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Gross Anatomical and Morphometry Studies on the Oscoxae of Indian Fox (*Vulpes bengalensis* (Shaw 1800))

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ABSTRACT

The study was conducted during January, 2024 at the department of Veterinary Anatomy, College of Veterinary Science, Proddatur, Andhra Pradesh, India to document the anatomical details of oscoxae in Indian Fox (*Vulpes bengalensis*) that died due to natural causes. The bones were collected by fresh water maceration technique. The gross anatomy of bones of pelvic limb was studied after fresh water maceration and cleaning. The oscoxae of Indian fox was found to be similar in structure and number to other carnivores that have been studied. Oscoxae, the bone of pelvic girdle showed a prominent psoas tubercle on the on the caudal half of ventral border in ilium, a less conspicuous caudal ventral iliac spine cranial to the acetabulum, tuber ischii was single, incomplete acetabular rim. The mean weight and mean length of the bone were 7.41 g and 7.2 cm respectively. Cranio-dorsal to the sacropelvic surface in ilium a small eminence, the iliac tuberosity was observed. The mean length of the ilium was 4.1 cm. The greatest breadth across the coxal tuberosity was 4 cm. Pelvic symphysis contained pubis and ischium. The blunt ischiatic spine and joined with the acetabulum. The mean length of the ischium was 2.7 cm. The obturator foramen was relatively large and oval. The mean sagittal length and breadth of obturator foramen was 1.5 and 1.2 cm. The mean length and breadth of the acetabulum was 1.3 cm and 1 cm respectively. The tuber ischii was single.

KEYWORDS: Indian fox (*Vulpes bengalensis*), gross anatomy, morphometry, oscoxae

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Data Availability Statement: Legal restrictions are imposed on the public sharing of raw data. However, authors have full right to transfer or share the data in raw form upon request subject to either meeting the conditions of the original consents and the original research study. Further, access of data needs to meet whether the user complies with the ethical and legal obligations as data controllers to allow for secondary use of the data outside of the original study.

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1. INTRODUCTION

The Bengal fox (*Vulpes bengalensis*), also known as the Indian fox is endemic to the Indian subcontinent from the Himalayan foot hills and Terai of Nepal through southern India and from southern and eastern Pakistan to eastern India and southeastern Bangladesh (Jhala, 2016 and Vanak, 2005). The Bengal fox is more daintily built than the red fox (*V. vulpes*) and can readily be recognized by its bushy, black-tipped tail, which is around 50–60% of the length of the head and body (Menon, 2014). Lack of habitat protection is perhaps the greatest threat to the Bengal fox. For example, in southern India, less than 2% of potential Indian fox habitat is covered under the existing protected area network of the states of Karnataka and Andhra Pradesh (Vanak et al., 2008). The Indian foxes have a commonplace existence because of their omnivorous dietary requirements which do not involve any conflict with humans (Vanak et al., 2008). IUCN lists Indian foxes as Least Concern (Sillero-Zubiri et al., 2004). Hunting for its skin and flesh, as well as conversion of its grassland habitat to agriculture, industry, and increasingly bio-fuel plantations have affected its population density. In addition, its body parts are used in traditional medicine and in some areas it is eaten. They are hunted by the narikuruva tribes of southern India (Johnsingh, 1978). In Karnataka, they are captured in rituals conducted during Sankranthi (Gompper and Vanak, 2006). The populations of Indian foxes are listed in the CITES Appendix III. The Indian Wildlife Conservation Act (1972 as amended to 2005) forbids the hunting of all wildlife and lists the Indian Fox in Schedule II. It is listed as Least Concern in the IUCN Red List of Threatened Species (Jhala, 2016). Hence, there is no information available on the anatomical features of the skeletal system of the Indian fox.

