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Role of Shrubs in ecosystem functions

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SUMMARY - Shrubs play an important role in ecosystems since they are resistent to climatic conditions, and in particular to drought and salinity. They are in general well consumed by browsing animals besides having a good nutritional value for livestock. Their role in ecosystem stability nevertheless requires the strict control of their utilization.

RESUME - "Rôle des arbustes fourragés dans les écosystèmes". Les arbustes tiennent une place importante dans les écosystèmes car ils résistent aux conditions climatiques extrêmes, et en particulier à la sécheresse et à l'excès de sel. Ils sont généralement bien consommés en particulier par les brouteurs et ont une bonne valeur nutritive pour le bétail. Leur rôle dans la stabilité des écosystèmes nécessite toutefois que leur utilisation soit rigoureusement contrôlée.

Introduction

Shrubby forages are usually divided in tall shrubs (0.5 to 3m high) generally known as nanophanerophytes and chamephytes which do not exceed 50 cm in height. According to LE HOUEROU (1980), shrubby plants rangelands cover, in North Africa, about 940 000 km^2 of which 65 000, 350 000 and 525 000 are located in semi-arid, arid and desert regions, respectively. Shrublands are degraded. Use of shrubs as fuel is one reason. The increase in the demand for cereals resulted in the farming of rangeland in regions where the precipitation averaged less than 240 mm. Farming these lands destroyed native species such as *Artemisia herba alba* and *Stipa tenacissima*. The probability to have a good year is low, land appeared to be abundant after being farmed once or twice. Desertification risk is now increasing. Shrubby plants are important in ecosystem functions for 5 main reasons, 1) resistance to extreme environmental conditions, 2) good nutritive value, 3) average to good palatability, 4) role in maintaining the ecosystem stability.

1. Resistance to severe environmental conditions

Resistance to water stress

Some shrubby species survived a higher water stress, e.g., *Ceratoides lanata* and *Atriplex confertifolia* grown at water potential of -70 to -80 bars. Three types of drought resistance have been suggested by Turner (1979). Drought escape is the ability to complete their life cycle before a serious water deficit develops. The second type of resistance is drought tolerance. Shrubs are able to tolerate periods of precipitation deficit. Drought tolerance can occur at high tissue water potential or low tissue water potential.

The maintenance of high-tissue water potential can be accomplished by restricting water loss or maintaining the current water supply. Changes in stomatal conductance or evaporative surface area can restrict water loss (Newton and Goodlin 1989). Water loss reduction can be achieved by reducing the amount of absorbed radiation. Radiation is also reduced by production of hair, wax, or salt on the surface.

Thirdly, shrubs have deep roots which enable them to adapt to extremely variable soil and moisture conditions. For instance, roots of *Atriplex halimus* and *Ziziphus lotus* can reach 10 and 60m, respectively. The deep root system allows shrubs to withstand an average water stress of -15 bars. Fischer and Turner (1978) suggested that the ratio of root/shoot changes to maintain plant water potential within certain limits. An increase in root/shoot ratio can be associated with deeper rooting (Kummerow 1980).

Resistance to salt

The shrubby plants tolerate various amounts of salt in the 0-30 cm layer of the soil as shown in Table 1. Many studies focused on the mechanisms of tolerance.

Grenway (1962) suggested that the tolerance to chloride and sodium ions is associated with the relatively low rate of ion absorption. Shrubby plants grown on saline media may regulate their ion uptake to a certain extent, but generally an increase in salinity causes an increase in ion uptake and consequent build-up of salt in the plants organs. The excessive uptake of cations by the plant cells is commonly associated with an increase in the synthesis of organic acids (Jacobson and Ordin 1954).

Atriplex plants are characteristic of those facultative halophytes that achieve salt tolerance by accumulating ions against a concentration gradient, and then parting those ions in specific cells. Salt glands, an anatomically distinct group of cells, concentrate the salt and then secrete salt crystals to the outside of the leaf surface (Thomson and Liu 1967). Rainfall washes the salt back to the soil surface.

