sciendo

DOI: 10.2478/fv-2020-0009

FOLIA VETERINARIA, 64, 1: 66—76, 2020

MORPHOMETRIC CHARACTERISTICS OF THE EXTREME EASTERN ALGERIAN DOMESTIC DONKEY (*EQUUS ASINUS*)

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ABSTRACT

The aim of this study was to define the morphometric variability of the extreme Eastern Algerian donkeys. The study was carried out from June to December 2018 in El-Tarf, Souk-Ahras, and Tebessa provinces. The study population involved 65 individuals (32 jacks and 33 jennies) between the ages of 3 and 16 years old. In total, 13 body measurements were used, and 5 zootechnical indexes were calculated. The quantitative and qualitative characteristics were studied in order to establish an ethnic and functional classification of this particular subspecies. The qualitative data demonstrated that the coat colour was variable. Bay and greyish colours were dominant with a respective rate of 61.5 % and 38.5 %, respectively. The head, the nose, as well as the eyes contour colours were mainly grey with 52.3 %, 58.5 % and 50.8 % respectively. The partial absence of the coat particularities was observed. The population presented a significate relationship between the quantitative characters ($P < 0.05$). The donkeys were longilinear, of a rectilinear profile, compact with massive trends. They had a hypermetric format. The animals are good for meat production. The General Linear Model (GLM) showed that the body measurements were variable by sex and body mass. The principal component analysis (PCA), the multiple correspondence analyses (MCA) and the ascending hierarchical classification (AHC) revealed that the population was composed of 2 clusters representing 4 animal classes. This study was the first report on the phenotypic characterization of donkeys in the extreme Eastern Algerian area, based on corporal measurements. The results indicated the existence of heterogeneity and suggested the possibilities of genetic improvement within the species.

Key words: Algeria; Body measurement; donkey; ethnology; improvement; phenotype

INTRODUCTION

Donkeys were domesticated in Africa since 5 000 years BCE [2, 24]. They were used to satisfy human needs in

transport and work, to allow the movement of people and goods, and to influence the organization of the first cities and pastoral societies [7, 42]. Their numbers decreased with the advent of motor vehicles.

The first genetic studies on mitochondrial DNA revealed that the African Wild Ass was the common ancestor of the present domestic donkey. Two different populations were described: *Equus africanus* and *Equus africanus somaliensis* [2, 19, 51]. However, the Maghreb domestic donkey has not yet been genetically identified; hypotheses suggest the possibility of belonging to the Atlantic donkey [36].

In Algeria, few studies have described the composition of the donkey population from the colonial era [5, 40, 46] to the present [1, 27]. The lack of data on the Domestic Animal Diversity Information System (DAD-IS) about the species in Algeria reflects the neglect and disinterest leading to the reduction of its population from 315 000 in 1961 to 136 000 in 2013 [37]. This study was conducted to contribute to a better understanding of the autochthonous donkey population in Algeria which may influence its preservation and genetic improvement. It may also serve as a reference for other work involving the Algerian and the Maghreb asinus species.

MATERIALS AND METHODS

Study area

This study was conducted from June to December 2018 in 3 wilaya (provinces) in the extreme East of Algeria: El-Tarf (36° 46' 02" N, 8° 18' 50" E), Souk-Ahras (36° 17' 15" N, 7° 57' 15" E) and Tebessa (35° 24' 00" N, 8° 07' 00" E) (Fig. 1).

Ethical approval

Given the passive nature and the lack of harm to the animal's health and welfare, no ethical approval was required for this study.

Studied animals

A morphometric description was carried out on 65 donkeys (32 jacks and 33 jennies) between the ages of 3 and 16 years old. The donkeys were divided into 3 age groups: 3—6 years (young); 6—9 years (adult); and >9 years old. The age of the animals was estimated by the observation of the dentition [25, 38]. The body condition scoring was based on the rating grid cited by Pearson and Ouassat [35], Vall et al. [47] and Svendsen [45]. The animals were used in traction work in the area of the study.

Data collection

Data collection was derived from the approach developed by Lauvergne [27] and adapted by FAO [14] for qualitative and quantitative characteristics.

Qualitative traits studied

Coat colour with its particularities, muzzle, head, mucous membranes, and eye border colours were described by direct observation of the animals in daylight [8, 10].

Fig. 1. Study area

Body measurements and zootechnic indexes

The body measurements were taken by the same operator in the morning. Height, width, and length measures were taken using a measuring rule. A measuring tape was used for the diameter and perimeter measurements. In total, thirteen (13) quantitative characteristics were measured for each animal. These concerned: the Withers Height (WH) measured from the highest point at the withers to the ground [29]; the Heart Girth (HG), the circumference measurement taken around the chest just behind the paws and behind the withers [16]; the Body Length (BL), the distance between the tip of the shoulder and ischium [16]; the Back Length (BkL), from the base of the withers to the base of the tail [16], the Cannon Circumference (CC), a metric tape was placed perpendicular to the axis of the cannon, four fingers below the lower part of the "Knee" joint [3]; the Cannon Length (CL), measured between the metacarpal IV head and the distal end of the metacarpal [3]; the Neck Length (NL), measured between the cranial edge of the atlas wings and the apex of the scapula [3]; the left and right ear length (LEL-REL); the Rump Width (RW), the distance between the ilia [3]; the Rump Height (RH), the distance between the rump and the ground [3] ; the diameter between the Ribs (DR); and the Head length (CLH), which was measured on the midline between the top of the occipital region and the tip of the nose [3] (Fig. 2).

