



# Asian Journal of Plant Sciences

ISSN 1682-3974

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## Contribution to the Plant Ecology and the Most Palatable Species for Grazing in the Gaza Strip Mediterranean Coast, Palestine

M.M. Abou Auda

Department of Biology, Faculty of Science, Al-Aqsa University, Gaza, Palestine

**Abstract:** This study carried out a survey during Spring and Summer in 2007 and collected information from people all around Middle Governorate area in Gaza Strip, Palestine. Total number of informants about 145 were interviewed in using a previously prepared questionnaire which related to the environmental and floristic knowledge. The questionnaire addressed each interviewed informant and included several aspects. Thirteen species of wild plants were mentioned by the interviewed informants as the best species for grazing in our study area. The surveyed study demonstrated that there were thirty additional annual plant species that were recognized, under grazing pressure as compared with the species mentioned by the interviewed informants. Various ecological conditions create a mosaic of different plant species. Some of the characteristic species occurring in different habitats of the coastal area in Gaza Strip were examined. The surveyed study demonstrated that there were thirteen plant species with a high adaptability to salinity can grow in the study area. *Solanum elaeagnifolium*, was a common plant species, with a high distribution in all locations of the study area. *Phragmites australis* and *Typha domingensis* were occupied at wetland edges, rich with sewage water.

**Key words:** Environmental knowledge, Floristic knowledge, Gaza Strip, Grazing, Palestine, plant ecology

### INTRODUCTION

The Mediterranean region retains its biological significance due to the high level of plant endemism and the occurrence of many relict species (Alhamad, 2006). The variety of flora is estimated at over 25,000 species (Olson and Dinerstein, 1998). Biodiversity plays a crucial role in ecosystem stability and productivity (Alhamad, 2006). Massive increase in the population (natural and mass emigration) followed by land encroachment for agriculture and urban utilization was reflected on natural resources, particularly species biodiversity (Al-Eisawi *et al.*, 2000). The Palestinian Mountains are rich in plant species, about 2600 species are found on this small Mediterranean area, of which more than 700 were mentioned in published ethnobotanical data (Palevitch *et al.*, 1986; Yaniv *et al.*, 1987; Palevitch and Yaniv, 1991; Ali-Shtayeh *et al.*, 1997, 1998; Ali-Shtayeh and Abu Ghdeib, 1999).

Distribution Atlas of plants in the Flora Palaestina area (Danin, 2004) comprises updated nomenclature, distribution and habitat data for the species in the area covered by Flora Palaestina (Zohary, 1966a, b, 1972a, b; Dothan, 1978a, b, 1986a, b; Dothan and Danin, 1991). Total number of 2750 species in 138 families listed in this Atlas and about 276 were not previously recorded in the Flora Palaestina. About 27 of them are found new to science, described after the publication of Flora

Palaestina; 105 are new adventive species, 34 of them escaped from cultivation and established through spontaneous germination. The marked aliens in the study area were 160 species (5.8% of entire flora). The diversity of habitat in the study area is rather high due to its inclusion of the relatively moist area in the Northern part and the extreme desert areas in the Southern and Eastern parts. Thousands years of stress caused by the grazing of domestic animals in addition to farming and other human activities, led to changes in the flora and the introduction of many Alien species. The vegetation of desert rocks, steppes and coastline in the study area is reviewed in detailed by Danin (1983, 1999) and Danin and Orshan (1999). The most common type of steppe in the semi-arid zone of the study area is shrub-steppe, rather than the steppe dominated by perennial grasses commonly mentioned in East European literature.

The most dominant families of Palestine were the Compositae, Gramineae, Leguminosae, Cruciferae, Labiatae and Liliaceae (PIALES-Palestinian Institute for Arid Land and Environmental Studies, 1996; Ali-Shtayeh and Jamous, 2002, 2003). Approximately 800 of these plants are rarely found and around 140 are endemic (Zohary, 1966a, b). Ali-Shtayeh and Jamous (2002) mentioned that a total number of 334 plant species were recorded to be threatened in the West Bank and Gaza Strip. A number of 219 plant species belonging to 167 genera and 55 families were recorded along Wadi

Gaza area, (2000 dunams) and extends for about 9 km from East to West of the Mediterranean Sea (Abou-Auda *et al.*, 2009a).

