Biodiversity Journal, 2014, 5 (4): 525–532

Biological diversity of the National Park of El-Kala (Algeria), valorization and protection

Sarri Djamel[1*], Djellouli Yamna[2] & Allatou Djamel[3]

[1]Department of Nature and life Sciences, Faculty of Science, University of M'Sila, Algeria; e-mail: djamel_sarri@yahoo.fr
[2]Social science and Faculty of Arts. University of Maine, Mans. France; e-mail: Yamna.djellouli@univ-lemans.fr
[3]Department of biology, Faculty of Science.University Constantine 1, Algeria; e-mail: djalatou@yahoo.fr
[*]Corresponding author

ABSTRACT The National Park of El-Kala (PNEK, biosphere reserve) conceals a remarkable biological and cultural richness. The investigations carried out through its territory (1996-2010) made it possible to count 1590 vegetable species (distributed among spontaneous vascular and introduced plants, mushrooms, lichens, algae and phytoplankton) as well as 718 animal species. Several of these species, vegetable and animal, are protected in Algeria and belong to the red list of the I.U.C.N. (International Union for Conservation of Nature). The safeguarding and valorization of this richness require the installation of a management plan in adequacy with the International Conventions of biological diversity within the framework of the durable development, i.e. to protect and develop the natural wealth by involving residents of the park.The aim of this paper is to present a detailed study of the flora and fauna of the entire ecosystem of the PNEK. We insist on the considerable importance that flora and fauna bring to the socio-economic life of the area and to its inhabitants.

KEY WORDS durable development; National Park El-Kala; natural diversity; safeguarding; valorization.

Received 13.10.2014; accepted 09.12.2014; printed 30.12.2014

INTRODUCTION

This work is an outline of a study entitled "Durable development in the protected area of Algeria, the case of the National Park of El-Kala (PNEK) and the bordering areas of important ecological interest". The principal thing before any intervention of valorization or protection of the natural resources is to make a full inventory and analysis on the biological diversity of the PNEK.

On the basis of prospection on the ground and examination of several works and papers realized in the area (Aouadi, 1989; Debelair, 1990; Miri, 1996; Samraoui & de Bélair, 1997; Kadid, 1999; Rezzig, 1999; Boutabia, 2000; Benyacoube & Chabi, 2000; Sarri, 2002) and other various documents on flora of Algeria (Battandier & Trabut 1902; Maire 1952; Quezel & Santa, 1962), we tried to inventory and make an assessment on the natural richness of the PNEK, as well as a collection of the various national and international legislative texts which can intervene for better management and protection of this protected surface.

The analysis of these data allowed us to make preliminary proposals, which concern the protection and the rational and durable use of this wealth with national and international interest, in order to ultimately pass to the phase of inquiries (Questionnar-

ies concerning the biodiversity and policy directives for the durable development).

National Park of El-Kala

Located at the extreme east of Algeria, the National Park of El-Kala extends on a surface of 76438 ha. It has some hills, not exceeding 600 m altitude and three lakes in North, West and East parts. The southernmost part is strewn with djebels which culminates with djebel El-Ghorra, 1202 m (Fig. 1).

The bioclimat is of the soft wet type with subwet heat, the annual temperatures minimal average reachs 9°C where as the annual maximum average is 30°C. The annual precipitations average ranges from 800 to 900 mm, often attaining a maximum of 1300 mm (Aouadi, 1989). According to Belouaham et al. (2009), the area's humidity of El-Kala reaches 72.4% which is relatively significant due to the proximity of the littoral and the huge forests and the whole wetlands surface, which furrow the Park territory. Wind, usually frequent, move the dunes, creating entirely bare spots. This is the case of the Lake Mellah outlet and te Messida beach.

The Park is characterized by two geological formations: the quaternary one, primarily represented by marine and river deposits, with the average Eocene corresponding to clays and sandstones of Numidia (mainly localized in the bottoms of valleys), and the Miocene corresponding to conglomerate sands and red clays principally localized in Southeast. The park's grounds are those of the forest, brown washed with a variant of forest humus mull acid Moder. The National park of El-Kala was created in 1983 by decree n° 83-462 of July 23rd, 1983, classified as "Reserve of the biosphere", by UNESCO, on December 17th, 1990.

The essential objective of the park is the protection and conservation of the floristic and faunal components as well as of both the natural environment and cultural-historical inheritance.

