A Study of the Biometry of Some Breeds of Arabian Camel (*Camelus dromedarius*) in Saudi Arabia

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ABSTRACT. Four breeds of Arabian camels have been identified in the mid-western region of Saudi Arabia: Sawahli, Meghem, Gamra and Awadi. The identification of these breeds was achieved by recording fourteen body measurements in adult females [leg length (fore) (A-B), leg length (hind) (C-D), body length (A-C), neck length (E-F), face length (F-H), distance between snout and eye (G-T), tail length (L-K), ear length (S-U), hump (B-P) and hind (D-Q), distance between eyes (T-R) and body weight (BW)]. All the above measurements showed significant differences between the four camel breeds. In addition, scanning electron microscopy of hair shafts from the head region of the four breeds has been conducted. The cuticular hair scales were found to be less serrated in Sawahli and Gamra than in the Meghem and Awadi breeds.

Introduction

The Arabian camel, *Camelus dromedarius*, (Order: Artiodactyla) has always held a very special position in the Arabian peninsula. This species being most important, but often neglected, is by far the most adapted of domesticated animals to the harsh environment of the arid areas, and to the mode of life of its human inhabitants. The Arabian breeds are considered to be the best of all dromedaries and have been used to improve other breeds[1].

There are several breeds of one-humped camel in Saudi Arabia[1], named according to their areas of origin. These breeds have been given local names according to Bedouin beliefs. There is, however, little scientific information on camel breeds in

Saudi Arabia, whereas India has more than four[2] and each breed has been identified by morphological characteristics. Gauthier-Pilters and Dagg (1981) listed 20 camel types in Africa[6], and 8 or 10 have been identified in Saudi Arabia[1,7].

In recent years, scanning electron microscopy (SEM) has been used for many purposes and gives a wealth of information about surface architecture of normal and abnormal hair shafts[3]. El Gohary[4] and El Gohary *et al.*[5] reported SEM structural differences in the cuticular scales of different species of mammals in Saudi Arabia and showed that these could be used as taxonomic characters in the keys for different mammalian species.

The objective of this study has been to identify the different breeds of Arabian camels in the Western region of Saudi Arabia by recording their biometry (body measurements and weight) as well as the surface ultrastructure of cuticular scales.

Material and Methods

1. Animals in Study

According to the Bedouins, four distinct breeds of Arabian camels, *C. dromedarius* (Meghem, Sawahli, Gamra and Awadi) occur in the Western Region of Saudi Arabia. Arabian camels *C. dromedarius* (10 adult females for each breed) were randomly selected from five herds in the Western Region of Saudi Arabia. All the animals were bred under the owner's control, and the camels separated for breeding purposes were allocated to the same breed of male and female, to facilitate subsequent brother-sister mating (thus maintaining the genetic homogeneity). They were living at the same habitat in the Mid-western Region of Saudi Arabia during the time of study.

2. Body Measurement (Biometry)

The morphological characteristics of these breeds were studied according to the techniques of Khanna *et al.*[2]. Fourteen body measurements (Fig. 1) as well as their colour were recorded. The body measurements of a 10 adult females (from each breed) were taken in a standing position on a level platform with the use of measuring tape, plumb line, etc.

3. S.E.M. Study of Camel Hair

Hair from the head region of 4 camels; black (Meghem); brown black (Awadi), brown (Sawahli) and white (Gamra)) were studied. The hair shafts were cleaned ultrasonically (Bransonic 12), dehydrated in ascending series of ethanol (70-100%) and critically point dried. Coating was conducted with carbon and gold in the carbon evaporator and viewed by Jeol SEM-35.

