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Zoometric characterization and body condition score in Canarian camel breed

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SUMMARY

Conservation and sustainable management of local animal genetic resources and their diversity are priority tasks within a national and international framework. Officially listed as a threatened native breed, Canarian camels *(Camelus dromedarius)* are marginally reduced to the eastern islands of the archipelago and mainly used in touristic activities; sporadically, these animals are used for production of food and other products. Morphostructural and zoometric characterization of Canarian camel will lead to the identification of those genetic-based characters or features involved in productive functional activities. The present methodological proposal is framed into a context of opportunity and resurgence of a potential production industry throughout the establishment of the baselines for a sustainable selective breeding program in this livestock species.

ADDITIONAL KEYWORDS

Canarian camel.
Camelus dromedarius.
Zoometrics.
Body condition score.
Conservation.

Caracterización zoométrica y evaluación de la condición corporal en la raza camellar canaria

RESUMEN

La conservación, mejora y uso racional de los recursos genéticos animales locales y su diversidad son propósitos prioritarios a nivel nacional e internacional de evidente carácter legítimo. Reconocida en situación de amenaza, la raza camellar canaria *(Camelus dromedarius)* se encuentra marginalmente reducida a las islas orientales del archipiélago. Su uso queda restringido fundamentalmente a la explotación turística y, de forma esporádica, a labores variadas en el ámbito agropecuario. La caracterización morfoestructural y zoométrica del camello canario es una tarea clave que permitirá la identificación de aquellos caracteres o rasgos fenotípicos implicados en la actividad productivo-económica de estos animales con el fin de recuperar posibles nuevos nichos funcionales. La presente propuesta metodológica se enmarca en un contexto de oportunidad y resurgimiento de una potencial industria de producción con el asentamiento de las bases para un programa de recuperación y cría selectiva de esta raza camellar a través de su sustentabilidad funcional.

PALABRAS CLAVE ADICIONALES

Camello canario.
Camelus dromedarius.
Zoometría.
Condición corporal.
Conservación.

INFORMATION

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INTRODUCTION

Zootechnics or scientific approachment of domestic animals husbandry aims to obtain high productive yields while seeking the greatest well-being status for these during the whole breeding cycle. Genetic assessment and management planning are intented to protect raised animals by providing them access to basic needs underpinning sustainable farming.

Progressive adaptation to a certain habitat or specific funcionality results in the distinction of a particular productive morphotype, that is a set of morphological and morphometric attributes than can be associated with certain performing traits. Economic value and profitability of those morphological types relies on the aesthetics of the genetically-based, visible characters and the uniformity of the products obtained.

Domestication and evolution are the main sources of genetic diversity within live organisms (Ermias & Rege 2003). However, the widespread trend towards exploitation of a small number of potentially improved breeds, the replacement of traditional production systems and, in particular scenarios, regional socio-economic and political drivers (Rischkowsky & Pilling 2010), have conducted certain breeds to endangered conservation status.

In particular, Canarian camel breed (*Camelus dromedarius*), the only genetic resource of such nature currently extant in Spain and Europe, is classified as an indigenous endangered breed due to the progressive mechanization of agricultural work and the adaptation of the transport network for road traffic from the last third of the 20th century. In this context, it is urgently needed to implement conservation programmes for this in order to recover the entity and identity that this breed enjoyed in the past. Related to this, Hodges (1990) argues that breeds are the main component and indicator of domestic animals' genetic diversity, as they are direct result of the genetic diversification of the different species during the evolutionary process.

Social and economic interests in camel husbandry are fortunately increasing since about the past three decades (Khan, Arshad & Riaz 2003). The dromedary presents itself as a potential production animal under extreme environmental conditions such as drought periods or high temperatures. This condition, in addition to their relatively low nutritional requirements compared to other livestock, make this animal an optimal candidate of environmentally-sustainable farming systems (Khan, Arshad & Riaz 2003; Naumann 1999). Their pivotal role for local communities' survival inhabiting arid and semi-arid regions in Africa and Asia, emphasizes this growing social interest and awareness (Yagil 1982).

