

## Notes on some common flora and its uses in Wadi Gaza, Gaza Strip

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**Abstract:** Wadi Gaza is an indispensable part of natural life in Palestine and has a rich biodiversity in terms of fauna and flora. This study aims at surveying the common flora of Wadi Gaza ecosystem during the spring season of 2004 and providing notes on their possible uses by the Palestinian community depending on direct observations, discussions with local people and available literature. As many as 70 plant species belonging to 32 families and 24 orders were identified during the spring months of 2004 in Wadi Gaza. The aster or daisy family (Compositae) was the largest family and comprised 14 plant species (20%) of the recorded species. The natural flora of Wadi Gaza was commonly used in different ways as a food source, herbal medicine, fodder for grazing animals and timber and fuel production. The other direct human uses for specific floristic species were also mentioned. Many wildlife species were found to utilize the wild vegetation of Wadi Gaza for multi-purposes as well. Finally, the authors recommend carrying out detailed scientific works regarding the ecology, distribution and uses of particular floristic species in the Gaza Strip.

**Key words:** Flora – survey – uses – herbal medicine – Wadi Gaza – Gaza Strip.

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and urinary disorders, respiratory problems, arthritis and cancer and prostate disorders. Said *et al.* [29] conducted an extensive ethnopharmacological survey among the most well known Arabic indigenous practitioners in Israel, the Golan Heights and the West Bank in order to evaluate the potential of local plants used in treating different diseases and illnesses. Abu-Rabia [30] described some floristic species that are commonly used as a food and medicine source in Palestine. More recently, Ali-Shtayeh and Jamous [31] carried out a comprehensive work in the Palestinian territories (West Bank and Gaza Strip) aiming at studying the status of the Palestinian herbal medicine. They revealed that 261 plant species are still in use in traditional medicine to treat various diseases and illnesses, with Leguminosae, Compositae and Rosaceaea are the most representative plant families. They also pointed out the threats facing the wild medicinal plants in Palestine and as a result they suggested the importance of adopting practical measures to conserve these plants and to preserve the traditional knowledge associated with them.

The Applied Research Institute – Jerusalem (ARIJ) [10] described the wild and agricultural plants occurring in Palestine with their nutritional, economic, medicinal and fodder values. Ali-Shtayeh and Jamous [3] mentioned that a total number of 334 plant species were recorded to be threatened in the West Bank and the Gaza Strip. As a means of protecting the Arabic traditional medicine in Palestine from the danger of disappearance, Azaizeh *et al.* [32] suggested a multilevel program involving the training of local practitioners, an establishment of a medicinal plant botanical garden and a field gene bank for plant preservation.

In the Gaza Strip, work on flora and wild plants is restricted to few studies. Boulos [33] studied the flora of the Gaza Strip since decades. He described as many as 251 floristic species and highlighted some aspects of their uses. Euroconsult/IWACO [9] displayed a variety of wild plant species inhabiting the sand dunes, agricultural orchards and Wadi Gaza of the Gaza Strip. Important contributions to the knowledge of flora were emerged during the last few years in the Gaza Strip [34, 35, 36]. These studies concentrated on the floristic species inhabiting the coastal sand dunes and Wadi Gaza. A total number of 128 floristic species was taxonomically identified and the uses of many species were mentioned. Added to that, the previously mentioned study of Ali-Shtayeh and Jamous [31] regarding the status of medicinal plants used in the West Bank and the Gaza Strip.

Wadi Gaza faced drastic deterioration in the last few years due to anthropogenic interventions and aggressions [37]. Therefore, it is necessary to document the flora of the degrading ecosystem and to highlight its

possible uses by the community depending on direct observations, discussions with local people and available literature. The present work aims at surveying the common wild plants of Wadi Gaza during the spring season of 2004 and providing notes on their possible uses by the Palestinian community. Although the current study knocks a "hot spot" in the Gaza Strip, further detailed works on the ecology and distribution of particular floristic species are essential.

## **2. Methodology**

### **2.1. Study Area**

Wadi Gaza is an indispensable part of natural life in Palestine and has an interesting history and rich biodiversity in terms of fauna and flora [37]. Wadi Gaza springs from the Negev Mountains and the Southern Heights of Hebron City in Palestine. It has a catchment or drainage area of about 3500 km<sup>2</sup> [38]. The total length of Wadi Gaza is 105 km from its source to its end, with the final portion lying in the Gaza Strip extends 9 km from the Truce line in East Gaza to the coast where it discharges into the Mediterranean Sea. A wetland or an estuary lake is formed at the mouth of Wadi Gaza before reaching the sea. The wetland is the most important habitat for migratory and resident water birds. The maximum elevation of the Wadi is 30 meters above sea level, dropping to sea level where it reaches the Mediterranean [38]. Since the early 1970s and after the implementation of retaining dams and diversion schemes by Israel on the upper course of the Wadi, the volume of water reaching Wadi Gaza began to diminish considerably and this contributed much to biodiversity loss. Large flows are restricted to occasional flash floods sweeping down the Wadi bed in wet years [39]. Figure 1 shows that Wadi Gaza lies in the mid of the Gaza Strip and is bordered in the north-west by the Mediterranean Sea, the south-east by Al-Bureij Camp, the south-west by Al-Nuseirat Camp, and the north by Al-Zahra City. The resident population of Wadi Gaza area accounts for approximately 10,000 people distributed in discrete, extended family groups of variable densities [38]. The sewage accumulation in Wadi Gaza from the neighboring residential masses poses serious environmental health hazards to inhabitants [37, 40].

The study area has a typical semi-arid Mediterranean climate; hot in summer and cold in winter. The average daily mean temperature ranges from 25°C in summer to 13°C in winter, with the average daily maximum temperature range from 29°C to 17°C and the minimum temperature range from 21°C to 9°C, in summer and winter respectively. The daily relative humidity fluctuates between 65% in daytime and 85% at night in summer and between 60% and 80% respectively in winter. The mean annual solar

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radiation amounts to 2200 J/cm<sup>2</sup>/day. The average maximum wind speed velocity is about 3.9 m/s. In winter, the prevailing wind direction is south-west with an average speed of 4.2 m/s and during summer the prevailing winds are from the north-west sector. The average annual rainfall is 335 mm. The mean daily evaporation in December is about 2.1 mm/d, rising to a maximum of 6.3 mm/d in July [38].