From the linear measurements, 5 corporal indexes developed in horses and adapted for donkeys were calculated [8, 10, 15]; they were defined in the following formulas. The Profile Index (PI) = WH/BL and the Body Index (BI) = BL/HG made possible the distinction between brevilinear, mediolinear and longilinear conformations. The animals were small (< 1) or medium (= 1); or fit for work traction. They could also have long conformation (> 1); good animals for speed [30, 31]. The Metacarpothoracic index (MTI) = CC/CW allowed defining three animal types: hypermetric, eumetric, and ellipometric animals [6]. The Compactness Index (CI) = BW/WH [4, 12] and the Height in Front of- Behind HFBI = WH/RH [13, 28]. The (CI) defined animals with or without weight overload; FBH ≤ 1: straight back (no overload) or HFBI > 1: the anterior region was higher than the posterior (overload). The body weight (BW) of each animal was calculated according to two validated formulas: BW1 = HG2.826/4434.7 [11] and BW2 = (HG2.575 × HW 0.240)/3968 [4].

Statistical analysis

Normality (Kolmogorov-Smirnov test) and homogeneity of variance (Levene test) were checked for all the variables. Variables without parametric test requirements were log-transformed to meet the assumptions of the analysis.

Principal component analysis (PCA) collapsed the 18 inter-correlated variables into independent vectors. The test reduced the dimensionality to a small number of representative and uncorrelated variables. Also, it prevented multi-collinearity.

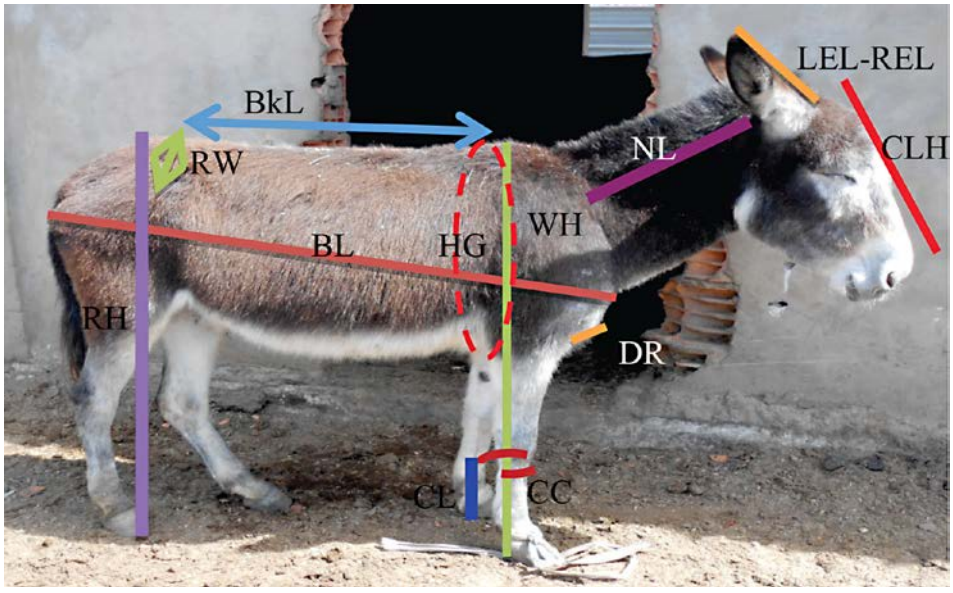

Fig. 2. Body measurements

Multivariate analysis of variance (MANOVA) with the General Linear Model (GLM) procedure was conducted. It assessed the variability of the defined independent vectors by sex, age, body mass, and their interactions. When significant overall F-test values were identified in each MANOVA, we compared the two post-hoc procedures, Scheffé method for univariate F [18].

Factorial analysis (AFC) was used for the qualitative variables. That permitted the differentiation of the donkeys and the construction of a typology, which consisted of identifying individuals who were relatively similar to each other 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 (version 17) and the R software.

RESULTS

Qualitative traits studied

For the donkeys studied, two main coat colours were observed: the bay colour (61.5 %) with its shades (light, dark and burnt) and the grey colour (38.5 %) with its shades (light and dark). The head, muzzle and eye contour colours were predominantly grey with 52.3 %, 58.5 %, and 50.8 %, respectively. Data analysis revealed a partial absence of the coat particularities, especially the back stripes and the zebra marks (100 %).

Quantitative traits studied

The donkeys had dolichocephalic head, length was greater than width (CLH = 40.79 ± 4.65 cm) with longer ears (REL = 26.06 ± 2.23 cm, LEL = 25.88 ± 2.05 cm) (Table 1).

Table 1. Descriptive analysis of the body measurements in the extreme Eastern Algerian donkeys

Traits	Min	Max	Mean ± SD (n = 65)	SE	Var.
HG [cm]	101.00	131.00	114.94 ± 6.78 a	0.06	0.25
BL [cm]	103.00	135.00	115.76 ± 7.23 a	0.11	0.75
HW [cm]	94.00	132.00	110.15 ± 8.49 a	0.07	0.28
NL [cm]	26.00	52.00	39.62 ± 5.38 a	0.84	45.96
REL [cm]	21.00	32.00	26.06 ± 2.23 a	0.90	52.27
LEL [cm]	22.00	32.50	25.88 ± 2.05 a	1.05	72.03
CLH[cm]	24.00	50.00	40.79 ± 4.65 a	0.67	28.91
CL [cm]	10.00	22.00	14.07 ± 2.28 b	0.28	4.97
CC [cm]	11.00	17.00	13.93 ± 1.33 C	0.25	4.20
BkL [cm]	51.00	107.00	69.95 ± 10.11 b	0.58	21.62
RW [cm]	27.50	40.00	32.76 ± 3.03 e	0.28	5.21
DR [cm]	19.00	33.00	25.93 ± 2.99 e	0.17	1.77
RH [cm]	96.00	137.00	114.02 ± 9.25 a	1.25	102.17
BW1 [kg]	104.08	217.04	151.30 ± 25.45 a	0.38	9.17
BW2 [kg]	108.95	227.33	158.83 ± 26.77 a	0.37	8.92

