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# COMPARATIVE ANATOMICAL STUDIES ON RIB CAGES OF KITE (*Millvus migrans*) AND CROW (*Corvus splendens*)

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## ABSTRACT

**A study was conducted on the rib cage of kite and crow collected by maceration process. The rib cage of kite and crow comprised of seven and six pairs of true ribs, respectively. A single pair of floating rib was found in both the species. The vertebral part of all true ribs, except the last one, in both birds was featured with uncinate process. The floating rib of crow unveiled a rudimentary uncinate process. The vertebral part of ribs of kite, except 6th rib, revealed the presence of pneumatic foramina. True and floating ribs of crow lacked pneumatic foramen in its vertebral parts. The medial surface of all sternal ribs of kite, except 7th one, had a well-developed pneumatic foramen. However, pneumatic foramen was absent in 3rd and 7th sternal ribs of crow. The last pair of ribs in both the species was attached to the preceding rib. The remaining pairs of ribs were in articulation with sternum. It may be concluded that the rib cage of kite is highly pneumatised as compared to that of crow. The greater number of pneumatic foramen in kite might be an adaptation feature to cope up with the larger sized organs during flight.**

**Keywords:** Anatomy, crow, kite, rib cage, uncinate process

## INTRODUCTION

Unlike mammals, due to lack of diaphragm, avians are characterized by a common thoraco-abdominal cavity. As a result of this, the rib cage of birds has more organ pressure as that of the mammals. Flying birds have an additional pressure of performing simultaneous ventilation and flight. To cope up these problems there must be some additional support to the rib cage of birds. The avian ribs, due the presence of uncinate processes, are closely attached to each other (Arriza *et al*., 2013). Morphological variations in uncinate processes have been shown to have a definite effect on different forms of locomotion. Flying birds show uncinate processes of intermediate length, whereas they are shortest in walking birds (Tickle *et al.*, 2007).Length of uncinate processes show a positive correlation with body mass as well as with metabolic rate (Tickle *et al*., 2009). Although much of the work has been done on ribcage of domestic fowl; however, very little work has been recorded in birds like kite (*Millvus migrans*) and crow (*Corvus splendens*). The present study was, therefore, aimed to record gross morphological features of rib cage of kite and crow as well as to find out possible correlation of these features with different body functions.

## MATERIALS AND METHODS

Dead birds, kite and crow, were collected around the COVAS, Parbhani campus during the year 2012 and processed for anatomical studies in the Department of Anatomy. Most of the muscles from carcasses were first manually removed. The carcasses were then boiled in plane water for 3 days @ 1-2 h day$^{-1}$ with the purpose to tenderize the remaining muscular mass. The ribcages were continuously monitored by visual examination to ensure their integrity. The rib cages were then placed in tap water mixed with 10-15 % washing soda ($Na_2CO_3$) for one week (Duzler *et al*., 2006). Finally the bones were dried at room temperature and various parameters *viz.*, curvature length of vertebral and sternal part and length of uncinate process assessed. For morphometrical studies Vernier caliper and plain thread were used.

## RESULTS AND DISCUSSION

The measurement of ribs in kite and crow is given in Table 1. The rib cages of kite and crow consisted of seven and six pairs of true ribs, respectively (Fig. 1). The number of rib pairs varies from 7 in fowl and pigeon to 9 in duck and geese (Nickel *et al*., 1986). Sathyamoorthy *et al*. (2012) have reported 7 pairs of ribs in white-rumped vultures. The vertebral and sternal parts of ribs in both kite and crow articulated with each other at an acute angle and the degree of this angle increased from cranial to caudal ribs. In both species a single pair of floating rib was found originating from the last cervical vertebrae. The floating ribs in both the birds were devoid of sternal part. Floating ribs attached to last few cervical vertebrae preceded the true ribs (Dyce *et al.*, 2009). These ribs do not articulate with the sterno-costal bones (Nickel *et al.*, 1986). The role of floating ribs is not yet clear.