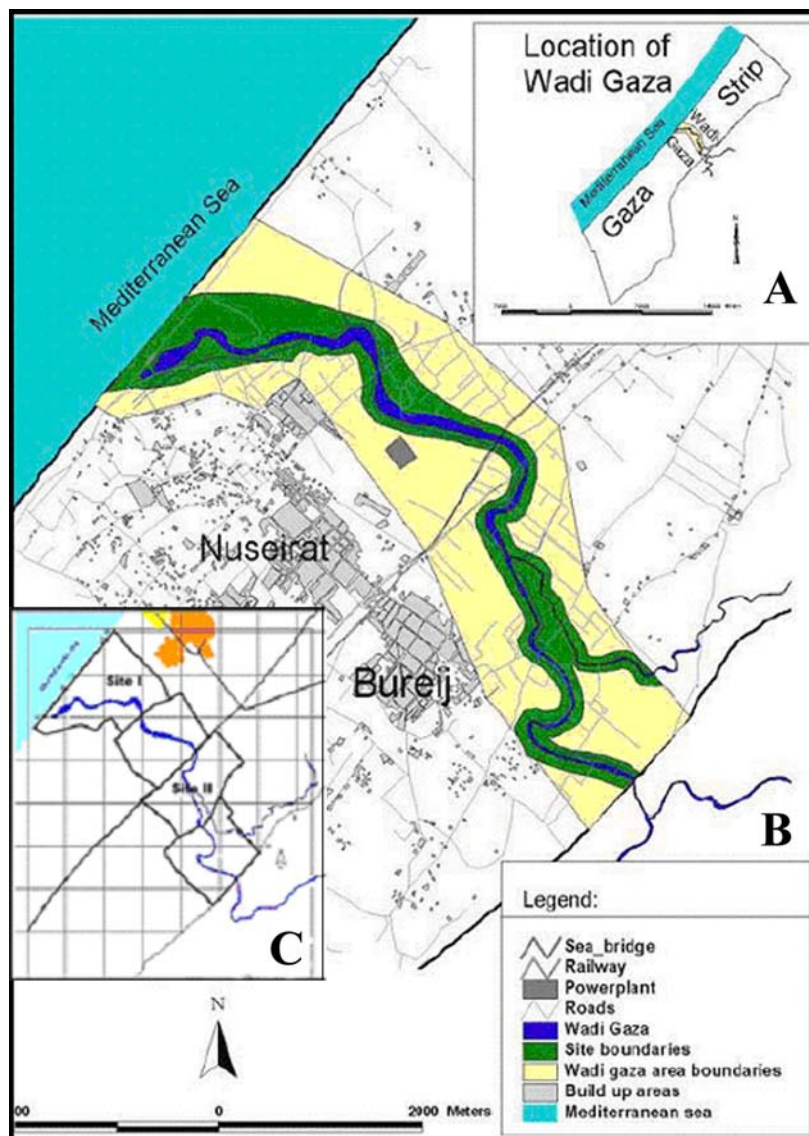


Figure 1: Wadi Gaza and its Location in the Gaza Strip (A), its site boundaries (B) and its study sites (C)

## 2.2. Study Sites

Due to their topography, water persistence and other demographic and environmental aspects and the Israeli security measures, only two parts were selected and surveyed for flora in Wadi Gaza. These parts were denoted to as site I and site II starting from the west to the east of Wadi Gaza (Figure 1). Site I represents the western portion of the Wadi where the wetland ecosystem and many occasional or temporary storm water or sewage ponds are present. Site II is almost dry except for some storm water ponds occurring during the rainy season. Many agricultural fields of grapevines, figs, olives, citrus and vegetables were found to border Wadi Gaza along the two mentioned sites.

## 2.3. Survey of Flora and its Uses

The two sites of Wadi Gaza were surveyed for various floristic species in spring months (March – May) of the year 2004, where flowering of most plant species takes place. Frequent site visits, observations and discussions with local people were carried out to determine the floristic species of Wadi Gaza and their possible uses. A variety of textbooks, guidebooks and scientific papers was helpful in identifying floristic species [3, 6, 10, 11, 34, 36, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50]. Although this plant cover plays a major role in harboring a diversity of wildlife species [37, 51, 52, 53, 54], it provides different uses for people as well [55]. The on-site exploitation of different plant species by the Palestinians and wildlife was highlighted and many photos were taken in this regard. Many uses of many floristic species were compiled from different literature as well.

## 3. Results

As many as 70 plant species (32 families and 24 orders) were recorded and identified during the spring season of 2004 in Wadi Gaza (Table 1). Fourteen plant species (20%) were found to comprise the aster or daisy family (Asteraceae or Compositae). Some agricultural plant species were found to grow in the wild such as the Barley *Hordeum sp.*, Parsley *Petroselinum sativum*, Common Sage *Salvia sp.*, Peppermint *Mentha sp.* and Sweet Basil *Ocimum sp.* Many floristic species were considered by farmers as pest weeds to cultivated crops such as the Broomrape *Orobancha aegyptiaca* and the Bermuda Grass *Cynodon dactylon*. The different uses of floristic species of Wadi Gaza are listed in Table 1.

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**Table 1: Floristic species of Wadi Gaza with their possible uses**

Order	Family	Scientific Name	Common Name	Site	Arabic Name	Possible Use*					
						Food	Medicinal	Fuel	Grazing	Industry	Others**
Pinales	Cupressaceae (Cypress Family)	<i>Cupressus sempervirens</i>	Evergreen Cypress	I,II	سرو			+		+	+
Cyperales	Graminae (Poaceae) (Grass Family)	<i>Phragmites australis</i>	Common Reed	I,II	قصب المكانس		+	+	+		+
		<i>Arundo donax</i>	Giant Reed	I	بوص فارسي					+	+
		<i>Polypogon maritimus</i>	Mediterranean Rabbit's Foot Grass	I,II	عشب المياه – ذيل الفار		+				
		<i>Cynodon dactylon</i>	Bermuda Grass	I,II	نجيل		+		+		
		<i>Hordeum sp.</i>	Barley	I,II	الشعير	+	+	+			
Liliales	Liliaceae (Lily Family)	<i>Pancratium maritimum</i>	Sea Daffodil (Pancratium)	I	نرجس بحري						
Arecales	Arecaceae (Palmae) (Palm Family)	<i>Phoenix dactylifera</i>	Date Palm	I,II	نخيل البلح	+	+			+	+
Caryophyllales	Aizoaceae (Fig-marigold Family)	<i>Carpobrotus edulis</i>	Hottentot Fig	I,II	إصبع الجارية						
		<i>Mesembryanthemum crystallinum</i>	Common Iceplant	I	الغاسول – قطر الندى						

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	Caryophyllaceae (Pink Family)	<i>Silene succulenta</i>	Campion	I	عطر – خبيزة البحر						
	Chenopodiaceae (Goosefoot Family)	<i>Atriplex sp.</i>	Shrubby Saltbush	I,II	القطف - الملاح				+	+	+
		<i>Salsola kali</i>	Russian Thistle	I,II	شنان		+	+			+
		<i>Chenopodium murale</i>	Nettleleaf goosefoot	I,II	فسيوه - خبيزة	+					
		<i>Arthrocnemum fruticosum</i>	Shrubby Swamp-fire (Glasswort)	I	نبته نار المستنقعات						
		Portulacaceae (Pursaline Family)	<i>Portulaca oleracea</i>	I,II	بقلة – رجلة - فرحيننا	+					
Gentanales	Apocynaceae (Dogbane Family)	<i>Nerium oleander</i>	Oleander – Rose Bay – South Sea Rose	I,II	الدفة - الدفلي		+				
Campanulales	Campanulaceae (Bellflower Family)	<i>Campanula sulphurea</i>	Bellflower	I	زهرة الجرس الصفراء						
Asterales	Asteraceae (Compositae) (Daisy - Aster Family)	<i>Anthemis leucanthemifolia</i>	Chamomile	I,II	أقحوان الساحل						
		<i>Artemisia monosperma</i>	Sagebrush	I,II	عادر		+		+		



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		<i>Artemisia herba-alba</i>	Worm Wood	I,II	الشَّيْح		+				
		<i>Centaurea pallescens</i>	Knapweed	I,II	يمـرور - مرار باهت						
		<i>Echinops sp.</i>	Globethistle	I,II	بيض الجمال - خـشـير - خروشوف						
		<i>Echinops philistaeus</i>	Globethistle	I,II	خـشـير فلسطيني						
		<i>Cichorium pumilum</i>	Cichorium	I,II	هـنـدباء - خربوع	+	+				
		<i>Matricaria sp.</i>	Wild Chamomile - Mayweed	I,II	البابونج البري						
		<i>Launaea nudicaulis</i>	Walha	I,II	حـواء - صفارة - حوا الغزال		+		+		
		<i>Scolymus maculatus</i>	Spotted Golden-thistle	I,II	سنارية حولية - شوكة الفار						