Values with different alphabet letters across the row for each parameter were significantly different at $P < 0.05$. (HG) Heart Girth, (BL) Body Length, Withers Height (WH), (NL) Neck Length, (REL) Right Ears Length, (LEL) Left Ear length, (CLH) Head length, (CL) Cannon Length, (CC) Cannon Circumference, (BkL) Back Length, (RW) Rump Width, (DR) Diameter between the Ribs, (RH) Rump Height, (BW 1) Body Weight 1, (BW 2) Body Weight 2

Table 2. Calculated zootechnical indexes

Indices	Min	Max	Mean ± SD (n = 65)	SE	Var.
CI	0.95	1.18	1.05 ± 0.05	0.01	0.00
PI	0.84	2.48	0.98 ± 0.20	0.02	0.04
BI	0.37	1.10	1.00 ± 0.09	0.01	0.01
MTI	0.10	0.15	0.12 ± 0.01	0.00	0.00
HFBI	0.89	1.03	0.97 ± 0.03	0.00	0.00

(PI) Profile Index, (BI) Body Index, (MTI) Metacarpo-thoracic index
(CI) Compactness Index, (HFBI) Height in Front of- Behind

Table 3. Body measurements according to the factors (sex and BCS)

Traits	According to sex		P	According to BCS		P
	Male n = 32	**Fem ale** n = 33		**BCS = 3** n = 43	**BCS = 4** n = 22	
HG [cm]	116.85 ± 7.18	112.97 ± 5.82	*	113.44 ± 4.66	117.52 ± 6.33	*
BL [cm]	116.85 ± 8.81	114.64 ± 5.02	Ns	115.82 ± 6.93	116.86 ± 6.94	Ns
HW [cm]	112.67 ± 9.90	107.55 ± 5.81	*	109.70 ± 4.59	111.55 ± 7.45	*
NL [cm]	40.45 ± 6.33	38.75 ± 4.09	Ns	36.61 ± 5.27	41.75 ± 4.31	
REL [cm]	26.58 ± 2.36	25.53 ± 1.99	ns	25.38 ± 1.14	26.73 ± 2.10	ns
LEL [cm]	26.36 ± 2.15	25.38 ± 1.84	ns	26.12 ± 1.22	26.52 ± 1.92	ns
CLH [cm]	41.33 ± 5.64	40.23 ± 3.33	ns	38.94 ± 7.73	41.86 ± 3.62	ns
CL [cm]	14.85 ± 2.16	13.27 ± 2.15	**	14.46 ± 1.80	14.25 ± 2.54	ns
CC [cm]	14.38 ± 1.32	13.47 ± 1.20	**	14.87 ± 1.44	14.09 ± 0.85	ns
BkL [cm]	72.21 ± 10.12	67.63 ± 9.70	ns	72.02 ± 11.74	71.18 ± 4.19	ns
RW [cm]	32.70 ± 3.38	32.83 ± 2.67	ns	34.07 ± 3.84	32.73 ± 3.44	ns
DR [cm]	26.00 ± 2.81	25.86 ± 3.21	ns	26.80 ± 3.52	26.36 ± 3.26	ns
RH [cm]	117.27 ± 9.70	110.67 ± 7.52	**	112.88 ± 8.74	116.48 ± 9.66	ns
BW1 [kg]	158.60 ± 26.79	143.78 ± 21.94	*	145.23 ±16.99	160.85 ± 25.04	*
BW2 [kg]	166.75 ± 28.61	150.66 ± 22.34	*	152.82 ± 17.57	168.42 ± 26.18	*

(HG) Heart Girth, (BL) Body Length, Withers Height (WH), (NL) Neck Length, (REL) Right Ears Length, (LEL) Left Ear length, (CLH) Head length, (CL) Cannon Length, (CC) Cannon Circumference, (BkL) Back Length, (RW) Rump Width, (DR) Diameter between the Ribs, (RH) Rump Height, (BW 1) Body Weight 1, (BW 2) Body Weight 2; * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$; ns: $P > 0.05$.

The body length (BL) was measured from the tip of the shoulder to the tip of the ischium. It was 115.76 ± 7.23 cm. The withers height was HW = 110.15 ± 8.49 cm and the rump height (RH) was 114.02 ± 9.25 cm with the highest variation (102.17 %) compared to the other measurements (Table 1). The HG was 114.94 ± 6.78 cm (Table 1). The BW average was 158.83 ± 26.77 kg, it varied between 108.95 kg and 227.33 kg. Our results showed a highly significant correlation between HG and BW ($P < 0.01$). There was a significant correlation between the quantitative characteristics ($P < 0.05$).

