Original Research Paper

MORPHOMETRIC CHARACTERIZATION AND TYPOLOGY OF DONKEY FARMING (EQUUS ASINUS) IN THE WILAYA OF TLEMCEN

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Abstract

Due to the absence of the ethnic data and studies of racial characterizations of this species in Algeria, which is an endangered species, we contributed to the phenotypical study of donkey population in the area of Tlemcen. A manpower of 61 adult asses, distributed on the level of two areas from where 11 body measurements and 06 phenotypical characters were retained for this study. Measurements LTC, HG, TP, LH, LE, PC, LoT, LoO, LQ, LaT and TM are respectively of 157,26±12,88; 116,16±7,23; 124,26±7,03; 37,15±3,21; 27,07±3,27; 17,50±1,86; 52,39±4,06; 30,15±2,19; 41,42±5,76; 23,01±2,06 and 46,24±4,16cm. the sex does not present any significant effect on studied body measurements (p>0,05). A factorial analysis of the multiple correspondences was carried out on the phenotypical characteristics, and it revealed two principal components which constitute 47,62% and 41,39% of total inertia, percentages respectively related to the color of the dress, the head, the members, the hairs, the muzzle and the belly .This analysis made it possible to establish remarkable phenotypical differences which have implications to take into account in the program of characterization and conservation of the species.

Key words: Donkey, Populations, Body measurements, Phenotype, Characterization, Algeria.

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Introduction

Livestock have been an essential part of agricultural production systems, particularly important in adverse environments where crops are difficult if not impossible. For breeders, the genetic zoo diversity represents a resource to draw on to select animals and develop new breeds. More broadly, genetically

diverse livestock populations provide society with a wider range of options to meet the challenges of the future.

At that time, the man has stopped living from hunting and gathering by moving towards the Asine species is de 43553894 head in 2016 (FAO, 2016), it is an endangered species in Algeria following the development of mechanization and the introduction of technology, after the 20th century, hence the ignorance of the importance of this animal. It has been used in the cities as a means of transport; it carries all the small building materials, such as building stones, bricks, tiles, lime, sand, cuttings, embankments, garbage.

Our study consists in phenotypically and morphologically characterizing the donkey population in the Tlemcen region using body measurements and phenotypic characters. This step is a very important prerequisite to then commit to a program of management and improvement of this resource.

Materials and methods

Study zone

Our study was conducted at the level of the wilaya of tlemcen in two different regions (souani and benkrama) during the spring 2016 period. These two regions are situated in the extreme west of the wilaya at the algerian-moroccan borders.

Table 1. Climate presentation of study areas (https://fr.climate-data.org)

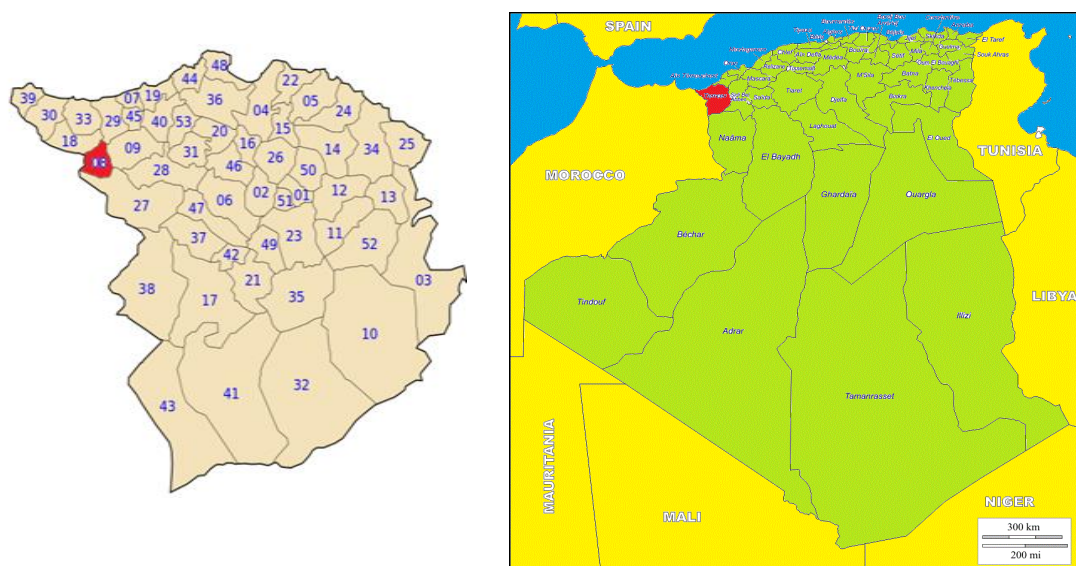|	Benkrama	Souani
Altitude	337 m	506 m
Climate	steppe	steppe
average annual temperature	16.6 °C	15.8 °C
Average annual precipitation	363 mm	365 mm