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		<i>Silybum marianum</i>	Blessed Milk-thistle	I,II	شوك الجمال – خفاش جمال - لحلاح	+	+				
		<i>Xanthium strumarium</i>	Rough Cocklebur	I,II	شبيط عريض						
		<i>Xanthium spinosum</i>	Spiny Cocklebur	I,II	شبيط شوكي						
Capparales	Brassicaceae (Cruciferae) (Mustard Family)	<i>Brassica tournefortii</i>	Asian Mustard	I,II	قراص - جريزة				+		
		<i>Cakile maritima</i>	European Searocket	I	رشاد البحر						
Euphorbiales	Euphorbiaceae (Spurge Family)	<i>Ricinus communis</i>	Castor Oil Plant – Castor Beans – Palma Christi	I,II	خروع		+	+			+
Fabales	Leguminosae (Fabaceae) (Legume - Pea Family)	<i>Acacia cyanophylla</i>	Acacia	I,II	أكاسيا – الأعراس		+	+	+		+
		<i>Acacia arabica</i>	Gum Arabic Tree	I,II	السنت العربي - الغيلانة			+	+		+

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		<i>Ceratonia siliqua</i>	Carob – John's Bread – Locust Bean – Algarroba	I,II	خروب						
		<i>Astragalus annularis</i>	Milk Vetch	I,II	أصابع العروس				+		
		<i>Alhagi maurorum</i>	Camel-thorn	I,II	العاقول		+	+	+		
	Rosaceae	<i>Sarcopoterium spinosum</i>	Prickly Shrubby (Thorny) Burnet	I,II	ننش - بلان						
Malvales	Malvaceae (Mallow Family)	<i>Malva parviflora</i>	Least Mallow – Cheeze-weed Mallow	I,II	خبيزة	+	+		+		
Urticales	Moraceae (Mulberry Family)	<i>Ficus sycomorus</i>	Sycamore Fig	I,II	جميز	+	+	+			+
		<i>Morus sp.</i>	Mulberry	I,II	توت بلدي	+					+
	Urticaceae (Nettle Family)	<i>Urtica membranacea</i>	Roman Nettle	I,II	قريص		+				
		<i>Urtica urens</i>	Roman Nettle	I,II	قريص - حريق		+				

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Myrtales	Myrtaceae (Myrtle Family)	<i>Eucalyptus camaldulensis</i>	River Red-gum Tree	I,II	الكافور - الكينا			+	+	+	+
Geraniales	Oxalidaceae (Wood-Sorrel Family)	<i>Oxalis pes-caprae</i>	Bermuda Buttercup	I,II	عرق الليمون		+				
Scrophulariales	Orobanchaceae (Broom-rape Family)	<i>Orobanche aegyptiaca</i>	Broomrape	I,II	الهالوك						
Papaverales	Papaveraceae (Poppy Family)	<i>Papaver humile</i>	Poppy	I,II	شقائق النعمان - حنون						
Polygonales	Polygonaceae (Buckwheat Family)	<i>Polygonum equisetiforme</i>	Knot Weed	I,II	قضاب		+		+		
		<i>Rumex pictus</i>	Dock	I,II	حمصيص	+					
Rhamnales	Rhamnaceae (Buckthorn Family)	<i>Ziziphus spina-christi</i>	Christ's Thorn - Jujube	I,II	سدر - نبق - تمر - دوم	+	+	+	+		+
Solanales	Solanaceae (Potato Family)	<i>Datura sp.</i>	Datura	I,II	الداتورة		+				
		<i>Hyoscyamus aureus</i>	Henbane	I,II	سكران - بنج	+	+				
		<i>Lycium europaeus</i>	Bramble (European Boxthorn)	I,II	العوسج	+		+			

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		<i>Solanum, elaeagnifolium</i>	Silver-leaf Night Shade	I,II	بازنجان بري – سجوة زيتية						
		<i>Nicotiana glauca</i>	Tree Tobacco	I,II	دخان شجري – تمباك		+				+
Apiales	Apiaceae (Carrot Family)	<i>Daucus guttatus</i>	Wild Carrot	I,II	جزر بري						
		<i>Foeniculum sp.</i>	Fennel – Sweet Anise	I,II	الشومر	+	+				
		<i>Petroselinum sativum</i>	Parsley	I,II	البقدونس	+	+				
Violales	Tamaricaceae (Tamarix Family)	<i>Tamarix nilotica</i>	Nile Tamarisk	I,II	الأثل – حطب أحمر		+	+	+	+	+
		<i>Tamarix aphylla</i>	Athel (Jointed) Tamarisk	I	الطرفة – طرفاء – أثل العقد		+	+	+	+	+
	Cucurbitaceae (Cucumber Family)	<i>Citrullus sp.</i>	Bitter Apple	I,II	الحنظل – العلقم – التفاح المر		+				
Sapendales	Zygophyllaceae (Creosote-bush Family)	<i>Zygophyllum album</i>	Beancaper	I	رطريط		+				
Lamiales	Boraginaceae (Borage Family)	<i>Moltkiopsis ciliata</i>	Maroon Seedheads	I,II	الحلم		+		+		

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Order	Family	Scientific Name	Common Name	Site	Arabic Name	Possible Use*					
						Food	Medicinal	Fuel	Grazing	Industry	Others**
	Labiatae (Mint Family)	<i>Salvia sp.</i>	Common Sage	I,II	الميرمية الشائعة	+	+				
		<i>Mentha sp.</i>	Peppermint	I,II	النعناع - النعنع	+	+				
		<i>Ocimum basilicum</i>	Sweet Basil	I,II	الريحان	+	+				