Table 1: Resistance to salt of some shrub species

	% of soluble salt in the 0-30 cm soil layer
Halocneum sp	2.5
Suaeda sp	2.5
Salicornia sp	2.5
Atriplex sp	0.5
Artemisia sp	0.08

2. Good nutritional value

Chemical content

Shrubs are known for maintaining a reasonably constant nutritive value. The protein content remains high late in the season in comparison to the herbaceous plants. With advance in season (early to late season) , shrub-protein content declines only about 40% in comparison to 75% for grasses. Table 2 reports the crude protein of four shrubs found in the southern part of the Mediterranean basin. Cook (1972) compared the content of digestible protein for the 3 plant groups (grasses, forbs and shrubs) with advance in season and their ability to meet the animal requirements. He concluded that shrubs meet animal maintenance and gestation requirements even late in the season. However, grasses and forbs do not meet the same requirement past the flowering stage of development.

Crude fiber content of the shrubs remains comparable to the other range species. The crude fiber varies between 20 to 35% depending on the season.

Table 2: Crude protein, crude fiber and in vitro organic matter digestibility (INOMD) of some shrubby species for different seasons.

	Crude Protein	Crude Fiber	INOMD
		Spring	
Acacia cynophylla[a]	13.52	26.19	26.48
Atriplex nummularia[a]	18.60	14.41	58.93
Medicago arborea[a]	19.64	18.43	61.74
Genista pseudopilosa[b]	12.76	30.57	
		Summer	
Acacia cynophylla[a]	10.44	23.57	20.80
Atriplex nummularia[a]	17.75	17.75	48.26
Medicago arborea			
Genista pseudopilosa		Autumn	
Acacia cynophylla[a]	11.07	26.79	20.09
Atriplex nummularia[a]	19.65	21.60	53.05
Medicago arborea			
Genista pseudopilosa[b]	10.28	33.57	

[a] Saadani (1987)
[b] El Aich (1979)

Phosphorus content of shrubby plants averaged 0.30 and 0.20% early and late in the season, respectively. Phosphorus content of grasses dropped 75% (0.25% early in the season and 0.05 late in the season) between vegetative stage and maturation while P content of shrubs declined only 33% (Cook 1972). The P content of shrubby plants was adequate to meet maintenance and gestation requirement of ewes.

Shrubby species decreased slightly in carotene content with advance in season because of the high content in the covering bark on young twigs. Grasses lose their carotene rapidly. Forbs are intermediate between the two groups (Cook 1972).

One other comparison needs to be made among shrubs, forbs and grasses. During drought shrubs provide a more dependable source of forage.

Digestibility of shrubs

The digestibility of shrubby plants varies among species and with advance in season. Saadani (1987) compared three shrubby forages, *Acacia cyanophyla, Atriplex nummularia* and *Medicago arborea*. His findings indicated that *Acacia cyanophyla* presented the lowest organic matter digestibility (IVOMD), regardless of the period of the year. *Atriplex nummularia* maintained an adequate organic matter digestibility throughout the entire season.

Medicago arborea showed a higher IVOMD in the spring.

Energy content

Energy content of some shrubby plants is presented in Table 3. Gross energy of these plants is comparable to herbaceous plants. Digestible energy, however, is lower as compared to herbaceous plants, because of the higher content of lignin. The metabolizable energy is even lower because of the essential oils. Cook (1972) reported that the metabolizability of shrubs is of the magnitude of 0.30 as compared to alfalfa hay, 0.82.

Table 3: Energy content of some shrubs (in Kcal/kg DM)

	Gross Energy	Digestible Energy	Metabolizable Energy
Artemisia nova	5101	2124	1044
Artemisia tridentata	4830	1948	1130
Atriplex concertifolia	3503	1174	847
Ceratoides lanata			*1400*
Agropyrum desertorum			1870
Alfalfa hay	4495	2940	2438

3. Average to high palatability

Shrub contribution to animal diet depends on the bioclimate. Contribution of shrubs increased with the severity of the environment. Higher contributions are found in arid to desert ecosystems. Ait Hammou (1990) reported that in the Moroccan desert, shrubs contributed up to 90% to camel diet. In arid ecosystems (Oriental Steppe, Morocco), Merzak (1990) found that the shrubs (*Artemisia herba-alba* and other shrubs) in sheep diet averaged 80 to 90%. In more favorable environments, animals use shrubs on a seasonal basis. El Aich (1979) found that shrub contribution to sheep diet in the middle Atlas averaged 35% late in the season. He concluded that shrubs constituted a source of protein late in the season.

In semi arid to humid ecosystems where shrub plant communities are associated with herbaceous communities, animals use habitats on a seasonal basis. Shrubby plant communities are generally used late in the season while the herbaceous ones are grazed earlier. This utilization of habitats ensures a balanced diet for grazing animals and copes with the seasonal shortage of adequate quantity and quality forage.