Among the members of the Carnivora, the hind limbs only carry the animal forward (Samuels et al., 2013). This has a stronger effect on the shaping of the movement than the front extremities (Martin-Serra et al., 2014). The morphology of these bones is very important, since the hind limb bones provide most of the driving force (Fostowicz-Frelik, 2007). Carnivorans show a great range of locomotor habits resulting in different functional adaptations of the skeleton and musculature (Fabre et al., 2013, 2015; Taverne et al., 2018). These functional adaptations have allowed members of this order to diversify their habitats and exhibit a wide range of different lifestyles. Together with locomotor behaviour and dietary habits, body size and proportions are important features for biological reconstruction, due to their relationship with physiological and ecological factors (energy cost of locomotion, prey size, home range, etc.) (Tarquini et al., 2018). Anatomical and morphometry studies of the pelvic limb bones have always been of interest to the researchers in the field of anatomy, due to its high significance in various fields of Veterinary Medicine and Zoology. The skeletal features of domestic mammals were recorded by Konig and Liebich (2009). Indian fox is one of the least studied canids in the world. There is paucity of literature on systematic information on characteristic anatomical features of the bones of Indian foxes. As the literature on the gross anatomical features about the oscoxae in Indian fox is meagre, the present study is conducted to contribute the dearth of information in Indian fox.

2. MATERIALS AND METHODS

The present study was conducted during month of January 2024 on oscoxae of four Indian foxes which were died due to natural causes. These were collected and macerated in fresh water at the department of Veterinary Anatomy, College of Veterinary Science, Proddatur, Andhra Pradesh, India. After maceration, the bones were cleaned and the gross anatomical features of the oscoxae were recorded. The terminologies were adopted from Nomina Anatomica Veterinaria (2017). Different biometrical parameters were measured with the help of a thread, meter scale, and Vernier calipers and weight was measured with digital balance. The parameters were weight of oscoxae, maximum length (the iliac crest to the caudal border of the ischium), maximum width (across the tuber coxae) , smallest width of shaft of ilium, maximum width across the acetabula , smallest width across the bodies of the ischia , maximum width across the ischial tuberosity, sagittal length of acetabulum, sagittal width of acetabulum, maximum length of ilium, maximum length of ischium, inner length of obturator foramen, inner width of obturator foramen.

3. RESULTS AND DISCUSSION

3.1. Oscoxae

The pelvic girdle consisted of left and right oscoxae. These two bones met at the pelvic symphysis ventrally. This bone articulated dorsally with the sacrum through ilium and runs linear to the vertebral column. The oscoxae built with three bones viz., ilium, ischium and pubis like other mammals (Figure 1). The mean weight and mean length of the ossa coxarum bone were 7.41 gm and 7.2 cm respectively (Table I). However, the mean length of oscoxae was 99.91 mm in racoon dog and 99.57 mm in red fox (Jurgelenas, 2015), 24.00 cm in spotted deer (Ranjani et al., 2013) and 16.70±0.60 cm in leopard (Podhade et al., 2014).

3.2. Ilium

In Indian fox, ilium formed the cranio-dorsal part of the oscoxae. It was the largest of the three parts. It was a wide curvilinear bone. It was wide above with a wing dorsally

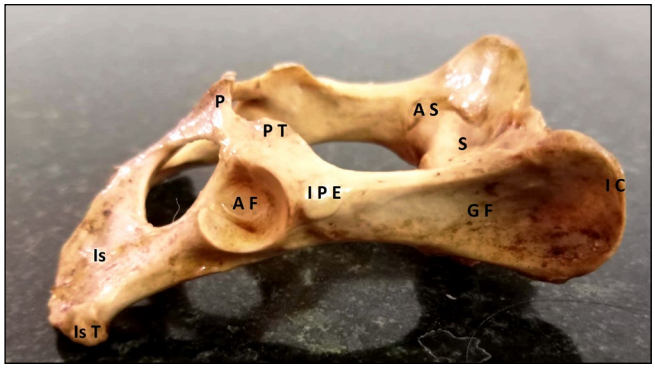

Figure 1: Lateral aspect of pelvic bone of Indian fox showing Iliac crest (IC), Gluteal Fossa (GF), Sacrum (S), Articular surface (AS), Iliopubic eminence (IPE), Psoas Tubercle (PT), Pubis (P), Acetabular Fossa (AF), Ischium (Is) and Ischial tuberosity (IsT)

Table I: Morphometrical data for different parameters of the Oscoxae in Indian fox

Sl. No.	Parameter	Mean value
1.	Weight of oscoxae (g)	7.41
2.	Maximum length (from most cranial part of the iliac crest to the caudal border of the ischium) (cm)	7.2
3.	Maximum width (across the tuber coxae) (cm)	4
4.	Smallest width of shaft of ilium(cm)	0.8
5.	Maximum width across the acetabula (cm)	4.8
6.	Smallest width across the bodies of the ischia (cm)	3.5
7.	Maximum width across the ischial tuberosity (cm)	5.6
8.	Sagittal length of acetabulum (cm)	1.3
9.	Sagittal width of acetabulum (cm)	1
10.	Maximum length of ilium (cm)	4.1
11.	Maximum length of ischium (cm)	2.7
12.	Inner length of obturator foramen (cm)	1.5
13.	Inner width of obturator foramen (cm)	1.2

and shaft ventrally. It was comprised of two surfaces, three borders and three angles.