Figure 1. Representation of the study regions in relation to the national map (on the right) and the Tlemcen map (on the left)

Choice of animals

Our work was based on the study of the morphological characters of 61 donkeys distributed in the wilaya of Tlemcen. The numbers grouped by sex and number by region are shown in Table 2

Table 2. Distribution of the study population by region and sex

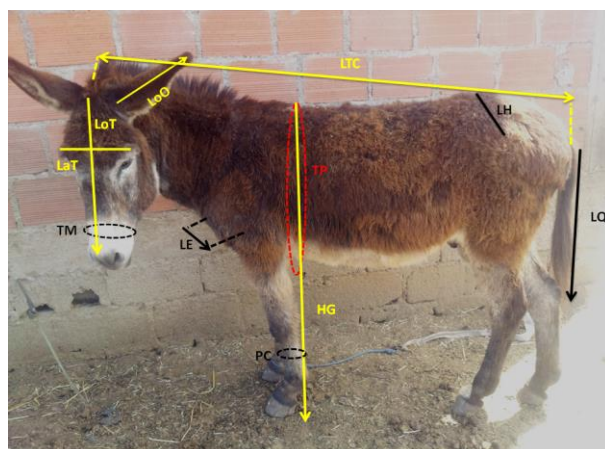| Région	males	females	total	% of males
Souani	2	31	33	6.66
Benkrama	28	0	28	93.33
Total	30	31	61	100

Variables studied

Quantitative variables

The different body measurements (Figure 2) were measured by the same operator in the morning, 11 measurements were used for each animal. These measurements carried out for phenotypic characterization are inspired by work on equids around the world (Pearson and Ouassat, 2000, Nicks et al 2006, Boujenane et al., 2008).

Following the absence of the rocker, the live weight of the animals was taken by the nomogram using two formulas according to Svendsen, (1997); Boujenane and Machmoum, (2008); Pearson, and Ouassat., (2000).

$$\mathbf{PV1} = (TP_{(cm)}^{2.575} * HG_{(cm)}^{0.240})/ 3968$$

$$\mathbf{PV2} = TP_{(cm)}^{2.65}/2188$$

Figure 2. The different body measurements performed.

For the realization of the body measurements, the instruments used are the tape measure and a rigid double girder.

Qualitative variables

The qualitative characteristics studied are presented in Table 3

Table 3. Qualitative characteristics that are distributed among the population

Color of the dress	Color of the head	Muzzle color	Member color	Horsehair color	Belly color
Rousse	gray	gray	gray	gray	Grise
Brown	Black	white	Black	Black	Marron
Black	white	Black	white	white	
gray	Brown		Brown	Brown	

Statistical analysis

The descriptive analysis of body measurements was analyzed according to SPSS v 19 software. The effect of sex was compared by Student Newman-Keuls multiple comparison test. Principal component analysis (PCA) was conducted to group homogeneous individuals with the same traits studied based on body measurements to differentiate donkeys according to these criteria, to define a classification of animals, and to construct a typology consisting of: identify individuals that are quite similar to each other.

A multiple correspondence factor analysis (MCA) was used for the qualitative variables to present common qualitative characteristics. Finally, to obtain the optimal number of groups, an ascending hierarchical classification (CHA) was used. These tests were processed by the SPSS software v19.

Results and discussion

Body measurements

Descriptive analysis

The averages, standard deviations, minima, maxima and coefficients of variation of body measurements of donkeys are reported in Table 4

Table 4. Descriptive analysis of body measurements in the study population studied

	Averages	SD	Std Err	CV	Variance	Min	Max
LTC	157,26	12,88	1,65	8,19	165,86	134,00	190,00
HG	116,16	7,23	0,93	6,22	52,28	103,50	144,50
TP	124,26	7,03	0,90	5,65	49,36	109,00	141,00
LH	37,15	3,21	0,41	8,65	10,33	31,50	46,00
LE	27,07	3,27	0,42	12,07	10,67	21,00	35,50
PC	17,50	1,86	0,24	10,63	3,46	14,00	22,50
LoT	52,39	4,06	0,52	7,75	16,48	43,00	60,00
LoO	30,15	2,19	0,28	7,28	4,81	25,00	34,50
LQ	41,42	5,76	0,74	13,90	33,14	31,00	57,00
LaT	23,01	2,06	0,26	8,97	4,26	20,00	30,50
TM	46,24	4,16	0,53	8,99	17,27	36,00	57,00
PV1 (Kg)	196,45	31,15	3,99	15,85	970,06	136,72	273,68
PV2 (Kg)	163,28	24,68	3,16	15,11	608,88	114,59	226,66