There is a limited number of investigations in Gaza Strip, related to environmental and floristic knowledge as well as the wild plant species used to grazing, therefore, the aim of the present contribution was to evaluate: (1) environmental and floristic knowledge of the local population, (2) determination of the most palatable species for grazing and (3) some observations of characteristic species that occur at different habitats of the coastal area, Gaza Strip and Palestine.

### MATERIALS AND METHODS

In order to collect data from people around the area of Middle Governorate in Gaza Strip. Consequently a survey was carried out during Spring and Summer, 2007. The data on the environmental and floristic knowledge was collected from interviewed informants of the study area. The choice of individual informants to be interviewed was according to fundamental importance to the reliability of the gathered information. One hundred and forty five inhabitants were selected based on one of the following criteria: that they have been living in the region for more than ten years and they have grazing sheep and goats. The selection of informants was performed based on a questionnaire which consists of a number of questions about personal experience with the environment around and the flora of the area. The questionnaire was addressed to each interviewed informants and included several aspects such as the knowledge about the floods impact on the overall environment and wildlife in Wadi Gaza area, sources of water in certain locations of Wadi Gaza aquifer, impact of wastewater on biodiversity, sources of solid waste, main agriculture crops, fruit trees, wild shrubs, harmful and useful wild plants, disappearance of some species, threats to plant species, pastures of plant species and trees, overgrazing problem and threats of pastures.

Voucher specimens of species mentioned by informants were collected. Where necessary, the informants were invited to go to the field to collect the plants or where shown by photographs to confirm if the

species were actually the right plants. Different plant specimens and relevant photographs throughout our trips were taken from various locations wherever the most palatable species for grazing sheep and goats were collected.

The study area was thoroughly surveyed throughout the year from time to time to study the characteristic species that occur at different habitats with various ecological conditions such as suffering coastal conditions, soil salinity, sewage water and soil moisture. Specimens were dried by pressing and the identification was carried out. Herbarium specimens were prepared according to usual herbarium techniques and kept at Biology Department in the Faculty of Science, Al-Aqsa University. Identification was carried out according to Täckholm (1974), Zohary (1966a, b, 1972a, b), Dothan (1978a, b, 1986a, b), Boulos (1999, 2000, 2002) and Danin (2000, 2004).

### RESULTS AND DISCUSSION

Table 1 shows that about 44% of the interviewed informants know that the floods affect on the overall environment and wildlife in Wadi Gaza area, 59% know the sources of water in certain locations of Wadi Gaza aquifer, 77% think that wastewater in Wadi Gaza negatively impacts on biodiversity in the Wadi and 73% know the sources of solid waste accumulated in specific area in the Wadi Gaza area.

Table 2 shows that informants with a sound traditional knowledge of the main agriculture crops are (91%), main fruit trees are (91%), main trees and wild shrubs are (86%) and harmful wild plants are (83%). About 53% of the interviewed informants have data about the useful natural plant species. Only 30% of the informants remember the plants which disappeared from the Wadi area and 28% of them can determine these species, time and the reasons of disappearance. Fifty percent of informants remember that there were forests in the area some years ago, 45% remember the forests species and 57% of the informants know the reasons of forests disappearance in Table 2.

A relatively high percentage of interviewed informants (83%), who have an opinion about the real

Table 1: Environmental knowledge of interviewed informants

Questions	N	Sum	Mean	SD	Percent
How long has water flown in Wadi Gaza?	145	169	1.17	0.88	58.28
Do floods occur in Wadi Gaza?	145	226	1.56	0.79	77.93
What is the impact of floods on resident and how they behave?	145	141	0.97	1.00	48.62
How do floods impact on the overall environment and wildlife in Wadi Gaza area?	145	127	0.88	0.99	43.79
What are the sources of water in certain locations of Wadi Gaza aquifer?	145	170	1.17	0.59	58.62
Do you think that wastewater in Wadi Gaza negatively impact on biodiversity in the wadi?	145	224	1.54	0.80	77.24
What are the sources of solid waste accumulated in specific area in the wadi?	145	212	1.46	0.54	73.10
Total	145	1269	8.75	2.49	62.51