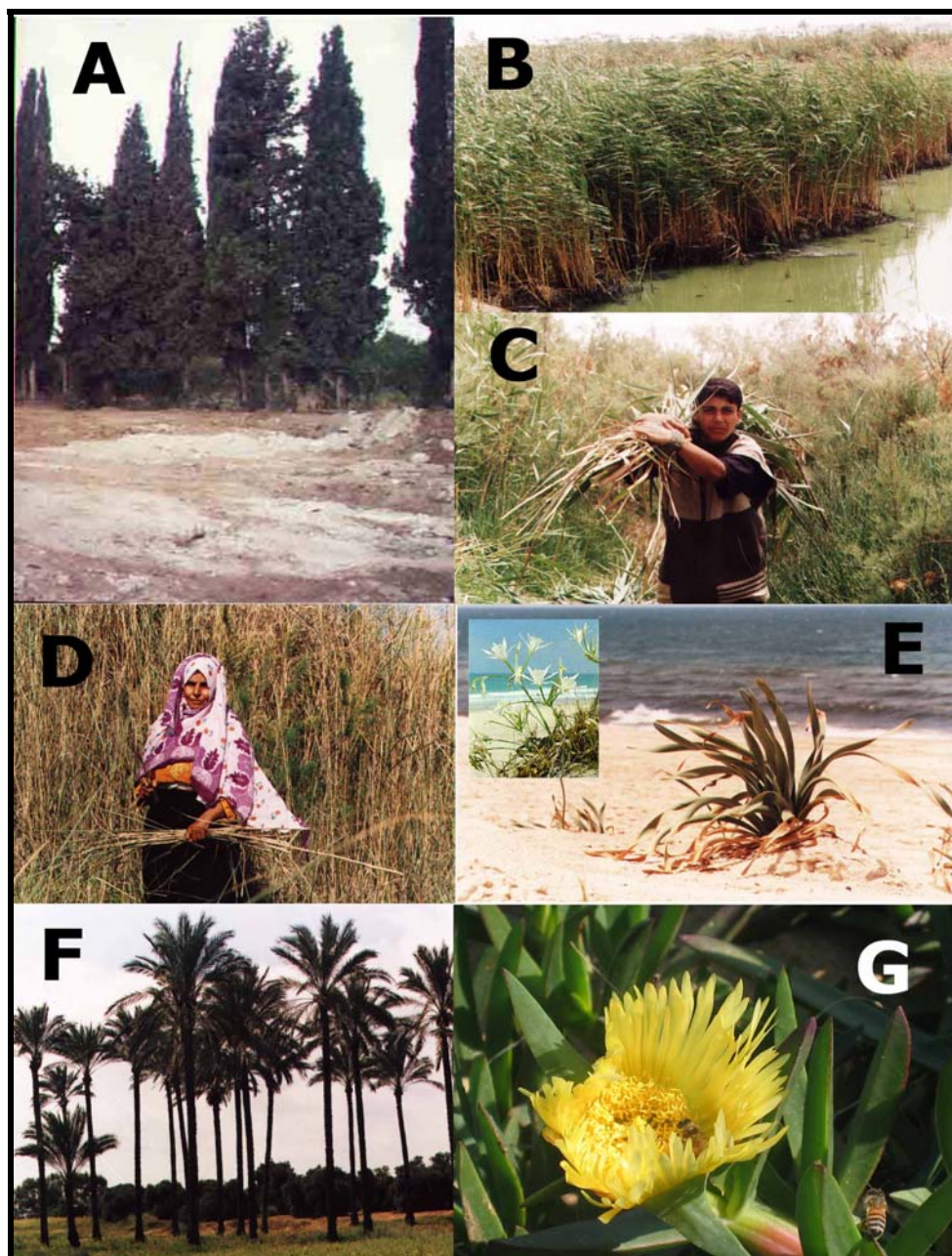
\* The possible uses of flora in Wadi Gaza were investigated either through direct observations and discussions with local people or with reference to available local literature [10, 28, 30, 31, 34, 35, 36].

\*\* Others include: Roofing, mats, gum, glue, dye, soap, boundary marking, fencing ... etc

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**1. Evergreen Cypress *Cupressus sempervirens*:** The Evergreen Cypress is a tall and a conical tree that may reach 30 meters in height. It is usually found bordering agricultural fields and orchards in both sites of Wadi Gaza (Figure 2A). Thus, the plant, either implanted or spontaneously grown, is used as windbreaks and as beauty element around fields and along roads. The plant attracts many bird species, of which the Hooded Crow *Corvus corone* was usually seen occupying the highest top of the tree, probably for nesting purposes. Medicinally, Wadi Gaza inhabitants claimed that in the past they used the fruits and sometimes the leaves of the plant for diabetes and diarrhea treatment and wound recovery. The species was and still under actual threat due to continuous cutting by the locals for the uses of timber and fuel. The trees were cut in most areas of the Gaza Strip in order to widen the roads and to exploit the land for residential expansions.

**2. Common Reed *Phragmites australis*:** The Common Reed is a large perennial reed and is very common in fresh and brackish water marshes in site I of Wadi Gaza. Small stands of the species were found in site II. The species is invasive and produces dense mono-specific stands (Figure 2B). The Moorhen *Gallinula chloropus* and Coot *Fulica atra* were common breeding birds in the reed marshes and they use it as nest material and site. Many of the herons and other non-breeding water bird species use *Phragmites* marshes for feeding as well. Some land birds use reed for cover in migration stopovers. Herons, egrets and raptors were found to use the reeds as roosting and foraging sites. The Caspian Freshwater Turtles *Mauremys caspica* and Frogs are common inhabitants of reedy marshes as they usually use the reed for cover, rest, nest, breeding purposes and sunbasking. However, the reed was thought by locals and even the municipalities to be a suitable environment for annoying insects; mainly mosquitoes. As a result, the plant was usually uprooted or even burned with no respect to the ecological and environmental values they serve for wildlife and wastewater treatment. From an economic viewpoint, the Common Reed was used in different ways by Wadi Gaza inhabitants (Figure 2C).

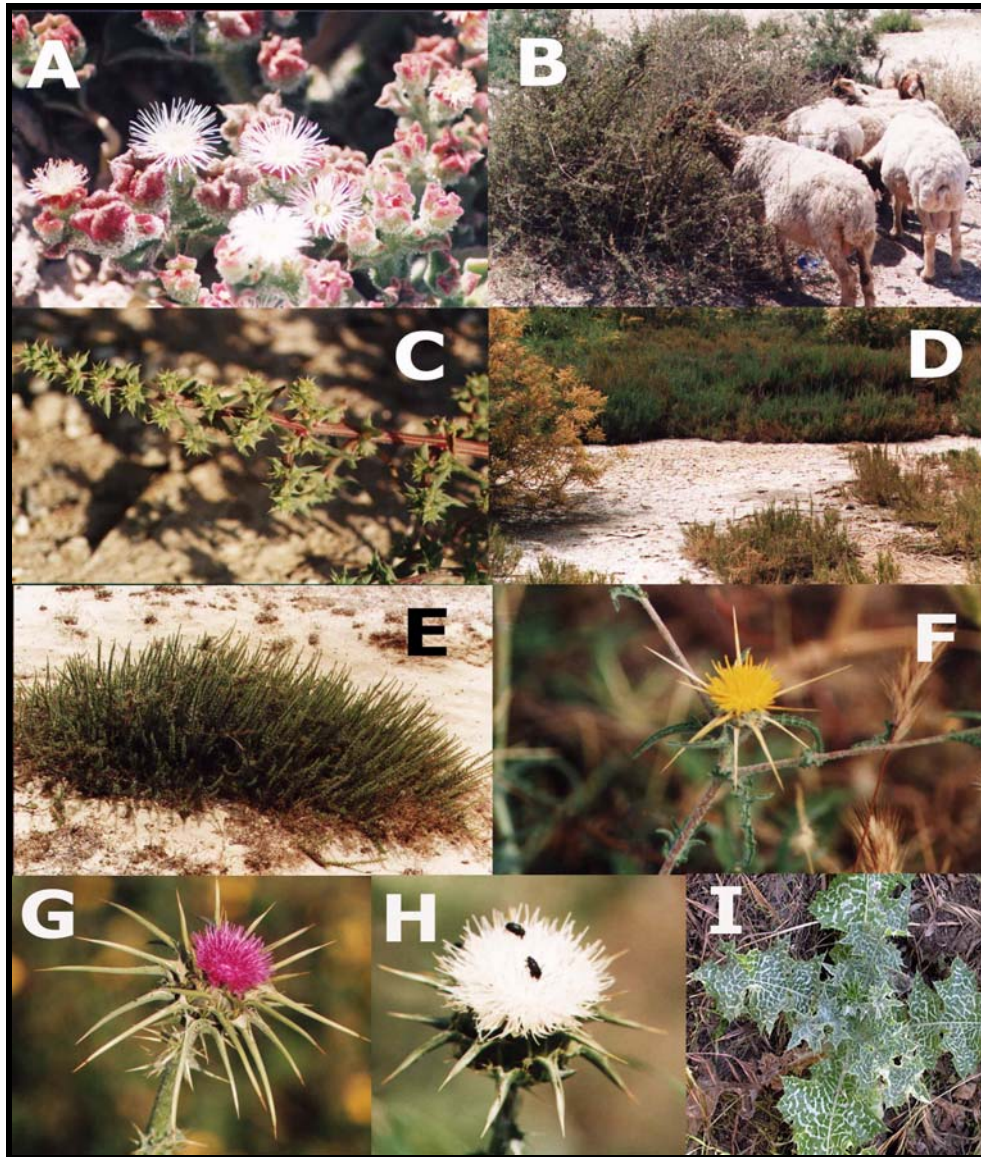


**Figure 2: Flora of Wadi Gaza**

(A) Evergreen Cypress *Cupressus sempervirens* (B-C) Dense mono-specific stands of the Common Reed *Phragmites australis* in the wetland ecosystem of Wadi Gaza and its harvest by local people (D) The harvest of the Giant Reed *Arundo donax* in Wadi Gaza (E) Sea Daffodil *Pancratium maritimum* (F) Date Palm *Phoenix dactylifera* (G) Hottentot Fig *Carpobrotus edulis*

