*Arch. Biol. Sci.*, Belgrade, 65 (2), 651-657, 2013 DOI:10.2298/ABS1302651Y

# COMPOSITION AND CHARACTERISTICS OF LIBYAN FLORA

YING FENG*, JIA-QIANG LEI, XING-WEN XU and BO-RONG PAN

*Xinjiang Institute of Ecology and Geography, Chinese Academy of Sciences,* Urumqi 830011, China

*Abstract* - The composition, life forms and the distribution of plants in Libya were studied. The results show that in Libya there are 2103 species that belong to 856 genera and 155 families. The distribution among Libyan seed plants was characterized by a high proportion of herbs (annual to perennial), unlike the low number of woody (tree and shrub) species; these have an important influence on the structure of floral composition. The geographic element of the flora was predominantly tropical and Mediterranean. The local plants belong to representative tropical desert flora. The presence and distribution characteristics of flora in Libya show that climate, environmental condition, ecological amplitude and adaptive capacity of the plants have a determinative influence on the floristic stock in the area studies.

*Key words:* Floristic composition; characteristics; Libyan flora

## INTRODUCTION

Libya is a country in the Maghreb region of North Africa. It is bordered by the Mediterranean Sea, Egypt, Sudan, Chad, Niger, and Tunisia. The region lies between 18°~33°N and 9°~25°E and has an area of 1760000 square kilometers (Fig 1.) consisting mainly of desert and the Mediterranean coast. In Libya, about 94 to 96 % of the land is desert and it is one of the driest countries in the world (Holdridge, 1974). Temperatures are very high with an annual average temperature of 27°C. Rainfall in the northern part of the country varies between 100-500 mm/year; the southern section receives only as much as 10 mm/year and some parts are rainless. The dominant climate influences come from the Mediterranean Sea and the Sahara Desert. The country has several saline lakes but no perennial watercourses (Cowling, 1999). Its desert climate is very hot in the summer, with extreme day/night temperature differences and the winters are mild. Precipitation ranges from light to negligible (Edawi Wheida et al., 2007). The harsh conditions and physical barriers limit human settlements and intensive agricultural activities (Samir Mohammad et al., 2011).


