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GENETIC DIVERSITY STATUS OF CAMEL'S RESOURCES (*Camelus Dromedarius. Linnaeus*, 1758) IN ALGERIA.

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Abstract:

In Algeria, the dromedary *Camelus dromedarius*, remains an important and valuable resource despite the decreasing number of its individuals. The situation of the livestock seems to be enhanced these last years, with the growing demand of camel's milk and meat. The dromedary is an excellent animal for using local food resources available in arid and semi-arid climates but sadly there are only few studies about it and the scientific progress contributes very little in its breeding cycles. The dromedary populations are so phenotypically Algerian so different that supposes a lot of differentiations on the genomic scale which could be a beneficial advantage in the context of the adaptation to the new environmental conditions.The dromedary has long suffered from the sedentarily of the breeders as well as the bad health conditions. Lately the government has launched economical programs that intend to promote the local animal resources so the situation of the dromedary is getting better, thanks to the support of the government and the benefits behind the dromedary products. We believe that there is a lot to be done yet about the identification of the dromedary genetics. The purpose of the coming efforts are conservation and amelioration of these local resources which has a great impact for the promotion of the Algerian economy

Keywords: Dromedary, Genetic diversity, phenotypic characterization, Arid and semi-arid climates, Conservation and sustainable production

Introduction

The genetic diversity of animals meant for food and agriculture is continuously diminishing. Numerous breeds have been disappeared within the last decade and the remaining ones are dramatically endangered. The FAO has adopted an efficient strategy based on the identification and characterization of the existing animal resources, breeds and populations, aiming to preserve these important sources of various products such as meat, milk, wool, etc. More than 8800 domesticated

animal breeds, belonging to 38 species, are catalogued in the FAO's DAD-IS database (http://dad.fao.org) (Leroy et al., 2017). They could be recognized thanks to a number of phenotypical, geographical and/or cultural specifications. It represent a potential tank that could be used to meet the future challenges of the international market regarding their ability to adapt to the changing production environments The breed constitutes the main subdivision within the domestic species. However, a very few works specialized the study of the genetic diversity in both the regional and national scales. Thus, no relationship is clearly established between the environmental diversity and the breeds diversification (Leroy et al., 2015).

Many countries, such as Algeria, possess the necessary potential, in terms of animal resources, to ensure their food sufficiency but they keep the importation of food which raises the question around the governmental strategies for the development of the animal production that contributes about 12% of the GDP (ONS, 2016 ; MADRP 2016).These strategies were developed to identify the livestock and the characterization of the different populations and breeds. The inefficiency of the application of these strategies has put algeria in a critical position facing a low local production combined to a diminishing livestock because of the unreasonable breeding. Political decisions have been subsequently made in order to reach meat and milk self-sufficiency through the enhancement of the local breeds. However, the lack of laws added to the lack of coordination between those working in this sector has made things even worse for the professionals and the animal breeders to access the zoogenetic resources and benefit from it. In Algeria, the situation of the animal genetic resources (AnGR) remains to be controlled and the efforts must be carried on to enhance it. Joint efforts from breeders and researchers are important to first estimate and characterize the livestock then to define the goals and the ways to promote it.

The current study is aimed to deliver valuable information for a better understanding animal production, specifically the dromedary, with the advantage of the collected data and analysis the results will be a better management of the AnGR and the decision-making in these sectors which will have a significant positive economical effect. The value of the AnGR goes beyond their current use to their conservation and future promotion. Breeding methods being used reflect the ignorance of the AnGR and represent a clear evidence of the necessity to quickly react to preserve it.

This study is about the variability of the dromedary (Camelus dromedarius. Linnaeus, 1758) in Algeria, especially about its breeds and ecotypes, which will help to determine the genetic variability according to the geographical component. This approach is based on the phenotypic aspect as well as some previous molecular data (microsatellites according to FAO-ISAG (2004) and FAO (2008) from Harek et al., 2015 and Cherifi Y.A., in progress). The results will constitute a milestone to future works around the dromedary.

Methodology

This study is meant to provide a clear vision of the dromedary's genetic diversity, its extent and status, thus making it easier to conservation within its natural habitat: the Sahara and the steppe. For each breed, we looked for the ecotypes that compose it as accurately as possible according to its name and the available descriptions from the locals.

1. *Importance of the biodiversity of domestic animals*

Biodiversity of a given species results from the evolution process of its populations under specific climatic and ecological conditions. Domestication has negatively contributed to the biodiversity because of the restricted genetic pool and the human-biased selection. Breeders are facing the double challenge of conserving the current diversity and enhancing the breeds able to adapt to the constantly changing climatic conditions.

Since the 60's, the Food and Agriculture Organization (FAO) is giving support to countries willing to indentify, characterize and promote their animal resources. In 1990, FAO's council recommended the establishment of a global program for the sustainable management of the genetic

resources of the world. As a part of this program, the qualitative and quantitative identification and the documentation of the animal populations are carried out to better knowledge of the animal resource, their current usage and its potential in terms of feeding and use in agriculture (FAO, 1984; Rege, 1992).

At the national scale, investigations lead to identify and systematically document the animal resources data. This kind of activity would help forecast objectively and accurately the animals' performances in their environment and compare it to the ideal performance under suitable production conditions. Therefore, it is more a serious management plan than a simple investigation (Rege, 1992). The results of such a work contribute effectively in the decision making at national and regional (between countries) scales as well as for international organisms (FAO, 1992; FAO/PNUE, 1998). The subsequent political decisions will be made to promote the resources taking into consideration the conservation aspect to meet the current and the future needs.

Gene variability within and between a species' populations is the basis of the genetic variability. At the molecular scale, it results from the genomic polymorphism under the effect of the environment (Stockwell et al., 2003).It enables the individuals of a species to cope with and adapt to new environmental conditions, especially under a changing climate. More importantly, a large variability reduces the inbreeding and diminishes the probability of species to get extinct (Frankham, 2005).

2. *Situation of the genetic resources in the world*

According to Blanc and Ennesser (1989) (in Ould Ahmed, 2009a), appoint the lack of studies on the characterization of the camel and dromedary in the world. Only superficial descriptions of some populations are given out of field investigations. No standard is clearly defined for the morphology neither is the genetic markers. The same authors have reported that the breeds described are closer to natural populations than to the product of the intense selection. The breeders have contributed to orient the selection for specific purposes (meat and recently milk production) and for morphological considerations such as the closeness of the stool. They have also benefited from the ecological constraints that have lead to adaptation to diverse habitats (plains and mountains).

The proposed classification of the camel and the dromedary breeds relies mainly on the individual morphology rather than its performance in terms of production. Thus, for the dromedary 3 types and 8 groups are described in the world with 97 breeds, 26 in Africa out of which 10 are found in Algeria (DAD-IS, 2015) (Figure 1)

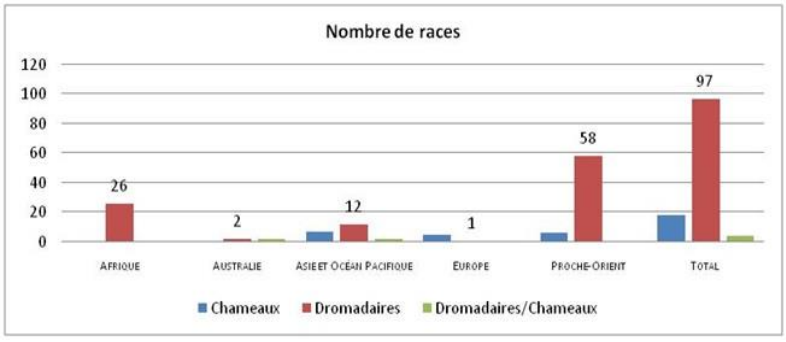


Figure 1: Number of Dromedary breeds and species by continent (DAD-IS 2015).

