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An Osteometric Study of the Skull of the West African Dwarf Goat from South Eastern Nigeria. I. Preliminary Study.

***Olopade, J. O and Onwuka, S.K**

Department of Veterinary Anatomy
Faculty of Veterinary Medicine
University of Ibadan, Ibadan. Nigeria

*Correspondence: jkayodeolopade@yahoo.com

SUMMARY

Osteometric analysis of the skulls of the West African Dwarf goats obtained from southeastern Nigeria was done in this study using 31 craniometric landmarks. The overall length and height were 15.33 1.15cm and 9.86 0.73cm, respectively. The whole skull index was 63.60 0.13. The orbital circumference including its horizontal and vertical diameters were 10.74 0.71cm, 3.06 0.15cm and 3.32 0.19cm, respectively. The foramen magnum index was 104.9710.03 with the foramen magnum height and width being 1.68 0.14cm and 1.60 0.10cm, respectively. Most craniometric values obtained in this study were smaller than those obtained from the same breed of goat from the southwest. The study suggests a possible under functioning of the pituitary as being the reason for the observed lower craniometric values.

KEY WORDS: Osteometry, Analysis, West African Dwarf, Goats

INTRODUCTION

The West African Dwarf (WAD) goat occurs in and near the tropical forest belt in West and Central Africa but its distribution does not extend to East Africa (Devendra and Burns), 1983. The breed which is peculiar for its ability to adapt to humid tropical environment and its resistance to trpanosomosis makes up 38% of about 38 million goats in the 15 countries of the West African humid zone (Gall, 1996). Despite the importance of skull morphometry for clinical and research purposes, little is found in literature on this breed (Olopade, 2003; Olopade and Onwuka, 2005a,b).

The aim of this work is to report an osteometric analysis of the skull of the WAD goat from Southeastern Nigeria.

MATERIALS AND METHODS

A total of twelve goats were used for this study. The goats were obtained from villages around Nsukka town in Southeastern Nigeria. The goats after being adjudged healthy on physical and clinical examination were restrained and then slaughtered at the occipito-atlantal joint. The severed heads were then frozen at -20 °C

The skulls were prepared according to the hot water maceration technique as described by (Olopade and Onwuka, 2005a; Onar,1999; University of Arizona, 1999).

A total of 32 craniometric indices were determined in the skulls. The indices were measured using metric rules, Vernier calipers, measuring cylinders, a pair of dividers and compasses. The landmarks and methodology of each value obtained is described below and shown in Figures 1-6.The data obtained were analysed using the SPSS 10 package and presented as Mean SD

- **Condylobasal length (CBL):** The length of the skull was measured from the front of the premaxillary bones to the rear surface of the occipital condyles.
- **Inter-orbital width (IOW):** Minimum distance between the upper edges of the orbits was measured across the top of the skull.
- **Inter-canthi distance (ICD):** This is the minimum, distance between the median margins of the orbits.
- **Orbital length (OBL):** This is the maximum circumference of the orbit, from rim to rim. Includes maximum orbital horizontal diameter **(OHD)** and vertical diameter **(OVD)**
- **Palate width:** The width across the median limits of the alveoli of the cheek teeth at Molar 2 **(MXPW A)** and at Molar 1 **(MXPW B)**
- **Minimum palate width (MIPW):** The minimum width across the palate measured at Premolar 1.
- **Nasal length (NSL):** Overall length of the nasal bones.
- **Overall length (ORL):** Maximum dimension of the skull when laid on level surface from the top of the dentary of the mandible to the level of the nuchal crest.
- **Total palate length (PTL A):** From midline of the mid-cranial end of the choana to the tip of the premaxilla.
- **Palate length (PTL B).**The length of the maxillary part from the midline of the junction of the suture of palatine bone to the tip of the premaxilla.
- **Zygomatic width (ZGW):** The maximum width across the zygomatic arches.
- **Whole skull height (WSH):** From the highest level of the frontal bone to the lowest level of the mandible.
- **Whole skull index (WSI):** $\frac{\text{Whole skull height} \times 100}{\text{Overall length}}$
- **Skull height (without mandible) (SH):** From the level of the highest point of the frontal bone to the base of the jugular process.
- **Basal length (BL):** From the cranial alveolar end of mandible to the occipital condyles at the level of the jugular process.
- **Neurocranium height (NCH):** From the deepest indentation of the sella turcica directly dorsal to the inner layer of the roof of the cranium.
- **Neurocranium length (NCL):** From the deepest indentation of the fronto-ethmoidal junction to the middle of the distal

surface of the cranium at the level of the cerebral surface of the external occipital protuberance.

