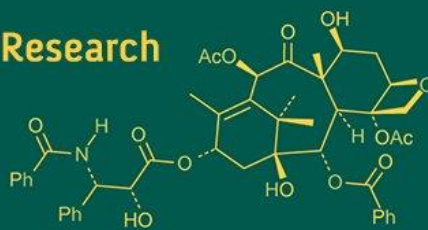


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## Gross anatomical and morphometric study of the cranial bones of the Indian wild boar (*Sus Scrofa Cristatus*)

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### Abstract

The skull of an Indian wild boar was collected during a routine post-mortem examination at the Veterinary College, Hassan and examined for its gross and morphological characteristics. The cranial bones of the skull of the wild boar were made up of the frontal, temporal, parietal, interparietal, occipital, sphenoid and ethmoid bones. The frontal and parietal bones were broad, offering strength and protection. The external surface of the frontal bone was slightly convex, rhomboid in outline and presented an orbital process. The interparietal bone was not distinct as it was fused with the occipital bone. The occipital bone was heavily built, supporting the attachment of strong neck muscles, with a deep and triangular occipital fossa. The jugular process was long and vertically elongated. The basisphenoid bone exhibited a wasp-like configuration, with a body, wings, and a pterygoid process. The body of presphenoid was short, laterally compressed, and articulated with basisphenoid caudally, ethmoid rostrally, vomer ventrally and palatine bone ventro-laterally. Tympanic bulla of temporal bone was small and laterally compressed. The root of zygomatic process presented an obliquely directed external acoustic meatus on its caudal surface, while the robust zygomatic arches in the lateral face suggested the presence of powerful masticatory muscles. The orbital rim was incomplete caudally as the orbital process of frontal bone did not articulate with the frontal process of the zygomatic bone.

**Key words:** Wild boar, cranial bones, foramen, process

### Introduction

The wild boar (*Sus scrofa*) is one of the most widespread mammals in the world, belonging to the family Suidae and superorder Cetartiodactyla. This species is believed to have originated in Western Europe and North Africa and extended to South-East Asia, including Korea, Taiwan, Malaya, India, Pakistan, Java and Japan (Beg, 1990). Approximately 500 distinct pig breeds exist globally, and they serve as the primary source of many important livestock species. Eight different species of pig were found in Asia, Europe and Africa. These include *S. barbatus*, *S. bucculentus*, *S. cebifrons*, *S. celebensis*, *S. salvanius*, *S. scrofa*, *S. verrucosus* and *S. philippensis*. According to Nidup (2011) <sup>[10]</sup>, twenty-one subspecies of the wild boar (*Sus scrofa*) were present. The sub-species *Sus scrofa cristatus* inhabited in India and Pakistan (Khan, 1990) <sup>[15]</sup>. Pigs are widely utilized in biological and experimental research because of their anatomical analogies to humans (Rothschild, 2004) <sup>[12]</sup>. The cranial bones of skull play a crucial role in body coordination, as it provides structural support to numerous vital organs including the brain, eyes and ears (Stembirek *et al.*, 2012). Differences in animals and taxonomic classification can often be determined by skull morphology. Morphometric analysis helps in understanding the variations in the shape and proportion of skull bones influenced by the genetic and environmental conditions. Hence, in osteological investigations, craniometry serves as an important diagnostic and comparative tool (Bruenner *et al.*, 2002). The present study was undertaken to elucidate the gross anatomical and morphometric details of the cranial bones of the Indian wild pig due to paucity of such data, particularly from Karnataka and South India.

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## Materials and Methods

The carcass of an Indian wild boar was presented to the Department of Veterinary Pathology, Veterinary College Hassan from Forest department suspecting for the electrocution. After post-mortem, the whole carcass was donated to the Department of Veterinary Anatomy for teaching and research purposes. The atlanto-occipital joint was disarticulated to separate the skull from the neck. Soft tissues and articulations were carefully removed by blunt dissection. Further, the skull along with the mandible was subjected to maceration in water for 30 days and two water changes at 15-day intervals to aid in the removal of intact soft tissues. Following maceration, the bones were boiled in a solution of 500 gram of Sodium carbonate in 20 litres of water for 20 minutes and sun-dried for two days. The specimens were subsequently bleached using 5 Litres of 6% w/v hydrogen peroxide in 20 litres of water for 24 hours, and bones were sun-dried again before use in the study (Rajashailesha *et al.*, 2024) <sup>[11]</sup>. Gross morphological and morphometric details of cranial bones of the skull were recorded using a Vernier calliper, metal scale and non-absorbable nylon thread. Photography of these bones was carried out using a Canon DS126621 EOS Rebel T6 18MP Digital SLR Camera.

