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BIOLOGICAL RECOVERY THE STEPPE OF *Hammada scoparia* AFTER ENCLOSURE IN THE REGION OF NAAMA (ALGERIA)

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Abstract

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This work was being carried out in the steppe of remth (*Hammada scoparia*) in Oranian part of the Saharan Atlas (Tiout – south of Naama). The *H. scoparia* of Saharan group occupies the foothills south of the Saharan Atlas and glazes and hamadas of the northern part of the Sahara where it seems to find its optimum development. The objective of the study is the floristic and ecological characterisation of the steppe vegetation groups of *H. scoparia* after 4 years of enclosure grazing (Eg). For the past three decades, steppe of *H. scoparia* were completely overwhelmed, both in their structure and their operation by increasing the herd and the continued use of natural pastures using animal load significantly higher than the production potential of course, which is reflected by the reduction of their capacity for natural regeneration.

Intervention measures that address this alarming situation are to foster the inverse process of degradation reconstruction and rehabilitation of degraded steppe rangelands by the technique of the Eg. The methodology involves a device that is composed of a series of transects that constitute a grid and allow to scan the whole website for Eg and part of the neighbouring paths. The results emphasise the interest and constructive impact of the Eg on plant diversity and the fight against the factors of degradation and desertification. This review highlights the importance of the technique of Eg for the rehabilitation and restoration of steppe rangelands in arid bioclimate.

Key words: steppe, Naama, *Hammada scoparia*, biological recovery, enclosure, grazing.

Introduction

Naama contains, according to studies by several authors, an important floristic richness that has to be valued. Indeed, many authors (Benaradj, 2009; Benaradj et al., 2013; Bouzenoune, 1984; Ozenda, 1977; Quezel, Santa, 1962–1963) have shown that wealth.

In Algeria, the term 'steppe' was adopted to describe the vegetation in arid and Saharan areas. Four major types of vegetation represent Algerian steppes: steppe of alfa (*Stipa tenacissima*), steppe of white wormwood (*Artemisia herba-alba*), steppe of Sparta (*Lygeum spartum*) and steppe of remth (*Hammada scoparia*).

Steppe of *H. scoparia* (Pomel) Iljin., the species of the family Amaranthaceae was described in 1875 by Auguste Pomel occupies habitats characterized by calcareous crusts, stone

encrusted surface (Pomel, 1875). It is limited to areas between 100 and 150 mm of annual precipitation. These steppes are subject to human pressures, where they are in an advanced state of degradation.

The restoration ecology and rehabilitation is part of the remedies as to limit the extension of these harms to delete or mitigate their consequences. The rehabilitation is preservation means to safeguard biodiversity against the factors of destruction and the extinction of the steppe ecosystem. It must first cause biological recovery of environmental conditions by natural and artificial methods. Of course, regeneration by shrub plantings and reseeding or enclosure grazing (Eg) most often requires a sufficient rest time dryland.

This work was being carried out in the steppe south Oranian area; it aims to explore the role of pastoral improvement 'enclosure grazing (Eg)' and the biological recovery of plant species in steppe rangelands.

Material and methods

Location of the study station (Zaboudja)

The station of Zaboudja (city of Tiout) from an altitude of 1112–1140 m is the northern limit of the range of *H. scoparia*; it is located in the south East part of the province of Naama where the area occupied by the Eg is 19,000 ha.

This station in past few years has seen a strong increase in the population and the number of sheep flocks. This trend is the main cause of degradation of pastoral ecosystems (Fig. 1).

The Zaboudja station is accessible, identifiable and recognisable on maps and aerial photographs; this station was being chosen for the importance of the existing biodiversity in the group of (*H. scoparia*).

