**Comparative morphology of the os coxae in black swan (*Cygnus atratus*) and domestic fowl (*Gallus gallus*)**

**ABSTRACT**

This study investigates the anatomical differences in the os coxae of black swans and domestic fowl. Specimens were collected from three black swans during post-mortem examination and six domestic fowl from a local butcher shop. In both species, the os coxae consisted of three fused bones—ilium, ischium, and pubis—forming the acetabulum. The ilium showed a preacetabular and postacetabular part wherein the preacetabular part was slightly longer than the postacetabular part in fowl while the postacetabular part was much longer than the preacetabular part in the black swan. The dorsal surface of the preacetabular part presented a fossa in both the species which was deeper in case of the black swan. The crest of the preacetabular part of the ilium and spinous processes of the lumbosacral mass fused and formed the canalesilioneurales anteriorly in the both the species which was long and narrow in the black swan. The cranial border of the preacetabular part was much wider and strongly convex in the domestic fowl than in the black swan. Anterolateral to the acetabulum, the pubis gives off a short and blunt process, the prepubic/preacetabular/pectineal process. Pectineal process was prominent in the fowl while it was rudimentary in the black swan. Acetabulum was perforated in both the species.

***Keywords*:**Os coxae, Comparative anatomy,Swan,Fowl.

1. **INTRODUCTION**

In birds, os coxae is a vital component of the skeletal system, contributing significantly to movement, upright posture, and reproductive function. Its size and shape are closely tied to the bird’s lifestyle and habitat, reflecting evolutionary adaptations to different modes of locomotion. Typically broad and expansive, the avian os coxae supports much of the body’s weight and offers a wide area for muscle attachment, which is essential for maintaining balance and mobility. The enlarged pelvic girdle is a key feature of bipedal birds, and its open structure beneath the body helps shield internal organs while allowing space for them within the body cavity (Mehta *et al.,* 2014). Furthermore, the pelvic bones are partially or fully fused with the synsacrum, creating a stable and rigid framework. This fusion enhances structural integrity, aiding in flight mechanics, walking efficiency, and even breathing. The black swan is a large water bird with black plumage and a red bill and is introduced in many countries as an ornamental bird. However, information on the comparative anatomical structure and variations between the os coxae of the black swan and the common domestic fowl is scanty. Hence this study was taken to compare the various morphological features of os coxae of black swan and the domestic fowl.

**2. MATERIALS AND METHODS**

The os-coxae of three black swans were collected during post mortem examination from the Department of Veterinary Pathology, C.V.Sc., Rajendranagar. Six os coxae were collected from local butcher shop from apparently healthy domestic fowl. By blunt dissection, all the pelvic muscles attached to the bones were removed and the specimens were macerated by wet method. After the bones were cleaned, their gross morphological features were studied.

**3. RESULTS AND DISCUSSION**

The os coxae of black swan and the fowl consisted of three bones; ilium, ischium and pubis. These bones fused to form acetabulum in accordance with the reports of Nickel *et al.,* (1977) in fowl and Mehta *et al.*, (2014) in Japanese quail. The space between the pelvic bones was occupied by rhomboid shaped lumbosacral mass.The ilium and ischium bones did not unite in the ventral aspect, so pelvis was open ventrally as observed by Mehta et al. (2013) in emu, Sasan*et al.*, (2017) in Bar-headed goose, and Sarma*et al.,*(2018) in Indian eagle-owl.

