Western Sahara Natural Heritage

Part 3

Ethnobotanical knowledge of Western Sahara plants in Tifariti and Bir Lahlou

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1. Introduction

The nomadic pastoralists of Western Sahara have always adapted to the harsh climatic conditions of their land. For hundreds of years, they suffered devastating droughts that forced them to take refuge on the desert fringes and dedicate themselves to alternative activities such as fishing in coastal cities, agriculture in the Sahara oases, or trade (Volpato and Howard, 2014). But whenever the rains returned and the pastures once again offered food for their camel herds, the Sahrawis always returned to the desert interior and resumed the activity that best defines them as Sahrawis, a word that literally means "people of the desert." Sahrawi pastoral nomadism is a complex and non-random process, resulting from a careful study of the available pastures in various locations, following ancestral knowledge of pasture ethnobotany. This process is called *rataa* (Volpato & Puri, 2014).

At the end of the 20th century, more precisely from 1975 onwards, the Sahrawis had to face military aggression from their Moroccan neighbors, in a war that destroyed their pastoral way of life, causing the death of their animals and forcing thousands to seek refuge in Algeria, where they were concentrated in refugee camps and dependent on international food aid.

Until recently, there was a growing interest in raising camels, goats, and sheep, driven by the desire to return to the desert and achieve greater food self-sufficiency and less dependence on international aid. This occurred particularly since the 1990s, when agreements with Morocco allowed free access to pastures in the Liberated Zone controlled by the Polisario Front. In these pastures, the plants most consumed by camels are solely wild plants, including shrubs, trees, and herbaceous species.

This study performed the ethnobotanical identification of plants found along the route between Tindouf and Tifariti (figure 1). Starting from a hyperarid and plant-poor location like the Tindouf Hamada, the desert was traversed to Tifariti, where geographic and climatic conditions are more favorable for plant development and the emergence of desert savanna. This ecosystem provides reasonable amounts of food for herbivores during the long dry periods that alternate with rare rains, which originate from the Atlantic low pressure centers, from the west, and the African monsoon from the south.

The main objective of this study was to identify the relationships of the Sahrawi population with the plants of the ecosystem in which they live, as well as to access traditional knowledge about vegetation, linking it with the results of scientific research. The surveys conducted in this study used the methodology described by Cabalzar *et al*. (2017).

Natural spaces are profoundly transformed by humans, and this transformation can be sustainable or detrimental. This is also why studying how populations interact with the environment and their relationship with biodiversity allows us to better understand the ties that bind people to their natural resources (Albuquerque *et a*l., 2014). Simply put, we can write that ethnobotany is the study of the relationships between people and

plants. However, it is a study related to cultural biodiversity and aims to clarify how people's cultures embrace the surrounding nature (Albuquerque *et al*., 2017).

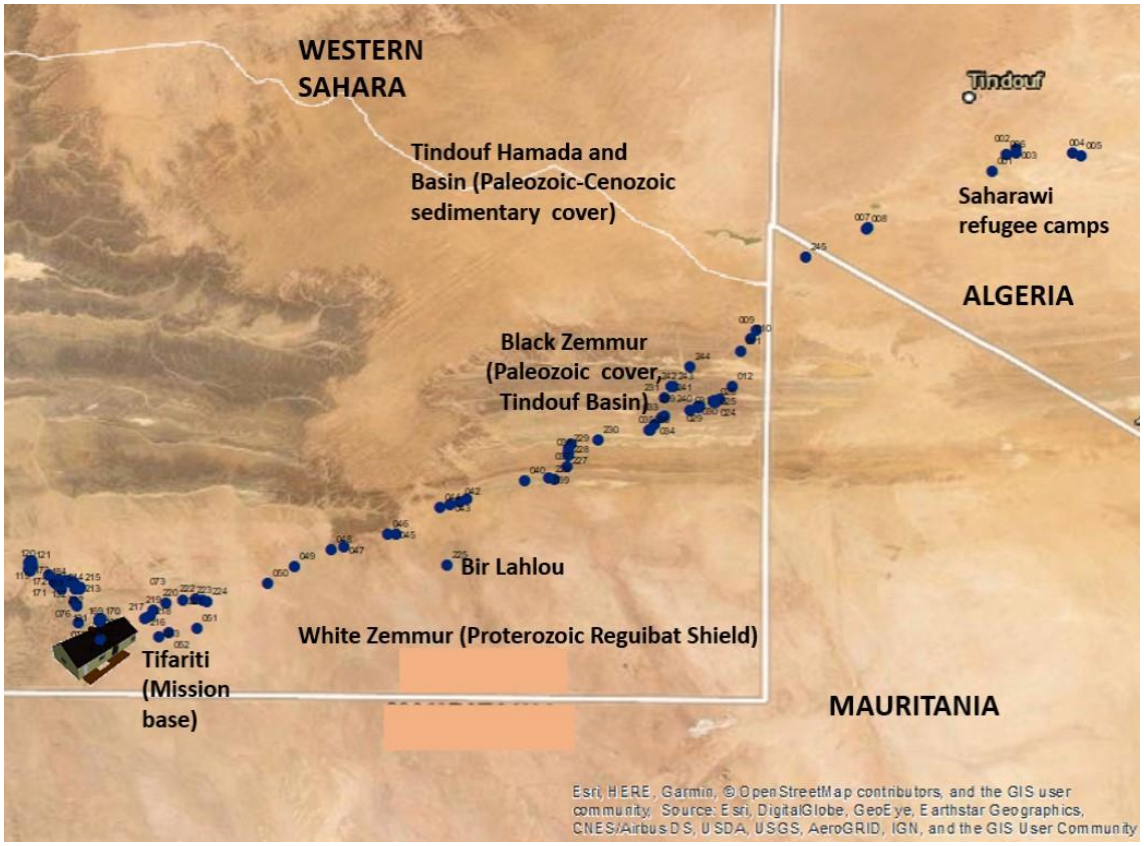

Figure 1. Route taken (blue dots) from the refugee camps in Tindouf to Tifariti, in Western Sahara and close to the border with Mauritania. The main geological zones are shown.

Environment varies considerably along our route. From a hyper-arid zone in Tindouf, where rainfall varies between 20 and 50 mm per year (Ozenda, 2004), we gradually transition to a more forested zone in Tifariti, with vegetation nestled in the wadi (temporary rivers) where large trees are found. This region, although located more than 300 km from the sea, is the sub-oceanic Sahara (Ozenda, 2004), an area of attenuated desert where moisture from the sea still reaches and characterized by the presence of perennial plants of the desert savanna (see part 1 of this work), nestled in the valleys but also extending into the *reg* (plains covered by small stones).

2. Characteristics of Western Sahara vegetation

Desert biome has a low plant biodiversity due to environmental aridity, and it is therefore significantly lower than that of the temperate and tropical zones that border it to the north and south, respectively. The areas with the greatest biodiversity are located where moisture is concentrated, such as around freshwater or saltwater lakes

that form in the middle of the desert. Also in the mountains, at the base of hillsides (*fedra)* where water that runs off the slopes infiltrates, and, especially, in the beds of sandy rivers or wadi, where rainwater collects and infiltrates, forming streams during years of greater rainfall.

The plants found in the Sahara Desert, and we are talking here only about vascular flora, are divided biogeographically into six major groups (Médail a& Quézel, 2018):

- the tropical-African group, consisting of plants originating mainly from the Sahel and penetrating the most humid areas of the Sahara. 32% of the species belong to this group, which is the predominant one. A notable example of plants in this group is the African acacias.

- the Saharo-Arabian group, consisting of plants from the Sahara and the desert of the Arabian Peninsula, which includes another group, the Saharo-Sindian plants, or plants found from the Sahara to the Sind (or Thar) Desert in eastern Pakistan. This group comprises 23% of the species;

- plants of Mediterranean origin (21%);

- plants endemic to the Sahara (12%);

- cosmopolitan plants, which can be found in other areas and continents (8%)

- irano-touraniens plants, species also found in Iran and adjacent arid areas in the Middle East and Central Asia (4%).

Mediterranean species are found particularly in the northernmost areas and in refuges where Mediterranean plants have been isolated by increasing aridity. A good example of these species are the cypresses (*Cupressus dupreziana*) and Laperrini olive trees (*Olea laperrini*) of Tassili, in the less arid Hoggar Mountains of Algeria. In the south, on the border with the Paleo-African Sudano-Angolan plants, the climatic transition allowed some of these typically tropical species to develop in the southern Sahara and its border with the Sahel (Ozenda, 2004; Rognon, 1994; Julivert, 2003).