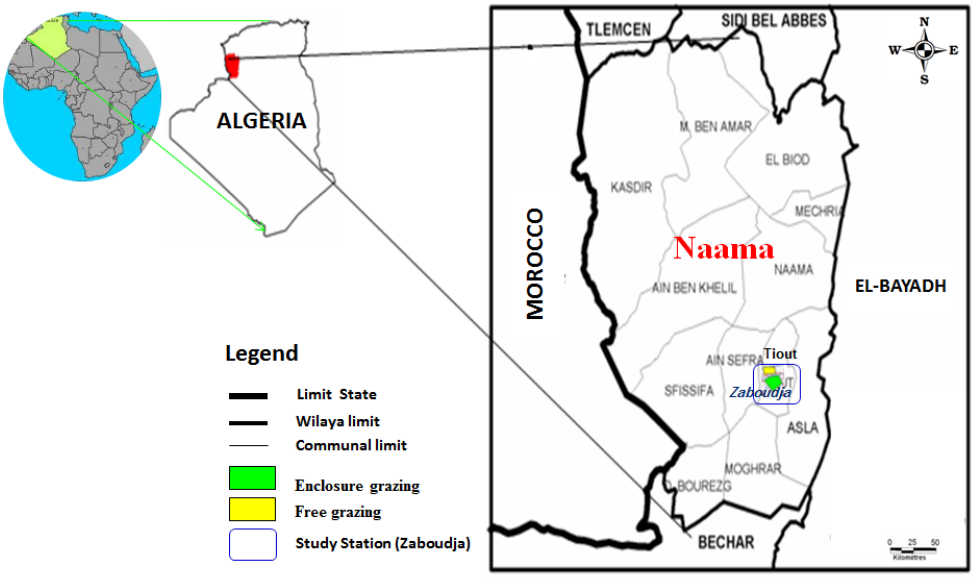

Fig. 1. Study area location of 'Zaboudja'.

Methodological approach

Many works study the effect of the Eg technique on the rehabilitation and restoration of degraded rangelands, including Achour et al. (2011), Amghar and Kadi-Hanifi (2008), Badji et al. (2013), Benaradj et al. (2010, 2013), Djaballah (2008), Diatta et al. (2000), Ferchichi and Abdelkebir (2003), Mansour (2010) and Ouaskioud (1999). These authors discuss the environmental benefits of this experiment on pastoral improvement in biological recovery, regeneration of species and the reconstitution of pastoral forestry areas.

The methodology involves a device that is composed of a series of transects that constitute a grid and help sweep the whole website for Eg and part of the adjacent course (Fig. 2).

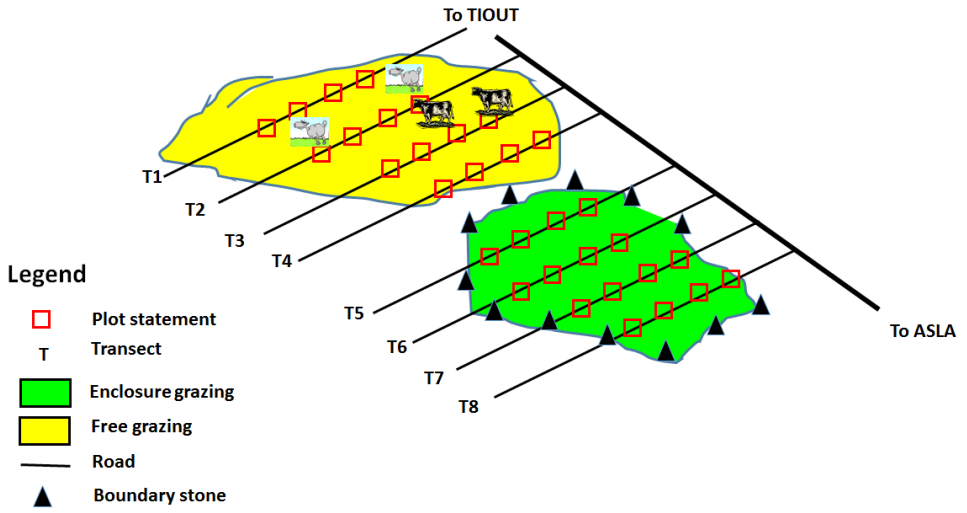

Fig. 2. Location of transects and floristic surveys.

The following are the studied parameters. We launched a sampling campaign in spring 2011 in order to determine the effect of the experimental practice on plant diversity and the state of the soil surface. To show the effects of this technique on pastoral improvement (Eg), several parameters were studied and evaluated based on their application in the courses of *H. scoparia*; amongst these study parameters include

- *Recovery:* The recovery of a species theoretically defined as the percentage of the area of land that would cover if projected vertically on the ground aerial organs of individuals of the species (Gounot, 1969). The recovery rate as a percentage denotes the degree of vegetation cover in the locality studied.
- *Floristic richness:* The richness of flora of an area is the total number of species it contains. In arid zone, floristic richness depends on the number to annual cash at the time of the execution of the statement (Djebailli, 1978).
- Floristic characterization
    1. *Biological:* The species found in and outside of Eg were indicated by their biological type. The biological classification takes into account the renovation bud position of the plant to the ground during the cold period and can recognise five biological types (phanerophyte, chamaephyte, hemicryptophyte, therophyte and geophytes) as defined by Raunkiaer (1934).
    2. *Systematic:* Systematic analysis allowed us to identify families and genera species inventories in both comparison sites of Eg and Fg.
    3. *Evaluation of phytomass:* Phytomass is the amount of energy stored at a given time. It is composed of all the species presented (perennial, woody and annual) (Pontanier et al., 1982; Floret et al., 1983).