## Results and Discussions

The skull of the wild boar was comparatively narrower and elongated than that of the domestic pig, whereas it was flat and wide in Caribbean wild boar (Mohamed, 2019). The dorsal wall of the cranial cavity of the skull was made up of frontal and parietal bones. The caudal wall was oriented obliquely downward and was formed by interparietal, squamous occipital, and ex occipital bones and the ventral floor was formed by basioccipital and sphenoid bones, whereas the lateral wall of the cranium was formed by squamous temporal and wings of the sphenoid and rostral wall was formed by ethmoid bone (Fig.1, Fig.2, Fig.3 Fig.4 and Fig.5). In contrast to the findings of Sisson (1975) in domestic pigs, Mohamed (2019) in Caribbean wild boar and Doley *et al.*, (2018) <sup>[2]</sup>. in Mizoram wild boar reported that the caudal aspect was oriented straight with a ventrally elongated paramastoid process.

The frontal bones measured 12.5 cm in length and 10.5 cm in width at their broadest point and were located between the parietal bones caudally and the nasal bones rostrally (Fig. 1 and Fig. 2). They articulate with the ethmoid, lacrimal, wings of pre and post-sphenoid, maxilla and squamous part of the temporal bones as in the domestic pig (Sisson, 1975). The frontal bone consisted of squamous, nasal and orbital parts. The external surface of the squamous part was slightly convex, rhomboid in outline. While in the domestic pig (Nickel *et al.*, 1981) and Mizoram wild boar (Doley *et al.*, 2018) <sup>[2]</sup>. it was strongly curved dorsally and deeply excavated at the level of the supraorbital foramen. Approximately two-thirds of the distance rostrally and centrally, the bones presented a supraorbital foramen directed obliquely backwards towards the dorsomedial part of the bony orbit, similar to that in domestic pigs (Sisson, 1975) and Pygmy hogs (Kalita *et al.*, 2015) <sup>[4]</sup>. The supraorbital groove measured 7 cm in length, was deeper and extended rostrally towards the nasal bone. The frontal fossa, which is present in short-headed wild pigs and

domestic pigs (Doley *et al.*, 2018 and Nickel *et al.*, 1981) <sup>[9]</sup>. was absent in the present skull. The orbital process measured 1.6 cm in length, projected ventro-laterally and was located at the caudolateral aspect of bone (Fig. 1, 2 and 4). This process was not connected to the frontal process of zygomatic bone, leaving an incomplete orbital rim. Similar observations were recorded in domestic pig (Sisson, 1975 and Nickel *et al.*, 1981), <sup>[9]</sup>. Mizoram wild boar (Doley *et al.*, 2018) <sup>[2]</sup>. and Caribbean wild boar (Mohamed, 2019). The nasal part was small and fused with the nasal bone by frontonasal suture (Fig. 1). The orbital part formed the greater part of medial wall of orbit and was perforated by the internal opening of supraorbital canal and ethmoid foramen at the junction with the wing of the presphenoid bone and the ethmoid bone (Fig. 2).

The parietal bones measured 8 cm in length and occupied the caudal portion of dorsal surface of the skull. The temporal line separated the external surface into the dorsal parietal plane and the lateral temporal plane. The lateral temporal plane formed a significant portion of the temporal fossa and blended caudally with the occipital bone to form the prominent nuchal crest, while the parietal plane joined rostrally with the frontal bone at the frontal margin and caudally with the occipital bone at the occipital margin, as in the domestic pig (Sisson, 1975) (Fig. 1 Fig. 2 and Fig. 4). The interparietal bone was not distinct as it was fused with the occipital bone (Fig. 3), similar to domestic pigs (Sisson, 1975).