4. Statistical Analysis

The statistical technique employed to find out the mean and standard error were similar to those of Howell[8]. The method of fitting constant was the same as that for assessing the analysis of variance and Student's 't' test[8].
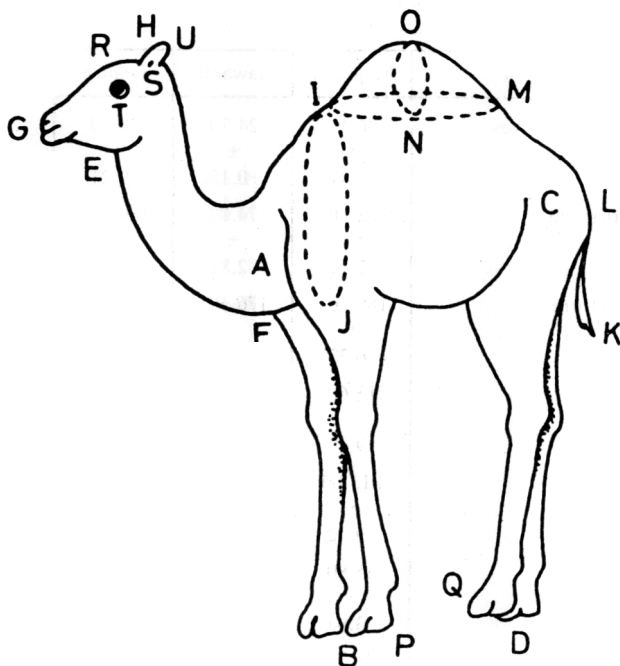
A - B	– Leg length (Fore)	I - M	
		O - N	Hump factor
C - D	– Leg length (Hind)	I - J	Heart girth
A - C	– Body length	B - P	
		D - Q	– Diameter of foot
E - F	– Neck length	G - T	Distance between snout and eye
G - H	– Face length	T - R	Distance between eyes
L - K	– Tail length	B - W	– Body weight
S - U	– Ear length		

FIG.   Body measurements adopted to identify different breeds of camels (Courtesy of Khanna *et al.* 1987).

Results

Biometry of the Four Camel Breeds

Table 1 presents the mean and standard error of the body measurements of 10 camels for each of the different breeds (Figs. 2-5). The differences between breeds were assessed statistically using the one way analysis of variance. There were signific-

TABLE 1. Body measurements of four breeds of Arabian Camels in the mid-western region of Saudi Arabia.

Measurement	Meghem	Sawahli	Gamra	Awadi
Distance between eyes (T-R)	26.10 ± 0.41	24.70 ± 0.15	24.50 ± 0.21	24.40 ± 0.23
Leg length (hind) (C-D)	182.40 ± 7.89	174.00 ± 2.81	180.00 ± 2.50	176.20 ± 1.70
Leg length (fore) (A-B)	189.60 ± 6.37	176.40 ± 2.73	183.30 ± 2.29	180.30 ± 2.25
Heart girth (I-J)	213.60 ± 9.42	199.50 ± 6.25	186.60 ± 4.92	185.40 ± 8.59
Hump factor (I-M) (O-N)	213.00 ± 9.42	213.90 ± 6.25	186.80 ± 4.92	185.60 ± 8.59
Tail length (L-K)	85.80 ± 3.64	72.80 ± 2.77	71.80 ± 2.92	71.00 ± 2.36
Ear length (S-U)	21.75 ± 0.21	11.65 ± 0.21	12.15 ± 0.29	11.15 ± 0.29
Face length (G-H)	54.30 ± 0.68	51.85 ± 0.41	51.60 ± 0.97	50.60 ± 0.56
Distance between Snout-eye (G-T)	26.70 ± 0.51	25.15 ± 0.33	24.90 ± 0.44	24.90 ± 0.27
Diameter of fore foot (D-Q)	20.00 ± 0.62	18.00 ± 0.24	20.00 ± 0.42	19.00 ± 0.31
Diameter of hind foot (B-P)	22.80 ± 0.50	19.75 ± 0.19	21.90 ± 0.19	20.50 ± 0.25
Neck length (E-F)	110.50 ± 2.78	102.80 ± 2.25	97.80 ± 1.93	97.80 ± 2.65
Body length (A-C)	167.70 ± 2.55	144.00 ± 2.41	149.60 ± 5.14	148.50 ± 2.17
Body weight (BW)	508.64 ± 49.56	359.30 ± 23.06	240.40 ± 9.19	315.01 ± 25.93

FIG. 2. Meghem breed of Arabian camel: black coloured with the heaviest and the longest build of all breeds in the Western Region of Saudi Arabia.

FIG. 3. Awadi breed of Arabian camel: brown black coloured.

FIG. 4. Sawahli breed of Arabian camel: brown coloured.

FIG. 5. Gamra breed of Arabian camel: white coloured.

ant differences with respect to the breeds of camels, in the following measurements: the distance between eyes (F = 8.58, d.f. 3,36, P < 0.001), heart girth (F = 3.15, d.f. 3,36, P < 0.05), hump factor (F = 15.13, d.f. 3,36, P < 0.001), tail length (F = 5.5, d.f. 3,36, P < 0.01), ear length (F = 6.1, d.f. 3,36, P < 0.01), head length (F = 5.5, d.f. 3,36, P < 0.01), distance between snout and eye (F = 8.7, d.f. 3,36, P < 0.001), diameter of fore foot (F = 8.2, d.f. 3,36, P < 0.01), diameter of hind foot (F = 12.4, d.f. 3,36, P < 0.001), body length (F = 10.1, d.f. 3,36, P < 0.001) and body weight (F = 12.1, d.f. 3,36 P < 0.001). This is due to the variance between the four breeds of camel, but none of the measurements: leg length (F = 0.71, d.f. 3,36, n.s.), foreleg length (F = 2.13, d.f. 3,36, n.s.) and neck length (F = 1.73, d.f. 3,36, n.s.) were significantly different.

