asphaltica Boiss.

Family: *Chenopodiaceae*
Local name: Al-Suwaydah السويدة
Common name: African salsola

Figure 117. *Suaeda asphaltica* at flowering stage

Distribution:	*Suaeda asphaltica* (Fig. 117) is widely distributed in Al-Mouh and Al-Hyjanah *sabkhas.*
Description:	Glabrous dwarf shrub, up to 80 cm. Stems much branched. Branches whitish. Leaves 0.5-1.8 (-3) × about 0.1 cm, short-petioled, terete, green, turning blackish when dry, covered with minute whitish scales. Clusters of 1-3 flowers sessile on the petioles, sometimes forming leafy spikes. Bracteoles minute, scarious; the 2 lateral flowers of each cluster 3-bracteolate, the middle one ebracteolate. Flowers hermaphrodite. Perianth segments 1-2 mm, ovate, obtuse, white-margined, connate to middle. Stigmas 3. Seeds horizontal, beaked, smooth. Flowers January-May.
Salt tolerance, habitat and uses:	Similar to *S. fruticosa*.

Suaeda carnosissima Post.

Family: *Chenopodiaceae*
Local name: Al-Suwaydah السويدة
Common name: Suaeda

Figure 118. *Suaeda carnosissima* at flowering stage

Distribution:	*Suaeda carnosissima* (Fig. 118) is found in Al-Mouh, Al-Jaboul and Al-Hyjana *sabkhas.*
Description:	Annual, glabrous, glaucous, somewhat mealy, 20-40 cm. Leaves fleshy, oblong, and sometimes flat to globular, 0.8-1.0 cm long. Spikes densely, bracts smaller than leaves. Cluster axillary 1-3 flowered, sessile or short-pedicelled Perianth small. Flowers August-September.
Salt tolerance, habitat and uses:	See *Suaeda fruticosa*.

Suaeda vera Forssk.

Family: *Chenopodiaceae*
Local name: Al-Suwaydah السويدة
Common name: Suaeda

Figure 119. *Suaeda vera* at flowering stage (seashore). Right: flowers

Distribution:	*Suaeda vera* (Fig. 119) is widely distributed at the seashore.
Description:	More or less glabrous or somewhat mealy low shrub, 20-50 cm. Stems woody, erect or prostrate, much branched. Leaves 0.5-1.5 (-2) × 0.1-0.15 cm, more or less sessile, dense, almost imbricated, fleshy, semiterete to flat, linear to lanceolate, rounded at apex. Bracts subessile, somewhat longer than flowers, leaf-like, oblong-linear, smaller than leaves; bracteoles scarious, irregularly denticulate. Flowers hermaphrodite, about 1.5-2 mm, usually solitary, sometimes 2-3 in a cluster, forming dense leafy spikes. Perianth segments ovate, obtuse, sometimes lanceolate and acute, connivent in fruit. Ovary pear-shaped; style dilated in upper part into a disk on which the stigmas are inserted; stigmas usually more than 3, club- shaped to spatulate. Seeds smooth, usually vertical. Flowers February-May.
Salt tolerance, habitat and uses:	See *Suaeda fruticosa*.

Suaeda vermiculata Forssk. Ex J. F. Gmel.

Family: *Chenopodiaceae*
Local name: Al-Suwaydah السويدة
Common name: Suaeda

Figure 120. *Suaeda vermiculata* at vegetative stage

Distribution:	*Suaeda vermiculata* (Fig. 120) is widely distributed at Al- Jaboul *sabkha.*
Description:	Half-shrub, glabrous at base, papillose-hirsute in younger parts, 20-50 cm. Stems glaucous, divaricately and very profusely branched. Branches whitish. Leaves 0.3-1×0.1-0.4 cm, succulent, the lower obovate- oblong, the upper nearly globular or linticular, obtuse. Bracts and upper leaves somewhat recurved, becoming black after desiccation. Clusters axillary, sessile, 1- or 2-3-flowered, forming loose, short, spike-like inflorescences. Flowers hermaphrodite, shorter than bracts. Fruiting perianth about 1 mm in diameter, ovoid, segments connivent. Stigmas 3, yellow. Seeds vertical, not beaked. Flowers March-April.
Salt tolerance and uses:	See *Suaeda fruticosa*.

Helianthemum lippii (L.) Dum. Cours.

Family: *Cistaceae*
Local name: Zahret el-Schams زهرة الشمس
Common name: Rockrose

Figure 121. *Helianthemum lippii* at flowering stage

Distribution:	*Helianthemum lippii* (Fig. 121) is widely distributed in Al-Hyjanah *sabkha*, and is also found in Al-Mouh *sabkha* (rare).
Description:	Dwarf shrub, procumbent, white, glossy, canescent, 20-30 cm. Stems many, dichotomously and intricately branched into spreading and horizontal twigs. Older branches with fissured bark, becoming spinescent. Leaves (0.6-) 1-1.5×0.1-0.2 (-0.5) cm, elliptical, ovate-lanceolate of linear-lanceolate to linear, revolute-margined, tomentose; winter leaves soon deciduous, larger than the summer leaves; stipules up to one third as long as the blade. Inflorescences spike-like, one-sided, loosely 3-8 flowered. Bracts much shorter than the calyx, subulate. Flowers subsessile. Calyx hairy; outer sepals linear, inner sepals 3-4 mm, more than twice as long as the outer ones. Petals somewhat longer than calyx, yellow or whitish, ovate-oblong. Capsule as long as the fruiting calyx or somewhat shorter, ovoid-oblong, villose. Seeds flattened angular, brown. Flowers March-April.
Salt tolerance:	Salt-tolerant species. Found in areas with soil salinity > 10 dS/m, sometimes > 15 dS/m.
Habitat:	Xerophyte, occurs in arid environments, especially in sabkha peripheries.
Uses:	Low palatability but eaten by camels. In folk medicine, tea made from the leaves is used to treat kidney ailments, sore throat and scrofula. Applied externally to treat skin diseases and eye infections.

Achillea fragrantissima (Forsk.) Sch.

Family: *Compositae*
Local name: Qaysum (Buaythiran) القيصوم (بعيثران)
Common name: Lavender cotton

Figure 122. *Achillea fragrantissima* at flowering stage

Distribution:	*Achillea fragrantissima* (Fig. 122) is widely distributed in valley beds in the deserts. It is common at the peripheries of *sabkhas.*
Description:	Fragrant chamaephyte, 50-100 cm, white-woolly, many-stemmed from a woody base, paniculate-corymbose above. Stems virgate, rigid. Leaves small, oblong or ovate, undivided, thickish, canescent, later glabrescent, callous-serrulate. Heads discoid in lax corymbs. Involucre 5 mm, oblong-ovoid, canescent. Flowers March-October, also as late as December-January.
Salt tolerance:	Salt-tolerant (Boeer and Stille 1990) found in areas with soil salinity > 10 dS/m.
Habitat:	Prefers medium (loamy) and heavy (clay) soils. Can grow in saline and highly alkaline soils.
Uses:	Not palatable; camels rarely eat it, while sheep and goats do not eat it at all. Dry aerial plant parts (at vegetative stage) contain 14.8% protein, 2.6% fat, 38.3% fiber, 6.7% ash and 37.6% NFE (ACSAD 1979). Infusion of dry or fresh, flowering herbs widely used for cough, stomach ache, and as anthelmintic. The volatile oil from flowering tops shows broad spectrum activity against various microbes (Barel et al. 1991). The fresh herb contains about 1% volatile oil, which contains pinene, limonene, cineole, linalool, carvacrol, eugenol and others; tannin content reaches 8% (Elgamal et al. 1991).
Notes:	Collected for medicinal use, also affected due to plowing (cultivation) of valley beds. Exploitation appears to exceed regeneration.

Centaurea postii Boiss.

Family: *Compositae*
Local name: Al-Myrar المرار
Common name: Centaury

Figure 123. *Centaurea postii* at flowering stage

Figure 124. *Centaurea postii* at vegetative stage

Distribution:	*Centaurea postii* (Figs. 123, 124) is widely distributed in Al-Mouh, Jyroud and Hyjana *sabkhas*. In Al-Mouh it is found together with *Farnkenia*, *Seidlitzia* and *Tamarix*.
Description:	Perennial, tomentosus, grayish, covered with mealy hairs, 10-50 cm. Stem prostrate dichotomous branching, with densely leaves. Leaves oblong in outline, cauline leaves sessile, linear, oblong, entire or lobed. Flowering head subsessile 1 cm in diameter. Involucre bracts ovate, entire, ending in rigid yellow spine. Florets yellow. Achene 4 mm, white. Flowers April-July.
Salt tolerance:	Salt-tolerant, grows in areas with soil salinity 14-20 dS/m.
Uses:	Medium palatability, grazed by sheep, goats and camels. Root and leaves are bitter and used in folk medicine as tonic, diuretic and for stomach ache. Also used for digestive system disorders and to reduce fever in children (Chiej 1984).

Inula crithmoides L.

Family: *Compositae (Asteraceae)*
Local name: Rassin راسن (حطب زيتي)
Common name: Golden samphire

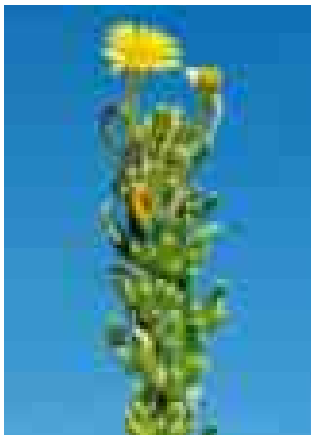

Figure 125. *Inula crithmoides* at flowering stage

Figure 126. Community of *Inula crithmoides*

Distribution:	*Inula crithmoides* (Fig. 125) is widely distributed at the seashore. It occurs in salt marshes and sandy littorals.
Description:	Shrub, woody at base, 30-60 cm, glabrous. Stems erect or ascending. Leaves glabrous, fleshy, green, sessile, linear or oblanceolate, entire or 3-dentate at apex; leaf axils with fascicle-like brachyblasts. Peduncles elongated, thickened above, bearing small linear acute bracts. Heads radiate, 1.5-3 cm, in diameter, in lax corymbs or solitary. Involucral bracts glabrous, acuminate. Ray florets about twice as long as involucre. Achenes ribbed, not tapering at tip. Pappus bristles not connate at base. Flowers May-October.
Salt tolerance:	Halophyte, can tolerate full-strength seawater and salinities up to 56 dS/m, can grow in seawater (Aronson 1989).
Habitat:	Saline marshes and rocks exposed to sea spray. Forms dense communities in some seashore sites (Fig. 126).
Uses:	Good potential for use in saline agriculture and as animal feed supplement. Throughout Europe, the flower buds were pickled and some times mixed with Salicornia. In Lebanon, young succulent leaves are eaten raw in salads, cooked or used as potherb, with good protein content (13%), and it has good potential as quality. Protein content 13%. Iodine content of shoot 0.8-1.4 mg/kg DW (Zurayk and Baalbaki 1996). The plant contains glycosides (El-Lakany 2003) and roots are used in folk medicine as a tonic. The plant attracts bees, also serves as an ornamental plant.

Inula viscosa (L.) Ait.
(Syn. *Dittrichia viscosa* (L.) Greuter.)

Family: *Compositae*
Local name: Al-Tayoon الطيون، عرق الطيون (طُبّاق)
Common name: Viscous inula

Figure 127. *Inula viscosa* at flowering stage

Distribution:	*Inula viscosa* (Fig. 127) is widely distributed throughout Syria, and occurs on the seashore.
Description:	Chamaephyte or perennial herb, woody at base, 50-120 cm, strong-smelling, glandular-hairy, viscid, with sparse long fine hairs. Stems rigid, branched. Leaves lanceolate, remotely dentate, sessile, half-clasping; cauline leaves about 1 cm broad or broader. Heads radiate pedunculate, 1.5 cm or more in diameter, arranged in relatively narrow long terminal panicles or in racemes. Involucre 8 mm; involucral bracts minutely glandular-puberulent. Ray florets few, nearly 11/2 times as long as the involucre. Achenes not ribbed, narrowed above into a short neck. Pappus bristles connate at base. Flowers July-December.
Salt tolerance:	Some populations tolerate salinities up to 8 dS/m (Aronson 1989). Some populations were found at the seashore on highly saline soil, together with *Halimione* and *Inula crithmoides*.
Habitat:	Seashore populations prefer sandy soil, also occur on wet loamy soil.

Uses:	Aerial plant parts contain sesquiterpinic acid which has anthelmintic activity (Suspluges et al. 1995). The essential oil also has significant antifungal activity against dermatophytes even at low concentrations (0.01 mg/ml) (Cafarchia 2002). Potential for use as herbal fungicide against foliar diseases caused by pathogens belonging to the families *Oomycetes*, *Ascomycetes*, and *Basidiomycetes* (Wang et al. 2004). In Palestine, it is believed *I. viscosa* helped prophet Jasop (Ayub) to endure torture. In folk medicine, used to treat wounds, ulcers, bleeding, joint pain, respiratory tract infections, athlete's foot, hemorrhoids, intestinal worms, fractured bones, blood pressure, diabetes, backache, gum disorders, and skin fungi (dermatophytes) (Krispil 1987).

Xanthium strumarium L.

Family: *Compositae*
Local name: Al-Lyziq اللزيق
Common name: Cocklebur

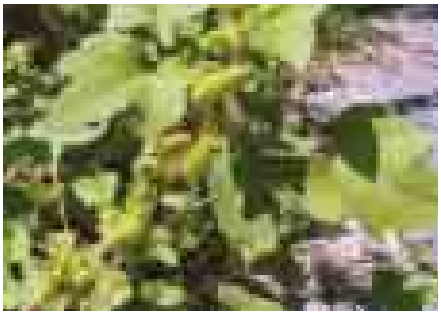

Figure 128. *Xanthium strumarium* at fruiting stage

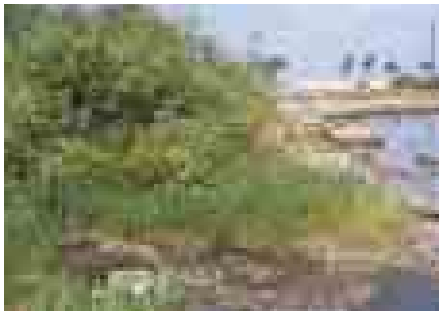

Figure 129. *Xanthium strumarium* and *Arundo* at the seashore

Distribution:	*Xanthium strumarium* (Fig. 128) is widely distributed at sabkha peripheries and the seashore.
Description:	Annual, 30-100 cm, scabridulous, with appressed short hairs. Stem erect. Leaves unarmed, triangular, irregularly lobed and dentate, cordate or cuneate at base; petiole about as long as blade. Staminate racemes axillary and terminal, pednuculate. Fruiting involucre ovoid or oblong, 1.5-2 cm, covered with prickles up to the tip; prickles straight, short-pubescent for about 2/3 of their length, hooked at tip; beaks straight, spinescent, about as long as prickles. Flowers May-September.
Salt tolerance:	Tolerates saline conditions (Duncan 1974). Grows at the seashore (Fig. 129).
Habitat:	Grows on all types of the soils, even nutritionally poor ones, but requires moisture. Cannot grow in the shade.
Uses:	Toxic; usually avoided by grazing animals (Foster et al. 2002). Seeds also contain toxins (Foster and Duke 1990). The toxic principle of *Xanthium* is a sulfated glycoside, carboxyatractyloside, found in seeds and at the two-leaf seedling stage (Cole et al. 1980). The plant is used to treat malaria (Chopra et al. 1986). Plant infusion used in rheumatism, kidney diseases and tuberculosis (Moerman 1998). Fruits contain phytosterols (WHO 1998). They are anodyne, antibacterial, antispasmodic, antitussive and stomachic; used internally in the treatment of allergic rhinitis, rheumatism, constipation, diarrhea and leprosy (Bown 1995). Roots have been used to treat scrofulous tumours (Foster et al. 2002). A decoction of the root is used in high fevers and to help women expel the placenta after birth. Seeds are used to treat bladder complaints (Moerman 1998). A poultice of the powdered seed is applied on open sores (Moerman 1998). Seeds contain an essential oil (Manandhar 2002) and about 36.7% protein, 38.6% fat and 5.2% ash (Reid 1977). The plant contains xanthinin which acts as a plant growth regulator (Caius 1986). Dried leaves are a source of tannin (Singh and Ckachroo 1976). A yellow dye is obtained from the leaves (Moerman 1998). The plants repel weevils from stored wheat grain (Stuart 1995).

