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IMPACT OF LIVESTOCK GRAZING ON THE FLORISTIC COMPOSITION: A CASE STUDY OF THE MOUNT OF TESSALA, WESTERN ALGERIA

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Abstract

The present work focuses on evaluating the impact of livestock grazing on the floristic composition in the mount of Tessala (Western Algeria). Phytoecological surveys were carried out at seven stations around north and south slopes of the mount. The obtained results through Principal Components Analysis (PCA) indicated the impact of man and herd on the floristic composition of sampling stations. Indeed, stations where grazing is low, have greater species richness marked by the strong presence of palatable species, unlike stations under permanent grazing, characterized in particular by the appearance of non-palatable species. Moreover, we note the dominance of therophytes at all stations not only due to grazing pressures but also to drought in the study area.

Keywords: floristic composition; phytoecological surveys; livestock grazing; Mount of Tessala

Introduction

The forest heritage of Western Algeria knows since decades a perpetual regression, due to the conjugation of the constraining climate characterized by a prolonged summer dryness and a irregularity of the rains (Quézel, 2000), anarchistic and unwise human activities (deforestation, excessive grazing, fire)and a bad management of ecosystem (Ferka-Zazou, 2006). Such evolution caused the substitution of a mesophytic vegetation by a xerophytic vegetation, confirmed in the works of Gaouar (1980); Alcaraz (1982); Benabdelli (1998, 2000); Bouabdellah (1992); Bouazza and al. (2004). The forest ecosystem of the mount of Tessala, is located in the Algerian west, this ecosystem characterized by an important ecological and socio-economic role, is exposed to an intense losing of the floristic composition (Cherifi et al., 2011). The study area is characterized by a strong increase in the population and the number of the bovine, ovine and caprine herds. This tendency is the principal cause of degradation of the pastoral ecosystems. Indeed, the increase in the number of the livestock generated an excessive grazing, accentuating the phenomenon of erosion and the desertification. The majority of the works carried out on the forest ecosystem of Tessala concern the inventory of the plants (Ouici, 2011; Mokaddem, 2012) and biochemical valorization of some medicinal plants (Attaoui, 2009; Bouterfas, 2011; Bouzidi et al., 2012). Those works reveal the underline the need of preservation actions in this fragile ecosystem.

It should be also noted that the works referring to the evaluation of the impact of the human activities on the vegetation cover of the forest of the mount of Tessala are very limited (Ferka-Zazou, 2006). In 2011, we carried out a preliminary study which consists on characterizing the floristic composition of this ecosystem by the means of phytoecological statements in order to analyze the impact of the human activities on the vegetation cover (Cherifi et al., 2011). The objective of this work is, to complete the previous study, by analyzing the vegetation cover, exposed to different levels of livestock grazing pressure, in order to understand the ecosystem dynamic, and to guide the conservation and the management actions in the study area.

Material and methods

Study area

The mount of Tessala is located north of the Sidi Bel Abbes province (West of Algeria), limited to north by the plain of Mleta and Oran Sebkha, in the east by the mounts of Béni

Chougrane, in the west by the mounts of Sebaa Chioukh and in the south by the plain of Sidi Bel Abbes. It is a part of the Tell Atlas, its highest point is 1061m elevation (Kiekken, 1962) (Figure 1). The mount of Tessala is a part of central Oran Tell. Its geological constitution is dominated by thrust sheets formations of Cretaceous-Oligocene complex described by Dellaoui (1952) and limestone formations with calcareous predominance not very resistant to erosion. The climate which reign is Mediterranean semi-arid with fresh winter, the annual rainfall average is varying between 335 and 400 mm and an annual temperature average between 8,33°C and 26,11 °C. The minimum average of the coldest month is 2°C, the maximum of the hottest month rarely exceeds 30 °C (Benyahia et al., 2001).