For Monod (1938), almost the entire territory of Western Sahara falls within a transitional vegetation zone, with Saharan-Arabian and Mediterranean vegetation. A coastal strip measuring 30 to 60 km, wider in the north and narrower in the south, encompasses a Saharan-Atlantic vegetation domain, where the greater humidity generated by the proximity of the sea allows for the development of its own flora despite the dryness caused by the lack of rainfall, and where a large number of endemic species thrive. Parallel to this zone and moving inland, there is a transitional band, the Saharan-Subatlantic domain, where atmospheric humidity is lower. Each of these domains has its own characteristic vegetation (Guinea, 1945; Monod, 1938).

Tifariti is located in the southern part of the Saquia al-Hamra river basin (literally "The Red River"), the most important temporary watercourse in Western Sahara, which is dry most of the time. Between this watercourse and the Tropic of Cancer lies a transition

zone where Mediterranean-type plants are gradually disappearing and giving way to Saharan-type ones (Guinea, 1945).

Vegetation distribution is not uniform, as it clusters in areas of the desert where moisture is concentrated, such as small ravines or the beds of the wadis, while the rest of the area is almost abandoned to mineral desert (Rognon, 2000), as in the large regs of Western Sahara. Plant biodiversity is greater in Western Sahara than in the eastern zone, as the latter experiences lower rainfall. Large areas of dunes and regs may be completely bare of vegetation for several years, but after heavy rainfall, they become covered with ephemeral plants that resist aridity through their ability to produce seeds in a short period of time. These constitute the *asheb* pasture, which remains green for a few weeks and provides good food for dromedaries (Volpato and Puri, 2014).

The area we studied had not received significant rainfall for two years. We were unable to find *asheb* plants, which during these dry periods lie dormant as seeds or with bulbs buried in the soil (geophytic plants). The plants described below are therefore mostly shrubs and trees.

List of informants:

Agronomist Taleb Brahim Sidi Mohamed, Mr. Taualo Ali , Mr. Mohamed Tadel Eswoyeh, Mr. Mulai Hamed, Mr. Brahim Bah, Mr. Hiarba, Mr. Saleh Afdfata.

Aizoon canariensis L.

Family: Aizoaceae

Hassaniya name: *lkumsa, teza*.

Location: wadi Annania and also granitic reg granítico around inselberg Uteit Annania.

Properties: the green leaves are edible by animals and humans.

General information: Suculent and prostrate plant growing in dry areas of northern and southern África, Arabia, Pakistan, Iran and Afganistan. Also ocurs in eastern Mediterranean, Madeira and Canary islands. Often found growing in saline soils.

Figure 1. Dry *Aizoon canariensis* L. in granitic reg near the inselberg Uteit Anania, Tifariti, showing its stellate pentagonal fruits. Long. -10,667108 W; Lat. 26,313142 N; Alti. 409 m.

Figure 2. Dry plants of *A. canariensis* growing in the Wadi Annania bed. Long. -10.742243 W; Lat. 26.355985; Alti. 405 m.

Anastatica hierochuntica L.

Family: Brassicacea

Hassaniya name: *lkamcha*

Location: Mainly found in reg. Near the berm and wadi Chertia. From here reg ground is covered with patches of dry *lkamcha,* sometimes as far as the eye can see.

In Fedrat el Erkeiz (Long. -10.743948; Lat. 26.365993 ; Alti. 405 m) associated to *Acacia tortilis* desertic savannah.

Properties: pasture for camels.

Figure 3. Dry *lkamcha* (*Anastatica hierochuntica*) in is habitat, the reg. Long. -8, 833584 W; Lat. 26,818007; Elevation: 419 m.

Figure 4. Dry l*kamcha* (*Anastatica hierochundica*) in the reg. When rains arrive it absorves water and the dry sructure opens, liberating the seeds. A plant very well adpated to this arid environment.

Figure 5. *Anastática hierochuntica* and *Salsola imbricata* in a *dei* (small water line) near Wadi Slouguiat. Long. -8.847996; Lat. 26.811046. Alti. 424 m.

Andropogon laniger Desf.

Familiy: Poaceae

Hassaniya name: *lidgir*

Location: in the base of Uteit Annania (Long. -10,678295; Lat. 26,305366; Alti. 421 m). Is common in the rocky hills of Zemmur and Tiris (Martinez *et. al*., 2007)

Properties: a pasture for herbivores.

Figure 6. *A. laniger* at the base of the inselberg Uteit Annania where it can find water and shadow.

Asparagus altissimus Munby

Family: Asparagaceae

Hassaniya name: *sacum*

Location: At the base of Mount Kedie Rkeiz developing between the rock blocks and in Fedrat el Erkeiz (Long. -10.743948; Lat. 26.365993; Alti. 405 m), here associated with *Acacia tortilis* tree. Also around the base of Uteit Anania. Only found at the base of rocky elevations.

Properties: is a type of edible asparagus and a good pasture for all animals.

General information: Endemic and rare plant of Western Sahara with mediterranean origin. Leaves are absent and substituted by clorofiline twigs named cladodes (Ozenda, 2004).

Figure 7. Sacum (*Asparagus altissimus*) at the base of Mount Kedie Rkeiz.

Figure 8 . Sacum (Asparagus altissimus) at Kedie Rkeiz hillls base, where it grows between rocks wich allow water accumulation in the soil.

Figure 9. Well developed *A. altissimus* showing its tipical pendant steams.

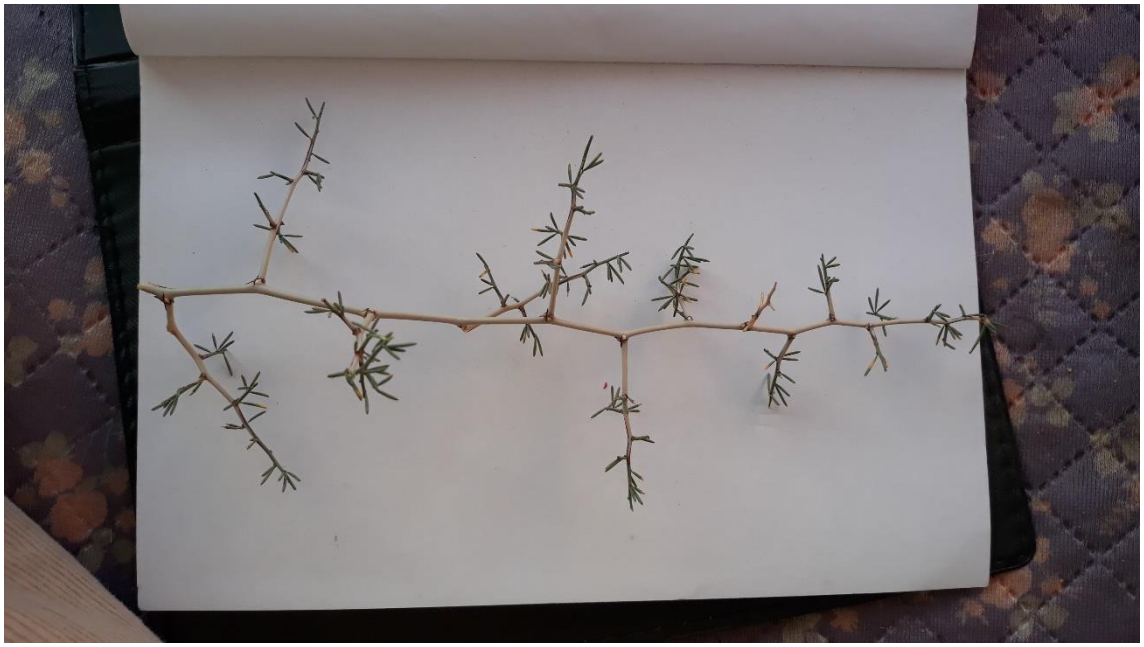

Figure 10. Detail of steams and cladodes of *Asparagus latissimus.*.

Atriplex halimus L.

Family: Amaranthaceae

Hassaniya name: *Legtaf*

Location: in the sandy soils of wadis, as in wadi Tifariti (Long. -10.550123; Lat. 26.20007; Elevation 472 m)(Figure 12) , and in other smaller watercourses (*dei*) where it can deepen its roots in the humid subsoil. Also in wadi Anania (Long. -10.667108; Lat. 26.313142; Alti. 409 m)) here associated with *Tamarix.* In wadi Tifariti in association with *Acacia tortilis* and *Tamarix* spp. trees.

