Biodiversity in Libya: Selected Countries in Africa

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CHAPTER 5

Biodiversity in Libya

MAHKLOUF H. MOHAMMED[1] and ETAYEB S. KHALID[2]

[1]Department of Botany, Faculty of Sciences, Tripoli University, Libya,
E-mail: mahklouf64@yahoo.com
[2]Department of Zoology, Faculty of Sciences, Tripoli University, Libya,
E-mail: khaledetayeb@yahoo.com

5.1 Introduction

Libya occupies a part of northern Africa from 20 to 34° N and 10 to 25° E. It is bounded in the east by Egypt (1,150 km)^2, in the west by Tunisia (459 km^2), and Algeria (982 km^2), Mediterranean Sea in the north, and by Sudan (383 km), Chad (1,055 km^2), and 'Niger (354 km^2), in the south (CIA, 2004). It has an important physical asset by its strategic location at the midpoint of Africa's northern rim. The total area of Libya is about 1.76 Million km^2; it ranks fourth in the area among all countries of Africa and 15th among all countries on earth (McMorris, 1979). More than 95% of Libya is desert, which is a part of Sahara, that is the most extensive area of severe aridity. The aridity of the central and eastern Sahara is due to its domination by continental tropical air all-year, which is continually descending from the upper levels of the atmosphere where, in these latitudes, anticyclone conditions are permanent.

The cultivable areas are estimated slightly over 2% of the total area (Ben Mahmoud, et al., 200). The fertile lands of Jifara Plain in the northwest, Jebal Al-Akhdar in the northeast and the coastal plain east of Sirt receive sufficient precipitation to support agriculture. As a result, more than 90% of Libyan population resides there. Between the productive lowland agriculture zones lies the Gulf of Sirt that stretches 500 km along the coast, from where deserts extend northward to the sea. Libya's total population was at 5.9 million in 2004 including more than 500,000 non-nationals; Almost 95% of the population lives in the coastal region in the north, and the rest in widely scattered oases in mid- and southern Libya.

According to the population distribution in Libya based on 2001 estimation, people concentrate on two centers, the first, in the northwest (Jifara Plain) where about 60% of all Libyans live, including Tripoli city – the capital of Libya – where more than 1 million people live, and the second center in northeastern Libya (Ben-Ghazi Plain).

5.2 Floral Diversity of Libya

Libya is characterized by a beautiful plant cover, especially during spring. As the traveler moves along the coastal highway, he observes numerous plant species with attractive flower colors. Also, the hills, mountains, the desert with its oasis, and the valleys dissecting these huge lands are as much wonderful as the coastal area. Each area has its own attraction and flowers.

Libya consists of three main local botanical habitats: the coastal, the mountainous, and the desert habitats with their crossing valleys from south to north and from west to east. More than 1800 plant species are flourishing in these habitats. These plant species form a vegetation type with variable features (Boulos, 1972). The original vegetation of the coastal area is dominated by wormwood (*Artemisia campestris*) and white broom (*Retama raetam*) with some early spring flowering plants such as *Senecio gallicus, Hussonia pinnata, Eruca sativa, Chrysanthemum segetum, Malva sylvestris,* and *Erodium laciniatum,* in addition to the perennial herb *Echium angustifolium*. Aljabal Alakhdar area comprises the most wonderful plant diversity in Libya. This area is characterized by the red alluvial soil (terra rosa), relatively good rainfall (up to 600 mm/annually in certain locations), and closeness to the sea. The dominant plant species are *Arbutus pavarii, Juniperus phoenicea, Olea europaea* var. *oleaster, Pistacia lentiscus, Phlomis floccosa*, and *Cupressus sempervirens*. The western mountain is dominated by the true esparto (halfa) *Stipa tenacissima* with *Asphodelus microcarpus.* Remnants of *Pistacia atlantica* exist in certain locations. The desert, well known by its dryness, constitutes the most area of Libya with low plant cover of poor diversity especially the sand dune covered areas lacking crossing valleys. The sand sea south of Jaghboub along the Egyptian border and sand dunes of Rebyana north east of Kufra, the Murzuq basin are examples of huge areas covered with sand. Here, the rainfall is few millimeters or nil for several successive years.