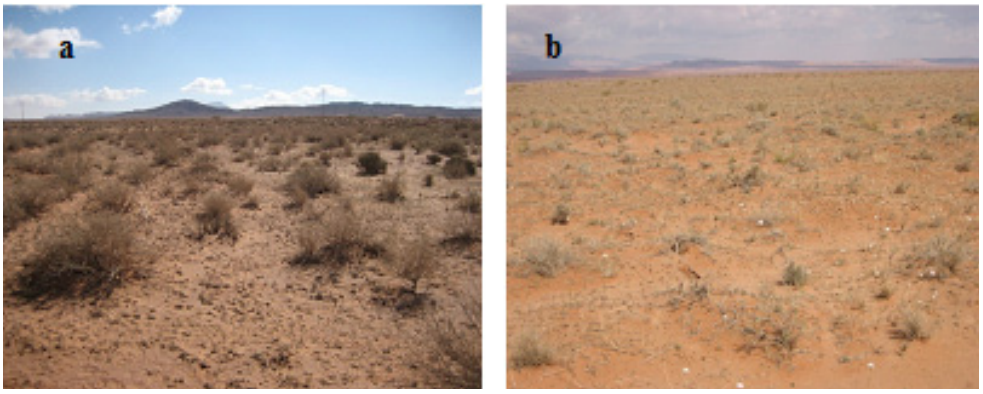

Fig. 3. The study site 'Zaboudja': (a) enclosure grazing and (b) free grazing.

Results and discussion

The results obtained in the field, the analysis is done by calculating the changes in various parameters (recovery rate, biological and systematic spectrum of species invented) by comparing data from the two study states: Eg (Fig. 3a) and Fg (Fig. 3b).

Effect of enclosure on the recovery rate

From Table 1, we see that there is a large difference between the Eg and the Fg. In the Eg, this covering is between 25 and 40%. Indeed, it is different in the Fg, where it did not exceed 20%.

The recovery rate is mainly influenced directly or indirectly by the pressure and overexerted by the local population. This improvement in the recovery rate is due to the process of biological recovery (Benaradj et al., 2013; Le Houérou, 1995).

T a b l e 1. Comparison of recovery rate (Eg and Fg).

	Enclosure grazing (Eg)	Free grazing (Fg)	Rate of change
Recovery %	40%	20%	2

Effect of enclosure on floristic richness

Floristic richness (Table 2) differs depending on the mode of use inside and outside of enclosure (Eg and Fg). The floristic enrichment is induced by protection and enclosure; this technique that reactivates the biological recovery of endemic species (Saharan and pastoral)

T a b l e 2. Floristic richness in the study station (Eg and Fg).

	Enclosure grazing (Eg)	Free grazing (Fg)	Rate of change
Number of species	108	44	59.26%

will be applied primarily to the types of courses with regeneration ability and rapid return of the species with great pastoral value, such as *Stipa tenacissima*, *Lygeum spartum*, *Artemisia herba-alba, A. campestris, Helianthemum lipii* and *H. hirtum* (Benaradj et al., 2013).

There is floristic diversity in the steppe-protected area in *H. scoparia* after 4 years of protection (enclosure).

Effect of enclosure on the floristic composition

According to Le Houérou (1995), the Eg is a natural technique to protect a territory or a parcel against humans and/or pets. It is a temporary subtraction of a surface grazing and implementation of developmental work for a period longer or shorter than 2 years of age, whose goal is the restoration of vegetation in a course sharp deterioration (Bourbouze, Donadieu, 1987).

Biologically

Biological types have grouped the species recorded inside and outside of the site closed for protection (Kadi-Hanifi-Achour, 1998; Negre, 1962; Quezel, Santa, 1962–1963). The floristic diversity is biologically characterised by a strong dominance (Table 3) of herbaceous or therophytes stratum (42.59%), the chamaephytes (29.63%), the hemicryptophytes (18.52%), geophytes (06.48%) and, finally, phanerophytique stratum (02.78%) represented by the following species: *Pistacia atlantica, Olea europaea, Rhus tripartitus, Retama retam* and *Ziziphus lotus.*

This therophytisation relates firstly to the harsh climate and other anthropogenic activities that degrade growing conditions for installation of new species. Emberger (1939) states the rate of increase of therophytes (annuals plants) in the arid environment. For Daget (1980), the therophytisation is a characteristic of arid environment; it expresses a commitment towards the adaptation strategy in unfavourable conditions and is a form of resistance to the harsh climate.

