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MORPHOMETRIC CHARACTERIZATION OF THE EQUINE BARBE BREED IN NORTHWEST OF ALGERIA

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Abstract

The Barbe horse occupies a prominent place in the history, culture and traditions of Algeria; it is at the base of the evolution of the main equine breeds in Maghreb. Nineteen (19) measurements were made on 58 pure and presumed Barbe horses (uncertain origins), all aged three years and over. From these, six body indices were calculated and live weight estimated. The cephalic profile survey was also performed. Statistical analyzes were carried out on these different measurements by software R 2.15.2 and XLSTAT2016. The statistical tests used were of the descriptive and analytical type including among others, the calculation of means, standard deviation, and principal component analysis (PCA) and ascending hierarchical classification (CAH). We also estimated genetic diversity by Shannon and Weaver index. They find that the Algerian Barbe horse is a eumetric, mediolinear horse with a body index of 0.955, (squared horse), with a median size of (152.5) cm, a chest of (175.5) cm and a posterior (19.8) cm and anterior (20.6) cm canon. It has a slightly hooked convex cephalic profile and a predominantly chestnut robe. Its characteristics make the horse Barbe of Algeria conform to the standard as defined by the world organization of the horse Barbe.

Keywords: Algeria; Barbe horse; mensuration; conformation, statistical analyzes.

Introduction

Biodiversity in agriculture is the product of thousands of years of activity in which humans have sought to meet their needs under very different climatic and ecological conditions. Indeed, the genetic variability of a species represents its evolutionary potential, which allows in particular the adaptation of species to environmental variations or resistance to new diseases. In Algeria, animal genetic resources offer a great diversity of breeds in terms of their adaptation and production ability in their natural environment. Equines are no exception to this observation. As such, they constitute a varied wealth, with great economic and socio-cultural importance. The horse sector occupies a prominent place in the history and economy of North Africa. In Algeria, the horse is a real actor of sustainable development especially in the environmental field, playing a special role in managing spaces and landscapes beneficial to the maintenance and development of biodiversity, but also in its relationship with humans contributing to sports, social and cultural activities. In this context, the development of equine breeding requires its rationalization and consequently the use of modern equine genetic resources management techniques. The Algerian equine population, estimated at 250,000 horses, is made up of 90% Barbe and Arab Barbe horses (and Algerian saddle). The remaining 10% is divided between Arab horses, Thoroughbreds and French Trotters.

Algeria, as well as the other Maghreb countries, how are the cradle of the Barbe breed, have become aware at the highest level of the importance of Barbe, Arab-Barbe and Algerian saddle horses. The European craze and the goals of popular riding - which seek more performance horses - but rather docile horses have made the success of the horse Barbe and its derivative Arab-Barbe. Thus, since the opening in December 1985 the competitions of equestrian sports to small horses by the International Equestrian Federation, the horse Barbe is promised a bright future. The Barbe horse occupies a prominent place in the history and economy of North Africa.

The official standard of the Barbe breed, adopted by the World Barbe Organization (OMCB), defines the Barbe morphologically as a eumetric, medioline breed whose main characteristics are: an average size of 1.55 m, head strong enough, loaded with ganache, convex cephalic profile, slightly hooked, neck well grafted, rolled, thick and short, rump in pulpit, tail tied down, gray dress, berry, chestnut, heavy and thick horsehair (Chabchoub, 1998).

Few works have been done on the horse Barbe and none on the saddle Algerian. As a result, they remain poorly known to the public. Geneticists, veterinarians and zootechnicians should have data to better characterize the horse Barbe and the saddle Algerian especially that they are undergoing certain variations related to the biotope and the man. The dangers of drifting and alteration of the breed are indeed numerous. They may come from different material or sporting interests, breeders may be tempted to favor certain conformations to seek the improvement of such and such aptitudes. The danger can also come from diverging aesthetic visions, some wanting to create a Barbe horse (for example) they dream of and not the Barbe horse. The morphometric and genetic study of the Algerian Barbe and Saddle horse would be very important because it would not only provide elements that define these breeds in an up-to-date and practical way, but also better analyze their aptitudes. During the morphometric study, we prepared for a study of the genetic characterization of the Algerian Barbe and Saddle horse in order to build a specific bass of data of these breeds. This step is very important for the improvement and preservation of our equine gene pool. We then proposed to undertake a morphometric and genetic study of the Barbe horse in Algeria by blood sampling and measurement and the assessment of 19 morphological parameters on a representative sample of this breed in Algeria.

Study Populations and Methods

Choice Animal

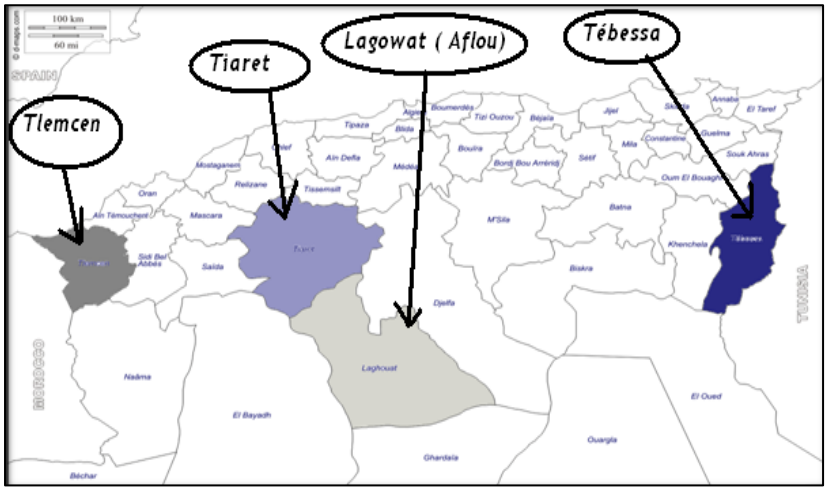

Figure 1. Geographical map of the wilayas, which represent the most important genetic reservoir of purebred horses in Algeria.

