Morphometric description of Algerian Arab-Barb horse

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SUMMARY

Arab-Barb, the main horse breed in Algeria, remains morphologically unknown. The aim of this study was, firstly, to show the variability of external morphometric measurements of Arab-Barb horse breed in four regions of Algeria: coastal plains, mountains, high tablelands and limits with desert areas (area bordering the desert) and secondly, to compare Algerian Arab-Barb (AAB) to Moroccan Arab-Barb and to Algerian, Tunisian and Moroccan Barb horse. Twenty external body measurements, three body indices (body profile index, relative body index and compact index) and live weight estimation were carried out on 219 horses, aged 4 years and more. Multivariate analysis was performed to determine the morphologic differences in the four Algerian regions. The results revealed that height at withers and total length values were highest in horses from coastal plains, followed by those from high tablelands, areas bordering the desert and mountains region, respectively. The Multivariate analysis (PCA) revealed the presence of three groups of horses according to the size: horses with large size in coastal plains, horses with average size in high tablelands and areas bordering the desert and horses with small size in mountains region. Compared to Moroccan Arab-Barb, AAB presented higher values of height at withers (152.15±3.59cm) and canon circumference (19.41±1.37cm) and lower values of cannons length (24.80±3.23cm). When compared to the Barb, AAB horse possessed lower height at withers and smaller canon circumference. The body profile index (0.99) and the live weight (415.51±28.30kg) showed that AAB is a mediolinear horse with an eumetric format. The current results could contribute to establish a morphometric standard for Arab-Barb horses in northern Africa.

Keywords: Algeria; Arab-Barb; Horse; Morphometry.

Résumé

Description morphométrique du cheval Arabe-Barbe en Algérie

L'Arabe-Barbe, la principale race chevaline en Algérie, demeure morphologiquement inconnue. L'objectif de cette étude est, d'une part, de montrer la variabilité des caractères morphométriques externes des chevaux Arabe-Barbe élevés dans quatre régions de l'Algérie: les plaines littorales, les montagnes, les hauts plateaux et les limites avec les régions désertiques et d'autre part, de comparer le cheval Arabe-Barbe de l'Algérie (AAB) avec le cheval Arabe-Barbe du Maroc et le cheval Barbe de l'Algérie, de la Tunisie et du Maroc. Vingt mensurations ainsi que trois indices corporels (Indice corporel de profil, Indice corporel relatif et Indice de compacité) et le poids vif estimé ont été effectués sur 219 chevaux, âgés de 4 ans et plus. L'analyse multivariée a été utilisée pour déterminer les différences morphologiques des chevaux des quatre régions. Les résultats de cette étude ont révélé que les valeurs de la hauteur au garrot et de la longueur totale étaient plus élevées dans les régions des plaines littorales, suivies par les régions des hauts plateaux, limitrophes du désert et des montagnes, respectivement. L'analyse multivariée (ACP) a permis de distinguer trois groupes de chevaux selon la taille, les chevaux de grande taille dans les plaines littorales, les chevaux de taille moyenne dans les hauts plateaux et les limitrophes du désert et des chevaux de petite taille dans les régions montagneuses. Par rapport à l'Arabe-Barbe du Maroc, le cheval Arabe-Barbe de l'Algérie présente des valeurs supérieures de hauteurs au garrot (152,15 ± 3,59 cm) et de périmètres du canon (19,41 ± 1,37 cm) et des valeurs inférieures de longueurs du canon (24,80 ± 3,23 cm). Comparativement au Barbe, le cheval Arabe-Barbe de l'Algérie possède des hauteurs au garrot inférieures et des périmètres du canon plus petits. L'indice corporel de profil (0,99) et le poids vif (415,51 ± 28,30 kg) ont permis de classer le cheval Arabe-Barbe de l'Algérie en tant que cheval Médioligne avec un format eumétrique. Les résultats obtenus pourraient contribuer à établir un standard pour le cheval Arabe-Barbe de l'Afrique du nord.

Mots-clés : Algérie, Arabe-Barbe, Cheval, Morphométrie.

Introduction

In Algeria, horses are considered as corner stone involved in the country history and culture. They are estimated to approximately 100 000 heads [14] and the majority of these horses (90%) are identified as Arab-Barb breed [21]. This horse is distributed in four regions of northern Algeria: coastal plains, mountains, high tablelands and areas bordering the desert. Arab-Barb represents also the predominant equine breed in other Maghreb countries, especially, Tunisia and Morocco [5, 16].