Phytoecological investigation

For the study of the vegetation, we adopted the stigmatist method developed by Braun-Blanquet (1951). For this purpose, seven stations spread over both sides north and south have been selected at the study area taking into account the exposure of the terrain, vegetation physiognomy and the pasture degree (Figure. 1).

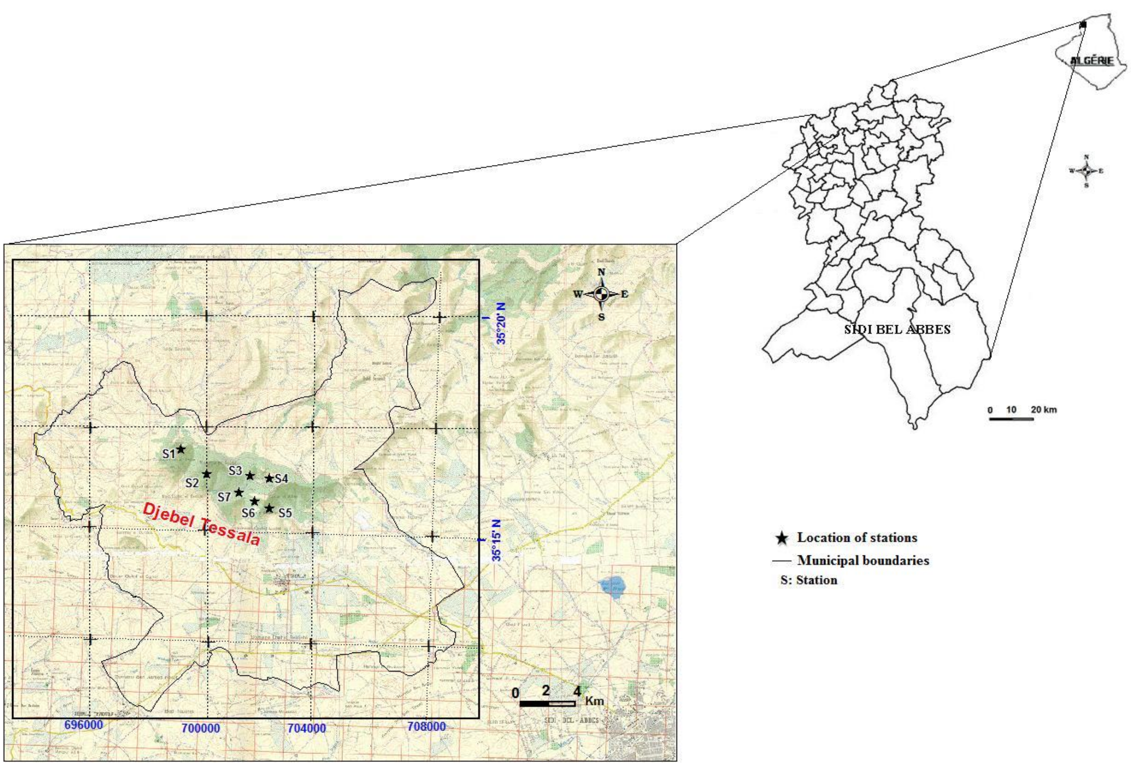

Figure 1. Location of the mount of Tessala and the sampling stations

At seven stations studied, 30 floristic surveys of 100 m² each were made during the growing season optimum, ranging from March to May 2009, following the classic designs of plant ecology. The floristic lists were compiled based on strata classic tree, shrub, bush and grass. Each species identified was assigned a coefficient of abundance-dominance and sociability. The surface of 100 m^2 is considered in this case as minimum area to identify the most species (Gounot, 1969; Guinochet, 1973). Altitude, slope, exposure, type of substrate and the recovery average rate for each survey were recorded. Determination of species recorded was made in the laboratory using the flora of Quézel and Santa ([1962] 1963). The characteristics of the sampling stations are shown in Table 1. The stations S5 and S7 where the grazing is low were taken as witness compared to the stations S1, S3, S4 and S6 characterized by a permanent grazing and the S2 station by an average grazing. This distinction will enable us to compare the floristic composition of these stations and to highlight the impact of the pasture which represents a form of disturbance and/or stress according to its intensity and its frequency.