The equine population in Algeria has more than 256,000 horses living on Algerian territory (censuses of the Algerian Ministry of Agriculture, 2012). In this strength, we distinguish race horses, saddles and horses intended for reproduction. These are usually purebred Arab horses and thoroughbred English. There are also the working horses that are used to perform traction and farm work in rural areas. These are usually Barbes, Arab-Barbes and those of undetermined origin. These animals belong to traditional small farms. This equine population is unevenly distributed over the Algerian territory. The number of horses and their breeds are indeed higher in some regions than in others. The Barbe breed, which is the subject of our study, is mainly found in Tlemcen (western Algeria in the border zone with Morocco). In the center at the Tiaret willaya and the Aflou Daira. East of Algeria in the border zone with Tunisia (Tébessa willaya). These regions represent the largest genetic reservoir of Pure Barbes horses in Algeria.

In our study, we made measurements on Barbes horses belonging to the region of Tiaret and Aflou. A total of 58 horses were studied of which 22 were females. They are all over the age of 3 year.

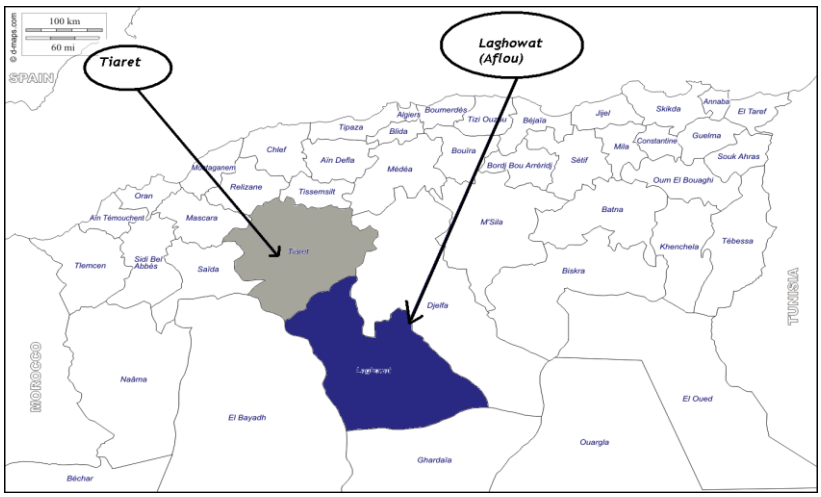

Figure 2: geographical map of the Algerian wilayas studied

Measuring equipment

We used a metric tape for measurement of length and circumference parameters and a hippie rod for height parameters.

Methods

Manipulations

The horse was placed on a horizontal plane well flattened and plumb. At first, we measured the heights at the withers and the rump using the hippometric rod. The cursor is raised above the height to be measured. The cane was brought closer to the animal, the free hand being applied to the horse to warn the subject. The cursor gradually lowered until very accurate outcropping on the most prominent part. In a second step, we highlighted the landmarks on the surface of the body using a marker pen. Eleven points were then highlighted (Figure 3), (Barone P, 1976, Barone P, 1980). It is:

1. External occipital protuberance (top of the forelock) (point: a).
2. Fore edge of the wing of the atlas. (Point: b).
3. Top of the scapula (at the intersection of the shoulder-tourniquet): It is at the end of the cartilage in the extension of the scapular spine (point: c).
4. Caudal part of the major tubercle of the humerus (tip of the shoulder): its external reference point is located in the prolongation of the scapular spine (point: d).

5. Lateral relief of the radial head (the region of the elbow) (point: e).
6. Distal part of the radius: is situated approximately at the intersection of the vertical line passing through the radius axis and the horizontal line passing through the apex of the pisiform bone. (Lateral and upper part of the "knee") (Item: f).
7. Head of Metacarp IV (lower lateral part of "knee") (point: g).
8. Distal end of the metacarpal (ball region) (point: h).
9. Angle of the hip (coxal tubercle region): ventrocranial iliac spine (point: i).
10. Crest of the greater trochanter of the femur (point: j).
11. Top of the tibial tuberosity (anterior lower part of the stifle region: knee region) (point: k).

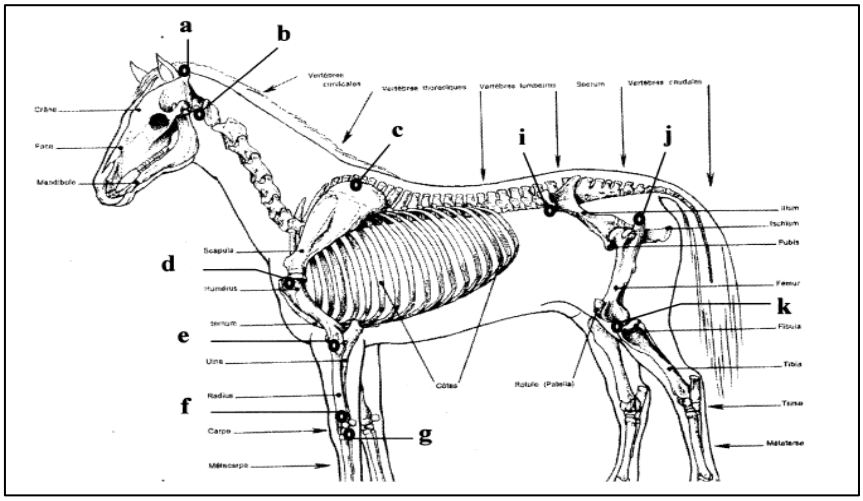

Figure 3: Landmarks defining the morphological parameters of the length of the horse Barbe.