Both the Profile and the Body indexes ($PI \approx 1$ and $BI \geq 0.90$) allowed us to organize the population as longilinear shaped, whereas the pelvic index ($HFBI \leq 1$) indi-

Table 4. Body measurements in the extreme Eastern Algerian donkeys according to age

Traits	3 ans6 ans	6 ans—9 ans	> 9 ans	P
	n = 28	n = 16	n = 21	
HG [cm]	116.46 ± 7.56	111.69 ± 5.38	114.94 ± 6.78	ns
BL [cm]	116.79 ± 7.89	113.81± 6.51	115.76 ± 7.23	ns
HW [cm]	110.54 ± 8.58	108.13 ± 8.14	110.15 ± 8.49	ns
NL [cm]	38.89 ± 6.46	40.56 ± 4.59	39.62 ± 5.38	ns
REL [cm]	26.50 ± 2.17	25.78 ± 2.25	26.06 ± 2.23	ns
LEL [cm]	26.20 ± 2.17	25.81 ± 1.56	25.88 ± 2.05	ns
CLH [cm]	41.18 ± 5.86	40.38 ± 2.55	40.79 ± 4.65	*
CL[cm]	14.77 ± 2.30	12.66 ± 1.60	14.07 ± 2.28	ns
CC [cm]	14.18 ± 1.21	13.44 ± 1.17	13.93 ± 1.33	ns
BkL [cm]	70.64 ± 9.59	67.13 ± 6.44	69.95 ± 10.11	ns
RW [cm]	33.20 ± 2.90	32.13 ± 3.48	32.76 ± 3.03	ns
DR [cm]	26.21 ± 2.77	25.06 ± 3.73	25.93 ± 2.99	ns
RH [cm]	115.89 ± 9.44	110.81 ± 8.74	114.02 ± 9.25	ns
BW1 [kg]	157.30 ± 28.93	139.07 ± 19.00	151.30 ± 25.45	ns
BW2 [kg]	164.70 ± 30.17	146.43 ± 20.50	158.83 ±26.77	ns

(HG) Heart Girth, (BL) Body Length, Withers Height (WH), (NL) Neck Length, (REL) Right Ears Length
(LEL) Left Ear length, (CLH) Head length, (CL) Cannon Length, (CC) Cannon Circumference, (BkL) Back Length
(RW) Rump Width, (DR) Diameter between the Ribs, (RH) Rump Height, (BW 1) Body Weight 1
(BW 2) Body Weight 2; * P < 0.05; ** P < 0.01; *** P < 0.001; ns: P > 0.05

cated that it was a rectilinear population. The HW was less important than the RH.

According to the dactylo-thoracic index, the donkeys were hypermetric (MTI > 0.1). They were compact with heavy tendencies. They could not even bear loads of their own weight (CI > 1). The results indicated that the body mass of the donkeys was greater than their size; they were overweight (Tables 1 and 2).

The multivariate analysis showed that the morphometry of the donkeys was variable by both sexes ($\lambda = 0.68$, $F = 3.75$, $p = 0.004$) and body status (BCS) ($\lambda = 0.80$, $F = 1.98$, $p = 0.004$). On the contrary, the variables were not affected by age ($\lambda = 0.75$, $F = 1.23$, $p = 0.27$). The interactions (sex × age), (sex × BCS), (BCS × age) and (sex × age × BCS) did not have any effects on the variation of the different measures performed. The interactions expressed the respective statistical values ($\lambda = 0.90$, $F = 0.44$, $p = 0.94$), ($\lambda = 0.97$, $F = 0.23$, $p = 0.97$), ($\lambda = 0.79$, $F = 1.02$, $p = 0.43$) and ($\lambda = 0.89$, $F = 0.47$, $p = 0.93$).

According to sex and BCS; Silhouette measurements (HG, BL, HW, NL, REL, LEL, CLH and RH, BW1 and BW2) were positively correlated with each other. There were highly significant differences between the two sexes ($F = 9.91$, $p = 0.003$) and BCS ($F = 7.54$, $p = 0.008$). Males expressed higher body measured values than females. They were generally heavier than females (Table 3).

Body measurements and zootechnical indexes related to the skeleton (Cl, BKL), proportions (PI, BI), format (CC, MTI), width (RW, DR), and corpulence (CI, HFBI) were not affected by sex, BCS or by the interaction between those factors ($P > 0.05$).

According to age, animals aged between 6 and 9 years old expressed lesser length and width than other animals with a lower HG and HW and a shorter head (CLH) (Table 4). According to the statistical study, age and its interactions with the other factors of variations (sex × age), (BCS × age) and (sex × age × BCS) didn't have any effect on the difference of the morphometry or the zootechnical indexes ($P > 0.05$).

Genetic variability of the population

The CPA performed on the body measurements yielded a cumulative effect on the first two axes expressing a total inertia rate of 63.73 %. The statistical analysis revealed that those two axes presented respective rates of 52.19 % and 11.54 % of the total inertia, which is statistically insufficient to explain the information (Table 5).

To find more meaningful representation, a hierarchical analysis (AFCM) was indispensable. It made possible the distinction between two clusters explaining 92.46 % of the information with a rate of 86.80 % on the first dimension and 5.66 % on the second one. The hierarchical clustering on the factor map illustrated the relationship between the clusters (Fig. 3). It appeared that, while confirming the structure population, the phylogenetic tree had to establish the relationships between the genetic types. The extreme Eastern Algerian donkey population was structured about four genetic types: A, B, C and D. A and B were closer together while C and D were distant. The results revealed some heterogeneity in the population.