The main criterion of this phenotypic classification is the body-size as follows:

Big body-size with 3 categories:

G1: individuals of the plains and the coast, large body, used to carry weights (the breed of the river of Mali), **G2**: heterogeneous group, individuals of different body-aspect and coat living in diverse habitats, used for different purposes (Arabe, Soudani, Tergui, Adrar) and **G3**: individuals living in desert plains, narrow body with a small-haired coat that varies from fair to dark, used as a mount called Méhara (Reguibi).

Mid body-size with 2 distinct categories:

M1: originating from Soudan, the animals are narrow-shaped body with a fair coat used as a mount and M2: living in plains (like Manga, Azmiyah), heavy body with the coat differing from one individual to another, used to carry weights.

Small body-size including three categories:

P1 : breeds living in rainfall high plains and coasts in eastern Africa, the coat is mainly ochre (example of the Guban in Somalia), used to carry weights, **P2** : this category includes the Maghreb breeds known to be rustic, living in arid plains, more or narrow-bodied, a dark coat, used for carrying weights and to ride on (example "Ould Sidi Cheikh" in Algeria), and **P3** : found in mountains, the coat is dark with long hair, very rustic, mainly used to carry weights (Bari in Pakistan). Faye (1997), reports that this classification is arguable since it relies on morphology and few ecological criteria with no consideration of the zootechnical quality. Today, 52 main dromedary breeds are described in the world with a hundred of associated breeds (**Figure 2).**

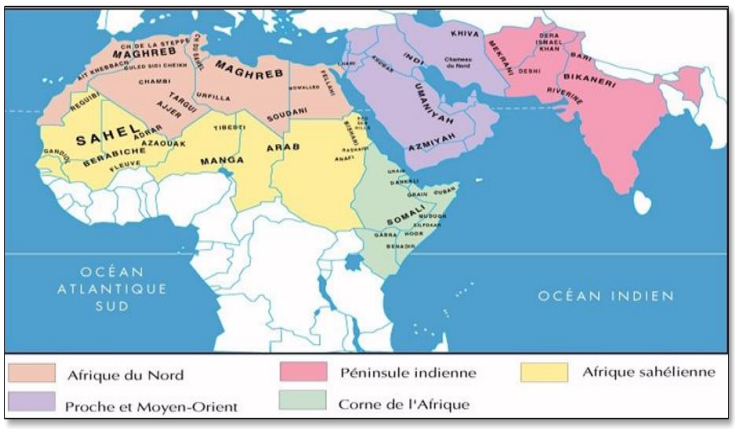


Figure 2: Location of the main camel breeds in the world.

According to Khouri (2000), the distribution of the dromedary in space and time induces specific variations for each breed in the considered middle Habitat. Wardeh (2004) mentions that the quite similar rude conditions under which camels and dromedaries are kept have resulted to unspecified populations. In most cases, the name of breed is related to the human tribe that it belongs to (Faye, 1997) ; this is the case for *El kebachi*, *Erchaydia*, *El bechari* found in the tribes of the same name in Sudan (ACSAD, 2002). Isam and Osman (2005) report that a recent classification, taking into account the type of production (meat, milk, mix or running), has been considered. This new system is based on the fact the dromedary being a principal and important component of the agropastoral systems in the unfavorable and rude pastoral zones in Asia and Africa sustaining millions of people (Wardeh, 2004).

Dromedaries used to meat-production: the individuals are of a big body-size with a long neck, big muscles, an impressive hump and a high growing rate. The more the individual is younger the better is the quality of the meat. This interest in the dromedary meat is more and more important as some countries (i.e. of the Arabian Peninsula) are getting industrialized. Some studies show that the dromedary possesses an excellent ability to accumulate fat provided the conditions are improved (**Table1**).

Table 1. Examples of meat camel breeds (Wardeh, 2004).

Breeds	Breeding country	Characteristics
El jandawel	Mauritania	-Big size -Heavyweight -Dark colors
Delta	Egypt	--Big size -Muscles developed -Supports heavy loads
El fellahi	Egypt	-Big size -Heavy skeleton -Not slow

As for milk-production females, the annual production exceeds 2500 liters. Their milk contains less fat and lactose compared to cow's yet the potassium, iron and C vitamin concentrations are higher. Table 2 summarizes the production level of some milk-producing breeds.

Table 2. Examples of dairy camel breeds (Wardeh, 2004)

Breeds	Breeding country	Production in (Kg)
Hoor	Somalia	800-2800 by lactation
Rachaida	Soudan	2000-3000 by lactation
Challageea	Soudan	15-18 by day
Sirtawi	Libya	3000-4000 by 305 days
Ouled Sidi Cheikh	Algeria, Morocco and Mauritania	2000-3500 by 305 days
Fakhreya	Libya	3500 by lactation

The mixed-use breeds include medium and big body-sized animals, with a relatively high growth rate, which females can produce between 1000 and 1500 kg of milk per lactation (table3).

Table 3. Example of some Mixed Camel Breeds (*Wardeh, 2004)*.

Breeds	Breeding country	Characteristics
Maghrebi	Egypt., Morocco, **Algeria**, Libya et Tunisia	-Variable size. -Various color.
Tibisti	Libya and Chad	-Small size. - Runner.
El majaheem	Saudi Arabia	-Big size. -Black color. -Dairy production.
El khawar	Syria and Iraq	-Adults weight 665Kg for the male and 540 kg for the female. -Production of milk: 1800-2000 per 15-18 months.

Situation of the dromedary genetic resource in Algeria

Local genetics resources have a great value since it can be used as a reliable source for food. According to Lesur-Gebremariam (2015), animal domestication has different forms depending on the type of culture and the environment where it took place. Likewise, the diffusion of domestic animals in new areas has deeply affected the societies and the ecosystems. In Africa, the mechanisms behind the choice of a specific breeding scheme remain unknown. The numerous pastoral populations have developed a way of living centered around the animal that has an economical, cultural and symbolic role. Asia has contributed in providing economically and culturally important domestic animals, like the dromedary, to Africa, through the Arabian Peninsula. This is confirmed by the remains in Qasr Ibrahim (Abraham's Castle) in Low-Nubie dating from 1 000 years B. C. (Rowley Conwy 1988). The extension of this species to the Maghreb and the Sahara has taken place slowly up to nowadays (Bulliet, 1990). The dromedary exists in the Arabian peninsula since 3 000 years ago (Grigson, Gowlett & Zarins 1989), but

the available data do not allow to say whether it came to Africa through the Sinaï (Egypt) or via the African (Lesur 2007). Some serious studies have been done in other countries such as South Africa (Nolte *et al.*, 2005), Saoudia Arabia (Abdulaziz *et al.*, 2009), Australia (Spencer et al., 2010), Tunisia (Ould Ahmed *et al.*, 2010), Canary Islands (Urusula *et al.*, 2010) and Algeria (Harek *et al*., 2015). Within the last 30 years, identifying genetically distinct populations was a key element to their conservation (Wayne, 1992; Paetkau, 1999; Frankham et al, 2002), Ryder (1986) and Moritz (1994).