- **Neurocranium volume (NCV):** The volume of the neurocranium in mls measured by using plastercine or gum to block all the foramina of the intact skull and the neurocranium is then filled with rice grains from the foramen magnum. When full, the rice is emptied into a measuring cylinder, and volume determined.
- **Foramen magnum height (FMH):** Mid-vertical height of the foramen magnum.
- **Foramen magnum width (FMW):** Largest width of the foramen magnum
- **Foramen magnum index (FMI):** Foramen magnum height x 100

Foramen magnum width

- **Occipital triangle height (OCH):** From the nuchal crest to the lower brim of the foramen magnum.
- **Occipital triangle height (without foramen magnum) (OCHW):** From the nuchal crest to the upper rim of the foramen magnum
- **Length of Cornual Process (LCP):** From the rostroventral line at the level of the horn corium to the top of the bony horn.
- **Intercondylar width (ICW):** Width between the lateral ends of the occipital condyles.
- **Interparacondylar width (IPCW):** This is the greatest breadth of the ventromedial ends of the jugular processes.
- **Thickness of Occipital Condyles (TOC):** Maximum width of a single occipital condyle.
- **Length of Paracondylar process (LPP):** The length from the tip of the paracondylar process to it's junction with the squamous occipital bone.

Maximum thickness of Paracondylar process (TLPP): The circumference around the thickest part of the paracondylar process.

TABLE I: Data of some indices of the skull of WAD goat

RESULTS

Table I: Data of some indices of the skull of WAD goat

Item	*Mean	±SD
CBL	15.35	0.71
IOW	7.68	0.46
ICD	6.74	0.38
OBL	10.74	0.71
OHD	3.06	0.15
OVD	3.32	0.19
MXPWA	3.31	0.20
MXPWB	3.18	0.38
MIPW	1.98	0.15
NSL	4.95	0.54

*All data is in cm

Table II: Data of some indices of the WAD of the goat

Item	*Mean	±SD
ORL	15.33	1.15
PTLA	8.33	0.49
PTLB	6.60	0.79
ZGW	7.78	1.04
WSH	9.86	0.73
WSI	63.6	1.31
SH	7.68	0.44
BL	13.68	1.04
NCH	4.17	0.22
NCL	7.12	0.37
NCV	72.83	8.88

* All data is in cm except NCV which is in millilitres and WSI which is an index.

Table III: Data of some indices of the skull of WAD goat

Item	*Mean	±SD
FMH	1.68	0.14
FMW	1.60	0.10
FMI	104.97	10.03
OCH	3.78	0.16
OCHW	3.11	0.12
LCP	3.28	1.22
ICW	3.57	0.18
IPCW	3.74	0.25
LPP	1.51	0.18
LPP	0.66	0.09

*All data is in cm except for FMI which is an index

The minimum palatine width and total palatine length (Fig.1) were1.98 ± 0.15cm and 8.33 ± 0.49cm, respectively while the overall length and whole skull height (Fig.2) were 15.33 ± 1.15cm and 9.86 ± 0.73cm, respectively. The whole skull index was 63.60 ± 0.13. The neurocranium height,

neurocranium length (Fig.3) and nasal length (Fig 4) were 4.17±0.22cm, 7.12 ± 0.37cm and 4.95 ± 0.54cm, respectively. The foramen magnum height and width (Fig.5) were 1.68 ± 0.14cm and 1.60 ± 0.10cm respectively, thus the foramen magnum index at 104.97±10.03 was slightly above 100. The orbital diameter was 10.74 ± 0.71cm while the horizontal and vertical diameters (Fig.6) were 3.06 ± 0.15cm and 3.

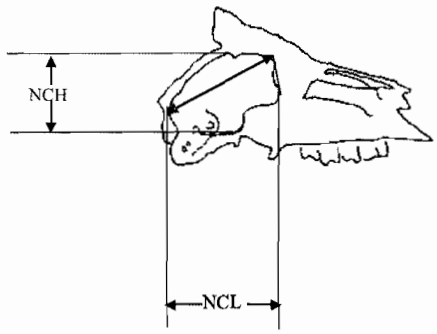

Fig. 3: Schematic diagram of the skull of the goat (median view)

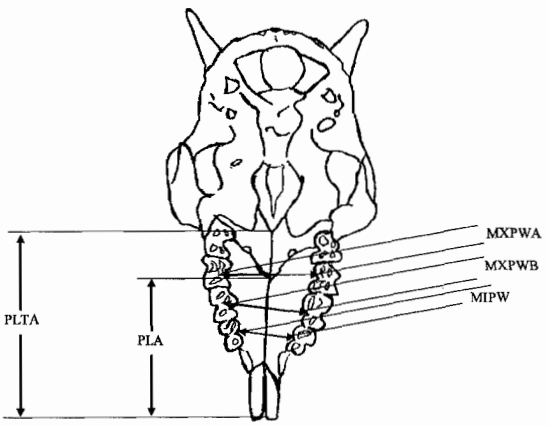

Fig. 1: Schematic diagram of the skull of the goad (ventral view)

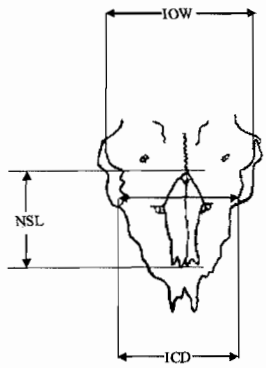

Fig. 4: Schematic diagram of the skull of the goat (Frontodorsal view)