Convolvulus lineatus L.

Family: *Convolvulaceae*
Local name: Lablab لبلاب
Common name: Bindweed

Figure 130. *Convolvulus lineatus* at flowering stage

Distribution:	*Convolvulus lineatus* (Fig. 130) is widely distributed at Al-Hyjanah and Jyroud *sabkhas.*
Description:	Perennial herb, 5-20 cm. Stem procumbent to erect. Leaves linear-elliptic, linear-oblanceolate. Flowers axillary and terminal, solitary or in 2-3 flowered cymes. Corolla pink, occasionally white, 1.5-2.5 cm. Flowers April-May.
Salt tolerance:	Salt-tolerant, found in areas with soil salinity > 10 dS/m, sometimes > 15 dS/m.
Habitat:	Xerophyte, occurs in dry areas.
Uses:	Poisonous, not grazed by animals. Widely used in folk medicine. The root, and also a resin made from the root, is cholagogue, diuretic, laxative and strongly purgative. Tea made from the flowers is laxative and also used to treat fevers and wounds.

Ipomoea stolonifera (Cyr.) J.F.

Family: *Convolvulaceae*
Local name: Al-Madadah el-Bahria المدادة البحرية
Common name: Beach morning glory

Figure 131. *Ipomoea stolonifera* at flowering stage

Distribution:	*Ipomoea stolonifera* (Fig. 131) is found at the seashore, restricted to a small area south of Tartous. It is a rare species in Syria and must be protected.
Description:	Perennial glabrous herb. Stems 30-50 cm or more, branched and creeping, rooting at the nodes. Leaves 1-3 cm, leathery, varying in shape, oblong or ovate-pandurate, cordate at base, retuse at apex, sometimes 3-5 lobed. Flowers solitary in axils of upper leaves; peduncle shorter than subtending leaf; bracteoles minute; pedicel about as long as calyx, thickened. Calyx 8-12 mm; sepals unequal, elliptic, obtuse, mucronulate. Corolla 40-60 mm, yellowish-white, glabrous. Stigma 2-lobed. Capsule subglobose, about 1.5 cm in diameter. Seeds large, densely villose. Flowers May-October.
Salt tolerance:	Tolerates sea-shore conditions, grows well in the spray belt. Can tolerate maritime exposure.
Habitat:	Psammophyte, grows well on maritime sands, where it is commonly found in *Euphorbia paralias* and *Pancratium maritimum* associations.
Uses:	Ornamental plant, with beautiful white flowers.

Cressa cretica L.

Family: *Convolvulaceae*
Local name: Al-Nadawa النداوى العليقية
Common name: Rosin weed

Figure 132. *Cressa cretica* at flowering stage.
Right: flowers

Distribution:	*Cressa cretica* (Fig. 132) is found in *sabkhas*, especially Al-Jaboul. It also grows in Al-Mouh in communities of *Halopeplis perfoliata.*
Description:	Perennial herb, 10-25 cm, branched from base, ash-grey,with appressed an spreading hairs. Stems ascending or prostrate, densely leafy> Leaves minute, salt-exuding, sessile, ovate-oblong or lanceolate, acute, subcordate. Inflorescences spike-like. Flowers shortpedicellate. Sepals 3mm, longer than cotolla-Tube> Corolla whitish or yellow. Capsule ovoid. flowering May-November.
Salt tolerance:	Hydro-halophyte, tolerates salinities up to 42 dS/m. Found in muddy sites at Al-Jaboul and Al-Mouh *sabkhas*.
Habitat:	Grows in alluvial soils inundated in winter.
Uses:	Aerial plant parts contain flavonoids quercetin, kampferol, and rutin. Known in folk medicine for its hypoglycaemic action, used as part of a plant mixture to treat diabetes.

Cakile maritima Scott.

Family: *Cruciferae*
Local name: Qaqli رشاد البحر (قاقلي)
Common name: Sea rocket


Figure 133. *Cakile maritima* at flowering stage.
Right: flowers

Distribution:	*Cakile maritima* (Fig. 133) is widely distributed in sandy area of the seashore.
Description:	Annual, succulent, 15-50 cm. Leaves 5-10 cm, petiolate, glabrous, pinnatifid to pinnatisect with more or less linear and obtuse lobes, or almost entire or sinuate-dentate. Inflorescences ebracteate. Flowers 0.7-1.2 cm, lilac to white. Petals twice as long as calyx clawed; limb obovate. Fruit 1.4-2.5 × 0.4-0.6 cm, on short stout and thick pedicels, tetragonous, 2-jointed; lower joint mostly top-shaped, with prominent lateral projections above; upper joint distinctly longer than lower, ensiform, ovoid or lanceolate. Seeds solitary in each joint, yellowish-brown, smooth. Flowers March-June.
Salt tolerance:	Salt-tolerant species, found in saline environments. Tolerates up to 18 dS/m salinity (Aronson 1989), also tolerates maritime exposure.
Habitat:	Psammophile, occurs in sandy seashore areas. Can grow in nutritionally poor soils.
Uses:	Peppery succulent leaves, stems, and young seed pods taste like horseradish and are eaten raw or cooked (Facciola 1990). Young leaves are rich in vitamin C and can be added to salads. Introduced to North America as a potential oilseed plant with 29% protein and 52% oil content (Facciola 1990).

Malcolmia grandiflora (Bge.) Kuntze. (Syn. *Strigosella grandiflora* (Bge.) Botsch.

Family: *Cruciferae (Brassicaceae)*
Local name: Al-Saleih السليح (الأسليح)
Common name: Alasleih

Figure 134. *Malcolmia grandiflora* at flowering stage

Figure 135. *Malcolmia grandiflora* forms dense communities in Al-Mouh

Distribution:	*Malcolmia grandiflora* (Fig. 134) is widely distributed in Al-Mouh *sabkha*, and also found (rarely) in Jyroud and Al-Jaboul. It forms dense communities in Al-Mouh (Fig. 135).
Description:	Erect annual, single-stemmed or branched from base, 10-40 cm high, pubescent in young parts, otherwise glabrescent. Leaves mostly in a basal rosette, oblong to oblanceolate, sinuate to dentate, tapering below to a petiole, the older ones sparsely ciliate at margins, the younger pubescent on faces. Petals 8-15 mm long, more than twice as long as the sepals, rather showy pink to purple with darker veins. Siliques 20-60 mm long, and 1 mm wide, spreading-ascending, straight or semi-coiled near the apex, on pedicels 1-2 mm long and about as thick as the fruit. Flowers February-March
Salt tolerance:	Locally common on highly saline soils, tolerates more than 14 dS/m. In Al-Mouh, grows in communities of *Limonium palmyrense*.
Uses:	Strong, pleasant scent. Grazed by camels and sheep.

Matthiola tricuspidata (L.) R. Br.

Family: *Cruciferae*
Local name: Al-Manthor المنثور
Common name: Three-horned stock

Figure 136. *Matthiola tricuspidata* at flowering stage

Figure 137. *Matthiola tricuspidata* community at the seashore

Distribution:	*Mathiola tricuspidata* (Fig. 136) is widely distributed on sandy soils of the Mediterranean coast.
Description:	Annual low, canescent, 10-25 cm. Stems ascending or procumbent, diffusely branching from base. Leaves 2-5 cm, somewhat fleshy, oblong to oblanceolate, sinuatedentate or pinnatifid, rarely almost entire, lobes rounded. Racemes short, and flowers short-pedicelled. Sepals about 8 mm, oblong tomentose. Petals 1.5-1.8 (-2) cm, exserted, purple or pink, obovate, clawed. Fruit 3-5 × 0.2-0.3 cm, on thick terete pedicels, subtorulose; stigma 2- lobed conical spreading, awl-shaped horns, equaling or somewhat exceeding the stigma in length. Flowers March-June.
Salt tolerance:	Salt-tolerant, grows on sandy soil with salinity up to 15-20 dS/m, tolerates maritime exposure. In many coastal sites, it forms dense communities (Fig. 137).
Habitat:	Widely distributed on sandy soils and spray zones of the Mediterranian seashore. Requires moist sandy soil.
Uses:	Seeds contain oil rich in Omega-3 linolenic acid. The oil can reduce cholesterol and triglyceride levels. Also used for ornamental purposes for its colorful and strongly scented flowers. The flowers also yield a dark blue or purple dye. In folk medicine, seeds used as aphrodisiac, diuretic, expectorant, stimulant, stomach ulcer and tonic (Chopra et al. 1986). An infusion, mixed with wine, is used as an antidote to poisonous snake-bites (Chopra et al. 1986).

Scirpus L.

Family: *Cyperaceae*
Local name: Asal el-Khybb أسل الخبّ، (ديس)
Common name: Bulrush

Distribution:	*Scirpus* has a cosmopolitan distribution and grows in wet lands and moist soils. Some species grow in saline soils and marshy environments.
Description:	Perennial or rarely annual herbs. Stems terete to 3-gonous. Leaves with flat or cylindrical blades; sometimes leaves reduced to sheaths. Inflorescence umbel-, spike- or head-like (sometimes reduced to single spikelet); terminal or seemingly lateral (pseudolateral) owing to erect lowest involucral bract simulating prolongation of stem. Involucral bracts 1 to several, leaf-like or scale-like. Spikelets 1 to many, sessile or pedunculate, 3- to many-flowered. Glumes spirally arranged, imbricate, the lower ones mostly longer, all fertile or lowermost 1-3 often empty. Flowers hermaphrodite; upper flowers in spikelets often staminate. Stamens usually 3, style almost always glabrous, not articulated with ovary, sometimes thickened at base, deciduous; stigmas 3 or 2. Nut 3- gonous or flattened, obovate or elliptic to oblong in outline, smooth or regularly rugulose transversely. The most important *Scirpus* species in Syria are *S. holoschoenus* L., *S. littoralis* Schrad. and *S. maritimus* L.

Scirpus holoschoenus L.
(Syn. *Scirpoides holoschoenus* (L.) Sojak.)

Family: *Cyperaceae*
Local name: Asal el-Khybb أسل الخبّ، (ديس)
Common name: Bulrush

Figure 138. *Scirpus holoschoenus* at flowering stage

Distribution:	*Scirpus holoschoenus* (Fig. 138) is found in coastal salt marshes north of Lattaqia on sandy soil. Psammophile, occurs in sandy coastal areas.
Description:	Perennial, 50-100 cm, with a creeping rhizome. Stems tufted, erect, terete, striate. Leaves reduced to sheaths; upper sheaths ending in short linear semiterete-canaliculate blades, usually shorter than inflorescence. Inflorescence pseudolateral, umbellate, of several pedunculate and sessile heads of spikelets; heads globose, very dense, 5-10 (-15) mm in diameter, with numerous spikelets. Involucral bracts (1-) 2, long, semiterete; the lowest erect, mostly longer than inflorescence. Spikelets 3-4×2 mm, obovoid, obtuse. Glumes 2-3 mm, obovate to elliptic, truncate to emarginated, mucronulate or nearly 3-lobed, ciliolate, brown to rust-coloured, green at keel. Hypogynous bristles absent. Stamens 3, stigmas 3. Nut 3-gonous, obovoid, minute, brownish-white, with persistent style- base at tip. Flowers May-August.
Salt tolerance:	Salt-tolerant (Aronson 1989). Found in sandy areas with maritime exposure.
Habitat and uses:	See *Scirpus maritimus*.

Scirpus littoralis Schrad. (Syn. *Schoenoplectus subulatus* (Vahl) Lye.)

Family: *Cyperaceae*
Local name: Asal el-Khybb أسل الخبّ (ديس)
Common name: Bulrush

Figure 139. *Scirpus littoralis* at flowering stage

Figure 140. *Scirpus littoralis* forms dense and widely distributed communities in Al-Jaboul

Distribution:	*Scirpus littoralis* (Fig. 139) is found in coastal sandy soils south of Tartous and in the shallow water of Al-Jaboul *sabkha.*
Description:	Perennial, 1-1.5 m, with a stoloniferous rhizome. Stems 3-quetrous. Leaves reduced to sheaths, or sometimes with blades up to 20 cm. Inflorescence pseudolateral, usually a compound umbel with unequal rays. Lowest involucral bract subulate, 3-quetrous, erect, shorter than to about as long as inflorescence, rarely longer. Spikelets 6-15 mm, oblong-ovoid, solitary or in small clusters. Glumes 3.5-4 mm, ovate broadly white-membranous at margin, brown at centre, obtuse or retuse, mucronate. Stamens (2-) 3 and stigmas 2. Nut 3 mm, plano-convex, obovate in outline, smooth or reticulate, brown. Flowers May-October.
Salt tolerance:	Tolerates salt marsh conditions. Forms dense and widely distributed communities in Al-Jaboul (Fig. 140).
Habitat and uses:	See *Scirpus maritimus*.

Scirpus maritimus L.
(Syn. *Bolboschoenus maritimus* (L.) Palla.

Family: *Cyperaceae*
Local name: Asal el-Khybb أسل الخبّ، (ديس بحري)
Common name: Bulrush

Figure 141. *Scirpus maritimus* at flowering stage

Distribution:	*Scirpus maritimus* (Fig. 141) is found at seashore marshes and river banks, mostly on saline soil. It is a hydro-halophyte and occurs in tidal salt marshes.
Description:	Perennial, 30-100 cm, glabrous (except for glumes), with creeping branched rhizome; rhizome often producing subglobose tubers 1-2 cm in diameter at ends of rhizome branches. Stems 3-quetrous, leafy, usually erect. Leaf-blades flat, keeled, long and up to 1 cm broad. Inflorescence terminal, varying from compact to lax, often umbel-like, rarely of a single spikelet; rays unequal, up to 5 cm. Involucral bracts 2-4, leaf- like, unequal, nearly all much exceeding inflorescence. Spikelets 10-20 mm, ovoid to oblong acute, many- flowered. Glumes ovate to oblong, 1-veined, not keeled, brown, finely hairy, acutely 2-fid or irregularly 4-lobed at tip, with an awn in the sinus. Stamens 3 and stigmas 3, rarely 2. Nut 2(-3) mm, 3-gonous-obovoid, tapering at base, apiculate at apex, brown, glossy. Flowers March-October.