Despite the importance of the resources for the food security and the economic and social development in arid and semi-arid regions, it remains victim of genetic erosion that is constantly growing. The exhaustive inventory of the dromedary resource is not yet officially established, only some basic surveys on the performancemanagement of some populations, other parameters being neglected because of the lack of means and materials. The studies carried out by the researchers tend to be descriptive relaying on morphology, the evaluation of the production potential and the reproduction of the local populations.

After the independence of Algeria, the dromedary contributed in the income and to answer the demand in terms of animal proteins (meat and milk) of a large group of people living in the step and the Sahara.It also provides raw material (skin, leather and hair) to craftsmen. The tendency of the breeders to sedentarization has negatively and deeply changed the role of the dromedary as a means of transportation and limited its distribution (Harek, 2008). The decrease in the number of individuals can be the result to drought and the social and economic mutations added to the weak productivity of the dromedary. These days, efforts to reconstitute the livestock have allowed to an increase this resource since it is used in the economical exchange with Mali and Niger (Harek, 2008). Locals are showing interest in the dromedary and they are including it in the national development programs. Consequently, more researchers are working on different aspects to its enhancement and promotion. Table 4 gives the situation of the zoogentic resource of the main breeds in Algeria.

Table 4: State of conservation and status report on camelina biodiversity in Algeria (DAD-IS, 2015).

Common name	Species	Breeds, Species, Varieties	State of Conservation
Camélidés	*Camelus dromedarius*	The Berberi, the Chaâmbi, the Chameau de L'aftouh, the Chameau of the Steppe, the ait Khebbach, the ajjer, the Ouled Sid Cheikh, the Reguibi, the Sahraoui and the Tergui.	Traditional livestock confined in steppe and Saharan areas (170,000 females in 2001) (AnGR, 2003).

3.1. Geographical distribution of the dromedary

Algeria comprises 2.381.741 km² of land with 2 main domains: the Sahara (four-fifths of the country) and the coastal and sub-coastal bands (600 km wide and 1 200 km large) (**ONS, 2015**). Thus, Algeria is a complex of a series of natural habitats composing 3 main types (the coast, the steppe and the Sahara) that is home of a variety of animals; this biodiversity is to be preserved and protected; livestock is to be sustainable and wisely used so as to reach the food security and maintain the fragile ecological equilibrium. The dromedary, despite its potential and specificities, is considered as a secondary animal resource that never met the expectations of the governmental programs. The lack of success of this valuable resource is due to either inappropriate development programs or it has long been occulted. Things are made worse by the decrease of food availability which has lead breeders to invest in other resources.

The ability of the dromedary to live and survive by itself in rude environments is the origin of respect for the local population, it had always been an addition to the economic and cultural value. Harek (2017) reports that the algerian dromedary livestock represents 1.32% of the world livestock 2% of the Arab's and 13% of the individuals of the Maghreb region, putting Algeria at the 19th rank worldwide, 8th rank in the Arab world. This resource undergoes genetic and socio-economic pressures putting the genetic diversity at risk.

3.2. Developpment of the livestock

From 2000 to 2014, the number of individuals has increased reaching 354 465 (MADR, 2014). This is due to a governmental fund for rural and agricultural development (Omari *et al.*, 2012). Its contribution is in favor of breeders with an important livestock (Bessaoud, 2006) which has resulted in the interest of the locals of the arid and semi-arid regions in the milk production thanks to the benefits it gives back (Figure 3). This favorable situation was precedent by the decrease of the livestock between 1990 and 2000 due to uncontrolled slaughter, furtive exportations, change in the way of living and the tendency to sedentarization of the nomadic populations.

Figure 3. Evolution of Dromedary effective in Algeria 1961-2014.

3.3. Distribution of the livestock

The analysis of statistical data shows that 72% of the dromedary livestock is located in Tamanrasset, Tindouf, Adrar and El Oued with 28% in the region of Tamanrasset alone.(Harek, 2008). The dromedary breeding is located in 3 main areas covering 18 wilayas (Saharan and steppe):

- 93,18 % of the livestock, (230 290 heads) are found in 10 Saharan wilayas with 50 % of the livestock in Tamanrasset and Adrar (MADR, 2014).
- 6,81 % of the livestock (24 139 heads) are found in 9 steppe wilayas.

Within its breeding zone, 4 main regions located in the Sahara are described (Figure 4). The Tamanrasset region with 85 895 heads, the Adrar regions with 49 950 heads, El Oued with 38 000 heads and illizi with 32 330 heads. The size of the livestock in the steppe is comparatively low. The usage of the dromedary has evolved independently and far away from the scientific progress; the traditions, the ancestral techniques and the local knowledge remain the principal ingredients having helped maintain and develop this valuable resource.

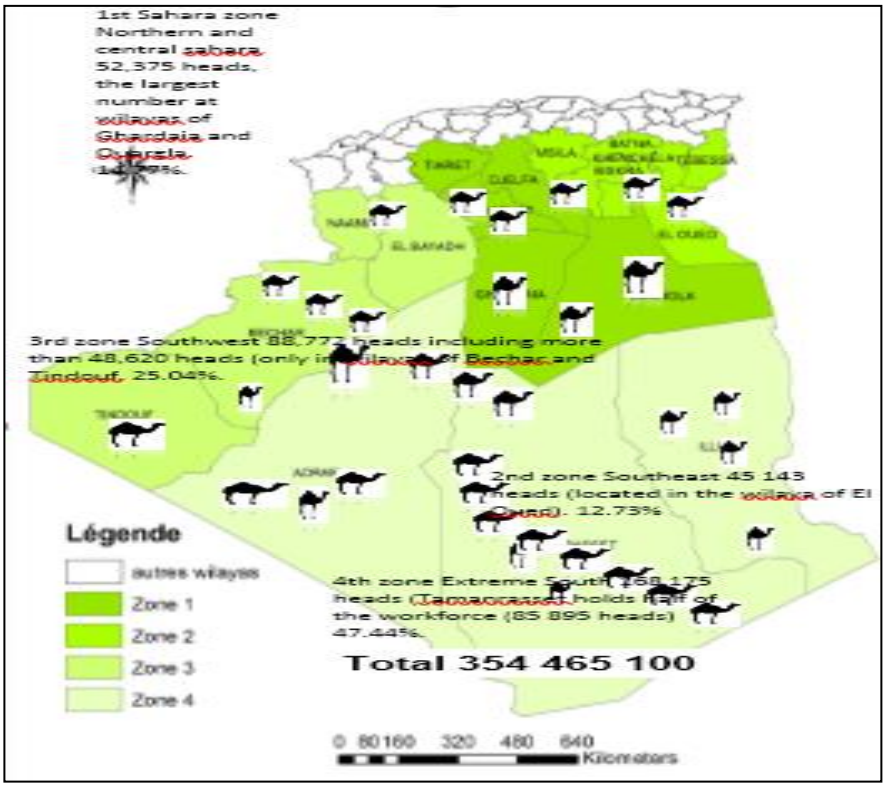


Figure 4. Location and distribution areas of dromedary in Algeria (Harek, 2017).