(SD) standard deviations ; Overall length of body (LTC), Height with the garrot (HG), Turn of chest (TP), Width with hips (LH), Width with the shoulders (IT), Perimeter of gun (PC), Length of the head (Batch), Length of the ear (LoO), Length of tail (LQ), Width of the head (LaT), Turn of the muzzle (TM)

Variation of variables by gender

The body measurements studied for both sexes in the study population are shown in Table 5. There are no significant differences between the two sexes (p> 0.05).
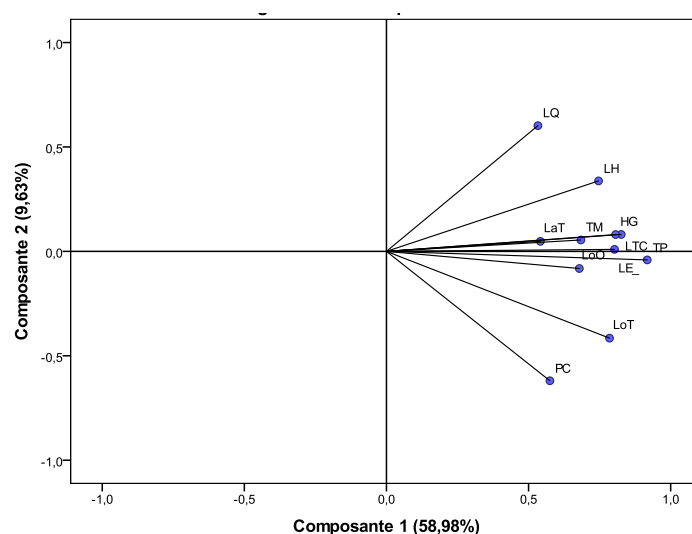
Table 5. Variations in variables by gender

Characters	Male (n=30)	Female (n=31)	*P values*
LTC	155,15±10,77	159,31±14,52	ns
HG	116,45±6,28	115,87±8,14	ns
TP	123,93±5,93	124,58±8,03	ns
LH	36,20±2,39	38,06±3,65	ns
LE	27,20±2,60	26,95±3,85	ns
PC	17,77±1,81	17,24±1,90	ns
LoT	53,15±3,22	51,65±4,67	ns
LoO	30,05±2,26	30,24±2,16	ns
LQ	40,22±5,62	42,58±5,74	ns
LaT	22,53±1,75	23,47±2,26	ns
TM	46,75±3,55	45,74±4,67	ns
PV1 (Kg)	194,78±26,23	198,06±35,63	ns
PV2 (Kg)	161,81±20,80	164,71±28,20	ns

Overall length of body (LTC), Height with the garrot (HG), Turn of chest (TP), Width with hips (LH), Width with the shoulders (IT), Perimeter of gun (PC), Length of the head (Batch), Length of the ear (LoO), Length of tail (LQ), Width of the head (LaT), Turn of the muzzle (TM)

Variation of individuals according to body measurements

Principal component analysis (PCA) was performed on body measurements. The result of this analysis showed that these variables presented 62.61% of the total inertia on both axes, which is relatively average. The analysis of the parameters studied shows that the two axes respectively represent 58.98% and 9.63% of the total inertia. Axis 1 (58.98%): is represented by the following variables: LTC, HG, TP, LH, LE, LoT, LoO, LaT and TM. Axis 2 (9.63%): is represented by the following variables: PC, LQ (Figure 3).