Ilium was comprised of two surfaces, lateral and medial. Lateral surface had a deep concave area called gluteal fossa. Similar observations were made in ossa-coxarum of leopard (Podhade et al., 2014). The medial surface was strongly convex and divided into a non-articular iliacus area cranially and a rough triangular shaped sacral articular area caudally in Indian fox. The articular facet for articulation with the wings of sacrum was bean shaped in leopard (Podhade et al., 2014); whereas the articular area was comma shaped in tiger (Pandit, 1994).

Ilio-pubic line extends from this surface to the anterior border of the pubis and carried a psoas tubercle at the middle. The dorsal border or iliac crest was thin. This feature is similar to that in Indian mangoose (Prasanth Babu et al., 2024) and in dog (Miller et al., 1979). The cotyloid border was thick and concave towards the shaft. The greater ischiatic notch was shallow. Similarly greater schiatic notch was gently concave in dog (Miller et al., 1979). Ischiatic border was concave met the blunt ischiatic spine and joined with the acetabulum. Similar observations were made in ossa-coxarum of leopard (Podhade et al., 2014).

The wing of the ilium was thin. The body of the bone was thick and presented a rough and raised circumscribed area for the origin of the rectus fermoris muscle cranial to the acetabulum in present study. Similarly, fox and dog both have a lump above the acetabulum; less well defined lump in badger and cat but not a depression as in other mammals (Anonymous, 2015). In the present study, the mean smallest breadth of shaft of ilium was 0.8 cm; whereas, it was 5.95 mm in racoon dog and 5.96 mm in red fox (Jurgelenas, 2015). The cranial and caudal ventral iliac spines were less defined than the cranial and caudal dorsal iliac spines. Craniodorsal to this surface a small eminence, the iliac tuberosity was observed. The mean length of the ilium was 4.1 cm. However; the same parameter was 10.20 cm±0.50 cm in leopard (Podhade et al., 2014); whereas in barking deer, the length of the ilium was 9.25 cm (Kalita et al., 2010). The tuber sacrale was thick and rounded in Indian fox. Coxal tuber was round and blunt. The greatest breadth across the coxal tuberosity was 4 cm. However, the same parameter was 52.45 mm in red fox and 57.28 mm in racoon dog (Jurgelenas, 2015). The ischiatic angle met the concerned angles of the ischium and pubis at the acetabulum in Indian fox similar to other mammals.

3.3. Ischium

Ischium had a twisted appearance, extended cranially from the acetabular fossa, connected to other half medially by symphysis and posteriorly by ischial tuberosity and ischial arch. It had two surfaces, four borders and four angles. The mean length of the ischium was 2.7cm. However, the mean length of ischium in the leopard was 6.10±0.45 cm (Podhade et al., 2014), 7.70 cm in barking deer (Kalita et al., 2010). The mean greatest breadth across ischial tuberosity was 5.6 cm. In contrast, the same parameter was 59.59 mm in racoon dog and 70.58 mm in red fox (Jurgelenas, 2015). The smallest breadth across the bodies of the ischia was 3.5 cm in present study but the same parameter was 45.22 mm in racoon dog and 48.12 mm in red fox (Jurgelenas, 2015). The dorsal or pelvic surface was deeply concave

and roughly triangular in shape. The ventral surface was divided by an ill developed or blunt ischial spine. The ischial spine was extended from the ischial tuberosity to the cranio-dorsal aspect of acetabular fossa. Caudal to the spine, the border of the lesser ischiatic notch is straight. The strong ischiatic tuberosity with a laterally projecting rough eminence represented the caudolateral part of the bone. Lateral border was straight formed the lesser ischiatic notch. Medial border met with the similar border of the opposite half and formed the ischial symphysis. The anterior border was concave and formed the posterior half of the obturator foramen. Posterior border was nearly straight extending from the ischial tuberosity to the ischial symphysis. Two lateral and two medial angles were present in ischium. The antero-lateral angle met the acetabular fossa and postero –lateral angle formed the rounded ischial tuberosity which was continued distally with the ischial spine. The medial angles met with the ischial symphysis. The description of ischium was similar to dog (Miller et al., 1979) and Indian mongoose (Prasanth Babu et al., 2024).