**Fig. 1.** Map of Libya.

**Table 1.** Statistics on generic and species number in families of plants in Libya (genera:species)

| | | | | |
|---|---|---|---|---|
| >50 species (8 families) | | | | |
| Asteraceae (97:237) | Gramineae (93:228) | Leguminosae (42:200) | Brassicaceae (59:100) | Rubiaceae (50:90) |
| Labiatae (22:63) | Caryophyllaceae (18:62) | Boraginaceae (23:53) | | |
| 50-31 species (4 families) | | | | |
| Chenopodiaceae (23:49) | Liliaceae (15:42) | Scrophulariaceae (10:34) | Euphorbiaceae (5:32) | |
| 30-21 species (9 families) | | | | |
| Ranunculaceae (8:29) | Geraniaceae (4: 28) | Cyperaceae (7:26) | Rosaceae (19:25) | Zygophyllaceae (8:25) |
| Solanaceae (10:24) | Malvaceae (10:22) | Polygonaceae (5:22) | Cistaceae (4:22) | |
| 20-11 species (20 families) | | | | |
| Anacardiaceae (11:20) | Crassulaceae (3:18) | Convolvulaceae (3:18) | Alliaceae (1:18) | Orchidaceae (5:17) |
| Plumbaginaceae (3:16) | Plantaginaceae (1:16) | Illecebraceae (5:715) | Agavaceae (6:14) | Rutaceae (5:14) |
| Cucurbitaceae (9:14) | Myrtaceae (6:13) | Iridaceae (5:13) | Tamaricaceae (2:13) | Orobanchaceae (2:13) |
| Resedaceae (5:13) | Oleaceae (6:12) | Urticaceae (4:11) | Amaranthaceae (4:11) | Capparaceae (4:11) |
| 2-10 species (61 families) | | | | |
| Valerianaceae (3:10) | Fumariaceae (1:10) | Papaveraceae (4:9) | Rhamnaceae (5:9) | Aizoaceae (5:9) |
| Lythraceae (4:8) | Verbenaceae (6:8) | Dipsacaceae (2:8) | Asclepiadaceae (8:8) | Juncaceae (1:8) |
| Potamogetonaceae (1:17) | Caesalpiniaceae (5:7) | Apocynaceae (6:6) | Casuarinaceae (1:6) | Mimosaceae (2:6) |
| Campanulaceae (3:6) | Hypecoaceae (1:6) | Primulaceae (5:6) | Commelinaceae (4:5) | Salicaceae (2:5) |
| Moraceae (2:5) | Frankeniaceae (1:5) | Lauraceae (4:5) | Fagaceae (4:5) | Molluginaceae (4:5) |
| Gentianaceae (1:5) | Clusiaceae (1:5) | Bignoniaceae (4:4) | Nyctaginaceae (3:4) | Cuscutaceae (1:4) |
| Amaryllidaceae (2:4) | Arecaceae (3:4) | Buddlejaceae (2:3) | Bombacaceae (2:2) | Ericaceae (2:3) |
| Araceae (3:3) | Caprifoliaceae (2:3) | Tiliaceae (2:3) | Thymelaceae (2:3) | Leonticaceae (2:2) |
| Cactaceae (1:3) | Oxalidaceae (1:3) | Nymphaeaceae (1:2) | Najadaceae (1:2) | Lentibulariaceae (1:2) |
| Lemnaceae (1:2) | Callitrichaceae (1:2) | Acanthaceae (2:2) | Alismataceae (2:2) | Vitaceae (1:2) |
| Portulacaceae (1:2) | Cannaceae (1:2) | Onagraceae (2:2) | Linaceae (2:2) | Typhaceae (1:2) |
| Polygalaceae (1:2) | Santalaceae (1:2) | Juncaginaceae (1:2) | Saxifragaceae (1:2) | Globulariaceae (1:2) |
| Strelitziaceae (1:2) | | | | |
| 1 species (42 families) | | | | |
| Coridaceae (1:1) | Theligonaceae (1:1) | Violaceae (1:1) | Neuradaceae (1:1) | Cynomoriaceae (1:1) |
| Vahliaceae (1:1) | Salvadoraceae (1:1) | Dioscoreaceae (1:1) | Rafflesiaceae (1:1) | Cymodoceaceae (1:1) |
| Posidoniaceae (1:1) | Punicaceae (1:1) | Pedaliaceae (1:1) | Elatinaceae (1:1) | Ceratophyliaceae (1:1) |
| Sterculiaceae (1:1) | Sapindaceae (1:1) | Meliaceae (1:1) | Myoporaceae (1:1) | Tropaeolaceae (1:1) |
| Juglandaceae (1:1) | Pittosporaceae (1:1) | Tetragoniaceae (1:1) | Menispermaceae (1:1) | Ruppiaceae (1:1) |
| Zannichelliaceae (1:1) | Araliaceae (1:1) | Balsaminaceae (1:1) | Simarubaceae (1:1) | Celastraceae (1:1) |
| Sapotaceae (1:1) | Aristolochiaceae (1:1) | Passifloraceae (1:1) | Ulmaceae (1:1) | Sparganiaceae (1:1) |
| Aceraceae (1:1) | Aquifoliaceae (1:1) | Polemoniaceae (1:1) | Musaceae (1:1) | Begoniaceae (1:1) |
| Phytolaccaceae (1:1) | Hydrocharitaceae (1:1) | | | |

Xinjiang is one of the more serious desertifications in China, but ecological engineering along the shelterbelt of the Tarim Desert highway is well known in the world, and the successful ecological wind preventing and sand binding have attracted the attention of African countries such as Libya and Syria. For this reason, the Xinjiang Province of China and the Libyan Arab Republic set up a desertification control technical cooperation project. Both parties agreed that Chinese researchers complete 4 km of road in drift desert sand, 20 km of gravel desert highway and 150 km of the coastal highway as sandstorm disaster experiments and demonstrations. We helped train local technical personnel. Due to differences between the Xinjiang desert and sub-Saharan Africa, especially in winter when the temperature varies more than 30°C, the ecological management and choice of tree species to be planted need to be adjusted to those familiar with local sand-fixation.

The floristic composition of plants in Libya is still comparatively unknown as far as in-depth ecological and botanical studies go (Pergent and Djellouli, 2002). The present paper provides an overview of plant diversity in Libya, with special reference to phytogeography and the identification of vegetation patterns. In addition, we provide the first tentative guidelines towards the protection and utilization of indigenous plants.

### *Floristic compositions in Libya*

This study is based on the analysis of flora by Ali and Jafri (1976) and Klopper et al. (2007). There are 2103 species belonging to 856 genera and 155 families in Libya. The main component of the flora, 2088 species, 844 genera and 145 families, are angiosperms. Fifteen species of 12 genera and 10 families are Pteridophyta, but gymnosperms appear in mountains.