Salt tolerance:	Tolerates brackish to saline conditions in tidal marshes and salinities up to 77 dS/m (Aronson 1989, Duncan 1974).
Habitat:	Scirpus species are widely distributed in coastal salt marshes, freshwater marshes and muddy marshy soils. They have horizontal underground rhizomes from which roots and multiple stems arise.
Food and medicinal uses:	Roots are rich in starch; usually dried and ground into a powder (Hedrick 1972). The rhizomes and roots form tubers along their length and new plants are formed from these tubers. The young tubers are white and starchy with a sweet coconut-milk flavor. Root, pollen, and seeds are used as food. Cooked seeds can be ground into a powder and used as a mush (Moerman 1998). *Scripus* species are widely used as medicinal plants. Rhizomes are harvested in autumn, dried, and used in herbal remedies. They are astringent and diuretic (Chopra et al. 1986). They are also used to treat amenorrhoea, dymenorrhoea, abdominal pains and indigestion (Yeung 1985) *Scirpus* rhizomes stimulate menstrual flow, promote the milk production, and reduce pain following childbirth.
Other uses:	A fiber obtained from the stems of *Scirpus* species is used for making paper. Leaves and stems are used for weaving or sewed together into hats, mats, and mattresses. Stems are very durable and take years to decay, are are used to make baskets (Moerman 1998).

Euphorbia paralias L.

Family: *Euphorbiaceae*
Local name: Hallab الحلاب البحري
Common name: Sea spurge

Figure 142. *Euphorbia paralias* at flowering stage

Distribution:	*Euphorbia paralias* (Fig. 142) is widely distributed at the seashore.
Description:	Half-shrub, glaucous, glabrous, 30-50 cm. Roots vertical. Stems many, erect, stiff and leafy, fertile and sterile. Leaves 1-2 (-3) × 0.2 -0.4 cm, dense, often imbricated, sessile, very thick and fleshy, elliptical to oblong, somewhat concave, with broad or almost cordate base, obtuse or acute at apex, entire; lower leaves sometimes opposite or whorled; umbellar and floral leaves 0.6-1.2 cm, ovate, cordate at base, mucronulate. Rays of umbel 3-5, short thick, simple or forked. Cyathia about 3 mm, pedicellate; involucre campanulate, hairy at throat, lobes oblong ciliate; glands transversely oblong, lunate, entire or dentate, with 2 short divaricate horns. Capsule about 4 × 6 mm, depressed-globular, 3-lobed, finely granular-wrinkled; carpels rounded. Seeds 3 mm, ovoid- globular, greyish with darker spots, smooth, with a very small reniform caruncle. Flowers April-August.

Salt tolerance:	Salt-tolerant (Aronson 1989) and tolerates maritime exposure. Grows on sandy seashore areas. At some sites, forms communities with *Eryngium maritimum*.
Habitat:	Psammophyte, with a deep tap root system. If leaves are buried in the sand they die and drop off and the stem is stimulated to grow and divide, producing clumps that colonize the dune.
Uses:	Poisonous; plant sap contains latex which is toxic on ingestion and highly irritating externally, causing photosensitive skin reactions and severe inflammation, especially on contact with eyes or open cuts. Toxicity can remain high even in dried plant material. The leaves contain triterpenoides, flavonoids and gallic acid (Foster and Duke 1990). The plant has traditionally been used to treat bronchitic asthma and laryngeal spasms, though in modern herbalism it is more used for intestinal amoebic dysentery (Stuart 1995). Should not be used without expert guidance since large doses cause gastro-intestinal irritation, nausea and vomiting (Stuart 1995). The whole plant is decocted and used in the treatment of athlete's foot, dysentery, enteritis and skin conditions (Duke and Ayensu 1985). The sap is applied 2-3 times a day over a period of several weeks, to destroy warts (Chopra et al. 1986).

Frankenia L.

Family: *Frankeniaceae*
Local name: Al-Hamrah الحمرة
Common name: Mediterranean seaheath, Europen seaheath

Fig. 143. *Frankenia intermedia* at flowering stage

Description:	Annual or perennial herbs or half-shrubs. Leaves opposite or whorled. Flowers in axillary or terminal dichasia. Calyx tubular, (4-) 5- lobed. Petals (4-) 5, small pink. Capsule 1-celled, dehiscing usually by 3 valves. Grows mostly in salt marshes and salt deserts in temperate and subtropical region. There are three species in Syria (Mouterde 1970): *F. hirsuta* L. var. *hispida* (D.C.) Boiss., *F. pulverulenta* L. and *F. intermedia*. D.C.

Frankenia hirsuta L. var. *hispida* (D.C.) Boiss.

Family: *Frankeniaceae*
Local name: Al-Hamrah الحمرة
Common name: Mediterranean seaheath, European seaheath

Fig. 144. *Frankenia hirsuta* at flowering stage.
Right: white flowers at seashore

Description:	Perennial with woody base, puberulent or white-hirsute, up to 25 cm. Stems procumbent, densely branched, leafy. Leaves (2-) 3-7 × 0.5-2 mm, whorled, sessile or tapering to a petiole, linear or linear-oblong, often revolute-margined, often with spreading white-ciliate hairs at base. Flowers in dense corymbose terminal clusters. Calyx 4-5 mm, sparingly hirsute. Corolla white, purplish or pink; petals 4-6 mm, obovate, long- clawed, finely denticulate above. Stamens 6. Capsule 2.5-3 mm, 3-valved, ovoid or oblong-ovoid. Seeds minute, oblong-ellipsoidal. Flowers May-September.
Salt tolerance and uses:	See *Frankenia pulverulenta.*

Frankenia pulverulenta L.

Family: *Frankeniaceae*
Local name: Al-Hamrah الحمرة
Common name: Mediterranean seaheath

Fig. 145. *Frankenia pulverulenta* at fruiting stage

Fig. 146. Salt crystals on the leaves of *Frankenia hirsuta*

Description:	Annual, mealy and puberulent, 5-30 cm. Stems ascending or procumbent, much branched. Leaves usually in whorls of 4, 2-5 × 1-2.5 mm, flat obovate to oblong, tapering to a petiole, obtuse to retuse at apex. Flowers 4-5 mm, solitary or in pairs, in short axillary or terminal spikes. Calyx 2.5-4 mm, cylindrical; lobes lanceolate-linear. Petals 3.5-5 mm, pale or deep violet, oblong to obovate, somewhat clawed at base, minutely denticulate at apex. Stamens 6, capsule 2.5-3 mm, 3- valved, ovoid or oblong-ovoid. Seeds oblong. Flowers April-August.
Distribution:	*Frankenia* (Figs. 143-146) species are widely distributed on the peripheries all sabkhas in Syria and in salt marshes at the seashore.
Salt tolerance:	*Frankenia* species are halophytes and can tolerate salinity > 20 dS/m. They are found in salt marshes at the seashore with maritime exposure. *Frankenia* species grow in Al-Mouh *sabkha* between phytogenic mounds formed by *Halocnemum strobilceum*.
Habitat:	*Frankenia* species tolerate saline and drought conditions. They commonly grow on sandy soils (seashore) and saline clay soils. *Frankenia* species are salt-excreting plants (Fig. 146).
Uses:	*Frankenia* species have beautiful flowers (Figs. 143, 144), thus ornamental. Some species contain gummy resin, used for glueng knife blades and to seal pottery (Fegler and Mose 1985). Contain tannin (about 6%), quercetin, and kaempferol. Fluid extract is used for catarrh diseases, and mucous discharges from the nose and genito-urinary tracts. Tea of roots used as a cold remedy (Fegler and Mose 1985).

Aeluropus lagopoides (L.) Trin.

Family: *: Gramineae* (Poaceae)
Local name: Al-Iqrish العكرش القصير
Common name: Iqrish

Fig. 147. *Aeluropus lagopoides* at flowering stage. Right: flowers

Distribution:	*Aeluropus lagopoides* (Fig. 147) is widely distributed in *sabkhas* and coastal plains. It forms dense plant cover in many sites of Al-Jaboul, Al-Mouh, Jyroud and Al-Hyjanah *sabkhas.*
Description:	Perennial, with flowering culms up to 15 cm. Basal leaf-sheaths hairy; leaf-blades of flowering shoots (up to 3 cm), hairy or glabrous, stiff, pointed, more or less spreading. Inflorescence a dense head, globose, ellipsoid or oblong, 0.7-1.5 cm (sometimes up to 2-2.5 cm). Spikelets 4-6 mm, densely aggregated on short branchlets, 4-7 (-11-20)-flowered, rounded at back, villose, membranous-margined. Flowers in summer.
Salt tolerance:	Halophyte, tolerates full- strength seawater and salinities up to 56 dS/m, grows on Mediterranean seawater at Asqalan (Aronson 1989).
Habitat:	Together with *A. littoralis*, is one of the characteristic plants of saline soil in *sabkhas*. Grows in saline soils that are inundated in winter (Fig. 27).
Uses:	Resistant to high salinity (can exude salt on to leaf surface). Grazed by animals despite its high salt content, but limited use as forage due to its stiff leaf blades (see also *A. littoralis*).

Aeluropus littoralis (Goun) Parl.

Family: *: Gramineae* (Poaceae)
Local name: Al-Iqrish العكرش (نجيل شيطاني) مليح
Common name: Iqrish

Fig. 148. *Aeluropus littoralis* at fruiting stage

Fig. 149. *Aeluropus littoralis* adapted to grow in saline soils (Al-Jaboul)

Distribution:	*Aeluropus littoralis* (Fig. 148) is a grass, and a characteristic plant of saline soils of the *sabkhas* and sea-shore.
Description:	Perennial, rhizomatous or stoloniferous, stolon slender, branched, producing sterile leafy shoots and numerous flowering culms up to 30 cm. Basal leaf-sheaths glabrous; leaf-blades of flowering culms up to 5 cm, usually glabrous, lanceolate-acuminate, subulate at apex, stiff, more or less spreading. Panicle 3-10 cm, spike-like, consisting of several spikelet-bearing branchlets, the upper often crowded, the lower usually spaced. Spikelets 3-4 (-5) mm, glabrous, 5-9 (-11) - flowered, ovate-oblong. Glumes subequal, glabrous; lemma 2-3 mm, oblong-lanceolate, abruptly apiculate, membranous-margined, glabrous or very sparsely pilose. Flowers April-July.
Salt tolerance:	Tolerates full-strength sea water and salinities up to 56 dS/m (Aronson 1989).
Habitat:	Hydrohalophyte, occurs in wet sandy areas at the edges of salt flats, marshes and salt deserts. Resistant to high salinity; plants exude salt onto leaf surface.
Uses:	Adapted to saline soil in desert regions (Fig. 149); provides fodder year-round where little else will grow. Foliage shows little variation in salt content despite a three-fold increase in soil salinity in summer, possibly due to salt secretion through leaf glands. The tough, widely spreading rhizomes make it effective as soil stabilizer. Palatable to animals, grazed by sheep, goats and camels despite its salt content. Dry aerial plant parts contain 8.6% protein, 2.4% fat, 17.2% fiber, 29.9% ash and 41.9% NFE (ACSAD 1979).

Agropyron junceum (L.) Beauv. (Syn. *Elytrigia juncea* (L.) Nevski subsp. *juncea*)

Family: *Frankeniaceae*
Local name: Safun, Sayfu سيفون، سفون
Common name: Sea wheat grass

Fig. 150. *Agropyron junceum* at vegetative stage. Right: spike

Fig. 151. *Agropyron junceum* forms a dense community at the seashore

Distribution:	*Agropyron junceum* (Fig. 150) is widely distributed in sandy soils at the seashore (Tartous and Lataqia).
Description:	Perennial, 50-80 cm, with long creeping rhizome. Culms rigid, fairly thick. Leaves usually rolled, rigid, glaucous, with elevated veins. Spike 15-35 cm, erect, 8-12 (-15)-speculate, usually longer than leaves; rachis more or less fragile, breaking at maturity above each spikelet, glabrous at angles. Spikelets 10-25 mm, 5-9- flowered glabrous, appressed to rachis, laterally compressed, awnless. Glumes 10-18 mm, lanceolate to oblong, obtuse, 6-12- veined, asymmetrically keeled, as long as or somewhat shorter than spikelet; lemma 10-20 mm, obtuse, keeled towards apex; palea spinulose-ciliate along keels. Flowers April-June.
Salt tolerance:	Tolerates soil salinity up to 34 dS/m. At many sites, grows vigorously less than 10 m from seawater (Fig. 151). Tolerates salt spray and maritime exposure.
Uses:	Seeds can be ground into flour and used to make bread. Leaves are used for making mats, ropes, paper etc. Often planted near the coast to stabilize sand dunes. Also used as a source of salt tolerance genes for wheat.

Ammophila arenaria (L.) Link.

Family: *Garmineae* (Poaceae)
Local name: Qasab el-Remaal قصب الرمال
Common name: Marram grass

Fig. 152. *Ammophila arenaria* at flowering stage

Distribution:	*Amophila arenaria* (Fig. 152) is widely distributed in sandy soils at the seashore.
Description:	Perennial, 50-120 cm. Rhizome creeping, stout, branched. Leaf-blades rigid, pungent, involute; sheaths ribbed; ligule membranous, 2-fid, 1-2.5 cm. Panicle 7-25 × 1.5-2.5 cm, cylindrical, straw-colored; branches erect. Spikelets 10-12 mm. Glumes persistent, lanceolate, usually acute, about as long as lemma; lemma 8-12 mm, lanceolate, with a short rigid awn in the sinus; hairs of callus 3-5 mm. Flowers March-August.
Salt tolerance:	Tolerates sea-shore conditions, and (by implication) salt spray and maritime exposure.
Habitat:	Psammophile, found in sandy seashore areas. It can grow in nutritionally poor soils.
Uses:	Extensive root system, grows naturally in coastal sand dunes, important for binding the dunes and therefore allowing other plants to grow. Widely planted in sand dunes and similar habitats for erosion control (Huxley 1992). Flowering stems and leaves used for thatching, in basketry, and making brooms (Usher 1974). Rhizomes used for making rope and mats. Fiber obtained from the stems is used for making a tan-brown paper (Bell 1981).

Arundo donax L.

