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ANIMAL SCIENCE

Phenotypic variability of two principal Algerian camel's populations (Targui and Sahraoui)

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Abstract

The camel population and its phenotype variability are not well described in Algeria. The studies at the colonial period were based primarily on a nomenclature associated with the names of tribes rather than the measurement of phenotypic parameters. The present study aimed to define the discriminating parameters of the two main populations described in Algeria, namely the Sahraoui and the Targui breed. An initial analysis was achieved for each population (95 Targui and 95 Sahraoui) to demonstrate an internal variability in each group that includes two to three subpopulations. A second analysis was focused on two populations combined. From the measurements of 190 adult animals, attached to one or the other population, a canonical discriminant analysis was applied to determine the most discriminant parameters, (abdominal circumference, chest circumference, height at withers and turn spiral) and to evaluate the percentage of classified assets. These four parameters were sufficient to distinguish the two populations with 98.5% camels well classified. For each of the populations and subpopulations, standard body measurements are proposed.

Key words: Algeria, Body measurements, Discriminant analysis, Dromedary, Phenotype

Introduction

In Algeria, the Sahara covers more than 85% of the total area. The dromedary is the only species capable to valorize this desert ecosystem (Chehma et al., 2008). The total number of the camels is estimated by the Ministry of Agriculture in 2010 to more than 300000 heads. Algerian camel populations are poorly described and the only indications were based on studies performed at the colonial period (Cauvet, 1925; Boué, 1946; 1948). In fact, the nomenclature of these populations was more related to the names of tribes who breed them (Chambi, Targui, Reguibi) than a distinction based on phenotypic characteristics.

Across the world, there were some reports done on the phenotypic diversity of camel populations, like those of Ishag et al. (2011) in Sudan, Faye et al. (2011) and Abdallah and Faye (2012) in Saudi Arabia.

Moreover, the two main tribes known for camel breeding in Algeria were the Chaamba in the northern Sahara and the Touareg in the central Sahara, breedingcamels type Sahraoui and Targui respectively (Ben Aissa, 1988; Oulad Belkhir 2008).

Thus, our study aimed to identify the principal phenotypic characteristics of these two camel populations (Sahraoui and Targui) the most dominant in Algeria in order to report the eventual variability between and within populations.

Materials and Methods

Study area

Our field investigations mainly involved two large Saharan regions known for the camel breeding in Algeria, which are: the Ouargla region (North-Western Sahara) and the region of Tamanrasset (Central Sahara).

Animals

The study of the two populations, Sahraoui and Targui, was focused on adult animals. The appreciation of their age was made on the basis of dentition. Therefore, 95 individus (males and females) were studied for each population and each region.

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Measurements

On each animal, twelve (12) measurements were performed according to standard techniques (Marmet, 1983; Pagot, 1985; Delaine Pagot, 1959), via a meter-ribbon, with the exception of the height at withers which was performed with toise. The different measurements performed on the animals were abdominal circumference (AC), heart girth (HG), the height at withers (HW), turn spiral (TS), the length of the head (LH), length of the neck (LN), the height at the hump (HH) and the length of the hind limbs (LHL).

Statistical analyses

Statistical analyzes included two stages, (i) an analysis of internal variability in each population (Sahraoui and Targui) and (ii) a comparative analysis to determine the variability between populations.

The analysis of internal variability included:

The description of the mean and standard deviation for each of the body measurements,

- The correlations between different body measurements for each population (Pearson correlation),

- Automatic classification of each population to identify homogeneous sub-populations (hierarchial ascending classification),

The analysis of the variability between populations consisted of:

Identifying the differences between body measurements (ANOVA).

Identifying the most discriminating body measurements for both populations (method of stepwise discriminant analysis) and determine the percentage of well classified according the parameters retained by the discriminating model

Performing an automatic classification of all two populations (k-means method).

Establishing a contingency table between population (Targui or Sahraoui) and classes from the previous step and test the independence between population and classes by the Chi² test.