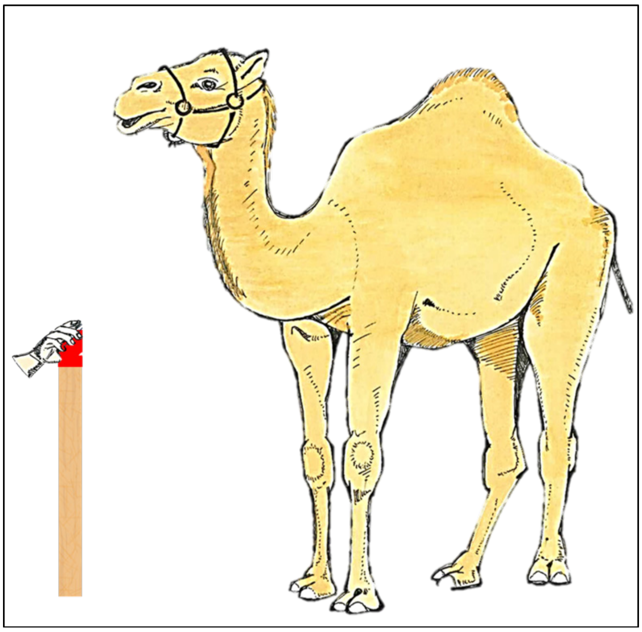

Figure 1. Camel position for lateral shooting with scaled stick (Ejemplo ilustrado de posicionamiento para fotografía lateral con barra de escala).

Multiple researches have been implemented in order to evaluate variability in morphometric characteristics between different camel breeds through traditional approaches, based them on some linear measurements. Intending to improve this gap in methodological knowledge, the present project are focused on developing a standardized method of geometric-morphometric assessment for Canarian camel as well as defining the criteria to consider when evaluating the body condition of these species. This methodological approach allows to characterize the morphological variation in live camels given the possible setbacks related to their behaviour (Alhaddad & Alhajeri 2019; Alhajeri, Alaqeely & Alhaddad 2019).

Although body conformation may be considered a subjective-assessed character (Dalton 1980), zoometrics enables for determine specific body measurements (Torrent 1982) to quantify this conformation as well as its variation in this camel breed.

MATERIAL AND METHODS

Initially, a lateral photograph is shooted for each animal being evaluated. A known-dimensioned scale stick is located next to the animal, as showed in **Figure 1**. This makes possible the subsequent extraction of a scale factor which will enable the conversion of pixels to centimeters.

After that, front and back photographs of each of the animals are taken, in order to assess the spatial arrangement of the front and rearlimb guidelines according to the criteria exposed in **Figure 2**. Conformation faults generate a non-homogeneous distribution of forces along the limbs during support and locomotion, being the origin of numerous bone and tendoligamentous pathologies. Camel's aplombs examination must be carried out on a flat and smooth surface, so that the animal supports both fore and hind limbs in a normal and natural way.

Morphostructural and zoometric evaluation

The evaluation of morphometric characteristics include 13 linear characters (**Table I**) (Parkinson 2011; Yilmaz & Ertugrul 2014) and 27 zoometric indexes (**Table II**) (Abdallah & Faye 2012; Chniter et al. 2013; Ishag, Eisa & Ahmed 2011a, 2011b; Ishag et al. 2010; Kamili, Bengoumi & Faye 2006).

Body weight estimate

Body weight is estimated, based on a previous comparative experience from five possible methods (Boujenane 2019), according to the following formula: $BW = 6.46 \times 10^{-7} \times (HW+CG+HG)^{3.17}$; where BW is the body weight (kg), HW is the stature (height to withers; in cm), CG is the thoracic perimeter (measured around the body just behind the sternal pad; in

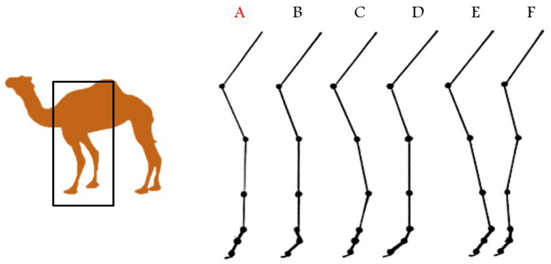

Figure 2a. Physiologic aplombs and their possible alterations in forelimbs in *Camelus dromedarius* (Aplomos normales y sus posibles defectos en el miembro anterior en *Camelus dromedarius)*.