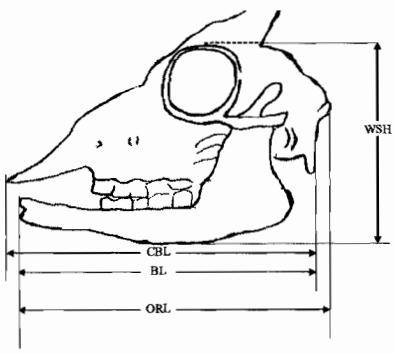

Fig. 2: Schematic diagram of the skull (with mandible) of the goat (Lateral view)

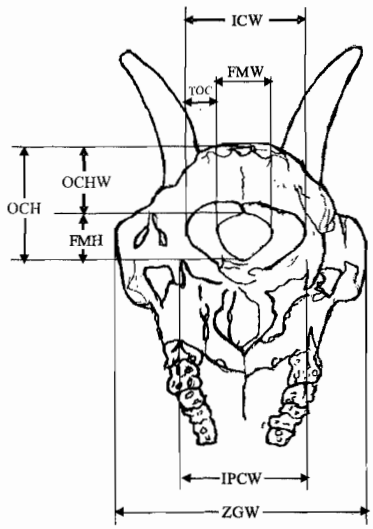

Fig. 5: Schematic diagram of the skull of the goat (Caudoventral view)

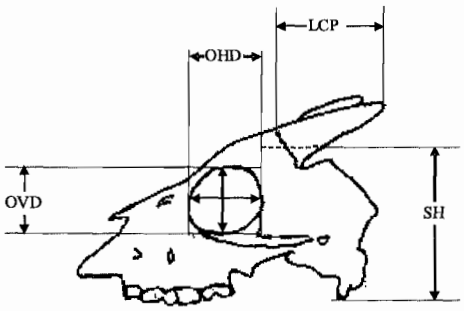

Fig. 6: Schematic diagram of the skull of the goat (Lateral view)

DISCUSSION

The condylobasal length (CBL) of 15.35cm in this study was shorter than that obtained in the Anglo Nubian breed, which was 21.5cm (Goat Skull, 2005). The overall length, basal length, neurocranium height and length, the foramen magnum width, height and index, the occipital triangle height and the intercondylar and interparacondylar width obtained in this study from WAD from South-Eastern Nigeria (SE) were consistently smaller than those obtained in the skulls of WAD from South-Western (SW) Nigeria (Olopade and Onwuka, 2005a. However, the latter had lower values for skull height, whole skull height, whole skull index and for the length of the cornual process.

The relatively higher skull in the (SE) WAD was most likely due to a greater ventral projection of the occipital condyles. The consistently smaller values of the metric indices of WAD from the SE could be as a result of the fact that they are proportionate dwarfs while those from SW are disproportionate (Gall, 1996). While the latter owe their dwarf nature to reduced length of their extremities caused by an abnormality of the epiphyseal cartilages of the long limbs (Achondroplasia); the former which are true dwarfs are small sized, produced by a reduced growth governed by limited function of the pituitary gland (Gall,1996). This occurrence could have led to reduced function of the growth hormone and thus reduced development of the skull.

The authors also observed with curiosity that a sizeable number of the goats in the herds in the SE group, were unilateral cryptorchids. The reason for reduced craniometric indices could also be because of testosterone deficiency which may actually result from disease or damage to the pituitary gland, and this can lead to abnormalities in muscle and bone development (Urology Channels, 2005).

Though goats from SW and SE are classified as the same breed, they live in two different environments separated by Nigeria's largest river. There has been no standing history of any appreciable movement of these goats across to each other's environment, and hence they are each unique with minimal crossbreeding expected. We thus propose that based on the consistently different osteometric dimensions that these goats, which are of the same breed, could be different subspecies. Endo *et al.* (2002) had reported that wild pigs in the island Iriomote in Japan, have been considered independent subspecies and distinguished from those of the same breed in the Japanese mainland due to smaller osteometric characters.

Like those from SW (Olopade and Onwuka, 2005b) the foramen magnum height of goats from SE was larger than the corresponding width thus both groups had a foramen index that was over 100. The disparity with different species and breeds of animals whose foramen magnum index have been reported to be below 100 e.g. the dog (Onar, 1999) and rabbit (Kahvecioglu *et al.*, 2000) could provide a strong reason for doing comparative morphometrical studies of the medulla oblongata and spinal cord (Dyce *et al.*, 2002).

The slightly longer cornual process observed in WAD goats in the study compared to those from SW could translate to a corresponding larger horn and this could confer superiority for the former as it relates to offence and defence of the animal.

The neurocranium volume in this study was 72.83 ml. Though the corresponding value for the WAD from the SW was not reported, it is worthy of note that the neurocranium height and length of the WAD from the SE was smaller that those from the SW; this could then suggest that the WAD from SW

could have a larger volume of the neurocranium and the brain. Golalipour *et al.* (2005) had suggested that the volume of the cranium correlates positively with that of brain volume.

CONCLUSION

In conclusion, this work has provided information on the skull typology of the WAD breed and this has not only helped in comparing within the breed but it can also be used to make a more accurate comparative anatomical study with other breeds of goat.

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