**3.1 Ilium**

In the black swan and the domestic fowl, the ilium was long and a prominent iliac crest divided the dorsal surface into preacetabular and postacetabular part. This concurs with the reports of Nickel *et al.,* (1977) in domestic fowlandMehta *et al.,* (2014) in Japanese quail. Similar findings were reported in ostrich (Tamilselvan *et al.,* 2015), guinea fowl and pigeon (Lavanya *et al.,* 2017), Indian eagle owl (Sarma *et al.,*2018), in crested serpent eagle and brown wood owl (Keneisenuo*et al.,* 2019) and in Common Hawk Cukoo and Yellow Billed Babbler(Supriya *et al.,* 2020). However, the ridge was not prominent in pigeon when compared to guineafowl (Lavanya *et al.,* 2017).In the present study, the preacetabular part was slightly longer than post acetabular part in the fowl while the postacetabular part was longer in the black swan.Longer preacetabular part was reported by Nickel *et al*., (1977) in pigeon and by Deshmukh *et al.,* (2016) in peacock and peahen. Similarly,Sreeranjini*et al*., (2011) reported long pre-acetabular part and short post-acetabular part in peahen and stated that the ridge which separated these parts extended up to the posterior extremity in peahen.In the present study of both the species, the preacetabular part was roughly quandrangularwhile the postacetabular part was roughly trapezoid. Quadrate shaped preacetabular part and trapezoid postacetabular part was reported in Ostrich (Tamilselvan *et al.,* 2015). The preacetabular part was quadrilateral and the postacetabular part was in the form of an elongated triangle in emu (Lakshmi*et al.,*2007). The preacetabular part of both the species showed a dorsal and ventral surface. The dorsal surface presented a fossa which was deeper in the black swan than in the domestic fowl. The dorsomedial borders of the preacetabular part of the ilium completely fused with the dorsal spinous processes of lumbosacral mass and formed a thin plate with it which was wider anteriorly in the black swan giving a triangular appearance while the plate was quadrangular in fowl.These borders formed crests were closely placed in the anterior portion but distantly placed in posterior region in both the species( Fig.1). Keneisonou*et al.,* (2019) reported that the crests which separated the preacetabular and post acetabular parts were very close to each other anteriorly in crested serpent eagle but were not too close to each other in brown wood owl.Fusion of the dorsal crests of the preacetabular part of the ilium with the spinous processes of the lumbosacral mass formed the canalesilioneurales anteriorly in both the specieswhereinit was narrow and elongated in the black swan. The presence of the canalesilioneurales was also described by Nickel*et al.,* (1977) in the domestic fowl. In contrast, Lavanya *et al.,* (2017) reported the presence of a dorsally opened narrow canalesilioneurales in pigeon.The cranial border of ilium which formed the anterior limit of the wing of ilium was convex in both the species which are in accordance with the recordings in peacock and peahen (Deshmukh*et al.,* 2016), and fowl (Nickel *et al*. 1977).However, the cranial border of the preacetabular part was much wider and strongly convex in the fowl than in the black swan. Lateral border was concave and presented a ridge at the posterior one third of preacetabular part in the black swan whereas the ridge was not appreciated in the common domestic fowl.The ventral border of the preacetabular part was concave and the concavity was more pronounced in the black swan than in the domestic fowl. The posterior border of the preacetabular part was marked by the iliac crest.The iliac crest which separated the pre and postacetabular parts was terminated dorsal to the antetrochanter in black swan and it was extended up to the posterior extremity in fowl(Fig. 2) which is in concurrence with the findings of Sreeranjini*et al*., (2011) in peahen. Sarma*et al.,*(2018) reported that the crest of pre-acetabular part continued as the lateral border of the post-acetabular part in Indian eagle owl.

The postacetabular part in fowl showed a dorsal and a lateral partdue to the presence of anelevationanteriorly which disappeared posteriorly and resulted in the formation of a flat plate posteriorly. Such division was not observed in black swan.The dorsomedial border of the postacetabular part fused with the transverse processes of the lumbosacral mass.Close to the junction of the postacetabular part with synsacrum, four large foramina were observed on either side of the median plane for the passage of spinal nerves in domestic fowl. The size of these four foramina increased posteriorly, the fourth one being the largest. Behind this,faint foramina were observed on the synsacrum which abruptly decreased in size and were covered by a plate of bone in fowl.The foramina were also present in black swan but the large postacetabular part concealed the foramina to a great extent. Similar observations were reported in brown wood owl (Keneisenou *et al.,* (2019) and in Indian eagle owl (Sarma *et al.,* 2018) who reported the presence of four large foramina on either side of the median plane. In crested serpent eagle, five large foramina were observed on either side of the median plane on the ventral surface of the ilium( Keneisenou *et al.,* 2019). However, Sathyamoorthy*et al.,* (2012) reported 7-8 openings on either side of the median ridge in spot-billed pelicans.The spinal nerves passthrough these foramina.The ventral border of the postacetabular part formed the dorsal boundary of the ischiaticforamen in both the species. This is in accordance with reports of Nickel *et al.,*(1977) in domestic fowl. However, the concavity of this border was much deeper in the black swan than in the domestic fowl. Anteriorly, it was demarcated from the preacetabular part by the iliac crest. Posterior borders of both right and left sides fused with the synsacrum which concurs with the reports of Tamilselvan*et al.,* (2015) in ostrich who reported that the posterior borders fused with synsacrum to form V shape.The internal surface of the ilium is excavated to lodge the kidney in both the species.

Acetabulum is circular and perforated in both the species and is formed by the fusion of ilium ischium and pubis which is in accordance with the reports of Saini and Bansal (2023) in Indian eagle owl. This contradicts the reports of Nickel *et al.,* (1977) that pubis was not involved in the formation of acetabulum in fowl and duck. The acetabulum presented the antetrochanter caudodorsally in both the species.This is for articulation with trochanter major of femur as reported in domestic birds, cattle egret, spot-billed pelicans, and Indian eagle-owl (Nickel *et al.,* 1977; Rezk, 2015; Sathyamoorthy*et al.,* 2012; Sarma*et al.,* 2018).