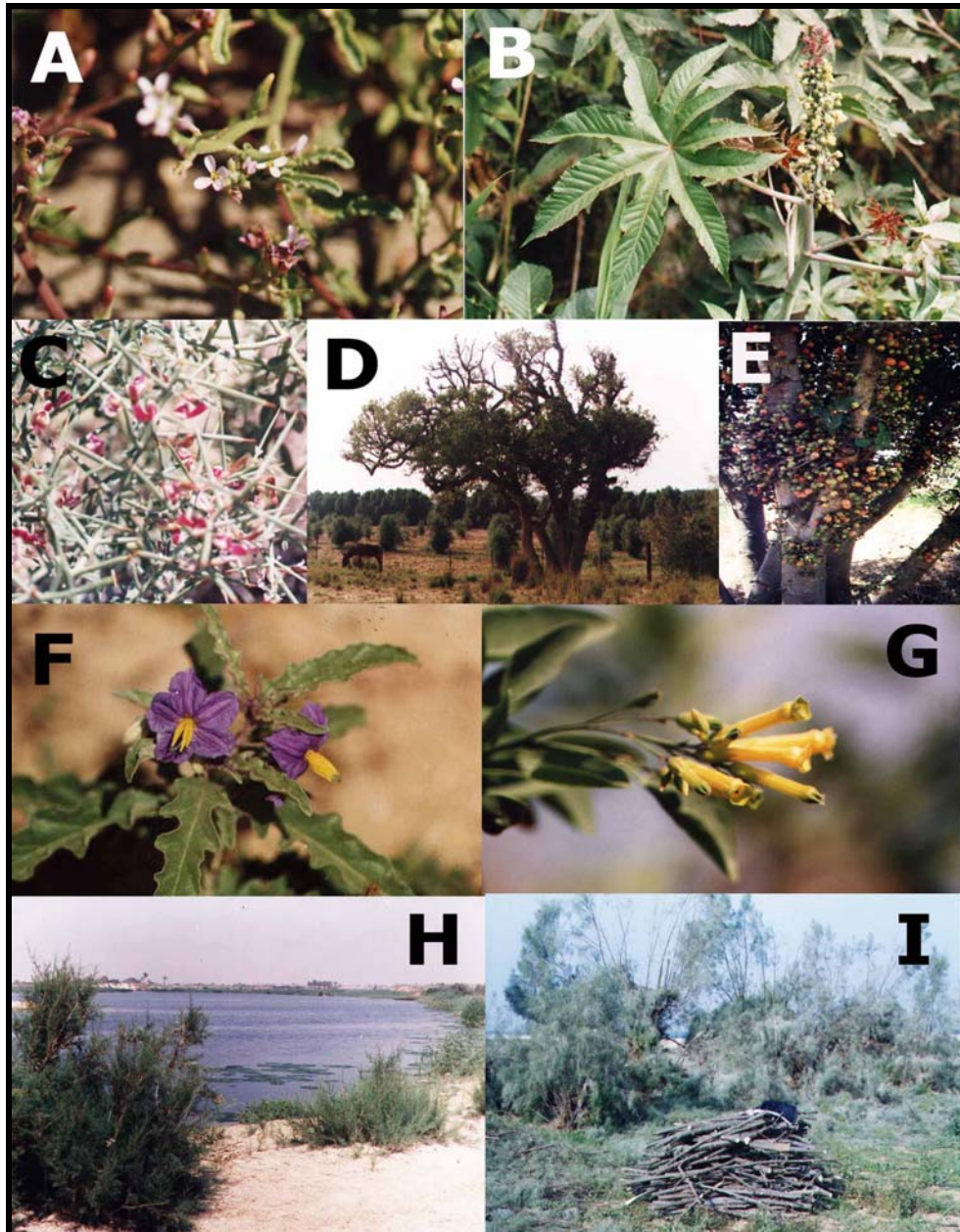


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**Figure 3: Flora of Wadi Gaza**

(A) Common (Crystalline) Ice-plant *Mesembryanthemum crystallinum* (B) Sheep graze on the Shrubby Saltbush (Sea Orache) *Atriplex halimus* in Wadi Gaza (C) Russian Thistle *Salsola kali* (D) Shrubby Swamp-fire (Glasswort) *Arthrocnemum fruticosum* grows in the saline depressions of Wadi Gaza (The soil appears white due to salt accumulation) (E) Sagebrush (Sand Wormwood) *Artemisia monosperma* (F) Knapweed (Cornflower or Pale Star Thistle) *Centaurea pallescens* (G-I) The purple and white flowers and the white mottled leaf of the Blessed Milk-thistle (Marian Thistle) *Silybum marianum*



**Figure 4: Flora of Wadi Gaza**

(A) Sea Rocket *Cakile maritima* (B) Castor-oil Plant (Palma Christi) *Ricinus communis* (C) Camel-thorn *Alhagi maurorum* (D-E) The horizontal growth and fruits of an old Sycamore Fig *Ficus sycamorus* (F) Silver-leaf Nightshade *Solanum elaeagnifolium* (G) The flower of the Tree Tobacco *Nicotiana glauca* (H-I) The shrubs of the Nile Tamarisk *Tamarix nilotica* around the wetland of Wadi Gaza are usually overexploited for its timber which is used as up-righting objects to grapevines



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1. It is used by farmers in the construction of huts (locally known as *Kookh*) and other small buildings inside their farms to be used for resting and storing of agricultural products and agrochemicals.
2. The species has served as decoration and weaving material for various purposes and for the making of arrow shoots, Cactus fruit-gathering poles and musical instruments (locally known as *Shibaba*) especially among Bedouin shepherds.
3. The leaves were used by locals for making bags and baskets, sleeping and sitting mats (small carpets used as a floor covering).
4. The mature stems served for filling in the fences and screens around homesteads and for interior partitions.

**3. Giant Reed *Arundo donax*:** The Giant reed is similar to the Common Reed in its ability to establish a large monoculture area. It usually inhabits moist habitats not far a way from the wetland ecosystem of Wadi Gaza. It was not seen in site II. The plant was observed to harbor an immense variety of wildlife species e.g., the Egyptian Mongoose *Herpestes ichneumon* and Moorhen *Gallinula chloropus*, indicating its importance as breeding sites for many faunistic species. Similar to *Phragmites*, the plant was harvested by locals to make baskets, carpets and many other products in addition to its use as construction material for huts (Figure 2D).