Arab-Barb is known for its strength, well adapted for different activities including the parade, the work and the instruction, it is used also in the fantasia (traditional exhibition of horsemanship in the Maghreb performed during cultural festivals). Furthermore, Arab-Barb is extremely economic due to its maintaining and feeding [2].

Arab-Barb horse is the product of Tiaret broodmares (western Algeria) in 1877, by crossing the Barb, the autochthonous breed, with the Arabian horses [22]. This crossing was realized for the needs of military cavalry to correct some defects of the Barb horse. Afterwards, the products of this cross were mated with each other or with one of the parental breeds. Horses resulting from these different crossings are considered as Arab-Barb horse and are registered in the stud-book of the OMCB (Organisation Mondiale du Cheval Barbe) [6, 20].

Morphometric measurements of a horse could be useful to show its characteristics and its general body conformation. These measurements might be used to compare between normal and abnormal growth rates [23]. Body conformation is also useful in evaluating and comparing breeds [15, 19]. In Morocco, Boujenan *et al.*, 2008 investigated the morphometric characteristics and conformation of Arab-Barb horses in different regions of Morocco [6]. In Algeria, morphometric characteristics and conformation of Arab-Barb horses were investigated by Guedaoura *et al.*, 2011. However, this study was limited to one region and to a small number of animals [11].

In this context, the objective of the present study was to define the morphological characteristics of the Arab-Barb horse breed distributed in different regions of Algeria and to compare these characteristics to those of Moroccan Arab-Barb and to Algerian, Tunisian and Moroccan Barb horses.

Material and methods

MORPHOMETRIC MEASUREMENTS, BODY INDICES AND ESTIMATED LIVE WEIGHT

A total of 219 Algerian Arab-Barb horses (AAB), aged 4 years and more, registered in studbook were included in this study. These horses have a degree of Arabian blood lower than 75%. They were from 4 regions of Algeria: 57 from the coastal plains (Annaba, El Tarf, Skikda Algiers), 41 from mountains (Aures), 65 from high tablelands (Batna, Khenchela, Oum El-Bouaghi, Tebessa, Tiaret, Constantine, Setif, Mila, M'sila) and 56 from southern areas bordering the desert (Biskra, El oued) (Figure 1).

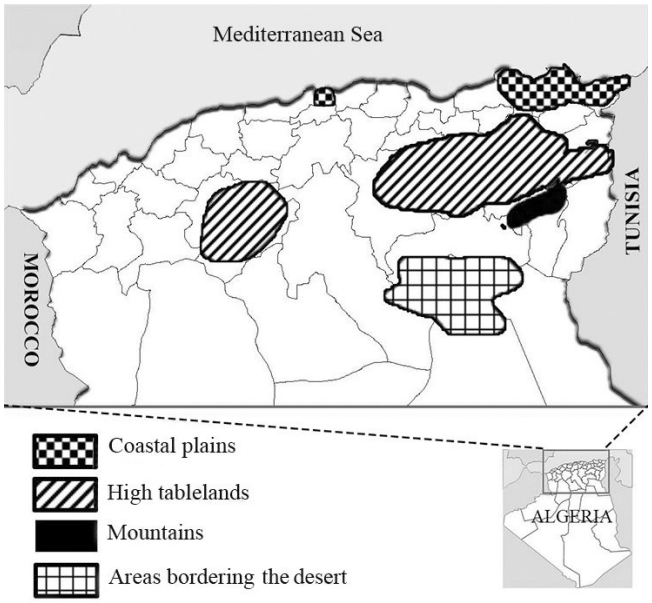

Figure 1: Location of horse flocks sampled in four regions of Algeria

For each horse, 20 morphometric measurements as described by Chabchoub [8] were recorded twice on the left side of each horse by the same person. The height measurements were taken by a measuring rod, whereas the other measurements by a measuring tape. For the measurement procedure, horses were put on a level and hard floor and held by the owners.