**3.2 Ischium**

The ischium was long flat, bony plate located below and lateral to the post acetabular part of the ilium in both the species.It was roughly triangular andits thickened anterior part participated in the formation of the acetabulum along with the ilium.The dorsal border of ischium formed the ischiatic foramen with the lateral border of post acetabular part of ilium which concurs the findingsof Nickel *et al.,* (1977) in domestic fowl and Rajalakshmi *et al.,* (2020) in Flamingo and the Great Indian Horned Owl. They observed large and oblong ischiatic foramen in flamingo and small oval ischiatic foramen in great Indian horned owl while it was long and irregularly oblong in black swan.The ventral border was concave and joined the pubis anteriorly to form the acetabulum This border formed theobturator foramen anteriorly and ischio-pubic fissureposteriorly in fowl, but in black swan -pubic inscisure merged with the obturator foramen anteriorly as in guinea fowl and pigeon (Lavanya *et al.,* 2017).The posterior border of the ischium in both the species presented a projection ventrally, theangulusischiadicuswhich joined the pubis in both species (Fig. 2). The findings concur with the reports of Nickel *et al.* (1977) in fowl and duck who further stated that the caudal border of the pelvis is formed by ilium and ischium.

**3.3 Pubis**

The pubis was a thin bony rod which projected further backwards and downward beyond the ilium and ischium beneath the ventral border of ischium.However,the pubis did not project beyond the ilium and ischium in Japanese quail (Mehta, 2014) and in emu (Mehta *et al.,* 2013).The pubis was narrower anteriorly and became progressively wider posteriorlyin both the species. At the caudal extremity, pubis was in the form of a thin wide circular plate in black swan and such plate was not noticed in fowl (Fig. 1).A small pectineal process was noticed at the anterior end of the pubis below the level of acetabulum in fowl. Similar findings were observed in peahen (Sreeranjini *et al.,* 2011). Pectineal process was rudimentary in the black swan( Fig. 3). Absence of pectineal process was reported in the Indian eagle owl (Saini and Bansal, 2023) and in Japanese quail by Mehta *et al.* (2014). Studies also report rudimentary pectineal process in duck and goose and well-developed process in the domestic fowl (Nickel *et al.,* 1977)

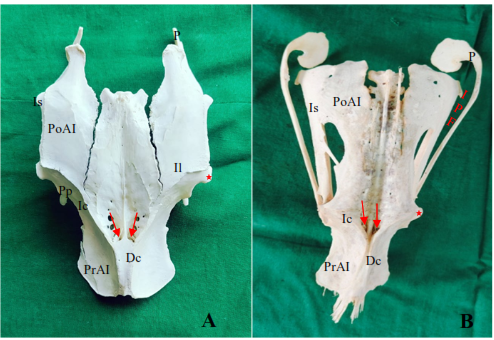


Fig.1 Os coxae of fowl(A) and black swan (b) showing preacetabular part (PrAI) and postacetabularpart (PoAI) of ileum (Il),Ishium (Is), Pubis (P), Iliac crest (Ic), dosal crest (Dc),canalesilioneurales( Red arrows), anti trochanter (\*), Ischio pubic fissure (IPF)and pectineal process (Pp)

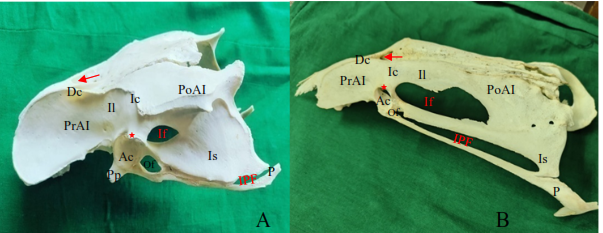


Fig.2 Os coxae of fowl (A) and black swan (b) showing preacetabular part (PrAI) and postacetabular part (PoAI) of ileum (Il), Ishium (Is), Pubis (P), Iliac crest (Ic), dosal crest (Dc), canalesilioneurales( Red arrow), anti trochanter (\*), Ischio pubic fissure (IPF), Acetabulum (A), Obturator foramen (Of), Ischiatic foramen (If) and pectineal process (Pp)

.