Table 1. Characteristics of sampling stations

Sampling stations	Latitude North	Longitude West	Grazing level
S1 (garrigue of calycotome and doum palm)	35°17’11" N	0°48’36" W	Intense grazing
S2 (open matorral of holm oak)	35°16’42" N	0°48’02" W	Average grazing
S3 (garrigue of calycotome and diss)	35°16’40" N	0°47’03" W	Intense grazing
S4 (garrigue of calycotome and doum palm)	35°16’37" N	0°46’37" W	Intense grazing
S5 (open forest of Aleppo pine)	35°16’02" N	0°46’36" W	Low grazing
S6 (garrigue of calycotome)	35°16’11" N	0°46’57" W	Intense grazing
S7 (matorral of holm oak)	35°16’21" N	0°47’18" W	Low grazing

S: Station

Data processing

For the treatment of our results, we used the principal components analysis (PCA) and hierarchical cluster analysis (HCA). The principal component analysis allows to highlight the similarities existing between the different variables considered and the sampling stations (Phillippeau, 1986). The hierarchical cluster analysis (HCA) was used to distinguish the boundaries between the different stations (Benzecri, 1984). The matrix of the principal component analysis (PCA) intersects the set of variables used: the degree of pasture, altitude, exposure, slope and recovery average rate for highlighting the impact of pasture on seven (07) stations sampled in the Mount of Tessala.

Results

Vegetation analysis

After analysis of data relating to different floristic surveys on selected stations, a synthetic table containing different species per stratum is prepared. These analyses have identified certain characteristics related to biological spectra of the 66 plant species identified.

Species inventoried in Tessala mount are divided into four strata:

The tree stratum is represented by *Pinus halepensis* L., *Quercus ilex* L., *Viburnum tinus* L., *Pistacia terebinthus* L., *Olea europea* Var. *Oleaster* Dc., *Ceratonia siliqua* L.

The shrub comprises *Pistacia lentiscus* L., *Quercus coccifera* L., *Arbutus unedo* L., *Phillyrea angustifolia* L., *Crataegus oxyacantha* L., *Ziziphus lotus* (L.) Lam., *Rhamnus alaternus* L., *Rubus caestus* L., *Rosa sempervirens* L., *Nerium oleander* L.

Bushy and herbaceous stratumis represented by a varied range of species: *Daphne gnidium* L., *Calycotome spinosa* Link., *Ampelodesma mauritanica* (Poir.), *Asparagus acutifolius* L., *Asphodelus microcarpus* Sal. et Viv., *Chamaerops humilis* L., *Cistus salvifolius* L., *Artemesia sp.*, *Stipa tenacissima* L., *Smilax aspera* L., *Lonicera implexa* Aiton., *Urginea maritime* L., *Adonis aestivalis* L., *Atractylis gummifera* L., *Aegilops triuncialis* L., *Avena sativa* L., *Anagallis arvensis* L., *Anagallis monelli* L., *Bromus rubens* L., *Brachypodium distachum* L., *Bellis annua* L., *Borago officinalis* L., *Calendula arvensis* L., *Cynodon dactylon* L., *Lagurus ovatus* L., *Leuzea conifera* (L.) D.C., *Centaurea incana* L., *Daucus carota* L., *Erodium moschatum (Burm)* L'Her., *Helianthemum polyanthum* (L.) Mill., *Hordeum vulgare* L., *Malva sylvestris* L., *Malva parviflora* L., *Marrubium vulgare* L., *Sinapis arvensis* L., *Raphanus raphanistrum* L., *Reseda alba* L., *Rumex pulcher* L., *Rubia peregrine* L., *Ruta montana* L., *Teucrium polium* L., *Trifolium stellatum* L., *Lobularia maritima* (L.) Desv., *Papaver rhoeas* L., *Plantago coronopus* L., *Plantago lanceolata* L., *Salvia argentea* L., *Scolymus hispanicus* L., *Thymus cilliatus* Desf.