Figure 3. Presentation of Body Measurements by PCA in the Algerian donkeys Population

Principal Component Analysis: PCA (Figure 3) and Hierarchical Ascending Classification (Figure 4) have identified two classes.
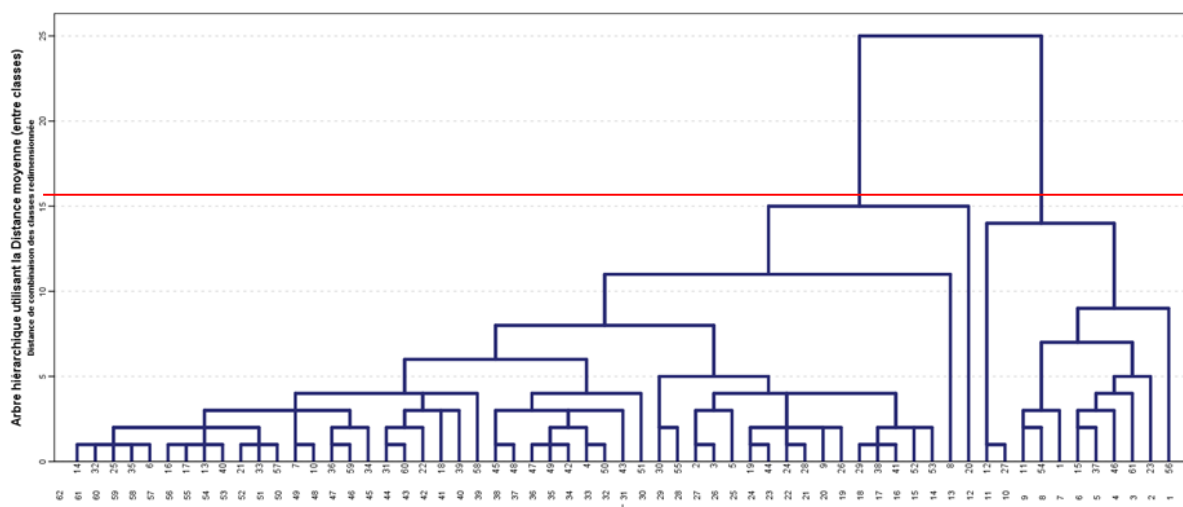
Figure 4: Hierarchical tree using average distance (between classes) among the population
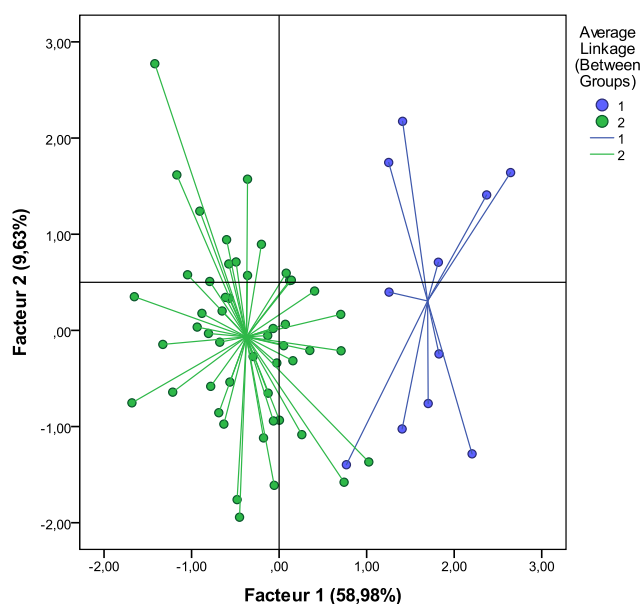

Figure 5. Presentation of individuals from the donkey population by PCA

Class 01: Animals in this class (11 individuals) are longer (177.14 ± 8.26) cm, taller (126.14 ± 8.74) cm and wider (31.18 ± 2.95) cm than animals of the second class. They have a more developed thoracic cavity (135.18 ± 3.39) cm, very long ears (32.50 ± 1.52) cm, a long head (56.77 ± 3.30) cm and wide ($25,09 \pm 1.64$) cm, a large snout (51.23 ± 3.80) cm and a larger pelvis (42.68 ± 2.10 cm). Class 02: The 50 animals of this class make up the majority of the studied population; they have a smaller format than the animals of the first class (Table 6).

Table 6. Classification of donkeys by PCA

	Class 01	**Class 02**
N	11	50
LTC	177,14±8,26	152,89±9,00
HG	126,14±8,74	113,96±4,60
TP	135,18±3,39	121,86±5,04
LH	42,68±2,10	35,93±1,83
LE	31,18±2,95	26,17±2,58
PC	18,91±1,55	17,19±1,79
LoT	56,77±3,30	51,42±3,56
LoO	32,50±1,52	29,63±1,98
LQ	45,73±7,42	40,47±4,93
LaT	25,09±1,64	22,55±1,87
TM	51,23±3,80	45,14±3,37