T a b l e 3. Comparative result of the biological spectrum between the two situations (Eg and Eg).

	Enclosure grazing (Eg)		**Free grazing (Fg)**	
	Absolute frequency	Relative frequency (%)	Absolute frequency	Relative frequency (%)
Phanerophytes	3	2.78	1	2.27
Chamaephytes	32	29.63	15	34.09
Hemicryptophytes	20	18.52	08	18.18
Therophytes	46	42.59	16	36.36
Geophytes	7	06.48	04	9.09
Total	108	**100**	44	**100**
Biological Spectre	**Th>Ch>He>Ge>Ph**		**Th>Ch>He>Ge>Ph**	

The systematic plan

In Table 4, we surveyed 31 families, 84 genera and 108 species in the Eg and 18 families, 37 genera and 44 species in the second situation (Fg). In the Eg, there was a marked diversity in families and genera after a period of protection.

The removal of grazing has allowed the exhaustion of vegetation regeneration potential, which results in plots protected by the trend towards greater heterogeneity and a very high floristic diversity (Ferchichi et al., 2003).

T a b l e 4. Botanical taxa between the two situations (Eg and Fg).

	Situation	**Enclosure grazing (Eg)**		**Free grazing (Fg)**	
	Families	**Genera**	**Species**	**Genera**	**Species**
1	Asteraceae	19	24	8	11
2	Poaceae	9	13	5	6
3	Brassicaceae	11	14	3	3
4	Fabaceae	5	9	3	4
5	Liliaceae	5	6	3	3
6	Caryophyllaceae	3	3	-	-
7	Chenopodiaceae	3	4	3	4
8	Cistaceae	1	2	-	-
9	Lamiaceae	1	1	-	-
10	Plombaginaceae	2	2	1	1
11	Geraniaceae	1	2	-	-
12	Resedaceae	1	2	-	-
13	Polygonaceae	1	1	1	1
14	Apiaceae	2	2	1	1
15	Borraginaceae	2	2	1	1
16	Amaranthaceae	2	1	1	1
17	Capparidaceae	1	1	1	1
18	Convolvulaceae	1	1	-	-
19	Ephedraceae	1	1	-	-
20	Euphorbiaceae	1	1	1	2
21	Malvaceae	1	2	1	1
22	Onagaceae	1	1	-	-
23	Orobanchaceae	1	1	-	-
24	Palmaceae	1	1	-	-
25	Plantaginaceae	1	1	1	1
26	Rhamnaceae	1	1	1	1
27	Rosaceae	1	1	-	-
28	Scrophulariaceae	1	1	1	1
29	Thymelaeaceae	1	1	1	1
30	Zygophyllaceae	2	3	1	1
31	Dipsacaceae	1	1	-	-
Total		**84**	**108**	**37**	**44**

Effect of enclosure on phytomass

Table 5 shows phytomass variations in the different modes of use within the Eg and outside the enclosure (Fg). In the Eg, we note that the average total plant biomass is higher in the Eg, 442.57 kg/Ms/ha, because it is dominated mainly by large plants with strong pastoral value of woody biomass palatability standpoint as (Fg).

Several authors (Negre, 1962; Ozenda, 1977) have reported this positive effect of protection on the production of biomass. In the same direction, Aidoud and Touffet (1996) conclude that in the absence of grazing, all resources appear towards the maintenance of a standing biomass at the expense of production.

By cons, in the free range, the phytomass is 200.94 kg/Ms/ha and this low phytomass can be explained by the intense grazing, anthropogenic intensity grubbing low wood and drought. This last factor has a great effect on the Eg where phytomass perennial grasses are important, despite the dry conditions in the current year.

T a b l e 5. Comparison of potential between the two situations (Eg and Fg).

	Enclosure grazing (Eg)	**Free grazing (Fg)**
Phytomass Kg / Ms / ha	442.57	200.94
Pastoral value / 100	10.51	5.52
Pastoral production UF / ha	78.88	41.34

Conclusion

Rehabilitation term of steppe *Hammada scoparia* by enclosure technique has a positive impact on the biological recovery. It allows a quantitative and qualitative increase in floristic richness and development of forage species, including therophytes.

The main features are represented by species of perennials (*Stipa tenacissima, Lygeum spartum Artemisia herba-alba, Helianthemum hirtum,* etc.) that are added during the wet period, and various annuals often described as ephemerophytes (plants that germinate, flower and fruit in less than a fortnight). This results in a significant phytomass and a relatively high recovery of the vegetation. The floristic composition is very diverse. It promoted the relocation and re-emergence of endangered species.

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