Properties: It is an excellent pasture much appreciated by animals. Young leaves and shoots have a good protein content. Wood is used as fuel.

General information: This bush is of mediterranean origin and some varieties are endémique in the Sahara (Médail and Quézel, 2018) . It occurs in North Africa, Portugal and southern and western Europe. The species is cultivated in Spain and Syria as pasture. According to Le Hérou (2002) plants present in Tifariti must be from the *schweinfurthii* subspecies, the plants most adapted to aridity. It adapts well to saline desert soils, rich in gypsum and limestone, developing well even in very saline soils. Plant is called saltbush in english, that is, “salt plant”.

Atriplex can be multiplied through seeds and then planted in the final location, protected from animals so that grazing is controlled. Animals do not consume highly developed and lignified bushes, which must be cut close to the ground so that they produce new shoots (Le Houérou, 2002). Dense atriplex forests provide a good refuge for wild animals. In Jordania they are planted to control erosion and soil conservation (Le Houerou, 2002).

Figure 11. Branch of *Atriplex halimus.*

Figure 12. *A. halimus* in a bed of a wadi in Tifariti (on the right in the foto).

Anvillea garcinii subsp*. radiata* (Coss. & Dur.) Anderb*.*

Family: Asteraceae

Hassaniya name: *Negued*

Location: In sandy wadis and stony regs.

Properties: Our local informants did not indicate any use for this plant. However according to Martinez *et al*. (2007) it is used in Western Sahara against sexual impotence and urinary tract diseases

General information: endemic plant with large distribution in Sahara but of mediterranean origin. Also found in mediterranean climate areas. Plant of central Sahara (Algeria) (Médail & Quézel, 2018). It forms hemispherical bushes until 50cm high flowering in spring. May be confused with *Asteriscus graveolens* that grows in the same places and at the same time.

Fig 13. *Negued* (*Anvillea garcinii*) .

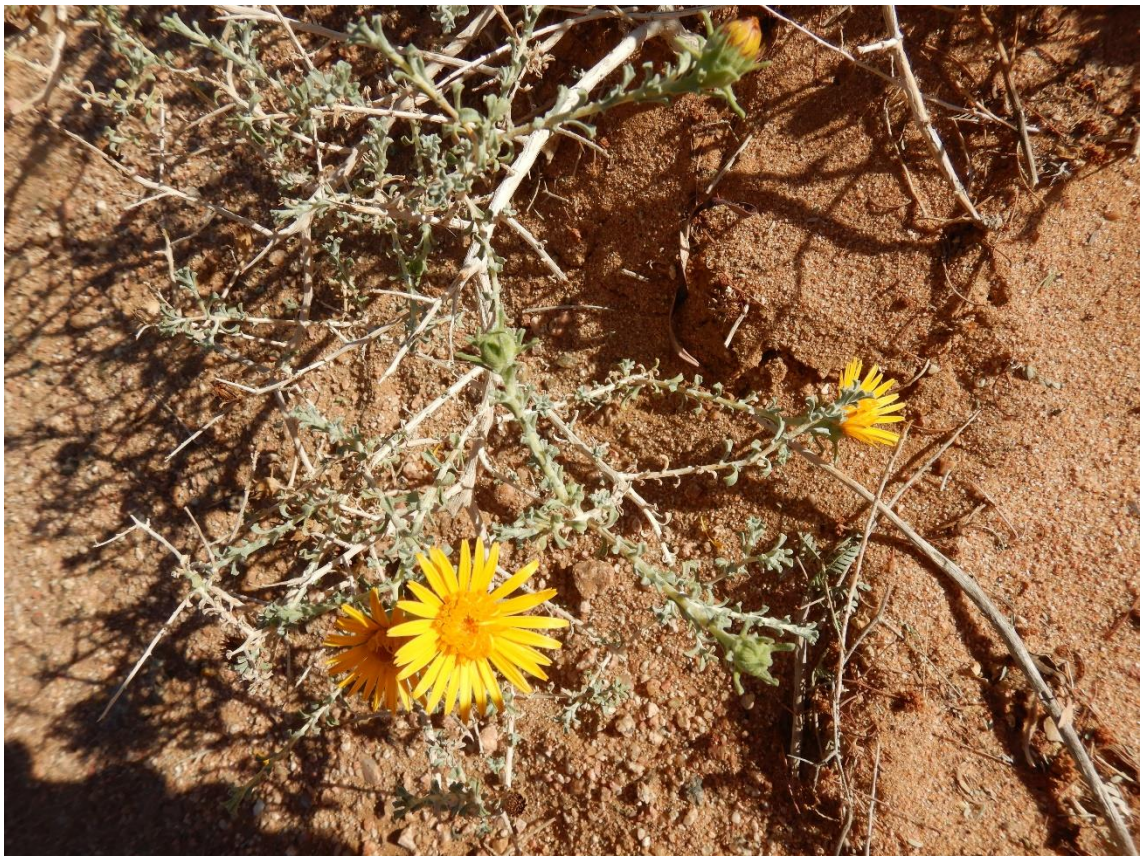

Figure 14. *Negued* in wadi Tifariti (Long. -10,618519; Lat. 26,292263; Alti. 430 m)

Barleria schmittii Bnoist

Family: Acanthacée

Hassaniya name: *zmar*

Location: Mount Erkeiz, Fedrat el Erkeiz (Long. -10,743948, Lat. 26,365993; Alti. 405 m) among big rocks at the base of the mountain. Some in reg.

Properties: camels eat young leaves when spines are still small and tender.

General information: associated with *Acacia tortilis*, some plants displaying their beautiful blue flowers. Thorny endemic plant of western Sahara of afro-tropical origin (Médail & Quézel, 2018) being part of the *A*. *tortilis* desert savannah ecosystem. Representative of African tropical flora in western Sahara. These plants are only found in particular locations and represent a testimony to the ancient expansion of this flora in western Sahara (Ozenda, 2004).

Figure 15. Flower and green leaves of *zmar* at Kedie Rkeiz rocky hillside, where they find water in the rock crevices. Camels eat the green spiny leaves when they are still tender.

Figure 16. Adult plant showing its big thorns, an efficient protection against herbivores.

Figure 17. *Zmar* (*Barleria schmittii*) a bush also found in deep sandy soil asssotiated with *A. tortilis* ecosystem, here in Fedrat el Erkeiz.

Figure 18. Detail of leaves, steams and spines of dry *Barleria shcmittii* .

Caralluma sp.

Family : Apocynaceae

Hassaniya name: legyeible, achaken

Location : inside caves at Mount Kedie El Rkeiz where they find a lot of shade.

Properties: Our local informants did not indicate any use for this plant. However Martinez *et al.* (2007) reports that animals and people eat the stems and flowers are sweet. According to Martinez *et al.* (2007), this plant could be the species *Caralluma europaea*. This author also noted that the plant only survives in the shade.

Figure 19. Steam of *Caralluma* sp. at mount Kedie el Rekeiz.

Figure 20. Caves in mount Kedie el Rkeiez where *Caralluma* sp. can be found (Long. -10,747938; Lat. 26,353484; Alti. 433 m).

Citrullus colocynthis (L.) Shcrad.

Family: Cucurbitaceae

Hassaniya name: *ilif.*

Location: wadi Aannania (Long. -10,667108; Lat. 26,313142; Alti. 409 m). A very common plant in the Sahara as was also noted by Ozenda (2004). Not found in more dry areas near Algeria border.

Properties: plant with several medicinal properties.

Figure 21. Dry fruit and leaves of ilif.

Figure 22. *C. colocinthys* fruits in Smara saharawui refugee camp (Tindouf, Algeria) in a place where in benefitis from artificial watering.

Deverra scoparia Coss. & Durieu

Family: Apiaceae

Hassaniya name: not found. But in n central Sahara, Algeria, it is called *tattayt* (Médail & Quézel, 2018)

Location: in the plains around mount Uteit (Long.-10,749449; Lat. 26,343506; Alti. 458 m).

Properties: not mentioned by our informants.

General information: may be confounded with *Retama retam* if flowers can not be observed. This plant is a shrub that can be found from Mauritania to Lybia. Is an endemic plant of western and central Sahara, vegetating in river beds as part of desert savannah. According to Médail & Quézel (2018) is an essentially saharian plant.

Figure 23. Deverra bush near Tifariti.

Figure 24. Detail of *Deverra scoparia* inflorescences.

Figure 25. Detail of *Deverria* scoparia small flowers.