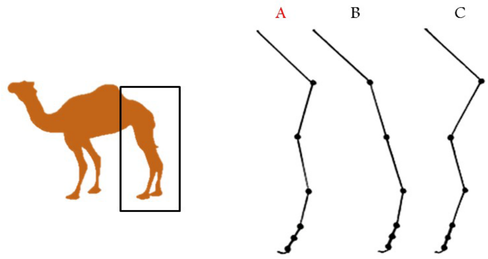

Figure 2b. Physiologic aplombs and their possible alterations in hindlimbs in *Camelus dromedarius* (Aplomos normales y sus posibles defectos en el miembro posterior en Camelus dromedarius).

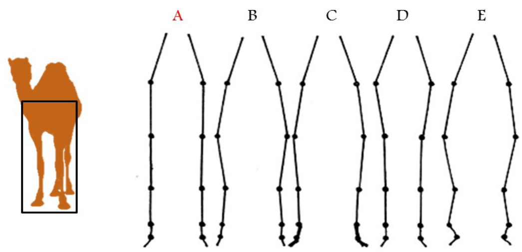

Figure 2c. Physiologic aplombs and their possible alterations in forelimbs in *Camelus dromedarius* (Aplomos normales y sus posibles defectos en el tercio anterior en Camelus dromedarius).

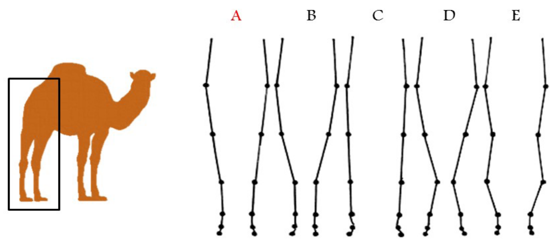

Figure 2d. Physiologic aplombs and their possible alterations in rear limbs in *Camelus dromedarius* (Aplomos normales y sus posibles defectos en el tercio posterior en *Camelus dromedarius*).

cm) and HG is the circumference of the hump (taken along the abdomen over the top of the hump; in cm).

Body condition

Body condition will be assessed at an average distance of 2-3 meters from the animal by visual assessment and, if necessary, palpation of body reserves to confirm visual judgment (Kamili, Bengoumi & Faye 2006). In particular, hump size can be also determined by estimating proportions of the dorsal line occuped by this body structure **(Figure 3)** (Robinson 2010).

A score (0-5) is attributed to the flank and rib region and another score (0-5) for the hindquarters, depending on the criteria described in **Table III** and **Figure 4**. The average score will be the final value for the body condition of the individual (Faye et al. 2002).

Hump dimension

Determining the volume and weight of the hump, is an useful accesory method for an outstanding ap-

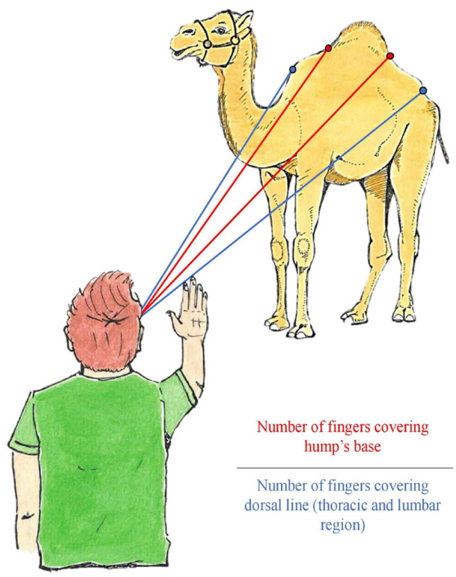

Figure 3. Simple technique to determine proportions of dorsal line occupied by hump's base in *Camelus dromedarius* (Estimación visual de las dimensiones de la joroba en *Camelus dromedarius*).