The parameters:

We measured quantitative parameters and assessed qualitative parameters. The quantitative parameters were heights and lengths. This was the height at the withers (interscapular region) (HG) and the height at the rump (sacral region) (HC), the total length (LT), the scapulo-iliac length (LSH), the length of the head (LTe), the distance between the internal angles of the eyes (AIY), the length of the neck (dorsal edge of the neck) (LE), the length of the shoulder (scapular region) (LEp), the length of the arm (brachial region) (LB), forearm length (antebrachial region) (LAB)), canon length (metacarpal region) (LC), ilium length (LI) and length thigh (femoral region) (LCe). These parameters were derived from landmarks defining the body of the animal. In addition we measured the circumferences. These were chest bites (sternal region) (TP); forearm (antebrachial region) (TAB); "knee" (carpal area), anterior cannon (metacarpal region) (TCA); posterior cannula (TCP) and the ball turn (metacarpophalangeal region) (TB). As well as the knee turn (carpal area) (TG). The term "knee" here refers to the region having for anatomical support the carp bones and not the knee in the anatomical sense (femoro-tibiopatellar joint). (Table 1).

Table 1: list and description of the measurements made.

Measure Type	Abbreviation	Description	Instrument Used
Height at withers	**(HG)**	(crown of the withers)	**T**
Height at the rump	**(HC)**	(sacred line at hip-ground height)	**T**
Total Length	**(LT)**	(tip of the shoulder-tip of the buttock)	**R**
Scapulo-iliac Length	**(LSH)**	(tip of the shoulder-tip of the hip)	**R**
Length of the head	**(LTe)**	(upper neck-upper nostrils)	**R**
Distanced between the internal angles of the eyes	**(AIY)**	Distanced between the internal angles of the eyes	**R**
Neck length	**(LE)**	(middle of the parotid-middle of the anterior edge of the shoulder)	**R**
Shoulder length	**(LEp)**	(top-tip of the shoulder)	**R**
Arm Length	**(LB)**	(shoulder tip-lateral relief of the radial head)	**R**
Length of the forearm	**(LAB)**	(lateral relief of the radial head-distal part of the radius)	**R**
Canon length	**(LC)**	(metacarpus head IV - distal end of the metacarpal at the level of the ball)	**R**
The length of the thigh	**(LCe)**	measured between the crest of the greater trochanter and the apex of the tibial tuberosity	**R**
Tower of the forearm	**(TAB)**	(10 cm above the chestnut)	**R**
Tower of the knee	**(TG)**	(through pisiform bone, prominent bone behind the articulation)	**R**
Anterior Canon Ream	**(TCA)**	(perpendicular to the canon axis, four fingers below the lower knee)	**R**
Posterior Canon Tower	**(TCP)**	(same as TCA)	**R**
The length of the ilium	**(LI)**	(is measured between the ventrocranial iliac spine and the ridge of the greater trochanter)	**R**
Chest size	**(TP)**	(behind the withers)	**R**

T: toise; R: metric tape

From these different measurements, seven body indices (Table 2) were calculated according to formulas described by several authors (Marcq et al, 1951, Chabchoub et al, 2004, Nicks et al, 2006, Boujenane et al, 2008). , (Table 2).

Table 2: The seven calculated body indices.

Indices	Abbreviation
Body Profile Index	(HG/LT)
Compactness Index	(PV/HG)
Corpulence Index	(TP/HG)
Dactylo-Thoracic	(TCA/TP)
Relative Body	(LT/TP)
Front Height Behind	(HG/HC)
Live weight (kg)	(PV/HG)

Statistical analysis

The study of genetic biodiversity requires special statistical approaches, performed by high-speed data analysis technologies, high speed and high computer memory. The development of bioinformatics and the technological progress of many statistical tools in population genetics makes it possible to process a series of data more quickly, as well as the massive production of different characteristics in given populations. The three software programs and the parameters for which they were used are shown in (Table 3).

Table 3: Software used in statistical processing.

software	**Caracteristics**
R STUDIO	Variable correlation circle
R (FactoMineR) V 2.15.2	Principal Component Analysis (PCA)
XLSTAT 2016	The comparison between the groups by the non-parametric test of Mann and Whitney
Excel	Averages, Percentage, Standard Deviation and the Shannon-Weaver Diversity Index (1949).

Results and discussion

Statistical analyzes were performed to describe the high equine population in the region of Tiaret and Aflou and to have an idea about the differentiation of individuals.

Body measurements:

Descriptive analysis

The averages, standard deviations, coefficients of variation, and coefficient of body measurements of horses are reported in Table 4.

Variation of variables by sex

The following table presents the results of comparing the averages of each parameter for males and females using the Man-Whitney significance test. This test allows us to see if sexual dimorphism exists in this species (Table 5).

Of the 26 parameters studied, 9 parameters express significant variations according to sex ($p < 0.05$) (see Table 5). We found that males were taller than females. The effect of sex on height is well known. It is related to the hormonal effect at the time of growth of the young (Ronciere A.P, 1998). On the other hand the males have wider heads, neck, shoulder, arm and thigh longer. The forearm more muscular and the "knee" (carpal area) thicker. Females are longer with a larger chest circumference, thicker guns, and are heavier than males. These results are also reported by the study carried out in Tunisia by Chabchoub et al, 1998.

Table 4: Mean, standard deviation, coefficient of variation (CV) and confidence index (CI) of the body indices and the 19 parameters measured on the Barbes horses studied.