From Table 1 it can be seen that Libyan plants are comparatively rich in number. The great majority of the families are widely spread (Aqciteex, 1985; Hammer K et al., 1988; Keith, 1965). The dominant families in Libya are Asteraceae (237 species), Gramineae (228 species), Leguminosae (200 species), Brassicaceae (100 species), Rubiaceae (90 species), Labiatae (63 species), Caryophyllaceae (62 species), Boraginaceae (53 species) and Chenopodiaceae (49 species). The dominant families encompass 51.8% of the species found. Libya's dominant genera are *Euphoria* (27 species), *Astragalus* (25 species), *Silene* (23 species, *Trifolium* (22 species, *Allium* (18 species), *Medicago* (18 species), *Erodium* (15 species), *Lotus* (15 species), *Ranunculus* (14 species) and *Helianthemum* (14 species). The dominant genera include only 9.15% on the species level, but these all belong to large and widely spread genera in arid zones (Szafer, 1964).

### *Life forms*

Life forms are given in Table 2. The life form distribution among Libyan plants was characterized by a high proportion of herbs (annual to perennial). The low number of woody (tree and shrub) species in our dataset reflects the defensive capabilities of the vegetation in bad conditions (such as drought), i.e. the lack of moisture in Libya. It seems that the herb life form is the preferable strategy in the temperate deserts of the studied area.

This is not only a reflection of the growth strategy, but also of the presence of highly adapted, drought-resistant species. These xerophytes are widely distributed in the subhumid and semiarid tropics and play major economic and ecological role. Therefore, these are very successful species, capable of stabilizing mobile sands by their rapid growth and long roots (Higgins et al., 1997). We should pay more attention to the matching ability between the protective effect of different life forms and the time of occurrence of strong winds and sandstorms during ecological "building" of vegetation so that the ground could be more efficiently and ecologically protected.

### *Geographical elements*

#### *Geographical elements of family level*

Floristic elements have been considered as useful tools in phytogeographical analysis (Preston and Hill, 1997). This is an important method in floristic

**Table 2.** Statistics and comparison of life forms of plants in Libya

| Life form | Tree | Shrub | Liana | Parasitical plant | Annual herb | Perennial herb | Total |
|---|---|---|---|---|---|---|---|
| No. of species | 133 | 234 | 44 | 14 | 858 | 805 | **2088** |
| Percentage of species | 6.4 | 11.2 | 2.1 | 0.7 | 41.1 | 38.6 | 100 |

**Table 3** Geographical elements of family level of plants in Libya

| No. | Distribution types | No. of family | Percentage in family (%) |
|---|---|---|---|
| 1 | Widespread | 52 | 35.9 |
| 2 | Pantropic | 47 | 32.4 |
| 3 | Tropical and Sub Tropical | 8 | 5.5 |
| 4 | Old World Tropic | 1 | 0.69 |
| 5 | Tropical Asia to Tropical Australasia and Oceania | 1 | 0.69 |
| 6 | Tropical Asia to Tropical Africa | 6 | 4.14 |
| 7 | Tropical Asia | 1 | 0.69 |
| 8 | North Temperate | 17 | 11.7 |
| 9 | East Asia and North America disjunct | 1 | 0.69 |
| 10 | Old World Temperate | 4 | 2.76 |
| 11 | Temperate Asia | 5 | 3.45 |
| 12 | Mediterranean, West Asia to Central Asia | 1 | 0.69 |
| 13 | Extra Tropical transpacific disjunction | 1 | 0.69 |

**Table 4.** Geographical types of genera of plants in Libya

| No. | Distribution types | No. of genera | Percentage in genera (%) |
|---|---|---|---|
| 1 | Widespread | 128 | 15.2 |
| 2 | Pantropic | 161 | 19.1 |
| 3 | Tropical Asia and Tropical America disjunct | 33 | 3.9 |
| 4 | Old World Tropics | 31 | 3.7 |
| 5 | Tropical Asia and Tropical Australasia | 12 | 1.4 |
| 6 | Tropical Asia to Tropical Africa | 38 | 4.5 |
| 7 | Tropical Asia | 7 | 0.8 |
| 8 | North Temperate | 117 | 13.9 |
| 9 | East Asia and North America disjunct | 12 | 1.4 |
| 10 | Old World Temperate | 96 | 11.4 |
| 11 | Temperate Asia | 5 | 0.59 |
| 12 | Mediterranean, West Asia to Central Asia | 177 | 20.9 |
| 13 | Central Asia | 11 | 1.3 |
| 14 | East Asia | 12 | 1.4 |
| 15 | Endemic to Libya | 4 | 0.47 |

research to divide distribution into different area-types. According to the Chinese botanist Wu's documentation (2003), the distribution type in Libya at the family level was counted and is presented in Table 3 as the percentage, relative contribution to the family.