As shown in figure 2 (except eye to eye space), the 20 morphometric measurements (cm) were (1) eye to eye space, distance between the inner canthi of eyes; (2) head length, distance between the neck and the tip of the nose; (3) neck length, distance between the middle of the anterior edge of the shoulder and the most noticeable part of the edge of the first cervical vertebra; (4) neck circumference, circumference measured at the base neckline; (5) shoulder Length, distance between the summit and the tip of the shoulder; (6) total length, distance between the greater tubercle (tuberculum majus) of humerus and the ischial tuberosity (tuber ischiadicum); (7) humero-iliac length, distance between the greater tubercle of the humerus and coxal tuber (tuber coxae) of the ilium; (8) chest circumference, circumference around the chest behind the withers; (9) withers height, vertical distance from highest point of withers to the floor; (10) croup height, vertical distance from the highest point over the sacral tuberosity to the floor; (11) space under the chest, distance between the sternum and the floor; (12) arm length, distance from the central area of the scapula-humeral joint to the central area of the humero-radial joint; (13) forearm length, distance from the central area of the humero-radial joint to the lateral middle third of the carpal joint; (14) cannon Length, distance from lateral middle third of the carpal joint to middle third of lateral face of the metacarpo-phalangeal joint of right forelimb; (15) ilium length, distance between the greater trochanter of femur and the coxal tuber of ilium; (16) femur length, distance between the greater trochanter of femur and the patella; (17) forearm circumference, midpoint between the distance from the central area of the humero-radial joint and the lateral middle third of the carpal joint; (18) knee circumference, central region of the carpus; (19) cannon circumference, the circumference of the cannon bone at the middle point of its length and (20) fetlock circumference, circumference of the middle third of the lateral face of the metacarpo-phalangeal joint.

The following morphometric measurements, withers height (WH), total length (TL), chest circumference (CC) and live weight (LW), were used to calculate the conformation indices reported by Martin-Rosset, 1990 [18], and Carroll *et al.*, 1988 [7].

Body Profile Index (BPI): = WH/TL.
Relative Body Index (RBI): = TL/CC.
Compact Index (CI) = LW/WH

We estimated live weight by the formula adopted by Martin-Rosset, 1990 [18] as follow:
LW (kg) = 4.3 x CC + 3 x WH - 785.

Fig.2. Morphometric measurements carried out on Algerian Arab-barb horse

(1) Eye to eye space -Distance between the inner canthi of eyes (not shown in the figure).
(2) Head length
(3) Neck length
(4) Neck circumference
(5) Shoulder Length
(6) Total length
(7) Humero-iliac length
(8) Chest circumference
(9) Withers height
(10) Croup height
(11) Space under the chest
(12) Arm length
(13) Forearm length
(14) Cannons Length
(15) Ilium length
(16) Femur length
(17) Forearm circumference
(18) Knee circumference
(19) Cannon circumference
(20) Fetlock circumference
*Discontinuous line shows the square format of the AAB

FIGURE 2: Morphometric measurements carried out on Algerian Arab-Barb horse

STATISTICAL ANALYSIS

The Statistical analysis was performed using XLSTAT 2009 software. The results were expressed in Means, Standard Deviations, Minima and Maxima. Then, ANOVA followed by Fisher's PLSD were used to determine the differences between the groups. In order to study the morphological diversity of AAB in the 4 regions, multivariate analysis, particularly, the principal component analysis (PCA) and the cluster analysis were performed. The PCA, visualization and synthesis technique, were used to unravel the complexity and redundancy of raw data and bring out hidden information in the data [13]. The cluster analysis was used to establish a dendogram which is the best visualization of distance between regions.

Results

MORPHOMETRIC MEASUREMENTS, BODY INDICES AND ESTIMATED LIVE WEIGHT

The results of 20 morphometric measurements, body indices and live weight estimation of AAB are set out in Table I. The results by region are presented in Table II.

Measurements	Mean±SD	Minima	Maxima
Eye to eye space (cm)	20.03±0.99	18	22
Head length (cm)	52.80±2.78	47	59
Neck length (cm)	63.60±6.94	52	89
Neck circumference (cm)	114±6.28	102	124
Shoulder length (cm)	53.40±2.69	49	58
Total length (cm)	154.15±3.74	144	161
Humero-iliac length (cm)	115±5.92	100	126
Chest circumference (cm)	173.03±5.96	161	187
Withers height (cm)	152.15±3.59	138	160.50
Croup height (cm)	151.91±3.51	138	159
Space under the chest (cm)	82.37±3.40	77	89
Arm length (cm)	39.94±2.07	37	44
Forearm length (cm)	40.60±1.76	38	43
Cannon length (cm)	24.80±3.23	18.50	30
Ilium length (cm)	24.44±2.18	18	28
Femur length (cm)	43.52±2.98	36	48
Forearm circumference (cm)	35.40±2.49	31	40
Knee circumference (cm)	29.80±1.80	28	36
Cannon circumference (cm)	19.41±1.37	17	21
Fetlock circumference (cm)	26.11±1.77	22	29
Body profile index	0.99±0.03	0.94	1.06
Relative body index	0.89±0.03	0.79	0.95
Compact index (kg/cm)	2.73±0.17	2.36	3.12
Live weight estimation (kg)	415.51±28.30	342.30	500.60

