GROSS MORPHOLOGICAL AND MORPHOMETRIC STUDIES ON THE STERNUM OF VICTORIAN CROWNED PIGEON (*Goura victoria)*

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ABSTRACT

The sternum of the Victorian crowned pigeon (Goura victoria) was a long (10.40cm), and triangular bone. The dorsal surface was deeply concave and showed very large foramina behind the cranial border in the centre. The dorsal surface showed a groove in the centre, which contained numerous small pneumatic foramina. The cranial border was thick, convex and narrow. Below the dorsal ridge of cranial border, a large, round pneumatic foramen was present. The sternal spine was rudimentary. The craniolateral processes were 1.0 cm long, thick, pneumatised, projected upwards and cranially. The lateral borders contained three articular cylinders for the sternal ribs and the troughs between them contained pneumatic foraminae. The thoracic processes were large, well developed and scythe-shaped. The caudolateral processes were 1.5cm long, thin and projected caudally. It enclosed along with the lateral borders of the corpus sterni, a triangular notch, an incisura ovalis. The caudal border of the corpus sterni was very narrow (0.5cm), convex and should be ended as blunt. The sternal crest was large and triangular in shape. It began from below the ventral ridge of the cranial border extended deeply ventrally, formed a gentle curve in the cranial half and a steep curve in the caudal half and reached up to the caudal border of the corpus sterni. It was 11.50 cm long and the height of the sternal crest between the midpoint of the cranial border of the sternum and the highest point of the sternal crest (H) was 6.10cm.

Key words : Caudolateral process, Corpus sterni, Craniolateral process, Sternal crest, Sternal spine, Thoracic process

INTRODUCTION

Victoria crowned pigeons are large birds, nearly as large as an adult female turkey. It is the largest living pigeon and the closest remaining relative to the extinct dodo bird. Its feathers and crest give them more of a peacock look than a pigeon.

The sexes look alike. The sternum is large unsegmented bone, which with its processes forms a considerable part of the ventral body wall and gives attachment to the large flight muscles (Dyce *et al*., 2010). The morphology of the sternum is unique

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to each species of birds and it is greatly modified according to their movements, habitat and other needs. The present study was undertaken to evaluate the gross morphological and morphometric features of the sternum of Victorian crowned pigeon, since the information available is very scanty.

MATERIALS AND METHODS

Carcass of Victorian crowned pigeon brought for post-mortem examination to the Department of Veterinary Pathology, Madras Veterinary College, Chennai was utilized for the present study. After the post-mortem examination the carcasses were allowed for biological maceration. The disintegrated skeleton was cleaned with fresh water and soaked in 10-15% NaHCO3 solution for whitening. The skeleton was then dried and morphological and morphometric studies were performed. Vernier caliper and ruler were used for morphometric studies.

RESULTS AND DISCUSSION

The sternum of the Victorian crowned pigeon (*Goura victoria)* consisted of a corpus sterni or body and processes (Fig.1), a large sternal crest or keel and a rudimentary sternal spine or manubrium sterni (Fig. 2).

The corpus sterni was a long (10.40cm), triangular bone, wide cranially and became gradually narrow and ended in a rounded blunt end caudally (Fig.1). It was 3.0cm wide up to the level of thoracic processes, at the level of caudolateral processes the width was 2.3cm and near the caudal end it was 0.50cm wide (Fig.1). It is in accordance with the observations of Nickel *et al*. (1977) in chicken, Wani *et al*. (2017) in common moorhen and Pathak *et al*. (2017) in white-breasted water hen, peacock and turkey.

The corpus sterni was rectangular in bald ibis (Dursun *et al.*, 2002), spot-billed pelicans (Sathyamoorthy *et al*., 2012b), pigeon hawk (John *et al*., 2014a), pigeon, crow and owl (John *et al*., 2014b), duck (Jayachitra *et al*., 2015), common myna, Himalayan bulbul and in house sparrow (John *et al*., 2017), crested serpent eagle (Choudhary *et al*., 2019), brown wood owl (Choudhary *et al*., 2018), blue and yellow macaw (Sathyamoorthy *et al*., 2019) and in Asian koel (Sathyamoorthy *et al*., 2020). The sternum was quadrilateral in ostrich (Sathyamoorthy and Ramesh, 2006) and bowl shaped in emu (Jagapathi *et al*., 2007).