DISCUSSION

Animal's description

In mammalian species, their hair coat properties reflect their health and welfare directly [33]. Despite its great phylogenetic proximity, the asine species have very different phenotypes from those of the horse [28]. Their diversity may be due to the migration of donkeys throughout the African continent [23]. The Extreme Eastern Algerian donkeys have diversified coat colour with a predominance of bay and grey colours (61.5 % and 38.5 % respectively). The results were correlated with the description given by A y a d et al. [1] for the donkeys in the Kabylie area (Centre of Algeria) where the animals were mostly bay (46 %) and grey (19 %). L a b b a c i et al. [26] reported a dominant brown coat colour of the donkeys of Tlemcen (West of Algeria) with a rate of 65.6 %. Our population was compared to the description of the African donkey *Equus asinus* nubicus (*Equus asinus africanus*) [39]. In addition, our observations were comparable to those obtained in the Bulgar-

Table 5. Eigen values (Total Variance explained)

Component	Initial Eigen values			Extraction of the sums of the squares		
	Total	% of variance	% cumul	Total	% of variance	% cumul
1	7.829	52.19	52.19	4.97	33.11	33.11
2	1.731	11.54	63.73	4.59	30.62	63.73

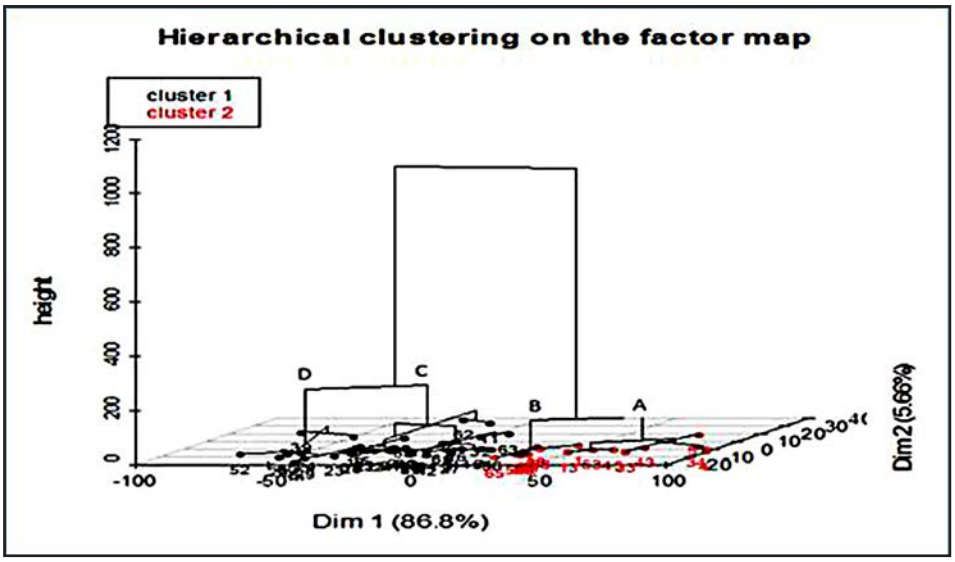

Fig. 3. Hierarchical clustering on the factor map of the extreme Eastern Algerian donkey population

ian donkey population [48]. Yilmaz and Ertuğrul [49, 50] reported mostly grey coloured donkeys in Turkey with a rate of 31.4 %. In addition, Gupta et al. [17] described a greyish colour dominance in the donkeys of the South-West region of Bihar (India).

Body measurements and zootechnical indexes

Cephalic measurements have been used to define the origins of species. Also, they have been used as the criteria for the characterization and the distinction between breeds [20]. The heart girth (HG) is the most commonly used parameter for the determination of the format of the animals [34, 35]. It reflects the development of the chest, and it's covering muscles [31]. The HG has also been used in the estimation of the animal's live weight (BW) for its lower variations. The circumference and length of the trunk may increase when the animal has a distended abdomen due to gestation or overfeeding [9].

The overall results yielded by this study were found to be closer to the donkeys described in the Kabylie area (Algeria) [1], Chad [8] and Turkey [50] (Table 6). However, they were higher than those raised in Mali and Niger [32] (Table 6). The averages obtained were, on the other hand, less important than those reported for the Tlemcen region (West of Algeria) donkeys [26], the Spanish Catalan donkeys [15] (Table 6), as well as those obtained in Catalan and Poitevine donkeys raised in Morocco [4]. Catalan donkeys were introduced in Algeria between the end of the 19th century and the beginning of the 20th century. Bulgarian donkeys were also relatively large compared to those described in our study [37, 48].

The significant correlations obtained between the quantitative characters ($P < 0.05$) for the population were also reported for the Turkish donkeys [49]. There were no significant differences recorded ($P > 0.05$) by Kefena et al. [23] and Defeu et al. [10] for eastern Ethiopia and

Table 6. Comparative analysis of the exterior measurements with the results of other authors

Study area	North- East of Algeria	Kabylie (center) Algeria	Tlemcen (West) Algeria	Niger	Mali	Tchad	Spain	Turkey (South- East)
n	65	126	61	281	292	408	98	194
Authors	Current study	[1]	[26]	[32]	[32]	[8]	[15]	[50]
HG [cm]	114.94±6.78	118.5±7.5	124.26±7.03	107.9±5.25	105.1±8.32	113.33±0.25	157.0±6.65	113.5±0.4
BL [cm]	115.76±7.23	110.1±5.9	157.26±12.88	100.3±5.89	104.8±7.81	109.32 ±0.30	–	105.2±0.5
HW [cm]	110.15±8.49	106.9 ±5.4	116.16±7.23	100.4±3.85	98.1±5.13	102.35±0.23	142.20±6.89	102.3±0.5
NL [cm]	39.62±5.38	46±4.7	–	35.1±4.41	28.4±2.19	46.18±0.19	–	–
REL [cm]	26.06±2.23	24.4±1.8	30.15±2.19	28.2±1.87	24.1±1.21	24.92±0.06	32.45±2.23	21.9±0.1
LEL [cm]	25.88±2.05	24.4±1.8	30.15±2.19	28.6±1.74	24.2±1.21	24.92±0.06	32.45±2.23	21.9±0.1
CLH [cm]	40.79±4.65	48.5±3.3	–	–	–	43.72±0.16	61.24±2.4	48.7±0.2
CL [cm]	14.07±2,28	21.07±1.72	–	–	–	12.56±0.04	–	–
CC [cm]	13.93±1.33	14.7±1.1	17.50±1.86	–	–	17.17±1.05	19.64±1.35	13.6±0.0
BkL [cm]	69.95±10.11	63.2±2.5	–	–	–	–	–	–
RW [cm]	32.76±3.03	32.4±1.6	37.15±3.21	–	–	36.60±0.25	42.28±2.26	–
DR [cm]	25.93±2.99	49.2 ± 1.94	–	–	–	18.36± 0.06	–	–
RH [cm]	114.02±9.25	109.6±4.8	–	–	–	106.18±0.41	141.80±7.73	–