SD :Standard Deviation

TABLE I: Descriptive statistics (Means, standard deviations, minima and maxima) of 20 morphometric measurements, body indices and live weight estimation in 219 Algerian Arab-Barb horses included in the present study.

The comparison between the horses of the four regions showed that Arab-Barb horses of mountains presented the lowest values for all the studied parameters; while, those of coastal plains showed the highest values. Statistically, the significant differences were registered in eye to eye space, head length, total length, height at withers, croup height, cannon length, femur length, fetlock circumference and live weight estimation. Regarding horses of areas bordering the desert and high tableland regions, the values were similar with no significant differences all parameters considered.

MULTIVARIATE ANALYSES

In the second part of the current study, PCA was performed to analyze the morphometric differences among the horses of coastal plains, high tablelands, areas bordering the desert and mountains. From 20 morphometric measurements, the number of new principal components was established and limited to five. These components were chosen as each eigenvalue was greater than 1.0. They explained 45.14% of the variability conditioned by all measurements. The first and the second components plotted on a two-dimensional (Figure 3) showed a variation among the horses included in this study. Indeed, the first component (PC1) described 13.6% of the total variability, whereas the second component (PC2) described 9.5%. This variability revealed that the horses of mountains, constituting the first group, differ significantly from those of coastal plains, forming the second group. Furthermore, the two-dimensional plotted by PC1 and PC2 showed also a third group morphologically similar including horses from high tablelands and from areas bordering the desert, . In fact, the third group represented an intermediate group which connected the two other groups.

The results of the dendogram presented in the Figure 4 are similar to those of PCA revealing three different groups with, horses of mountains and coastal plains representing the first and the second groups and horses of high tablelands and areas bordering the desert constituting the third group.

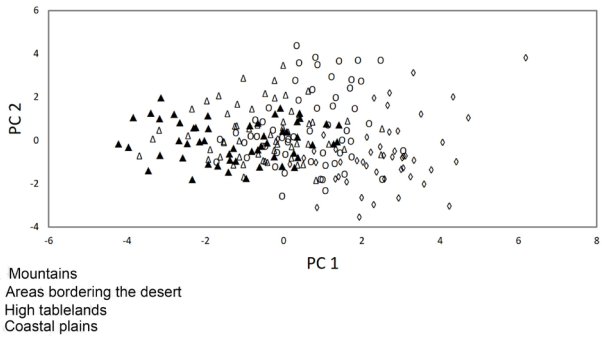

Figure 3: Principal components analysis performed according to the four regions sampled in Algeria