**B**

**A**

Fig.3 Os coxae of fowl (A) and black swan (b) showing ileum (Il), Ishium (Is), Pubis (P), Iliac fossa (F), Lumbosacral mass (LS), anti trochanter (\*) and pectineal process (Pp)

**4. CONCLUSION**

The os coxae of black swans and domestic fowl exhibit distinct anatomical adaptations reflective of their differing locomotor and ecological behaviors. While both species share a foundational pelvic structure composed of the ilium, ischium, and pubis forming a perforated acetabulum, the morphology of these bones diverges notably. Black swans possess a longer postacetabular ilium and a deeper gluteal surface fossa, suggesting greater support for powerful leg muscles associated with swimming and walking. In contrast, domestic fowl show a more prominent pectineal process and a strongly convex cranial border of the ilium, features likely optimized for terrestrial stability and perching. These variations underscore evolutionary specialization and functional morphology tailored to each species’ lifestyle.

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**7.REFERENCES**

Deshmukh, S.K., Karmore, S.K., Gupta, S.K., Kodape, S. and Prakash, R. (2016).Comparative biometrical studies on the os-coxae and synsacrum of peacock and peahen. Vet. Pract., 17(1): 41-42.

Keneisonou,K., Choudhary, O. P., Arya, R. S., Kalita, P. C., Doley, P. J., Rajkhowa, T. K., &Kalita, A. (2019). Comparative Gross Morphological Studies on the Os-Coxae of Crested Serpent Eagle (*Spilornischeela*) and Brown Wood Owl (Strixleptogrammica). Journal of Animal Research, 9(3), 439-442.

Lavanya, C., Jayachitra, S., Iniyah, K. and Balasundaram, K. (2017). Comparative anatomy of os coxae in guinea fowl and pigeon. International Journal of Current Microbiology and Applied Sciences, 6(9): 3655-3659.

Mehta, S., Guha, K., Shalini, S. and Kumar, C. (2014). Gross anatomical studies onthe os coxae and synsacrum of Japanese quail. Indian Journal of Veterinary Anatomy, 26(2): 126-127.

Nickel, R., Schummer, A. and Seiferle, E. (19770. Anatomy of the Domestic Birds. 1st edn., Verlag Paul Parey, Berlin, Hambu p 16-17.

Rajalakshmi, K., Sridevi, P. and Siva Kumar, M. (2020).Comparative Gross Morphological Studies on the Os-Coxae of Flamingo and the Great Indian Horned Owl. International Journal of Current Microbiology and Applied Sciences, *9*(3): 1879-1883.

Rezk, H. M. (2015). Anatomical investigation on the appendicular skeleton of the cattle egret (*Bubulcus ibis*). Journal of Experimental and Clinical Anatomy, 14(1):5-12.

Saini, S. and Bansal,S .(2023). Gross anatomical studies on the skeleton of pelvic limb of Indian eagle owl (*Bubo bengalensis*).International Journal of Veterinary Sciences and Animal Husbandry 8(4): 149-153

Sarma, K., Suri, S., and Sasan, J. S. (2018). Gross anatomical studies on os-coxae of Indian eagle owl (*Bubo bengalensis*). Exploratory Animaland Medical Research, 8(2):208-210.

Sathyamoorthy, O. R., Thirumurugan, R., Kumar, K. S., and Jayathangaraj, M. G.(2012). Gross morphological studies on the pelvic girdle of spot-billed pelicans (*Pelecanusphilippensis*). Indian Journal of Veterinary Anatomy, 24:109-110.

Sasan, J. S., Suri, S., andSarma, K. (2017). Gross anatomical studies on the os-coxae of Bar-headed goose (*Anser indicus*). The Indian Veterinary Journal, 94(05):09-10.

Lakshmi, M. S., Rao, T. S., Ramayya, P. J., &Ravindrareddy, Y. (2007). Gross anatomical studies on the os coxae and femur of emu (*Dromaiusnovaehollandiae*). Indian Journal of Poultry Science, *42*(1), 61-63.

Sreeranjini, A.R., Ashok, N., Indu, V.R., Lucy, K.M., Syam, K.V., Chungath, J.J. and Harshan, K.R. (2011). Morphological studies on the pelvic girdle of a peahen. Journal of Indian Veterinary Association, Kerala, 9(3): 46-48.

Supriya, B., Bharath Kumar, M. L., & Jamuna, K. V. (2020). Comparative morhological study of os coxae and synsacrum bones of Common Hawk Cukoo (*Hierococcyx varius*) and Yellow Billed Babbler (*Argya affinis*). International Journal of Current Microbiology and Applied Sciences, *9*(10), 1284-1288.

Tamilselvan, S., Iniyah, K., Jayachitra, S., Sivagnanam, S., Balasundaram, K. and. Lavanya, C. (2015). Gross anatomy of os coxae of ostrich (*Struthio camellus*). International Journal of Current Microbiology and Applied Sciences, 4(4): 201-205.