Family: *Gramineae* (Poaceae)
Local name: Al-Zall الزّل (القصب)
Common name: Giant reed, Spanish cane

Fig. 153. *Arundo donax* at flowering stage (Jyroud *sabkha*)

Distribution:	*Arundo donax* (Fig. 153) is widely distributed at Al-Jaboul and the seashore, while it is rare at Al-Mouh and Jyroud *sabkhas.*
Description:	Perennial grass, with thick, short, branched rhizomes; culms up to 6 m tall, arising from large knotty creeping rootstock, terete, 2-4 cm in diameter, smooth, hollow, reed-like, many-noded. Leaves numerous, blades flat, smooth, 30-70 cm long, 2-7.5 cm broad on main stem. Leaf-sheaths tightly cordate-clasping, hairy tufted at base; spikelets 8-16 mm long, 2-7 flowered; florets all bisexual except the reduced uppermost one; glumes equal, narrowly lanceolate, acuminate, 3-nerved, slightly longer than florets; lemmas lanceolate, 7-10 mm long, 3-5-veined with shorter veinlets between, 2-toothed at apex, with long white hairs on back; awn between the teeth at apex, 1-3 mm long, slender, erect; callus small, broadly ovate, with short hairs 1.5-2 mm long on both sides; palea one-half to two-thirds as long as lemma; anthers 2.5-3 mm long. Flowers August-November.
Salt tolerance:	Halophyte species (Fegler and Mota-Urbina 1982). Similar to Phragmites and takes over its habitat (Fegler and Mose 1985, Fegler and Mota-Urbina 1982). Can tolerate salinity up to 10,000 ppm, reportedly up to 40.6 dS/m (Aronson 1989). Great variability among different populations. Some populations grow in Al-Jaboul in highly saline soils (Fig. 154).

Fig. 154. *Arundo donax* in saline soil at Al-Jaboul

Habitat:	Native to the Circum Mediterranean area and to the Lower Himalayas from Kashmir to Nepal and Assam. Has been introduced to many subtropical and warm temperate regions as an ornamental plant, often found as a stray from cultivation. Adapted to tropical, subtropical and warm climates. Often found on sand dunes near the seashore. Grows best along river banks and in other wet places, best developed in poor sandy soils and in sunny situations. Tolerates all types of soils, from heavy clays to loose sands and gravely soils (Duke 1975, 1979).
Uses:	The stems serve as support for vines and similar climbing plants. Used for making trellises, and for climbing cultivated plants. Also used to make fishing poles, musical instruments, baskets and mats. Makes good quality paper, used in Italy in the manufacture of rayon. Because of its high yields from natural stands, potential for cultivation for biomass for energy. As fodder, only the young leaves are browsed; the stems are woody, and the grass unpalatable in later stages (Gohl 1981). The dry green roughage contains 6.9 % protein, 1.3% fat, 37.5% fiber, 9.2% ash and 45.1% NFE (Miller 1958). Dry cane yields of 10-20 t/ha depending on soil fertility. Brooms are made from the terminal panicles (Huxley 1992). Plants are grown alongside irrigation canals to check soil erosion (Uphof 1959). Can be grown as a windbreak. Leaves can be woven into mats etc, split and flattened stems are used to make screens, walls of houses etc (Uphof 1959). A yellow dye is obtained from the pollen (Moerman 1998).
Medicinal uses:	The root is diaphoretic, diuretic, emollient and galactogogue (Al-Oudat and Laham 1994). An infusion stimulates menstrual discharge and diminishes milk flow (Chopra et al. 1986). Isolated alkaloids have been experimentally shown to raise blood pressure and contract the intestine and uterus (Chopra et al. 1986). The rhizome or rootstock is used to treat dropsy. Boiled in wine with honey, the root or rhizome has been used for treating cancer (Chopra et al. 1986). Contains alpha-amyrin acetate, bufotenine, bufotenidine, campesterol, dehydro-bufotenine, N-dimethyltryptamine, donaxerin, friedelin, gramine, gramine methohydroxide, lupeol (anticancer), 5-metlioxy-N-methyl-tryptamine, sitosterol (antitumor), stigmasterol, triacontane and triacontanol (Chopra et al. 1986).

Cynodon dactylon (L.) Pers.

Family: *Gramineae* (Poaceae)
Local name: Shirsh el-Enjil, Irq el-Enjhl النجيل، شرش الانجيل
Common name: Bermuda grass

Fig. 155. *Cynodon dactylon* at flowering stage

Distribution:	*Cynodon dactylon* (Fig. 155) is widely distributed along the seashore and in *sabkhas.*
Description:	Perennial, creeping by scaly, whitish rhizomes and by strong flat stolons, that lie on the surface of the ground. Both rhizomes and stolons grow rapidly, roots readily at the nods. Culms erect, 10-40 cm, leafy. Leaf blade dark green 2.5-10 cm. Inflorescence of 3-6 digitate slender spikes 3-5 cm long. Spikelets arranged in two rows on one side of the axis. Flowering most of the year.
Salt tolerance:	Can survive salinities above 10,000 ppm (17 dS/m), but this tolerance reduces its growth.
Habitat:	Prefers light (sandy) and medium (loamy) soils, requires well-drained soils and can grow in heavy clay and nutritionally poor soils. Requires moist soil and can grow in very alkaline and saline soils.
Uses:	High palatability, eaten by sheep and goats throughout the growing season. Reported to cause photosensitizing in animals, dermatitis and hay fever in human beings, because it contains hydrocyanic acid. However, analyses of plants in Syria show that they do not contain such substances (AOAD 1998).

<table>
<tr><td>Feed composition:</td><td>Composition (%) of aerial parts of Cynodon dactylon (ACSAD 1979, Sankary 1981).

<table>
<tr><th>Stage</th><th>Protein</th><th>Fat</th><th>Fiber</th><th>Ash</th><th>N.F.E</th></tr>
<tr><td>Maturity</td><td>7.0</td><td>3.1</td><td>31.7</td><td>14.7</td><td>43.5</td></tr>
<tr><td>Late vegetative</td><td>11.0</td><td>2.2</td><td>21.5</td><td>20.9</td><td>44.4</td></tr>
<tr><td>Mid bloom</td><td>6.4</td><td>1.2</td><td>27.2</td><td>5.7</td><td>59.5</td></tr>
</table></td></tr>
<tr><td>Uses:</td><td>Cynodon dactylon is reported to be astringent and diuretic. The decoction of the root is used as a diuretic and in treatment of dropsy and secondary syphilis (Chopra et al. 1986). An infusion of the roots is used to stop bleeding from piles, to treat leprosy, scabies and skin diseases (Arshad and Rao 1998, Suwal 1993). Extracted juice of the plant is used in the treatment of hysteria, epilepsy, chronic diarrhea and dysentery. The plant is a folk remedy for tumour, cough, headache and hypertension. The plant contains triterpines, flavones, tricin and minerals (Arshad and Rao 1998).

Sometimes grown as a cover for warm sunny banks, or used for lawns. Stays green even in hot dry weather. Plants succeed on most soil types and give complete ground cover in 4-8 weeks when planted 30-45 cm apart. Valuable for soil conservation due to its long runners that root at the nodes. The plants are used to produce biomass (Huxley 1992).</td></tr>
</table>

Hyparrhenia hirta (L.) Stapf.

Family: *Gramineae* (Poaceae)
Local name: Al-Hamrour الحمرور
Common name: Bluestem, Coolatai grass

Fig. 156. *Hyparrhenia hirta* at flowering stage

Distribution:	*Hyparrhenia hirta* (Fig. 156) is widely distributed at the seashore at Tartous, Lattakia and Banias.
Description:	Perennial, 40-100 cm, densely tufted, coarse. Culms slender, wiry, glabrous, sometimes fastigiate, passing into a panicle subtended by a spathe. Leaf-blades narrow, with a whitish midvein and with a few scattered long tubercle-based hairs above ligule; cauline leaves usually rolled or folded, attenuate above to a fine point; ligule oblong. Panicle 10-40 cm, spatheoles turning pale reddish, acuminate, usually glabrous. Racemes 2-3 cm (excluding awns), slightly diverging, not deflexed, oblong, flattened, often purplish. Sessile spikelets 6 mm, linear-oblong reddish. Lower glume 9-11-veined, upper glume 3-veined, lower lemma about as long as glumes; upper lemma narrowly linear, hyaline, with 2 short lobes; awn 1.5-3.5 cm, slightly geniculate and twisted; column appressed-hairy. Pedicellate spikelets 7 mm. Flowers February-June.

Fig. 157. *Hyparrhenia hirta* growns on hard stony soil at the seashore

Salt tolerance:	Salt tolerant species. Found at the seashore, with maritime exposure at some sites.
Habitat:	Drought tolerant, and it tolerates a range of soil types including dry, hard rocky and deep sandy soils. Can establish on hard stony soils and eroded lands. The prominent species on some stony hillsides north of Lataquia (Fig. 157).
Uses:	Medium palatability; dry aerial parts contain 3.2% protein, 1.8% fat, 38.1% fiber, 12.3% ash and 45.6% NFE (Karue 1974). Valuable fodder grass when young; also used for thatching, mat weaving and baskets. In South Africa and the USA, recognized as a useful conservation grass on hard stony soil and as a pioneer in vegetating areas.

Polypogon monspeliensis (L.) Desf.

Family: *: Gramineae* (Poaceae)
Local name: Thail Al-quot ذيل القط، ذيل الثعلب
Common name: Rabbit's foot, Beard grass


Fig. 158. *Polypogon monspeliensis* at flowering stage. Right: flowers

Distribution:	*Polypogon monspeliensis* (Fig. 158) grows naturally in damp brackish pastures, salt marshes along the coasts, and on waste land and rubbish tips near ports.
Description:	Annual, (10-) 20-80 cm, height varying with soil moisture. Panicle 2-15 × 1.5-3 cm (including awns), dense, very soft-bristly, oblong to ovoid, sometimes lobed, much branched; pedicels of spikelets jointed at or above middle. Spikelets 2-3 mm (excluding awns), falling at maturity with thickened upper part of pedicel (callus). Glumes membranous, obtuse, emarginated at apex, ciliolate at margin, scabridulous, awn about 3 times as long as glume proper, arising from sinus Just below apex; lemma half the length of glume, short-awned; awn fragile. Flowers March-June.
Salt tolerance:	Salt-tolerant. It grows in Al-Jaboul on soil with salinity > 10-15 dS/m. Ubiquitous, often considered a weed. It has many tiny seeds that are easily spread. Occurs in diverse habitats, suggesting that its salt tolerance may be a response to selection pressure (Wiggins 1980).
Habitat:	Prefers sandy and loamy moist soils, can grow on alkaline and saline soils.
Uses:	Palatable forage at vegetative stage. It is a heavy seed producer; seeds are eaten by birds. Occasionally cultivated in gardens for its attractive silky panicles. The compact silky inflorescence is used in fresh and dried flower arrangements (Huxley 1992). An infusion of the plant ashes has been used to treat heart palpitations (Moerman 1998).

Puccinellia distans (L.) parl.

Family: *Gramineae* (Poaceae)
Local name: Buccinella البوكسينيلا
Common name: Alkali grass, Sea grass

Fig. 159. *Puccinellia distans* at flowering stage

Fig. 160. *Puccinellia distans* forms a dense community on the seashore

Distribution:	*Puccinellia distans* (Fig. 159) is distributed in salt marshes at the seashore.
Description:	Perennial, tufted up to 80 cm. Leaf-blades folded; ligule membranous, ovate. Panicle 15-30 cm, broadly pyramidal, erect; branches 5-6 at lower nodes of rachis, spreading at anthesis, naked in their part. Spikelets 4-7 ×1.5 mm, oblong, 4-7-flowered, shortly pedicellate. Glumes very unequal, broadly membranous-margined, ovate obtuse to truncate; lemma 2.5-3 mm, glabrous or slightly hairy near base, obsoletely veined. Flowers April-June.
Salt tolerance:	Halophyte, tolerates full-strength seawater. Grows in waterlogged soils with salinity values in the range of 10-40 dS/m. The most salt tolerant of all commercially available grasses, no significant loss of production even at high salinity levels. Forms dense communities on the sea-shore in Lattakia (Fig. 160).
Habitat:	Salt marshes and maritime sand along the seashore.
Uses:	Used to stabilize and reclaim land along the seashore. Good livestock feed, with high protein (10-18%) and digestibility (60-78%), and low salt content.

Sphenopus divaricatus (Gouan) Reichb.

Family: *Gramineae* (Poaceae)
Local name: Hachechet tadmyr
Common name: Sphenopus

Fig. 161. *Sphenopus divaricatus* at flowering stage

Fig. 162. *Sphenopus divaricatus* grows in the *Arthrocnemum-Salicornia* community

Distribution:	Dainty annual, up to 30 cm. Leaf blades short. Culms smooth and glabrous, with dark nodes. Panicle 6 × 4 cm; branches in pairs at each node of rachis, di- and trichotomously branched. Spikelets 2 (-2.5) mm. Lower glume minute, veinless; the upper longer, veinless or with 1-3 short veins; lemma obtuse. Flowers March-May (Figs. 161-162).
Salt tolerance:	Salt tolerant (Aronson 1989). Found at Al-Jaboul in soils with salinity up to 20-25 dS/m.
Habitat:	A species of open habitat. Grows on saline soils, maritime sand and salt swamps.

Sporobolus arenarius (Goun) Duv- Jouve.

Family: *Gramineae* (Poaceae)
Local name: Malhi مالحي
Common name: Drop seed

Fig. 163. *Sporobolus arenarius* at flowering stage

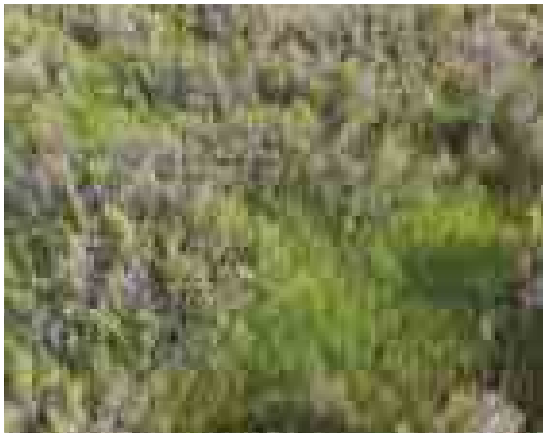

Fig. 164. *Sporobouls arenarius* in a seashore salt marsh together with *Arthocnemum macrostachyum*

Distribution:	*Sporobolus arenarius* (Fig. 163) is distributed in sandy soils along the seashore and inland *sabkhas.*
Description:	Perennial, 20-50 cm, with creeping rhizome. Culms numerous, ascending, simple or branched from lower nodes, densely distichously leafy. Leaves rigid; leaf-sheaths imbricate, bearded at mouth; blades rolled when dry, hairy on adaxial surface, ending in a pungent point. Panicle 3-5 (-6) × 1-1.5 cm, oblong- ovate in outline, partly enclosed by uppermost leaf. Spikelets 2.5-3 mm, glabrous, shortly pedicellate. Glumes unequal, lanceolate, subacute; lower glume shorter and narrower than the upper; upper glume nearly as long as lemma; lemma and palea similar in texture and length. Flowers June-October.
Salt tolerance:	Halophyte, tolerates brackish to full-strength seawater (35 g/l). Found in salt marshes at the seashore. Studies in the UAE report normal growth of Sporobolus when irrigated with saline water up to 20 g/l.
Habitat:	Grows vigorously in sandy to loamy and muddy soils and in brackish and saline marshes at the seashore with frequent maritime exposure (Fig. 164).
Uses:	A drought-tolerant grass, provides good forage for livestock. Dry aerial parts at early bloom contain 7.5% protein, 0.5% fat, 48.8% fiber, 7.6% ash and 35.6% NFE (ACSAD 1979). Some species of Sporobolus including S. arenarius are being cultivated for fodder and used for rehabilitation of degraded pasture and soil stabilization in salt-affected deserts.

Juncus acutus L.