Parameters (measurements and indices)	**Mean (n = 58)**	**Standard deviation**	**CV**	**IC**
Height (cm)				
at the withers	152.5	2.4	0.016	0.6
at the rump	150.1	2.3	0.015	0.6
Length (cm)				
total	160	6.3	0.039	1.6
scapular-iliac	118.2	4.3	0.036	1.1
of the head	53.1	1.6	0.042	0.4
between the internal angles of the eyes	18.6	0.8	0.042	0.2
neckline	62.8	2.6	0.042	0.7
shoulder	54.4	2.5	0.046	0.6
arm	32.6	1.8	0.054	0.5
forearm	36.9	2.2	0.058	0.6
cannon	25.9	1.2	0.048	0.3
illium	37.4	2.5	0.067	0.6
Thigh	45.8	2.8	0.062	0.7
Circumference (cm)				
chest	175.5	2.8	0.062	0.7
forearm	40.4	2.3	0.056	0.6
knee	30.1	1.2	0.041	0.3
ball	28.6	1.4	0.048	0.3
anterior cannon	19.8	1.2	0.060	0.3
the posterior canon	20.6	0.9	0.043	0.2
Index				
Body Profile Index (HG/LT)	0.955	0.036	0.037	0.009
compacite index (PV/HG)	2.688	0.172	0.064	0.044
Body mass index (TP/HG)	1.151	0.040	0.035	0.010
Tactylorothoracic (TCA/TP)	0.113	0.008	0.071	0.002
Relative body (LT/TP)	0.913	0.042	0.046	0.011
Height in front of back (HG/HC)	1.016	0.009	0.009	0.002
Live weight (kg)	409.9	27.9	0.068	7.2

Table 5. Mean values of different parameters in males and females and significance test.

Parameters (measurements and indices)	**Average Males (n =36)**	**Average Females (n = 22)**	**Meaning (P < 0.05)**
Height (cm)			
at the withers	153.30	151.50	**NS**
at the rump	150.63	149.90	**NS**
Length (cm)			
total	159.58	160.68	**NS**
scapular-iliac	118.17	118.36	**NS**
of the head	53.19	52.91	**NS**
between the internal angles of the eyes	18.56	18.73	**NS**
neckline	63.36	61.95	**NS**
shoulder	55.11	53.23	0.01
arm	32.92	32.14	**NS**
forearm	37.14	36.55	**NS**
cannon	26.00	25.82	**NS**
illium	37.89	36.59	**NS**
Thigh	46.22	45.09	**NS**
Circumference (cm)			
chest	171.36	182.18	< 0.0001
forearm	40.67	39.91	**NS**
knee	30.75	29.14	0.0001
ball	28.78	28.27	**NS**
anterior cannon	19.69	20.09	**NS**
the posterior canon	20.86	20.23	0.027
Index			
Body Profile Index (HG/LT)	0.960	0.947	**NS**
compacite index (PV/HG)	2.581	2.862	< 0.0001
Body mass index (TP/HG)	1.120	1.201	< 0.0001
Tactylorothoracic (TCA/TP)	0.115	0.110	< 0.0001
Relative body (LT/TP)	0.932	0.882	0.001
Height in front of back (HG/HC)	1.018	1.013	**NS**
Live weight (kg)	**394.92**	**434.5**	**< 0.0001**

Comparison parameters studied between breed

There was also a comparison of our study population (Barbe) where no horse had a concave or sub-concave cephalic profile with the English Thoroughbred horse (PSA) and Thoroughbred horse which is rather characterized by this phenotype (Ketata A, 1980). This morphometric difference was also observed for other characters (Table 6, 7 and 8), we will rely on the results found by Legault (Legault R.J, 1977), El Beji (El Beji A, 1997), and Ketata (Ketata A, 1980).

Table 6: Comparison of the values of total length, humeral iliac length and length of the neck in studied Barbes horses and English Thoroughbred.

Parameters (Length)	**Average value for The sample studies (cm)**	**Mean values (PSA). (cm), (legaultr.J.1977)**
Total	160,0	162.93
Scapular-iliac	118,2	109.41
Neckline	62,8	80.56

Table 7: Comparison of the chest and anterior guns between the studied sample, the standard Barbe in Algeria and the thoroughbred Arabian.

Parameters (Circumference)	**Mean values for the studied sample (cm)**	**Average values of the standard Barbe in Algeria**	**Mean values Thoroughbred Arabic, (El Beji, 1972)**
chest	175.5	> 170	-
anterior cannon	19.8	> 18	20-21

Table 8: Comparison of shoulder length, arm length, forearm length, canon length, ilium length, and thigh length between l sample studied and the thoroughbred English.

Parameters (Length)	**Average value for the sample is studying (cm)**	**Average value (PSA) (cm), (Legaultr.J.1977)**
shoulder	54,40	46.98
arm	32.62	33.39
forearm	36.91	45.36
cannon	25.93	26.7
illium	37.40	27.24
Thigh	45.79	35.67

Parameters related to the size of the horse

Two characters are compared here, the height at the withers (HG) and the height at the rump (HC). We find that the average HG value of the sample studied is comparable to the value of the Barbe horse standard and that of the Arabian thoroughbred (PSAR), while it is much lower than that of the PSA, which the same goes for the HC. The values of HG are comparable to those obtained for HC, moreover these two parameters are perfectly correlated (Figure 3). The slight lowering of the front of the horse being disadvantageous for draft animals, on a smaller scale for those of saddle, and with fortiriori of race for which a predominance of size of the rump is sometimes sought especially for the horses of the steeple which explains these results, (Marcenac LN and Aubert H, 1974). According to these results, our horse would be especially a horse adapted to the race.

Parameters related to the length of the horse

The characters describing this parameter are the total length (LT), the hemi-iliac length (LSH) and the length of the neck (LE). We note that for LT the mean in Barbe is closer to that of PSA by cons the value of LE is much lower than those of PSA. As for the average LSH value of Barbe, it is higher than that of PSA (Table 6). LT has an impact on the length of the kidney, the more important it is, the more the horse is enselled (Marcenac L.N. and Aubert H, 1974). This provides a significant physiological benefit to the breed studied.

Body Profile Index (HG / LT)

The body or body index is used to assess the proportion of an animal. A horse is said to be short if the index is less than 1, mediolate if it is 1 and lanky for an index greater than 1 (Marcenac L.N. and Aubert H, 1974). The average HG / LT value of our sample is 0.955, approximately equal to 1; that is, the value required by O.M.C.B. (Chabchoub A, 1998). This result means that our study was done on animals representing the international standard of the horse Barbe. This index corrects the errors of the visual appreciation and proves that a horse called bréviligne (heavy horse) is longer than high and that an elongated horse is higher than long. The equality of these dimensions gives the square horse.