Table 2: Floristic knowledge of population

Questions	N	Sum	Mean	SD	Percent
What are the main agriculture crops (vegetables, grains) produced in Wadi Gaza area?	145	265	1.827586	0.396947	91.38
What are the main fruit trees in Wadi Gaza area?	145	263	1.813793	0.471201	90.69
What are the main trees and wild shrubs exist in Wadi Gaza and its use?	145	248	1.710345	0.644606	85.52
What are the species of harmful grasses exist in the wadi and what is its harm?	145	240	1.655172	0.73955	82.76
What are the species of useful grasses exist in the Wadi and what is its use?	145	153	1.055172	0.998466	52.76
Do you remember plants (trees and grass) which disappeared from the Wadi Area?	145	86	0.593103	0.916641	29.66
If you remember, determine its species,time and reasons of disappearance?	145	80	0.551724	0.896994	27.59
Do you remember forests existed before in Wadi Gaza Area?	145	146	1.006897	1.003442	50.34
If you remember, determine species of trees were in such forests?	145	130	0.896552	0.998082	44.83
What are the reasons of forests disappearance from the Wadi Area?	145	165	1.137931	0.990375	56.90
Do you think that there are real notification threatening the wild and plant life in Wadi Gaza?	145	242	1.668966	0.7365	83.45
If so specify these notification?	145	228	1.572414	0.80575	78.62
What do you think about the importance of plant and wildlife?	145	229	1.57931	0.663209	78.97
Are there located areas used or specified for pastures in Wadi Gaza area?	145	235	1.62069	0.782348	81.03
What are the species of plants and trees used as pastures in Wadi Gaza Area?	145	165	1.137931	0.983338	56.90
Do you think that there is overgrazing problem in Wadi Gaza Area?	145	127	0.875862	0.985187	43.79
Do you think there is real notification threatening the pastures in Wadi Gaza?	145	209	1.441379	1.95745	72.07
Do you think that removal of pastures will impact on the extension of wildlife in Wadi Gaza?	145	159	1.096552	0.974139	54.83
Total	145	3370	23.24138	7.486354	64.56

notification threatening the wild and plant life in the area. About 79% of the informants can specify the previous notification and feel the importance of plants and wild life. Eighty-one percent of the informants mentioned that there are no located areas used or specified for pastures in the Wadi area and 57% of them have good knowledge about the plant species and trees used as pastures. Forty four percent of informants accept the overgrazing problem in the area and (72%) think about the threatening of pastures. Finally, medium percentage (55%) of the informants believe that the removal of pastures is important and will positively impact on the extension of wildlife in Wadi Gaza area.

Thirteen plant species of wild plants were mentioned by the interviewed informants as the best species for grazing on our study area, as follows: *Cynodon dactylon*, *Polygonum* sp., *Astragalus* sp., *Trifolium* sp., *Avena wiestii*, *Malva parviflora*, *Papaver humile*, *Tamarix nilotica*, *Rumex* sp., *Vicia* sp., *Alhagi graecorum*, *Polypogon* sp. and *Silybum marianum*. The surveyed study demonstrates that there are thirty additional annual plant species that were recognized, under grazing pressure as compared with the species mentioned by the interviewed informants. These surveyed wild species (most palatable species for grazing sheep and goats) are the following; *Conyza bonariensis* (L.) Cronquist, *Conyza canadensis* (L.) Cronquist, *Spergularia bocconeii* (Scheele) Graebn, *Spergularia diandra* (Guss.) Boiss, *Trigonella arabica* Delile, *Trigonella spinosa* L., *Vicia sativa* L., *Vicia narbonensis* L., *Medicago polymorpha* L., *Medicago truncatula* Gaerten, *Medicago rotata* Boiss., *Astragalus pelecinus* (L.) Bameby, *Astragalus asterias* Hohen., *Astragalus annularis* Forssk., *Astragalus boeticus* L., *Trifolium purpureum* Loisel,