The data was subsequently subjected to paired comparisons (Student's 't' test) to confirm the differences between the breeds of camel. The Meghem breed showed a significant increase compared with the Sawahli, Gamra and Awadi breeds in all of the following measurements: distance between eyes (t = 3.175, P < 0.011; t = 3.45, P < 0.001 and t = 3.58, P < 0.001, respectively), hump factor (t = 0.05; t = 6.02, P < 0.001 and t = 3.32, P < 0.001, respectively), tail length (t = 2.84, P < 0.01, t = 3.0, P < 0.001 and t = 3.41, P < 0.001, respectively), head length (t = 3.1, P < 0.001, t = 2.53, P < 0.01 and t = 4.18, P < 0.001, respectively), distance between snout and eye (t = 2.5, P < 0.01, t = 2.8, P < 0.01 and t = 3.4, P < 0.001, respectively), body length (t = 6.75, P < 0.001; t = 3.16, P < 0.01 and t = 5.73, P < 0.001, respectively) and body weight (t = 2.48, P < 0.01; t = 4.97, P < 0.001 and t = 3.20, P < 0.001, respectively). In addition, the Meghem breed showed a higher measure in heart girth compared to the Gamra and Awadi breeds (t = 2.52, P < 0.01 and t = 2.24, P < 0.05, respectively). The Meghem breed also showed a significant difference compared with the Sawahli and Awadi breeds with respect to ear legnth (t = 3.66, P < 0.001, and t = 3.9, P < 0.001, respectively), diameter of fore foot (t = 4.91, P < 0.001 and t = 3.47, P < 0.001, respectively) and diameter of the hind foot (t = 6.19, P < 0.001 and t = 4.4, P < 0.001, respectively). However, other breeds have shown significant differences in some of measurements. The Sawahli breed exceeded the Gamra breed in the hump factor (t = 5.12, P < 0.01), and the Awadi breed in head length (t = 1.8, P < 0.05) but the Sawahli breed showed a significant increase over the Gamra breed in the hump factor (t = 5.12, P < 0.001) and over the Awadi breed in head length (t = 1.8, P < 0.05). The Gamra breed showed significant increases compared with the Sawahli and Awadi breeds in the diameter of fore foot (t = 3.18, P < 0.001 and t = 2.0, P < 0.05, respectively), the hind foot (t = 3.39, P < 0.05 and t = 1.9, P < 0.05, respectively) and in body weight (t = 4.79, P < 0.001 and t = 2.71, P < 0.01, respectively).

Each breed has its own colour (Figs. 2-5). The Meghem breed has black hair, the Sawahli and Awadi breeds are brown but the Sawahli breed is light and the Awadi breed more dark in the hump; while the Gamra breed is more white than the others.

Surface Ultrastructure (SEM) of Hair Shafts of the Four Camel Breeds

In the present study, the cuticular hair scales of the camel hair shafts were found to

be of the imbricate type. They have serrated margins with narrow spaces in between, with their free edges relatively small in the black (Meghem) and brown black (Awadi) breeds. In contrast, the cuticular hair scales are less serrated in the brown (Sawahli) and white (Gamra) breeds respectively (Plate 1).
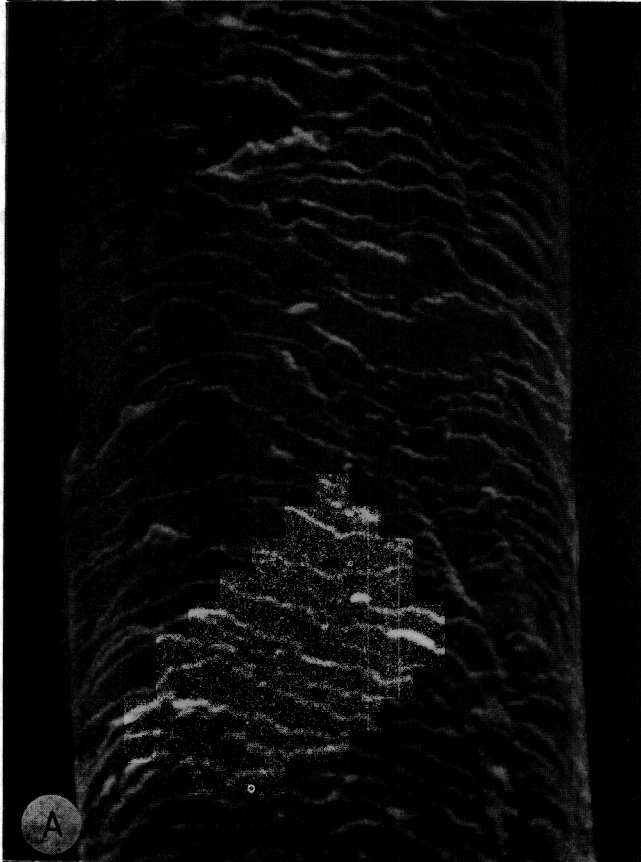