Measurements	Mountains (n=47)	Areas bordering the desert (n=56)	High tablelands (n=65)	Coastal plains (n=51)
Eye to eye space (cm)	19.90^{a} ± 0.68	20.10^{ab} ± 0.80	20.24^{ab} ± 1.01	20.50^{b} ± 0.95
Head length (cm)	55.63^{a} ± 6.79	57.53^{ab} ± 6.01	58.81^{b} ± 8.33	59.49^{b} ± 6.38
Neck length (cm)	63.02 ± 5.76	63.16 ± 6.59	63.31 ± 6.91	63.41 ± 6.85
Neck circumference (cm)	113.31 ± 6.27	113.62 ± 6.30	113.64 ± 6.66	114.04 ± 6.02
Shoulder length (cm)	53.13±0.34	53.26±0.44	53.21±0.41	53.31±0.46
Total length (cm)	150.94^{a}**±4.49	153.24^{b} ± 5.08	153.26^{b}±4.90	154.98^{c} ± 4.30
Humero-iliac length (cm)	114.39 ± 5.82	114.53 ± 5.73	115.14 ± 5.55	115.53 ± 5.52
Chest circumference (cm)	171.94 ± 5.36	172.66 ± 5.52	172.68 ± 5.57	173.02 ± 5.77
Withers height (cm)	150.68^{a}**±4.08	152.77^{b} ± 4.00	152.88^{b}±4.39	154.45^{c} ± 3.39
Croup height (cm)	150.25^{a}**± 4.34	151.82^{b} ± 4.47	151.87^{b}±4.10	153.91^{c} ± 4.11
Space under the chest (cm)	81.20 ± 3.51	81.50 ± 4.09	81.84 ± 3.54	82.12 ± 2.57
Arm length (cm)	29.30 ± 2.77	29.38 ± 2.46	29.69 ± 2.30	30.39 ± 1.19
Forearm length (cm)	44.50 ± 2.33	44.53 ± 2.24	44.69 ±2.16	44.73 ± 1.51
Cannons length (cm)	28.00^{a} ±1.47	28.22^{a} ± 2.26	28.34^{a} ± 1.90	29.80^{b} ± 2.32
Ilium length (cm)	36.13$_{a}$ ± 1.93	36.79^{a} ± 2.26	37.81^{b} ± 3.30	38.35^{b} ± 1.32
Femur length (cm)	39.22^{a*} ± 1.80	41.07^{b} ± 2.64	41.17^{b} ± 3.71	41.39^{b} ± 2.67
Forearm circumference (cm)	42.28^{a} ± 3.55	44.87^{b} ± 4.29	46.41^{b} ±2.91	46.94^{b} ± 2.03
Knee circumference (cm)	30.87^{a*} ± 5.83	32.15^{b} ± 7.56	32.33^{b} ± 5.32	34.19^{c} ± 8.53
Cannon circumference (cm)	19.11^{a} ± 1.04	19.34^{ab} ± 0.97	19.68^{b} ± 2.04	19.73^{b} ± 0.96
Fetlock circumference (cm)	25.24^{a} ± 1.54	25.49^{ab} ± 1.58	26.24^{bc} ± 4.17	26.66^{c} ± 1.99
Body profile index	0.99 ± 0.009	0.99 ± 0.010	0.99 ± 0.011	0.99 ± 0.008
Relative body index	0.87 ± 0.006	0.88 ± 0.008	0.88 ± 0.008	0.89 ± 0.005
Compact index (kg/cm)	2.70 ± 0.040	2.72 ± 0.038	2.72 ± 0.037	2.73 ± 0.036
Live weight estimation (kg)	406.38^{a} ± 7.88	415.74^{ab} ± 8.64	416.16^{ab}±7.21	422.33^{b}±10.53

Means followed by different letters within the line are significantly different (P<0.05);*P<0.01 ;**P<0.001.

Table II: Descriptive statistics (Means ±standard deviations) of 20 morphometric measurements, body indices and live weight estimation in 219 Algerian Arab-Barb horses included in the present study, distributed by region.

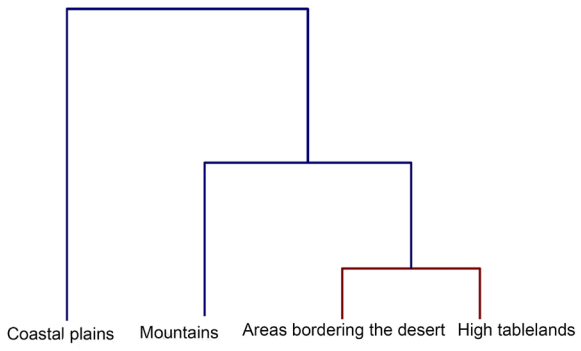

Figure 4: Dendrogram based on morphological traits (distances between regions)

Discussion

Arab-Barb constitutes the dominant horse breed in Algeria; however, this breed remains morphometrically unknown. Therefore, the objective of the current study was, firstly, to realize a morphometric characterization of AAB distributed in 4 regions: coastal plains, mountains, high tablelands and areas bordering the desert and secondly, to compare the obtained morphometric measurements to those of Moroccan Arab-Barb and to Algerian, Tunisian and Moroccan Barb horses.

The morphometric measurements showed that Algerian Arab-Barb horse, as well as the Barb horse, has a square format. In AAB, this format was characterized by height at withers: 152.15 cm, total length: 154.15 cm and cannon circumference 19.41cm, indicating that AAB has thick members relative to its size [17]. This promotes its strength and thickness. In addition, AAB presented a large chest circumference necessary for a fast saddle horse. Besides, 1.001 ratio of the height at withers/croup height (152.15cm/151.91cm) revealed that AAB is slightly horizontal and less oblique, correctly appropriated for all services [17].