*Trifolium bullatum* Boiss and Hausskn., *Trifolium cherleri* L., *Trifolium palaestinum* Boiss., *Polypogon monspeliensis* (L.) Desf., *Polypogon maritimus* Willd., *Hordeum glaucum* Steud., *Phalaris paradoxa* L., *Crypsis schoenoides* (L.) Lam., *Polgonum equisetiforme* Sm., *Polygonum arenastrum* Boreau, *Urospermum picroides* (L.) F.W Schmidt, *Setaria adhaerens* (Forssk.) Chiov, *Sisymbrium irio* L., *Erodium telavivense* Erg., *Rumex dentatus* L., *Rumex pictus* Forssk., *Eruca sativa* Mill. and *Cyperus rotundus* L. The observation of a large number of the recognized additional species might be attributed to the interviewed informants who cannot distinguish between the different species which belong to the same genus.

Noy-Meir *et al.* (1989) reported that the high incidence of annual herbaceous species compromising wide range of functional group types under light to moderate grazing pressure. Whereas, protected areas were dominated by tall perennial and tall annual grasses. *Tamarix nilotica* is a perennial tree, densely distributed at the Wadi Gaza area, palatable for grazing livestock on only spring season. Our thorough observations throughout the year from time to time demonstrated that sheep and goats did not prefer *Tamarix nilotica* in Summer season.

High soil salinity and unsuitable structure are among the reasons that make difficulty in the establishment and regeneration of saline land plants. Thirteen plants with high adaptability to salinity can grow in the mentioned conditions which were recorded such as, *Tamarix nilotica*, *Cakile martima*, *Mesembryanthemum crystallium*, *Sarcocornia perennis*, *Salsola kali*, *Paronychia argenta*, *Spergularia bocconeii*, *Spergularia diandra*, *Eucalyptus camaldulensis*,

*Casuarina cunninghamiana*, *Acacia saligna*, *Juncus maritimus* and *Artemisia monosperma* are the most important plants that grow in saline soils of the study area. Abd El-Ghani (2000) demonstrates that the cultivation of trees and shrubs of a high ability to consume water, e.g. *Tamarix* sp., *Acacia* sp., *Eucalyptus* sp. and *Casuarina* sp. A new agriculture strategy must be applied in the Egyptian Oases. This strategy should aim at minimization of the amount of water flowing into the lakes, hence avoiding more salinized lands. We also suggest this strategy of trees and shrubs cultivation aimed at minimization and avoiding more salinized lands of Wadi Gaza area.

The vegetation-environmental relationships in the inland saltmarshes of two geographically distant oases of the Western Desert of Egypt, Siwa and Dakhla Oases, are described by Abd El-Ghani (2000). Twelve halophytic plant communities linked to two main habitats (wet-moist and dry-mesic) were identified. *Alhagi graecorum*, *Tamarix nilotica*, *Juncus rigidus* and *Phragmites australis* were most common in the two oases. The most important edaphic variable affecting the distribution and structure of the plant communities are salinity and moisture content. A similar species and environmental conditions were recorded in present study area.

*Solanum elaeagnifolium* was a common plant species, with a high distribution in all locations of the study area, could be regarded as a local problem and is quite noxious due to its rapid spread and probably high competitive ability. The species known as a colonizing invader from various parts of the world (Dafni and Heller, 1980). Madi *et al.* (2002) mentioned that it spreads mainly along roadsides, both sexually and vegetatively, which creates dense populations. Nowadays, it penetrates mainly into gardens, fields and orchards. Due to the rapid spread and regeneration of *Solanum elaeagnifolium*, harmful influences to the field, it is necessary to carry out further investigations.

