P-ISSN: 2304-3075; E-ISSN: 2305-4360
International Journal of Veterinary Science
www.ijvets.com; editor@ijvets.com

Research Article

Comparative Morphometric Study of the Right and Left Pectoral and Pelvic Bones of Cattle Egret (*Bubulcus ibis*)

Oyetunde Kazeem Ekeolu[1], Ifukibot Levi Usende[2*], Olumuyiwa Abiola Adejumobi[3], Ayodeji Idris Azeez[4] and Marufat Oladayo Orolu-Adedeji[5]

[1]Department of Veterinary Anatomy, Faculty of Veterinary Medicine, University of Benin, Benin City Nigeria
[2]Department of Veterinary Anatomy, Faculty of Veterinary Medicine, University of Abuja, FCT, Nigeria
[3]Department of Veterinary Medicine, Faculty of Veterinary Medicine, University of Ibadan, Ibadan, Nigeria
[4]Department of Veterinary Anatomy, University of Jos, Plateau, Nigeria
[5]Department of Veterinary Anatomy, Faculty of Veterinary Medicine, University of Ibadan, Ibadan, Nigeria
***Corresponding author:** ifukibot.usende@uniabuja.edu.ng

Article History: Received: July 27, 2016 Revised: August 06, 2016 Accepted: August 25, 2016

ABSTRACT

Cattle egrets (*Bubulcus ibis)* are cosmopolitan species of heron found in almost all the zones of the world and can be described base on the colour of their plumage, habitat, and feeding habit. The importance of this bird to the farmer has initiated an increasing interest to establish more accurate and specific anatomical facts especially as the greatest part of daily activities of the birds is devoted to obtaining food. Here, we provide for the first time, basic information on gross morphometrics of the forelimb and hindlimb skeleton of the cattle egrets (*Bubulcus ibis*). Ten apparently healthy adult migrant cattle egrets live-trapped at the University of Ibadan, Nigeria teaching and research farm were used for this study. The birds were euthanized by lethal injection using a combination of xylazine (10mg/kg) and ketamine (100mg/kg), eviscerated and de-fleshed and bone prepared using cold water maceration method. Digital venire caliper was engaged in taking the linear measurement of the various parts of the long left and right bones in millimeters. The study showed the long bone skeleton of the forelimb to consist of the humerus, ulna and radius, carpus, metacarpus and the skeleton of the long bones of the pelvic limb to include the femur, tibiotarsal and fibular and the tarsometatarsals. Morphometric results showed no significant difference when the parameters between the left and right forelimb and hindlimb bones were compared except for the breadth of the distal extremities (BDE) of the tarsometatarsal bone. Studies on the morphological and morphometrical analyses of the forelimb and hindlimb such as this can give understanding on the anatomical characteristic of osseous structures in relation to body size explaining many environmental and ecological adaptations in cattle egrets.

Key words: Cattle egret, Limbs, Skeleton, Morphometrics, Distal extremities

INTRODUCTION

Cattle egret (*Bubulcus ibis)* is a cosmopolitan species of heron found in almost all the zones of the world including the tropics (Rezk, 2015). As the only member of the monotypic genus *Bubulcus (*Rezk, 2015*)*, it has two subspecies; the western cattle egret and eastern cattle egret. The *Bubulcus* is similar to *Egretta* as the appearance of their plumage looks alike (Hancock, 1984) but it is more closely related to the herons of *Ardea* family *(*Rezk, 2015*)*. In Nigeria, cattle egrets are colonial and white in colour, covered with buff plumes and are found around water bodies and open lands. The cattle egret has widely been described base on the colour of their plumage, habitat, and feeding habits. Recently, Khalifa (2014) emphasized the importance of cattle egret to the farmer and this has initiated an increasing interest to establish more accurate and specific anatomical facts especially as the greatest part of daily activities of these birds as well as others birds are devoted to obtaining food (Barbosa 1993) pointing to a relationship between feeding ecology and morphology (Carrascal *et al.*, 1990). The skeletal frame work of cattle egret plays a role in its feeding habit (Rezk, 2015). The locomotor system, particularly hind-limb morphology is critical to the role of foraging behavior (Moreno 1991; Barbosa 1993) of cattle egret. Here, we provide for the first time, basic information on gross morphometrics of the forelimb and

Cite This Article as: Ekeolu OK, IL Usende, OA Adejumobi, AI Azeez and MO Orolu-Adedeji, 2016. Comparative morphometric study of the right and left pectoral and pelvic bones of cattle egret (*Bubulcus ibis*). Inter J Vet Sci, 5(4): 285-289. www.ijvets.com

hindlimb skeleton of the cattle egrets (*Bubulcus ibis*) as studies dealing with morphometric of the skeleton of this bird is scarce and the scarcity applied to evolutionary study of the bird morphology.