The plant species in the desert valleys are totally different from those in the coastal or mountainous areas. The life signs are clear in the oasis and valleys of the desert represented by date palm trees (*Phoenix dactylifera*), *Tamarix* shrubs, white broom (*Retama raetam*), lotos (seder) *Ziziphus lotus*, European boxthorn (Ausej) *Lycium europaeum*, *Acacia* trees (*A. tortilis*), and the perennial grasses such as the panic turgid grass (*Panicum turgidum*), Sbut (*Stipagrostis pungens*), *S. plumosus*, and members of the Compositae as *Francoueria crispa* (crisp fleabane), *Artemisia judaica, Hyoscyamus muticus* (the Egyptian henbane) of the Solanaceae, and *Zilla spinosa* (shobrum) of the Cruciferae. The coastal areas are well known by its flower-

ing colored spring. During the spring season, many annual plants appear dominating large spots in a short time after the winter rainfall. These annuals flower in the early spring or even during the sunny warm days of winter. Examples of some early spring flowering plants are *Senecio gallicus, Hussonia pinnata, Eruca sativa, Chrysanthemum segetum, Malva sylvestris,* and *Erodium laciniatum*. These annuals shed fruits and dry just before summer. This phenomenon is applicable to ephemerals of the desert habitats where the rain usually falls in late summer or early autumn.

Salt marshes occur along the coastal strip and dominated by halophytes. These are mostly succulent plant species belong mainly to the family Chenopodiaceae, few other plants belong to the families Zygophyllaceae and Plumbaginaceae. Examples of halophytes are *Suaeda* sp., *Atripkex halimus* (qataf)*, Limoniastrum monopetalum* (zeta), *Limonium pruinosum* (sea lavender or thrift), *Nitraria retusa* (ghardaq or sea plum)*,* and *Zygophyllum album* (belbal). The winter rain lowers the salinity rate and compensates the evaporated water during summer allowing some salt tolerable annuals such as branching century *Centaurium pulchellum* to appear.

5.2.1 Floristic Composition

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 analysis of flora according to Jafri and Ali (1981) and Klopper et al. (2007) (Feng et al., 2013) resulted in occurrence of about 2,118 species belonging to 864 genera and 161 families in Libya, of them 2,088 species, 844 genera and 145 families, are Angiosperms, 15 species of 8 genera and 6 families are Gymnosperms and 15 species of 12 genera and 10 families are Pteridophyta.

From Table 5.1 it can be seen that Libyan plants are comparatively rich in number. The great majority of the families are widely spread (Aqciteex, 1985; Hammer 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) (Table 5.2).

Table 5.1. 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),

Table 5.1. (Continued)

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)

Table 5.2. Dominant Families in Libya

Global		Local		
Species	**Genus**	**Species**	**Genus**	**Family**
1,100	25,000	237	97	Asteraceae
700	11,000	228	93	Poaceae
500	2,000	200	42	Fabaceae
350	3,000	100	59	Brassicaeae

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) (Table 5.3).

5.2.2 Life Forms

Life forms are given in Table 5.4. 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 (Table 5.4).

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.

Table 5.3. Dominant Genera in Libya

Genus	Global No	Libyan No
Euphorbia	2,000	26
Astragalus	1,500	25
Silene	500	23
Trifolium	300	22
Medicago	60	18
Lotus	100	15
Erodium	90	15
Convolvulus	250	14
Stipagrostis	50	13
Echium	40	13

Table 5.4. 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

5.2.3 Geographical Elements

5.2.3.1 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 research to divide the distribution into different area types. According to the Chinese botanist Wu's documentation (Wu et al., 2003), the distribution type in Libya at the family level was counted and is presented in Table 5.5 as the percentage, relative contribution to the family.

5.2.3.2 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

Table 5.5. 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 disjunction	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

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.

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 (Table 5.6).

5.3 Survey of Main Ecological Systems in Libya

5.3.1 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.,

Table 5.6. 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 disjunction	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 disjunction	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

Borassus, Phoenix, etc. The ecotype consisted of Mediterranean groups of xerophytes that protect shorelines from erosion and storms.

5.3.2 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 217,000 m^2) is woodland, with an 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 regions are located in the transitional zone between the mountain and desert zones, with an annual rainfall of about 50–150 mm.

5.3.3 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 ecoenvironment is fragile. Due to human activity, the ecoenvironment is severely degraded. Pioneer species formed a 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* (Feng et al., 2013).