**4. Bermuda Grass (Common Stargrass) *Cynodon dactylon*:** Bermuda Grass is a creeping runner found everywhere in Wadi Gaza particularly in open areas. Economically, the Bermuda Grass provides more and better grazing for horses, sheep and cattle than any other grass. It is also valuable for soil conservation due to its long runners that root at the nodes. In many areas of the Gaza Strip, it is used for lawn and turf especially in ministries, universities, parks, gardens of public and private buildings and even in houses. It can become a serious pest in cultivated lands; difficult to eradicate; its thick network of runners can starve out crops and vast areas of land may become unfit for cultivation. Medically, the Bermuda Grass was reported to be a folk remedy for convulsions, cough, cramps, cystitis, diarrhea, dysentery, headache, hemorrhage, warts and wounds.

**5. Sea Daffodil (*Pancratium*) *Pancratium maritimum*:** The sea Daffodil is found growing around the Mediterranean coastline on the sand beaches (Figure 2E), coastal and inland sand dunes embracing Wadi Gaza at both sites. Its leaves are fleshy, grey-green and strap-shaped. Strongly and sweetly scented, this bulbous plant produces large white blooms or flowers whose six petals frame the corona in the manner of daffodils (*Narjis* in Arabic); hence the common name "Sea Daffodil." The plant is used to add beauty in gardens and houses. Medically, it was stated that the bulbs were

used for treating tumors and many types of cancer.

**6. Date Palm *Phoenix dactylifera*:** The Date Palm species was recorded at the two sites of Wadi Gaza, mainly inside olive and citrus orchards bordering the Wadi course (Figure 2F). The species characterizes an area named as Deir Al-Balah in the Middle of the Gaza Strip. The maximum height of the trees may reach 15-20 meters, as the stem is usually straight and unbranched. The fresh or dried date fruits are usually eaten or sold by locals. Many local, national or even regional food industries are dependent on dates of the Gaza Strip. In medicine, the plant is known to be used to cure many illnesses such as fevers, cystitis and edema. The ripen fruits enhance the contraction of the uterus during delivery and hence mentioned in the Holly Qur'an. The long leaves (*Sa'af* or *Jareed*) are used as cleaning tools or in roofing recreational places. The trunks are usually used in building purposes or industry. Apart of human usage, many wildlife species use the plant in different ways including nesting or resting as in the case of the Doves *Streptopelia spp.* and the Hooded Crow *Corvus corone*, perching as in the case of the Lesser Kestrel *Falco naummani* and many passerine and non-passerine species, and foraging and feeding as in the case of the Egyptian Fruit Bats *Roussettus aegypticus*. Many Syrian Wood-peckers *Dendrocopos syriacus* were seen by the surveyors to peck on the upper parts of the stem; probably for making nesting or resting holes there.

**7. Hottentot Fig (Highway Ice-plant) *Carpobrotus edulis*:** The Hottentot Fig is a ground-hugging succulent perennial that gives roots at the nodes. It has a creeping habit, and often forms deep mats and mono-specific stands covering large areas (Figure 2G). The species is planted in coastal areas facing the Mediterranean Sea and in the high cliffs facing the wetland ecosystem of Wadi Gaza to stabilize the soil and to prevent its erosion.

**8. Common (Crystalline) Ice-plant *Mesembryanthemum crystallinum*:** The Common Ice-plant is a succulent, prostrate (flat), low-growing herb spreading over ground with flat, fleshy leaves. It was only found in saline soils and salt marshes near the estuary of Wadi Gaza. The stem and leaves are covered with tiny glistening or shining vesicles (Figure 3A).

**9. Tuna Cactus *Opuntia ficus-indica*:** This succulent species was commonly seen bordering agricultural fields in both sites of Wadi Gaza and in the whole Gaza Strip as well. A variety of faunistic species were recorded to occur inside the area occupied by this plant species such as snakes, lizards, turtles, Little Owl *Athene noctua* and other bird species. Burrows of rats were seen built beneath the plant. In summer months, the delicious fruits of the species are usually harvested for food. The fruits are also sold in local markets. The young stems of the plant could be eaten by people after

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being cleared from spines. Domestic animals such as camels may also graze on these stems.

**10. Shrubby Saltbush (Sea Orache) *Atriplex halimus*:** The Shrubby Saltbush was commonly seen along the coastal road of the Gaza Strip. In Wadi Gaza, the species was found in the salty marshes, Wadi bed and in agricultural areas not far a way from the observation sites. The plant has a spherical shape with a height not exceeding 2-3 meters. The leaves are small, oval in shape and green to grey in color. It is a shelter for small wildlife species e.g. the Agama *Agama stellio*, lizards, Spur-thighed Tortoise *Testudo graeca*, warblers and other passerines. The plant seems to be a soil binder, i.e. it stops further erosion when it grows on hillsides and high cliffs facing the sea. Moreover, it protects the coastal farms from the adverse impacts of sea winds. In the vicinity of Wadi Gaza, the surveyor used to observe herds of sheep and goats ( $n \geq 150$ ) grazing on the plant in the Wadi bed and the neighboring habitats (Figure 3B). Medicinally, it was claimed by locals that the leaves were used to treat arthritis, rheumatism and other joint pains.

**11. Russian Thistle *Salsola kali*:** The Russian Thistle is an erect, spiny annual plant (Figure 3C). It grows in the two sites of Wadi Gaza, mainly in cultivated fields, pastures, waste areas, irrigated areas, sand dunes and around the edges of the wetland ecosystem of Wadi Gaza. The species was used as fodder for animals and sometimes as a fuel. The species was also said to be diuretic and to regulate blood pressure.

**12. Shrubby Swamp-fire (Glasswort) *Arthrocnemum fruticosum*:** It is a perennial plant growing in the shallow saline depressions of site I of Wadi Gaza, where the soil seemed moist and white due to salt accumulation (Figure 3D). No uses were recorded locally.

**13. Sagebrush (Sand Wormwood) *Artemisia monosperma*:** The Sagebrush is a perennial plant found in both research sites of Wadi Gaza (Figure 3E). It was seen on roadsides, waste areas, sand dunes, Wadi bed and terrace, near the sea and around the wetland. The plant is supported by a woody root stock producing many erected bushy stems that grow from 50 to 120 cm in height. The plant is highly grazed by livestock in Wadi Gaza area. Medically, the species, as claimed by locals, is used to cure certain diseases related to nervous system.

**14. Knapweed (Cornflower or Pale Star Thistle) *Centaurea pallescens*:** This annual plant is commonly observed in the vicinity of Wadi Gaza (Figure 3F). It grows in a variety of habitats and soil types such as the Wadi bed, Wadi terrace, edges of wetlands, cultivated fields and waste areas. No economic use was documented for this plant in Wadi Gaza.

**15. Blessed Milk-thistle (Marian Thistle) *Silybum marianum*:** The Blessed Milk-thistle *Silybum marianum* is an erect, annual herb growing from one to two meters tall in both sites of Wadi Gaza. It inhabits waste and neglected places, abandoned fields, disturbed soils, cultivated areas, dry and rocky areas, old pastures, roadsides, Wadi bed, and the grassy areas surrounding the wetland of Wadi Gaza. The flowers generally appear purple in color (Figure 3G), and sometimes white (Figure 3H). It can be distinguished from other thistles by its distinctive white-mottled leaves (Figure 3I). Economically, the plant was used for grazing and medical purposes which involve seeds and flowers for the treatment of sexual weakness and liver diseases. Many farmers were seen harvesting the plant and transporting it on their donkey carts to feed their livestock.