In the present study, the dorsal surface was deeply concave and showed very large foramina behind the cranial border in the centre which extended into the cranial border of the sternal crest. The dorsal surface showed a groove in the centre starting from behind the foramina, which contained numerous small pneumatic foramina up to the level of the caudolateral processes. Also, on either side of the large pneumatic foramina, two shallow depressions containing three to four small pneumatic foramina were noticed (Fig.1). It is in accordance with the observations of Nickel *et al*. (1977) in chicken, Dursun *et al*. (2002) in bald ibis, Sathyamoorthy *et al*. (2012a) in spot-billed pelicans, Choudhary *et al*. (2019) in crested serpent eagle and Sathyamoorthy *et al*. (2020) in Asian koel. In Himalayan bulbul (John *et al*., 2017) and in common moorhen (Wani *et al*., 2017) the dorsal surface showed a characteristically enriched median pneumatic foramina. In

contrary in emu, foramina were absent on the dorsal surface (Jagapathi *et al*., 2007).

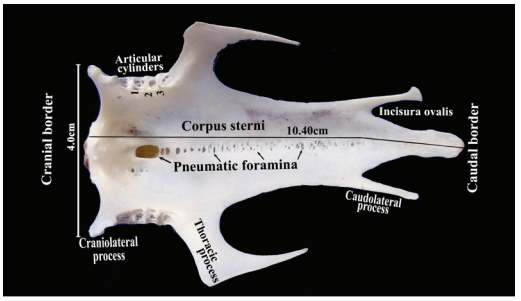

Fig.1. Dorsal view

The cranial border of the Victorian crowned pigeon was thick, convex and narrow. It contained a short, thick, and pneumatised dorsal ridge directed slightly upwards, and a convex, sharp, prominent ventral ridge directed slightly downwards. The dorsal ridge contained two tubercles on either side of the midline. On the ventral surface of the dorsal ridge a large, round pneumatic foramen extending into the dorsal ridge was present. From below the pneumatic foramen a groove extended on to the centre of the dorsal surface of the ventral ridge. The dorsal and ventral ridges were separated widely and contained short and narrow articular facets for the coracoids bones on either side of the central groove (Fig.2). It is in accordance with the observations of Sathyamoorthy *et al*. (2012b) in spot-billed pelicans and Choudhary *et al*., (2019) in crested serpent eagle. However, the cranial border was triangular in pariah kite (Tomar *et al.,* 2011), peacock and turkey (Pathak *et al.* 2017).

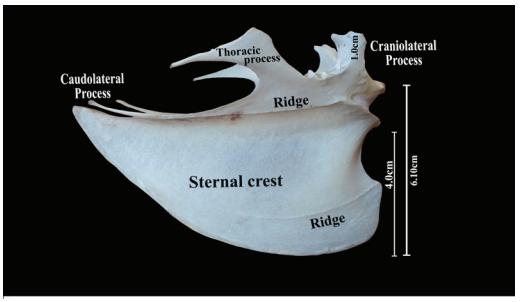

Fig 2. Lateral view

In Victorian crowned pigeon, the manubrium sterni or sternal spine was rudimentary, seen in the middle of the ventral ridge (Fig.2). In contrary, in fowl (Nickel *et al*., 1977) and in turkey and peacock (Pathak *et al*., 2017), it was prominent and arose as two processes from the dorsal and ventral edges of the cranial border, which fused into a medium vertical bony plate, leaving an opening between them in. In Asian koel (Sathyamoorthy *et al*., 2020) the sternal spine was about 4mm long, quadrilateral, flattened plate of bone with rounded tip, projecting cranially and arose from both the dorsal and ventral edges of the groove. It In the pigeon they remain separate, while in the duck and goose (Nickel *et al.,* 1977), spot-billed pelicans (Sathyamoorthy *et al*., 2012b), common moorhen (Wani *et al.*, 2017), white-breasted water hen (Pathak *et al.,* 2017), crested serpent eagle (Choudhary *et al*., 2019) and in blue and yellow macaw (Sathyamoorthy *et al*., 2019) only the ventral process was present. In contrary, the manubrium sterni was absent in ostrich (Sathyamoorthy and Ramesh, 2006), emu (Jagapathi *et al*., 2007) and in pariah kite (Tomar *et al.*, 2011).