Family: Juncaceae
Local name: Al-Assel سمار، أسل، بوط
Common name: Sea Rush

Fig. 165. *Juncus acutus* at fruiting stage

Fig. 166. *Juncus acutus* community at a marsh near the seashore

Distribution:	*Juncus acutus* (Fig. 165) is widely distributed in saline marshes near the seashore.
Description:	Perennial, 50-150 cm, dark green, in large dense more or less round tufts 0.5-1 m in diameter, forming no creeping rhizomes. Stems numerous, rigid, erect, terete; pith continuous. Leaf-sheaths brown; blades terete, pungent, not septate, usually shorter than stems. Inflorescence pseudolateral, many-flowered varying in shape and length, compact and short, or lax and elongated, with more or less spreading branches. Lower involucral bract dilated at base, subulate and strongly pungent, shorter to longer than inflorescence. Flowers aggregated in few-flowered clusters, each cluster subtended by several scarious bracts. Perianth segments brown-maroon, hyalinemargined; the outer nearly boat-shaped, obtuse or acute, short-mucronate; the inner flat, oblong, truncate and retuse, hyaline-margined; the hyaline margin much broadened towards apex, forming auricles. Stamens 6, capsule hard, brown to maroon, glossy, acute, mucronate, much varying in size and shape. Seeds caudate. Flowers April-September.
Salt tolerance:	Hydrohalophyte, occurs in salt marshes at the sea-shore. Tolerates full-strength seawater and salinities up to 56 dS/m. Forms dense communities at the seashore (Fig. 166).
Habitat and uses:	See *Juncus maritimus*

Juncus arabicus (Aschers and Bunhenau)

Family: Juncaceae
Local name: Al-Assel الأسل، سمار الحصر
Common name: Sea Rush

Fig. 167. *Juncus arabicus* at fruiting stage

Distribution:	*Juncus arabicus* (Fig. 167) is widely distributed in saline soils and marshes near the seashore.
Description:	Perennial, 75-150 cm, growing in large tufts. Stems numerous; pith continuous. Leaf sheaths brown; blades terete, not septate, pungent. Inflorescence pseudolateral, many-flowered, up to 35 cm, narrow, with more or less erect branches. Involucral bracts 2; the lower subulate, pungent, shorter to longer than inflorescence. Flowers aggregated in few-flowered clusters. Perianth-segments straw-coloured; the outer somewhat longer, boat-shaped, narrowly ovate, obtuse or acute, often mucronate; the inner flat, oblong, rounded and narrowly hyaline-margined at apex. Stamens 6; anthers 3-5 times as long as filaments. Capsule 3.5-5 × 1.5-1.75 (-2) mm, oblong-ovoid, tapering towards apex in its upper 1/3, or more, yellow to pale brown. Seeds caudate, with equal or unequal appendages. Flowers March-December.
Salt tolerance:	Halophyte, tolerates full-strength seawater.
Habitat:	Hydrohalophyte, occurs in salt marshes at the seashore, with maritime exposure.
Uses:	See *Juncus maritimus*

Juncus maritimus Lam.

Family: Juncaceae
Local name: Al-Assel, Al-Sammar الأسل – السّمار
Common name: Sea Rush

Fig. 168. *Juncus maritimus* at fruiting stage (seashore)

Distribution:	*Juncus maritimus* (Fig. 168) is found at the seashore and at Al-Hyjanah, Al-Mouh and Jyroud *sabkhas* (Fig. 169). It prefers moist and saline environments, especially sandy soils.
Description:	Perennial, 50-100 cm. Stems numerous, in rows along horizontal creeping rhizomes; pith continuous. Leaf-sheath brown; blades terete, not septate, pungent. Inflorescence pseudolateral, many-flowered, with more or less erect branches. Lower involucral bract subulate, pungent, shorter to longer than inflorescence. Flowers aggregated in few-flowered heads. Perianth segments straw-coloured; outer segments somewhat longer, boat-shaped, ovate, acute, short-mucronate; inner segments flat, oblong, rounded and narrowly hyaline- margined at apex. Stamens 6, rarely 3; anthers about twice as long as filaments. Capsule 2.5-3.5 (-4)×1.8-2 mm, broadly ellipsoid to ovoid, mucronate, as long as or slightly longer than perianth, yellow to pale brown. Seeds caudate, with long or short appendages. Flowers June-September.

Fig. 169. *Juncus maritimus* in saline sandy soil at Jyroud

Salt tolerance:	Hydrohalophyte, tolerates full-strength seawater and salinities up to 77 dS/m. Grows in Mediterranean seawater at Asqalan (Aronson 1989).
Habitat:	Prefers light (sandy) and medium (loamy) soils, and can grow in saline conditions. Requires moist or wet soils and can grow in water, but can withstand periods of drought.
Uses:	Usually unpalatable for cattle, but grazed by goats when palatable plants are not available. Fresh aerial parts contain 9% water, 8.6% protein, 1.7% fat, 32% fiber, 11.9% ash and 37.2% NFE (ACSAD 1979). Various conservation uses: erosion control, sediment accretion and stabilization, food and cover for wildlife, wastewater treatment application (the rhizomes form a matrix for many beneficial bacteria). Stems used in basket making, thatching, and weaving mats (Usher 1974). Some species of Juncus are cultivated in Japan for weaving latem, the traditional floor covering used in Japanese homes. Dry stems soaked in oil can be used as candles (Usher 1974), and fibers obtained from stems are used for making paper (Uhl 2000). The pith of the stem is antiphlogistic, diuretic, febrifuge, pectoral and sedative (Stuart 1995, Yeung 1985). Used to treat sore throat, jaundice, oedema, and acute urinary tract infection (Yeung 1985).

Alhagi maurorum Medik.

Family: Leguminosae (Papilionaceae)
Local name: Aqoul, Shouk El-Jamal العاقول، شوك الجمل
Common name: Camel Thorn, Manna plant

Fig. 170. *Alhagi maurorum* at flowering stage

Distribution:	*Alhagi maurorum* (Fig. 170) is widely distributed at the peripheries of *sabkhas* and at the seashore.
Description:	Shrubby, perennial, 0.4-1 m. Stems erect to ascending, much branched, with short, spinescent twigs. Leaves 1-2 cm, oblong to obovate. Flowers 1-1.2 cm, axillary, on spiny twigs, purple. Pod 1.2-2.5 cm linear-cylindrical, 2-8 seeded, often constricted between seeds. Flowers April-August.
Salt tolerance:	Salt tolerant (Aronson 1989). Grows at Jyroud and Al-Mouh *sabkhas* in soil with salinity > 10 dS/m.
Habitat:	Noxious weed, occurs in deep alluvial soils, grows best in alkaline soils, tolerates saline soil. Limited mainly to the plains and valleys. Occurs as a weed in arid to semi-arid areas particularly where subsoil moisture is high, also grows well under irrigation. Found mostly in pastures and neglected areas. Deep-rooted, rhizomatous, with roots that can extend 3 to 5 m into the ground. Because of its deep root system, grows successfully in dry saline soil. Spreads by seeds and rhizomes.

Uses:	Unpalatable and injurious to some animals, but eaten by goats and camels and stored as fodder in Central Asia. The whole plant is used as diaphoretic, diuretic, expectorant, antibacterial, cholagogue, hemostatic and anti-inflammatory. Oil from the leaves is used to treat rheumatism, flowers used to treat piles (Bown 1995). The plant contains volatile oil, vitamin K, A, C, B, coumarin, catechin, flavonoids and organic acids (Al-Oudat and Laham 1994, Tyrova 1974). A sweet-tasting Manna is exuded from the twigs at flowering time. It contains about 47% melizitose, 26% sucrose, 12% invert sugar. The Manna obtained from pods is sweet and laxative. (Huxley 1992, Usher 1974).

Astragalus squarrosus Bunge.

Family: Leguminosae (Fabaceae)
Local name: Al-Qatad Al-Melhi القتاد الملحي
Common name: Astraglus squarrosus

Fig. 171. *Astragalus squarrosus* at fruiting stage

Distribution:	*Astragalus squarrosus* (Fig. 171) widely distributed in Jyroud, Al-Hyjanah and Al-Mouh *sabkhas.*
Description:	Perennial, woody, stems intricately branched, erect, up to 30-50 cm, older stems greyish, younger stems grey-green. Whole plant covered with fine white hair. Leaves with 3 leaflets, 0.2 x 0.6 cm each, oval with pointed tips. Flowers on terminal spikes, without stalk, pink with darker veins, to 1 cm long. Calyx as long as flower, brownish, hairy. Pods egg-shaped 1 cm long, with long white hairs, hair-like appendage from pointed tip, two bracts persisting like spread wings. Flowers April-May.
Salt tolerance:	Salt tolerant. Grows in Jyroud, Al-Hyjanah and Al-Mouh *sabkhas*, under soil salinity of 10-14 dS/m.
Uses:	Medium palatability, eaten by sheep, goats and camels.

Glycyrrhiza glabra L.

Family: Leguminosae (Fabaceae)
Local name: Iriq es-Sus عرق السوس
Common name: Liquorice

Fig. 172. *Glycyrrhiza glabra* at flowering stage. Inset: fruits

Distribution:	*Glycyrrhiza glabra* (Fig. 172) is widely distributed especially on river banks and swamps, and is found in saline soil at Jyroud *sabkha*, between the phytogenic mounds formed by *Halocnemum* or *Nitarria.*
Description:	Erect perennial herb, viscid, 50-100 cm. Stems many, sparingly branching. Leaves 5-15 cm; stipules oblong, hairy, mostly inconspicuous; leaflets 4-8 pairs, 3-5 × 1-2 cm., oblong-elliptical, acute or obtuse, viscid beneath. Racemes shorter than or as long as subtending leaves, loose, cylindrical. Flowers 1 cm. Calyx teeth often longer than tube, equal, linear-or triangular-lanceolate. Corolla blue or violet with whitish standard. Ovary glabrous or glandular- hairy. Pod (1-) 2-3×0.4-0.7 cm, flattened, oblong to linear, glabrous or sparsely or densely glandular, (1-) 2- to many seeded. Flowers May-October.

Fig. 173. *Glycyrrhiza glabra* in saline-sandy soil in Jyroud *sabkha*

Salt tolerance:	Salt tolerant (Aronson 1989). Grows in Jyroud in in sandy soil with salinity > 10 dS/m (Fig. 173).
Habitat:	Grows well in deep sandy or loamy soils; prefers neutral or alkaline soils and can grow in salty soils (Aronson 1989). Extensive root system with a main tap root and numerous runners. The main taproot, which is harvested for medicinal uses is soft, fibrous, with a bright yellow interior. Fixes atmospheric nitrogen.
Uses:	Not palatable to animals. Aerial parts at flowering stage contain 9.8% protein, 6.3% fat, 41.3% fiber, 5.5% ash and 37.1% NFE (ACSAD 1979). Widely known medicinal plant in ancient history, mentioned in Assyrian tablets of 2000 BC. Various properties attributed, including that of quenching thirst if one holds it in the mouth (Bondarenko 1992). The roots contain glycyrrhizin, which is 50 times sweeter than sucrose, and has a cortisone-like effect. Roots contain also flavonoids, asparagin, isoflavonoids, and chalcones (Lange 1998). Used traditionally to relieve cough and sore throats, and against gastric inflammation. They are antispasmodic, demulcent, diuretic, expectorant, laxative and tonic, and have a hormonal effect similar to ovarian hormone (Chiej 1984). Used in the treatment of Addison's disease, asthma, and bronchitis. In European folk medicine, used to treat gastric ulcers. Can be safely taken by diabetic patients. Extracts from the roots are used as a foaming agent in beers and fire extinguishers. The fibers can be used, after removing the medicinal and flavoring constituents, for insulation, wallboard, boxboard etc (Bown 1995). The roots are used as a flavoring agent in sweets and tobacco.
Caution:	Due to its cortisone-like action it should not be used continuously. Sustained doses could lead to high blood pressure and oedema. Should be avoided during pregnancy, and by those with high blood pressure, inflammation or cirrhosis of the liver, or potassium deficiency.

Lotus corniculatus maritimus Clavaud.

Family: Leguminosae (Fabaceae)
Local name: Qeren el-Ghazal قرن الغزال (لوطس قريني)
Common name: Birdsfoot trefoil

Fig. 174. *Lotus corniculatus maritimus* flowers and fruits

Distribution:	*Lotus corniculatus maritimus* (Fig. 174) is widely distributed near the seashore.
Description:	Perennial, 20-40 cm. Stems prostrate or ascending, much branching. Leaflets obovate lower pair a little shorter than others. Racemes 2-5 flowered and corolla yellow. Pod cylindrical, 2-4 cm long. Flowers February-March.
Salt tolerance:	Salt tolerance up to 10-12 dS/m. In some seashore sites, grows together with *Inula crithmoides* (Fig. 175) and can tolerate maritime exposure. Some species of *Lotus* including *L. cytisoides* has been trialed at Asqalan on diluted Mediterranean seawater (Aronson 1989).
Habitat:	Psammophile, occurs in sandy seashore areas especially in Lataqia and Raas-Shamra. Can grow in nutritionally poor soils.

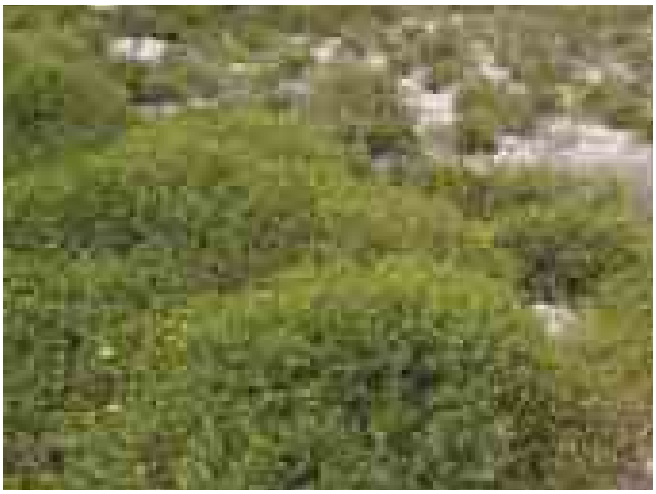

Fig. 175. *Lotus corniculatus maritimus* grows together with *Inula crithmoides*

Uses:	All parts of the plant contain hydrogen cyanide (cyanogenic glucosides). In small quantities it improves digestion; also beneficial in the treatment of cancer. In excess, it can cause respiratory failure and even death. Completely safe when dried (Duke and Ayensu 1985). The plant is used in folk medicine as carminative, febrifuge, hypoglycaemic and vermifuge. Flowers are antispasmodic, cardiotonic and sedative (Chiej 1984). The plant is used externally as a local anti-inflammatory compress in cases of skin inflammation (Chiej 1984). An orange-yellow dye is obtained from the flowers.

Medicago littoralis Rhode ex Loisel.