5.3.4 Important Plant Areas in Libya (IPAS)

Botanically and in terms of threatened habitats, there are five general important plant areas in Libya, representing the coastal belt, mountainous, and desert habitat types. Those are Jabal Alakhdar, Jabal Nafusah, Tawuorgha wetland on the coast, the Messak area at the southwestern part, and the Alaweinat at the southeastern corner on the borders of Egypt and Sudan, with a further six areas that require study to confirm their status as internationally significant sites for plants (Alheesha, Farwa Island, Mamarica, Jabal Al Harouj and Benghazi Coast, Msellata Natural Resesrve). The oil

exploration, hunting, overgrazing, and tourism are the main threatening factors for the biodiversity of those habitats.

Tawuorgha is characterized by a hot spring making a small lake. Its water runs in open canals providing wet habitats for many aquatic plant species. The *Phyla nodiflora* of the Verbenaceae family was discovered in 2002 to grow there after reporting it as an extinct species from Libya. For Jabal Nafusah (the western mountain) which extends for 500 km from the Tunisian borders to Niggaza area on the seashore. Sha afeen protected area (or national bark) is a recently established protected area characterized by the newly recorded species *Bupleurum jibraltaricum* Lam. (Umbelliferae) which represents the western limit of its range of distribution (starting from south Spain). *Ebenus pinnata* Ait. (Fabaceae) is endemic to North Africa existing in the reserve and other locations on the mountain.

There are some efforts towards making the Akakoos desert mountainous area, close to the Messak, as a national reserve by cooperation with Catania university of Italy. During October 2001, the French Total oil company conducted an excellent environmental baseline study for the Messak resulted in lists of biodiversity components of the area. Jabal Alharuj al Aswad needs more investigation; even it is subjected to a lot of misuses, before identifying it as an important plant area. Oil companies exploring the area are required to do environmental impact assessment studies before they get permission to start seismic work and drilling. However, strict following up is much needed.

The Environmental General Authority (EGA) is planning to conduct an investigation for the Alaweinat at the southeastern corner of the country. Of course, there are previous studies for the area conducted by Boulos (1972). Libyan IPAs face a number of threats including the development of tourism infrastructure, overgrazing of livestock, forest cutting for wood and charcoal and the spread of invasive alien species. Unregulated development at the coast is a particular threat. Planning processes are erratic and environmental impact assessments (although required by law) are seldom completed or adhered to (Figure 5.1).

Here, we will focus on Al-Jabal Al-Akhdar IPA (The Green Mountain), which is a priority IPA.

5.3.4.1 Jabal Akhdar

Jabal Akhdar is located in the northeastern part of the country bordered by the sea from the north and west, the Marmarica Plateau at the east, and the desert at the south (320–330 N and 200–230 E). Al Jabal Al Akhdar IPA (The

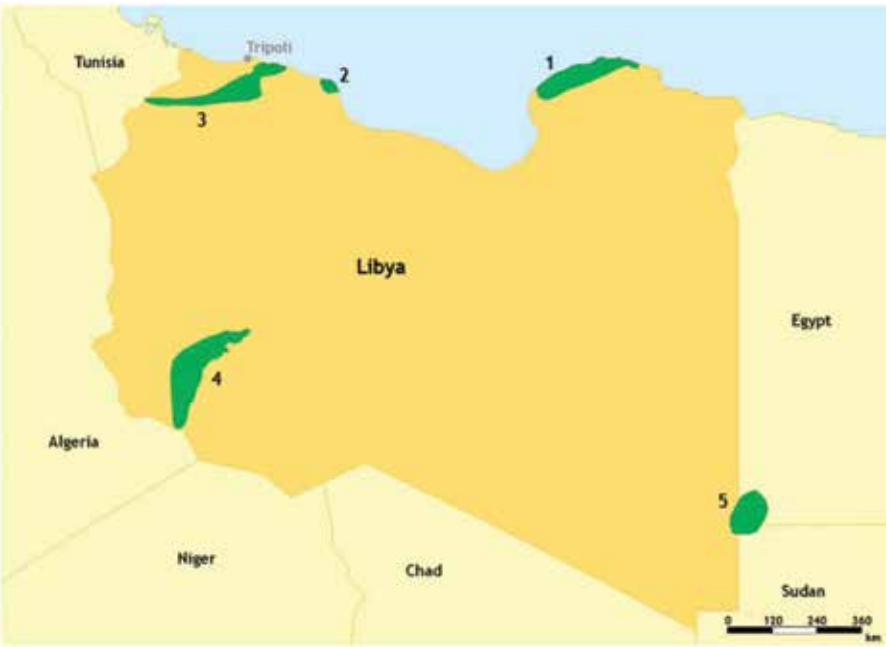

Figure 5.1. Important plant areas in Libya (IPAS) [1 – Jabal Alakhdar, 2 – Tawuorgha, 3 – Jabal Nafusah, 4 – Messak, 5 – Alaweinat].