In the present study, the craniolateral processes were 1.0 cm long, thick, pneumatised, projected upwards and cranially. The distance between the two craniolateral processes was 4.0cm (W) (Fig.1). The caudodorsal angles of the processes showed a short spine-like projection (Fig.3). The medial surface showed a ridge, whereas the lateral surface showed a concavity with few small foramina and near the base short and pointed bony projections. These processes were very large in the fowl, very short in the pigeon, small in duck and goose (Nickel *et al.,* 1977). They were short, thin, cranially directed and showed a pneumatic foramen dorsally in white-rumped vultures (Sathyamoorthy *et al*., 2012b) and short, flat, triangular and dorsolaterally directed in spot-billed pelicans (Sathyamoorthy *et al*., 2012a). They were moderately built-in common moorhen (Wani *et al.*, 2017), short in crested serpent eagle (Choudhary *et al*., 2019) and in blue and yellow macaw (Sathyamoorthy *et al.*, 2019). In contrary, the craniolateral processes were absent in pariah kite (Tomar *et al.,* 2011).

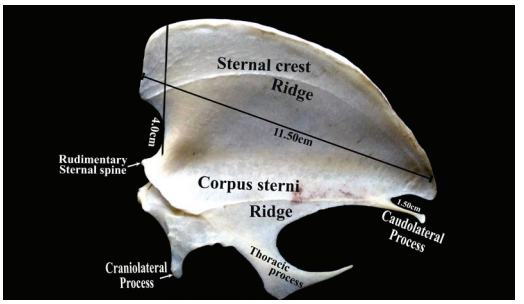

Fig.3. Ventrolateral view

In the present study, the lateral borders between the craniolateral processes and thoracic processes contained three articular cylinders for the sternal ribs. The troughs between them contained pneumatic foramina (Fig.1). Accordingly, in rhea three pairs of articular cylinders were present (Brett and Hopkins, 1991). The numbers of articular cylinders were four pairs in chicken (Nickel *et al*., 1977), emu and turkey (Jayachitra *et al.,* 2015), Asian koel (Sathyamoorthy *et al*., 2020) five pairs in ostrich (Sathyamoorthy and Ramesh, 2006), white-rumped vultures (Sathyamoorthy *et al*., 2012b), six pairs in green-winged macaw (Sreeranjini *et al.,* 2015), and seven pairs in duck, goose (Nickel *et al*., 1977) and white-breasted water hen (Pathak *et al*., 2017). The pneumatic foramina were absent between the troughs in emu (Jagapathi *et al*., 2007) and in white - breasted water hen (Pathak *et al.,* 2017).

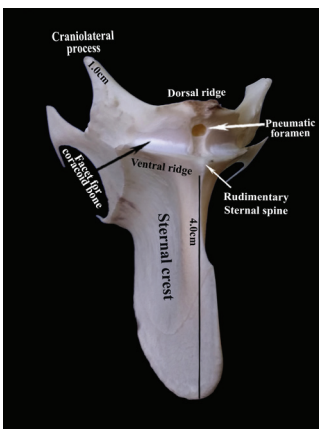

Fig.4. Cranial view

In the present study, the lateral borders behind the articular cylinders showed a large, well developed, roughly triangular or scythe-shaped thoracic processes. It contained a vertical broad, plate-like ventral portion and a long, thin caudally extended portion which ended in a point. Its cranial and dorsal borders were straight and the caudal

border was concave. It arose independently from behind the last articular cylinder and enclosed along with the concave lateral border of the sternum a large oval notch (Fig.1). Accordingly, the thoracic processes arose independently in pigeon (Nickel *et al*., 1977). But, in fowl (Nickel *et al*., 1977) and in peacock and turkey (Pathak *et al.,* 2017) the thoracic processes arose with the caudolateral processes and had shovel-like broadened end.