MATERIALS AND METHODS

Ten apparently healthy adult migrant cattle egrets live-trapped at the University of Ibadan, Nigeria, teaching and research farm were used for this study. The birds were euthanized by lethal injection using a combination of xylazine (10mg/kg) and ketamine (100mg/kg). They were then eviscerated and de-fleshed as much as possible using scalpel blade. Cold water maceration method (Tahon *et al.,* 2013) was then used to prepare the bones. Briefly, the egrets were soaked in cold water with ammonium solution and sodium hydroxide overnight to remove grease and soften the connective tissues and muscular attachment on the bones. The solution was changed daily. This was repeated for a week. Then the extraneous tissues on the bones were picked using hand (thumb) forceps, after brushing the muscles fibers and connective tissues attached to the bones with sponges. The bones were then washed in clean water and air dried. Digital venire caliper was engaged in taking the linear measurement of the various parts of the long left and right bones in millimeters. All the parameters measured are defined briefly and some illustrated in Figures 1-3.

Definitions of parameters

Humerus

HH: Humeral length; measured from the highest point on the humerus to the lowest point on the humeral condyle
CD: Humeral condyle diameter, measured at the point from the medial to the lateral epicondyles
SD: Diameter of the proximal epiphysis measured at where the shaft curved out
DPH: Diameter of the proximal epiphysis measured at the widest point.
HT1: The distance between the lesser tubercle and the highest point on the head of the humerus.
HT2: The distance between the greater tubercle and the highest point on the humeral head.
HP: Length of the inter-tubercular groove, measured between the medial surfaces of the lesser and greater tubercles.

Radius and Ulna

PE: Diameter of the proximal part of radius, measured at the widest points.
DRU: Inter osseous space; distance between radius and ulna, measured at the widest points.
RL: Length of radius, measured from the highest point on the proximal part of radius to the lowest point on the distal part of the bone.
UL: Length of ulna, measured from the highest point on the proximal part of ulna to the lowest point on the distal part of radius.
DE: Distance between the lateral part of the distal epiphysis of radius and ulna.

Femur

BPE: Diameter of the proximal epiphysis measured from the lateral aspect at the widest point to the widest point on the femoral head.
FH: Diameter of the head of the femur.
FB: Diameter of the body of femur, measured at the proximal half of the bone
FL: The length of femur, measured at the highest point on the proximal epiphysis and the lowest point on the distal epiphysis.

Carpometacarpal

WL: Distance between the highest and lowest point of the bone, measured as the length.
BMC: Diameter of major metacarpal bone.
BNC: Diameter of minor metacarpal bone
DBC: Distance between the two metacarpal bones
WB: Distance between the lateral aspects of the two metacarpal bones, measured at the widest region.

Tibiotarsal and Fibula

TTL: Length of the tibiotarsal measured from the highest point of the proximal articular surface to the lowest point on the distal articular surface.
FL: Length of the fibula.
TTB: Diameter of the tibiotarsal bone measured at the proximal half or mid-point on the body of the bone
TTPE: The diameter of the widest part of the proximal extremity of tibiotarsal bone.
TTDE: The diameter of the widest part of the distal extremity of tibiotarsal bone.
TTCB: Tibiotarsal condylar diameter, measured from the medial to the lateral aspects
TTFPE: Tibiotarsal and fibula diameter, measured at the widest region on the proximal extremity.
FB: Fibula diameter taken at the widest point.

Tarsometatarsal

TML: The length of the bone measured from the highest point on the proximal extremities to the lowest point on the distal aspect.
TMB: Diameter of the bone, taken at the proximal one-half.
TMDE: Diameter of the distal articular surface measured at the widest parts.
TMPE: Diameter of the proximal part of the bone taken at the widest points.
DFL: Diameter of the proximal extremities taken from the cranial point to the caudal aspect
DFB: Diameter of the proximal aspect of the fibula, measured between the lateral and medial borders

Statistical analysis

All numerical data generated from the morphometric studies of left and right limbs were subjected to statistical analysis using student t-test, Graph Pad Prism version 4 and expressed as mean±standard deviation (SD). Values of $P<0.05$ were considered statistically significant.

RESULTS

Bones of the thoracic limb

The skeleton of the forelimb consist of the pectoral girdle (scapulae, coracoids and fused clavicles) and the wing bones (humerus, ulna and radius, carpus, metacarpus and digits).