**Table 1: Measurement of ribs in kite and crow**

| Ribs | Kite (*Millvus migrans*) | | | Crow (*Corvus splendens*) | | |
|---|---|---|---|---|---|---|
| | Curvature length (cm) | | Length of UP* (cm) | Curvature length (cm) | | Length of UP (cm) |
| | Vertebral part | Sternal part | | Vertebral part | Sternal part | |
| 1$^{st}$ | 4.2 | 1.2 | 0.9 | 3.3 | 0.8 | 1.1 |
| 2$^{nd}$ | 4.3 | 1.9 | 1.3 | 3.6 | 1.1 | 1.4 |
| 3$^{rd}$ | 4.7 | 2.3 | 1.5 | 3.8 | 1.6 | 1.2 |
| 4$^{th}$ | 4.5 | 2.6 | 1.5 | 4.1 | 1.9 | 1.1 |
| 5$^{th}$ | 4.5 | 2.9 | 1.5 | 4.4 | 2.2 | 0.9 |
| 6$^{th}$ | 4.6 | 3.5 | 0.8 | 4.7 | 2.5 | Absent |
| 7$^{th}$ | 4.7 | 3.9 | Absent | Absent | absent | Absent |

*UP = Uncinate process

The 3$^{rd}$ and 4$^{th}$ ribs of kite were heavily built, whereas last rib was thinly built. However, in crow the 2$^{nd}$ and 3$^{rd}$ rib were heavily built in rib cage, whereas last rib was similar to that of kite. The uncinate process, a hook-like structure, was located towards the vertebral end of vertebral part (Fig. 1). The process was observed in all the ribs, except the last one, in both the species. These processes were directed craniodorsally at an acute angle against vertebral ribs. This angle was in opposite direction to that formed between the head and tuberculum of vertebra rib. The acuteness of angle increased from 1$^{st}$ to 3$^{rd}$ rib and then decreased from 4$^{th}$ to 6$^{th}$ rib in kite. However, the uncinate processes of crow did not show any considerable variation in the degree of acuteness. Each uncinate process of the preceding rib overlapped the body of succeeding rib in both the species. The floating rib of crow unveiled a rudimentary uncinate process (Fig. 2). However, no such process was observed in the floating rib of kite. Uncinate processes are supposed to be an adaptation for

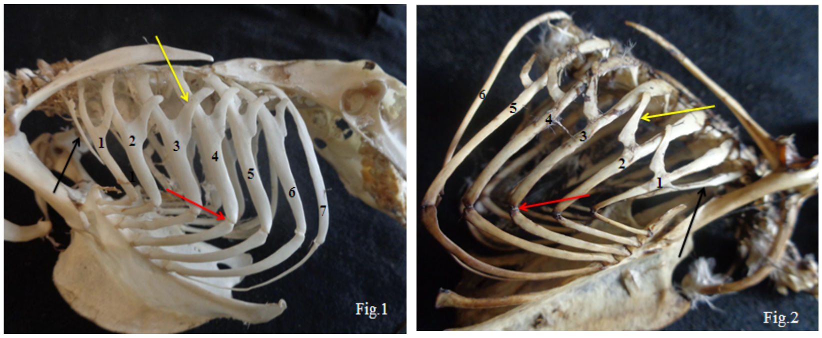


**Fig. 1: Rib cage of kite (a) and crow (b) showing floating rib (black arrow), uncinate process (yellow arrow) and acute angle (red arrow) formed between vertebral and sternal rib**

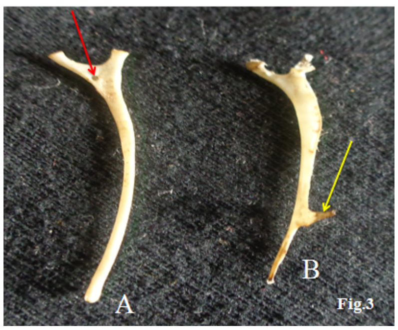


**Fig. 2: Floating rib of A) kite B) crow showing pneumatic foramen (red arrow) and rudimentary uncinate process (yellow arrow)**