Biological spectrum

The vegetation of the study area as a whole is characterized by a high percentage of therophytes with 39 %, followed respectively by phanerophytes (31%), hemicryptophytes (14%), chamaephytes (13%) and geophytes (3%) (Figure 2). The therophytes are represented by *Aegilops triuncialis* L., *Avena sativa* L., *Anagallis arvensis* L., *Anagallis monelli* L., *Bromus rubens* L., *Brachypodium distachum* L., *Bellis annua* L., *Borago officinalis* L., *Calendula arvensisi* L. *Cynodon dactylon* L., *Lagurus ovatus* L., *Leuzea conifera* (L.) D.C., *Centaurea incana* L., *Malva sylvestris* L., *Malva parviflora* L., *Sinapis arvensis* L., *Raphanus raphanistrum* L., *Rubia peregrina* L., *Trifolium stellatum* L., *Papaver rhoeas* L., *Salvia argentea* L., *Scolymus hispanicus* L., etc..The therophytes predominance in the seven stations sampled reflects the degraded state of these latter.

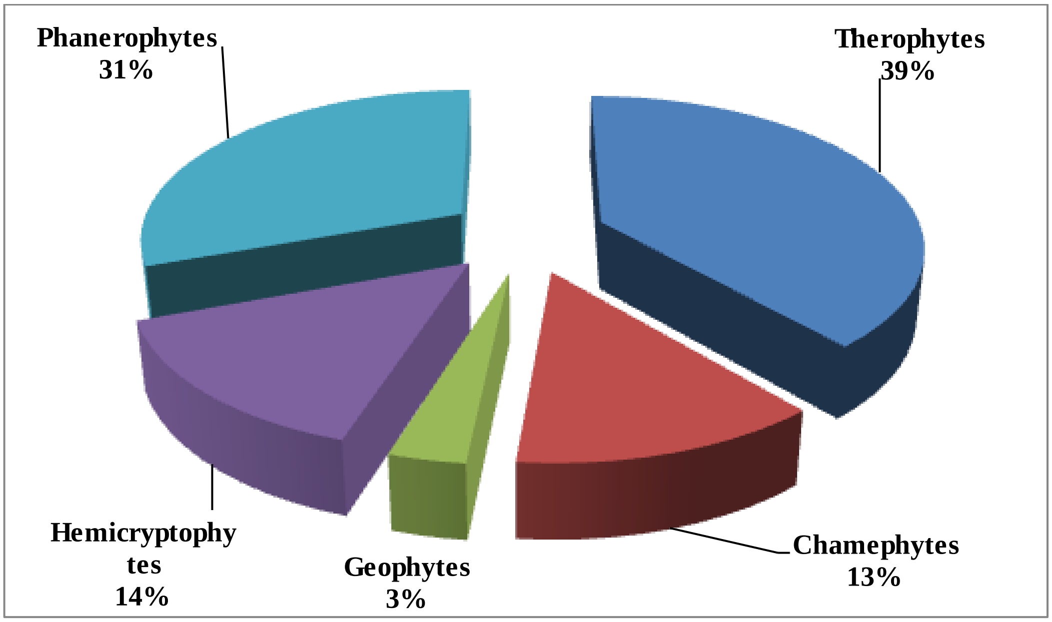

Figure 2. Total biological spectrum

Data processing

The Principal Components Analysis (PCA) identifies two groups of stations (Figure 3). In fact, on the factorial design, the F1 axis gives the most information in the PCA (48.10 % of inertia) compared to the F2 axis (28.14 %), opposed the group G1 to group G2. The choice of these two groups of stations has been supported by the hierarchical cluster analysis (HCA) performed in parallel, to highlight the differences between their floristic compositions. Based on this factor segregation in the F1 axis, oppose facies (outward appearance of flora) related to the degradation: less degraded to the positive side (G1) and degraded to the negative side (G2).