Fig. 1: Cranial view of the right humerus of the cattle egret showing some of the parameters measured

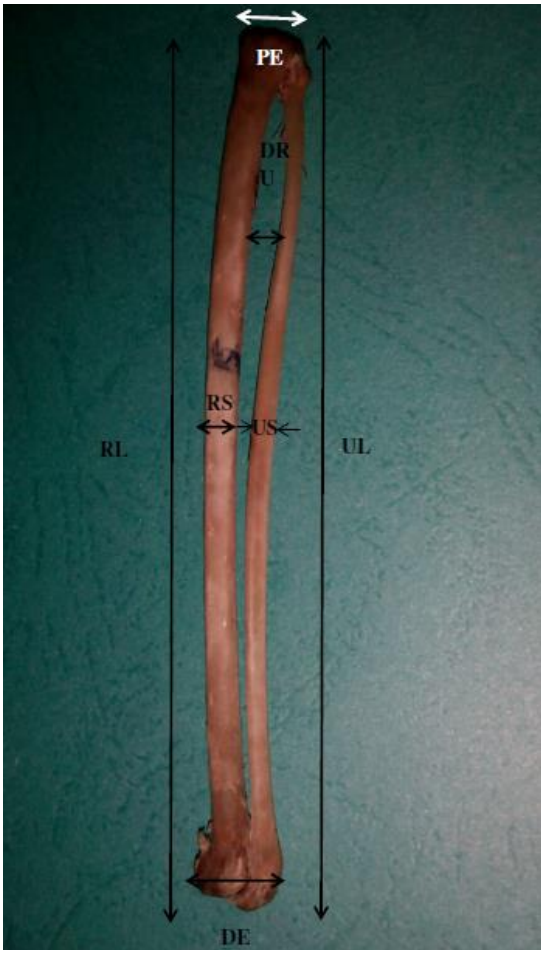

Fig. 2; Cranial view of left radius and ulna of the cattle egret showing some of the parameters measured

Fig. 3: Cranial view of the left femur with some of the parameters measured.

Humerus

The humerus of the cattle egret studied appeared flat and expanded proximally and distally with a tubular shaft. Results of the morphometric studies on the left and right humerus are presented in Table 1. The mean height, mean diameter of the proximal epiphysis, shaft diameter, average condular diameter as well as the mean diameter of the humeral head showed no statistical significance difference between the right and left humerus (Table 1). However, the left humeral head had a slightly higher mean value (8.057±0.22mm) than the right (7.500±0.21 mm). Also, there was no significance difference between the left and right dorsal and ventral tubercle of the head of the humerus, the humeral mean distance between the dorsal and ventral tubercle and the head of the right and left humerus.

Radius and Ulna

Results of the morphometric studies on the left and right radius and ulna are presented in Table 1. When the average values of all the parameters measured for the right and left sides of the radius and ulna were compared at p value <0.5, there was no significant difference. However, the radial length (RL) average value (98.60±2.21mm) for the right was slightly lower than the left (99.50±1.54mm). The radial shaft mean diameter (RS) for the right (3.020±0.02mm) was slightly higher than the left (2.750± 0.170mm) with no statistical significant difference. There was also no significant difference between the average values of the ulna length and shaft diameter, mean diameter of proximal and distal extremities for the left and right ulna. Although, the mean distance between the radius and ulna was slightly higher in the right (4.500± 0.158mm) than the (4.425±0.250mm) it showed no statistical difference.

Table1: Right and left Morphometrics of the humerus, radius and ulna and carpometacarpals of the cattle egret

Humerus				Radius and Ulna				Carpometacarpal			
	Right	Left	LVS		Right	Left	LVS		Right	Left	LVS
	Mean± SEM	Mean± SEM			Mean± SEM	Mean± SEM			Mean± SEM	Mean± SEM	
HH	90.78±0.94	90.72±0.89	ns	RL	98.60±2.21	99.50±1.54	ns	WL	47.50±0.75	47.50±0.53	ns
DPH	14.44±0.26	14.06±0.14	ns	RS	3.020±0.02	2.750±0.17	ns	WB	5.85±0.11	5.64±0.14	ns
SD	5.467±0.33	5.47±0.22	ns	UL	104.5±1.44	103.5±1.63	ns	BMC	2.75±0.17	2.71±0.10	ns
CD	11.78±0.22	12.00±0.23	ns	US	4.300±0.12	4.167±0.11	ns	BNC	1.25±0.11	1.35±0.09	ns
HP	7.50±0.21	8.06±0.22	ns	PE	9.900±0.25	11.00±0.69	ns	DBC	2.58±0.08	2.50±0.10	ns
DT	4.16±0.08	4.27±0.08	ns	DE	9.700±0.20	9.833±0.91	ns	-	-	-	-
VT	5.05±0.17	5.05±0.13	ns	DRU	4.500±0.16	4.425±0.25	ns	-	-	-	-
LDF	15.44±0.42	15.50±0.47	ns	-	-	-	-	-	-	-	-
HT1	3.11±0.13	3.05±0.10	ns	-	-	-	-	-	-	-	-
HT2	2.77±0.35	2.66±0.31	ns	-	-	-	-	-	-	-	-

LVS – levels of significance, NS- not significant.

