FLORISTIC DIVERSITY OF THE GROUPING AT PISTACIA ATLANTICA IN THE REGION OF NAÂMA (ALGERIA)

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Abstract
Floristic inventory carried out on grouping range at Pistacia atlantica in southern region of Naama makes it possible to identify 135 taxa, divided into 36 families and 105 genera. This large specific diversity, belong to 36 botanical families, best represented (48%) being Asteraceae, Poaceae, Fabaceae and Brassicaceae. The biological analysis shows predominance of Therophytes with 68 species, i.e. 50%. This predominance is characteristic of arid regions vegetation which adapt to saharan and steppe environment. The biogeographic analysis reveals a predominance of three biogeographical types (mediterranean, saharan and endemic) with a rate of 64% or 87 species. This biogeographic distribution reveals floristic heterogeneity and confirms mediterranean affinity of region flora, which combines three sets: high steppe plains, saharan atlas and Saharan border to South.

Keywords: floristic diversity, grouping, Pistacia atlantica, Saharan atlas

1. INTRODUCTION
The saharan atlas covers important plant resources spread over plains, mountains, chotts, dayas and saharan areas (Benaradj, 2017).
According to MICLE (1997), their potential for biological resources and their impressive diversity across the country imperatively require a preservation strategy is developed.
The ratification by Algeria, the Convention on Biological Diversity is an important step in the management of this valuable capital and an irrefutable proof which strengthens the position of our country in the conservation of biological diversity across planetary and in building sustainable development (Benaradj et al., 2015a)
The purpose of this study is to analyze ecological and floristic indicators of grouping at Pistacia atlantica. This woody and xero-thermophilic species of Anacardiaceae family is a tree par excellence of arid, semi-arid and saharan areas, although for Boudy (1952), pistachio trees are characteristic species of mediterranean region. Most of range is found in North Africa (Morocco, Algeria, Tunisia), but it is also found in Canary Islands, Libya (Cyrenaica), Cyprus and the Near East (Quézel and Médail, 2003).

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We have focused our work on establishment of a descriptive inventory of grouping situation in *Pistacia atlantica*. It was carried out at an area of this taxon in Naama region. This work has not been undertaken in arid and saharan zones to date; Hence its interest.

2. MATERIALS AND METHODS

2.1. Geographic location

Trees of *Pistacia atlantica* are well distributed in study station of Hadjadj (South of Naama). This choice was imposed naturally by *Pistacia atlantica* dissemination in saharan atlas. This choice is to better understand the phytoecological aspects of its distribution in this part of the region of Naama. On biogeographical level, study station is part of saharan atlas (sub-sector AS1) sector in sense of Quézel and Santa (1962); that is to say in most western part of Algeria.

Hadjadj station is located 20 km south of Ain Sefra and 30 km north of Moghrar (between Ain Sefra and Moghrar). It is spread over an area of more than 30,000 hectares and on altitudes oscillating between 930 m and 1,300 m. Trees of *Pistacia atlantica* are well dispersed in talwegs and outcrops of mountains or valley.

Geographically, study area is between 32°41’31.74“ N and 32°38’12.15“ N of north elevation and between meridians of longitude 0°26’29.83”W and 0°22’20.82”W to the west (Fig.1).

![Figure 1. Geographical location of the study station at “Hadjadj” (South of Naama) (I.G.M, 1999)](http://www.natsci.upit.ro)
2.2. Methods of study

2.2.1. Structure of sampling
We have opted for systematic transect sampling. This approach, with help of 50 floristic surveys carried out, makes it possible to identify largest number of plant species on the one hand and is effective in the arid and semi-arid open ecosystems on the other.

2.2.2. Quantitative study
Technique of transect was described by several authors (Gounot, 1969; Godron, 1968; Daget and Poisson, 1971). It is well adapted to steppe ecosystems in analysis of vegetation and soil surface characteristics (Aïdoud, 1983; Nedjraoui, 1990; Slimani, 1998). It is considered as an efficient means of studying evolution of vegetation cover in case of a permanent line (Gounot, 1969; Aïdoud, 1983). The reading is done every 10 cm on a line marked with a graduated ribbon stretched over vegetation.

According to Kadi-Hanifi (2003), this quantitative method consists of enumeration within each stand or formation of species total number and population number of each species. It is specific wealth which is one of characteristic of a stand.