The temporal bones form the caudolateral wall of the cranial fossa and consist of squamous, tympanic and petrous parts, in which squamous part was extensive, measuring 12.4 cm in length. The caudal part of the squamous temporal had an occipital process whose lateral surface presented a temporal crest as in domestic pigs (Sisson, 1975) (Fig.1and Fig 4). The zygomatic process was 9 cm long and arose from the ventral part of temporal surface of the squamous part. The root of the zygomatic process presented an obliquely directed external acoustic meatus on its caudal surface (Fig. 2, Fig.4 and Fig. 5), as in Mizoram wild boar (Doley *et al.*, 2018) <sup>[2]</sup>. The zygomatic process of temporal bone was short and broad, and it articulated with the temporal process of zygomatic bone to form a broad zygomatic arch. Similar findings were also made in domestic pig (Sisson, 1975), Caribbean wild boar (Mohamed, 2019) and Mizoram wild boar (Doley *et al.*, 2018) <sup>[2]</sup>. In addition to this, Doley *et al.*, (2018) <sup>[2]</sup>. in Mizoram wild boar stated that the laterally flattened zygomatic arch was short, massive and projected far beyond the temporal line. The caudal part of zygomatic arch was wide for the attachment of powerful masticatory muscles and presented a facet for articulation with the condyle of mandible (Fig. 4). Further, Neaux *et al.*, (2021) <sup>[8]</sup>. reported that captive wild boars developed wider, more robust zygomatic arches due to increased masticatory muscle size and were forced by altered feeding behaviour. This induced bone remodelling for greater strength and reflected adaptations such as a more upright mandibular ramus and a reduced mandibular angle facilitating stronger chewing. The mandibular fossa was shallow, limited caudally by the articular area for condyles, showing a greatly reduced retro-articular process as observed in domestic pigs (Sisson, 1975). In contrast, in Mizoram wild boar, Doley *et al.*, (2018) <sup>[2]</sup>. reported that the articular facet

for mandible condyles was transversely elongated with a centrally grooved articular area. The temporal fossa was deep and lay in an oblique plane (Fig. 2, Fig. 3 and Fig. 4). However, it lay in a vertical plane in short-headed domestic pigs (Sisson, 1975 and Nickel *et al.*, 1981)<sup>[9]</sup>, and Mizoram wild boar (Doley *et al.*, 2018)<sup>[2]</sup>. The retro-articular foramen was absent. The petrous part was small and irregular in shape. The mastoid process was greatly reduced. The tympanic part was located ventral to the petrous part, with an oval, laterally compressed tympanic bulla highly similar to the human middle ear and the muscular process was oriented ventrally; it was short and pointed (Fig.4). Similar findings were reported by Sarma *et al.*, (2002)<sup>[13]</sup>, in the Dum pig of Assam.

The caudal part of the skull was mostly occupied by a flat and elongated occipital bone. It was oriented obliquely downwards, whereas it was straight in domestic pigs (Sisson, 1975 and Nickel *et al.*, 1981)<sup>[9]</sup>. It comprised three parts i.e., squamous occipital or supraoccipital, ex occipital or lateral occipital and basioccipital (Fig. 2 and Fig 3). Squamous occipital measured 10.5 cm in length, triangular in shape with a wide, caudally curved base measuring 9.3 cm and narrow apex measuring 2.4 cm placed between the two occipital condyles, which were notched in the middle, forming the dorsal border of large trapezoidal foramen magnum. The occipital fossa was oval and deep (Fig. 3), whereas the occipital fossa was deep and triangular in the Dum pig of Assam (Sarma *et al.*, 2002)<sup>[13]</sup>, and Mizoram wild boar (Doley *et al.*, 2018)<sup>[2]</sup>. The external occipital protuberance was absent, as in domestic pigs (Nickel *et al.*, 1981 and Sisson, 1975)<sup>[9]</sup>. However, Doley *et al.*, (2018)<sup>[2]</sup>, observed that a rough, elongated ridge resembling the external occipital protuberance was present at the centre of the occipital fossa, which was connected to the central tubercle of nuchal crest by a thick ridge in Mizoram wild boar.

