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The impact of anthropic action and aridity on the pastoral production in the *Stipa tenacissima* L. steppes of Algeria

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SUMMARY – The current state of the steppe rangelands came as a result of precarious environment constraints (climatic and edaphic aridity) and of an old and increasingly intense anthropic exploitation. To assess the pastoral production of the alfa steppes, a matrix of 183 groups and 499 species collected in all the *Stipa tenacissima* (alfa) formations of Algeria, was subjected to factorial analyses of the correspondences combined with ascending hierarchical ranges. Thus ten distinguished groups were characterized on the floristic, ecological, biological, phytochoric and pastoral scale. The latter were conducted by the following two methods; a quantative method, consisting of cutting the vegetation and assessing its energy value and a qualitative and simpler method, which gives a pastoral value to a group starting from the coefficient values assigned to each species as well as their relative frequencies (Delpech, 1960 *in* Hirche, 1995). From the pastoral analysis, we observe that the pastoral value of the various alfa groups has no correlation with the rainfall. The pasture intensity inhibits the beneficial effect of the rainfall.

Keywords: Steppe, anthropic action, pastoral value, desertification.

RESUME – *"Impact de l'action anthropique et de l'aridité sur la production des pâturages des steppes de* Stipa tenacissima *L. en Algérie". L'état actuel des parcours steppiques est le résultat des contraintes d'un milieu précaire (aridité climatique et édaphique) et d'une exploitation anthropique ancienne et de plus en plus intense. Pour évaluer la production pastorale des steppes à alfa, une matrice de 183 relevés et 499 espèces récoltées dans toutes les formations à* Stipa tenacissima *(alfa) de l'Algérie, a été soumise à des analyses factorielles des correspondances combinées à la classification hiérarchique ascendante. Ainsi dix groupements distinctifs ont été caractérisés sur le plan floristique, écologique, biologique, phytochorique et pastoral. Cette dernière peut être appréhendée par deux méthodes. La première, quantitative, consiste à couper la végétation et évaluer sa valeur énergétique. La deuxième, plus simple et essentiellement qualitative, consiste à donner une valeur pastorale à un groupement à partir des coefficients de valeurs affectés à chaque espèce ainsi que de leur fréquence relative (Delpech, 1960 dans Hirche, 1995). Il ressort de cette analyse pastorale que la valeur pastorale des différents groupements à alfa n'est pas corrélée à la pluviosité. L'intensité du pâturage inhibe l'effet bénéfique de la pluviosité.*

Mots-clés : *Steppe, action anthropique, valeur pastorale, désertification.*

Introduction

Stipa tenaciccima L. steppe habitats are important because of their ecological (against desertification) and economic (paper pulp manufacturing) interest, both on a national and an international scale. Similar to other steppe formations of great importance (*Artemisia herba alba* and *Lygeum spartum*), the alfa formations underwent intense degradation resulting in either their disappearance in some areas of the country (75% of the area in a century, 1900-1990) (Le Houérou, 1995) or their regression into other formations such as those of *Artemisia herba alba* or *Lygeum spartum*. In some cases, this regression is obviously accompanied by a fall in the floristic wealth and the appearance of "banal flora" for both men and animals (Aidoud, 1997).

Overgrazing, clearing of wastelands and ploughing are the major causes of this situation, which worsens with dryness.

The increasing concern for this phenomenon has led organizations and the government to consider the conservation and safeguarding of this ecosystem. However, in order to achieve these

goals effectively it is necessary to be acquainted with the ecology of these steppes, their biological diversity and their value.

The present work follows this approach and deals with the identification of vegetation groups and their characterization on a phytoecological and pastoral scale.

Materials and methods

Data collection

The data used within the framework of this study belong to Kadi-Hanifi-Achour (1998). The sampling was carried out on the basis of those data and the preliminary prospection of various cartographic documents.

The whole distribution surface of the alfa was sampled, integrating all the formations, i.e. the pre-forest, the scrublands, the tree steppes and the alfa steppes. In this work only the latter two formations were considered.

The work consisted of a description of the general features of the station, the physiognomic and floristic features and the ground surface features. Moreover, a coefficient of abundance-dominance was assigned to each species in the work, and the assessment was established according to the Braun-Blanquet *et al*. (1952) scale.

Data processing

Statistical and multivariate analyses

All the floristic data were treated by the correspondence factorial analysis (AFC), combined with the ascending and hierarchical classification (CAH), which represents the completion of any correspondence factorial analysis. The aim is to describe the relations between the environment and the vegetation and to distinguish between vegetation groups.