1.4. The breeds and the phenotypic specifications of the dromedary

So far, the dromedary populations can't be considered as belonging to types, genetic branches or ecotypes; the available data are very few and the methodology used by authors differs from one another. The only possible classifications are based either upon the mode of usage (carry of weights or as a mount) or according to the habitat (mountains or plains) (Richard, 1985).Other criteria can be considered, especially those related to the purposes of breeding (meat, milk or dual-purpose), the color of the coat (Faye, 1997) as well as a set of measurements according to the color of the coat (Harek, 2008).

The genetic diversity of the dromedary and the relationships between its populations are not well documented; their classification is often done according to their tribal origin, the measurements related to the body (Chniter et al., 2013), and the ecotypes (according to the range of distribution) as it has been done for the camel (Abdallah and Faye, 2012).

1.4.1. Classification of the dromedary breeds

All domesticated animal species are selected for a specific trait that is economically interesting. The dromedary has undergone very a few selections and thus did not specify to the different production functions (such as meat, milk, hair or other). Richard (1985) defines 2 main categories of dromedary according to the habitat:

- The dromedary of the mountains, well adapted to carrying weights and performing agricultural work. Generally, the body is short combined to a mid body-size (1.8 to2 m tall), muscles are compact, and the bones are strong, round legs with a hard sole and long-haired coat.
- The dromedary of the plains, the individual is tall (1.9 to 2.2 m tall) long neck and legs, the sole is often soft and a short-haired coat.

Faye (1997), made the distinction between the milk-producing breeds, their hump is small and their udders are well developed, and the meat-producing breeds that possess a bigger hump and well developed limbs provided their food is rich enough. In Libya, Shareha (*1990 [a] et [b]*) has tried to determine a number of morphological traits that would allow the classification according to the purpose of production (meat and/or milk). The same attempt was carried out in Arabia Saudi using morphology to characterize the existing breeds (Souad et Al-Motairy, 1988 et Marzouk, 2003). In Algeria, Harek (2008) has identified the phenotypic variation within the «Tergui» population; the results show the existence of a structure of sub-populations (called ecotypes) as well as phenotypes within each sub-population. Phenotypic traits and zootechnical parameters are of great use to the identification and characterization of camel and dromedary populations. The current proposed classification is based on the coat color, the body shape, the purpose of production and the tribal origin.

1.4.2. The different nominal breeds in Algeria

The morphology of the dromedary is unique (long neck, the hump and the protuberant sternum) (Wilson, 1989).The dromedary is 2.2 to 2.5 m tall and weighs from 400 to 1 100 kg, according to the breed, with a life expectancy of 25 years. Most of mammals living in desert regions go underground, either in tunnels or holes, to avoid heat and drought. The dromedary possesses physiological characteristics that allow it to adapt to such rude conditions. It has a large head, a long and fine neck, small ears, salient large eyes and ample and deep paranasal sinus. It is the only animal species that has a lateral blind sinus; this kind of anatomy allows retrieving a part of water vapor lost from expiration. The upper mouth-lip is divided and very sensitive and the lower one is large and pending; its members are strong and the skin is thick. One of the anatomic traits that distinguish the dromedary from other ruminants is its large and elastic foot well adapted to send. The hump is a white lipidic tissue with a soft consistency susceptible of variations in volume according to the animal feeding state. According to Kayouli *et al.,* (1995) and Jouany (2000), the digestive system, both the structure and function, of the dromedary is different of others' animals; it is capable of efficiently using the food resource of the desert.

The algerian species is recognizable thanks to the body-size and the color of the coat. From the North to the South, there is a variability in the color of the and the nature of the hair. The breeds derive from cross-breeding with the Arab dromedary. Beyond the genetic component, the common point is the decrease in the number of individuals and a critical decline of some ecotypes such as the camel of the stepp and the the breed Ouled Sidi Cheikh that used to be found in the of the plain of Oran, it has been replaced by the Sahraoui type. Chaâmbi and Tergui are the most robust and yet looked; the first breed is an excellent méhari (runner), the second is looked for male breeders, increasing inbreeding among existing populations. The number of dromedary individuals in Algeria is found in 4 main areas where variability (in terms of body-size and purpose of breeding and breeds) is observed within each region (**Figure 5).**

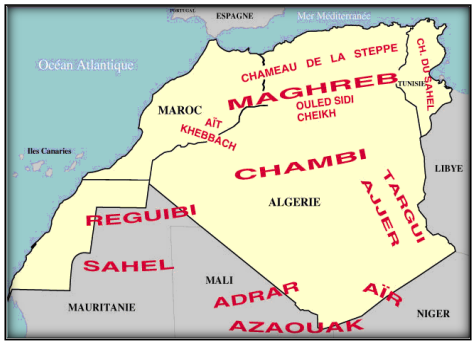


Figure 5: Geographical distribution of the main dromedary breeds in North Africa.

The dromedary resource in Algeria can be grouped into 2 genetic groups: the Châambi and Tergui (Mahri) groups. Eight sub-types are inventoried: Reguibi, Sahraouian, the Camel of Aftouh, Ajjer, Aït Kebbach, Ouled Sidi Cheikh and the Camel of the steppe. This is confirmed by the studies carries in Algeria by other authors (Boue, 1952; Lasnami, 1986; Ben Aissa, 1988; Oulad Belkhir, 1993) **(Table 5).**

The phenotypic features of the dromedary

Table 5.

Breeds	Characteristics	Regions
Barbari	Fine shape, a well muscled back and good milk producer.	Southern limit of the steppe
Chaâmbi	Line media animal, muscular, "Race" strongly crossed with the rank of the Arab dromedary, small size, Has different colors. Very good for transportation and a good milk producer.	From the big Western ERG to the big Eastern ERG
Ouled Sidi Cheikh	Animal media line, solid, Dark coat mid-long and saddle animal.	Highlands north of Great Western Erg
Sahraoui	Chaâmbi crossing and Ouled Sidi Cheikh and Robust with dark coat of red color mid-long.	Large Western ERG at the center of the Sahara
Ait Khebbach	Breviline animal of normal size , Very dark dress with short hair and Bat animal.	Southwest Algeria
Tergui	"Race" of Northern Touareg, Fine animal and well muscled, Small bump thrown backwards, Little tail, An excellent Mahri noble, Arab and Clear white dress or pie.	Hoggar and central Sahara
L'Ajjer	breviline animal, Small size, Adapts well to the courses in Mountain and Beast and saddle animal.	Tassili N'Ajjer
Reguibi	Lean, energetic animal, A very good Mahri and excellent saddle animal and Clear dress and short hair.	Southwest (Bechar and Tindouf)
Aftouh	breviline animal, Excellent saddle animal and Draft animal and bat	Reguibet

According to Adnane and Zohir (1990), the dromedary is a big-size animal. Seen from distance, its body parts can easily be told apart. The ears and tail are small relatively to the body, the neck is long and the members are high. It has always been described according to the color of its coat that has no impact on the reproduction physiology. It is hereditary and subjected to environmental conditions.The majority of these colors are used to make the difference between the types of a same breed (CERD, 1989).Table 6reports the different ancestral names of the dromedary (nominal species).