Echinops spinosissimus Turra

Family: Asteraceae

Hassanyia name: not mentioned

Location: in a wadi bed near Tifariti (Long. -10,611036; Lat 26,286473; Alti. 423 m).

Properties: Our local informants did not indicate any use for this plant.

General information: this plant was only found in riverbeds. It is of mediterranean origin also vegetating in southern Europe.

Figure 26. *Echinops spinosissimus* in a river bank of wad Tifariti.

Figure 27. *Echinops spinosissimus* growing inside a *Salsola imbricata* bush, in wadi Tifariti.

Ephedra alata Decne.

Family: *Ephedraceae*

Hassaniya name: *schdida*

Location: In Mount Jerleixa (Long. -9,027939; Lat. 26,731479; Alti. 449 m) and Uteit Aannania (Long. -10,679216; Lat. 26,307858; Alti.427 m)**.**

Properties: hard pasture eaten by all animals. It also has medicinal utilizations.

General information: As it has no leaves is particularly adapted to arid environment. In Mount Jerleixa growing between the rocks associated with lgalga (*Pergularia tomentosa*) and ascaf (*Nucularia perrini*) in places with scattered vegetation (Figure 28).

Figure 28. Schdida (*Ephedra alata*) growing between the rocks, at the base of Mount Jerleixa.

Figure 29. Landscape around Mount Jerleixa.

Figure 30. Detail of *E. alata* stems.

Figure 31. *E. alata* at the base of Uteit Aannania.

Figure 32. Uteit Anania, a granitic *inselberg* near Tifariti, a part of the Proterozoic Regueibat Shield.

Euphorbia officinarum subesp. *echinus* (Hook. f. & Coss.) Vindt

Synonimous : *Euphorbia echinus*

Family: Euphorbiaceae

Hassaniya name: *dagmus*

Location: rocky banks of wadi Tifariti (Long. -10,618693; Lat. 26,292091; Alti. 427 m). Here we can see a population of *dagmus* vegetating in the rocks cracks, accompanied by small and scarce plants of *lyarguig* (*Helianthemum lippii*). Wadi Tifariti opens here into a wide valley.

Properties: used in traditional medicine despite its latex being quite toxic.

General information: cactiform plant from rocky soils of northwest Africa, in Morocco, Western Sahara and Mauritania, where it is endemic. For Julivert (2003) this is an endemism characteristic of the meeting between the Mediterranean and Saharan zones, ranging from the western Anti-Atlas to Layoune and Zemmour. This plant is part of the Atlantic Sahara ecosystem, which is characterized by precipitation in the form of fog and dew coming from the ocean. Although this vegetation is located close to the coast, there are pockets hundreds of kilometers inland, in places where atmospheric humidity can reach, such as the Seguiet el Hamra valley (Médail & Quézel, 2018) and here in Tifariti.

Figure 33. *Dagmus* in a wadi Tifariti rocky bank. After long periods without rain the plant starts loosing its green color.

Figure 34. Dagmus grows quite well in rock surface crevices, where roots develop absorbing infiltrated water.

Figure 35. Detail of *Euphorbia echinus* stems and spines. It is one of the few cactiform plants from Sahara desert. They are mainly found in Americas hot dry lands.

Faidherbia albida (Delile) A. Chevalier

Synonimous : *Acacia albida*

Family: Fabaceae

Hassaniya name*: afarfar*

Location: near Tifariti hospital (Long. -10,558641: Lat. 26,158906. Alti. 488 m). Also not far away in wadi Tifariti (Long. -10,561421; Lat. 26,159091; Alti.479 m) . In Tifariri hortus there is also a large acacia albida that reaches large proportions, perhaps because it is located in an area protected from animals and their predation, as well as because it benefits from the irrigation water of the crops in the garden (Figure 38).

Properties: one of the most important forage tree in África. Cattle eats its nutritious leaves and pods. As leguminous tree provides a lot of protein for animals and increases soil nitrogen content and organic matter. Thus benefits the entire ecosystem.

General information: Alltought it is find mainly in steppe climate areas (Sahel, southern Angola, etc…) some trees can develop in particular areas of Sahara where underground water accumulates like river beds. Also in vegetable gardens and orchards where there is water for irrigation (Figure 38). Here they can reach a great height. Some *F. albida* also develop in mountainous areas of Sahara, where the amount of rain increases (Médail & Quézel, 2018).

Like other saharien acacias (*A. tortilis, A. seyal, A. ehrenbergiana, A.laeta, A. nilotica*) it is of tropical origin and all of them are a a testimony of the advancement of tropical flora in the Sahara (Médail & Quézel, 2018).

We measured the trunk perimeter at 20 cm from the ground of seven randomly selected trees in the hospital area and obtained the following results: 96, 73, 159, 136, 34, 33 and 99 cm). Near these acacias trees are shrubs producing edible red berries, the *lghardag* (*Lycium intricatum* Boiss.).

Figura 36. Detail of *F. albida* branches in a river bed near Tifariti hospital. Leaf loss reflects drought conditions and overgrazing by camels.

Fig. 37. Population of *F. albida* near Tifariti Hospital. All are intensely grazed by camels but young trees can be seen growing spontaneously.

Figure 38. Well developed *F. albida* near a vegetable garden and greenhouses in Tifariti where it profits from irrigation water. Here they are also protected against grazing by a wall and fences. Coordinates not shown for security reasons.

Figure 39. A tree near Tifariti hospital showing heavy grazing by camels.

Figure 40. Tall *F. albida* near Tiifariti.

Figure 41. *F. albida* and behind it a *A. tortilis* in wadi Tifariti.

Globularia arabica Jaub. & Spach

Synonimous: *G. alypum* L. subsp. *arabica* (Jaub. & Spach) Gobignard

Family: Globulariacae

Hassaniya name: not mentioned

Location: only found growing in rocks at mount Kedie Rkeiz, near Tifariti, where it absorves water contained in the crevices (Long. -10,749683; Lat. 26,341505; Alti. 446 m).

Properties: our informants didn't refer any. It was also not mentioned in Martinez's extensive study of Western Sahara plants (Martinez *et. al*., 2007). However in some places of Sahara people use them for its magical properties (Ozenda, 2004).

General information: shrub with 3-6 dm high, very branchy. Leaves are small, alternate, leathery and glabrous. Also lanceolate and often tridentate at the top; flower heads hemispherical surrounded by an involucre of bracts (Ozenda, 2004).

Globularia has a mediterranean origin and can also be found in Iberian peninsula. As here in Mount Kedie Rkeiz it preferentially colonizes rocky environments (Médail & Quézel, 2018). According to Ozenda (2004) this plant is also present in Hoggar Mountain, in algerian Sahara and in the Moroccan Atlas .

Figure 42. Stem, leaves and flowers of *Globularia arabica*.

Figure 43. Details of the stems, leaves and inflorescences. These are made up of small flowers with blue petals.

Figure 44. *Globularia arabica* developing in the rock crevices at Kedie Rkeiz hills.

Figure 45. *Globularia arabica* (left) and eydari (*Rhus tripartita*) (right) growing in rock crevices at the baseof Mount Kedie Rkeiz

Launaea arborescens (Batt.) Maire

Familiy: Asteraceae

Hassaniya name: *mulbaina*

Location: very common plant in Tifariti region. *Mulbaina* belongs to the desert savannah ecosystem found in river beds of Western Sahara. In wadi Tifariti or Uteit Annannia grows under talha tree (*A. tortilis*) canopy with *Panicum turgidum.* Around Uteit Annannia mulbaina develops along waterlines (Long. -10,667108; Lat. 26,313142; Alti. 409 m).

Properties: it serves as pasture for all animals.

General information: endemic plant of Northwest Africa (Ozenda, 2004) and Madeira island.

Figure. 46 Mulbaina (*Launaea arborescens*) in wadi Tifariti (Long. -10,550123; Lat. 26,200070; Altitud 472 m). This bush grows in the valley of the rivers where the roots find water in depth.

Figure 47. *Mulbaina* (*Launea arborescens*) in Smara refugee camp hortus (Tindouf, Algeria), where it can find water from irrigation and protection from herbivory. Here it develops a lot and remains green all year around.

Lycium intricatum Boiss.