The treatment was carried out according to several stages: A global analysis, which treated a matrix of 183 vegetation groups and 500 plant species, using the abundance-dominance criterion. Thirteen partial analyses were carried out after eliminating a certain number of vegetation groups which took a marginal position or following each analysis of a deciding which is to be eliminated for the analysis to be continued. This procedure permits the breakdown of all the groups which were concentrated around the origin.

Characterization of plant groups

Physiognomic and floristic characterization

By using ANAPHYTO software, a phyto-sociological table was specified for each group. Then, the covering of each species in each group was calculated according to the Tomasseli method (*in* Long, 1954) in order to assign the physiognomic type of the first two dominant species of the group. As regards the floristic characterization, the species which are exclusive for this characterization and those particularly dependent on it were maintained in each group.

Ecological characterization

The groups were characterized ecologically by taking into account the ecological variables of the group and the auto-ecology of their characteristic species as well.

Pastoral characterization

Two approaches are generally used to assess rangeland quality: a phytoecological and a zoo-technical approach.

The first aims to quantify the vegetation and to assess its energy value. As a result, pastoral production is expressed in UF/ha by taking into account seasonal energy values and production coefficients concerning both the plants and the animals. However, this concept of pastoral production, expressed in energy equivalents, has limitations –even if it has the advantage of allowing the calculation of the load– because it requires a tiresome measurement protocol (Hirche, 1995), among other things. In order to mitigate that difficulty an easier classification of the rangelands was suggested. This classification deals with a total coefficient for quality, assigned to a pasture according to its composition in fodder species and their contribution to the vegetation. The pastoral value (PV) is, thus, obtained by multiplying, for each species, its specific contribution (Csi) to the vegetation by a quality index (Is) and then by adding the results for all the species (Floret, 1988). Thus, the qualitative aspect of the rangeland is expressed by the specific quality index (Isi) and the quantitative aspect is appreciated by the specific contribution to the vegetation (Csi). The formula used in various experiments related to the Algerian steppe (Aidoud, 1989; Boughani and Hirche, 1991) is the following:

$$\mathbf{PV = 0.1 \times \sum_{n=1}^{N} Csi \times Isi,}$$

with $\mathbf{Csi = Fsi / \sum Fsi \times 100}$

where Csi is the specific contribution of the species defined as the ratio of the specific frequency (Fsi) and the sum of the specific frequencies of all the species listed on 100 sampled points, and Isi is the specific quality index.

The specific quality index (Isi) refers to an empirical expression of the food value of the plants. It is based on several parameters, such as the speed at which the vegetation grows, its digestibility, its assimilability, its flavour and its importance for the animals. It is scored on a scale of 5, 8 or 10 levels according to the authors. As a consequence, it is a rather relative index and can only be used on a purely comparative basis as stated by Poissonet and Toure (1986 *in* Floret, 1988). However, its application allows for a very instructive comparison between the pastures within the same natural area.

The disturbance index (IP), defined by Hebrard *et al*. (1995), was calculated for each group, in order to appreciate the individualized group degradation state, as:

IP= Chamaephyte + therophytes / total number of species.

Results and discussion

Total analysis results

The total factorial analysis allowed the determination of the factors, which would explain the vegetation distribution in these ecological groups by seeking the ecological significance of the factorial axes.

The factors influencing the vegetation distribution of the alfa formations studied would be: (i) rainfall; (ii) thermophily; (iii) anthropic degradation; (iv) minimum average of the coldest month (m); and (v) the ground surface state.

In order to obtain significant sets of the groups, we took into consideration the CAH that classifies them gradually on the basis of their floristic similarity for obtaining relatively homogeneous floristic units. Ten groups were distinguished during these partial analyses and characterized on a floristic and ecological scale. They correspond to different steppe formations:

Group A: *Stipa tenacissima*, *Juniperus phoenicea* and *Globularia alipum* tree steppe.
Group B: *Stipa tenacissima* and *Arthrophytum scoparium* pre-Saharan steppe formations.
Group C: *Stipa tenacissima, Atractylis humilis* and *Rosmarinus tounifortii* steppe.
Group D: *Stipa tenacissima* and *Lygeum spartum* and *Cutandia dichotoma* steppe.
Group E: *Stipa tenacissima* and *Launea acanthoclada* steppe.
Group F: *Stipa tenacissima, Artemisia herba alba* and *Asphodellus microcarpus* steppe.
Group G: *Stipa tenacissima, Atractylis humilis* and *Helianthemum hirtum* steppe.
Group H: *Stipa tenacissima, Eruca vesicaria* and *Artemisia herba alba* steppe.
Group I: *Stipa tenacissima*, *Schismus barbatus* and *Artemisia herba alba* formations.
Group J: *Stipa tenacissima* steppe.