Overall length of body (LTC), Height with the garrot (HG), Turn of chest (TP), Width with hips (LH), Width with the shoulders (IT), Perimeter of gun (PC), Length of the head (Batch), Length of the ear (LoO), Length of tail (LQ), Width of the head (LaT), Turn of the muzzle (TM)

Phenotypic characters

Descriptive analysis

Table 7. Descriptive analysis of qualitative traits in the study population studied

Qualitative characters		Effective	Percentage
Color of the dress	Russet-red	11	18,0
	Brown	40	65,6
	Black	7	11,5
	Gray	3	4,9
Color of the head	Gray	16	26,2
	Black	12	19,7
	White	3	4,9
	Brown	30	49,2
Muzzle color	Gray	49	80,3
	White	9	14,8
	Black	3	4,9
Member color	Gray	14	23,0
	Black	17	27,9
	White	5	8,2
	Brown	25	41,0
Horsehair color	Gray	3	4,9
	Black	14	23,0
	White	1	1,6
	Brown	43	70,5
Belly color	Gray	52	85,2
	Brown	9	14,8

Variation des individus

The analysis carried out on 61 animals of the donkey population in the wilaya of Tlemcen shows that the first two factorial axes 1 and 2 respectively express 47.62% and 41.39% of the inertia, the total inertia of which is 89.01%. Axis 1 (47.62%) is presented by the following variables: Color of the dress, the head, the limbs and the color of the hair. While the axis 2 (41.39%) is presented by the following variables: Color of the dress, muzzle and belly color (Figure 6).
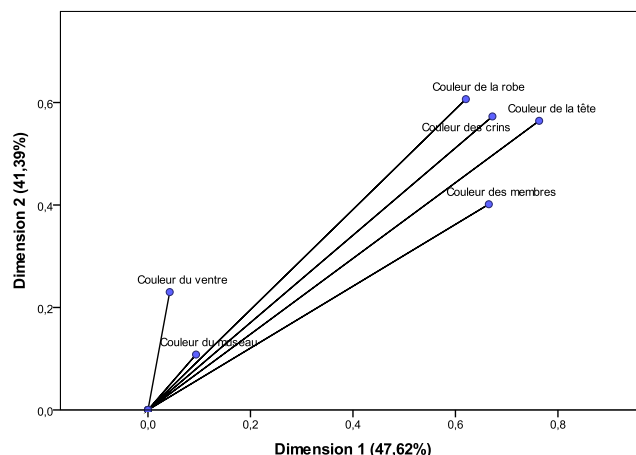

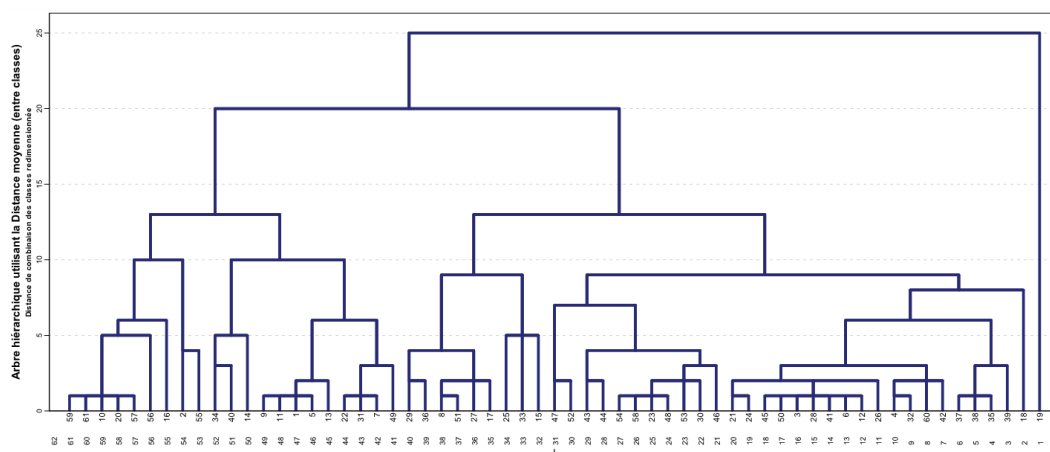**Figure 6.** Graphical Representation of Variables by MCA

Figure 7. Hierarchical tree using average distance (between classes) among the population