*Phragmites australis* is occupied at wetland edges, some sites of Wadi Gaza Bottoms fully of sewage water. These findings agreed with Elliman (2005) revealed that the invasive common reed *Phragmites australis* dominates many of the freshwater wetlands of Boston Harbor. Mashaly (2001) stated that *Phragmites australis* occurs as corresponding species with hummock forming halophytes. In addition, Abd El-Ghani (2000) revealed the distribution of swamp *Phragmites australis* vegetation in oases is remarkable and their growth was usually confined to the areas around the waterholes of Springs.

Whereas, we recorded the plant species of *Typha domingensis* only at one site, on the Wadi Gaza

Bottom, rich with sewage water. This is an agreement with Abd El-Ghani (2000), which revealed that *Typha domingensis* has a very limited range of distribution in the saltmarshes of Siwa Oasis in Egypt and did not form a discrete community. According to the plant species salt sensitivity, our findings are in agreement with Simpson (1932) stated that *Typha domingensis* is more sensitive to salt than *Phragmites australis*. Danin (1981) recorded characteristic species that are similar to our mentioned species at local, small depression among sand dunes close to the coast between Haifa and ElArish with fresh-water swamps. The most important species are: *Typha latifolia*, *Typha australis*, *Phragmites australis*, *Juncus acutus* and *Artemisia monosperma*.

Present results strongly agree with finding of Abd El-Ghani (2000) research titled vegetation composition of Egyptian inland saltmarshes, mentioned that the vegetation composition of the inland saltmarshes in western Egypt is a mosaic of twelve plant communities. The most important species are *Alhagi graecorum*, *Tamarix nilotica*, *Phragmites australis* which are ubiquitous species and indicating their wide range of ecological amplitude. Whereas, communities of *Typha domingensis* have a very limited range of distribution.

The phytogeographical analysis emphasized the high level of functional group diversity including trees, shrubs and grasses. Arid and semi-arid regions are often characterized by an abundant flora of annual plants that complete their life cycle within a relatively short favorable growth period (Alhamad, 2006). The highest percent of surveyed plants on the study area were annuals 67.6%, comparing with another life form such as chamaephytes, phanerophytes, hemicryptophytes, cryptophytes, 10.8, 10.6, 10.9 and 4.2%, respectively. Plants with buds higher off the ground (phanerophytes and chamaephytes) are more sensitive to trampling than plants with their buds at or in the ground (hemicryptophytes and geophytes) (Liddle, 1975).

The therophytes along the Egyptian Mediterranean coast approximate 59% of the total Egyptian flora (Hassib, 1951). The relatively high (67.6%) representation of the therophytes in Wadi Gaza area as compared with the Egyptian Mediterranean zone may be related to the high rain-fall of the former (approx. 360 and 200 mm year<sup>-1</sup>), respectively. Generally, the dominance of the therophytes reflects the desertic nature of the area (Arcihold, 1995). Grime (1979) demonstrated the success of several therophytes members to colonize in many highly distributed areas as they have higher reproductive capacity and more ecological, morphological and genetic plasticity. The most important factors

controlling the distribution and richness of plant communities are soil texture, soil moisture, soil salinity, urban effects, bordering agricultural fields, suffering coastal conditions, sewage water and solid waste which create a great variety of ecological conditions for plants (Abou-Auda *et al.*, 2009b).

In conclusion, the cutting of trees and shrubs by people and the digging of valuable herbs are increasingly altering the composition and distribution of plants in the study area. An urgent solutions to stop such deterioration must be planned by responsible authorities. Goats and sheep are the main threat for the vegetation of the study area. Grazing pressure becomes more intense each year and the habitat is being modified as a result in the area. Cultivation of trees and shrubs of a high ability to consume water, e.g., *Tamarix* sp., *Acacia* sp., *Eucalyptus* sp. and *Casuarina* sp. aimed at minimization and avoiding more salinized lands of area. A land management concerned with conservation of species diversity may need to formulate a grazing management plan that maintains different levels of grazing pressure at different parts of the area and during different seasons.

#### ACKNOWLEDGMENTS

Author is grateful to Mr. Nasser deeb from Ministry of Agriculture, Palestine for his useful help of field study and to Dr. Abdul Hafeez El-Eila from Alaqsa University for his useful comments on the manuscript and his correction of the English text.

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