**16. Spiny Cocklebur *Xanthium spinosum*:** The Spiny Cocklebur was found in a wide range of habitats in both sites of Wadi Gaza, growing in cultivated fields, wastelands, flood plains, and along waterways and the wetland banks. The species is an erect, much branched annual that grows up to about one meter high. Long spines are found in leaf axils and at stem nodes. The burrs of Spiny Cocklebur can become tangled in the hide of cattle and horses and in the wool of sheep and the clothes of people as well. The species is a nuisance to pickers in hand-harvested crops. The locals of Wadi Gaza claimed that the seeds and seedlings of the plant are poisonous, and many poisoning cases have occurred in domestic livestock due to the ingestion of the seedlings. However, the plant may have a medical value as diuretics.

**17. Sea Rocket *Cakile maritime*:** The Sea Rocket is an annual plant of the sand dunes and the sandy upper seashores around the coast of the Gaza Strip (Figure 4A). It tolerates salty conditions. As the surveyors move from the coastline towards the wetland of Wadi Gaza, this species along with the Sea Daffodil were the first plant species to be seen on the coastal dunes i.e., there is a zonation regarding these two plants with respect to salinity tolerance. The species was not recorded in site II of Wadi Gaza. No uses of the species were recorded in the field.

**18. Castor-oil Plant (Palma Christi) *Ricinus communis*:** The Castor-oil Plant (Figure 4B) is a big shrub ranging between 1-4 meters in height. The plant is highly distributed in the Gaza Strip and in both sites of Wadi Gaza. It is often seen bordering agricultural fields along with the gum Arabic *Acacia arabica*. It was also found in neglected and waste areas. The plant seems to be of less use by wildlife because of its brittle structure. Some people said that the species is beneficial in repelling mosquitoes and other annoying insects. Economically, the Castor-oil Plant is used in

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shampoo and soap industry. Many beneficial chemicals are also extracted from the plant. The seeds are of great importance in medicine as they are used as laxatives, anti-parasite drugs, and hair loss and skin treatment. The leaves could be boiled and used to treat back pain.

**19. *Acacia cyanophylla*:** *Acacia cyanophylla* is a about 5-meter high ever-green shrub growing in various localities in Wadi Gaza and the Gaza Strip as well. The species harbors many reptilian and avian species including chameleons, lizards, passerines and doves. As many as four nests of the Laughing Dove *Streptopelia senegalensis* were seen to be built on these shrubs. The plant was also used as windbreaks, sandy soil fixation and for grazing. Shepherds were noticed to graze their sheep and goats in the shrubby areas of *Acacia cyanophylla*. The shrubs were considered as a vital resource to the Palestinian community in the last few decades due to its exploitation as a fuel material. The use of leaves for medicinal purposes was also stated by locals to treat gastrointestinal troubles. Many vast areas were rich in this species in the past, but now the areas are seriously diminished due to residential and agricultural expansions. It is worth mentioning that most areas classified as B according to Oslo Agreement between the Palestinian Authority and Israel in 1994 are rich in this species, and the access of Palestinians to these areas is now forbidden.

**20. Gum Arabic Tree *Acacia Arabica*:** The Gum Arabic plant is usually found in the sedges of agricultural fields and citrus orchards in both sites of Wadi Gaza. The maximum height observed for the plant is around 5 meters ( $n \geq 130$ ). The plant is spiny and thus helpful in preventing people to enter these fields and orchards. A variety of faunistic species including reptiles, birds and mammals were found to exploit the area beneath the shrubs. The burrows ( $N=16$ ) of some animals were seen beneath these plants. Egyptian Mongooses *Herpestes ichneumon* and Blackbirds were seen many times emerging from collections of these shrubs. Other herbal plants including the Least Mallow *Malva parviflora*, the Bermuda Grass *Cynodon dactylon*, the Roman Nettle *Urtica spp.* and others were found to grow in the shade of this *Acacia* species. Economically, the dried twigs and branches of the species were usually used by locals as an energy source. The leaves were used as fodder by grazing animals. Medicinally, the gum was said to cure many diseases, though it was rarely used by locals for this purpose.

**21. Camel-thorn *Alhagi maurorum*:** The Camel-thorn is a perennial, deep-rooted, rhizomatous, grayish green with lance-shaped leaves (Figure 4C). The species is unpalatable and injurious to some animals and even people. The surveyors suffered much from the spines of the species during their visits to Wadi Gaza. The species was seen to invade cultivated fields

causing harm to farmers during harvesting and their normal farming activities. It was claimed by locals that the roots of this species may have a medical importance in curing certain urinary system diseases.

**22. Sycamore Fig *Ficus sycamorus*:** The Sycamore Fig is one of the old and historic plant species in the Palestine coastal valley and the study area as well. Tens of these evergreen trees have been recorded in both sites of Wadi Gaza. The length of old trees was estimated to range between 8 to 20 meters, and the growth of the very old trees is usually horizontal (Figure 4D). The fruits of this plant (Figure 4E) are usually eaten fresh nearly year long by locals. The trees have some medicinal values as the sap extracted from the trunk can cure some skin diseases. The species is under actual threat due to agricultural and residential expansion. From an ecological point of view, the plant provided shade and nesting or resting sites for many wildlife species. In about four occasions, the surveyors saw women collecting the dried branches of the species for fuel purposes.

**23. River Red-gum Tree *Eucalyptus camaldulensis*:** The *Eucalyptus* is a huge evergreen plant species found either single or in small groups in both sites of Wadi Gaza. The height of some was estimated to exceed 20 meters. The species is favored by people because of its elegance, shade provision and, especially, rapid growth. The timber of the species is used in the industry of furniture and the production of coal and for fuel purposes. The green belts of this plant species are good windbreaks protecting agricultural crops from the negative impacts of strong storms and winds. The nectar of the plant is usually imbibed by the honeybee for the production of honey as was admitted by many people rearing the bees. The plant may have a medicinal value through producing of anesthetics and other medical products. Ecologically, the Red-gum trees support some faunistic species to occur and forage. It is worth mentioning that during the first Palestinian uprising (*Intifada*) started in 1987, the Israeli army cut and uprooted hundreds of the *Eucalyptus* trees in the main Salah Ed-Din Road of the Gaza Strip. Nowadays, the road seems to be bare except for some scattered trees here and there.

**24. Christ's Thorn (Seder or Nabk) *Ziziphus spina-christi*:** The Christ's Thorn is a relatively big shrub or tree reaching 5-6 meters in height as was estimated by the surveyors. It was seen in both sites of Wadi Gaza bordering agricultural fields. Many bird species were seen to build their nests on the tree. The timber of these trees is hard and could be used in construction activities and as a fuel. The fleshy fruits are very delicious and are usually eaten fresh or sold in markets. The plant is used as a laxative and in the treatment of diabetes, skin diseases, eye inflammation, parasitic worms and joint diseases.



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**25. Silver-leaf Nightshade *Solanum elaeagnifolium*:** The Silver-leaf Nightshade is one of the most common plant herbs in Wadi Gaza. It occurs in roadsides, construction sites, neglected areas, livestock feeding and watering areas (grazing areas), orchards and other cultivated fields. The violet flowers characterizing the species have 5 fused petals, with bright yellow stamens (Figure 4F). The fruits are yellow to brownish juicy berries. Due to its deep roots, the species seems to lower agricultural crop yield through competition. As mentioned by farmers and shepherds in the vicinity of Wadi Gaza, the species is not desired by livestock and may be toxic.