Family: Solanaceae

Hassanyia name: *lghardag*

Location: around Tifariti or in Fedrat el Erkeiz associated with *Acacia tortilis* trees (Long. -10,743948; Lat. 26,365993; Altitude 405 m). This bush occupies the bottom of wadi where it grows sometimes in dense formations in large areas. In very small waterlines (*dei* and *chelkas*) along the *reg* they can survive drought altought here plant development is low. Some very small plants can even survive in granitic reg like around Uteit Annannia (Long. -10,659581; Lat. 26,288892; Alti. 420 m).

Properties: this bushy plant is a good pasture to all animals; its small sweet red fruits can be eaten fresh or as marmelade.

General information: shrubs with very thorny branches; small, narrow, spatulate fleshy leaves; fruit in berries. Berries reddish, ovoid; plant having branchy habit. According to Ozenda (2004) is a plant of western Sahara but of mediterranean origin. It can be find from eastern Spain to western Sahara (Guinea, 1948). Animals eat the berries, thus dispersing the seeds in nature (Ozenda, 2004) in a process called endozoochory. According to Guinea (1948) it was an extraordinarily abundant pasture in the northwest of Western Sahara, with the ripe fruit being highly sought after by the population.

Figure 48. *Lghardag* near Tifariti Hospital. A bush from wadi ecosystem covering some times large areas in Tifariti valleys.

Figure 49. After long dry periods plant start loose their leaves, and spines become much more visible.

Figure 50. *Acacia tortilis* trees and *lghardag* bush in the rocky soils of Mount Erkeiz, where roots find water in the crevices.

Figure 51. Detail of lghardag leaves in wadi Tifariti (Long. -10,612699; Lat. 26,286373 Alti. 423 m). This plant stores water in its fleshy leaves.

Figure 52. *Lghardag* forming a *fersig* (sand mound) in wadi Tifariti. Sediments brought by wind and water are captured by plant branches forming the mound.

Maerua crassifolia Forssk.

Family: Capparaceae

Hassaniya name: *atil*

Location: *atil* was found only around Tifariti. It vegetates associated with *Acacia tortilis* in many places in Tifariti but only in wadis, like in wadis around Uteit Anaannia (Long. -10,659581; Lat. 26,288892; Alti. 420 m).

Properties: atil is a forage tree of great importance in arid areas of Africa, particularly in the Sahara and Sahel (Sékouna et al. 2021). Traditionally, sticks made from atil are used to teeth cleaning (Figure 58) but any data was found about anti-microbial properties of atil wood. According to Matinez *et al.* (2007) seeds are edible, nutritive and have good taste.

General information*: M. crassifolia* is an evergreen tree. It is very branched and can reach 10 m in height. Main trunk is twisted and poorly developed. According to Ozenda (2004) is a specie of tropical origin that is part of the Saharo-Sindian flora.

Almost every trees observed in Tifariti show signs of overgrazing, which could endanger the survival of this species in this area of Western Sahara. Overgrazing was also referred as a problem in other parts of Africa like in Sahel areas of northern Senegal (Sékouna et al. 2021). Camels seem to really like this plant, as the trunks are broken and parts of the bark are torn off. However, no completely dead trees are found.

Figure 53. Well developed *Maerua crassifolia* associated with *Acacia tortilis* trees. Tree showing strong herbivory by camels.

In Fedrat El Erkeiez (Long. -10,743948; Lat. 26,365993; Alt. 405 m) several specimens are found widely consumed by camels. Height of 7 specimens found in this point was measured: 3.5 m; 1.7m; 1.75 m; 1.5m; 1.18 m; 0.53 m; 3.71 m. On the slope of the mount trees vegetating here that are safe from camels and grow with greater vigor, whether they are *M. crassifolia* or *A. tortilis*.

In the reg close to Fedrat El Erkeiez soil contain a lot of clay, but in some places there is a transition to the sandy soil of the fedra. Here some *Acacia tortilis* were found but just one small *M. crassifolia* which may indicate that this is a wadi and fedra plant.

The species is very common in the arid areas of the Sahel, but in desert it occupies mainly the sandy soils of wadi beds where it finds underground water. Very resistant to aridity (Le Houérou, 2002).

Figure 54. *Atil* near Fedrat El Erkeiez at the base of Mount El Erkeiez.

Figure 55. Detail of leaves and branches.

Figure 56. Detail of trunks at Fedrat el Erkeiz where this trees can grow up to 3,7 m. Most of them are severely grazed by camels.

Figure 57. Normaly growing as trees *atil* may become bushy if strongly grazed by camels.

Figure 58. Making of *atil* steaks (*messuak*) for tooth cleaning by Mr. Taualo Ali. This is a tradition of Western Sahara (Informant Mr. Sidi Ahmed from Tifariti University).

Nauplius graveolens. (Forssk.) Wiklund

Synonymous: *Asteriscus graveolens* (Forssk.) Maire)

Family: Asteraceae

Hassaniya name: *Tafsa*

Location: It is abundant throughout the Bir Lahlou and Tifariti region.

Properties: Our informants do not refer to any use of this plant. According to Martinez *et al.* (2007) serves as occasional food for animals.

Figure 59. Almost dry *tafsa* plant but still with flowers near Uteit Annania (Long. -10,749449; Lat 26,343506; Alti. 458m)

Nitraria retusa (Forssk.) Asch.

Family: Zygophyllaceae

Hassaniya name: *lguerzim*

Location: very common in wadi around Tifariti. It is a plant from river beds where its long roots can find water.

Properties: Produces small red fruits wich can be eaten fresh or used to make marmelade. This plant is also a good pasture for animals.

General information: This shrub has grey woody twigs that become spinecents and characteristic red fruits. *N. retusa* is a salt tolerante (halophyte) shrub. Was already found in wadi Saguia el Hamra, wadi Draa and wadi Noun and is a typical saharian plant (Ozenda, 2004). According to Guinea (1945) it was a very abundant shrub in northern Western Sahara at the date, vegetating in wadi and also around wells and in depressions where brackish water accumulates forming lakes (*sehbka*). In the information collected by Guinea it is a good pasture for camels when there are young shoots. According to Mandaville (2011) the red drupe is also often collected by people in northwestern Arabia.

Figure 60. *N. retusa* plant growing on a small mound of sand in the middle of a wadi near Tifariti. Despite being alive, the absence of leaves is almost total due to the lack of rain (Long. -10,613326; Lat. 26,286194; Alti. 421 m).

Figure 61. Flower buds, leaves, steams and spines of l*guerzim*.

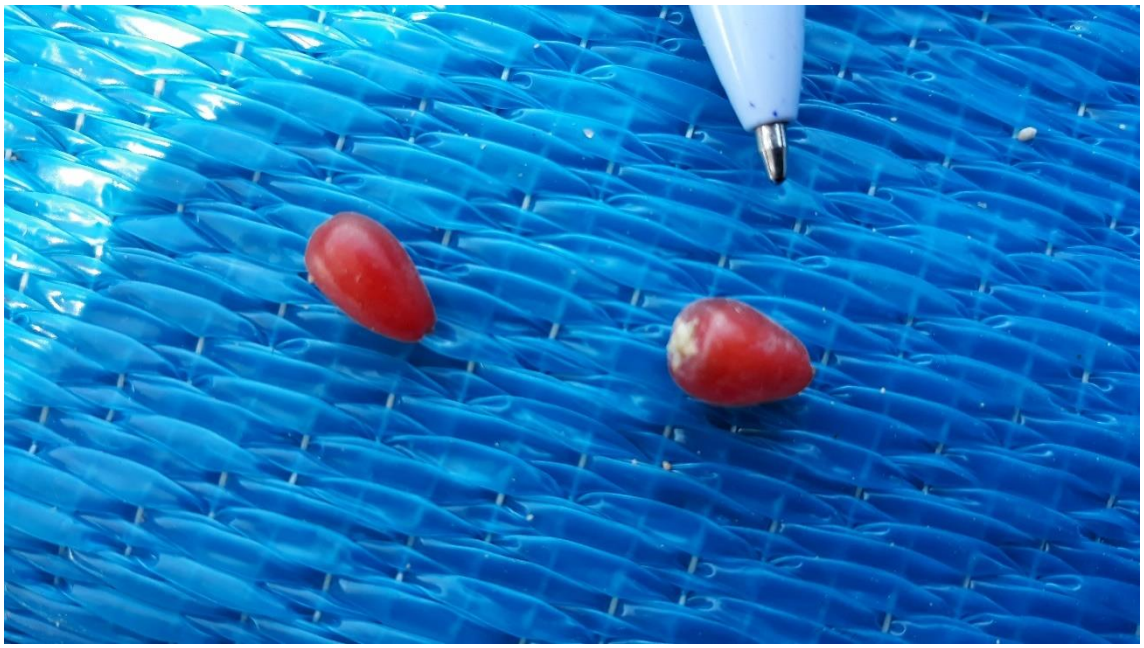

Figure 62. Edible fruits of *Nitraria retusa* are named *aghamis*.