The factor analysis of the multiple MCA matches (Figure 6) and the hierarchical ascending classification (Figure 7) allowed the determination of five classes (Table 7).).
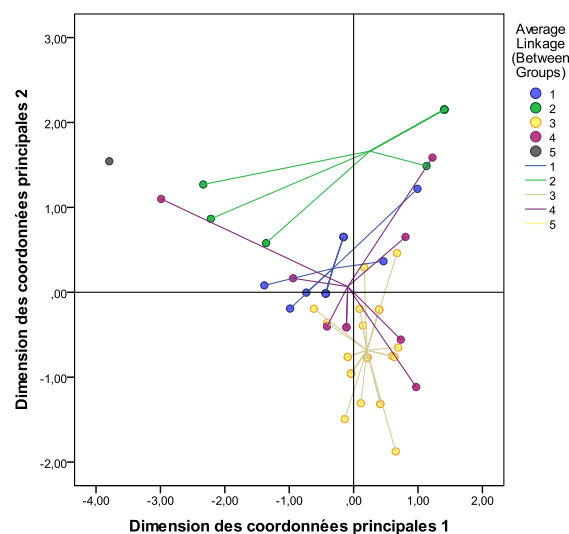
Figure 8. Presentation of individuals by MCA

Class 01: The animals in this class are 12 individuals, the majority of which are brown in color (83%). The gray color is dominant in most of the animals' bodies: the belly is gray in all individuals (100%) while 75% have a gray head, snout and limbs. The hair is black (33%) in some and brown in most animals (67%). (Figure 9)

Figure 9. Animal from class 01

Figure 10. Animal from class 02

Class 02: The animals of this class (9 individuals) have three types of dress color where 67% of the animals have a black dress, while the rest have a gray dress (22%) or red (11%). The black color is dominant in most animals, whose head and limbs are black (67%) like the dress, but in some individuals the head can be gray (33%) and the limbs are gray (22%), white (11%). The muzzle and belly are gray (100%). The hair is brown (56%) or black (22%). (Figure 10)

Class 03: Animals of this class make up the majority of the population (30 individuals). Brown is the dominant color in this class. These animals are brown (80%) or red (20%); but all have a brown head (100%). The muzzle can be gray (77%), white (17%) or black (07%) The limbs are brown (60%), they can be black (30%), gray (07%) or white (03) %) with brown hair (90%) and a belly is gray (77%) or brown (23%). (Figure 11).

Figure 11. Animal from class 03

Figure 12. Animal from class 04

Class 04: Animals in this class (9 individuals) have a color mixture. The color of the dress is brown (67%), black (11%) or red (22%) with a gray head (44%), black (44%) or white (11%) and gray muzzle (89%) or black (11%). The members are brown (78%) or white (22%) with a gray belly (78%) or brown (22%). The hair is brown (67%), black (22%) or white (11%). (Figure 12)

Class 05: A single individual constitutes this class which is totally different from the other classes by its gray and white color which dominate the whole body of the animal. The coat, belly and hair are greyish, while the head, muzzle and limbs are white. (Figure 13)

Figure 13. Animal from class 05

Table 7. Characteristics of classes determined by MCA analysis

Qualitative characters		Class 01	Class 02	Class 03	Class 04	Class 05
		12	9	30	9	1
Color of the dress	Gray	-	22%	-	-	100%
	Brown	83%	-	80%	67%	-
	Black	-	67%	-	11%	-
	Russet-red	17%	11%	20%	22%	-
Color of the head	Gray	75%	33%	-	44%	-
	Black	17%	67%	-	44%	-
	White	08%	-	-	11%	100%
	Brown	-	-	100%	-	-
Color of the muzzle	Gray	75	100%	77%	89%	-
	White	25	-	17%	-	100%
	Black	-	-	07%	11%	-
Color of the members	Gray	83%	22%	07%	-	-
	Black	17	67%	30%	-	-
	White	-	11%	03%	22%	100%
	Brown	-	-	60%	78%	-
Color of the hairs	Gray	-	22%	-	-	100%
	Black	33%	56%	10%	22%	-
	White	-	-	-	11%	-
	Brown	67%	22%	90%	67%	-
Color of the belly	Gray	100%	100%	77%	78%	100%
	Brown	-	-	23%	22%	-

Determination of live weight

Body measurements have not only been used for animal characterization but also for live weight determination. The height at the withers and the chest circumference make it possible to determine the weight of the donkey; using the nomogram (RESEARCH DEPT., 2014; Pearson and Ouassat., 2000; Vall et al., 2002). In addition, HG and TP can be used for weight estimation using the formula of Svendsen. (1997)**.**

Live weight (kg) = (Right chest circumference [cm] 2.575) x (Height at withers [cm] 0.240) / 3968