In contrary, the thoracic processes were absent in duck, goose (Nickel *et al*., 1977), ostrich (Sathyamoorthy and Ramesh, 2006), spot-billed pelican (Sathyamoorthy *et al*., 2012a), crow and owl (John *et al.,* 2014b), pigeon hawk (John *et al*., 2014a), green-winged macaw (Sreeranjini *et al.,* 2015), white-breasted water hen (Pathak *et al.,* 2017), common myna, Himalayan bulbul, house sparrow (John *et al*., 2017), common moorhen (Wani *et al*., 2017), crested serpent eagle (Choudhary *et al*., 2019), blue and yellow macaw (Sathyamoorthy *et al*., 2019) and also in Asian koel (Sathyamoorthy *et al*., 2020). Both, the caudolateral processes and thoracic processes, and the lateral notches were absent in emu (Jagapathi *et al*., 2007) and in pariah kite (Tomar *et al*., 2011).

In the present study, the lateral borders of the corpus sterni behind the thoracic processes were thin, sharp and concave and showed the caudolateral processes. They were short (1.5cm), caudally projected, thin, concave dorsally, convex ventrally with its caudal ends slightly expanded and terminated well before the caudal border of the sternum. The processes enclosed along with the lateral borders of the corpus sterni, a triangular notch, the incisuraovalis (Fig.1). It is in accordance with the observations of Sathyamoorthy *et al*. (2020) in Asian koel. But in Asian koel, the caudolateral processes were broad and short. In contrary, the caudolateral processes were very long and narrow forming an elongated incisura ovalis in fowl (Nickel *et al.,* 1977) and in peacock and turkey and clasp-like in duck and white-breasted water hen (Pathak *et al*., 2017). In white-breasted water hen (Pathak *et al*., 2017) and in common moorhen (Wani *et al*., 2017) it extended beyond the caudal end of the sternum. In pigeon (Nickel *et al*., 1977), green-winged macaw (Sreeranjini *et al*., 2015) and blue and yellow macaw (Sathyamoorthy *et al*., 2019) the caudolateral process was short, broad, thin and fused with the caudal border of the sternum and formed the lateral boundary of the oval foramen. In contrary, in emu (Jagapathi *et al*., 2007) and in pariah kite (Tomar *et al*., 2011) the caudolateral processes and the incisura ovalis were absent.

In the present study, on Victorian crowned pigeon, the caudal border of the corpus sterni was very narrow (0.5cm), convex and ended in a blunt. It formed the caudal most point of the sternum (Fig.1). In bald ibis (Dursun *et al*., 2002) and in brown wood owl (Choudhary *et al*., 2018) the caudal border of the sternum showed three eminent processes, the lateral caudolateral processes, intermediate processes and a medial process formed by the sternal body. In Asian koel the caudal border was broad and convex (Sathyamoorthy *et al*., 2020).

In the present study on Victorian crowned pigeon, the ventral surface of

corpus sterni was convex, showed two faint muscular ridges one on either side, which began from the end of the ventral ridge of the cranial border and extended up to the level of the base of the caudolateral processes and a very prominent sternal crest in the middle. The sternal crest was large and triangular in shape. It began from below the ventral ridge of the cranial border extended deeply ventrally, formed a gentle curve in the cranial half and a steep curve in the caudal half and reached up to the caudal border of the corpus sterni. It was 11.50 cm long (Fig.4) and the height of the sternal crest between the midpoint of the cranial border of the sternum and the highest point of the sternal crest (H) was 6.10cm (H) (Fig.3). Its cranial border was long (4.0cm), concave dorsally, straight ventrally, and extended slightly beyond the cranial border of the sternum and formed the cranial most point of the sternum (Fig.3). The ventral border was convex, thick in the middle and thin at either side. Its lateral surface showed a faint curved muscular ridge starting from the middle of the cranial border up to the caudal border (Fig.4). The sternal crest was thin above this ridge, but thick below the muscular ridge and in the cranial border. It is accordance with the observations of Nickel *et al*. (1977) in fowl, turkey, duck and pigeon. In spot - billed pelicans the sternal crest was triangular, small and, caudally extended only up to the cranial half of sternum; but its cranial border extended beyond the cranial border of the sternum and the clavicle was fused to it permanently (Sathyamoorthy *et al.,* 2012a).

The W/H (4.0/6.1) value in the present study was 0.65. It indicated that they were walking type of birds. It is in total agreement with the findings of Duzler *et al.* (2006) in turkeys. In contrary, Nickel *et al.* (1977) and McLelland (1990) reported that the keel is prominent in the birds with well-developed powers of flight and it gives attachment to the two important flight muscles.

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