Table I. Linear appraisal scheme for *Camelus dromedarius* (Propuesta de hoja de calificación lineal para Camelus dromedarius).

Linear trait	1	2	3	4	5
Head size (*1* quite short; *5* quite large)					
Eyelashes (*1* very short; *5* too long)					
Cheek (*1* sunken; *5* broad and high)					
Beard (*1* absent; *5* long hair)					
Lips (*1* quite thin; *5* too thick)					
Ears (*1* small and backward; *5* large and erect/slightly forward)					
Neck (*1* short, thick and arched; *5* long, thing and extending forward)					
Legs (*1* weakly harmonic; *5* too thick)					
Feet (*1* small and poorly shaped; *5* very large, affect locomotion)					
Hump (*1* too small; *5* very large)					
Lateral side of hump (*1* little bulky; *5* too bulky)					
Curly hair in anterior part of hump (*1* absent/scarce; *5* noticeably present)					
Straight hair in flank (*1* absent/scarce; *5* noticeably present)					

**1* y *5* are the deficiency or excess, undesired characteristics, respectively; *3-4* the optimum or desired

preciation of camel fat condition, as this body region constitutes the main fat storage in these animals. In good health status, this body reserve may represent up to 80% of the total body fat (Gebreyohanes & Assen 2017).

In live animals, following measurements are considered when evaluating hump volumen and weight (**Figure 5**) (Faye et al. 2001b; Faye et al. 2002; Faye et al. 2004; Yousif & Babiker 1989):

Length (L) or, hemicircumference seen from the side, is the distance between the front (A) and the back (B) of the hump passing through the top of it (E).

Width (W) or, hemicircle seen from above, is the distance between A and B, passing through one of the sides of the hump (C or D).

Height (H) or, hemicircumference seen from the front or back, is the distance between C and D through the top of the hump (E).

As the hump can be considered a hemielipsoid with different radius rL, rl and rH, the volume can be calculated according to: $V = ½ (4/3 * rL * rl * rH)$. Since the hemicircunferences are respectively equal, this expression would be simplified as follows: $V = ½ (4/3 * L * W *H)$ o $V = 0,07 (L * W * H)$.

On the other hand, hump weight is obtained according to the formula: $Wh (kg)= (1,59 +0,0836H)^2$, error =0.571, P <0,0001; where Wh is the weight of the hump in kg and H the height (as defined above) in cm.

INTERPRETATION OF RESULTS AND CONCLUSIONS

Morphostructural characterization and its phenotypic variability are presented as indispensable requirements for the design and implementation of conservation and regional development programs of endangered native breeds (Alderson 1992). The efforts to characterize this camel breed aimed their selective breeding and genetic improvement for high productive yields within proper managerial practices in regions and production systems in which these animals are reared.

In comparison with other camel breed or genetic lines, the Canarian camel is an eumetric animal with relatively strong constitution and whose stature, in general terms, usually exceeds the trunk in length. Their body proportions are quite homogeneous and maintain a general harmony (Khan, Arshad & Riaz 2003; Schulz et al. 2010).

Regarding body condition, the optimal index for camels has to be relativized according to the physiological and body growth state in which the animals are at the time of evaluation (Faye et al. 2001a; Faye et al. 2002). In mating season, the dromedary should not be too thin or with too many body reserves, that is, a body condition between 3 and 4. In the last third of pregnancy, females must have a sufficient fat reserve (body condition between 3.5 and 4) to cope with the milk production for their offspring. At the beginning of lactation, food intake may not be enough to satisfy milk production and, therefore, the animal losses weight. At the peak of lactation, the body condition can go down up to 2 points. Food supplementing in dairy animals could improve milk production, but if the camel is not well selected for this productive purpose, this action could increase fat storage instead of improving udder activity. Scores below 2 could also be related to diseases characterized by apetite loss, such as parasitic processes (especially trypanosomosis). In any case, the optimal body condition in dromedaries is between 2 and 3. The evaluation of the possible correlations between body condition and the ecological adaptability or plasticity of an animal or a group of animals, could enrich the improvement and conservation programs in camels as could constituted new possible selection criteria.