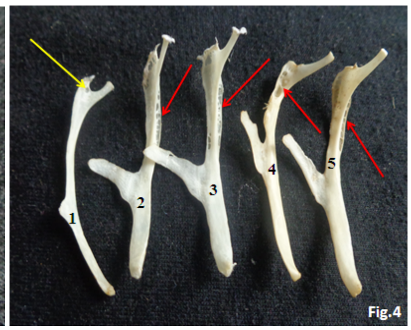


**Fig. 4. Vertebral ribs of kite showing single pneumatic foramen in 1st rib (yellow arrow) and multiple number of pneumatic foramen in remaining ribs (red arrow)**


**Fig. 5. Vertebral ribs of crow appearing smooth due to lack of pneumatic foramen**


**Fig. 6: Sternal ribs of kite showing pneumatic fora-men towards distal end except last**


**Fig. 7: Sternal ribs of crow showing pneumatic fora-men in 1st, 2nd, 4th & 5th rib**

flight in birds (Welty, 1988). Uncinate processes, in addition to the strength-ening rib cage, reportedly provide mechanical support to ribs (Liem *et al*., 2001). Sereno (1997) suggested that with-out uncinate process the rib cage in birds might collapse during flight. Electromyo-graphic studies in giant Canada goose have revealed that these processes are the integral component of ventilatory mechanics of birds being involved in both inspiration and expiration (Codd *et al.*, 2005). Further, the base of uncinate process acts as a brace for the insertions of ‘finger-like’ projections of *M. externus obliquus abdominus* that pull the sternum dorsally during expiration. Tickle *et al.* (2007) provided a model in which uncinate process acts as lever and also enhance the mechanical advantage for forward rotation of dorsal rib and consequent lowering of sternum during respiration. Further, they opined that uncinate processes are long in diving birds, short in walking birds and of intermediate length in non-specialist birds. Thus uncinate processes contribute to three broad functions *viz.*, protection to rib cage, breathing and flight. The vertebral part of 1st rib in kite, on its medial surface just below tuberculum costae, more than one (Fig. 4). However, the vertebral part of 6th and 7th ribs lacked any such kind of foramen. A noteworthy feature of true as well as floating ribs of crow was the lack of pneumatic foramen in their vertebral parts (Fig.3 & 5). The length of sternal and vertebral ribs increased from cranial to caudal direction in both kite and crow. Sathyamoorthy *et al*. (2012) during their study on the rib cage of white- rumped vulture reported an increase in the length of sternal ribs cranio-caudally. The medial surface of all sternal ribs of kite, except 7$^{th}$ one, just above the distal end presented a well-developed pneumatic foramen (Fig. 6) in agreement with the reports of Sathyamoorthy *et al*. (2012). However, pneumatic foramen was absent in 3$^{rd}$ (Fig. 7) and 6$^{th}$ sternal rib of crow. The pneumatic foramens present in sternal ribs of crow were less prominent as compared to those of the kite. The presence of these pneumatic foramina can be correlated with breathing system of birds. The entry of oxygen into sternal ribs, during inspiration, lightens the rib cage resulting in the enlargement of the thoraco-abdominal cavity. Thus the organs are prevented from being pressed against the rib cage. The first six pairs of the sternal ribs articulated with the sternal facets, whereas the distal end of seventh rib was attached to the distal part of sixth sternal rib. Similarly the first five pairs of sternal ribs articulated with the sternal facets and the sixth sternal rib was attached to the distal part of fifth sternal rib. From the above findings it can therefore be concluded that the rib cage of kite is highly pneumatised as compared to that of crow. The greater number of pneumatic foramen in kite might be an adaptation feature to cope up with the larger size organs during flight.

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