Parameters related to the weight of the horse

This parameter is represented by the live weight (PV), the chest circumference (TP), the round of the anterior canon (TCA) and the posterior round of the canon (TCP). For estimation of live weight, we preferred to use the formula of Caroll and Hungton (Caroll CL and Huntigton PJ, 1988), to the method of Crevat (Marcenac LN and Aubert H.1974) which estimates the weight only from the thoracic perimeter, measured at the level of the 9th dimension, raised to the cube and multiplied by the coefficient 80. The average value of the PV in our sample is 409.9 kg. It is therefore a light horse in comparison with heavy horses (600 to 1000 kg) and saddle horses (450 to 600 kg) (Marcenac L.N. and Aubert H.1974). For the chest measurement, the average value of our sample is consistent with the value of the standard Barbe in Algeria (Ben Aissa R. and Tamzali Y, 1989), (Table 7), however, we can say that we are in the presence a horse with voluminous thorax next to his waist. The examples of Theret (Marcenac L.N. and Aubert H, 1974), confirm this hypothesis. In fact, the Arabian-Barbe is 170 cm long and 153 cm tall. For the Anglo-Arabian, it is 188 cm for a height of 160 cm and for the half-saddle it is bust is 200 cm for a height of 169 cm. The average perimeter of the front canon is in accordance with the standard Barbe. From these data, we notice that our horse has quite thick limbs relative to its size. Indeed, Marcenac & coll. (Marcenac L.N. and Aubert H, 1974), approximate the TC to size as follows:

- 18 cm for a height less than or equal to 157 cm,
- 19 cm for a height greater than 157 cm,
- 20 cm for heavy horses.

However, our horse has a canon perimeter of 19.8 cm for a size of 152.5 cm, this is in favor of the strength and thickness of its members.

Compactness index (PV / LT) and body mass index (TP / LT)

We found at the level of the population studied an average of 2.688 kg / cm for the compactness index. For comparison, we give some compaction indices calculated from the data reported by Theret (Marcenac L.N. and Aubert H, 1974):

- Arab-Barbe: 2.62 kg / cm,
- Demi-saddle Normand: 3,55 kg / cm,
- Anglo-Arabian: 2.79 kg / cm.

Thus, we note that the average of the studied sample is greater than that of the Arab-Barbe and inferior to that of the Anglo-Arab and incomparable with that of Half-saddle Norman. We can say that our horse is compact by contribution to its weight. Regarding the body mass index (TP / HG), the average of our sample is 1.151. Marcenac reports that the best body index oscillates between 0.885 and 0.90 (Marcenac L.N. and Aubert H, 1974), and that above 0.90 the horses are compact. We can thus deduce that the studied Barbe is among the horses with a heavy tendency.

Parameters related to bone length

These parameters are estimated from the length of the head (LTe), the distance separating the internal angles of the eyes (AIY), the length of the neck (LE), the length of the shoulder (LEp), the length of the arm (LB), the length of the forearm (LAB), the length of the canon (LC), the length of the ilium (LI) and the length of the thigh (LCe). We notice that there are three parameters whose average values in the horse Barbe are higher than those of the PSA, these parameters are: LEp, LI, LCe, whereas for LAB and LC, the average values found in the Barbe are lower those of the PSA (Table 8). Marcenac reports that the shoulder is the longest in the race horse, the shortest in the trotter. The arm is the longest in the line, the shortest in the trotter. The length of the arm must be extended to accommodate very active muscles that will operate the forearm. It must, however, be proportionate to the shoulder and remain short compared to it to prevent the horse "shaving the rug" in its stride (Marcenac L.N. and Aubert H, 1974). The forearms of the gallopers must be long and the canon short to give the stride more amplitude than a short forearm and a long canon allow. The width of the forearm (circumference) as large as possible is an indication of a powerful musculature. The shoulder is the longest in the race horse, the shortest in the trotter. The arm is longer at the draft, the shorter at the trotter. The average LB value of the Barbe studied is approximately equal to that of the PSA. It is also noted that the average value of LTe is rather different from the average value of LE, the mean value of AIY is 18.59 cm, so the sample Barbe studied has a long and wide head. Values of the forearm (TAB), knee (TG) and ball (TB) indicate a thick limb with fairly large joints. This type of limb is found in heavy horses.

Comparison of mean Barbe measurements of our study with those reported by other authors (Table 9).

The results of this study relating to the morphology of the Barbe were compared with those obtained by other authors having studied the Barbes horses of Tunisia (Chabchoub and al, 1998), Morocco (Jary quoted by Rahal and al, 2009).) and the Chaouchaoua region (Tiaret) in Algeria (Rahal et al, 2009) and (Guedaoura S. 1 and al, 2011) (Table 9). The main result is that the Tunisian Barbe is larger, close to that observed for horses in eastern Algeria (Guedaoura, 2008). These differences could be explained by the effect of the environment. Indeed, the size and morphology of the horse are different depending on whether it has been developing for generations in coastal plains or mountainous regions, highlands or the limit of desert regions in the south; it is obvious that the temperature and the rainfall affect the vegetation and that the development an animal is a function of how it is nourished over generations (Tamzali 1989, Kadri 2006). These authors also noted that the Barbe raised in the phosphate soil of eastern Algeria is larger and more robust than that of the West. The Western horse is very close to the Arabian, but he has not taken the horizontal rump nor the tailport tied up (French Association of the Barbe Horse, 1987).

Table 9: Comparison of mean Barbe horse measurements of our study with those reported by other authors.