*Geographical elements of generic level*

Szafer (1964) and Wu (1991) have proposed that geographical elements of genera are the greatest contributors to the analysis of flora. Meanwhile, some genera contain species that have the same origin and similar evolutionary trend. Thus, from the viewpoint of phytogeography, genera accurately reflect plant systematics, evolution and regional characteristics. In order to demonstrate the floristic characteristics of the flora of Libya, the genera have been studied and classified according to the Wu system (1991). Statistics show that the geographical elements are multiple since there are 16 area-types in this region (Table 4).

Among them, the type of tropical distribution (2-7 types) compose 282 genera, or 33.4% of the total genera; such genera include *Aristida*, *Impatiens*, *Euphorbia*, *Paspalum*, *Phaseolus*, *Heliotropium*, *Acacia*, *Celosia,* etc., and shows the highest percentage among plant types. The Mediterranean type includes genera such as *Alhagi*, *Anabasis*, *Bassia*, *Calligonum*, *Cardaria*, *Cistanche*, *Nitraria*, *Triticum*, *Haloxylon,* etc. (20.9%), and shows the second highest percentage group. Next is the type of widespread distribution, such as the genera *Xanthium*, *Senecio*, *Salsola*, *Phragmites*, *Ranunculus*, *Carex*, *Astragalus*, *Lepidium* etc. (15.2%), immediately followed by the North Temperate types, *Acer*, *Allium*, *Avena*, *Capsella*, *Alopecurus*, *Cirsium*, *Iris*, *Malva*, *Potentilla*, *Populus* etc., which contribute 13.9%. Only four are endemic to Libya, such as the genera *Oudneya* and *Pseuderucaria,* all in Brassicaceae. Undoubtedly, the tropical and Mediterranean elements were the main part of local flora. These results strongly support the floristic affinity of geographical location. Libyan flora has strong tropical features and tropical nature. It is fully proved that the methods of quantitative classification can objectively reflect plant origin and relationships of each area type can be shown by such classification.

*Survey of main ecological systems in Libya*

*Coastal ecosystems*

Coastal ecosystems are from 25-100 km wide in the northern regions of Libya. In this area, the annual rainfall is about 200-250 mm. Over 75% of vascular plants are distributed in the coastal areas, such as *Acacia spp., Borassus, Phoenix* etc. The ecotype consisted of Mediterranean groups of xerophytes that protect shorelines from erosion and storms (Fig 2).

*Mountain ecosystem*

The mountain ecosystem is located in the western mountains of Libya, Nafosa Mountain and Green Mountain. It ranges from dry mountain forests at low elevations to mountaintop vegetation. Only 0.1% of the land (about 217000 $m^2$) is woodland, with annual rainfall of about 200-300 mm. However, these forests should be more accurately called Mediterranean coast shrub. The native forest is the richest; the biodiversity index is the highest. The dominant species were *Cupressus sempervirens*, *Eucalyptus camaldulensis*, *Melia azedarach* and *Olea europaea*.

*Semi-desert ecosystem*

Semi-desert ecosystem regions are located in the transitional zone between the mountain and desert zones, with an annual rainfall of about 50-150mm.

*Desert ecosystem*

Since 90% of Libya is desert, this ecosystem is the most characteristic. The desert landscape ecosystem is made up of three landscape types: rocky desert, sandy desert and congenital desert. Here, the climate is hot and dry, the desert ecosystem has sparse vegetation and small biomass, and the eco-environment is fragile. Due to human activity, the eco-environment is severely degraded. Pioneer species formed a

**Fig. 2.** Showing Natural Vegetation Status in Libya

unique form of adverse environment, with strong resistance to drought and barren stress. Such forms are *Haloxylon schweinfurthii*, *Acacia flava*, *Aristida acutiflora*, *Euphorbia abyssinica*, *Calligonum comosum*, *Acacia senegali*, *Cordia africana*, *Tamarix mannifera* and *Salsola tetrandra.*

## CONCLUSION AND DISCUSSION

Libya is a country with more than 94% of desert area, a narrow Mediterranean coast and a vast expanse of arid regions. There are 2103 species belonging to 856 genera and 155 families in Libya. The floristic composition in Libyan reflects the plant strategy to resist atrocious weather.