Table 6: Classification and names of dromedary in Algeria

Name of the animal	The colour	Region and source
El Wadha ou Magatair	- Blanche.	
Chakha	-Light red	
Chaala	- A red maroon	
Malha ou Mahgim	- Black	Adnane et Zohir
El Hamra	- Red	(1990).
El Safra	- Brown.	
El Zarka	- Red coat, the sludge of the "oubar"are black (Gray).	
El Hadjla (El Ahdjel)	- Red body, white paws	
El Arkam	- Association between Whites with Yellow.	
El Beydi	- Dark red.	
El Achaal	- Between yellow and red.	
El Khoare (fauve)	- A light gray	
El Chakraa	- A bright yellow to white.	
El Hammay	- Between black and white.	
El Zaghma (Sammounar ou Samoukaila)	- Color that looks like flames of fire.	
El Chahba (el chaaba)	- Dark yellow	
El Dakhna	- Very dark color but it is not black.	
E-Zarkaf	- A white with spots of another color (pie dress).	
El Harcha	- Yellow color.	Ayad (1996).
El Athra	- A brilliant yellow.	
El Ranbi	- Sand color of Reg (desert bunny)	
El Khouar	- A curly Oubar whatever the breed.	

Color of the coat

The color of the coat is used in the classification of some animal breeds. For the bovine, it is often a morphological feature related to the breed (Girardot *et al.*, 2003). The dromedary is represented by many populations throughout North Africa (Ben Aissa, 1989; Hermas et al., 1998). In Algeria, seven colors exist (white, red, brown, fair-red, grey, reddish-brown and piebald); they are different from a region to another which allows the breeders recognize the breeds (Tableau 7).

Table 7: The different colors of the dromedary dress in Algeria.

Appellation	Colors of the dress	Characteristics
Hamra	Reddish brown color. Brown uniform coat.	Very appreciated by the breeders for aesthetic and religious reasons, Dominant in Algeria (30% of the workforce) (Cherifi *et al.*, 2013). The red camels are the most sought after.
Safra	Yellow tanned takes the color of desert sand. painting uniform light yellowish color	Yellow tanned takes the color of desert sand. painting uniform light yellowish color
Chegra	Double reddish color Mixture between yellow and red.	Less appreciated by the breeders, it constitutes 11% of the Algerian camel herd (Cherifi *et al.*, 2013).
Baydha	Extra white color. A very light gray or white coat	Extra white color. A very light gray or white coat
Hadjla	-Red light with a white color very apparent on the limbs. A head and limbs of white color and a yellowish shade on the rest of the body.	-very aesthetically pleasing (9.5% of the workforce) (Cherifi *et al.*, 2013).
Zarga	-Red with black hairs. Total black coat less	-7.5% of the workforce (Cherifi *et al.*, 2013).
Zerwala	-It's an alternation of white with other colors and white eyes. a coat that is a mixture of black and blue white (hybrid).	Little appreciated by breeders, this dromedary has a serious form of deafness.

3.4.4. Naming according to the geography

Numerous names according to cultural and geographical considerations have been reported for the dromedary. The name of the populations is those of the tribe that keeps it or the region it belongs to. Thus, 10 branches exist in Algeria: Tergui, dromedary of the steppe, Reguibi, Aftouh (called also Azawak), Ouled Sidi Chikh, Sahraoui, Châambi, Ait Kebbach, Berbari and Ajjer.This study allows us to identify the pure breeds in their original range and realize morphological measurements as well as blood sampling for genotyping and therefore enrich the genetic database.

3.5. The main breeds existing in Algeria

The national camel population has eight sub-types listed above. This distribution is confirmed by the studies carried out in Algeria by several authors (Boue, 1952, Lasnami, 1986, Ben Aissa, 1988, Oulad Belkhir, 1993). The synthesis of the works of Mud (1949), Ben Aissa (1989), Bouregueba and Lounis (1993), Arrif and Reggab (1995), Baatout (1996) and Harek (2008), this distribution is illustrated in Figure (6) Let us note an interaction and primacy between the different populations, which generates a shift or a dispersion of some populations that existed before (Ould Sidi Chikh), and also a homogenization of a population compared to others (Tergui like reproducer).

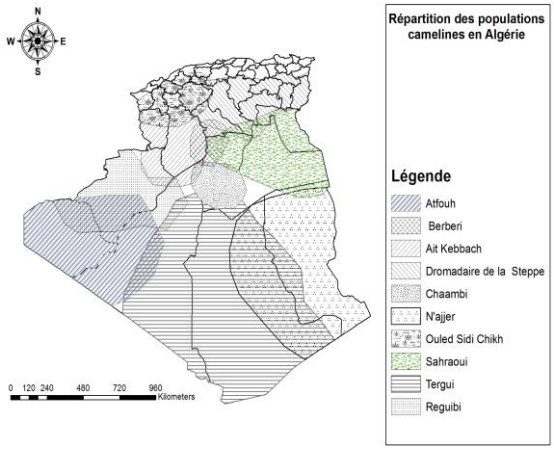


Figure 6: distribution of camel populations in Algeria.

The statistical parameters (mean and standard deviation) of each variable are presented in Table 18. A large inters and intra variability is found in a 95% confidence interval. The first indicator of this variability is the extent that is important among the four (4) populations studied (Table 8).

Table 8: Descriptive statistics of the quantitative variables of 4 camel populations in Algeria (Harek, 2015).

Variables	Reguibi population	Sahraoui population	Tergui population	C. Steppe population
HP	110,55 ± 6,64	111,72±8,5	115,91±2,91*	106,28±10,2
HG	185,43 ± 14.0	175,06±14,1	187,30±10,2*	170,50±18,7
Hge	57,74 ± 3,4	57,09±2,5	58,35±1,7*	53,44±3,5
Hbo	197,42 ± 15,2*	195,81±3,8	183,17±18,4	183,17±10,3
Hba	177,74 ± 8,8	175,56±9,1	182,30±6,5	168,22±6,7*
HCr	151,44 ± 9.0	150,31±8,7	157,04±6,5*	141,28±9,8
LCp	155,51 ± 10.6	155,75±8,3	162,26±8,0*	148,00±10,9
LTr	90,59 ± 7,6	92,25±7,1	92,48±6,7*	88,22±6,6
Lba	39,22 ± 2,8	39,56±3,8	39,78±2,4*	37,11±3,4
Lte	58,49 ± 4,3	58,00±2,9	60,09±2,6*	55,22±6,1
LO	11,22 ± 1,2	12,06±0,9*	11,13±1,2	10,83±0,9
Lco	126,49 ± 10,6	133,31±5,3*	125,48±11,3	125,78 ±7,8
LQ	61,02 ±5,2	64,94±6,0*	60,04±4,9	59,33 ±4,9
LGi	32,87 ±2,4	34,75±2,5*	32,91±1,7	30,00 ±3,0
LCh	32,20 ±3,9	32,88±4,6*	31,26±3,6	28,67 ±4,6
LTra	20,21 ±2,5	20,44±2,1*	19,35±2,9	19,33 ±2,0
PP	56,61 ±4,2	56,63±3,1	58,39±3,4*	52,67 ±3,1
Tbo	237,38 ±19.6	236,75±16,3	243,78±20,8*	227,67 ±15,6
TP	194,69 ±16,5*	190,31±7,8	190,67±12,7	179,44 ±11.4
TSt	204,98 ±11,2*	208,88±10,0	204,74±12,9	195,00 ±11,7
TCa	24,93 ±2,4*	23,69±3,1	23,91±2,9	23,67 ±2,2
Tcou	65,70 ±4,5	67,13±4,2	68,22±2,2*	63,44 ±4,8
TVB	180,25 ±17,4	181,25±12,3	186,83±9,2*	175,22 ±20,8
DT	2,93 ± 0,6	3,86± 1,2	3,05± 0,4*	2,83 ± 0,5
DDT	6,71 ± 3,7	11,14± 2,6*	10,5± 1,2	7,33 ±3,4
QL/j	6 ± 1,4	6,86 ± 1,2	6,35 ± 0,6	7,33 ± 1,7*
Pds	356,94±66,2*	320,46±40,6	353,77±36,8	284,94±55,7

The representation of the dendrogram shows that the most important classes are the Motioned in (*) for the 4 populations studied, and demonstrates the variability for certain variables in the absence of indicators characterizing the dromedary morphometry (Figure 7).