Green Mountain) in the Cyrenaica region of northeast Libya is the largest and most significant IPA in Libya, it is characterized by distinct ecological features since it is the only evergreen forest area of unique type along the coastal belt from Atlas Mountains in the west to Palestine-Syria-Lebanon in the east. Jabal Akhdar is similar in its biodiversity to the areas south and east of the Mediterranean. The ancient civilizations established on Jabal Akhdar area were correlated with its unique natural vegetation. Although the area of Jabal Akhdar is not more than 1% of the total area of the country, it is distinguished by its high percentage of the country's biodiversity. It contains about 1,300 plant species, which encompasses 70–80% of the Libyan flora. The general topography of the area consists of three levels of escarpments differs little bit climatically. The first level adjacent to the seashore up to altitude 200 m represents a plain with Mediterranean climate, the second level is from 200 m to 600 m, and the third level is from 600 to 800 (the highest is 882 m (a.s.l.) is characterized by cool winter and hot summer. Temperature means ranges from about 7°C during the winter months to about 27.6°C during the summer period in Shahat area on top of mountain range. The

mountain slopes gradually towards the desert (south) and northern slopes facing the sea are very steep.

Also, the difference in the geographical locations of the subareas of the Jabal Akhdar led to notable variation in average annual rainfall. The maximum annual rainfall reaches 600 mm at Shahat (Cyrene) and this annual average drops as we move to the east, west, or south to reach the lowest 200 mm south of the limits of the forest range. These climatic and topographical differences are reflected on the types and characters of the plant cover in these areas and types of soils (mostly red alluvial *terra rosa*) spreading within which produced ecological variation allowed agricultural activities along the year in different locations.

The vegetation communities are (from sea level): the coastal plain, coastal escarpment, central plateau and upper escarpment, and upper plateau. The coastal plain consists of the sandy beaches, salt marshes, and rocky coasts. As in the majority of Mediterranean dune communities *Elytrigia juncea* (L.) Nevski subsp. *juncea* is common, its association on Jabal Akhdar with *Centaurea pumilio* L. and *Silene succulenta* is unusual. Endemics of the dunes include *Helianthemum cyrenaicum*, *Thapsia garganica* var. *sylphium, Anthemis taubertii, Teucrium zanonii,* and *Plantago libyca.* The salt marshes are analogous to others in the Mediterranean with endemic species such as *Frankenia syrtica* and *Limonium teuchirae.*

The coastal escarpments are dominated by *Juniperus phoenicea* scrub/forest. Endemic species include *Cyclamen rohlfsianum, Micromeria conferta* and *Stachys rosea.* The wadis are poorly known; the vegetation comprises *Juniperus phoenicea* scrub/forest on the slopes, with dense semi-deciduous mixed woodland in the channels dominated by *Quercus coccifera, Pistacia lentiscus, Arbutus pavarii, Ceratonia siliqua, Olea europaea* and *Cupressus sempervirens*. These wadis are rich in endemic plant taxa, e.g., *Arum cyrenaicum, Erica sicula* subsp. *cyrenaica, Onosma cyrenaica* and *Nepeta cyrenaica.*

The central plateau of Al Jabal Al Akdhar is used heavily for agriculture. The vegetation of this area is a mixture of *maquis* and a shrubby *batha community* in areas of grazing and/or shallow soils. Patches of dense woodland also occur on the upper escarpment above the central plateau. The tree layer here is dominated by *Cupressus sempervirens*, *Juniperus phoenicea, Olea europaea, Quercus coccifera, Ceratonia siliqua,* and *Pinus halapensis*.

The upper plateau is also heavily used for agriculture, with only small patches of *Juniperus* remaining. *Batha* forms a major plant community in this area, again often dominated by *Sarcopoterium spinosum, Phlomis floc-*

cosa, Pallenis spinosa and a rich diversity of grasses and ruderal species. The upper plateau site of Sidi Al Hamri is one of two known locations for *Pachyctenium mirabile*. Many areas of Al Jabal Al Akhdar lack botanical data, which greatly hinders conservation planning. Four areas within Jabal Akhdar were investigated during the compilation of this report and are described in more detail within the national report (see references): Ain Estowa, Dabbusia spring, Morcus Valley and Spring and El Kouf Valley. The principal threats to the conservation of this IPA are: heavy grazing and inappropriate development and agricultural activities. There is poor environmental planning and management, and the coastal zone is being developed without detailed environmental impact studies. Deforestation is occurring for domestic fuel and charcoal and there is die-back of *Juniperus* forest.