Relatively less marked by the impact of human activities, this park consists of a mosaic ecosystems which have great biological and ecological importance. Here we distinguish:

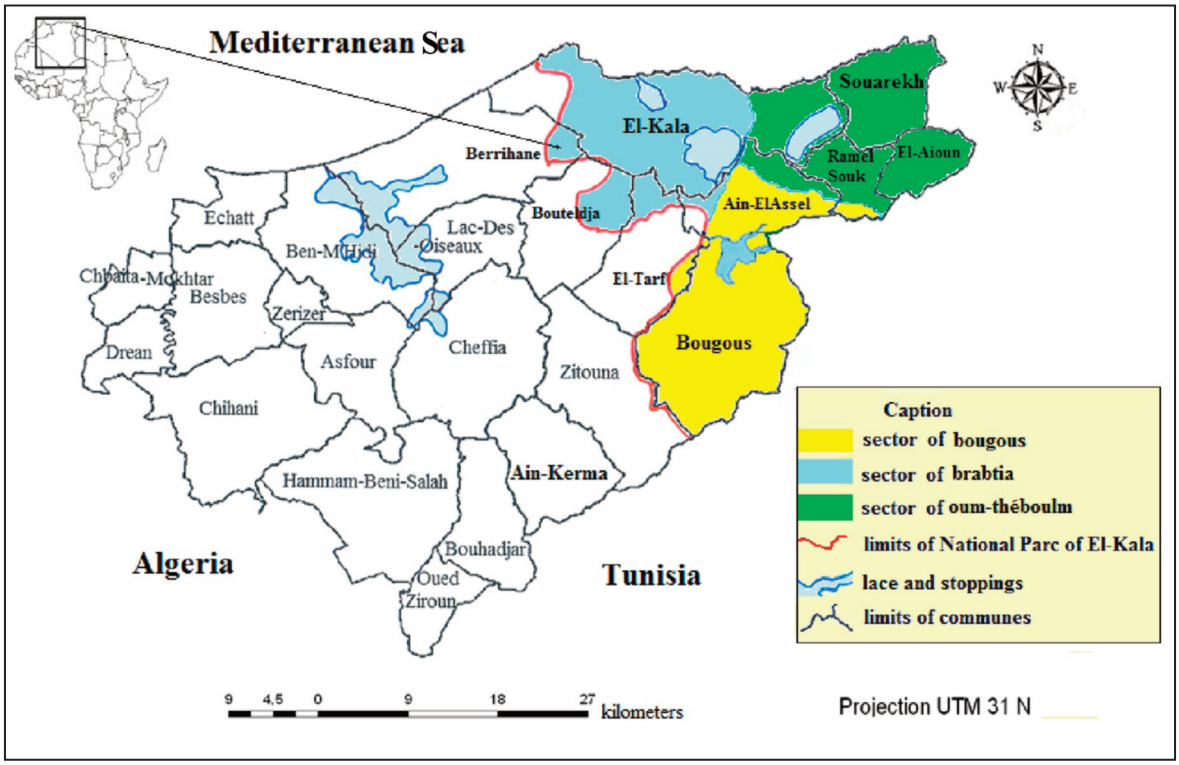

Figure 1. Study area: chart of the administrative limits of the wilaya of El-Tarf (Algeria) with the limits of the National Park of El-Kala.

- a marine ecosystem (length of 50 km), containing a particular flora and fauna (for example: red coral) not very disrupted (varied submarine habitats and absence of pollution).

- a dune ecosystem, consisting of a littoral dune cord still stable (20 to 120 m of altitude), the maquis of the kermes oak with some testifies of the floristic procession such as: *Quercus coccifera* L., *Juniperus phoenicea* L., *J. oxycedrus* L., *Pistacia lentiscus* L., *Retama monosperma* (L.) Boiss., *Ephedra fragilis* Desf., etc...

- a lake ecosystem, constituted by the low marshy plains and the lakes some of which are classified as "Ramsar Sites": lake Oubeira, (2200 ha), lake Tonga (2600 ha), lake Mellah (860 ha, the only lagoon in Algeria which communicates with the sea), Marais of Bourdim (11 ha), Blue lake (3 ha) and Black lake (6 ha).

These appreciated water tanks constitute a shelter of biological richness and are of great interest for the park habitats.