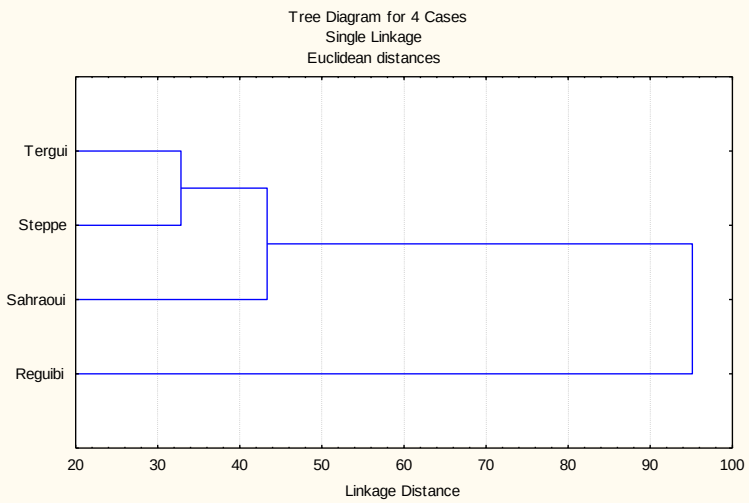
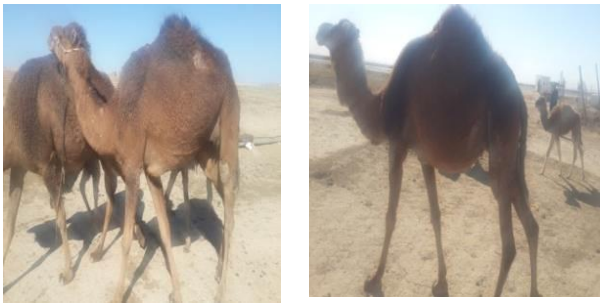


Figure 7: Dendrogram classification of 4 Algerians population (Harek, 2015)

3.2.1 Dromadaires de la steppe :

It is a common endangered breed that is found in the deep Sahara and the steppe, the body is small it is mainly used for transportation. The girth is small with little musculature. The coat of this breed is of good quality. (Figure 8).



Photos of Dromedary of the Steppe (Harek, 2016)

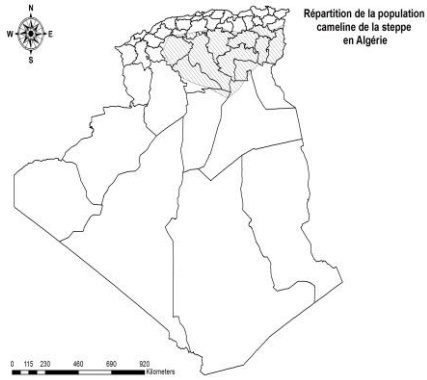


Figure 8: Distribution of the Dromedary of the Steppe population in Algeria

3.2.2 Ould Sid cheikh

The animals are of medium body-size (around 1.8 m), robust, a dark-colored coat with mid-hair, highly crossbred to the Arab dromedary. Well adapted to be riding on capable of walking on sand and rocks. It is found in the northern plateau of the grand western erg (to South of Oran). Breeders'are replacing this breed by the Sahraoui an (Figure 9).

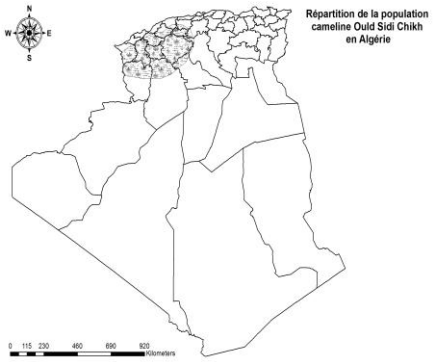


Figure 9: Distribution of Ould Sidi Cheikh camel population in Algeria.

3.2.3 Chaâmbi

A medial, muscular animal with a large musculature and a strong skeleton, it is characterized by various variations in size and coat. its height at the shoulder can reach 1.65m, the individuals of this population are very good saddle animals and transport, they are spread like the best compared to others concerning the production of meat, but generally the hairs are short It is a strongly crossed breed with Arab dromedary blood. It is used for dual purpose (building and saddle) and is rumored the great Western erg in Grand Erg Oriental (favorite place: Metlili Chaâmba (figure 10).

Photos of Chaâmbi population (Harek, 2010)

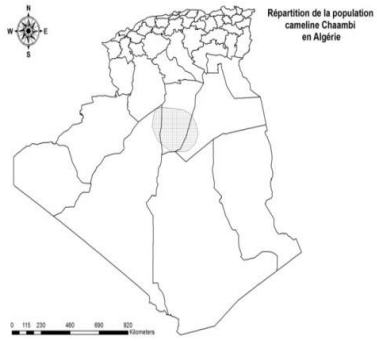
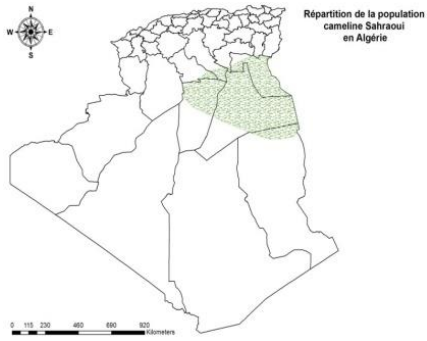


Figure 10: répartition de la population cameline Chaâmbi en Algérie.

3.2.4 Sahraoui

The body size and width are medium (around 1.9 m tall**) (Oulad Belkhir A, Chehma A. and Faye B. 2013).**The coat is dark and mid-haired (sometimes short-haired and curly). It is the breeding result of the Châambi with Ouled Sidi Cheikh. It is an excellent méhari used by the military to control the borders, living in western grand erg and the center of the Sahara (Figure 11).



Photos of Sahraoui population (Harek, 2012)

(Babelhadj Baaissa, 2016)

Figure 11: Distribution of Sahraoui camel population in Algeria.

3.2.5 Ait khebbach

It is strong stocky animal, with a medium body-size and well-developed muscles. The coat is dark and the hair is short. It is found in the South-Ouest of the country (Figure 12).

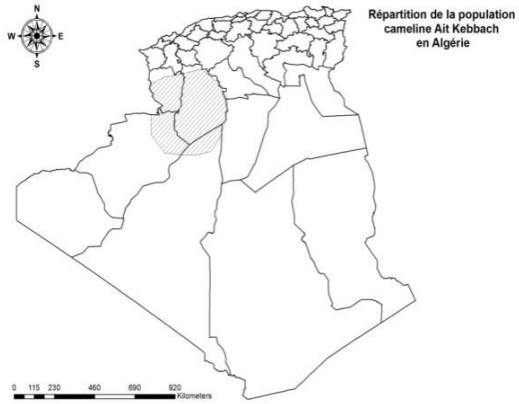


Figure 12: Distribution of the camel population Ait Kebbach in Algeria.