Pearson and Ouassat (1996, 2000) are working on donkeys in Morocco showed that the thoracic perimeter (TP) is the variable, the most appropriate for estimating the live weight of the animal. In addition, this in cases where the contention of the animal is difficult so it is better to use a formula to calculate the live weight using the TP only

Live weight (kg) = right Turn of chest (cm)$^{2.65}$/ 2188 . We can say that the population studied has an average HG of 116.16 ± 7.23cm and a TP of 124.26 ± 7.03cm; using the nomogram (Research Dept, 2014, Pearson, and Ouassat, 2000, Vall et al., 2002), the live weight of animals can reach a weight of 190 ± 10Kg. This weight and almost identical to that used by the formula of Svendsen, (1997), the weight is 196.45 ± 31.15kg. While the use of TP showed a lower PV of 163.28 ± 24.68Kg. According to Pearson and Ouassat. (2000) and Research Dept., (2014); we can say that the donkeys studied have a very good condition of overweight with no effect of sex and region on PV. If we compare the living weight of our population to that of the Catalan breed (330.7 ± 5.08kg) and the Poitevin breed (346.4 ± 5.00kg) (Boujenane and Machmoum, 2008), we find that this population is light compared to these two breeds.

Morphological characterization

Body measurements are also used for the morphological and ethnic characterization (FAO, 2013) of ashen breeds (Boujenane and Machmoum, 2008)**.** Our study shows the absence of significant effect of sex on body measurements in the study population. Principal component analysis showed heterogeneity of the donkey population in this region; where we have determined two classes of which the first class consists of small numbers (11 donkeys); these animals are heavy (240Kg) and large in size with a very long head and ears. While the second class constitutes the majority of the breeding population in this region, these animals are smaller with an average weight of 180 kg. Cephalic measurements were used for the identification of race, origin, and species relationship (Jewel, 1963). The animals heads 52.39 ± 4,06cm in length and 23,01 ± 2,06cm in width

The chest circumference (TP) taking the top of the tourniquet as a marker appeared to be more relevant than that established behind the withers, being more correlated with other body measurements. In practice, the measurement of the back of the withers is more subject to variations due to the respiratory activity of the animals (inspiration / expiration) than the measurement at the withers, this measurement accounts for the development of the chest and muscles which are covered by it (NICKS et al., 2006) .The study population studied has a thoracic development (TP: 124,26 ± 7,03cm) less important than that of the Catalan breed (149,7 ± 0,84cm) and Poitevin (152.4 ± 0.83cm) (BOUJENANE and Machmoum, 2008). The perimeter of the barrel is used for the calculation of the skeletal fineness (Cerqueira et al., 2011, Boujenane and Machmoum, 2008, Nicks et al., 2006) it is of 17.50 ± 1.86cm. This value is lower than that of the Catalan breed (19.0 ± 0.17cm) and Poitevin (20.5 ± 0.16cm) (Boujenane and Machmoum, 2008)

According to Nicks et al., (2006), the size at the withers (HG) is the most frequently quoted parameter to account for the size of the animals. The majority of the population has an average HG of 113.96 ± 4.60cm; which is close to the Norman donkey (1,10 to 1,25) m (Association of the Norman ass, 2003); then class 01a has a HG (126,14 ± 8,74cm) close to that of the Cotentin race (♂: 1,20 to 1,35m and ♀: 1,15 to 1,30m) (Aneac., 2003). But the whole population is smaller than other French breeds such as Bourbonnais (♂: 1,25m to 1,35m and ♀: 1,18m to 1,28m) (association of ane bourbonnais., 2003); the Big Black Berry (1.35 m to 1.45 m) (Afagnb., 2003); the donkey of Provence (♂: 120 cm to 135 cm and ♀: 117 cm and 130 cm) (association of the ass of Provence., 2003); the Pyrenean donkey (1,20m to 1,35m) (National Association Of pyrenees d'asses, 2003); and the Baudet du Poitou (1.40 to 1.50 m) (UPRA., 2003) and Moroccan such as Catalan (140.2 ± 0.78cm) and Poitevin (139.7 ± 0.77cm) (Boujenane and Machmoum, 2008)

We cannot compare our results with other authors to the absence of studies on the ethnology and the characterization of this species in Algeria. Concerning these criteria and the absence of local data, the results cannot be compared.