(HG) Heart Girth, (BL) Body Length, Withers Height (WH), (NL) Neck Length, (REL) Right Ears Length, (LEL) Left Ear length, (CLH) Head length (CL) Cannon Length, (CC) Cannon Circumference, (BkL) Back Length, (RW) Rump Width, (DR) Diameter between the Ribs, (RH) Rump Height

the upland of Cameroon donkey's population's characters, consecutively.

The males registered higher body measurement values than females. This variation may be due to physiological differences and activity [22, 43]. The results were consistent with those obtained by K a b o r e [22], R o a m b a [41], J o h n [21] and N i n i n a h a z w e et al. [32].

The zootechnical indexes have been used to describe the structural characteristics, type, and performance of the animals [11, 12]. In our study, they were calculated and analysed to make ethnologic classifications for the extreme eastern Algerian donkeys.

The animals are longilinear, rectilinear, hypermetric and overweight. The body mass was greater than their size [30]. Those results suggested that the population was suitable for meat production. That was in concordance with the description of D e f e u et al. [10] for the uplands of north-western Cameroon donkeys.

Genetic variability of the population

The statistical analysis and the phylogenetic tree establish the relationships between 4 heterogeneous genetic types. D e f e u et al. [10] reported 3 heterogeneous genetic types in the uplands of north-western Cameroon donkeys. However, P a p a and K u m e [36] identified 2 genetic types in Albania. The heterogeneity may be due to the genetic stirring between different populations due to the movement of asine populations. This study area was an informal trade crossroads between Algeria and Tunisia, where the donkey was used as the most appropriate means of transportation. R o a m b a [42], K a b o r e [22] and S t a n i š i ć [44] found that the asine population of Senegal, Burkina Faso, and Balkan were homogeneous, respectively.

CONCLUSIONS

This is the first report on the phenotypic characterization in donkeys in the extreme Eastern Algerian area, based on corporal measurements. The results indicated that heterogeneity exists and suggest that the possibilities of genetic improvement within the species may be possible. However, the molecular characterization would better identify donkey breeds in Algeria.

ACKNOWLEDGEMENT

We are thankful to all the personnel of the BRABTIA zoo for their collaboration and help so that we could conduct the present study on the species.

REFERENCES

1. **Ayad, A., Aissanou, S., Amis, K., Latreche, A., Iguer-Ouada, M., 2019:** Morphological characteristics of donkeys (*equus asinus*) in Kabylie area, Algeria. *Slovak J. Anim. Sci.*, 52, 2, 53—62.
2. **Beja-Pereira, A., England, P.R., Ferrand, N., Jordan, S., Bakhiet, A.O., Abdalla, M.A., et al., 2004:** African origins of the domestic donkey. *Science*, 304, 5678, 1781. DOI: 10.1126/science.1096008.
3. **Benhamadi, M., Mezouar, K., Benyarou, M., Bouhandasse, A., Gaouar, S. B. S., 2017:** Morphometric characterization of the equine barbe breed in northwest of Algeria. *Gen. Biodiv. J.*, 1, 2, 48—65.
4. **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. DOI: 10.19182/remvt.10015.
5. **Camps, G., Musso, J.C., Chaker, S., 2012:** *«Âne», Encyclopédie Berbère.* Document A218, Online since 01 December 2012, Accessed on 26 October 2019. URL: http://journals.openedition.org/encyclopedieberbere/2503.
6. **Chabchoub, A., Landolsi, F., Jari, Y., 2004:** Etude des paramètres morphologiques des chevaux Barbes de Tunisie. *Revue Méd. Vét.*, 155, 1, 31—37.
7. **Colli, L., Perrotta, G., Negrini, R., Bomba, L., Bigi, D., Zambonelli, P., et al., 2013:** Detecting population structure and recent demographic history in endangered livestock breeds. *Anim. Genet.*, 44, 1, 69—78. DOI: 10.1111/j.1365-2052.2012.02356.x.
8. **Daloum, S., Meutchieye, F., Manjeli, Y., 2015:** Phenotypic diversity of domestic donkeys in the sahelian region of Hadjer-Lami, Chad. *Bull. Anim. Hlth. Prod. Afr. AnGR,* Special edn., 123—135.
9. **De Aluja, A.S., Tapia Pérez, G., Lopez, F., Pearson, R.A., 2005:** Live weight estimation of donkey in Central Mexico from measurement of thoracic circumference. *Trop. Anim. Health. Prod.*, 37, Suppl. 1, 159—71, DOI: 10.1007/s11250-005-9007-0.