Measurements	Our study (Algeria, n=58)	Guedaoura et al 2011(Algeria, n = 43)	Chabchoub *et al*., 2004 (Tunisia, n= 41)	Rahal *et al*., 2009 (Tiaret, n=35)	Jary cité par Rahal *et al*, 2009) (Morocco, n =46)
Height (cm)	152.6	151.3	155.7	151.8	155.1
at the withers	150.3	150.7	154.9	151.6	155.9
at the rump					
Length (cm)					
total	160.0	148.2	155.5	157	157.1
of the head	53.1	54.6	67.2	66.6	66.4
neckline	62.8	65.3	69.1	74.6	67.9
shoulder	54.4	52.7	53.1	53.3	54.1
forearm	36.9	39.9	35.9	35.4	35.1
cannon	25.9	19.9	25.3	23.2	25.1
Circumference (cm)					
forearm	40.4	35.3	39.3	36.6	42.3
knee	30.1	30.3	31.7	29.3	32.8
anterior cannon	19.8	19.2	19.7	18.9	20
posterior canon	20.6	20.6	21.6	20.6	21.9
ball	28.6	26.4	27.6	26.2	27.7
chest	175.5	171.4	181.6	177.6	178.6
Live weight **(kg)**	409.9	412.7	433.5	443.6	423.8

Comparison of mean Barbe measurements between Tiaret and Aflou

If we compare the results of the region of Tiaret with those of the Aflou region of Laghouat (Table 10). We will notice a deference between the two populations studied. Of the 26 parameters studied. There are nine parameters (3 calculated and 6 measurable) which represents a significant differentiation. Indeed, the parameters for which the means show a significant difference ($P < 0.05$) are those related to the length of the head (LTe), and the round of ball (TB).

There is a difference between the two populations that is highly highly significant ($P < 0.01$ to $P < 0.0001$) for animal size-related (LT) traits, eye length (AIY), forearm length (LAB), canon length (LC) as well as for the 3 parameters calculate which are the body index profile (HG / LT), the relative body index (LT / TP) and the front height index behind (HG / HC). It appears mainly that the Barbe raised in the region of Tiaret to a total length and forearms longer and a more muscular ball than the Barbe horse raised in the region of Aflou. On the other hand, the animals of the region of Aflou have a rather long and wider head and a longer canon compared to that of the Barbe horse raised in the region of Tiaret.

These differences could be explained by the effect of the environment. Indeed, the size and morphology of the horse are different depending on whether it has been developing for generations in coastal plains or mountainous regions, highlands or the limit of desert regions in the south; it is obvious that temperature and rainfall affect the vegetation and that the development of an animal is a function of how it is fed over generations (Tamzali 1989, Kadri 2006).

Table 10: Comparison of mean Barbe measurements between Tiaret and Aflou.

Parameter (measurements and indices)	Tiaret mean (n =23)	Aflou mean (n = 35)	Signification (P < 0,05)
Height (cm)			
at the withers	151.91	152.89	**NS**
at the rump	150.72	149.71	**NS**
Length (cm)			
Total	164.78	156.86	0.0002
Scapular-iliac	116.52	119.37	**NS**
Head	52.30	53.60	0.013
between the internal angles of the eyes	18.09	18.91	0.0002
Neckline	62.43	63.09	**NS**
Shoulder	54.17	54.54	**NS**
Arm	32.87	32.46	**NS**
Forearm	38.74	35.71	< 0.0001
cannon	24.83	26.66	0.0001
illium	38.30	36.80	**NS**
Thigh	46.39	45.40	**NS**
Circumference (cm)			
Chest	174.30	176.23	**NS**
Forearm	40.17	40.51	**NS**
Knee	30.43	29.94	**NS**
Ball	28.09	28.91	0.049
Anterior cannon	19.46	20.09	**NS**
Posterior canon	20.74	20.54	**NS**
Index			
Body Profile Index (HG/LT)	0.924	0.976	**< 0.0001**
compacite index (PV/HG)	2.691	2.685	**NS**
Body mass index (TP/HG)	1.147	1.153	**NS**
Tactylorothoracic (TCA/TP)	0.112	0.114	**NS**
Relative body (LT/TP)	0.946	0.891	**0.0001**
Height in front of back (HG/HC)	1.008	1.021	**< 0.0001**
Live weight (kg)	408.96	410.57	**NS**

Shannon and Weaver Diversity Index in the Both Regions Surveyed.

Of the 20 parameters studied at the Tiaret population level, there are 6 parameters that represents a diversity that was estimated at 0.43 (maximum value). These characters are: Neck length (LC), shoulder length (LEp), canon length (LC), thigh length (LCe), chest circumference (LT) and estimated live weight (kg). This means that the 6 characters listed are probably controlled by genes that do not have a significant effect on the body (possibility of cumulative gene mutation at the heart of generations). On the other hand, the minimum population diversity of Tiaret was estimated at 0.26 for the character "posterior gunshot (TCP)" this character is probably controlled by genes that have a significant physiological effect on the body. The other characters have a diversity that varies between 0.27 and 0.42. Some differences exist for this parameter concerning the population of Aflou which is probably due to the influence of the environment on the expression of these characters. Comparing the average values of this parameter between the two populations shows that the difference is not very important. It is 0.38 for the Tiaret Barbe population and 0.34 for the Aflou Barbe population.

The equine breeding at the Tiaret region being closed and consanguineous (unlike that of the region of Aflou) were expected to have contrary results. That said, this small difference between the two values may be due to the fact that the population raised in the region of Aflou has probably suffered a recent founder effect. Principal Component Analysis of the Study Population (ACP) Principal component

analysis (PCA) was performed on the quantitative variables studied (figure 3). The result of this analysis showed that these variables presented 33.96% of the total inertia on both axes, which is relatively average (Table 12).