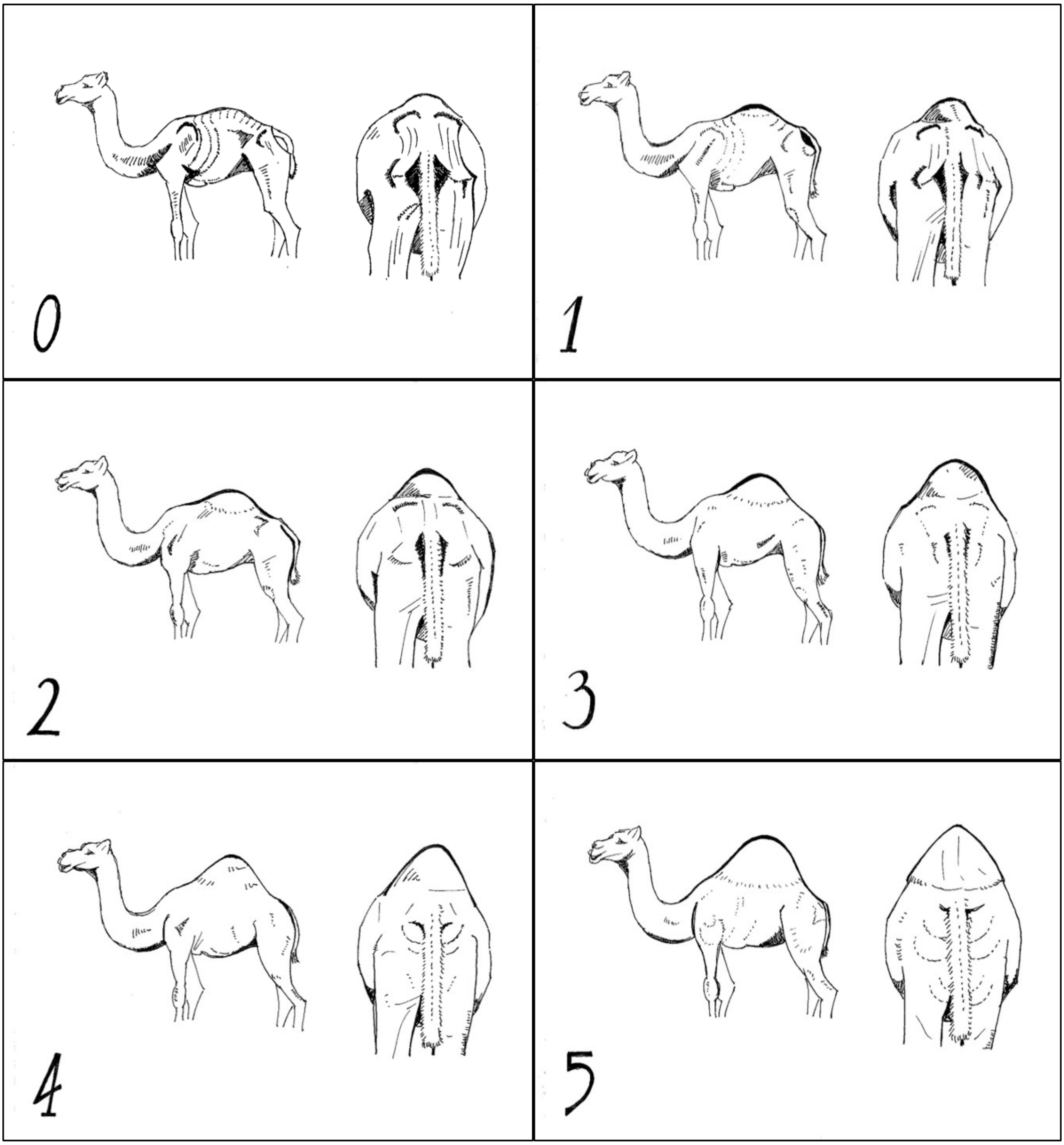

Figure 4. Body condition score in camels illustration (Representación gráfica de la condición corporal (0-5) en camellos).