**26. Tree Tobacco *Nicotiana glauca*:** The Tree Tobacco is a tall ligneous and a much branched shrub that grows abundantly in Wadi Gaza and other localities in the Gaza Strip. It was recorded year round in many habitats of Wadi Gaza including the wetland and its surroundings, the Wadi bed, the Wadi terrace, sand dunes and dumping sites. According to locals, this plant species is not favorable to grazing animals and livestock, due to its toxicity. However, the species owes a medicinal value as it may have a narcotic and sedative impact. From an ecological point of view, the surveyor used to see as many as tens of the Palestine Sunbird *Nectarinia osea* (an endemic bird species in Palestine) favoring the plant and sucking its nectar (Figure 4G).

**27. Nile Tamarisk *Tamarix nilotica*:** The Nile Tamarisk is a tall salt and drought tolerant shrub growing extensively in both sites of Wadi Gaza (Figure 4H). The seedlings were found everywhere in Wadi Gaza terrace, bed, wetland edge and other localities near the channel of the Wadi. The plant is flourishing in the sand dune habitats along the Gaza Strip seacoast as well. *Tamarix nilotica* forms dense and extensive mono-specific stands, especially in the central section of the downstream part of Wadi Gaza. An immense variety of wildlife and domestic species exploits the dense areas of the species for resting, nesting, foraging and other purposes. The plant is overexploited for its timber (Figure 4I) which is used as up-righting objects to grapevines that are grown intensively in the sand dunes surrounding the wetland ecosystem of Wadi Gaza. The exploitation of the species as a fuel material and for charcoal production was documented. Many medicinal uses of the leaves were mentioned by some locals in Wadi Gaza.

## 4. Discussion

Different assemblages of floristic species have been encountered during this study in both sites of Wadi Gaza. The total number of 70 floristic species recorded in this study is smaller when compared to 251 and 128 species recorded in the Gaza Strip and Wadi Gaza in the studies of Boulos [33] and Madi [35] respectively. This could be attributed firstly to

overpopulation and depletion of natural areas especially sand dunes and forested areas due to human encroachment and resource over-exploitation. The role of the Israeli occupation to the Gaza Strip in 1967 and its continual aggression towards the Palestinian environment is highly considered regarding the depletion of natural and human-made resources including natural flora. Vast vegetated areas have been demolished by the Israeli army since the beginning of the second Palestinian uprising started in 2000 because of claimed security reasons [1]. Secondly, the limited study area and the limited period utilized during this study were contributing factors to the relatively smaller number of species encountered here. However, the significance of vegetation cover is attributed to its role in the various ecological operations like its support to wildlife as well as to human beings. The relatively high animal diversity of Wadi Gaza [37, 51, 52, 53, 54] was attributed in part to the dense plant cover either being natural or cultivated and to the various habitats the Wadi Gaza possessed particularly the wetland ecosystem which harbors a diversity of wildlife species [55]. Nearly, all wildlife species depend in a way or another upon the trees, shrubs and grasses characterizing Wadi Gaza. However, the continuous deterioration and/or fragmentation of wild vegetation in Wadi Gaza by local people seem to have adverse impacts on wildlife ecology and population; particularly terrestrial and aquatic birds. The current massive drainage of the wetland ecosystem threatened many wildlife species. For example, the aquatic Coot *Fulica atra*, which was common in the wetland ecosystem of Wadi Gaza in the past, has totally disappeared nowadays [51]. Many studies concerning vegetation structure and vegetation composition and their impacts on wildlife revealed similar results [56, 57].

Due to their cultural and traditional habits, the Bedouins and local people of Wadi Gaza area seemed to depend much on the medicinal uses of Wadi Gaza plants. This could be attributed to their knowledge on the healing power of many floristic species to certain diseases [31] and to the poverty, which characterizes a big sector of Wadi Gaza inhabitants. Moreover, the far distances of clinics from residential areas and the difficulty of reaching these clinics could contribute to herbal medicine dependence. According to Elvin-Lewis [58], herbal medicine seems to substitute the dependence on chemical drugs, particularly in developing countries [25, 27, 59, 60] that suffer from poverty and have a diversity of plant life. Other areas in Palestine including the Israeli Arabs were found to apply herbal medicine for more or less similar reasons [28, 29, 32, 39, 61].

Although real pastures and rangelands are lacking in the Gaza Strip compared to the West Bank [62], grazing is still a common practice by

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Bedouin families inhabiting Wadi Gaza. Such grazing activities could harm the growth pattern of wild plants and fragment the patchy assemblages of plant communities in Wadi Gaza. Consequently, intensive grazing could compact the soil particles and as a result impedes plant growth in some areas [63]. More impacts were mentioned by Belsky *et al.* [64] who pointed out that livestock grazing has damaged approximately 80% of stream and riparian ecosystems in the western United States through trampling and overgrazing of stream-banks, soil erosion, loss of stream-bank stability and declining water quality. These changes have reduced habitats for riparian plant species and wildlife, thereby causing many native species to decline in number or go locally extinct. In the light of these impacts, such grazing activities could be detrimental to the sustainability of Wadi Gaza ecosystem. Logging is another harmful activity in Wadi Gaza, where trees and shrubs were mostly cut for wood and timber production as was mentioned for tamarisks, *Eucalyptus* and *Acacia spp.* The commonest use of wood was found for supporting the loose stems of grapevines, which were intensively cultivated in the area. It is the responsibility of the authorities in charge to find appropriate solutions to stop such deterioration to the shrubby cover of Wadi Gaza, which is vital for wildlife support and sheltering. The other uses of reeds and other common plants seemed to have lesser impacts on plant and animal diversity if these uses are well managed. Although population studies regarding flora in Wadi Gaza have never been conducted, serious botanical studies are urgently needed to explore more about the uses, zonation, distribution and human disturbance of plant cover. It is worth mentioning that zonation regarding the distribution of some halophytic plant species was evident in Wadi Gaza. According to Ali [65, 66] and Ali and Dreyling [67], zonation is attributed to many variables including water availability and distribution, salt tolerance and anthropogenic disturbances. The present practices of some Palestinians towards the ecology of Wadi Gaza make the future of the ecosystem uncertain. The wetland ecosystem is now facing removal or deletion from the map of the area where most of it was drained and the surrounding plants were mostly uprooted. The observation rooms with their leading bridges built in the wetland ecosystem of Wadi Gaza to be used by the scientific parties in birding were totally uprooted and destroyed. No protective measures were adopted by the authorities in charge to stop such destruction to the wetland and its biota and to save this treasure to future generation. Instead, the area of the wetland was transferred to suit construction of various buildings with no considerations to its importance as the only unique coastal wetland ecosystem in Palestine [38]. If this situation continues, the ecology of the

whole area of the Gaza Strip will be degraded in the near future. It is the responsibility of the Environment Quality Authority (EQA) and the different parties to deal with this dangerous situation in a serious way and to promote and re-establish management plans for Wadi Gaza.

Scientifically, this study is preliminary in its style and to complete the picture for Wadi Gaza and the whole Gaza Strip, further biodiversity studies and surveys concerning flora and fauna are highly needed. This is expected to be somewhat easier especially after the withdrawal of the Israeli Occupation and its settlements from the Gaza Strip, which started in 15.8.2005. Most of the restrictions and limitations facing the surveyors like difficulty in accessibility and free movement in Wadi Gaza will be erased and as a result the gates will be opened and better chances are expected for interested parties to investigate more and more about biodiversity and wildlife ecology and dynamics in the area. The near future is expected to be promising for the high educational institutions to start new era of research and accurate documentation.

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