Table 11: Comparison of the Shannon and Weaver Diversity Index for the two regions studied.

parameter (measurements and indices)	**Index of Shannon and Weaver in Tiaret (n=23)**	**Index of Shannon and Weaver in Aflou (n = 35)**
Height **(cm)**		
at the withers	0.42	0.37
at the rump	0.33	0.39
Length (cm)		
Total	0.37	0.37
Scapular-iliac	0.41	0.37
Head	0.41	0.30
between the internal angles of the eyes	0.30	0.19
Neckline	0.43	0.36
Shoulder	0.43	0.35
Arm	0.39	0.38
Forearm	0.27	0.34
cannon	0.43	0.27
illium	0.38	0.35
Thigh	0.43	0.39
Circumference **(cm)**		
Chest	0.43	0.33
Forearm	0.41	0.37
Knee	0.34	0.38
Ball	0.39	0.37
Anterior cannon	0.31	0.28
Posterior canon	0.26	0.29
Live weight (kg)	0.43	0.39
Mean	**0.38**	**0.34**

It appears from the ACP that the parameters, age, TCA and LE are statistically interpretable because they are too close to the center of the ACP. For the rest of the characters we can say that they are subdivided into four groups (from top to bottom):

First group only includes the LTe parameter which has no correlation with the parameter LEp which constitutes the fourth group, Second group and third group they are juxtaposed, but we can say that the parameters TP, LC, AIY, HC, HG, weight kg, LSH and TB form the second group and the parameters TCP, TG, LB, TAB, LT, LAB, LCE and LI form the third group. This is probably due to the existence in the control of the expression of these characters of a number of genes in common and that these characters react more or less in the same way vis-à-vis environmental factors.

Table 12: Representations of the eigenvalues of the PCA.

Component	**F1**	**F2**
Own value	4.275	2.518
Variability (%)	21.373	12.592
% of total resources	21.373	33.964

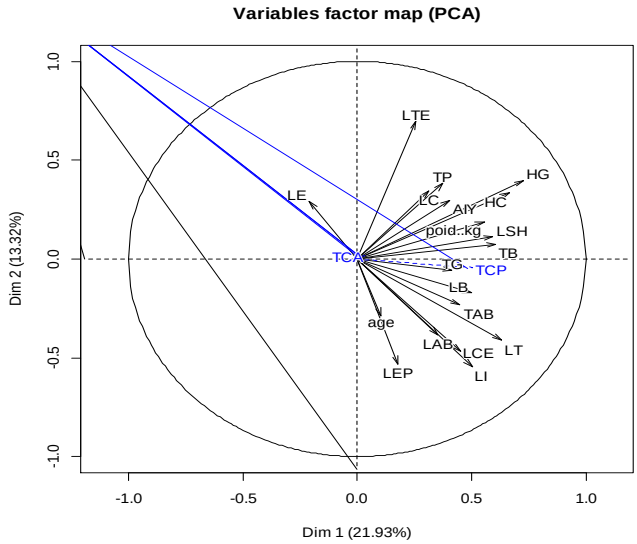

Figure 3: Presentation of body measurements by PCR in the population Barbe studied.

It can be seen from the PCA (Figure 4) and CAH (Figure 5) that the breed studied has no population structure, according to the data collected based on the geographical location of the animals. This being said, the CAH shows us the subdivision of our study taxon into three large groups and those that take into account the geographical location of the animals. This is due to the fact that the environment is therefore the farming practices at the level of the two regions (Tiaret and Aflou) is similar.

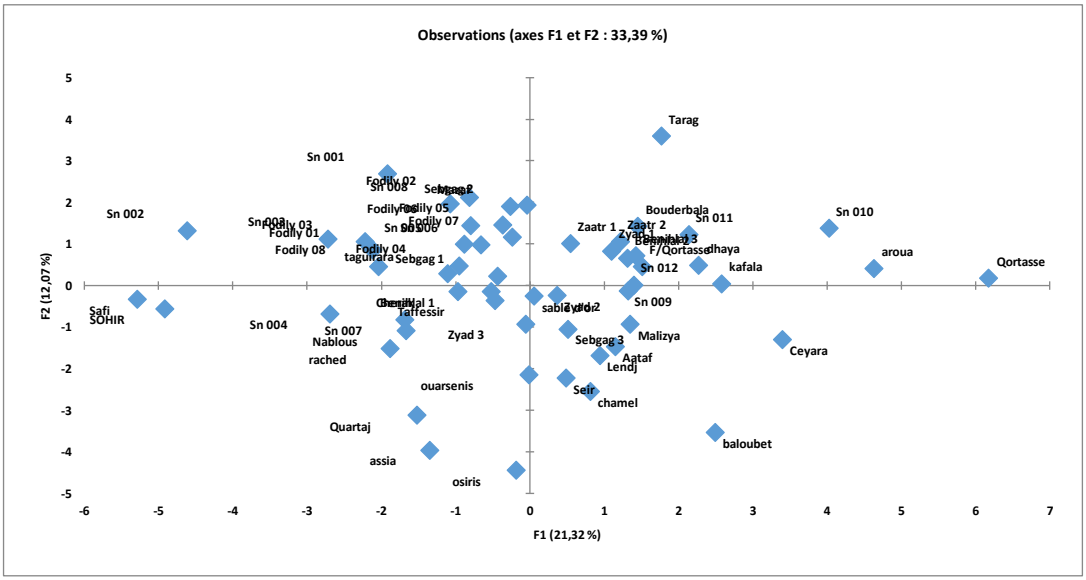

Figure 4: Presentation of the distribution by PCA for the population Barbe studied.