- As far as concerns the forest ecosystem, populating the mountainous zone, of average altitude, intersected by interior depressions and dominated by important relieves, the oak cork represents the climactic forest on siliceous ground. It is replaced in altitude (700 m) by the Zeen oak (*Quercus faginea* Lam.).

The National Park of El-Kala is one of the most prestigious protected zones of the Western Mediterranean. It is characterized by the presence of truly peculiar natural conditions which make it a place of uncommon biological richness. For this reason, it can be considereded as one of the highest relictual places of the geological and biogeographical history of the Mediterranean area (Benyacoube & Chabi, 2000).

MATERIAL AND METHODS

This work is the result of a set of field and bibliographical investigations, including observation on the field made by us, along with the follow up of several actions, realized through the territory of the park, joined to the consultation of several papers (thesis, dissertation, reports, expertise, etc...) realized in the territory of the park and its nearby, as well as of all available data on the flora of Algeria and North Africa.

RESULTS AND DISCUSSION

Floristic diversity of the National park of El-Kala

The natural vegetation which we meet in different ecosystems of the National Park of El-Kala is represented by the cork oak which dominates with other tree species including Zeen oak, Kermes oak, Pine of Alep, glutinous Alder, Wilows, white Poplar, and other introduced species as *Eucalyptus*, the Acacias, the Maritime pine and the bald cypress. The floral diversity of the national park of El-Kala is represented by 1590 botanical species. This figure includes the spontaneous botanical species, mushrooms, algae, lichens, phytoplankton and the introduced or cultivated vegetable species (Tables 1, 2).

The vegetable kingdom is also rich and varied. The lower plants (Algae, Foams, mushrooms, Lichens) remain less studied. We count however more than 175 (Sarri, 2006) species of mushrooms including Truffles (560 for Algeria) and 117 species of Lichens (Boutabia, 2000). The Higher Vascular plants, more than 1050 species (3750 for the flora of Algeria), were better inventoried including 382 rare and 27 protected species.

The region of El-Kala is itself a "biological crossroads", in time (since it reflects the succession of the climates of Quaternary) and in space (it is characterized by habitats overlap and biogeographic interpenetrations). Species and their status are reported in the Tables 1, 2.

Biogeography of the vascular vegetable species listed in the PNEK

Several authors (see for example: Paccalet, 1981; Ozenda, 1982; Guittonneau, 1982; Quezel, 1957, 1978, 1983, 1993; De Belair, 1995, 1996) were interested in the study of the biogeography (of plants and animals) considered by International Conventions one of the criteria of appreciation of biological diversity.

For example, Quezel (1978; 1983; 1993) reported that septentrional Africa (Mediterranean and Saharan) represents at the present time the part of this continent where biological and ecological diversity is most significant (Belouahem et al., 2009) (Figs. 3–6).

VEGETABLE SPECIES	STATUS OF SPECIES	N. of species by details	N. of species by groups
VASCULAR PLANTS	Species without status	674	1050 *
	Species appearing in the red list (IUCN)	20	
	Protected species	27	
	Spontaneous medicinal species	58	
	Useful spontaneous species	19	
	Endemic species - endemic of North Africa	80	
	Watery and cultivated species	85	
	Fodder species	87	
MUSHROOMS	Species without status	175	175
LICHENS	Species without status	65	117
	Protected species	52	
ALGAE	Species without status	70	70
THEPHYTOPLANKTON	Species without status	93	93
INTRODUCED SPECIES	Decorative introduced species	62	77
	Medicinal cultivated species	15	
SAILOR	Species being reported on appendices II and III of ASP Protocol (Convention of Barcelona)	08	08
	TOTAL	**1590**	**1590**

Table 1. Floristic diversity of the National Park of El-Kala, Algeria.
*: 1050 for PNEK (3750 for Algeria) including 382 rare, 122 families (128 for Algeria) and 392 kinds (907 for Algeria)

In the present study we report several plants of different biogeographic origins (Fig. 2). In particular, the species of Mediterranean origin are most numerous (445 species which accounts for 42.38%) followed by 5.24% of species of tropical origin which shows the first origin of the site. The specific biological diversity observed wihin the National park of El-Kala (which belongs to Algerian Numidia) is related to the favorable ecological conditions which allow the preservation of these species.

In fact, in sub-littoral Numidia both the high temperatures in summer and the accentuate humidity, due to the dune barrier, combine together to create a real subtropical climate. On the other hand, wintry weather conditions (low T°C and high pluviometry) contribute to create a remarkable moderate climate (Belouahem et al., 2009).