Shrubs have a high content of secondary compounds which constrain their utilization by animals. El Honsali (1982) compared the use of oak leaves, highly rich in tannins, by sheep and goats. He concluded that goats digestibility was more efficient especially after a concentration of 6%. In reviewing factors that affected shrub palatability, McKell (1989) reported that the major secondary compounds in shrub species that had negative influence on palatability were: essential oils, saponins, phenolics and sesquiterpenes.

4. Role in the stability of the ecosystem

Shrubs can be used as cover ensuring soil stability. They are an important fuel in some areas. Shrubs play a major role in nutrient cycling. Other roles of shrubs are: modification of microclimate, modification of air boundary layer near soil surface and protection of some herbaceous plants from herbivory.

Shrubs can survive extreme environmental conditions and tolerate browsing. This resistance allows them to be introduced in degraded marginal areas. For successful range rehabilitation, shrubs' aptitude to germinate, grow, and reproduce must be taken into consideration.

In conclusion, management of shrubs alone or in relation to the other species is critical. Indeed, unregulated and selective grazing by livestock has shifted many plant communities to a situation where aggressive shrubs of low palatability dominate. Good management is the key for maintaining a desired species balance. Even though shrubs are resistant to browsing, their reestablishment may take more than a decade.

References

AIT HAMMOU, 1990. Comportement alimentaire et systemes d'elevage du dromadaire. Memoire de fin d'etude de l'Institut Agronomique et Veterinaire Hassan II, Rabat.

COOK, C. W. 1972. Comparative nutritive values of forbs, grasses and shrubs. Wildland Shrubs: Their Biology and Utilization. USDA Forest Service Technical Report INT-I, 1972. Intermountain Forest and Range Experimentation, Ogden, Utah 84401.

EL AICH, A. 1979. Préfèrences alimentaires et valeur nutritive de la ration des ovins sur parcours. Memoire de fin d'étude de l'institut Agronomique et Vétérinaire Hassan II, Rabat.

EL HONSALI, A. 1982. Utilisation comparée des feuilles de chêne vert par les ovins et les caprins. Mémoire de fin d'étude de l'institut Agronomique et Veterinaire Hassan II, Rabat.

FISCHER, R. A., and TURNER, N. C. 1978. Plant productivity in the arid and semiarid zones. Annu. Rev. Plant Physiol. 29: 277-317.

GRENWAY, H. 1962. Plant response to saline substrates. I. Growth and ion uptake on several varieties of Hordeum during and after sodium chloride treatments. Aust. J. Biol. Sci. 15: 16-38.

JACOBSON, L., and ORDIN, L. 1954. Organic acid metabolism and ion absorption in roots. Plant Physiol. 29: 70-75.

KUMMEROW, J. 1980. Adaptation of roots in water-stressed native vegetation. In "Adaptation of plants to water and high temperature stress" (N. C. Turner and P. J. Kramer, eds). pp. 57-73, Wiley, New York.

LE HOUEROU, H. N. 1980. Colloque sur les fourrages ligneux en Afrique. Addis Ababa: 8-12 Avril 1980. Centre International Pour l'Elevage En Afrique (CIPEA).

MCKELL, C. M. 1989. Shrub palatability. In "The Biology and Utilization of Shrubs" (C. M. MCKell, ed), Academic Press, pp. 365-383.

MERZAK, S. 1990. Contribution a la définition d'une utilisation appropriée des parcours a Armoise dans l'Oriental . Mémoire de fin d'étude de l'institut Agronomique et Veterinaire Hassan II, Rabat.

NEWTON, R. J. and J. R. GOODIN. 1989. Moisture stress adaptation in shrubs. In "The Biology and Utilization of Shrubs" (C.M. MCKell, ed), Academic Press, pp. 365-383.

SAADANI 1987. Production fourragère et comportement alimentaire des ovins et des caprins dans un parcours mixte a *Acacia cyanophylla, Atriplex nummularia* et *Medicago arborea.* Mémoire de fin d'étude de l'institut Agronomique et Veterinaire Hassan II, Rabat.

THOMSON, W. W. and L. L. LIU. 1967. Ultrastructural features of the salt gland of *Tamarix aphylla* L. Planta 73: 207-220.

TURNER, N. C. 1979. Drought resistance and adaptation to water deficits in crop plants. In "Stress Physiology in crop plants" (H. Mussel and R. C. Staples, eds), pp. 343-372.