10. **Defeu, M., Meutchieye, F., Manjeli, Y., 2015:** Phenotypic diversity of domestic donkeys (*Equus Africanus Asinus*) in Northwest Cameroon Highlands. *Bull. Anim. Hlth. Prod. Afr. AnGR*, Special edn., 137—149.
11. **Djaout, A., Afri-Bouzebda, F., Bouzebda, Z., Benidir, M., 2018:** Morphological characterization and study of zootechnical indexes of Berbere sheep in Eastern Algeria. *Ind. J. Anim. Sci.*, 88, 6, 706—713.
12. **Ebangi, A. L., Vall, E., 1998:** Phenotypic characterization of draft donkeys within the Sudano-Sahelian zone of Cameroon. *Revue Élev. Méd. Vét. Pays Trop.*, 51, 4, 327—334.
13. **Esquivelzeta, C., Fina, M., Bach, R., Madruga, C., Caja, G., Casellas, J., et al., 2011:** Morphological analysis and subpopulation characterization of Ripollesa sheep breed. *Anim. Genet. Res.*, 49, 9—17. DOI: 10.1017/S2078633611000063.
14. **FAO, 2012:** Phenotypic characterization of animal genetic resources. *FAO Animal Production and Health Guidelines*, No. 11. Rome, 7—28.
15. **Folch, P., Jordana, J., 1997:** Characterization, references ranges and the influence of gender on morphological parameters of endangered Catalonian donkey breed. *J. Eq. Vet. Sci.*, 17, 2, 102—111. DOI: 10.1016/S0737-0806(97)80347-4.
16. **Guedaoura, S., Cabaraux, J. F., Moumene, A., Tahraoui, A., Nicks, B. 2011:** Evaluation morpho-métrique de chevaux de race barbe et derives en algerie. *Ann. Méd. Vét.*, 155, 14—22.
17. **Gupta, A. K., Kumar, S., Pal, Y., Chauhan, M., Kumar, B., Prince, P., 2017:** Phenotypic characteristics and general managemental practices for working donkey populations in South Western Bihar region of India. *Ind. J. Anim. Sci.*, 87, 11, 1414—1417.
18. **Hair, Jr., J. F., Black, W. C., Babin, B. J., Anderson, R. E., 2014:** *Multivariant Data Analysis. Pearson Education Limited by Pearson New International Edition, U. K.* Printed in the United States of America, 519—540.
19. **Han, H., Chen, N., Jordana, J., Li, C., Sun, T., Xia, X., et al., 2017:** Genetic diversity and paternal origin of domestic donkeys in Animal Genetics. *Anim. Genet.*, 48, 6, 708—711. DOI: 10.1111/age.12607.
20. **Hanot, P., Bochaton, C., 2018:** New osteological criteria for the identification of domestic horses, donkeys and their hybrids in archaeological contexts. *J. Archaeol. Sci.*, 94, 12—20. DOI:10.1016/j.jas.2018.03.012.
21. **John, P. A., 2016:** *Characterization of Donkeys () in Northwestern Nigeria Using Morphological and Morphometric Measures*. A dissertation submitted to the school of postgraduate studies, Ahmadu Bello University, Zaria, Nigeria, 64—182.
22. **Kabore, S., 2014:** *Caractérisation Morphobiométrique et Biochimique des ânes (Equus asinus) du Burkina-Faso*. PhD. Thesis No 15. Cheikh Anta Diop University (UCAD). Burkina-Faso. 41—68.
23. **Kefena, E., Beja-Pereira, A., Han, J. L., Haile, A., Mohammed, Y. K., Dessie, T., 2011:** Eco-geographical structuring and morphological diversities in Ethiopian donkey populations. *Livest. Sci.*, 141, 232—241.
24. **Kimura, B., Marshall, F. B., Chen, S., 2011:** Ancient DNA from Nubian and Somali wild ass provides insights into donkey ancestry and domestication. *Proc. Biol. Sci.*, 278, 1702, 50-57. Epub July 28, 2010. DOI: 10.1098/rspb.2010.0708.
25. **Konen, F., 2011:** Dermatologie de l'âne (*Equus asinus*). Thèse pour obtenir le grade de Docteur Vétérinaire. *Vet. Agro Sup.*, Campus vétérinaire de Lyon. 33-37.
26. **Labbaci, M., Djaout, A., Benyarou, M., Ameur, A., Gaouar, S. B. S., 2018:** Morphometric characterization and typology of donkey farming (*Equus Asinus*) in the wilaya of Tlemcen. *Genet. Biodiv. J.*, 2, 1, 60—72.
27. **Lauvergne, J. J., 2006:** Inventaire des ressources génétiques caprines dans un pays d'Afrique à l'aide de différents marqueurs et indices. *Synthèse Méthodologique*, INA-PG, Clamart, 5 pp.
28. **Legrand, R., Abitbol, M., 2016:** Identification of mutations at the origin of various phenotypes in donkeys. *Bull. Acad. Vét. France*, 169, 2, 110—116. DOI: 10.4267/2042/60679.
29. **Marcenac, L. N., Aublet, H., D'autheville, P., 1980:** Etude comparative des régions proportions- compensations hippométrie. In **Maloines, A. (Ed.):** *Encyclopédie du Cheval*, Paris, France, 195—212.
30. **Mariante, A., Da, S., Miserani, M. G., Mc Manus, C., Santos, S. A., De Abreu, U. G. P., et al., 2002:** Body indexes for the Pantaneiro horse. In *Proceedings 7th World Congr. Genet. Appl. Livest. Prod.*, 30, 431—434.
31. **Nicks, B., Delfontaine, B., Canart, B., Vanderbruggen, J., Vandenheede, M., 2006:** Caractéristiques morphologiques des juments de Trait belge. *Ann. Méd. Vét.*, 150, 247—251.
32. **Nininahazwe, P. C., Sow, A., Roamba, R. C., Kalandi, M., Ahmed, H. D., Ouédraogo, G. A. et al., 2017:** West African donkey's liveweight estimation using body measurements. *Vet. World*, 10, 10, 1221—1226. Published online Oct. 12, 2017. DOI: 10.14202/vetworld.2017.1221-1226.
33. **Osthaus, B., Proops, L., Long, S., Bell, N., Hayday, K., Burden F., 2017:** Hair coat properties of donkeys, mules and horses in a temperate climate. *Eq. Vet. J.*, 50, 2018, 339—342. DOI: 10.1111/evj.12775.