The morphometric comparison between AAB from the four studied regions showed significant differences in height at withers and total length values. Indeed, these values were higher in coastal plains, followed by high tablelands region, areas bordering the desert and mountains, respectively.

Concerning the comparison of the average of morphometric measurements of AAB with those of Moroccan Arab-Barb and with Algerian, Tunisian and Moroccan Barb horses, the results showed that they all present the same square format. However, there were significant differences ($P < 0.05$) in some morphometric measurements, particularly concerning, height at withers, chest circumference and cannon length. In fact, the height at withers of AAB (152.15cm) was higher than that observed by Boujenane for Moroccan Arab-Barb [6] and lower than that reported by Chabchoub for Tunisian Barb [8]. Furthermore, The Arab-Barb horses, in the present work, had a larger chest circumference than that observed by Boujenane for Moroccan Arab-Barb horse [6], but smaller than that cited by Guedaoura in Algerian Barb [11] and by Chabchoub in Tunisian Barb horses [8]. Moreover, cannon length of AAB (24.8 cm) was lower than that of Moroccan Arab-Barb horses [6].

In order to study deeply AAB conformation, body profile index, relative body index, compact index and body live weight were assessed from the morphometric measurements. The body profile index of AAB was 0.99, close to 1 leading to classify this horse as a mediolinear breed, meaning that its total length is substantially equal to its height [17]. This result is in agreement with the results of body profile index obtained for Moroccan Arab-Barb horse [6] and for Barb horse [8, 11, 12]. The remaining indices, especially, relative body index and compact index were similar between AAB, Moroccan Arab-Barb [6] and Barb horses [8, 11, 12]. In addition, Arab-Barb horses from the four Algerian regions presented the same indices indicating that their conformations are similar. Regarding body live weight, AAB presented an average of 415.5 kg, a weight heavier than that Moroccan horse [6]. The weight of AAB led to considered it as a medium sized horse.

In the present work, the multivariate analysis was used to evaluate the morphometric differences of AAB in the four studied regions. According to horse size, the results of PCA revealed the presence of three groups of horse: (i) horses of mountains regions, (ii) horses of coastal plains and (iii) horses of high tablelands and areas bordering the desert.

The horses of the second group (coastal plains) were heavier and larger than those of the first group (mountains). In this respect, the horses of the mountains seem to be more thickset and less elegant. They used to produce the mules which are more adapted for mountain activities. The differences in size between the 2 groups may be related to the climate and vegetation characteristics of each region. Indeed, coastal plains region, characterized by mediterranean humid climate, is covered by a rich vegetation constituting an important source of food [1, 3], whereas mountains region (Aures), a broad ecotone between the subhumid climate and the Sahara desert, is known for climatic variability and vulnerability to desertification [4].

Concerning the third group (high tablelands and areas bordering the desert), the dominant climate of the two regions of this group is semi-arid, with similar vegetation [3, 9, 10]. These characteristics may explain the morphometric similarity between horses of these regions.

Furthermore, PCA analysis revealed that high tablelands and areas bordering the desert represented together an intermediate region connecting the two other regions (mountains and coastal plains). The overlapping point clouds in the intermediate region means an approximation of morphological characters between the third group and the other groups which may be due to the use of Barb and Arab-Barb stallions of high tablelands as studhorses in stud

farms throughout the country. The choice of stallions of high tablelands region for reproduction might be related to their morphologic characteristics. Indeed, they are strong, harmonious and elegant [11].

In conclusion, the results of morphometric characterization of AAB indicated that this horse is strong, a saddle horse, ideal for several activities such as fantasia, endurance and riding. Furthermore, AAB population could be classified, according to the morphometric characteristics and geographic distribution, into three groups: horses with a large size in coastal plains, horses with an average size in high tablelands and areas bordering the desert and horses with a small size in mountains region. AAB is larger than Moroccan Arab-Barb and smaller than Barb horse. Finally, more studies on Arab-Barb breed including morphometric and genetic parameters are required, to establish accurately a standard for this breed.

Acknowledgements

The assistance of Rahab Hamza, Lamine Noui and Nadjib Ghassir in data collection is greatly appreciated.

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