Nucularia perrini Batt.

Family: Chenopodiaceae

Hassaniya name: *ascaf*

Location: very common in wadis around Tifariti. It grows below *A. tortilis* canopy (Long. -10,550123; Lat. 26,200070 : Alti. 472 m) and in Fedrat el Erkeiz (Long.-10,743948; Lat. 26,365993; Alti. 405 m).

Properties: very apreciatted by camels.

General information: this shrub is endemic of western and central Sahara (Ozenda, 2004)

Figure 63. Ascaf (*Nucularia perrini*) in a very dry area of *reg* at the base of Mount Jerleixa (Long. -9,027939; Lat. 26,731479; Alti. 449 m) where roots can find some water.

Figure 64. Detail of *N.perrini* leaves and steams.

Figure 65. *Nucularia perrini* grazed by camels.

Figure 66. *Acacia tortilis* trees associated with *Nucularia perrini* and *Panicum turgidum* in wadi Tifariti (Long. -10,550123; Lat. 26,200070 : Alti. 472 m).

Panicum turgidum Forssk.

Family: Poaceae

Hassaniya name: *mrobka*

Location: *P. turgidum* is found in the beds of the watercourses of Western Sahara, forming the desert savannah common throughout Western Sahara. It has also been found associated with acacias in the reg around the base of Uteit Anania inselberg, where there is accumulation of moisture in the soil from the water that runs off these elevation. More developed populations where found in wadi El Rkeiz associated with *A. tortiis* (Long. -10,748450; Lat. 26,352139; Alti. 439 m) (Figure 71). In Fedrat el Erkeiez (Long. -10,743948; Lat. 26,365993; Alti. 405 m) also under A. *tortilis* trees. In wadi Annania (Long. -10,667108; Lat. 26,313142; Alti. 409 m) here in association with *Tamarix* spp.. In wadi Tifariti in association with *A. tortilis*, *Tamarix* spp. and *M. crassifolia* trees. In wadi Tifariti (Long. - 10 33 06; Lat. 26 11 55 ; Alti. 421 m) associated to *A. tortilis* and around sand mounds with *Ziziphus lotus*.

Properties: very important pasture in Western Sahara as it provides energy and digestible fiber for camels, goats, sheep, donkeys and wild herbivores. Even when it is dry provides fodder to animals. Fruits - *arudan* or *az* - are ground to make edible flour for humans. Young green stems – *djumag* - are also edible (Julivert, 2003; Martinez et al., 2007). Very important as “nurse-plant” as they protect young trees from animals (Médail & Quezel, 2018).

General information: perennial grass very resistant to drought.

Figure 67. Mrobka in wadi Sluguiat, near Algerian border (Long. -8,847547; Lat. 26,810891; Alti. 425 m)

Figure 68. Mrobka in Wadi Sluguiat at sunset (Long. -9,910351; Lat. 26,; Alti. 513 m)

Figure 69. Detail of steams and leaves of mrobka.

Figure 70. Desert savana of talha trees and mrobka near Tifariti

Figure 71. Dense *mrobka* pasture near Fedrat el Rkeiez associated with *A. tortilis*.

Figure 72. Camels grazing *Panicum turgidum* grass and *A. tortilis* leaves at wadi Rkeiz making a good nutritional balance of energy and proteins.

Pergularia tomentosa L.

Family: Asclepiadacea

Hassaniya name: *lghalga*

Location: characteristic plant of reg and sandy or rocky surfaces, as in Mount Jerleixa (Long. -9,027939; Lat. 26,731479; Alti. 449 m). This environment is very dry and has very poor biodiversity. We found this plant often on the route along the reg between Tindouf and Tifariti.

Properties: camels can eat this plant despite its caustic and toxic latex. After being crushed it is used to remove hair from animal skins.

General information: plant of the saharo-sindian botanical group and of tropical origin, very common in all the Sahara desert (Ozenda, 2004).

Figure 73. *P. tomentosa* in a sandy reg near Western Sahara – Algeria border (Long. -8,798169; Lat. 26,854516; Alti.415 m)

Figure 74. Detail of *P. tomentosa* flowers. The whole plant is covered with hairs.

Figure 75. Small *P. tomentosa* in a sandy soil of the reg.

Figure 76. *P. tomentosa* severely grazed by camels in wadi Tifariti banks.

Figure 77. Rocky reg banks of wadi Tifariti where *P. tomentosa* can be found.

Figure 78. *P.turgidum* (left) and *P. tomentosa* (right) in the sandy reg at Bir Lahlou (Long. -9,588446; Lat.26,355863;mAlti. 481 m).

Rhus tripartita (Ucria) Grande

Family: Anacardiaceae

Hassaniya name: *eydari*

Location: This plant is found in the beds of Tifariti rivers like in wadi Tifariti (Long. -10,552918; Lat. 26,205639; Alti. 463 m). In some mountains it also grows well by introducing its roots into the rock cracks like in Mount Kedie Rkeiz (Long. -10,749561; Lat. 26,341274; Alti. 434 m) (Fig. 80). Here steep rocky slopes provide also protection against camels. In Fedrat el Erkeiz (Long. -10,743948; Lat. 26,365993; Alti. 405 m) vegetates associated with *A. tortilis* in the desert savannah .

Properties: Animals eat the leaves when other pastures are scarce. Ripe fruits are edible and have good nutritional value (Fig. 83). Also used to tan leathers.

General information: This shrubs is of mediterranean origin (Médail & Quézel, 2018) and sometimes reach the size of small trees covering large areas.

Figure 79. *Rhus tripartita* keeps its foliage green even in very arid conditions in its normal habitat, the wadi, like here near Tifariti.

Figure 80. *Eydari* growing in a rocky hill at Kedie Rkeiz (Long. -10,749683; Lat. 26,341505; Alti. 446 m)

Figure 81. Leaves and flowers of *eydari* (*Rus tripartita*) at Kedie Rkeiz hills.

Figure 82. Detail os *R. tripartita* white spines.

Figure 83. *R. tripartita* small red fruits in wadi Tifariti.

Salsola imbricata Forssk.

Family: Amaranthaceae

Synonymous: *S. foetid*a Del.

Hassaniya name: *aghasal*

Location: This bush was found along our entire route from the border with Algeria but more often after wadi Chertia. It develops in tufts scattered throughout reg and wadi.

In the reg near wadi Sluguiat, between Tindouf and Bir Lahlou (figure 84) (Long. 24-8,845822, Lat. 26,811079, Alti. 420 m and Long. -8,845813, Lati. 26,811074, Alti. 415 m).

In Tifariti and wadi El Rkeiz, associated with *A. tortilis* (Long. -10,550123, Lat. 26,200070, Alti.472 m).

In wadi Annania associated with *Tamarix* spp. (Long. -10,667108, Lati. 26,313142, Alti. 409 m).

In Fedrat el Erkeiz associated with *A. tortilis* (Long. -10,743948; Lati. 26,365993; Alti. 405 m).

Properties: leaves are used as soap for washing clothes and the name of the plant means “the one that cleans” (Martinez *et al.*, 2007).

General information: this specie only vegetates in salty soil and is classified as an halophile.

Figure 84. Reg with *aghasal* near wadi Sluguiat.

Figure 85. *Aghasal* growing in the reg and acompanied by *lkamcha* (*Anastatica hierocchundica*) near wadi Sluguiat.

Figure 86. *Salsola* leaves. They are small and accumulate water and salt.

Tamarix amplexicaulis Ehremb.

Family: Tamaricaceae

Hassaniya name: lfersif

Location: neat mount Annania ((Long. -10,667108; Lati. 26,313142; Alti. 409 m) also associated with *Tamarix aphyla* (Figure 87).

Properties: it is a pasture for animals.

General information: It is a shrub that prefers salty soils in depressions in the ground or around salt lakes (Martinez *et al.,* 2007*).*

Figure 87. *T. amplexicaulis* in the middle of wadi Annania bed forming a *fersig* (sand mound). This land form is originated in the name of the species and is originated by accumulation of sediments around the tamarix branches during floods.

Tamarix aphylla (L.) H. Karst.

Family: Tamaricaceae

Hassaniya name: *lezle*

Location: this tree can be found in wadi around Tifariti. In some parts of desert it grows also around salt water lakes (*sebka*).