3.2.6 Reguibi

Used to ride on, thanks to its medium body-size, and for milk production because of its relatedness to the breed Ould Sidi Chikh; its range of distribution is limited to the Northern Sahara (Bechar, Tindouf).According to Boue (1946) et (1948), the convergence of the 2 main caravans' movements, the northern-Saharan and the southern-Saharan, after they have travelled throughout Africa, has resulted in the appearance of such a good-quality breed (figure 13).

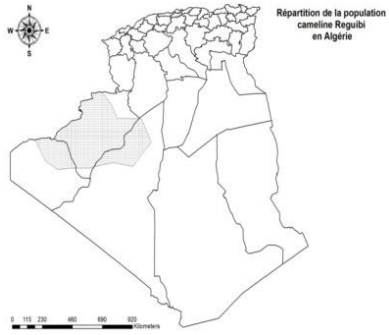


Photo of Reguibi population (Harek, 2008)

Figure 13: distribution of the Reguibi camel population in Algeria.

3.2.7 berbari

The animal is rather fine, looking like the Châambi and Ouled Sidi Cheikh with a less heavy body. It can be found in the south-western Sahara as well as the steppe, precisely in the contact zone between the Sahara and the tellian region (Figure 14).

Photos of berbari population (Harek, 2010)

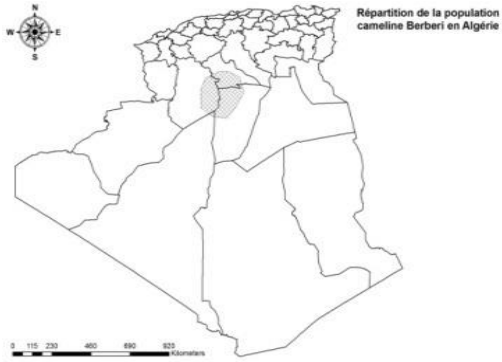


Figure 14: Distribution of the Camels Berbari population in Algeria.

3.2.8 Tergui (Northern Touareg Breed)

The animals are used to rude road conditions of the Tassilli and the Central Massif of Hoggar. They are good runners, pretty tall (more than 2 m) with fine and muscly members. The hump is relatively small. The tail is small and the sole is fine. The coat is fair or dotted, the hair is short and the skin is thin. The males are largely used for repoduction. This breed is found mainly round the Hoggar and in the central Sahara (Figure 15).

Photos: Tergui (Amelal) Tergui (Azerghaf)

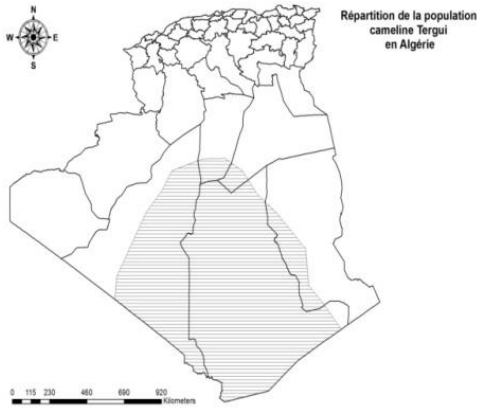


Figure 15: Distribution of the Camelin Tergui population in Algeria.

The results obtained make it possible to confirm the existence of a large diversity genetically on the plan phenotypically. Variation occurs for all traits studied as a continuous range of phenotypes rather than a series of distinct phenotypic classes; the variation is therefore quantitative and qualitative. Similarly, these results provide ample information on the structure of the "Tergui" camel population, which is made up of three "twig" subpopulations: Mahri (66.731%), Marouki (30.385%) and Azerghaf (2.885%), which are in turn subdivided into phenotypes (ecotypes) composed of: Amelal, Abahou representing the

"race" Mahri, Atelagh and Alemlagh representing the Marouki and finally the Azerghaf representing the "race" Azerghaf. These observations are confirmed by the PCA and CAH is also corroborate, the results recorded by Longo-Hammouda *et al.* (2011) and Harek (2008) (Figure 16).

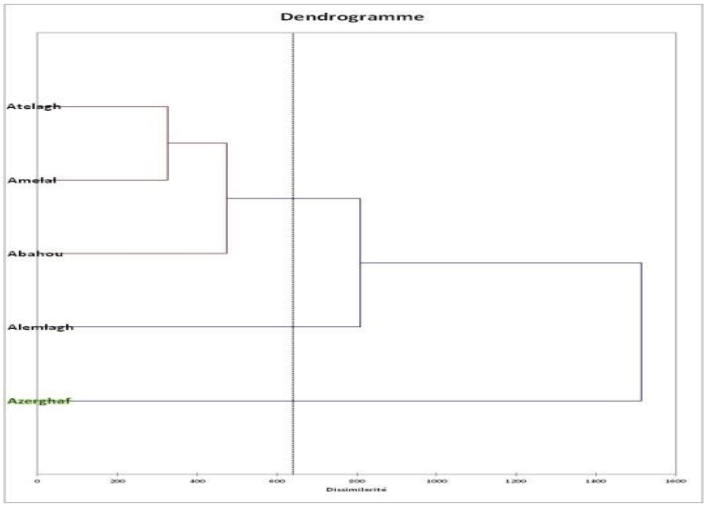


Figure 16. Dendrogram classification of 5 Algerians population

The usefulness of microsatellite markers to estimate the genetic variability within and among closely related breeds has been documented for many studies in the field of preserving biodiversity of indigenous species an unprecedented study using molecular markers to characterize five Algerian Tergui camel breeds. All Tergui ecotypes (Abahou, Amelal, Alemlagh, Atelagh, and Azerghaf) had high heterozygosity values (0.62, 0.63, 0.62, 0.59, and 0.62, respectively); these values are comparable to those observed in the Tunisian dromedary populations (Ould Ahmed *et al.*, 2010). Genetic differentiation values among the population analyzed were much lower and the level of differences explained 1.1% of the total genetic variation.

The genetic similarity between the Tergui populations was further illustrated using a genetic distance approach with based on genetic relationships gave similar results. The neighbor-joining 3 (DR) showed a clear subdivision of the breeds into tree main groups divided each in subgroups, and Azerghaf population was more closely related to Abahou- Amelal group than the Alemlagh-Atelagh group (Figure 17). Our estimates for the indigenous population relationship are similar to one reported by Harek (2008) where it has been pointed out using phenotypic characteristics (color). These results could be explained by common ancestors and that there is extensive gene flow between the 5 Tergui's ecotypes.

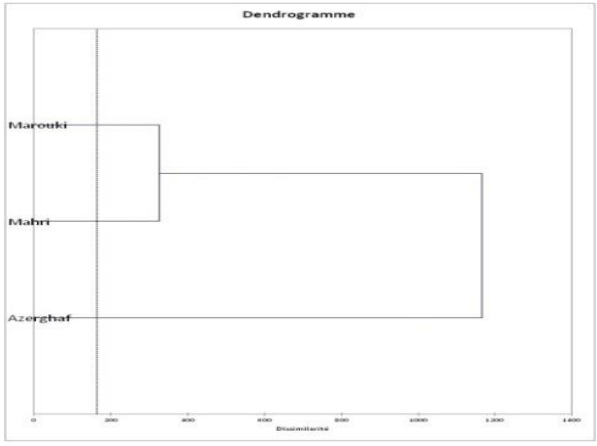


Figure 16: Classification dendrogram of Tergui population (Harek, 2017).