The size of the hump and its upright disposition in relation to the cranio-caudal axis of the animal's body are susceptible to variate depending on the nutritional and general health status of the camel, while movilization of fat reserves during starvation episodes can be denoted or as an early expression of the suffering of other morbid processes (Khan, Arshad & Riaz 2003). In contrast, Faye et al. (2001a) point out that in most cases, body condition and hump size are unrelated characters. In any case, this condition may be assessed and evaluated individually from the photographs taken.

Farming systems and tourism businesses involving camels as multipurpose animals scarcely dispose of scientifically-based knowledge regarding genetic improvement of these animals, but demonstrate a competent and traditional understanding of the differents breeds and their management. In this contextual framework, the beginning for the conservation of the Canarian camel through its morphometric characterization and evaluation of its body condition, will make it possible to propose objective criteria and standardized improvement strategies for the selective breeding of this animal. Consequently, the quality of the products obtained will

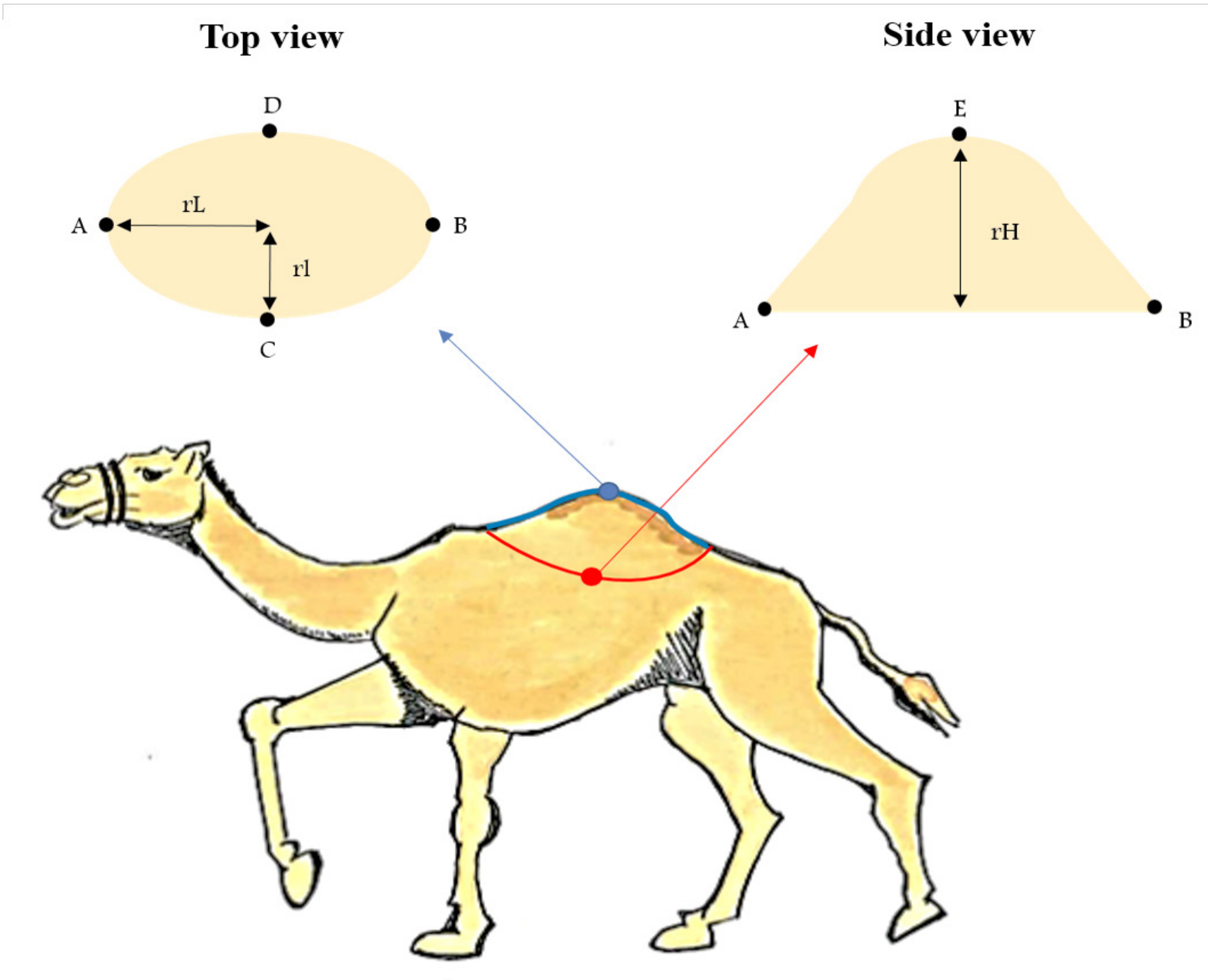

Figure 5. Hump volume and weight measurement in *Camelus dromedarius* (Medidas para la determinación del volumen y peso de la joroba en *Camelus dromedarius*).

Table II. Zoometric assessment scheme for *Camelus dromedarius* (Propuesta de hoja de campo para la medición de variables zoométricas en *Camelus dromedarius*).

Zoometric variable	Value (cm)	Zoometric variable	Value (cm)
Head length (measured from nose to occipital crest)		Hump perimeter (measured on its upper line)	
Head width (distance between ear cartilages)		Hump-tail distance	
Neck length (superior line)		Hip length (measured between coxal and ischial tuberosities)	