A large population of these trees was found in Wadi Annania (Long. -10,667108; Lati. 26,313142; Alti. 409 m). It's an area of deep sandy soil where our cars easily sank. This wadi is home to numerous *Tamarix* trees, and around each one, a mound is formed, built by their roots and trunks, protecting the sand in the wadi bed from being swept away by torrential waters. The trunks retain the sediments carried by the currents and form small hills in the middle of the wadi, the *fersig* (Figures 90, 91), a berber word.

Properties: It serves as food for all animals and provides wood for the manufacture of many utensils.

General information: It grows in association with *A. tortilis* and *M. crassifolia*. All three species are important for feeding camel herds. Also *Panicum turgidum, Atriplex halimus, Salsola imbricata, Launea arborescens, Lycium intricatum* and *ilif* (*Citrullus colocinthis* (L.) Schrad.). Both *Tamarix* and *Panicum* plants are badly damaged by camels.

Trunks of these *lezel* trees reach large dimensions, considering the arid surroundings (Figure 88). Its leafless stems allow it to withstand arid conditions (Figure 92). Halophyte plant, which can withstand high concentrations of salt in the soil.

Figure 88. *T. aphylla* can develop large trunks, here in the middle of wadi Annania bed.

Figure 89. Detail of *T. aphylla* steams shwoing its leafless constitution, a strong adaptation to drought.

Figure 90. The acumulation of sand and vegetal residues around the trunks forms a mount frequently ocuped by other plants.

Figure 91. During heavy rains, torrential waters can knock over older *Tamarix* trees.

Figure 92. A large *lezl* in the middle of wadi Annania (Long. -10,743366; Lat. 26,353996; Alti. 404 m)

Figure 93. *Lezl* trees with good development near a *sebkha* (salt water lake) in Tindouf Saharawi refugee camps, Algeria.

Trichodesma calcaratum Coss.

Family: Boraginaceae

Hassaniya name : *Lharcha, tainast*

Location: banks of wadi Tifariti (Long. -10,616933; Lati. 26,292067; Alti. 420 m).

Properties: this perennial plant is a good pasture to all animals (Martinez *et al.*, 2007).

General information: endemic plant in Western Sahara where it lives in rocky and sandy areas.

Figure 94. Lharcha in a bank of wad Tifariti.

Vachellia flava (Forssk.) Kyal. & Boatwr.

Sinonymous: *Acacia ehrenbergiana* Hayne; *Acacia flava* (Forssk.) Shweinf.

Family: Fabaceae

Hassaniya name: *tamat*

Location: a small population was found only near Bir Legacia (Long. -9,910351; Lati. 26,398034; Alti. 513 m) in sandy soil of wadi.

Properties: small compound leaves and fruits (pods) have a high nutritional value for camels, sheep and goats due to the high protein content. Like most legumes, its roots contain nitrogen-fixing bacteria and improves soil quality.

General information: this legume plant has the form of a bush or small tree up to 4 m. This specie is very rare in Tifariti and Bir Lehlu region. *Tamat* can survive in very arid saharian environments due to its long roots, wich can reach very deep underground water, and very small leaves that reduce water transpiration (Figure 95).

Can be confused with *A. tortillis* vari. *raddiana*. Pods of *V. tortillis raddiana* are very or slightly spiral-shaped. They become larger trees also. If smooth gray trunk then is *V. tortillis raddiana* but if dark brown very rough is *V. flava*. If several trunks of small diameter then *V. flava.* Both have very long white spines as a protection against herbivory.

Figure 95. *Tamat* (*Vachellia flava*) near Bir Legacia, in association with *talha* (*A*. *tortilis raddiana*) and *mrobka* grass (*Panicum turgidum*).

Figure 96. *V. flava* showing its bushy form with several small diameter branches.

Figure 97. Sandy deep soil in wadi where tamat can develop their long roots in searchig for water.

Vachellia tortilis subsp. raddiana (Savi) Kyal. & Boatwr.

Synonymous: *Acacia tortilis* subsp. *raddiana*

Hassaniya name: *talha*

Family: *Fabaceae*

Location: Just after crossing the border into the far north of Mauritania, and in a very arid environment, these trees are observed accompanied by *Pergularia tomentosa. P. tomentosa* is a bush that indicates extreme aridity and is very common in the refugee camps in Tindouf. Trees are small here and found in scattered groups or in lines following *dei* (water drainage lines), or even isolated. A few *lyarguig* (*Helianthemum lippui* (L.) Pers.) plants were also observed as also small tufts of *Pannicum turgidum.*

Figure 98. *V. tortilis* in *dei* Lefteig, near wadi Sluguiat (Long. -8,845813; Lati. 26,811074; Alti. 415 m)

Figure 99. *V. tortilis* in wadi Sluguiat. In the drier areas this trees remains small and with bushy aspect due also to heavy grazing by goats and dromedaries.

During a first stop in Sahrawi territory, near Wadi Slougia and next to the famous rock inscriptions, the perimeter 20 cm above the ground of three trees was measured: 63 cm, 47 cm and 70 cm (Figures 95 and 96). These trees where located on a deep sandy soil of a *dei* (Figure 100).

Figure 100. Sandy soil with some gravel in wadi Slougia. Trees can expand their big roots here and find water in this very dry area.

Bir Legacia, which we found after Wadi Slouguia, is located next to a large *A. tortilis* forest, surprising visitors given its location surrounded by a very dry reg. This green area, with its many trees and a well, deserves to be protected.

In Leglem (Long. -9,373876; Lati. 26,591092; Alti. 458 m), after passing Bir Legacia, we encountered many goats grazing on *A. tortilis* and *Panicum turgidum* grass, in a desert savannah environment that is already more developed (Figure 101).

We stopped at a wadi that cuts through the reg (Figure 102), with a combination of small fruiting *A. tortilis* and *Panicum turgidum* grass in the undercover, on the sand bed of the wadi. We also observed a mixed stand of *A. tortilis* and *Maerua crassifolia* trees (Figure 102). Shortly after, we found a landmark marking the route between Maknes and Tifariti. Here landscape changes and becomes greener, with larger and more numerous trees as we enter a more humid area of the sub-oceanic Sahara.

Figure 101. *A. tortilis* in its typical desert savannah environment.

Figure 102. Mixed desert savannah with *V. tortilis* ans some *Maerua crassifolia* trees (*atil*) (Long. 9,875014; Lati. 26,405362; Alti. 504 m)

Figure 103. Small *A. tortilis* trees assotiated with *Panicum turgidum* grass. Trees had a remarkable production of pods.

In the valleys of Tifariti we find a high plant biodiversity associated with large V. tortilis: *ascaf* (*Nucularia perrini*), mulbaina (*Launea arborescens*), *Tamarix* spp.. . *eydary* (*Rhus tripartita*) , *agasa*l (*Salsola imbricata*) anf *legtaf* (*Atriplex halimus*) (Figure 104).

Figure 104. *A. tortilis* in wadi Tifariti. These desert trees reach their maximum development in the wadi valleys of Tifariti. (Long. -10,549676; Lati. 26,201197 ; Alti. 465 m)