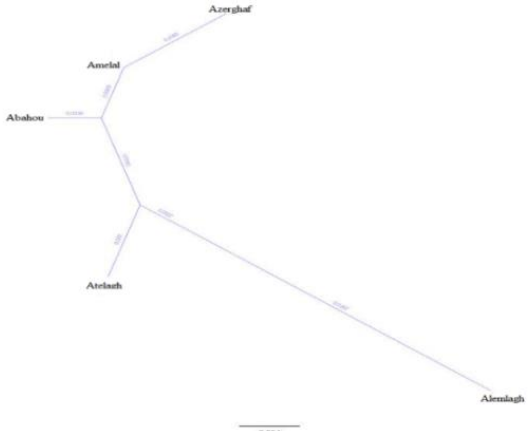


Figure 17: Neighbor-Joining Tree based on Reynolds distance for the five phenotypes studied. The numbers on the branches represent the percentages obtained with 1000 bootstraps (Harek, 2017).

3.2.9 Ajjer

The animal is short, well adapted to riding, often used for transportation and tourism. The breed is scattered around the Tassili N'Ajjer. The general scheme from east to west, according to Boue (1946), shows that there are perturbation transversal streams with the Soudani breed from Soudan to Egypt and Libya while in the opposite direction, the breed Tibesti, related to the breed Ajjer, has its origins in the North of Libya (figure 18).

2.10 Aftouh dromadary

It is appreciated of its meat. The origin of the breed called Aftouh is not clearly defined. It genetically derives from Reguibi because of their close morphology despite the Aftouh being more massive. The two breeds live in the same area but the locals'prefer Aftouh to travel (Messaoudi, 1999). Its expansion range is limited to Reguibet (Tindouf and Bechar) and to the Western Sahara and Mauritania (Figure 19).

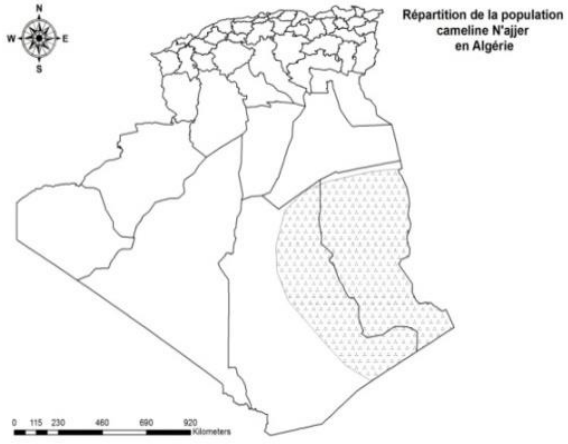


Figure 18: Distribution of N'Ajjer population in Algeria.


Photos Aftouh Dromedary (Harek, 2011)

Photo: Aftouh Dromedary (CIRAD, 2001)

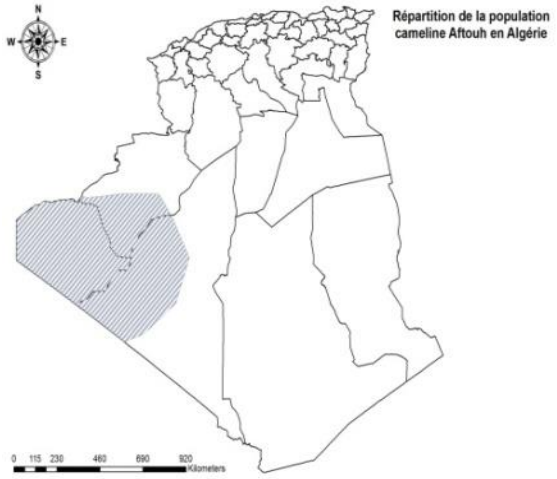


Figure 19: Distribution of Aftouh population in Algeria.

Conclusion

In Algeria, the dromedary populations and their genetic variability are important yet not well documented. The first studies report the names of the breeds according to the tribes they belong to rather than the phenotypic and productive features. From one region to another, the breeds and the populations are very different due to the geographic and bioclimatic conditions. It is interesting to study the impact of the mode of breeding on the genetic variability under different environments. The identification of the genotypes adapted to different conditions (food availability, heat-resistance, etc.) as well as the analysis of the phenotypic features will help to establish a valuable database. Such information would contribute positively to a better usage and the promotion of the dromedary resource.

It is challenging to conserve the genetic diversity through the preservation of the populations within their range of distribution. Our view is based on the fact that even though the breeds genetically related, they are deeply influenced by the local mechanisms of adaptation, extinction and recolonization. Under the arid climate, the populations are supposed to form an open and wide breeding system that would allow a high gene-flow. For the dromedary, the relationships between the gene-flow and the continuous movements of the livestock are particularly important to the species conservation. The high diversity in habitats in Algeria, from the steppe to the Sahara and the isolated ecosystems, has resulted in a high genetic diversity for the dromedary. Our study has allowed determining if the isolation due to the distance and the weak gene-flow between populations are the origin of the genetic differences between the existing breeds. It has also helped determine a common genetic structure, independently from the aire of distribution or localities of the breeds. Keeping the dromedary in Algeria remains a traditional activity away from the scientific progress. The number of individuals is decreasing as the distribution range. Attempts to promote the sector have been undertaken these last years in order to enhance the breeding systems thanks to the use of concentrated food, early weaning, the use of artificial milk to feed the young individuals and sometimes the use of veterinary products (Cherifi *et al.,* 2013).

The dromedary breeds are closer to natural unselected populations. The breeders have interfered very a little in the enhancement of the genetic potential of the populations they keep. This preliminary study has allowed establishing a set of valuable elements that can be used in the morphological

characterization as a milestone for the upcoming studies. At the genomic scale, the vaste range of distribution of the dromedary and the way the reproduction is lead within a population using almost the same blood suppose that the species is suffering a genetic drift made worse by the inbreeding. Authors have tried to draw a standard of classification using some descriptors for the Algerian breeds. This study confirms the conclusion of a previous study (Cherifi *et al.*, 2013) that clearly shows the major role of the ethnic characterization of the dromedary in the process of establishing a valid standard to its classification. Data available can be completed by a molecular approach.The inventory of the Algerian dromedary breeds let us conclude to an important diversity of breeds and ecotypes; this is related to the diversity of breeding systems and the nature of their goals.

These breeds are hardly known and the exact livestock is not well estimated. The existing ecotypes are adapting to ever changing breeding systems under the influence of the market and the demand for food (meat and milk) in combination to the demographic component. It is therefore crucial to characterize the breeds for a better choice to a better livestock management and a more intensive well-thought production system. The study has shown that these ecotypes belong to a same population with a great genetic diversity. The high values of heterozygosity, effective number of alleles and the great diversity allow saying that it is possible to enhance the dromedary resource. The future development plans are to consider the social and cultural aspects around the dromedary as well the breeders' habits in order to sustainably preserve this resource.

Through this study, the first dromedary DNA database is created; it contains 200 samples from unrelated individuals scattered across the range of distribution of the dromedary in Algeria. Upcoming studies will be using molecular makers that will help clarify the genetic status of the populations and the relationships between the ecotypes. All these studies have the same goal, which is the conservation and the sustainable management of the dromedary resource.

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