These analyzes were performed using the software XLStat (Addinsoft ©).

Results and Discussion

Differences in the body measurements between camel populations

Wither height, abdominal circumference length of the head and neck were significantly greater in the Targui compared to Sahraoui (Table 1).

Table 1. Mean ± standard deviation of body measurements of camel populations Sahraoui and Targui (in cm).

	Sahraoui	Targui
HW	1,781 ± 0,119 [a]	1,922 ± 0,187 [b]
HG	1,901 ± 0,248 [a]	1,815 ± 0,223 [a]
AC	1,638 ± 0,199 [a]	2,200 ± 0,258 [b]
HH	2,386 ± 0,271 [a]	2,140 ± 0,200 [a]
TS	2,285 ± 0,238 [a]	2,286 ± 0,302 [a]
LHL	1,745 ± 0,165 [a]	1,977 ± 0,265 [a]
LN	1,028 ± 0,106 [a]	1,092 ± 0,126 [b]
LH	0,500 ± 0,047 [a]	0,521 ± 0,051 [b]

a, b: the difference of letters on a line attests to a significant difference at P <0.05

Table 2. Correlation matrix between the measurements in each population camel. The characters in bold are significant at P <0.05.

Sahraoui	HG	CT	CA	HB	TS	LMP	LC	LT
HG	**1**	**0,333**	**0,433**	**0,267**	**0,597**	**0,717**	**0,394**	**0,483**
CT	**0,333**	**1**	**0,599**	**0,672**	**0,517**	-0,056	**0,457**	-0,003
CA	**0,433**	**0,599**	**1**	**0,676**	**0,487**	0,202	**0,512**	0,113
HB	**0,267**	**0,672**	**0,676**	**1**	**0,583**	-0,024	**0,375**	0,016
TS	**0,597**	**0,517**	**0,487**	**0,583**	**1**	**0,451**	**0,344**	**0,311**
LMP	**0,717**	-0,056	0,202	-0,024	**0,451**	**1**	0,176	**0,519**
LC	**0,394**	**0,457**	**0,512**	**0,375**	**0,344**	0,176	**1**	**0,293**
LT	**0,483**	-0,003	0,113	0,016	**0,311**	**0,519**	**0,293**	**1**
Targui	HG	CT	CA	HB	TS	LMP	LC	LT
HG	**1**	**0,736**	**0,642**	**0,792**	**0,584**	**0,332**	**0,571**	**0,623**
CT	**0,736**	**1**	**0,812**	**0,737**	**0,698**	**0,404**	**0,653**	**0,693**
CA	**0,792**	**0,737**	**1**	**0,782**	**0,720**	**0,452**	**0,632**	**0,664**
HB	**0,642**	**0,812**	**0,782**	**1**	**0,645**	**0,315**	**0,600**	**0,612**
TS	**0,332**	**0,404**	**0,315**	**0,452**	**1**	**0,596**	**0,539**	**0,497**
LMP	**0,584**	**0,698**	**0,645**	**0,720**	**0,596**	**1**	**0,692**	**0,658**
LC	**0,623**	**0,693**	**0,612**	**0,632**	**0,692**	**0,539**	**1**	**0,683**
LT	**0,571**	**0,653**	**0,600**	**0,664**	**0,658**	**0,497**	**0,683**	**1**