NOTE. The presence of the two protected vascular plants *Euphorbia dendroies* L. and *Orchis provincialis* Balbis is uncertain;

- the truffle *Terfezia arenaria* (Moris) Trappe (1971), reported in the littoral dunes of the territory of the park, represents some sort of curiosity;
- the very few studies on the flora in this region make our study very difficult;
- the document on flora of Algeria should be updated as based on data by Quezel & Santa (1962-63);
- floristic list may change at any time due to the large area and its ecological characteristics.

Fauna diversity of the National park of El-Kala

The most important groups of animals we observed in the National Park of El-Kala include

Subdivisions biogeographic	Numbers by geographical category	Percentage
Mediterranean species	445	42.38
Species of transitions	280	26.66
Scandinavian species	125	11.90
Endemic species	75	7.14
Cosmopolitan species	64	6.10
Tropical species	55	5.24
Species without indications	6	0.57

Table 2. Frequencies and number of species inventoried in the PNEK by biogeographic subdivisions.

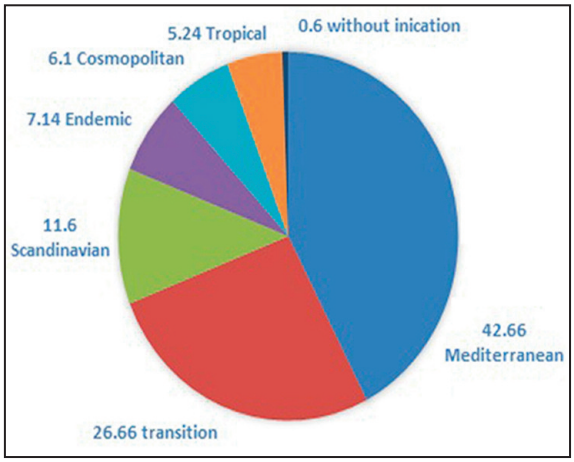

Figure 2. Biogeographic spectrum of the National Park of El-Kala, Algeria (expressed in %).

Figure 3. *Geranium atlanticum* B.R., endemic of N-Africa. Figure 4. *Scolopendrium vulgare* Sm., very rare species. Figures 5, 6. *Campanula alata* Desf., endemic of Algeria-Tunisia, Red List-IUCN.

mammals, insects, reptiles, Amphibians, birds and fish. We counted up to 706 animal species including the zooplankton (Table 3). The National Park of El-Kala is one of the last refuges for the stag endemic to Algeria and Tunisia. Forty years ago, there were more than 300 individuals. This number fell considerably because of the hunting and the forest fires. Currently, its number does not reach 30 individuals; maybe less. Several animal species are endemic to the region, others are more widely distributed, but they do not live any more in the area. The faunistic list can change at any moment seen the importance of the zone for its surface and ecology (Figs. 7–9).

Protection and valorization of the richness

The years lived in the National Park of El-Kala, allowed us to gather information about the needs and the socio-economic activities of the inhabitants as well as a considerable knowledge on its natural and even cultural potential.

Rational and durable exploitation of the flora

Several examples can be enumerate:

- the cork oak for its cork;
- heathers for the clothes industry of pipes and ornament;

- fruit trees of forest (Olive-tree, Cane-apple bush, Myrtle, Hawthorn…) for food purposes;
- the medicinal plants (Bay-tree sauce, Lavender, Myrtle...) have great potentials (they can be employed directly, i.e. roots, leaves, flowers, or by extraction of essential oils and/or substances to be used for pharmaceutical products);
- decorative plants (including ferns, and many Liliaceae;
- mushrooms (including truffles) for food purposes;
- olive oil and mastic tree oil.

All plants quoted above can become an important source of incomes for the residents (inhabitants of the park) and thereafter for the investors.

Within the framework of the valorization of the flora, we also record the various scientific works in phytochemistry done by national researchers, which one of the Authors participated to by collecting and identifying several samples: *Genista aspalathoides* Lamk ssp. *erinaceoides* (Lois.) Maire, *Genista ferox* Poirret, *Genista ulicina* Spach, *Genista tricuspidata* Desf., *Serratula cichoracea* (L.) DC., *Halimium halimifolium* (L.) Willk., *Matricaria chamomilla* L., etc...