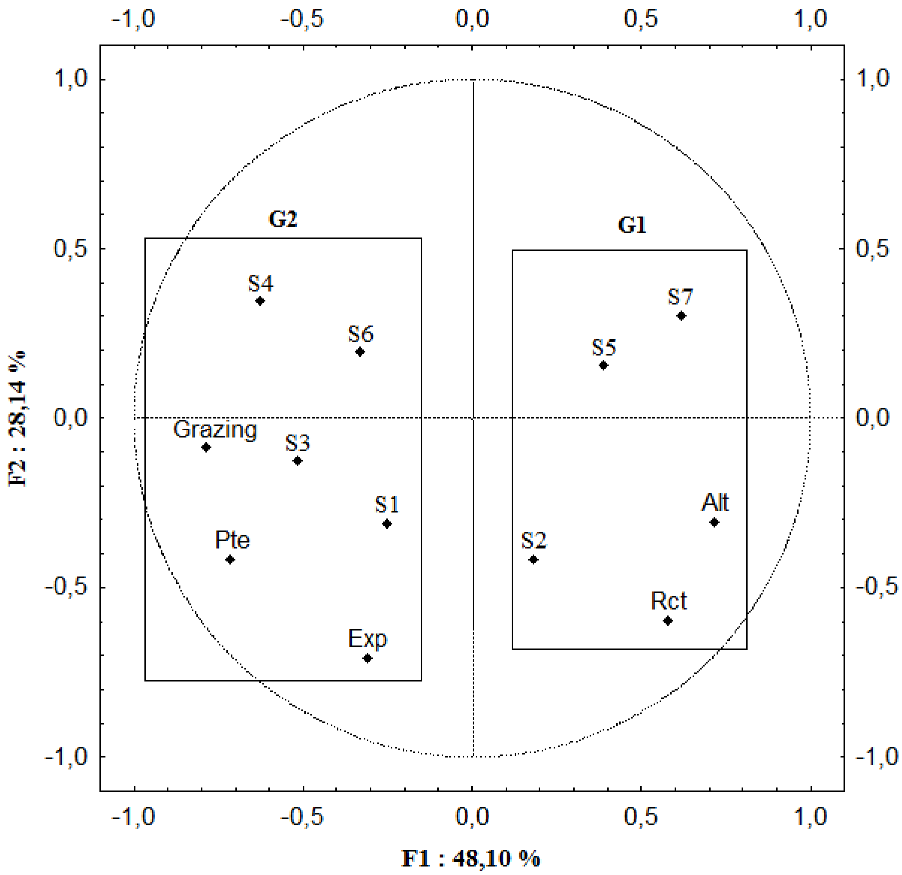

Figure 3. Principal component analysis (correlation circle, map 1-2)

S: station; Alt: altitude; Rct : coverage rate ; Pte: slope ; Exp: exposure; G: group.

Grazing actions

The livestock of the study zone is based on sheep, cattle and goats unequally distributed. It is a livestock of mountain related to the conditions of pasture which are offered. The data in figure 4 shows undoubtedly high pasture pressure of livestock in the study area. Indeed, it should be noted, from 1989 to 2008, a gradual increase in livestock numbers. Pasture is a heavy burden on the environment of the area because the loss of vegetation cover and change in species composition are the elements that characterize the regressive evolution of the vegetation of the region.