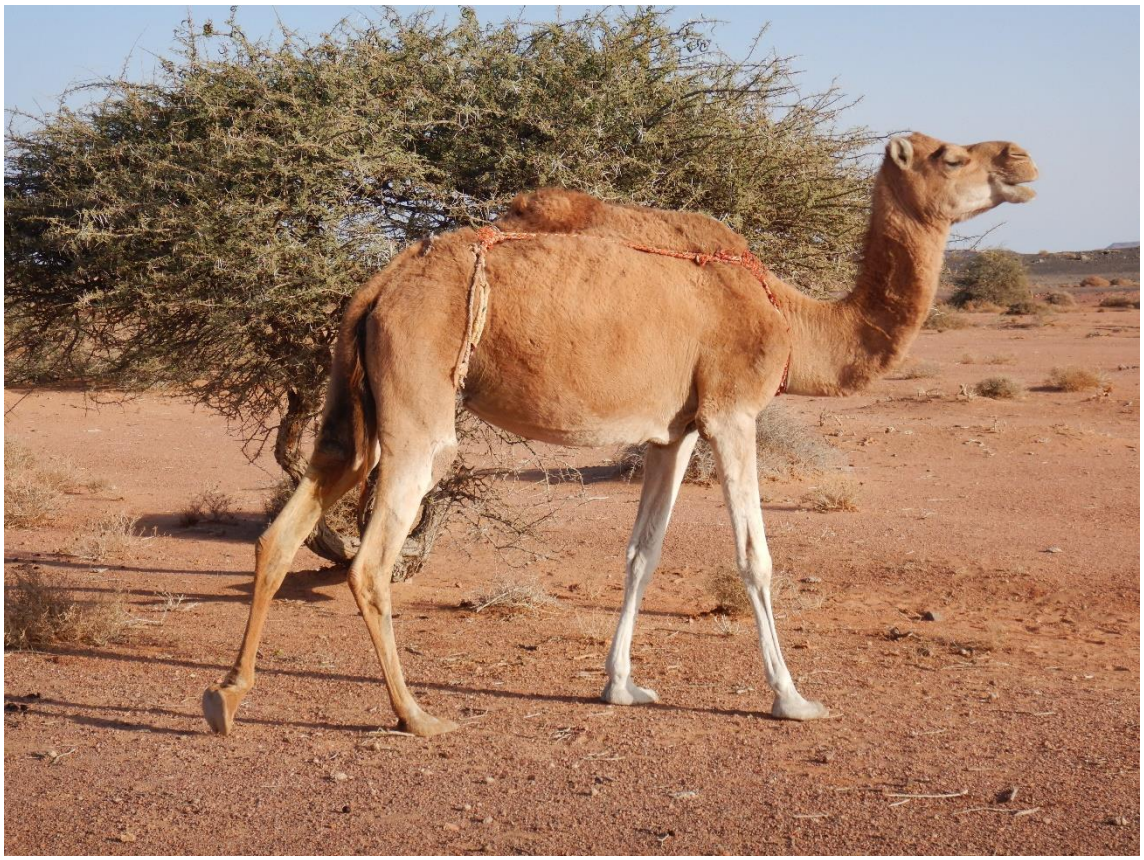

Figure 105. A camel (*Camelus dromedarius*) eating talha leaves, at Wadi Annania, Tifariti. Many animals show red lips due to being stung by tree thorns.

In wadi El Rkeiz, near the caves of the same name (Long. -10,749449; Lati. 26,343506; Alti. 458 m) in association with *Panicum turgidum*. In this location, *Maerua crassifolia* trees are also found, much degraded by overgrazing as in the other locations, Also very developed *Salsola imbricata*.

Another well-developed forest site is Fedrat El Erkeiez (Long. -10,743948; Lati. 26,365993; Alti. 405 m), a dejection cone or *fedra,* where *A. tortilis* forest is enriched in biodiversity with *Panicum turgidum*, *Maerua crassifolia*, *Nucularia perrini*, *Lycium intricatum*, *Neurada procumbens*, *Asparagus altissimus* , *Rhus tripartita, Salsola imbricata*, *Nauplius graveolens* , *Anastatica hierochuntica* and *Barleria schmittii* (Figure 112).

Properties: It is called " the tree of life" of the Sahara. *A. tortilis*, a Fabacea tree, is the main component of Western Sahara silvopastoral ecosystem. These acacias are of great ecological importance in the Sahara. More than one hundred different species of animals, including birds, reptiles, insects, and spiders, have been found under the shelter of a single Sahara acacia tree (Rognon, 1994). It's leaves (Figure 110) and fruits (Figure 111) are rich in nitrogen and provide digestible protein for animals. This protein intake is important for the microbial flora in the stomachs of dromedaries and goats. With this

nitrogen supply, the microbial flora can digest the highly fibrous and dry desert pastures and provide the animals with metabolizable energy and protein (Figure 112).

Beneath the canopy of these trees, the soil becomes enriched with nitrogen due to the association of their roots with nitrogen-fixing bacteria. The fixed nitrogen also allows for greater growth of grass pastures. This process also enriches the soil with organic matter (Figure 106).

Figure 106. Hortus of Smara refugee camp in Tindouf, Algeria. System of agroflorestation with *A. tortilis* and carots under irrigation. Trees fixes nitrogen and provides organic matter to the soil. A line of *Arundo donax* protects the crops against the wind and sand storms.

Strong, deep roots contribute to soil formation by breaking up the parent rock (Figure 108).

Wood is of great importance to the Sahrawis as fuel (Figure 107). However, uncontrolled grazing and the widespread use of wood as fuel are increasing desertification. Therefore, it is urgent to plant large areas of this native species.

Its gum (*elk*) is used in various medicines, such as cough suppressants. The mixture is tasty and forms a dense, stable foam. It's the Sahrawi recipe for all types of colds. Acacia resin is produced by these trees at the end of summer due to the high temperatures. It's

collected for consumption and can be purchased locally (Figure 109). Its properties must be very similar to those of Arabic gum, which is extracted from the *Senegalia senegal* tree in the Sahel region, and has many industrial applications.

Figure 107. Our guides cut branches to cook lunch.

Figure 108. *A. tortilis* growing on the rocks of Mount Erkeiz.

Figure 109. Solution of gum in water is used against caugh.

Figure 110. Talha branch showing spines and the small compost leaves.

Figure 111. *V. tortilis* green pods with its characteristic screw form.

General information: In Wadi Tifariti, around the point with coordinates Long. -10,550123; Lati. 26,200070, Alti. 472 m , where a well is located, we measured tree height and trunk circumference at 20 cm above the ground. Sixteen acacia trees were randomly selected, and trunk circumference was measured only for those with a single trunk. The values were taken with a metal measuring tape. We obtained the values shown in Table 1.

Tree number	Perimeter at 20 cm (m)	Height (m)
1	1,48	5,05
2	-	4,83
3	1,07	3,84
4	1,15	5,60
5	0,57	3,64
6	0,53	4,60
7	0,75	4,30
8	1,07	4,20
9	0,78	3,70
10	1,12	3,96
11	-	2,60
12	-	3,71
13	1,34	6,46
14	1,39	7,00
15	-	2,8
16	1,40	5,30
Average	1,05	4,47

Figure 112. The acacia forest in Fedrat El Rkeiz. Deep sandy soil with dense tree cover and grass (*P. turgidum*) development makes this place an ideal location for camel grazing.

Zygophyllum gaetulum (Maire) Dobignard

Family: Zygophyllaceae

Hassaniya name: *lagaia*

Location: grows on salty soils around Tifariti. In can be found in reg and in wadi. In Tindouf Saharawi refugee camps is very common and also found around *sebkhas* (salt water lakes). Largest shrubs are found in wadi valleys and depressions (Figures 113, 114).

Properties: Camels can eat it. Is an important medicinal plant with several uses.

General information: endemic species of Northwest Sahara (Ozenda, 2004). Leaves store water allowing plant to survive long dry periods (Figure 115)

Figure 113. *Z. gaetulus* is an endemic plant of Northwest Sahara.

Figure 114. Lagaia (*Z. gaetulum*), a shrub that can be found in reg and in wadi around Tifariti, in soils with high salt concentration.

Figure 115. Detail of *lagaia* almost spherical succulent leaves.

Figure 116. *Lagaia* in Wadi Tifariti bed (Long. -10,611036; Lat. 26,286473; Alti. 423 m).

Zizyphus lotus (L.)Lam.

Family: Rhamnaceae

Hassaniya name: *sder, sedra*

Location: this shrub is not very common in the region. But in wadi Tifariti and along the road leading to Tifariti, we find a population of *Zizyphus lotus* on the top of a *fersig* (Long. -10,550123; Lati. 26,200070; Alti. 472 m). *Fersigs* are mounds of sand and debris that form in wadis. Surrounding the mound vegetates plenty of *Panicum turgidum* grass, *A. tortilis* trees, and shrubs of *Launea arborescens*, *Atriplex halimus*, *Salsola imbricata*. Sharing the hilltop with *Z. lotus* are *Rhus tripartita* and *Nitraria rtusa shrubs* (Figure 119).

Properties: the plant is consumed by animals and fruits (*enbeg*) are eaten fresh by people (Figures 117 and 118).

General information: plant of mediterranean origin, according to Médail & Quézel (2018). Also according to these authors *Z. lotus* acts as a nurse plant as the thorns (Figure 117) protect young trees from herbivory.

Figure 117. Steams, leaves. flowers and fruits of *sder* (*Ziziphus lotus*).

Figure 118. *Sder* bush in wadi Tifariti showing the small orange fruits.

Figure 119. *Sder* on a *fersig* in wadi Tifariti bed. On this same *fersig* also can be found yedari (*Rhus tripartita*) and lguerzin (*Nitraria retusa*).

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