Family: Leguminosae (Fabaceae)
Local name: Nafel النفل الشاطئي
Common name: Medick

Fig. 176. *Medicago littoralis* at flowering stage

Distribution:	*Medicago littoralis* (Fig. 176) is widely distributed on coastal sand.
Description:	Annual, hairy, 7-15 cm. Stems procumbent, branching from base. Stipules lanceolate, dentate to laciniate; leaflets 3-8 × 2-7 mm, obovate to obcordate, rounded or truncate at apex, mucronulate, serrate above, pubescent on either side. Peduncles about as long as petiole, aristate at tip. Racemes 1-3-flowered. Flowers 3-6 mm. Calyx short-toothed, hairy. Corolla about twice as long as calyx, standard longer than keel and wings. Pod 0.3-1 cm. Thick, cylindrical or discoid, flat at both ends, glabrous, spiny (with spines varying from very short to longer than radius of coil) or tuberculate, rarely smooth. Seeds 1-2 in each coil, 2-3.5 mm, yellow, smooth; radicle less than half as long as cotyledons. Flowers February-May.
Salt tolerance and uses:	See *Medicago marina*.

Medicago marina L.

Family: Leguminosae (Fabaceae)
Local name: Nafel Bahri النفل البحري
Common name: Sea alfalfa

Fig. 177. *Medicago marina* at flowering stage

Distribution:	*Medicago marina* (Fig. 177) is widely distributed on coastal sands. It is the dominant species in the community *of Euphorbia paralias – Eryngium maritimum.*
Description:	Perennial, woolly-canescent, 10-20 cm. Stems ascending to prostrate. Stipules ovate-lanceolate, nearly entire; leaflets 0.8-1.5×0.5-0.8 cm, obovate-cuneate, obtuse, mucronulate, denate above, tomentose. Peduncles nearly as long as subtending leaves. Racemes 5-12 (-14)-flowered. Pedicels as long as filiform bracts. Flowers about 0.7-1 cm. Calyx canescent; teeth longer than tube. Corolla twice as long as calyx, yellow. Pod 5-6 mm. across, discoid or cylindrical, truncate on both ends. Seed 1 in each coil, 3× 2 mm, reniform, brown. Flowers February-June.
Salt tolerance:	Salt-tolerant; tolerates salinities up to 20 dS/m, also tolerates maritime exposure.
Habitat:	Psamophile, occurs in sandy seashore areas.
Uses:	Contains saponin-like substances (Foster and Duke 1990), making it poisonous to livestock. Eating large quantities of the leaves may cause break down of red blood cells (Foster and Duke 1990). The fresh leaves contain up to 6% protein, 0.4% fat, 9.5% fibre and 1.4% ash (Duke and Ayensu 1985).

Acacia cyanophylla Lindley
(Syn. *A. salign* (Labill) H. Wandl.

Family: Mimosaceae
Local name: Al-Sant al-Azraq السنط الأزرق
Common name: Blue-leafed wattke

Fig. 178. *Acacia cyanophylla* at flowering stage

Distribution:	*Acacia cyanophylla* (Fig. 178) is widely distributed on sandy soils of the seashore, where it grows together with *Tamarix* and *Halocnemum macrostachyum.*
Description:	Dense, multi-stemmed, thornless, spreading shrub or single-stemmed small tree up to 9 m in height. The bark is smooth and grey to red-brown on branchlets. Young plants become dark grey and fissured with age. Dark green to blue-green phyllodes with conspicuous midribs are long and narrow to lanceolate and 8-25 cm long. Flower heads globular, containing 25-55 (up to 78) bright yellow, five-parted flowers. Pods narrow, 4-6 mm wide, usually 8-12 cm long. Seed 5-6 mm long x 3-3.5 mm wide, dark brown to black and shiny. Flowers April-May.
Salt tolerance:	Salt-tolerance varies with ecotype, generally withstands root zone salinities from 9 to 33 dS/m. Some populations found at the seashore in contact with seawater.

Habitat:	Native to South-Western Australia, naturalized in parts of North Africa and the Middle East, where the mean annual rainfall is > 300 mm. Sensitive to frost, severely damaged if temperature falls below −4°C. Fast growing and tolerates a wide range of soils, including calcareous and saline soils.
Uses:	Planted in North Africa and the Middle East for fodder, fuelwood, sand stabilization, and as a windbreak. In Australia, used as an ornamental plant, but is being increasingly planted for fodder production and soil conservation. The wood is used as fuel and charcoal and for vine stakes and small agricultural implements (Michaelides 1979). The phyllodes, young shoots, pods and seeds, whether fresh or dry, are protein rich, non-toxic and palatable to sheep and goats (Michaelides 1979), although some studies uggest otherwise (Woodward and Reed 1989). Especially valuable in the dry season, when forage is scarce. Chemical composition: dry matter 50-55%, crude protein 12-16%, crude fiber 20-24%, crude fat 6-9% and ash 10- 12%. Rich in tanin (Turnbull 1987). Used extensively to sablize coastal sand dunes in North Africa, the Middle East, and South Africa and for gully erosion control in Uruguay. In Australia, it has been used to rehabilitate sand mining areas (Hall and Turnbull 1976). Widely planted as an ornamental tree. Trees were planted in the past for tannin production from the bark (Hall and Turnbull 1976). The damaged bark exudes copious amounts of a highly acidic gum that has potential use for pickles and other foodstuffs (Michaelides 1979).

Prosopis farcta (Banks et sol.) Macbride *(Lagonychium farctum)*

Family: Leguminosae (Mimosaceae)
Local name: Khrainebah, Al-Ghaf الخرينيبه، الغاف
Common name: Mesquite bean, Screw bean

Fig. 179. *Prosopis farcta* at fruiting stage

Distribution:	*Prosopis farcta* (Fig. 179) is widely distributed at the along the peripheries of sabkhas, and forms dense communities with *Cynodon dactylon* and *Alhagi maurorum.*
Description:	Perennial dwarf shrub 0.4-1 m, usually branching from the base and propagating by suckers. Roots and rhizomes very long, often reaching 15 m or more. Branches slender, prickly all along. Leaves up to 5 cm, ovate, 2-pinnate with 5-7 pairs of pinnae. Leaflets 10-15 pairs, sub-sessile, oblong. Spikes up to 7 cm. Flowers short-pedicelled, pale yellow. Pods ovoid to ellipsoidal, with spongy mesocarp, dark brown when ripe. Flowers May-August.
Salt tolerance:	Tolerates salinity up to 12 dS/m (Aronson 1989).
Habitat:	Widely distributed in valleys, depressions, cultivated fields, saline soils and around settlements. It is an indicator of shallow groundwater and overgrazing.

Uses:

Reputed to be poisonous, because leaves and seeds contain saponins, which cause dissolution of corpuscles and inflammation of digestive tract (Wahby 1940). All parts of the plant are eaten by camels, while sheep and goats eat only the pods.

Composition (%) of mesquite bean (ACSAD 1979)

	Protein	Fat	Fiber	Ash	N.F.E
Leaves	14.2	4.2	34.0	8.6	39.0
Stems	11.7	2.5	23.6	3.8	58.4

Pods used in folk medicine as an astringent and anti-dysenteric (Zohary and Feinbrun-Dothan 1972). The plants are an astringent, antirheumatic, demulcent and pectoral. Used to treat painful inflammations and scorpion stings (Arshad and Rao 1998).

Another naturalized species, *Prosopis juliflora*, is cultivated in saline soil in the Euphrates basin (Fig. 180).

Fig. 180. *Prosopis juliflora* at vegetative stage

Plantago coronopus L.

Family: Plantaginaceae
Local name: Rabel الربل
Common name: Plantain

Fig. 181. *Plantago coronopus* at flowering stage

Distribution:	*Plantago coronopus* (Fig. 181) is widely distributed in the coastal area, Al-Hyjanah sabkha and in arid regions.
Description:	Annual, 5-20 cm, stem-less, more or less appressed-hairy. Leaves rosulate, narrow oblong-lanceolate to linear-lanceolate. Scape thick, erect or ascending, longer or shorter than leaves. Spikes rigid, very dense, narrowly cylindrical, 3-10 cm. Fruit capsule, 3-5 seeded. Flowers March-April.
Salt tolerance:	Tolerates nearly full-strength seawater (43 dS/m) (Aronson 1989), and can tolerate maritime exposure.
Habitat:	Xerophyte, occurs in arid areas.

Uses:	Plantago species are highly palatable, especially at vegetative and flowering stage. Dry aerial parts of P. coronopus at flowering stage contain 16% protein, 2.5% fat, 17.0% fiber, 9.1% ash and 55.4% NFE (ACSAD 1979). Leaves of Plantago species contain up to 11% mucilage, also contain flavonoids, aucubine vitamins K, C and carotene. The seeds contain up to 30% mucilage, which swells up in the gut (Arab Organization for Agricultural Development 1988, Tanaka 1976). Leaves are bitter and are used for salads. Leaves are antiperiodic and ophthalmic, used as a remedy for ague and sore eyes. (Grieve 1984) Seeds act as a laxative and sooth irritated membranes (Bown 1995), also used in the treatment of diarrhea, and to reduce irritation of hemorrhoids. The jelly-like mucilage produced when plantain seeds are soaked in water has the ability to absorb toxins, it helps to remove toxins from the body and can be used to reduce autotoxicity (Chevallier 1996). The oil in the seed embryo contains 50% linoleic acid and has been used to prevent atherosclerosis. Also effective in reducing blood cholesterol (Chopra et al. 1986).

Plantago maritima L.

Family: Plantaginaceae
Local name: Rabel الربل البحري
Common name: Plantain

Fig. 182. *Plantago maritima* at flowering stage

Distribution:	*Plantago maritima* (Fig. 182) is distributed in the coastal region, and in Al-Hyjanah *sabkha.*
Description:	Perennial herb, 20-25 cm. Stem-less. Leaves rosulate, oblong lanceolate or linear, 10-20cm, 3 to 5 veined. Spikes ovoid to cylindrical, 2-6 cm. long. Stamens yellow. Seeds dark brown. Flowers March-September.
Salt tolerance:	Some populations tolerate salinities up to 43 dS/m. It has been trialed on Mediterranean seawater at Asqalan (Aronson 1989).
Habitat:	Psammophile, occurs in salt marshes.
Uses:	See *Plantago coronopus*.
Notes:	Many other species of *Plantago* including *P. lanceolata* and *P. ovata* are salt tolerant. They tolerate brackish to saline conditions (Duncan 1974).

Limonium Mill. (Statice L.).

Family: Plumbaginaceae
Local name: El-Areal الأريال
Common name: Sea lavender

Distribution:	*Limonium* species are mostly adapted to saline habitats (salt marshes, seashore, and deserts). The centre of diversity of the genus *Limonium* is the Mediterranean region, where *Limonium* species play an important role in coastal ecosystems (Liedo et al. 2003). *Limonium* is an ancient Greek name, probably derived from the word 'meadow'.
Description:	Perennial or annual herbs or shrubs. Leaves usually in a basal rosette. Stems scapiform, simple or repeatedly forked, with reddish-brown scale-like leaves or with 3-5 herbaceous wings and leaf- like appendages. Inflorescence a panicle with terminal one-sided spikes; spikes lax or compact, of 3- bracteate and 1-5-flowered spikletes. Calyx showy, persistent, infundibular, 5-veined, with a scarious, membranous or papery coloured limb. Corolla not conspicuous, divided nearly to base or with a short tube, after flowering crumpled and enclosed within the calyx-tube. Fruit obovoid circumscissile near the apex or rupturing irregularly, rarely dehiscing by valves. According to Mouterde (1970) there are six species in Syria: *L. angustifolium* (Tausch) Degen., *L. globuliferum* (Boiss et Held) O. Kuntz., *L. globuliferum* (Boiss et Held) O. Kuntz., *L. sieberi* (Boiss) O. Kuntz., *L. sinuatum* (L.) Mill. and *L. virgatum* (Willd.) Four.

Limonium angustifolium (Tausch) Degen.

Family: Plumbaginaceae
Local name: El-Areal الأريال
Common name: Sea lavender


Fig. 183. *Limonium angustifalium* at flowering stage. Right: flowers

Distribution:	*Limonium angustifolium* (Fig. 183) is widely distributed on saline soils, and marshes near the seashore.
Description:	Perennial, glabrous, glaucescent, 30-80 cm. Leaves in a basal rosette, 20×3 cm. Flowering stem branched, spikelets 2-3 flowered, flower violate. Flowers August-November.
Salt tolerance:	*Limonium* species are halophytes and drought resistant; tolerate salinities up to full-strength seawater (35 g/l). *L. palmyrense* grows in Al-Mouh *sabkha* on Solonchak soil together with *Halocnemun strobilaceum*. It is a salt-excreting plant.
Habitat:	Many species of Limonium flourish in saline soils, and are common near coasts and in salt marshes. They grow on saline, gypsum and alkaline soils in the continental interiors.
Uses:	*Limonium* species are not palatable, and inedible by sheep or goats. They are some of the best perennials as ornamental plants; can be dried and used for years in permanent flower arrangements. When they used as fresh flowers, they may last only few days before leaf yellowing or *Botrytis* infection occur. *Limonium* flowers keep their color for years, if they were cut and dried when just fully open.

Limonium palmyrense (Post) Dinsm.

Family: Plumbaginaceae
Local name: El-Areal el-Tadmyrii الأريال التدمري
Common name: Lavender

Fig. 184. *Limonium palmyrense* at flowering stage. Inset: flowers

Fig. 185. Salt crystals on leaves of *Limonium palmyrense*

Distribution:	*Limonium palmyrense* (Fig. 184) is widely distributed in Al-Mouh *sabkha.*
Description:	Perennial, glabrous, glaucescent, 30-50 cm. Leaves numerous 1-2 × 0.4-0.8 cm, lancealate, spathulate. Spikes 3-4, spikeletes 1-3 flowered. Corolla pale rose. Flowers July-August.
Salt tolerance and uses:	See *Limonium angustifolium. L. palmyrense* is a salt secreting plant (Fig. 185).

Limonium sieberi (Boiss.) O. Kuntze.

Family: Plumbaginaceae
Local name: El-Areal الأريال
Common name: Lavender

Fig. 186. *Limonium sieberi* at flowering stage. Right: flowers

Distribution:	*Limonium sieberi* (Fig. 186) is widely distributed on saline soils, and marshes near the seashore.
Description:	Perennial, glabrous, glaucescent, 20-60 cm. Leaves numerous in a basal rosette, 1-3 cm long, obovate, spatulate. Spikeletes 1-2 flowered. Flowers violate. Flowers May-November.
Salt tolerance and uses:	See *Limonium angustifolium*

Limonium virgatum (Wild) Four.

Family: *Plumbaginaceae*
Local name: El-Areal الأريال
Common name: Lavender

Fig. 187. *Limonium virgatum* at flowering stage

Distribution:	*Limonium virgatum* (Fig. 187) is widely distributed on saline soils and marshes near the seashore.
Description:	Perennial, glabrous, 30-40 cm. Leaves oblong to lancealate-spathulate, obtuse, spikes 3-4 cm, spikelets 2-4 flowered. Flowers pale violet. Flowers June-October.
Salt tolerance and uses:	See *Limonium angustifolium*.

Polygonum maritimum L.