Neck length (inferior line)		Tail length	
Neck girth (measured around atlanto-occipital joint)		Thigh girth (measured in its medium part)	
Neck girth (measured in its medium part)		Hock width	
Neck girth (measured in cervicothoracic junction)		Fore cannon girth	
Chest width		Rear cannon girth	
Withers height		Nipple length	
Height to the top of hump		Udder length	
Thoracic girth (measured between the front of the hump and behind pedestal callosity)		Sole length	
Body length		Foot perimeter	
Hump length		Pastern and hoof depth	
Hump width			

Table III. Body condition assessment in *Camelus dromedarius* (Criterios para la evaluación de la condición corporal en *Camelus dromedarius*).

Score	Flank			
	Flank hollow	Transverse apophyses	Rib	Hump
0	Highly apparent	All proeminent	All visibles (skin on bones)	Absent
1	Clearly apparent	Clearly proeminent	Clearly visible	Very small
2	Visible	Visible all along the back	Visible in front	Small
3	Very slight	Slightly visible	Invisible or slightly visible in front of thorax	Medium size
4	Almost invisible	Invisible	Invisible	Big
5	Invisible	Invisible and rounded back	Visible fat cover	Very big, covering all the back

Score	Back				
	Ischial tuberosity	Sacrotuberal ligament	Ano-genital region	Spinous apophyses	Coxal tuberosity
0	Very proeminent	Very concave	Very deep at the base of the tail	All visible	Very proeminent
1	Well visible	Concave	Deep, base of the tail still proeminent	Proeminent on the back	Proeminent
2	Well visible	Flat	Visible hollow	Visible on the back	Visible
3	Visible, low quantity of fat	Flat to convexe	Slight hollow	Slightly apparent	Slightly visible
4	Hardly visible and covered with fat	Convexe	Filled	Well covered by fat	Almost invisible
5	Disapeared in fat	Convexe	The base of tail is covered by fat	Invisible	Invisible

also be enhanced, that implies a competitive technical training for camel farms and breeders.

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