Table 2: Right and left Morphometrics of the femur, tibiotarsal and fibula and tarsometatarsals of the cattle egret

Femur				Tibiotarsal and Fibula				Tarsometatarsal			
	Right	Left	LVS		Right	Left	LVS		Right	Left	LVS
	Mean± SEM	Mean± SEM			Mean± SEM	Mean± SEM			Mean± SEM	Mean± SEM	
FL	53.42±0.700	52.70±0.51	ns	TTL	113.3±1.24	113.9±1.17	ns	TML	78.11±0.94	78.38±0.91	ns
FH	4.50±0.12	4.00±0.27	ns	TTB	3.94±0.05	3.77±0.87	ns	TMB	3.16±0.08	3.18±0.09	ns
BPE	9.00±0.12	8.90±0.18	ns	TTPE	9.61±0.34	9.61±0.20	ns	TMPE	8.72±0.08	8.75±0.16	ns
BDE	9.25±0.11	8.80±0.12	*	TTDE	8.000±0.08	7.88±0.07	ns	TMDE	9.16±0.14	9.25±0.13	ns
FB	4.08±0.15	4.10±0.11	ns	TTCB	8.05±0.55	8.01±0.01	ns	DFL	9.72±0.33	10.16±0.32	ns
-	-	-		FL	21.17±1.13	21.94±1.15	ns	DFB	2.61±0.13	2.50±0.21	ns
-	-	-		FB	2.05±0.05	2.01±0.01	ns	-	-	-	-
-	-	-		TTFPE	9.38±0.24	9.61±0.13	ns	-	-	-	-

LVS – levels of significance, NS- not significant.

Carpometacarpal

These set of bones are taken as one unit because the distal row of the carpal bones fuses with the proximal end of the metacarpus forming the carpometacarpal bones. The mean dimensions of the carpometacarpal bones measured showed no significant variations when the left and right sides were compared although the average length of the whole breadth (WB) was 5.85±0.11mm for the right and was slightly higher than the left (5.64±0.14mm). The same pattern was seen in the average distance between the metacarpals and breadth of the major metacarpal (BMC). However, the mean values of the breadth of the left metacarpal (BNC), (1.25±0.11mm) was lower than the right (1.35±0.09mm) but with no significant difference (Table 1).

Bones of the pelvic limb

The skeleton of the long bones of the pelvic limb include the femur, tibiotarsal and fibular and the tarsometatarsals.

Femur

The femur appeared as a tubular and strong bone with hemispherical head. Results of the morphometric studies on the left and right femur are presented in table 2. All the dimensions measured showed no significant difference (Table 2) except for the breadth of the distal extremities (BDE) which were (9.25±0.11mm) and (8.80±0.12mm) respectively (Table 2).

Tibiotarsal and Fibula

The distal end of the tibia fused with the proximal row of the tarsal bones to form the tibiotarsals. This bone appeared longer than the femur. Upon morphometric analysis and comparism between the left and right tibiotarsal, there was no statistical difference in all the parameters measured (Table 2). However, the average value for tibiotarsal breadth (TTB) was greater (3.94±0.05mm) for the right than the left (3.77±0.87mm). Similar pattern was observed for the mean values of the tibiotarsal (TTDE) between the right (8.000±0.08mm) and left (7.88±0.07mm).

Tarsometatarsal

The tarsometatarsal is formed by fusion of the distal tarsal bone with metatarsals II, III and IV. The average values of all the dimensions of the tarsometatarsal bone measured are presented in Table 2 and showed no significant variations when the left and right sides were compared. However, the mean diameter values of the tarsometatarsal distal extremity (TMDE) were lower in the right (1.25±0.11mm) then the left (1.35±0.09mm). The dorsal flap length was (9.72±0.33mm) and (10.16±0.32mm), while the dorsal flap breadth measured (2.61±0.13mm) and (2.50±0.21mm), for right and left respectively. There was no significant difference in these parameters.