PLATE   Surface Ultrastructure (SEM) of the hair shaft of four breeds of Arabian camels (Meghem, Awadi, Sawahli and Gamra) in the Western region of Saudi Arabia.
(a) SEM of hair shaft cuticular scales of black camel (Meghem) to show imbricated elongated cuticular scales with serrated free margins ($\times$ 3000).

Discussion

The present study has revealed that the Arabian camel is slightly different from other camel breeds in Asia and Africa. According to Angelo Pesce[1], the Arabian camel, *Camelus dromedarius,* is a higher-built and longer-limbed animal than its Central-Asian congener *C. bactrianus* and stands to about 2 m at the shoulder. The head is comparatively short with a long sloping muzzle and convex forehead. The eyes are large and are protected against sand by two rows of lashes, one on the upper
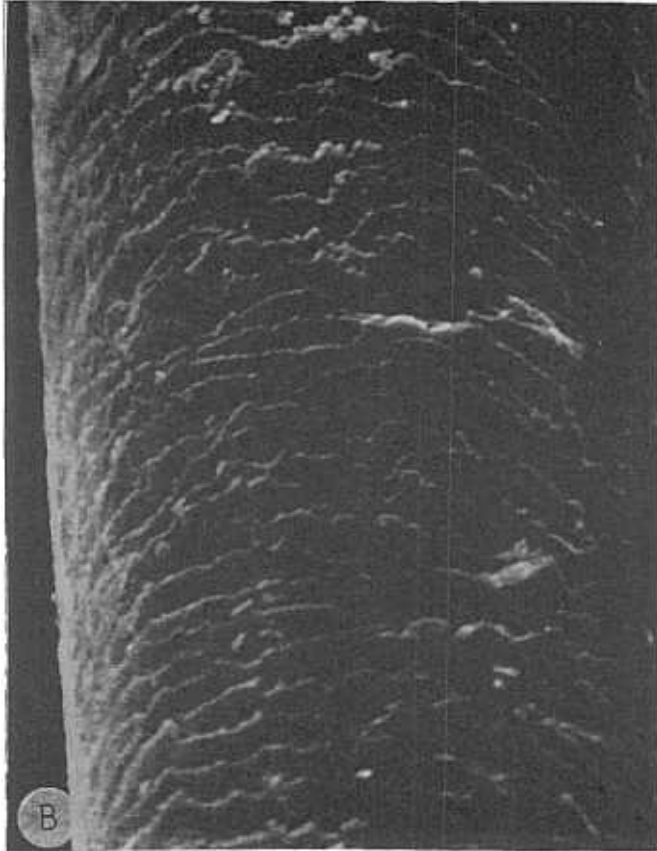
(b) SEM of hair shaft of brown black camel (Awadi) demonstrating similar pattern to the black one ($\times$ 3600).

and the other on the lower lid. The small, rounded, and hairy ears are situated well back on the sides of the head. The cleft upper lip overhangs the lower and the large, slit-like nostrils can be closed at will. The arched neck is laterally compressed and thickest in the littoral-middle. The body is massive, and the contour of the back rises from the neck to the loins and then falls rapidly away to the tail.