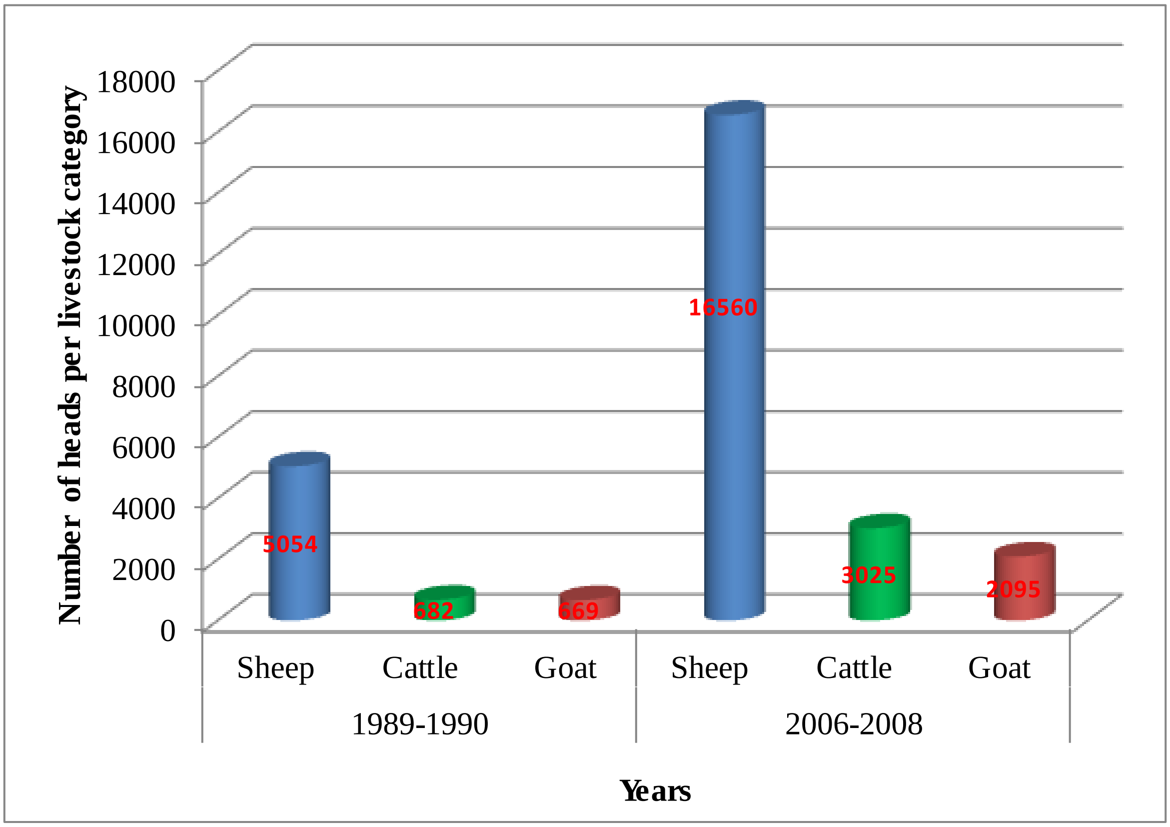

Figure 4. Distribution of the livestock number in the study area

(Agriculture services of Sidi Bel Abbes, 2009)

Discussion

Data analysis of the phytoecological surveys, shows in the station S1, a large dominance of scrub species (*Chamaerop shumilis* L., *Asphodelus microcarpus* Sal and Viv., *Calycotome spinosa* Link., *Cistus salvifolius* L., *Ampelodesma mauritanica* (Poir.)) with the detriment of the species that characterizing the forest environment as *Quercus coccifera* L., *Pistacia lentiscus* L., *Pistacia terebinthus* L., *Olea europea* Var. *Oleaster* Dc., *Phillyrea angustifolia* L., *Rhamnus alaternus* L., and *Rosa sempervirens* L. We also note that the substrate on which to develop these taxa is predominantly calcareous. The vegetation cover is estimated at 20 % relatively average. Some tree species such as *Pinus halepensis* L., *Quercus ilex* L., *Pistacia terebinthus* L., *Olea europea* Var. Oleaster Dc., *Ceratonia siliqua* L., observed especially in training to *Calycotome spinosa* Link., and *Ampelodesma mauritanica* (Poir.), dominate the stations S2, S5 and S7. Indeed, wooded areas are developed, reaching over 3 meters in height for *Pinus halepensis* L.