The measures of a quantitative nature are as follows:
- **Measurement of vegetation cover:** The recovery of a species is theoretically defined as soil surface percentage that would be covered if species individual’s aerial organs were projected vertically on ground (Gounot, 1969).
- **Floristic richness:** This corresponds to the realization of a floristic inventory; this stage is based on a census of floristic procession species constituting of grouping in *Pistacia atlantica*.

2.2.3. Qualitative study
It consists of studying biological, systematic and phytogeographical composition of a plant in a given region (Kadi-Hanifi, 2003).

The qualitative measures are:
- Biological characterization: The 5 biological types, which were defined by Raunkiaer (1934) according to morphological nature and which are: Phanerophyte, Chamaephyte, Hemicryptophyte, Geophyte and Therophyte. Raw biological types production is oriented on taxa counting by biological type and carried out on all groups floristic cortege species at *Pistacia atlantica*.
- Phytogeographic characterization: According to Barry and Celles (1973), about the phytogeographical division, study area belongs to holarctic empire, mediterranean region, euromediterranean region, maghrebin-steppic domain and algerian-oranian highlands and saharan atlas.

2.2.4. Determination of floristic, biological and phytogeographical characteristics
Botanical, taxonomic, biological and phyto-geographical determinations of species recorded in field were made at Botanical Laboratory of Tlemcen University and using usual identification keys:
- The Flora of Maire (1952-1987);
- The flora of Algeria (Quézel and Santa, 1962-1963);
- The flora of the Sahara (Ozenda, 1977);
- The great flora in colors: France, Switzerland, Belgium and neighboring countries (Bonnier, 1990);
- The Flora and vegetation of southern Tunisia (Guittonneau et al., 2011);
- Works of dissertations and theses of (Bouzenoune, 1984; Benaradj, 2010; Babali, 2014);
- Works of Le Houérou (1995) and Kaabèche (1990, 2003).
3. RESULTS AND DISCUSSIONS

Our contribution concerns floristic diversity study as well as an analysis of flora within grouping at *Pistacia atlantica* on biological, taxonomic and phytogeographical of pre-Saharan ecosystems. This contribution makes it possible to highlight their floristic originality, their state of conservation.

3.1. Recovery and flora richness

The floristic study within group at *Pistacia atlantica*, allowed us to rise following points (Table 1):

- Coverage around 35%;
- A floristic richness represented by 135 tree, shrub and herbaceous plant species.

| Parameters                          | Results          |
|------------------------------------|------------------|
| Recovery from vegetation (%)       | 35%              |
| Floristic wealth (number of species)| 135 species     |

From these results, we find that recovery rate and floristic richness are generally influenced by several factors:

- **Rainfall and water transfer**: these two factors play a very important role in vegetation reconstruction by seeds germination, because water is an important factor in triggering germination. Year 2012 is experiencing an exceptional rainfall (more 108 mm only in November months 2012) (Benaradj, 2017). According to Poilecot (1996), vegetation is dependent on moisture factor and moisture retention soil capacity. It is this high availability of water for plants that explains the specific richness of sandy soils despite their low retention capacity and which is high in sandy clay soils.

- **Floristic migration**: according to Quézel (1995), our study area has been subjected to a floristic migration which can be caused by two major causes: climate change, which is a major floristic migration process and flora dissemination by long-distance transport by wind, birds and animals by their displacement.

- **Proliferation and settlement of non-palatable (toxic and/ or spiny) species**: another finding was made, non-palatable species establishment in *Pistacia atlantica* (*Ziziphus lotus*, *Centaurea maroccana*, *Asparagus altissimus*, *Atractylis humilis*, *Atractylis serratuloides*, *Urginea maritima*, *Ferula cossoniana*, *Nerium oleander*, *Hammada scoparia*). Same observation was reported by Benabadj and al., 2007. This is explained by a regeneration *Pistacia atlantica* within *Rhus tripartita* tufts, *Launaea arborescens* and *Zilla macroptera* (Benaradj, 2010; Benaradj et al., 2015b).