Extensive work on body measurement and weight have been carried out in various breeds of cattle[9-12] and on Indian breeds of camel[2]. Khanna et al.[2] reported that some distinct camel breeds have been classified according to body characteristics and traits where these are predominantly found. These include Bikaneri, Jaisalmeri, Sindhi, Marwari, Mewati and Kutchi. All these breeds show differences from each other demonstrated by the Khanna et al.[2] technique. The present data on fourteen parameters of body measurement of four breeds of the Arabian camel in the western region of Saudi Arabia show statistically significant differences between the breeds.
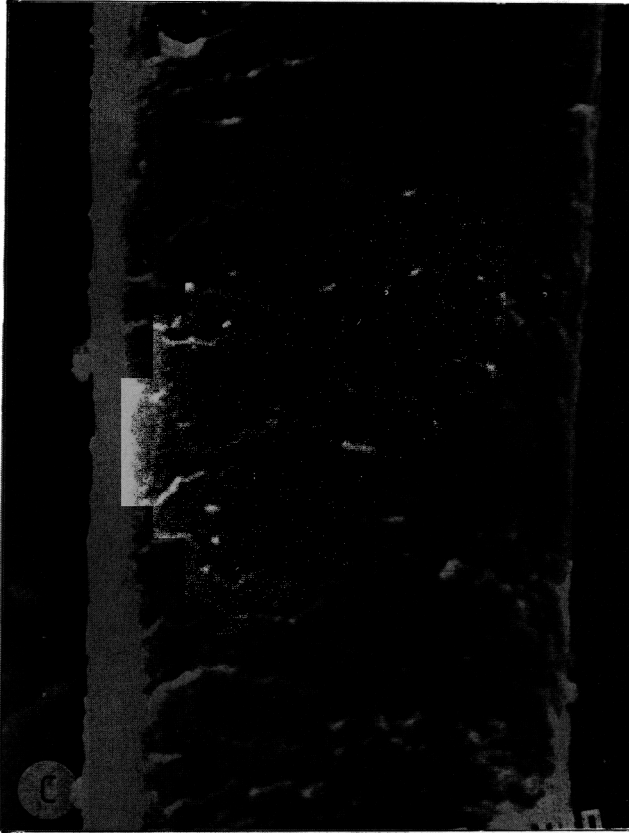
PLATE   (c) SEM photograph to show less serration of cuticular scale free margins and large spaces be·
tween the scales of hair shaft of the brown camel (Sawahli) (× 3000).

The further comparisons reveal clear differences between the breeds. The
Meghem breed has the largest body measurements, and body weight compared with
the other breeds. The Gamra, Sawahli and Awadi breeds have lower body measure-
ments and body weight which the Gamra breed has the lowest body measurements
and weight.

In all breeds the hair is soft at the top of the head, neck, shoulders, hump, the tip
of the tail. In the upper part of the forelegs, it is longer than elsewhere in the body. Its
colour is very variable in all the breeds, although light brown is most common in
Sawahli and brown in Awadi. There are, however, an entirely white Gamra breed
and an entirely black Meghem breed. The hair falls off and is renewed every year at
the end of spring (sometime in March).

It has been clearly demonstrated from our scanning electron microscopy photo-
graphs that detailed surface architecture of the hair shaft cuticular scales of camels

PLATE   (d) SEM of hair shaft of camel (Gamra) showing smooth free margin and larger spaces between the cuticular scales (× 3000).

shows varying patterns. Similar results from microscopical studies of the cuticular scales structures of the hair shafts of mammals[3,4,13-15], have been of great value in revealing anatomical structure which can be used in the classification of mammals. In addition, El Gohary[5] has investigated 15 species of Saudi Arabian bats and demonstrated structural differences on the species level which could be used for taxonomic purposes. From preliminary results, it has been suggested that the SEM structural differences in scales are related to species and, to a lesser extent, to individuals.

It is hoped that this preliminary study will be further documented by data on the iso-enzymes and chromosome mapping of different camel breeds in other regions of the Kingdom of Saudi Arabia.

Acknowledgement

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دراسة على مقاييس الجسم لبعض سلالات الإبل العربية *C. dromedarius* في المملكة العربية السعودية

منصور عطية الحازمي ، أحمد محمد غندور و محمد الجوهري

قسم علوم الأحياء ، كلية العلوم ، جامعة الملك عبد العزيز

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المستخلص . تم التعرف على أربعة سلالات للإبل العربية في المنطقة الغربية بالمملكة العربية السعودية : السواحلي والمجهم والقمرا والعوادي . وقد تم التعرف على هذه السلالات باستخدام ١٤ قياس للشكل الخارجي وكذلك الوزن للنوق البالغات (طول القدمين ، حجم الصدر ، طول الجسم ، طول الأذنين ، الذيل ، المسافة بين العينين والمنخار ، ارتفاع عرض الجسم ومحيط القدمين وحجم السنام ووزن الجسم) .

وقد سجلت اختلافات إحصائية في هذه المقاييس في السلالات الأربعة . كما تم دراسة السطح الدقيق لسطح الشعر من السلالات الأربع باستخدام المجهر الإلكتروني الماسح . وكانت جليد قشور الشعر أقل تموجا في السلالتين السواحلي والقمرا عنها في المجهم والعوادي .