and 2 meters for *Quercus ilex* L. and *Olea europea* Var. *Oleaster* Dc. It should also be noted that the cover of these three stations is greater where an average cover respectively 30 % (S2) and 35 % (S5 and S7). These courses are currently an effective role in soil protection. Their high density protects against the ravages caused by the excessive burden of grazing for livestock penetrates easily. At stations S3, S4 and S6, we distinguish facies where degradation thermophilic species spiny Mediterranean dominate. These species are abandoned by the herd, it is: *Chamaerops humilis* L., *Asphodelus microcarpus* Sal and Viv., *Calycotome spinosa* Link., *Ampelodesma mauritanica* (Poir.)., *Hispanicus scolymus* L. *Atractylis gummifera* L., *Centaurea incana* L. and *Urginea maritima* L.. These taxa have a face dominated by scrubland *Chamaerops humilis* L., witnessed the opening of the vegetation favored by the excessive grazing action (Alcaraz, 1982). It should also be noted that the recovery average rate of vegetation at these stations is small hardly exceeding 15 % compared to the two stations (S5 and S7), considered as a witness. The predominance of therophytes is due to drought that marked the region, a phenomenon reported by Quézel (2000). Several authors agree that this is a form of therophytisation drought resistance and ultimate degradation stage (Daget, 1980; Kadi-Hanifi, 2003; Barbero, Quézel and Loisel 1990; Cherifi et al., 2011). The variations in biological spectrum of identified species can be explained mainly by the altitudinal layering, local fluctuations of bioclimatic parameters and by multiple pressures from human and animal (Sauvage, 1961). The rates of different biological types based on the whole of the vegetation shows that therophytes are indicators of degradation.

Based on observations in the field, we find that the main plant formations characterizing the study area are summarized as follows:

- Clear forest of Aleppo pine (*Pinus halepensis* L.) and holm oak (*Quercus ilex* L.), resulting from the degradation of a dense forest where the oak is present in the form of sub shrub. This course is located on a south-east exposure. This is a clear forest, reforestation, consisting essentially of Aleppo pine and holm oak incidentally;
- The dense scrub oak is considered as the most common stage of degradation. Located on a northwest exposure, it still plays a scrub forest and meadow forest. The holm oak (*Quercus ilex* L.) is the essence of this training, continuing despite all the pressures on (grazing cattle intense, cutting, etc..) and regenerates whenever it is mutilated or defaced;
- The scrubland calycotome is a final stage of degradation characteristic bushy stratum. This vegetation type is the most represented. The main species that characterize are the

calycotome (*Calycotome spinosa* Link.), the doum palm (*Chamaerops humilis* L.), (*Ampelodesma mauritanica* (Poir.)) and the asphodel (*Asphodelus microcarpus* Sal. and Viv.). Most often these are used as garrigue rangelands.

Based on the contributions that individuals make (stations) and the variables selected, the group G1 is represented by stations S2, S5 and S7 dominated by tree formations. This type of plant formation according to the factorial axes is seen attached including recovery rate (Rct) and the factor altitude (Alt). Tree and shrub strata have a high recovery rate characterizing the less degraded stations. These stations are represented by wooded matorrals based on holm oak (*Quercus ilex* L.) (S2 and S7) and woodland based on Aleppo pine (*Pinus halepensis* L.) (S5), the rate of recovery varies between 30 to 35 %. The high density of the vegetation protects livestock pasturages which are difficult to access.