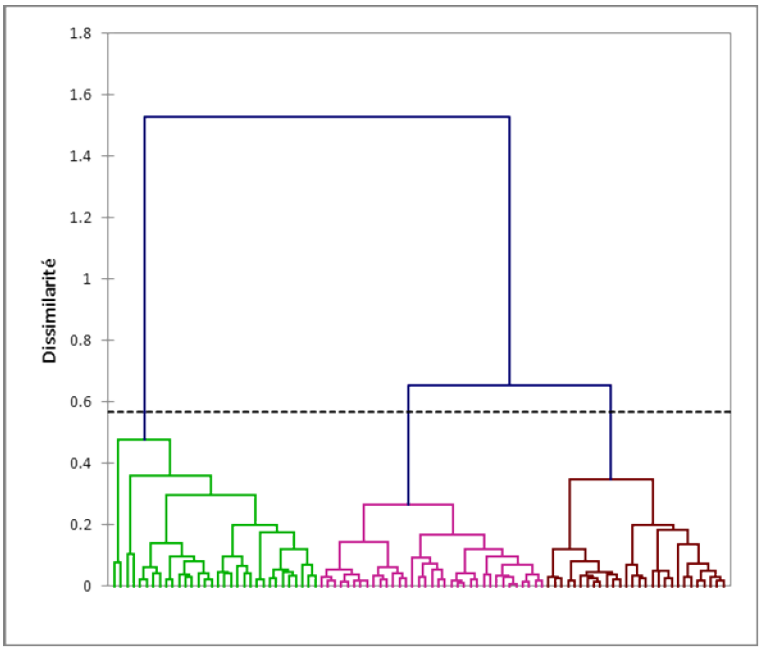

Figure 1. Hierarchical clustering of Saharaoui's dromedary based on their measurements.

Table 3. Mean body measurements of different classes of the Sahraoui population.

classe	HW	HG	AC	TS	LN	LH
A	1,799 [a]	1,675 [a]	1,480 [a]	2,267 [a]	0,973 [a]	0,522 [a]
B	1,770 [a]	1,980 [b]	1,730 [b]	2,169 [a]	1,060 [b]	0,495 [b]
C	1,773 [a]	2,060 [b]	1,704 [b]	2,453 [b]	1,052 [b]	0,480 [b]

a, b: the difference of letters on a line attests to a significant difference at P <0.05

Correlations between the measurements

The correlations were generally positively significant between different measurements of the animal in the two populations, but more significantly in the Targui population which had, therefore, a better proportionality in its measurements (Table 2). The height at the withers and the spiral turn measurements appeared more correlated to the other measurements.

Classification of the Sahraoui population

The hierarchical classification of the body measurements performed on the Sahraoui population has identified a clear partition in 3 different classes expressing 71.4% of the variance (Figure 1).

The three Sahraoui subpopulations could be described as follows (Table 3):

- A group of 32 animals rather narrow but with a lower thoracic and abdominal circumference and a longer neck
- A group of 35 animals rather large but with a higher thoracic and abdominal circumference and a shorter neck
- A group of 28 dromedaries to raise spiral turn, a large chest circumference but with a small head.

Classification of the Targui population

The hierarchial classification of body measurements performed on the Touareg population identified a partition in 3 classes also clearly distinct and expressing 64.9% of the variance (Figure 2).

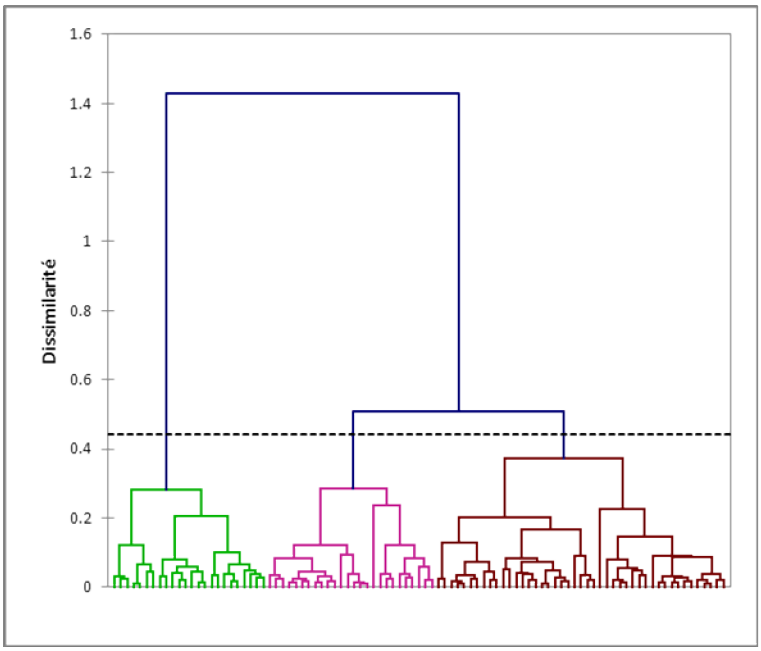

Figure 2. Hierarchical clustering of Targui's dromedary on the basis of their measurements