- **Adaptation and acclimatization**: Various morphological and physiological adaptations allow these plants to resist, adapt and maintain themselves in their arid (very dry) environments. Among these forms of adaptations are leaf area reductions (plants that may have very thick leaves or reduced to spines, which allows them to limit their water losses (*Fagonia glutinosa*, *Fagonia latifolia*, *Zilla spinosa*, *Launaea arborescens*). The formation of a cushion is also a form of adaptation to xeric medium with a morphological modification, for example species (*Anabasis aretioides*) may take on a ball or pin cushion appearance and *spinous xerophyte*. Some plants may have considerably developed underground organs (Rhizomatous) (*Scorzoner a undulata*). Leaves can also take needle or scales forms, as is case with following species: *Hammada scoparia*, *Hammada schmittiana*, *Thymelae a microphylla*, *Ephedra alata*, *Genista saharae*, *Retama retam*. In
the end, the vegetative apparatus reduction constitutes a remarkable adaptation to conditions of very
difficult environment. This is reflected in certain woody species tolerance of that opts for a
morphological plasticity that reflects the resilience capacity in response to disturbances of biotic or
abiotic origin. These species bury their woody structures below ground level or spread their root
system on supports with higher water availability (Pistacia atlantica, Ceratonia siliqua, Hammada
scoparia) (Birnbaum, 2012; Benaradj, 2017).

3.2. Biological, systematic and biogeographic analysis
3.2.1. Biological analysis
The table below shows floristic composition according to presence number and each biological type
percentage in relation to total number of 135 species recorded in study station. These biological
forms show biological spectrum seasonal variation.

| Biological type     | Absolute frequency | Relative frequency (%) |
|---------------------|--------------------|------------------------|
| Chamephytes         | 25                 | 18.52                  |
| Geophytes           | 06                 | 04.44                  |
| Hemicryptophytes    | 27                 | 20.00                  |
| Phanerophytes       | 09                 | 06.67                  |
| Therophytes         | 68                 | 50.37                  |
| Total               | 135                | 100%                   |

From Table 2, it can be seen that biological spectrum is of following type: Th> He>Ch>Ph> Ge. There is a remarkable dominance of herbaceous stratum by therophytic species with 68 species, i.e. 50.37%, followed by hemicryptophytic species with 27 species, i.e. 20%, chamaephytes having 18.52% (25 species), phanerophytes with 6.45% (9 species) and finally by geophytes with 4.44% (6 species). This dominance of therophytes is strictly related to seasonal rains (Belhacini, 2011). The percentage of phanerophytes, hemicryptophytes and geophytes decreases with aridity and aperture of medium, while those of therophytes and chamaephytes increase (Kadi-Hanifi, 2003). Among phanerophytic species: Pistacia atlantica, Ceratonia siliqua, Nerium oleander, Retama retam, Retama sphaerocarpa, Rhus tripartita, Olea europaea, Genista saharae and Ziziphus lotus. Using the different results, we can make the following observations:

- Biological analysis confirms regressive evolution of vegetal carpet as it was glimpsed by floristic
composition group examination. Vegetation matrix regression results in progressive disappearance
of phanerophytes, extension of geophytes (Urginea maritima, Urginea noctiflora, Gymnarrhena
micrantha, Gynandriris sisyrinchium) and progressive appearance of hemicryptophytes (Astragalus
vogelii, Erodium garamantum, Paronychia chlorotheysa, Plantago albicans). It is also noted some
chamaephytes (Hammada schmittiana, Hammada scoparia, Atractylis serratuloides) become
dominant in contribution to vegetal mat, although they are few in number thus favoring their
development. This observation was also pointed out by Kadi-Hanifi (2003).
- Biological spectrum is considered by phytogeographers as a strategy for flora adaptation to
unfavorable environments conditions and more particularly to climatic conditions (Daget, 1980).
Thus the various biological forms inform about growth forms and therefore the plants response to
the environment local conditions (Aidoud, 1998).

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In general, it can be seen that study area presents a floristic procession marked by heterogeneity between woody and herbaceous plants and between perennials and annuals. This landscape disparity may be linked to orographic, edaphic and hydrological environment conditions.