The group G2 is represented by the stations S1, S3, S4 and S6 dominated with low formations. It is correlated to grazing, exposure (Exp) and slope (Pte). These stations are represented by highly degraded scrub based on calycotome (*Calycotome spinosa* Link.) associated with saw palmetto (*Chamaerops humilis* L.) and diss (*Ampelodesma mauritanica* (Poir.). Installation of these species in the stations raised is explained by their good adaptation to environmental conditions. According to Le Houerou (1992), the excessive grazing of sheep and cattle leads to the development of chamaephytes mainly represented by *Calycotome spinosa* Link. and *Chamaerops humilis* L. Livestock grazing has a permanent and uncontrolled resulting in the modification of the floristic composition of plant communities with a decrease in the number of palatable species. This is the mainly case of *Plantago coronopus* L., *Plantago lanceolata* L., *Aegilops triuncialis* L., *Erodium muschatum* Burm. and *Avena sativa* L., which are well represented in the stations S2, S5 and S7 where grazing is low to medium, contrary to the stations S1, S3, S4 and S6 where grazing takes place permanently. At these stations, the species are replaced by other little palatable species, generally neglected by livestock. This is the case of *Atractylis gummifera* L., *Asphodelus microcarpus* Sal. andViv., the *Calycotome spinosa* Link., of *Chamaerops humilis* L., *Centaurea incana* L., *Scolymus hispanicus* L. and *Urginea maritima* L. This group of species proliferates and gradually invades large areas causing a change in the physiognomy of the vegetation (Madani et al., 2001; Bourbouze, 2006). Our findings are consist with those of Benabdelli (1983); Bouazza (1991); Bouazza et al. (2004) which indicate that animals select species and therefore requires the consumable biomass provided a selective important. This is the aspect of the palatability of the species which represents the degree of preference granted by the livestock to different species. In addition, our forests are often sought by pastors as extra source for livestock feed (Benabdelli, 1996). Indeed, livestock surplus destroys vegetation cover and compacts the soil by trampling. This results in reduced permeability, so its water, and promotes runoff (Bedrani, 1993). The human impact is also noted, the excessive logging causes a considerable threat to the main forest vegetation across the study area. Collecting firewood, considered the sole source of energy in rural areas, contributing significantly to the destruction of the vegetation cover. It is therefore important to find alternatives that are less destructive, while enabling the rural poor to meet their needs.

Under the combined action of the man and his animal, all the vegetation groups were degraded if not at least strongly disturbed in their dynamics initially then in their floristic composition, causing the deterioration of biodiversity.

Conclusion

At the end of this work, one of the principal conclusions which emerge is the advanced degradation state of forest species such as Aleppo pine (*Pinus halepensis* L.) and holm oak (*Quercus ilex* L.) in the study area, to leave place to shrubby formations based on Calycotome (*Calycotome spinosa* Link.) associated with dwarf palm (*Chamaerops humilis* L.) forming mainly the matorrals associated in best cases with forest species, corresponding to the original vegetation cover. In the forest, the anthropic action remains the independent factor of degradation (Bouabdellah, 1992). The vegetation formations are represented primarily by raised matorrals (dense and clear) and degraded garrigues. Consequently, the state of vegetation cover is alarming and current situation analysis shows the extent of the man and his herd impact on the forest ecosystem in the mount of Tessala. In addition, the study of the vegetation highlighted that the degradation related to the anthropic actions, and the climatic constraints of all kinds, involve the development of forsook and thorny species with rapid growth. It is the case of the following species: *Atractylis gummifera* L., *Asphodelus microcarpus* Sal and Viv., *Calycotome spinosa* Link., *Chamaerops humilis* L., *Scolymus hispanicus* L. and *Urginea maritime* L. The obtained data through this study will constitute a database which will make it possible thereafter to come to a conclusion about the dynamics and the evolution of the forest ecosystem of the mount of

Tessala. Ultimately, the mount of Tessala remains a large pole of ecological diversity which deserves protection and conservation.

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