34. **Pearson, R. A., Ouassat, M., 1996:** Estimation of the live-weight and body condition of working donkeys in Morocco. *Vet. Rec.*, 138, 10, 229—233.

35. **Pearson, R., Ouassat, M., 2000:** *A Guide to Live Weight Estimation and Body Conditions Scoring of Donkeys. Centre for Tropical Veterinary Medicine*, University of Edinburgh, Scotland, 4—16.

36. **Papa, L., Kume, K., 2012:** The results of identification and characterisation the donkey population in Albania. *Agric. Forest.*, 58, 3, 125—134.

37. **Porter, V., Alderson, G. L. H., Hall, S. J. G., Sponenberg, D. P., 2016:** Asses. In *Mason's World Encyclopedia of Livestock Breeds and Breeding*. CABI Edition, U.K., 2 (pack), Vol 1, 1—53.

38. **Rabier, L., 2012:** *L'Alimentation de l'âne et ses Relations avec les Maladies Asines*. Thèse d'exercice, Ecole Nationale Vétérinaire de Toulouse—ENVT, 151 pp. http://oatao.univ-toulouse.fr/ Eprints ID: 6261.

39. **Raveneau, A., Daveze, J., 1996:** Le livre de l'âne, son histoire, sa famille, son éducation, toute sa vie. *Collection archives animaux. Rustica Editions*, France, 128—129.

40. **Richard, M. M., 1857:** *Bulletin Mensuel de la Société Impériale Zoologique d'Acclimatation: Espèces Chevaline, Asine, Bovine et Porcine de l'Algérie*. T 4. 323—389. https://gallica.bnf.fr/ark:/12148/bpt6k5448173s/f6.image.

41. **Roamba, C. R., 2014:** Caractérisation morpho-biométrique et biochimique des asins (*Equus asinus*) du Sénégal. *These Med. Vet. Dakar*, 10, 100.

42. **Rosenbom, S., Costa, V., Al-Araimi, N., Kefena, E., Abdel-Moneim, A. S., Abdalla, M. A., et al., 2014:** Genetic diversity of donkey populations from the putative centers of domestication. *Anim. Genet.*, 46, 1, 30—36. DOI: 10.1111/age.12256.

43. **Shawaf, T. M., Almathen, F., Al-Ahmad, J., Elmoslemany, A., 2016:** Morphological characteristics of Hassawi donkey, Eastern Province, Saudi Arabia. *Alexandria J. Vet. Sci.*, 49, 2, 178—183. DOI: 10.5455/ajvs.226158.

44. **Stanišić, L., Dimitrijević, V., Simeunović, P., Lakić, N., Radović, I., Ivanković, A., et al., 2015:** Morphological, biochemical and haematological characterization of endangered Balkan donkey breed. *Acta Vet.-Beograd*, 65, 1, 125—136. DOI: 10.1515/acve-2015-0010.

45. **Svendsen, E., 2008:** *The Professional Handbook of the Donkey*. Whittet Books Ltd U. K., 3rd edn., 438 pp.

46. **Thomas, P., 1884:** *Recherche Stratigraphiques et Paléontologiques sur Quelques Formations d'eau Douce de l'Algérie*. Mémoire de la société géologique de France. Troisième série. Tome 3. 19—51.

47. **Vall, E., Ebangi, A. L., Abakar, O., 2001:** Mise au point d'une grille de notation de l'état corporel des ânes de trait au Nord du Cameroun. *Revue Élev. Méd. Vét. Pays Trop.*, 54, 3—4, 255—262.

48. **Vlaeva, R., Georgieva, S., Barzev, G., Ivanova, I., 2016:** Morphological and phenotypic characteristics of donkeys in some regions of Bulgaria. *Trakia J. Sci.*, 14, 1 92—95. DOI: 10.15547/tjs.2016.01.013.

49. **Yilmaz, O., Ertuğrul, M., 2011:** Some morphological traits of donkeys raised in Iğdir, Turkey. *Iğdir Üniv. J. Inst. Sci. Tehn.*, 1, 2, 113—116.

50. **Yilmaz, O., Ertuğrul, M., 2012:** The morphologic traits of donkeys raised in east and southeast of Turkey. *Hayvansal Üretim*, 53, 1, 10—13.

51. **Zhang, Y. S., Yang, X. Y., Wang, X. B., Zhang, C. M., Qin, F., Zhou, Z. H., et al., 2010:** Cytochrome b genetic diversity and maternal origin of Chinese domestic donkey. *Biochem. Genet.*, 48, 7—8, 636—46. Epub May 25, 2010. DOI: 10.1007/s10528-010-9345-0.

Received October 27, 2019
Accepted February 21, 2020