To a large extent, the ten groups belong to the fresh and cold variables of the semi-arid bioclimate, but the group B belongs to the fresh arid area. The geomorphological situation of most of the groups is variable (djebels slopes, glacis) except for groups A and C, which are only located on the djebels slopes. Furthermore, we notice the presence of the harsh elements in all the groups with rates varying from 14% in group A to 40% in group H.

Pastoral characterization

Table 1 shows the pastoral values of the 10 groups distinguished by the numerical analyses with their corresponding characteristics. In general, the variation of the pastoral value between the groups is not significant. According to Figs 1 and 2 where the groups are classified by the pluviometric and anthropic gradients respectively, there is no correlation between the latter and the pastoral value. Nevertheless, we notice that for group C the pastoral value of alfa and rosemary is relatively weak if we consider the rainfall (473.09 mm/year) and floristic richness (247 species), which however, represent the highest group with the second weak rate of therophytes (50.41 %). This low value could be due to the fact that this group contains the highest number (21) of species that are toxic or not accepted by the cattle.

Table 1. Pastoral value of the groups

Groups	Formations	Pastoral value	Floristic richness	Rainfall (mm/an)	Rate of therophytes (%)	Index of disturbance (%)
A	*Stipa tenacissima* and *Juniperus phoenicea*	41	155	341	59	72
B	*Stipa tenacissima* and *Arthrophytum scoparium*	38	178	295	60	77
C	*Stipa tenacissima, Rosmarinus tounifortii* and *Atractylis humilis*	36	247	473	50	66
D	*Stipa tenacissima, Lygeum spartum* and *Cutandia dichotoma*	41	121	323	63	73
E	*Stipa tenacissima* and *Launea acanthoclada*	39	172	316	66	75
F	*Stipa tenacissima* and *Asphodelus microcarpus*	34	136	334	60	72
G	*Stipa tenacissima, Atractylis humilis* and *Heliathemum hirtum*	40	110	324	53	69
H	*Stipa tenacissima* and *Eruca vesicaria*	42	107	409	49	67
I	*Stipa tenacissima, Schismus barabtus* and *Artemisia herba alba*	45	113	409	56	75
J	Pure *Stipa tenacissima*	33	161	303	62	71

Group J is characterized by the lowest pastoral value (33.20%). Indeed, it covers 43 poor fodder species with a significant contribution to the vegetation (79.57%). However, the 77 well classified fodder species only cover 12.96%.

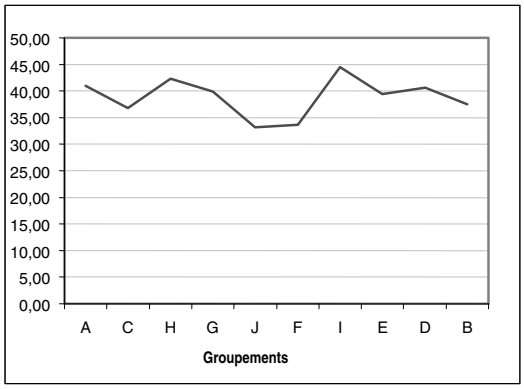

Fig.1. Pastoral values of the groups classified according to the pluviometric gradient.

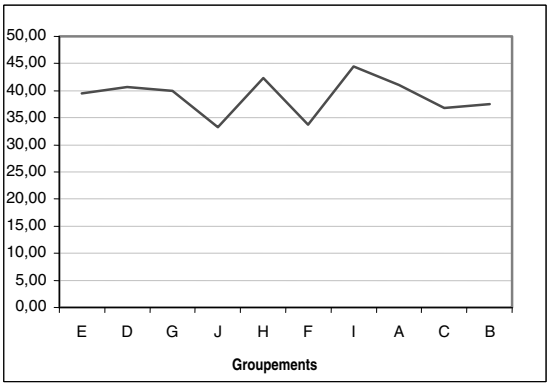

Fig. 2. Pastoral values of the groups classified according to the anthropic gradient.

Conclusions

The factorial analysis of correspondences enabled us to carry out a global analysis using all the groups. The global analysis allowed us to determine the factors affecting the vegetation distribution of the alfa formations: rainfall, thermophily, anthropic degradation, minimum average of the coldest month and surface quality of the ground. With the 13 partial analyses, we discriminated 10 plant groups corresponding to alfa tree steppe, alfa steppes more or less degraded of the fresh and cold semi-arid area, and the *Arthrophytum scoparium* pre-Saharan steppe formations. The pastoral characterization of the groups, classified according to the pluviometric and anthropic gradients, does not show a correlation with the pastoral value. Human intervention inhibits the beneficial effect of the rainfall. Any therophyte growth is immediately grazed.

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