DISCUSSION

Body size is an important factor driving the evolution and diversification of organisms (Van-Den-Elzen and Nemeschkal, 2008).To represent overall body size, measures such as calculating the cube root of a compound measurement of the body core skeleton ((Hoerschelman 1996) are very critical. The pneumatic skeleton of birds such as cattle egrets and flying mammals like bats play important role in their flying ability. However, it is erroneous that birds skeleton are light weight but are dense (Dumont, 2010). We show

that skeleton of the forelimb consist of the pectoral girdle (scapulae, coracoids and fused clavicles) and the wing bones (humerus, ulna and radius, carpus, metacarpus and digits). This finding is in agreement with Rezk (2015). However, for the first time, investigations on the morphometrics and comparism between the left and right forelimb and hindlimb of the cattle egret is been carried out. We show no significant difference when the morphometric parameters between the left and right of these bones were compared. Again, we report the skeleton of the long bones of the pelvic limb to include the femur, tibiotarsal and fibular and the tarsometatarsals similar to earlier report of Rezk (2015) and except for the breadth of the distal extremities (BDE) of the tarsometatarsal bone, showed no significant difference when the morphometric parameters between the left and right were compared. The similarities between the left and right limbs could be the reason for the steady gait when the bird is on motion (flight). Our results on the length of the humerus are lesser than the reported length of same bone in male and female *Aechmophorus occidentalis* (122.7±3.8mm and 114.2±3.8mm respectively) and male (119.1±3.1mm) and female (107.2±3.4mm) *Aechmophorusclarkii* (Livezey and Storer 1992). Again, we reported a greater length of femur than that earlier reported by Livezey and Storer (1992) of male (47.0±1.5mm) and female (43.8±1.5mm) *A. occidentalis* and male (46.4±1.3mm) and female (42.2±1.2mm) *A. clarkia* (Livezey and Storer 1992). These differences can be attributed to the different types of birds used. However, our findings on the ulna length, carpometacarpal length, tibiotarsus length and tarsometatarsal length are similar to reports of Livezey and Storer (1992) on *A occidentalis*and *A. clarkii*. The long lengths of the humerus, ulna, tibiotarsus and tarsometatarsus could explain the "weight-strength-rule" (Van Den Elzen and Nemeschkal 2008) that regulates flying ability.

Studies on the morphological and morphometrical analyses of the forelimb and hindlimb such as this can give understanding on the anatomical characteristic of osseous structures in relation to body size explaining many environmental and ecological adaptations (Charuta *et al.*, 2005) in cattle egrets.

REFERENCES

Barbosa A, 1993. Morphometric variation of the hindlimb of waders and its evolutionary implication. Ardeola. 40: 65-75

Carrascal LM, E Moreno and JL Tellerja, 1990. Ecomorphological relationship in a group of insectivorous birds of temperate forest in winter. Holartic Ecol, 13: 105-111

Charuta A, BJ Bartyzel, M Karbowicz and H Kobryn, 2005. Morphology and morphometry of the antebrachial skeleton and bones of hand of the domestic pekin duck. Vet Zootech-LITH, 29: 26-30

Dumont ER, 2010.Bone density and the lightweight skeletons of birds. Proceedings of the Royal Society B Biological Sciences. DOI: 10.1098/rspb.2010.0117

Hancock J, 1984. Field Identification of West Palearctic White Herons and Egret. Brit Birds, 77: 451-457

Hoerschelmann H, 1996. Allometric investigations on rump and wing of snipes (*Charadriidae* and *Scolopacidae*). Z Zool Syst Evol, 4: 209-317

Khalifa EF, 2014.Gross Anatomical Studies on the Celiac Artery in Cattle Egret (*Bubulcus ibis*) with Special Reference to the Arterial Supply of the Stomach. J Vet Anat, 7:1-13.

Livezey BC and RW Storer, 1992. Morphometric comparison of skeletons of the Western Grebe complex Aechmophorus of the United States and Canada. The condor, 94: 668-679

Moreno E, 1991. Musculature of the pelvic appendages of the tree creepers *(Passeriformes certhiidae)*: myological adaptations for tail-supported climbing. Can J Zool, 69: 2456-2460

Rezk MH, 2015. Anatomical Investigation on the Appendicular Skeleton of Cattle Egret *Bubulcus ibis*. J Exp Clin Anat, 14: 5-12.

Tahon RR, SA Ragab, MA Abdel Hamid and HM Rezk 2013: Some anatomical studies on the skeleton of chicken, A PhD thesis. Anatomy and Embryology, Faculty of veterinary medicine, Cairo University.

Van Den Elzen R., and H.LNemechkal, 2008. The impact of Body mass on morphology integration in Avian Skeleton (Aves, fringillidae; carduelinae, Fringillinae). Bonn Zool Beitr, 50: 25-35