Family: *Polygonaceae*
Local name: Al-Batbat البطباط البحري
Common name: Sea plantain, Salt marsh plantain

Fig. 188. *Polygonum maritimum* at flowering stage

Distribution:	*Polygonum maritimum* (Fig. 188) is distributed at the seashore (Tartous and Raas Shamra).
Description:	Glabrous, greyish-glaucous perennial, 15-50 cm. Rhizome woody, branching. Stems numerous, usually procumbent, with short internodes and few branches, densely leafy. Leaves 1.5 -3.5 × 0.5-0.8 cm, subsessile, leathery-fleshy, elliptical to lanceolate or oblanceolate, roundish or more or less acute , with revolute margin and prominent nerves; ochreae shorter or longer than internodes, up to 1.5 cm, membranous or silvery- hyaline, dark brown at base, many-nerved, 2-fid, later lacerate. Inflorescences leafy, loose, denser towards apex. Bracts leaf- like, longer than flowers. Flowers 1-4 in axil, short-pedicelled. Perianth about 4 mm, pink or white, greenish at base. Styles 3, very short. Achene 3-4 mm, acute, smooth, dark brown, shining. Flowers May- August.
Salt tolerance:	Salt tolerant (Aronson 1989), and can tolerate maritime exposure.
Habitat:	Psammophile, occurs in sandy seashore areas.

Uses:	Many species of Polygonum can cause photosensitivity in susceptible people. Many species also contain oxalic acid (Bown 1995). Leaves are nutritious and beneficial to eat in moderate quantities; cooking reduce the oxalic acid content. People with a tendency to rheumatism, arthritis, gout, and kidney stones should take special caution before including this plant in their diet. Leaves (fresh weight) contain: 81.6% water, 1.9% protein, 0.3% fat, 10.2% carbohydrate, 3.5% fiber and 3.5% ash (Duke and Ayensu 1985). The plant contain flovonoides, and is rich in vitamins E, C, A, and K. Used to treat dysentery (Chevallier 1996). The whole plant is anthelminitic, astringent, cardiotonic and cholagogue. The juice of the plant is used to stop nose-bleeds and to treat sores (Duke and Ayensu 1985, Grieve 1984).

Ruppia maritima L.

Family: *Ruppiaceae* (*Potamogetonaceae*)
Local name: Hazlol حزلول
Common name: Widgeon grass

Fig. 189. *Ruppia maritima* at flowering stage

Fig. 190. *Ruppia maritima* vigorously grows in the north-east of Al-Jaboul lake

Distribution:	*Ruppia maritima* (Fig. 189) is widely distributed in the shallow water of Al-Jaboul lake, especially in the north-eastern part. It forms a dense plant cover on the soft, muddy sediments; also common in sandy substrates.
Description:	Submerged perennial herb of saline or brackish water. Stem elongate, slender. Leaves linear to filiform, alternate, and simple. Flowers small in 2-flowered spikes. Peduncles are recurved after anthesis, do not exceed 6 cm and are not spirally coiled in fruit. Pollination often occurs underwater or at the water surface. Fruit dark colored, egg to pear-shaped.
Salt tolerance:	Can tolerate salinities exceeding that of seawater (35,000 ppm) (Fegler and Mota-Urbina 1982).
Habitat:	Aquatic hydrohalophyte, occurs in saline marshes, saline lagoons, saline springs, and shallow brackish ponds. Grows vigorously in parts of Al-Jaboul lake, forming dense vegetation especially where *Scirpus litoralis* also occurs (Fig. 190).
Uses:	Very high growth rate and biomass production; good potential as a feed. Provides cover and food for many aquatic species. All plant parts are eaten by waterfowl (over 5000 seeds were found in one duck). Contains more protein, carbohydrate and minerals than other aquatic plants, but nutritional value can vary seasonally. Occurs typically in a substratum of mud-silt mixture. Aids in binding sediment and reducing erosion, hence often used for habitat rehabilitation. Also used in wastewater treatment applications.

Solanum elaeagnifolium Cav.

Family: *Solanaceae*
Local name: Bathenjan barii باذنجان بري
Common name: Silverleaf nightshade

Fig. 191. *Solanum elaeagnifolium* at flowering stage

Distribution:	*Solanum elaeagnifolium* (Fig. 191) originated in North and South America and is now considered a weed in many temperate regions. It is found at the peripheries of Al-Mouh *sabkha.*
Description:	Perennial herb or chamaephyte, 40-60 cm, erect, spreadingly branched, canescent, stellate-tomentose and mostly bearing weak straight reddish-yellow prickles on various parts, especially on older stems. Leaves petiolate, oblong, more or less entire; lower leaves usually sinuate-lobed, olive-green on the upper face, whitish on the lower (resembling leaves of Elaeagnus); petiole and midvein sometimes aculeate. Flowers in terminal cymes; pedicels erect in flower, nodding in bud and in fruit. Calyx-lobes linear-subulate, about as long as calyx-tube. Corolla rotate, lilac, about 3 cm in diameter, divided to about middle into ovate, cuspidate lobes. Anthers yellow, oblong, dehiscing by apical pores. Style longer than stamens. Berry globose, about 1 cm, yellow, smooth, glabrous. Flowers May-August.
Salt tolerance:	Grows in soils with salinity > 10 dS/m (Fig. 192).

Fig. 192. *Solanum elaegnifolium* at fruiting stage (Al-Mouh)

Habitat:	Primarily a weed of agronomic crops, pastures and roadsides. Well adapted to semi-arid regions. It has a very deep taproot and horizontally roots which produce shoots. Slow to germinate: seeds can last 10 years in the soil and germinate only in occasional years (Parsons and Cuthbertson 1992). Also spread by seeds, rhizomes and root fragments (Boyd and Murray 1982). Typically occurs on coarse texture and sandy or loamy soils.
Uses:	The fruits are deadly poisonous, and should never be eaten. The plant contains toxic alkaloids that combine with sugars to produce glycoalkaloides that irritate the gastrointestinal tract (Boyd and Murray 1982). Symptoms of poisoning in livestock include rapid breathing, nasal discharge, trembling of muscles in back legs, anemia and increased heart rate (Buck et al. 1960). Historically used by native Americans. It is rich in solasodine, a chemical used in the manufacture of steroidal hormones. Native Americans used the crushed berries of the plant to curdle milk and make cheese (Boyd and Murray 1982).

Stellera lessertii (Wickstr) Boiss. (Syn. *Thymelaea*)

Family: *Thymelaeaceae*
Local name: Stellera ستليرا
Common name: Stellera

Fig. 193. *Stellera lessertii* at flowering stage

Distribution:	*Stellera lessertii* (Fig. 193) is widely distributed in Al- Hyjanah *sabkha* and on saline soils in Der-Ezzor.
Description:	Shrub up to 40 cm tall; branches ascending, reddish brown, tips of shoots tomentose. Leaves 1-2 cm long, 5-10 mm broad, obovate to elliptic, obtuse, apiculate, coriaceous, subsessile. Flowers in terminal spikes up to 5 cm long or in capitate heads. Calyx tube 9 mm long, pubescent, 4-lobed, constricted above the ovary, base with dense long silky hairs; lobes 3.5 mm long, acute, pubescent. Stamens 8, 2-seriate. Ovary 2 mm long, ovoid. Fruit 4 mm long, densely woolly. Flowers May-September.
Salt tolerance:	Salt-tolerant. Grows in soil of salinity 10-14 dS/m.
Habitat:	Xerophyte, occurs in dry regions of Syria. Also widely distributed in Al-Hyjana *sabkha* on saline soils.
Uses:	Low palatability, lightly grazed by sheep, goats and camels. In folk medicine, decoction of roots and root bark are used to treat sprains. The root is poisonous, but the leaves have strong anticancer activity.

Reaumeria alternifolia (Lab.) Grande.

Family: *Tamaricaceae*
Local name: Al-Maloh, Al-Malah (الملوح (الملاح)
Common name: Reaumeria

Fig. 194. *Reaumeria alternifolia* at flowering stage. Inset: flowers

Fig. 195. Salt crystals on new and old leaves of *Reaumeria alternifolia*

Distribution:	*Reaumeria alternifolia* (Fig. 194) is widely distributed in Al-Mouh, Jyroud, Al-Jaboul and other *sabkhas.*
Description:	Dwarf shrub, glabrous to scabridulous, 10-30 cm. Stems many, erect, branched from base, leafy. Branches paniculate, ascending to erect. Leaves flat, not succulent; winter leaves 0.7-2 × 0.1-0.3 cm, subsessile, elliptical or lanceolate to nearly linear, tapering at base, acute, pitted-punctuate; summer leaves minute. Bracts almost as long as the calyx or longer, erect, linear, mucronate. Flowers terminal, up to 1.3 cm across. Calyx 6-7 mm, sepals connate up to one fourth their length, free part ovate-lanceolate, mucronate- acuminate. Petals 0.9-1.1 cm, pink, obliquely truncate, squamate at base; scales 2, unequal, ciliate-dentate at apex. Filaments with dilated, obscurely crenate-dentate base. Capsule shorter than the calyx. Seeds long-hairy. Flowers May-July.
Salt tolerance:	Halophyte, tolerates salinities up to 30 dS/m. Grows in Al-Mouh *sabkha* in communities of *Tamarix – Halocnemum strobilaceum*.
Habitat:	Xerohalophyte, occurs in dry saline, solonchak, and loamy soils. A salt secreting plant (Fig. 195); more than 67% of the absorbed NaCl is secreted by the leaves during the day. The rejection mechanism at the plant roots and the secretion mechanism at shoots allow the plant to maintain internal salt content roughly constant despite variations in soil salinity (Ramadan 1998).
Uses:	Very low palatability. Camels eat it but sheep and goats rarely do. In folk medicine, used to treat itching (Uphof 1959).

Tamarix species

Family: *Tamaricaceae*
Local name: Athel, Tarfa, Ubal الأثل، الطرفة، العبل
Common name: Tamarisk, Salt cedar

Fig. 196. *Tamarix smyrnensis* at flowering stage

Distribution:	The family *Tamaricaceae* consists of 4 genera and about 100 species. The genus *Tamarix* occurs naturally from western Europe and the Mediterranean to North Africa, northeastern China, India, and Japan (Baum 1978), generally in dry, saline habitats in the subtropical and temperate zones (Mozingo 1987). In Syria, *Tamarix* species are widely distributed at the seashore and at Al-Mouh, Hyjanah, Jyroud and Al-Jaboul *sabkhas*. The main type of the vegetation at Al-Mouh is the *Tamarix-Halocnemum* association, where *Tamarix* forms forest-like communities in some parts, with a covering value up to 60% (Figs. 196-198).

Fig. 197. *Tamarix tetragyna* at Al-Jaboul. Inset: flowers

Fig. 198. Forest of *Tamarix macrocarpa* at Al-Mouh. Inset: flowers

Description:	Trees or shrubs, mostly with distinct stems, profusely branched. Young branches glabrous or hairy. Leaves small, scale-like, sessile, amplexicaul or sheathing, glabrous or papillose, rarely hairy, mostly with salt-exuding glands; blade distinct, rarely reduced. Inflorescences simple or compound spike-like racemes on previous- (vernal) or current-year (aestival) branches or both. Flowers hermaphrodite, rarely unisexual (plant then dioecious), with 4-5 (-6) merous calyx and corolla, mostly pedicellate, bracteate. Calyx herbaceous or membranous; sepals free or slightly connate at base, entire or slightly dentate, glabrous. Petals caduceus or persistent, free or slightly connate at base, erect or deflexed, white, pink or reddish, entire or emaginate. Disk variously formed, usually with 4-5 entire or emarginte lobes, sometimes almost 0. Androecium mostly haplostemonous; stamens episepalous, constantly or predominantly 4 or 5 or 4 to 5 (in the various flowers of the same raceme); Sometimes androecium diplostemonous and then inner whorl of 1-10 epipetalous stamens usually somewhat shorter than the episepalous stamens of the outer whorl; filaments arising from the top of lobes of the disk or from the sinuses between the lobes. Capsule many-seeded, conical, pyramidal or pyriform, loculicidally dehiscent. Seeds with a sessile apical pappus of unicellular hairs. About 90 species, mostly in the deserts of temperate and subtropical regions of the Old World, also introduced into new world (Zohary and Feinbrun-Dothan 1972). The genus *Tamarix* has long been subject to general and regional revisions, with much disagreement on species delimitation and groupings. The most important species in Syria (Mouterde 1970) are: *T. smyrnensis* Bunge, *T. tetragyna* Ehrenb., *T. mannifera* (Ehrenb.) Bunge (syn. *T. nilotica* (Ehrenb.) Bunge) and *T. macrocarpa* (Ehrenb.) Bunge.
Salt tolerance:	Some *Tamarix* species tolerate seawater salinity (56 dS/m), other species can tolerate even higher salinity (up to 90 dS/m) as at Al-Mouh.

Habitat:	*Tamarix* species can tolerate an extreme range of environmental conditions (Brotherson and Winkel 1986). The deep, extensive root system extends to the water table, and is also capable of extracting water from unsaturated soil layers (a facultative phreatophyte). Tamarix has a primary root that grows with little branching until it reaches the water table, at which point secondary root branching is profuse (Brotherson and Winkel 1986). For example, a plant that was 38 cm tall had a well-developed primary root about 76 cm deep, and a branch root that extended laterally 244 cm. In areas where mature plants are spaced 8 m or less, their roots may be intermixed and occupy the entire area. The location of the water table during root formation influences the morphology of the root system. Lateral root development is more extensive in areas with a shallow water table. When the water table rises above the surface, adventitious roots appearealong the stem (Merkel and Hopkins 1957). Mature Tamarix plants can reproduce from adventitious roots, even after the aboveground portion of the plant has been removed (Gary and Horton 1965). When *Tamarix* is in contact with groundwater, stomatal control of water loss may be slight, but under dry conditions, it can exert effective stomatal control (Smith et al. 1997). Even when the water supply is interrupted or reduced, Tamarix maintains relatively high transpiration rates, (Pockman and Sperry 2000). Its ability to closely regulate photosynthesis and leaf conductance during drought increases its survivability and competitive ability in arid and semi-arid rangelands (Mounsif et al. 2002). *Tamarix* accumulates salt in special glands in its leaves (Fig. 47), and then excretes it onto the leaf surface. Foliage of *Tamarix* is often covered with a bloom of salt (Figs. 200, 201) (Decker 1961, Mozingo 1987), which is later blown onto the soil surface (Mozingo 1987). Surface soils become more saline over time, impairing germination and establishment of many native species (Smith et al. 1997). *Tamarix* can tolerate wide variations of soil and mineral types and survive in salinities exceeding 50,000 ppm (Brotherson and Winkel 1986). It is well adapted to the saline and alkaline soils of the *sabkhas*. It grows in saline habitats forming huge photogenic mounds (Fig. 202). Mature *Tamarix* plants reproduce vegetatively by adventitious roots or by seeds. Tamarix seeds are short-lived and do not form a persistent seed bank. The seeds produced in summer remain viable for up to 45 days under ideal conditions (ambient humidity and full shade), or for 24 days when exposed to full sunlight and dry conditions (Hansen et al. 1995). The seeds have no dormancy or after-ripening requirements. Germination requires direct contact with water or extremely high humidity, and is very rapid. Establishment is highly dependent on surface moisture conditions, and the height and fluctuation of the water table. Tamarix requires moist soils for germination and seedling establishment and usually establishes on sites where surface soils are moist in the spring and early summer, and subsoils remain saturated throughout the growing season (Hansen et al. 1995).