Phenotypic characters

Given the lack of data on the phenotypic characterization of this species in Algeria, apart from Richard document, (1857) which described two races or populations. A small population of gray-mourish or black dyed and the other gray or black Gascogne race and stronger. The MCA analysis allowed us to note that brown is the dominant color of the body (dress, head, limbs and hairs) of donkeys studied. While, the gray color is dominant for the muzzle and belly. In addition, the presence of five different classes of color (brown, black, white and red) shows the heterogeneity of the breeding population in this region. We can therefore propose these phenotypic criteria as a key to racial identification of the asylum population in Algeria.

Conclusion

Finally, it can be said that the Asses population in Algeria experienced a drastic decrease, without knowing a morphological and phenotypic characterization of this species. Taking into account our

results and considering the importance of the donkey in our society and especially in the mountain agriculture. It is necessary to come out with proposals to improve the productivity of the Asinian breeding which is a much neglected breeding, put this species in a danger of extinction. It is then necessary to evaluate the genetic resources of this species by the phenotypic characterization of the breeding population in our country in order to determine the races or populations present; and this to launch a project of genotypic characterization by microsatellite markers. These results would allow us to know the genetic diversity of donkeys in Algeria. According to our results, the studied population presents a morphological heterogeneity (size, format, weight ... etc.) and phenotypic (color of the dress, of the members of the head ... etc.); we can say that the donkey population in this region is medium in size and brown in most animals; with the presence of other colors such as gray and black; which requires a genotypic study to identify these races or populations.

References

AFAGNB 2003. Ane Grand Noir du Berry. *Association française de l'Âne Grand Noir du Berry et Les* Haras Nationaux

ANEAC 2003. Anes du Cotentin. Association Nationale des éleveurs d'Anes du Cotentin et Les Haras Nationaux.

Association de l'âne bourbonnais 2003. L'âne Bourbonnais. Association Française de l'âne Bourbonnais. Maison de l'âne – Beauregard., et Les Haras Nationaux.

Association de l'âne de Provence 2003. Ane de Provence. Association de l'Âne de Provence, Le Colombier et Les Haras Nationaux

Association de l'âne normand 2003. Ane Normand. Association de l'Âne Normand, Haras National du Pin et Les Haras Nationaux.

Association Nationale des Eleveurs d'ânes des Pyrenees 2003. Ane des Pyrénées. Association Nationale des éleveurs d'Ânes des Pyrénées, Bardou et Les Haras Nationaux

Boujenane I. Touati I. Machmoum M 2008. Mensurations corporelles des chevaux Arabe-arabes au Maroc. Revue Méd. Vét., 159(3) : 144-149.

Boujenane I. Machmoum M 2008. Mensurations corporelles des ânes des races Poitevine et Catalane et de leurs croisés au Maroc. Revue Élev. Méd. vét. Pays trop. 61 (1) : 63-67

Cerqueira JOL. Feas X. Iglesia A. Pacheco LF. Araujo JPP 2011. Morphological traits in Portuguese Bordaleira de Entre Douro e Minho sheep: divergence of the breed. An. Prod. Sci. 51: 635-641.

FAO 2013. Caractérisation phénotypique des ressources génétiques animales. Directives FAO sur la production et la santé animales No. 11. Rome. FAO, 2013. p 151.

FAO 2016. L'effectif modiale de lespece asine consulter le mai ,2018

Jewel PA 1963. Cattle from British archaeological sites. In: MOURANT, A.E.; ZEUNER, F.E. (Eds.) Man and cattle. London: Royal Anthropological Institute of Great Britain and Ireland, p.79-85.

Nicks B. Delfontaine B. Canart B. Vanderbruggen J. Vandenheede M 2006. Caractéristiques morphologiques des juments de Trait belge. Ann. Méd. Vét., **150**, p 247-251.

Pearson A. Ouassat M 2000. A Guide to Live Weight Estimation and Body Condition Scoring of Donkeys. Centre for Tropical Veterinary Medicine University of Edinburgh. P21.

Research Dept 2014. Condition scoring and weight estimation. The Donkey Sanctuary. P4.

Richard 1857. Société impériale zoologique d'acclimatation: Espèces chevaline, asine, bovine et porcine de l'Algérie.

Svendsen ED 1997. The Professional Handbook of the Donkey. 3rd Edition, Whittet Books, Ltd, London

UPRA 2003. Baudet du Poitou. Association des races mulassières du Poitou ; CREGENE, Parc Interrégional du Marais Poitevin ; et Les Haras Nationaux

Vall E. Ebangi AL. Abakar O 2002. Barymétrie des ânes de trait Une méthode simple pour estimer le poids vif des animaux. Conception Cirad-Tera - Cathy Rollin.