The life form distribution among Libya plants was characterized by a high proportion of herbs (annual to perennial) and a low number of woody (tree and shrub) species. These reflect the defensive capabilities of vegetation in such drought conditions.

The geographical elements of Libyan flora are dominated by the Mediterranean Sea and the Sahara Desert. The floristic elements and distribution characteristics also indicate that the climate and environmental conditions, ecological amplitude and adaptive capacity of the plants are influenced by the floristic origin and spatial patterns of plant diversity. Plant community patterns can be a functional tool for ecological restoration. Therefore, native species should be used for cultivation and regional vegetation should be used during the process of ecological recovery and rehabilitation. We hope to develop a predictive understanding of the structure and function of plant ecosystems in order to provide insight

into the sensible management and use of the region's natural resources. Such research will improve our global understanding of the ecology of arid lands.

*Acknowledgments* - This research was supported by International Cooperation Program of China "China-Libya desertification control technical cooperation projects" (No. Y165061001, No.Y165041). The authors gratefully acknowledge data collection assistance by Patima and Kong Da Kui.

## REFERENCES

*Aqciteex, A.O.* (1985). Status of plant genetic resources in the Libyan Arab Jamahiriya. *Plant Genetic Resources*. **62**, 25-27.

*Cowling, R. M., Esler K. J.* and *P. W. Rundel* (1999). Namaqualand, South Africa – an overview of a unique winter-rainfall desert ecosystem. *Plant Ecology* **142**, 3-21.

*Hammer, K., Lehmann, C.O.* and *P. Perrino* (1988). A check-list of the Libyan cultivated plants including an inventory of the germplasm collected in the years 1981, 1982 and 1983. *Kulturpflanze*. **36**:475-527.

*Higgins, S., Rogers, K.H.* and *J. Kemper* (1997). A description of the functional vegetation pattern of a semi-arid floodplain, South Africa. *Plant Ecol* **129**, 95-101.

*Holdridge, L.R.* (1974). Determination of world plant formations from simple climatic data. *Science*. **105**,367-368.

*Jafri, S.M.H.* and *S.I. Ali* (1981). Flora of Libya, Tomus (1-145). Published by Dept Botany, Al-Faateh Univ. in Tripoli .

*Keith, H.G.* 1965. A preliminary check list of Libyan flora. 2 vols. Ministry of Agriculture and Agrarian Reform, London.

*Klopper, R.R., Gautier, L., Chatelain, C., Smith, G.F.* and *R. Spichiger,* (2007). Floristics of the angiosperm flora of sub-Sahara African: an analysis of the Africa Plant Checklist and Database. *Taxon* .**56**, 201-208.

*Laubenfels, D.J.* (1975). Mapping the world's vegetation: regionalization of formations and flora. Syracuse University Press, Syracuse.

*Mabberley, D.J.* (1997) The plant-book, a portable dictionary of the vascular plants. Secedi. United Kingdom Cambridge University Press.

*Miller, A.G.* and *T.A. Cope* (1996). Flora of the Arabian Peninsula and Socotra. Vol .1. Edinburgh University Press, Edinburgh, UK.

*Pergent, G.* and *A. Djellouli* (2002). Characterization of the benthic vegetation in the Farwà Lagoon (Libya). *Journal of Coastal Conservation* **8**, 119-126.

*Preston, C.D.* and *M.O. Hill* (1997). The geographical relationships of British and Irish vascular plants. *Botanical Journal of the Linnean Society*. **124**, 1-120.

*Samir Mohammad Ali Alredaisy*. (2011). Recommending the IHACRES model for water resources assessment and resolving water conflicts in Africa. *Journal of Arid Land*, Vol. **3**(1), 40-48.

*Szafer, W*. (1964). General Plant Geography. Warszawa. PWN-Polish Scientific Publishers.

UNESCO-FAO. 1963. Bioclimatic map of the Mediterranean zone. UNESCO arid zone research. Vol. 21-58.

*Wheida, E.* and *R. Verhoeven* (2007). An alternative solution of the water shortage problem in Libya. *Water Resource Manag.* **21**:961-982.

*Wu, Z.Y., Zhou, Z.K., Li, D.Z.* and *H. Peg* (2003). The areal-types of the World Families of Seed Plant. *Acta Botanica Yunnanca*.**25** (3), 245-257.

*Wu, Z.* (1991). The areal-types of Chinese genera of seed plants. *Acta Botanica Yunnanica* (Supp1. IV), 1-139.