5.3.5 Endemism in Libya

The total endemic plant species in Libya about 80–81 species, distributed in four centers of endemism in Libya: (i) Jabal Akhdar with 44 species, about 50% of endemic plants in the country, (ii) coastal belt including the Jabal Nafusah and Marmarica plateau with 26 endemic species, the center of the Sahara with 8 to 9, and the plateau of Ghat, Tebesti, and Aweinat with 2 species. Generally, the flora of Libya possesses a low percentage of endemic plants, not more than 7% because of the similar topography and harsh environment. However, the endemic plants constitute a unique genetic diversity limited to the flora of the country. There are three endemic genera represented by one species each: *Pachyctenium mirabile* (Umbelliferae), *Oudneya africana* (Cruciferae), and *Libyella cyrenaica* (Gramineae). Examples of endemic plants in Libya are *Cyclamen rholfsianum* (Primulaceae), its picture on the series of the Flora of Libya's cover, *Arum cyrenaicum* (Araceae), *Teucrium cyrenaicum* (Labiatae), *Linaria tarhunensis* (Scrophulariaceae), and *Tourneuxia varrifolia* (Compositae). *Sedum cyrenaicum* (Crusulaceae), *Thapsia garganica var. sylphium* (Apiaceae), *Cupressus sempervirens var. horizontale* (Cupressaceae) (Figure 5.2).

5.4 Faunal Diversity in Libya

Libya is mostly characterized by arid climatic conditions, except the coastal strip and the northern hills toward the east and the west, while the rest of the country is located under the conditions of desert and semidesert because of its geographical location in terms of latitude (Essghaier et al., 2015). This resulted in the presence of environments with distinct characteristics in

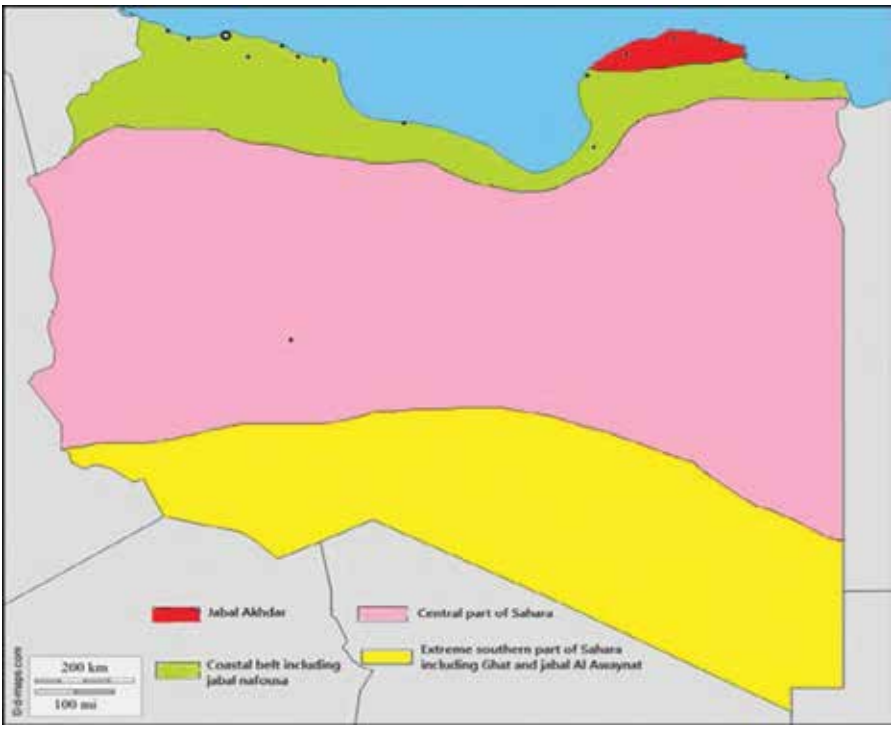

Figure 5.2. Centers of endemism in Libya.

terms of temperature, humidity, and rainfall that reflected on the biological components of the plants and the animals that are able to coexist in various ways with those difficult environmental conditions (Hufnagel, 1972). In Libya, there are a lot of ecosystems that range from the coastal environment with all its scattered salt marshes along the coastline, to green plains in the northeastern region and northwest highlands (which include Nafusa Mountains), to desert and semidesert ecosystem showing its content of oases and valleys (Toschi, 1969). The desert is ecologically sensitive and very important in terms of wildlife (flora and fauna), which coexist in this habitat in spite of the harsh living conditions as much heat, especially during the summer months in addition to water scarcity and drought. However, these systems include a few diversity and abundance of species particularly those that have the capacity to live under these circumstances and some of them are endemic.