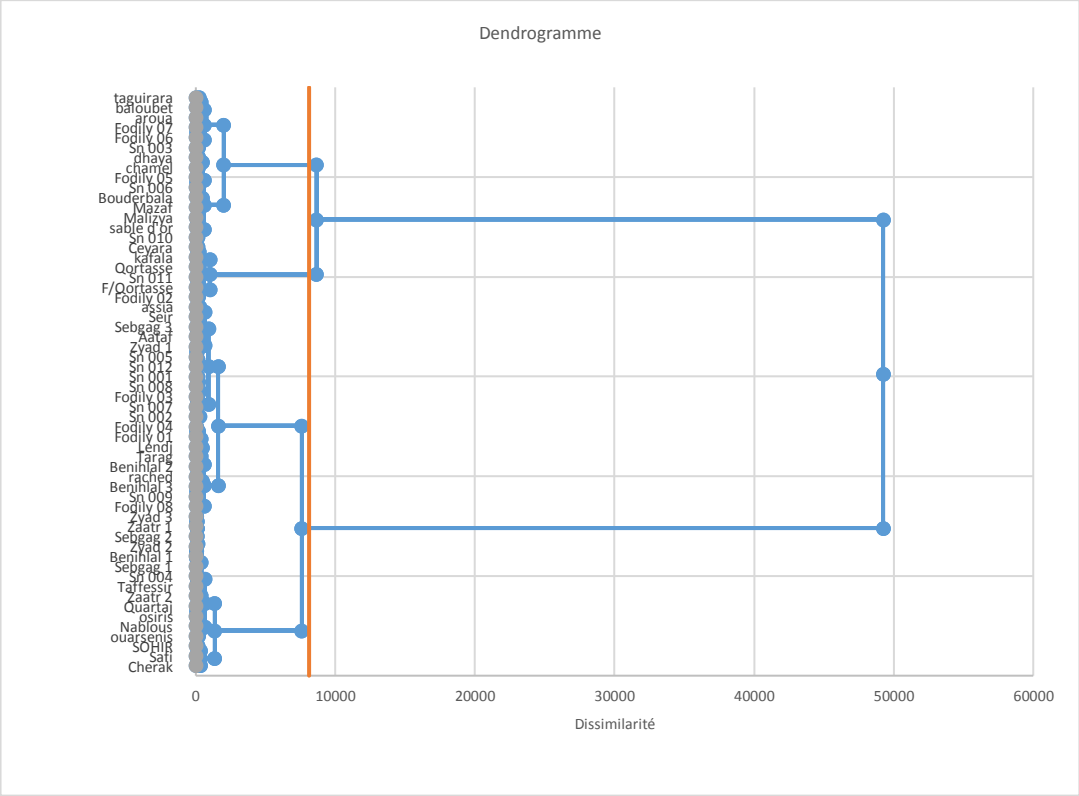

Figure 5: Ascending hierarchical classification (CAH) at the level of the studied population.

Conclusion

Animal genetic resources are an important element in the economic, food, environmental and sociocultural domains of a country. In Algeria, equine genetic resources are part of our national heritage and have great economic and socio-cultural value. However, information on the genetic diversity of the Algerian equine breeds is essential for the establishment of conservation and sustainable management strategies, especially for the two indigenous Barbe and Arab-Barbe races. During this original study, we contributed to the morphometric study (20 measured and 06 estimated) of the equine Barbe race at one of these most important cradles (wilaya of Tiaret and Laghouat (Aflou)), at L analysis of the diversity of the race studied, from 20 parameters by the calculation of the Shannon and Weaver index and the comparative study between males and females. The study was conducted on a sample of 58 animals of the Barbe breed. The data collected is analyzed by principal component (PCA) in order to know the different correlations that exist between the characters studied and a hierarchical ascending group classification by the CAH function. These statistical analyzes were carried out by the R version 2.15.2 software and the XLSTAT2016 software.

We also performed a morphometric comparison of our study population (Barbe) with the standard Barbe described by OMCB and a comparison with other breeds reported by other authors. The principal component analysis of our sample shows a grouping of characters into 4 classes. The first group includes only the LTe parameter which has no correlation with the LEp parameter which constitutes the fourth group, whereas the parameters TP, LC, AIY, HC, HG, weight kg, LSH and TB form the second group and the TCP, TG, LB, TAB, LT, LAB, LCE, and LI parameters form the third group that are juxtaposed to each other. The correlation of these characters between them is probably due to the existence of a certain number of genes in common in the control of their expression or that these characters react more or less in the same way with respect to environmental factors. The results obtained from the analysis of the diversity between the two populations showed that the difference is not very important. It is 0.38 for

the Tiaret Barbe population and 0.34 for the Aflou Barbe population. The equine breeding at the Tiaret region being closed and consanguineous (unlike that of the region of Aflou) were expected to have contrary results. That said, this small difference between the two values may be due to the fact that the population raised in the region of Aflou has probably suffered a recent founder effect. The statistical comparison between the two populations studied shows that the Barbe raised in the region of Tiaret to a total length and forearms longer and a more muscular ball than the Barbe horse raised in the region of Aflou. On the other hand, the animals of the region of Aflou have a rather long and wider head and a longer canon compared to that of the Barbe horse raised in the region of Tiaret. It is also clear from this study that the sample Barbe of Algeria is very close to the standard of the horse Barbe in general and that it has morphological characteristics close to the PSAr but very different from the PSA (the arm, the forearm and the canon shorter). As a result, the Barbe horse can not perform as well as the Thoroughbred in speed races, although he has some characteristics of the fast-moving saddle horse, namely the forehead, chest and broad limbs. , long shoulder, back, kidney and anterior forelock short. Nevertheless, the Barbe horse can be used in speed races but over long distances. On the other hand, since he has morphological characteristics very close to those of the Thoroughbred Arab, he could thus constitute a major competitor of the latter in the endurance raids, knowing that for some, the Arab-Barbe would be the best in this field. In addition, the Barbe horse has wide limbs and thick joints therefore a "safe foot", so it could be considered an excellent horse riding initiation and could also be used in treks in mountainous areas difficult to access. This study is an important prerequisite for initiating management and improvement plans for this resource. That said, our future goal would be to expand our study to other breeds such as the Breton Algerian (we suspect crossbreeds of this breed with the Barbe for the creation of the Algerian saddle) and the Algerian saddle and to expand the geographical scope investigation. Finally, any project of this scope would be complete if it was not initialized by a molecular study, an important step that we want to be the initiators in Algeria.

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