Table 4. Mean measurement of the different classes of the population Targui.

Classe	HW	HG	AC	TS	LN	LH
A	1,965[a]	1,980[a]	2,374[a]	2,526[a]	1,103[a]	0,542[a]
B	1,990[a]	1,840[b]	2,189[b]	2,302[b]	1,123[a]	0,545[a]
C	1,980[a]	1,916[b]	2,346[a]	1,996[c]	1,020[b]	0,519[b]

a,b,c the difference of letters on a line attests to a significant difference at P <0.05

The analysis of variance applied to the three sub-populations indicates that they are distinguished as follows:

- A population of 26 camels of large size (HG, AC, TS, LN, LH large size),
- A population consisting of 45 animals with a long neck and long head but thoracic and abdominal circumferences less developed.
- A group of 24 dromedaries characterized by low turn spiral, a small head and neck of modest size. The thoracic and abdominal circumferences appeared intermediate.

Parameters discriminating the 2 populations

The stepwise discriminant analysis identified the measures in order of importance in their discriminating power. In order, the most discriminant variables were: the abdomen circumference, the circumference of the chest, shoulder height and turn spiral. The addition of other measurements didn't improve the discriminating power. These four parameters were sufficient to distinguish the two populations with 98.5% of well-classified animals. The percentage of well-classified was identical in the two populations.

Confusion matrix

In the last step, it was conducted a global analysis of the whole camel population (190 dromedaries) by the method of k-means which classified individuals according to a random number of classes. The result gave five morphological types (classes of measurements) which were faced to the two populations Targui and Sahraoui. This global analysis confirmed the strong phenotypic dichotomy since the classes 1 and 2 respectively comprised 100 and 98.7% of Sahraoui camels population, and Class 3, 4 and 5 respectively congregating 95.6, 96.1 and 100% of Targui camel population (Figure 3).

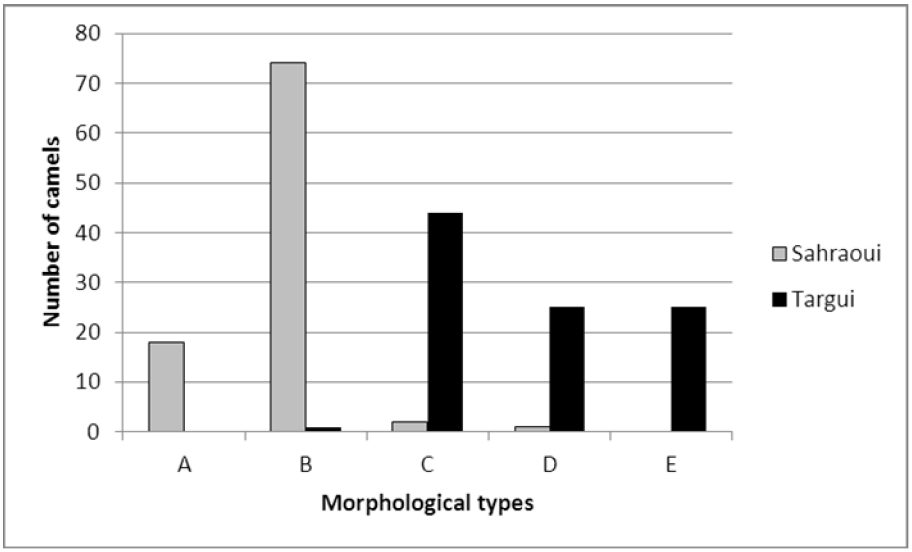

Figure 3. Distribution of morphological types among the camel populations Targui and Sahraoui.