3.4. Pubis

The body of pubis was a thin plate of bone with an acetabular branch cranially and caudal symphysial branch. The dorsal or pelvic surface was slightly convex and the ventral surface was concave with rough lines. The anterior border was concave and thin which was continued anteriorly with the cotyloid border of the ilium. The caudal border was deeply concave and formed the anterior border of the obturator foramen. The mean sagittal length and breadth of obturator foramen was 1.5 and 1.2 cm. in contrast, the mean length of obturator foramen was 22 mm in red fox and 17.69 mm in racoon dog (Jurgelenas, 2015). The medial border met the similar border of the other half forming the pubic symphysis (Figure 2). The lateral angle joined with the similar angles of the ilium and ischium and formed the acetabular fossa.

In the present study acetabulum was a very deep cotyloid cavity which was formed by the contribution of the acetabular angles of the ilium, ischium and pubis. The mean length and breadth of the acetabulum was 1.3 cm and 1 cm respectively. However, the length of acetabulum was 15.06 mm in red fox and 15.29 mm in racoon dog (Jurgelenas, 2015). Acetabulum had an articular and deep non-articular area for the round ligament of the hip joint. The articular area was nearly circular for the head of the femur. A wide acetabular notch was present at the postero-medial aspect of the rim of the acetabular fossa that ended in short narrow fissure caudally (Figure 3). The gross morphology of the pubis of Indian fox resembled to that of leopard (Podhade et al., 2014); tiger (Pandit, 1994) and dog (Miller et al., 1979).

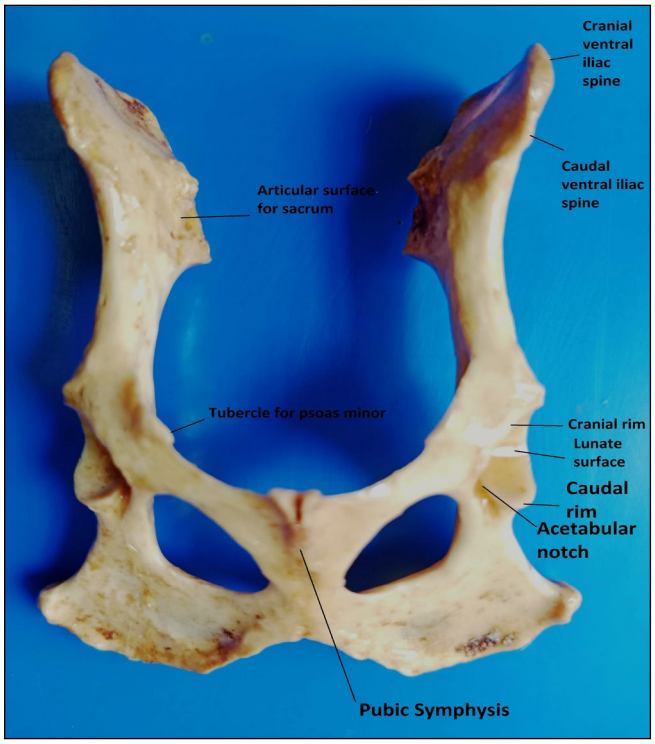

Figure 2: Ventral view of the Oscoxae of Indian fox showing different parts of bone

Figure 3: Dorsal view of Oscoxae showing the representation of measurements taken. Maximum length of oscoxae (1), maximum length of ilium (2), maximum length of ischium (3), length between tuber coxae (4), smallest width between the bodies of ilium (5), inner length of obturator foramen (6), inner width of obturator foramen (7) and width across the tuber ischii (8)

4. CONCLUSION

The morphology of the Oscoxae of the Indian fox was almost similar to that of some carnivore like the domestic dog, leopard, Indian mongoose and tiger. The gross morphological and morphometrical parameters of bone were established. The information obtained by this study will be of diligent importance in veterinary science, zoology and archeology.

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