3.2.2. Systematic Analysis

Table 3 shows a variation in distribution and families, genera and species distribution encountered. This systematic evaluation took into account species number in each family in descending order. Floristic inventory made it possible to identify 135 species of spermatophytes belonging to 105 genera and 36 botanical families.

| No. | Families       | Number of Genera | Number of Species | Percentage (%) |
|-----|----------------|------------------|-------------------|----------------|
| 1   | Asteraceae     | 27               | 35                | 25.92          |
| 2   | Poaceae        | 10               | 14                | 10.37          |
| 3   | Brassicaceae   | 10               | 11                | 8.15           |
| 4   | Fabaceae       | 6                | 9                 | 6.67           |
| 5   | Papaveraceae   | 4                | 5                 | 3.70           |
| 6   | Boraginaceae   | 4                | 4                 | 2.96           |
| 7   | Caryophyllaceae| 4                | 4                 | 2.96           |
| 8   | Resedaceae     | 1                | 4                 | 2.96           |
| 9   | Zygophyllaceae | 2                | 3                 | 2.22           |
| 10  | Geraniaceae    | 1                | 3                 | 2.22           |
| 11  | Lamioidea      | 2                | 3                 | 2.22           |
| 12  | Plantaginaceae | 1                | 3                 | 2.22           |
| 13  | Plumbaginaceae | 2                | 3                 | 2.22           |
| 14  | Polygonaceae   | 3                | 3                 | 2.22           |
| 15  | Apiaceae       | 2                | 2                 | 1.48           |
| 16  | Amaranthaceae  | 2                | 2                 | 1.48           |
| 17  | Anacardiaceae  | 2                | 2                 | 1.48           |
| 18  | Asparagaceae   | 2                | 2                 | 1.48           |
| 19  | Convulvulaceae | 2                | 2                 | 1.48           |
| 20  | Xanthorrhoeaceae| 1               | 2                 | 1.48           |
| 21  | Euphorbiaceae  | 1                | 2                 | 1.48           |
| 22  | Malvaceae      | 1                | 2                 | 1.48           |
| 23  | Rosaceae       | 2                | 2                 | 1.48           |
| 24  | Apocynaceae    | 1                | 1                 | 0.74           |
| 25  | Capparidaceae  | 1                | 1                 | 0.74           |
| 26  | Cistaceae      | 1                | 1                 | 0.74           |
| 27  | Cucurbitaceae  | 1                | 1                 | 0.74           |
| 28  | Dipsacaceae    | 1                | 1                 | 0.74           |
| 29  | Iridaceae      | 1                | 1                 | 0.74           |
| 30  | Oleaceae       | 1                | 1                 | 0.74           |
| 31  | Onagaceae      | 1                | 1                 | 0.74           |
| 32  | Arecaceae      | 1                | 1                 | 0.74           |
| 33  | Rhamnaceae     | 1                | 1                 | 0.74           |
| 34  | Rubiaceae      | 1                | 1                 | 0.74           |
| 35  | Scrophulariaceae| 1               | 1                 | 0.74           |
| 36  | Thymelaeaceae  | 1                | 1                 | 0.74           |
|     | **Total**      | **105**          | **135**           | **100%**       |
The plant diversity analysis shows that specific richness represents 3.45% of Algeria flora estimated at 3139 by Quézel and Santa (1962-1963), indicating a specific, generic and systematic diversity of floristic procession within grouping in *Pistacia atlantica*. This result is broadly similar to those obtained by several authors (Quézel and Bounaga, 1975; Bouzenoune, 1984; Gherzouli and Djellouli, 2005; Yahi et al., 2008; Bouallala, 2006; Rebbas, 2014) in their vegetation studies. An examination of different taxa list (Table 3) shows that most representative families in species number are Asteraceae (35 species and 27 genera), Poaceae (14 species and 10 genera), Brassicaceae 11 species and 10 genera) and Fabaceae (9 species and 6 genera). These four families alone represent 69 species, i.e. 51% of floristic group at *Pistacia atlantica* in study station. These species are divided into 53 botanical genera within 4 families already mentioned. The other families that are less represented are variable; Papaveraceae with 5 species, 3 families with 4 species (Caryophyllaceae, Borraginaceae and Resedaceae), 7 families with 3 species (Lamiaceae, Geraniaceae, Plumbaginaceae, Polygonaceae, Plantaginaceae and Zygophyllaceae), 9 families of bispecific with 2 species (Cistaceae, Apocynaceae, Cucurbitaceae, Iridaceae, Arecaceae, Capparidaceae, Onagaceae, Dipsacaceae, Oleaceae, Rhamnaceae, and the other two species (Amaranthaceae, Asparagaceae, Apiaceae, Euphorbiaceae, Anacardiaceae, Malvaceae, Convolvulaceae, Rosaceae and Xanthorrhoeaceae) and finally 12 families are monospecific (Cistaceae, Apocynaceae, Cucurbitaceae, Iridaceae, Arecaceae, Capparidaceae, Onagaceae, Dipsacaceae, Oleaceae, Rhamnaceae, Rubiaceae and Scrophulariaceae).