The idea is to create small eco-exploitation farms or eco-companies which cultivate, protect, exploit, and trade local products (at the finished or raw state) in a rational and long-lasting way through their own territory (in the short and medium term) and, in the future, towards abroad (in the long term).

Rational and durable exploitation of fauna

Among the animal species occurring within the Park, the least protected and valued are water birds, sea and freshwater fish (as the eel), mollusks (as the clam of the Melah lake) and the deer (*Cervus elaphus barbarus* Bennett, 1833). The extraction of the Coral requires some precautions because it is in permanent reduction. To avoid the disappearance of the stag from the National Park of El-Kala and even from the whole Algeria, a program was set up for breeding it in captivity and in a so-called "bilateral" semi-captivity, between the National Park and the hunting center of Zéralda, with the aim of ensuring its existence, perenniality and releasing them periodically. Until 2002 it produced more than 50 individuals.

These results, which are very satisfactory and encouraging, let us think and suggest that, altough it ensures a good protection of this animal, with a rigorous application of legislative texts and the mul-

ANIMAL SPECIES	NUMBER OF SPECIES	OTHER DETAILS	PROTECTED SPECIES
MAMMALS	43 (107 for Algeria in [6])	Terrestrial 39 Sailors 04	17
REPTILES ET AMPHIBIANS	24 (82 for Algeria)	Reptiles 19 Amphibians 05	03
INSECTS	215	All groups 215	13
BIRDS NICHOR AND MIGRATING	214 (402 for Algeria in [16])	water and forest birds 117 birds navy 12 Raptors 25	26 and 31 02 25
FISH	128	marine fish 104 fresh water fish 24	09
ZOOPLANKTON	94	Mollusques (clams) 55 Crustacées (crustaceans) 33 Brachinopodes (brachiopods) 03 Tuniciens (tunicates) 03	
TOTAL	718	718	126

Table 3. Faunal diversity of the National Park of El-Kala, Algeria.

tiplication of breeding programs, in a short time we could get to the point where we could see the meat of the stag for sale from the butcher. Meat which, in turn, would come from regular regulated and paying hunting tourism.

Or, still, one can quote another economic activity practised in the territory of the park representing a good source of job and currency, i.e., the harvesting of snails, which are generally sold at 200 DA for kilo to Tunisians.

The legislative arsenal protecting national parks (protected areas)

A collection of 133 legislative texts was carried out. This arsenal of texts reflects the importance of the national natural inheritance of the national park of El-Kala. These texts give a great support to the management of the whole protected area of the Country. In reality, these laws are constantly disregarded (are not met) and do not give any real indication neither to managers nor to administrations and residents.

CONCLUSION

The originality of the National Park of El-Kala returns especially to its biological diversity. A floristic diversity of 1590 vegetable species including 1050 vascular seedlings (27 protected, 80 endemic and 20 species appearing in the red list (IUCN)), 175 mushrooms, 117 lichens (52 protected), 70 algae, 93 species of phytoplankton, 77 species of vascular introduced and cultivated plants as well as eight vegetable sailors species being reported on Appendix II and III of Protocol of the Convention of Barcelona.

The faunal diversity is marked by 718 animal species including 43 species of mammals (17 protected), 24 reptiles (3 protected) and Amphibians, 215 insects (13 protected), 214 species of birds (87 protected), 104 marine fish species (9 protected), 24 fresh water fish species and 92 species of zooplankton. To preserve this originality, the study recommends creating small Eco-exploitations farms or eco-companies, which exploit and at the same time protect this floristic and faunistic richness. One should not forget that the flora and fauna not only represent an important source of incomes for the inhabitants of the park but also can contribute to in the economic development of country. The knowledge of faunistic and floristic diversity and of the distribution methods of the fauna and flora of a territory,

Figure 7. Delicious Lactaire; possibility of potential significant culture. Figure 8. Exploitation of light for drying of the cork. Figure 9. The Barbary stag in semi captivity.

allows us to have an effective tool for control and management of the natural habitats.

It is up to people having in charge and managing the protected areas, and a good information helps in directing reasoned actions of maintenance of the Territory. The park of El-Kala is a national heritage. Unfortunately, today we are witnessing a series of irresponsible and irrational behaviors that demonstrate a lack of education and environmental awareness. It is important that people understand that the peculiarities of PNEK reflect the deep meaning of Numidia and Krumiria (Northeast Algeria) and therefore this park is a treasure that must be protected and defended.

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