These morphological types showed the following characteristics (Table 5):

- Type A: small morphology for all measurements
- Type B: the larger, medium-sized animals, with high thoracic perimeter, and low abdominal circumference and small head,
- Type C: large animal morphology for all dimensions,
- Type D: average size of animals with long neck and well-developed head,
- Type E: larger animals differing from the previous type by its thoracic and abdominal perimeters stronger but a spiral turn smaller

It appears from these results a clear phenotypic difference between Sahraoui and Targui populations. The first appearing smaller, skinny but relatively long (the spiral turn appears relatively long in some individuals) with a smaller head and a neck less developed (photo 1), the opposite of the Targui with larger dimensions (photo 2).

Discussion

The coat color parameter, whitish in the Targui population, brown to dark brown in the Sahraoui, is not the only discriminating character. Our results based on measurements only, showed morphologies very well-marked to classify over 98% of animals solely on the criteria of thoracic perimeter, abdominal perimeter, spiral turn and height at the withers. However, our results also showed that through phenotypic body measurements, the two studied populations (Sahraoui and Targui) were not homogeneous and morphological subpopulations for each of them were existing and were relatively distinct. This can be explained by the fact that these two populations have been named on the basis of their tribal affiliation and not on phenotypic parameters.

Table 5. Mean measurements in the different classes of the Algerian camel population (m).

	nb	HW	HG	AC	TS	LN	LH
typeA	18	1,670^{d}	1,543^{d}	1,367^{d}	2,010^{c}	0,906^{d}	0,493^{c}
typeB	75	1,801^{c}	1,992^{a}	1,691^{c}	2,325^{b}	1,057^{b,c}	0,499^{c}
typeC	46	2,031^{a}	1,981^{a}	2,367^{a}	2,511^{a}	1,132^{a}	0,548^{a}
typeD	26	1,911^{b}	1,761^{c}	2,080^{b}	2,265^{b}	1,086^{b}	0,539^{a,b}
typeE	25	1,964^{b}	1,871^{b}	2,313^{a}	1,976^{c}	1,022^{c}	0,518^{b}

a,b,c,d : the difference of letters on a line attests to a significant difference at P <0.05

Photo 1. Dromedary of population Sahraoui.

Photo 2. Dromedary of population Targui.

These subpopulations may also be associated to a set of dietary practices, themselves related to the quality of rangeland whose influence on morphological development of animals was widely noted. Based on discriminant analysis of two populations, it appeared that the discriminating variables were especially those related to height (height at the withers) and the circumference of the body (abdominal circumference, chest circumference, and spiral turn). In fact, the Targui population is recognized as an animal higher and used especially as racing animal (especially animals with high thoracic perimeter and low abdominal perimeter) and riding, contrary to Sahraoui which is an animal rather more robust and heavier, used for packing and meat production (Ben Aissa, 1988; Oulad Belkhir, 2008).

However, this differentiation is therefore based on usage rather than on a reasoned selection scheme piloted by farmers. The relationship between morphology and a set of performances (production, growth, reproduction) obviously deserves to be deepened. Current studies based on tools of molecular genetics, should confirm or refute these results in order to clarify whether the observed phenotypic differences were based on genetically distinct populations, which, according to the preliminary results did not appear to be different (Burger, personal communication).

Conclusion

This work is a small contribution to the knowledge of the phenotypic variability of the two principal camel populations in Algeria. The results reported the existence of subpopulations even within each population. And the discriminant analysis direct us to the parameters related to the uses of these two populations. However, for further refining this study, it is necessary to consider the performance characteristics (meat production, milk productivity and numerical productivity), with the perspective to lead to a kind of standards Algerian camel races.

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