5.4.1 Components of Biological Diversity

Depending on climatic and topographic biological data, the main four basic bio-geographic ecoregions can be distinguished (EGA, 2010) as given in the following subsections.

5.4.1.1 Coastline

Coastline varies in width; it is generally between 5 and 25 km, and about 100 km in some areas such as Al-Jfara plain. The Libyan coast extends over a distance of about 1970 km, to occupy the majority of the southern coast of the Mediterranean Sea. Moreover, this coastline contains many ecosystems; gulfs, rocky and sand beaches, coastal lagoons, islands and Sabkhas (Salt marshes).

5.4.1.2 Mountains

Mountains two main regions are located south of the coastal strip, one at the eastern part called Al-Jabel Al-Akhder (Green Mountain), with the highest peak of 880 m, and the other at the western part of the country called Jabel Nafusa (Al-Jabel Al-Gharbi). These mountains contain many valleys. The average rainfall in Al-Jabel Al-Akhder mountains is between 250–600 mm, and less than that in Jabel Nafusa (200–300 mm).

5.4.1.3 Arid or Semi-Desert Region

Arid or semidesert region, which lies directly south of the mountainous regions, and in parallel to it. The average precipitation is between 50 to 150 mm. This area is often used as pastures and some agricultural activities that carried out by some of the Bedouin in some valleys.

5.4.1.4 Sahara

Sahara occupies about 90% of Libya, a barren land includes sand dunes and the vegetation is very scarce. Very low precipitation or almost nonexistent.

5.4.2 Basic Features of Animal Biodiversity in Libya

Globally, Libya is a poor country in term of living species space that occupies its area. From a total of 1.7 million described, Libya has about 2,135 plants and 4,590 animals (EGA, 2010).

Libya also has a large diversity of habitats and ecosystems such as sea and beaches, forests, mountains, steppes, grasslands, a variety of wetlands land and desert.

The diversity of wetlands in Libya:

1. Salt marshes (Sabkhas), such as Sultan, Abo Kemmash and Benghazi sabkha.
2. Coastal lagoons, such as Al-Ghazala and Azzayana.
3. Water springs, such as Tawergha and Ain Kaam.
4. Desert oases, such as Gaberoun, Bzimah Oasis.
5. Dams, such as Almjenin dam Wadi Attot.
6. Artificial reservoirs, such as Made River reservoirs.
7. Water treatment plants.

These ecosystems have a great economic importance, they are also shelters for many species. So, any disturbance, threats or destructing of these habitats will negatively affect the components of biodiversity of these areas. Furthermore, they have a great value as touristic and recreational zones. They also have a crucial role in the purification of contaminated water (working as kidneys in nature).

5.4.3 Libyan Fauna

The number of animals in Libya according to preliminary estimates 4,590 species. The most important of these taxa in terms of number is the insects (81%), followed by birds (7%). However, animals diversity in Libya still needs further taxonomic studies to be well documented.

Estimates of marine animal and plant species are about 1,500 species, for instance, 560 species of marine algae, and three species of endangered seagrasses in the Mediterranean Sea, and about 100 species of fish and three species of marine reptiles (turtles).

- No available information on the Protista.
- A total of 139 species of Molluscs.
- The number of Arachnids is about 170 species.
- Insects are the majority of Libyan animal diversity. The approximate number is 3,763 species.
- The number of fish species is 98 includes one endangered species.
- The smallest number of Libyan animals is three of amphibian species.
- The Libyan reptiles are 25 (Frynta et al., 2000).

- The recent documentary publication has confirmed that the total number of birds in Libya is 350 species (100 are currently breeding in Libya) (Isenmann et al., 2016).
- Libyan mammals are 76 species, including 4 endemics and 12 threatened (EGA, 2010).

Keywords

• animal biodiversity • Libyan fauna

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Q1

Appendices

Some of the endemic species in Libya

Q2

A- *Cupressus sempervirens var. horizontale* B- *Sedum cyrenaicum*

C- *Linaria tarhunensis* D- *Thapsia garganica var. sylphium*

Q2 **Some photos from ecosystems and flora in Libya.**

Some photos from ecosystems and flora in Libya.