Fig. 199.*Tamarix smyrnensis* grows in seawater

Fig. 200. Salt crystals on the leaves of *Tamarix tetragyna*

Fig. 201. Salt crystals fall on the hand from *Tamarix macrocarpa*

Fig. 202. *Tamarix tetragyna* trees form a phytogenic mound at Al-Mouh

Uses:	*Tamarix* stands can be a refuge for honey bees, especially during the season when insecticides are applied to croplands. Production of fuelwood from Tamarix is probably important for Bedouins. *Tamarix* species were not grazed in the air-dried state and rarely consumed in the fresh state. More commonly, livestock tend to browse native plants, giving Tamarix a competitive advantage in areas grazed by livestock. Leaves and new branches of Tamarix species contain 7.21-8.15% protein, 3.11-3.25% fat, 23- 24.2% fiber, 20.1-25.2% ash and 40.54-45.24% NFE (El Shaer et al. 1991, Hoddenbach 1989). *Tamarix* provides some cover for livestock and wildlife, and nesting sites for many bird species.

Typha latifolia L.

Family: *Typhaceae*
Local name: Al-Halfa الحلفا
Common name: Cat-tail

Fig. 203. *Typha latifolia* at flowering stage

Distribution:	*Typha latifolia* (Fig. 203) is found around wells in Al-Mouh *sabkha*, and locally in Al-Jaboul.
Description:	Plant 1.5-2.5 m. Leaves 9-20 mm broad. Staminate and pistillate parts of spike usually contiguous. Stamens mostly 3; pollen in tetrads. Pistillate spike dark brown at end of flowering, 10-32 × 1-3.5 cm; pistillate flowers ebracteolate; stigma spathulate-lanceolate, acute, as long as or longer than hairs; carpodia rounded at apex, ending in a short point. Flowers in summer.
Salt tolerance:	Salt tolerant. Some populations tolerate salinities of 10,000 ppm, up to 37,000 ppm has been reported (Aronson 1989). Found in shallow water in Al-Mouh, where the dominant species is *Halocnemum strobilaceum* (Fig. 204).
Habitat:	Banks of rivers, ponds and lakes. Hydrophyte, occurs in brackish water: marshes, drainage canals and standing water (Duncan 1974).

Fig. 204. *Typha latifolia* at Al-Mouh (note the salt on soil surface)

Uses:	Dried roots ground into powder, rich is protein and can be mixed with wheat flour for making bread and pastry (Elias and Dykeman 1982). The pollen can be used as a protein rich additive to flour when making bread and porridge (Elias and Dykeman 1982). The roots contain 7.8% protein, 30% starch, and 1% sugar. Aerial parts contain 1.5-3.5% fat, 7-12% protein, and 38-48% carbohydrates. The pollen (used both as a medicine and foodstuff) contains 19% protein, 17.8% carbohydrates, and 1.1% fat (Elias and Dykeman 1982). Annual biomass production of managed cat-tail swamps averages 10-20 tons/ha. One hectare can produce 8 tons of flour from root stock. In folk medicine the roots are used as remedies for tumors. Also diuretics, glactogogoue, and tonic (Duke and Atchley 1984), mixed with oil and used as a poultice on sores (Moerman 1998). Decoction of the stems used to treat whooping cough (Moerman 1998). The plant contains quercetin, kaempferol, and rich in vitamin B1, B2, and C (Duke and Atchley 1984). *Typha latifolia* and other shoreline plants can perform important ecological functions: filtering runoff as it flows into the lake, providing habitat for wildlife and food for some animals. Birds use the fluff of the flowers to line their nests. Stems and leaves used in making paper, mats, chairs, hats and others. Plant pulp can be converted into rayon (Foster and Duke 1990). Hair of the fruits used for stuffing pillows (Moerman 1998).

Eryngium maritimum L.

Family: *Umbelliferae (Apiaceae)*
Local name: Qors-nna Bahriah قرصعنة بحرية (لحية المعزى)
Common name: Sea holly

Fig. 205. *Eryngium maritimum* at flowering stage

Distribution:	*Eryngium maritimum* (Fig. 205) occurs in sandy seashore areas.
Description:	Perennial, glaucous, glabrous, 20-50 cm, mostly forming globular tufts. Stems thick, prominently ribbed, much branched. Leaves leathery, thick and whitish, prickly-lobed, copiously nerved; basal leaves 5-10×5-15cm, long-petioled, suborbicular to truncate or crodate-reniform at base, undivided or plamately lobed, coarsely dentate or lobulate at margin; upper leaves 3-8 cm. Long and broad, clasping, palmately lobed, lobes triangular and terminating in long sharp spines. Inflorescences repeatedly di- or trichotomous- branched; heads many-flowered, usually 2-3 × 0.8-1.5 (-2) cm. Bracts 3-5 (-7), 2-5 × 1-3 cm, broadly rhombic to ovate, usually with 3-5 spiny lobes. Bracteoles about 1 cm, longer than the flowers, narrowly lanceolate, 3- cuspidate. Calyx teeth 4-5 mm, elliptical to lanceolate, aristate, broadly scarious-margined. Fruit about 1 cm, spongy, densely scaly-prickly, crowned with the spreading calyx teeth. Flowers April-August.
Salt tolerance:	Salt-tolerant (Aronson 1989). Can grow in very alkaline and saline soils, can tolerate drought and maritime exposure.
Habitat:	Sandy and shingly beaches.

Uses:	The roots have a chestnut taste; they are cooked and served with sauce, or candied as sweets (Facciola 1990). Leaves and shoots are cooked and used as an asparagus substitute (Facciola 1990). They are palatable and nourishing (Grieve 1984). The roots have been used as diuretic, laxative, anti- inflammatory, and expectorant. Decoction of the roots used for urinary infections, cystitis, urithritis, prostrate complaints, renal colic, and to eliminate toxins from the body. Roots help to retard the formation of kidney stones, and to treat enlargement or inflammation of prostate (Chevallier 1996), and liver and kidney diseases (Bown 1995, Grieve 1984).

Nitraria retusa (Forsk.) Asch.

Family: *Zygophyllaceae*
Local name: Al-Gharqad الغرقد
Common name: Nitraria

Fig. 206. Branch of *Nitraria retusa* at flowering stage

Distribution:	*Nitraria retusa* (Fig. 206) is a xerophyte and occurs in arid areas. It is found in Jyroud *sabkha*, and the sabkhas near Al-Raqqa and Deir-Ezz or.
Description:	Description: Shrub, 1-2; twigs appressed-canescent. Stems many, erect, profusely branched. Branches erect-spreading. Leaves 1-2 (-3) cm, alternate or fasciculate, conspicuously petiolate, fleshy, obovate-cuneate, retuse or 3-5-crenate-dentate at apex, appressed-pubescent or glabrescent; stipules minute, persistent. Flowers 6-8 mm, long-pedicelled, in loose dichotomous cymes at the ends of young twigs. Calyx 2 mm, with persistent, ovate-triangular lobes. Petals twice as long as calyx or longer, white or greenish-white, hispid. Fruit a fleshy, berry-like drupe, 0.6-1 cm, trigonous, foveolate at base, sulcate above. Flowers April-May.
Salt tolerance:	Halophyte, tolerates salinities up to 90 dS/m, grows on Mediterranean seawater at Asqalan (Aronson 1989).

Fig. 207. *Nitraria retusa* forms phytogenic mounds at Jyroud

Fig. 208. The fruits of *Nitraria retusa*

Habitat:	A common shrub in halophytic vegetation. Grows in saline habitats forming huge phytogenic mounds (Fig. 207).
Uses:	Fruits are sweet and edible (Fig. 208), the wood is widely used by Bedouins for fuel. In folk medicine, leaves used to treat urinary tract infections, and have been shown to have hypolycaemic effects (Shabana et al. 1990). The aerial parts contain 11.3% protein, 2.55% fat, 31.5% fiber, 30.2% ash and 24.45% NFE (El Shaer 1995).

Peganum harmala L.

Family: *Zygophyllaceae*
Local name: Al-Harmal الحرمل
Common name: Syrian rue

Fig. 209. *Peganum harmala* at flowering stage. Inset: fruits

Distribution:	*Peganum harmala* (Fig. 209) is widely distributed at *sabkha* peripheries, and in some cases, as in Jyroud *sabkha*, is found in highly saline soil, where it grows between the mounds formed by *Nitraria* or *Halocnemum*.
Description:	Perennial, woody at base, green, glabrous, leafy, 30-50 cm. Stems much branched, angular above. Branches erect and ascending. Leaves 5-10 cm, sessile; stipules 1.5-2.5 mm, subulate to setaceous; blade irregularly pinnatisect; lobes 2-4 cm, spreading, linear-lanceolate, acute, entire. Inflorescences terminal, cymose. Flowers large, on long pedicels thickening above. Sepals 1.5-2 cm, linear, sometimes 3-fid, with minute scales of epicalyx between the seplas. Petals about 1.5 × 0.5-0.7 cm, white or yellowish, oblong-elliptical. Capsule 0.8-1 cm, 3-celled, many seeded depressed-globular, 3- lobed, glabrous, with persistent style. Seeds about 2 mm, triangular, blackishbrown, tuberculate. Flowers March-April.

Salt tolerance:	Some populations have salt tolerance of up to 12 dS/m, has been trialed at Asqalan using diluted Mediterranean seawater (Aronson 1989). *Peganum harmala* prefers loamy soils, and can grow in very alkaline and saline soils. It propagates either from seed or root, and can stand considerable drought. Sometimes, it is the only visible plant especially around settlements. It is an indicator of overgrazing and vegetation degradation.
Habitat:	Prefers loamy soils, and can grow in very alkaline and saline soils. Propagates either from seed or root, and can stand considerable drought. Sometimes, it is the only visible plant especially around settlements. It is an indicator of overgrazing and vegetation degradation.
Uses:	Poisonous and unpalatable. Animals graze it only if they are starving or suffering from severe mineral deficiencies. Seeds and fruit are the most toxic; a lethal dose is 0.15% of the animal's body weight. Leaves are somewhat less toxic than the seeds. Dry leaves are apparently non-toxic. If ingested in large quantities, it is narcotic, nauseating, and depressant emetic, may also cause abortion. May also affect the central nervous system causing irritation and paralysis (Wahby 1940). Seeds are used as an emmenagogue, diuretic, emetic, stimulant of intestinal function, arterial pressure regulator, anthelminitic, and to treat itches and allergic rashes. Roots are used to reduce trembles, Parkinson's disease, rheumatism and nervous conditions (Al-Oudat 2001, Chevallier 1996). Roots widely used in folk medicine as a parasiticide in order to kill body lice (Chopra et al. 1986, Tanaka 1976). The plant contains harmine, harmaline, peganine, harmalol and fixed oil. The seed also contain soft resin with a narcotic odor similar to the resin of Cannabis sativa (Chopra et al. 1986). A red dye is obtained from the seed (Usher 1974). It is widely used in Western Asia, especially as for colouring carpets (Emboden 1979). Ripe seeds are ineffective as a contact poison, but are active in vapor form, effective against algae, in higher concentrations to water animals and lethal to moulds, bacteria, and intestinal parasites (Chopra et al. 1986). Seeds are used as incense (Singh and Kachroo 1976).

Zygophyllum fabago L.

Family: *Zygophyllaceae*
Local name: Qyllab قلّاب، الرطريط
Common name: Syrian bean caper

Fig. 210. Branch of *Zygophyllum fabago* at flowering stage. Inset: flowers

Distribution:	*Zygophyllum fabago* (Fig. 210) is widely distributed at Jyroud, Al-Mouh, and Al-Soukhneh *sabkhas*.
Description:	Perennial, green glabrous herb, 30-80 cm. Stems erect or ascending, sometimes hanging from walls, woody at base. Leaves 2-foliolate; stipules 4-8 mm, connate at base or free, herbaceous, ovate or elliptical; about as long as the leaflets, slightly winged; leaflets 1.5-3 × 1-2 cm, thick, somewhat fleshy, abovate to axillary, solitary. Sepals 5-7 mm, ovate, membranous-margined. Petals almost as long as sepals, whitish-cream, yellow below, obovate, rounded or emarginated. Scales at base of filaments as long as the ovary, linear-oblong, papillose, ciliate. Capsule (1.5-) 2-3 × 0.4-0.5 cm, many -seeded, erect to deflexed, oblong-cylindrical, 5-angled; style filiform. Seeds compressed, oblong, tuberculate. Flowers April-June.

Fig. 211. *Zygophyllum fabago* association at Jyroud *sabkha*

Salt tolerance:	Can tolerate salinity of 8 dS/m, and has been trialed at Asqalan, using diluted Mediterranean seawater (Aronson 1989). Found at Jyroud and Al-Mouh sabkhas in soils with salinity > 14 dS/m (Fig. 211).
Habitat:	Prefers light (sandy) and medium (loamy) soils and requires well-drained soil. Prefers neutral and alkaline soils. It has a stout, deep, branched taproot, sometimes with long, fleshy lateral roots that can produce new shoots. Reproduces by seeds and vegetatively from lateral roots. Root fragments can produce new plants (Chittendon 1951).
Uses:	Leaves of *Zygophyllum coccineum* contain: 6.7% protein, 5.3% fat. 3.7% fiber, 32.7% ash and 51.6% NFE (ACSAD 1979). The flower buds are pickled and used as a caper (*Capparis spinosa*) substitute (condiment) (Facciola 1990, Hedrick 1972). The vegetative parts (especially the leaves) contain alkaloids (Zygofabagin), saponins, vitamin C, and tannin (Al-Oudat and Laham 1994). Traditionally used in many countries as poultice for the treatment of external cancers, wounds, and injuries in humans and animals. Aqueous and methanolic extracts of whole plant are antibacterial and inhibit germination, growth, development and yield of plant species grown nearby. Pollen grains contain allergenic proteins (Castells et al. 2002).

Phyla nodiflora (L.) Greene.

Family: *Verbenaceae*
Local name: Phyla فيله
Common name: Frogfruit

Fig. 212. *Phyla nodiflora* at flowering stage

Fig. 213. Stem of *Phyla nodiflora* rooting at nodes

Distribution:	*Phyla nodiflora* (Fig. 212) is widely distributed along the seashore.
Description:	Perennial herb, 10-30 cm. green or grey, appressed-setulose. Stems procumbent, rooting at nodes and ascending (Fig. 213). Leaves cuneate-spathulate, serrate in the upper part. Peduncles solitary in leaf-axils, 2-4 times as long as subtending leaves. Bracts obovate or muticous imbricate, about as long as corolla-tube. Corolla white at first, pale lilac afterwards. Fruit ovoid, smooth. Flowers April-September.
Salt tolerance:	Tolerates seashore conditions (Duncan 1974), grows well in spray belt along seashore, can tolerate maritime exposure.
Habitat:	Grows on sandy seashore soils and in damp places, also cultivated as a lawn plant.
Uses:	In folk medicine, fresh leaves used as a tea substitute. The plant is used as anodyne, antibacterial, deobstruent, diuretic, emmenagogue, parasiticide, refrigerant and in the treatment of hookworm (Duke 1975). Juice of the plant used to relieve fevers, coughs and colds. Inhalation used to treat coughs and colds, juice of the root used to treat gastric problems (Manandhar 2002).

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