This diversity of families is due to several factors: climate, type of habitat, orography, anthropogenic action, biotopes ecological diversity within study station (valley, mountain, rocky outcrops). It is reported that these figures are in adequacy with those quoted by Ozenza (1991) for Sahara. This generic variation is explained by Boughani et al. (2009): in arid zone and Sahara, most families are represented by only one or two genera and most genera by only one or two species. There families of Saharan-northern domain (Ozenza, 1977), such as Euphorbiaceae, Plantaginaceae, are represented but with a small percentage. These families are characterized by Saharan genera (*Fagonia, Astragalus, Arnebia, Ifloga, Zilla, Senecio, Pergularia, Neuroda, Morettia, Molikia*).

### 3.2.3. Phytogeographic analysis

This analysis of flora within grouping at *Pistacia atlantica* reveals diversity in phytogeographical elements (Table 4).

#### Table 4. Biogeographical distribution of the procession floristic

| No. | Phytogeographical types     | Number of Species | Percentage (%) |
|-----|-----------------------------|-------------------|----------------|
| 1   | Mediterranean               | 34                | 25.19          |
| 2   | Saharo-Sindian              | 29                | 21.48          |
| 3   | Endemic                     | 24                | 17.78          |
| 4   | Multi-regional              | 20                | 14.81          |
| 5   | Saharan                     | 12                | 8.89           |
| 6   | Ibero-Mauritanian           | 7                 | 5.18           |
| 7   | Cosmopolitan                | 3                 | 2.22           |
| 8   | Tropical                    | 3                 | 2.22           |
| 9   | Palaeo-temperate            | 3                 | 2.22           |
|     | **Total**                   | **135**           | **100%**       |

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The phytogeographical analysis shows that biogeographical type’s distribution is as follows: Mediterranean > Saharo-Sindian > Endemic > Multi-regional > Saharan > Ibero-Mauritanian > Cosmopolitan = Tropical = Palaeo-temperate.

At the study station level located in western part of Saharan atlas, species majority belong to Mediterranean element (2519%) domains, element Saharan -Sindian (with 29 species, i.e. 21.48% of listed species (Zilla spinosa, Zilla macroptera, Cleome arabica, Gynoncarpos decander, Polycarpacea repens, Rumex vesicatorius, Calendula aegyptiaca, Morettia canescens, Fagonia glutinosa, Fagonia latifolia)), endemic element (24 species, i.e. 17.78% of flora), multi-regional element representing 20 species, i.e. 15% of floristic cortege, and presence of this multi-regional element with a considerable rate in this flora is caused by seeds dissemination by different modes (anemochory, zoomchory, hydrochory). The Saharan element represents 9% (12 species), and for the other elements stories have less than 10 species to know (Iberian Mauritanian 7, Cosmopolitan 3, Tropical 3 and Paleo-temperate 3).

Study station has a very high rate of endemism, which explains why station is less anthropized, this protection is due to its location near border strip of Morocco and inaccessibility of these places by man and their flock.

Bouallala (2013) indicates that Hamadas biotope is characterized by dominance of Saharo-Arabic element and a weakness for Mediterranean element. There are also numerous Saharan taxa (Retama retam, Randonia africana, Rhantherium suaveolens...), these Saharan trees dominate very clearly.

In study station, a presence of steep slopes, certain exposure and altitude allow installation of typically hygrophylous vegetation: Nerium oleander, Phoenix dactylifera.

4. CONCLUSIONS

Grouping at Pistacia atlantica has an important biological, systematic and biogeographical floristic diversity. This diversity makes it possible to appreciate different coping strategies of life and a wide geographical distribution.

Floristic procession within grouping at Pistacia atlantica conceals a large heterogeneous phytodiversity on a quantitative and qualitative level; it is linked to geographical position, edaphic structure, geological history, altitude, types of Mediterranean steppe and/ or Saharan vegetation, orography, climate, topography, the nature and depth of soils, and various degrees of anthropozoic pressure.

Its conservation and multiplication are therefore an essential necessity; forest managers and administrators must address valorization problem of this plant genetic resource and give it much more importance.

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