The lateral occipital comprised of paired small, oval and laterally compressed occipital condyles and distinct elongated jugular process which was 7.7 cm in length on both side and a lateral fan shaped projection which fused with the occipital process of temporal bone (Fig. 3 and Fig. 5). Similar observations were also made by Doley *et al.*, (2018)<sup>[2]</sup>, in Mizoram wild boar where they reported that occipital condyles appeared as a pair of ventro-laterally directed triangular articular areas separated by a non-articular groove. Further, he reported that the slightly caudally inclined dorso-ventrally directed paracondylar process was very long, showed a thick base and a rostrally curved pointed apex. Similar observations were recorded by Konig and Leibich (2014), who reported that the paracondylar process was elongated in pigs, shorter in ruminants and horses, and bulb-shaped in carnivores that thought to be a rudimentary transverse process analogous to those of the cervical vertebrae. Further, Sisson (1975) reported that jugular process in pigs was extremely long. The base of the jugular process and the lateral margins of occipital condyles were separated by the condylar fossa. In conjunction with the tympanic bulla, this process formed the jugular foramen. The hypoglossal foramen was located just caudal to this jugular foramen for the passage of hypoglossal nerve (Fig. 4).

The basi-occipital was triangular in outline with a wide base and narrow apex, which showed basilar tubercles for muscular attachment similar to the Mizoram wild boar (Doley *et al.*, 2018)<sup>[2]</sup>, (Fig. 4). However, Sisson (1975) reported that the basilar part of occipital bone was hexagonal in shape and its external surface was marked by a narrow median ridge, the pharyngeal tubercle in pigs.

The sphenoid bone was located at the base of the cranium with two parts basisphenoid and presphenoid, which became indistinct after birth. The basisphenoid comprised of a body, a pair of wings and a pair of pterygoid process. The body was short, triangular, compressed laterally and presented a low sagittal ridge on the ventral surface. It articulated caudally with the basioccipital bone, which was fused completely, indicating an adult animal (Fig. 4). The wings extended from the body and curved dorso-laterally, and articulated laterally with the squamous temporal and rostrally with the presphenoid. A shallow groove was noticed on the ventromedial aspect of the wing at the base of the pterygoid process, which continued rostrally as pterygoid canal that opened into the pterygopalatine fossa. The wing of basisphenoid concurred with the wing of presphenoid in the formation of foramen orbitorotundum (Fig. 2 and Fig. 8). The pterygoid process extended ventrally from the body and wing, and it presented a thickened pterygoid crest (Fig. 4). The presphenoid comprised a body and a pair of wings. The body was short, laterally compressed and articulated with the basisphenoid caudally, ethmoid rostrally, vomer ventrally and palatine bone ventro-laterally. The wings curved dorso-laterally and is perforated by the opening of the optic canal i.e., the optic foramen, in its root. Just 2 cm rostral to this opening was the ethmoid foramen (Fig 2). Similar observations were made by Sisson (1975) in the domestic pig.

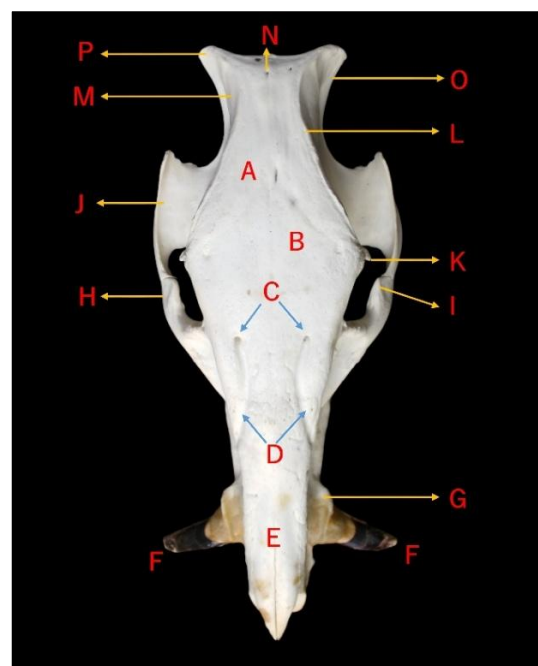


**Fig 1:** Skull of Wild boar - Dorsal view. A. Parietal bone B. Frontal bone C. Supra orbital foramina D. Supra orbital grooves E. Nasal bone F. Upper canine tooth G. Eminentia canina H. Zygomatic bone I. Frontal process of Zygomatic bone J. Zygomatic process of temporal bone K. Orbital process of frontal bone L. Temporal line M. Temporal bone N. Nuchal crest O. Temporal crest P. Occipital process of squamous temporal bone.

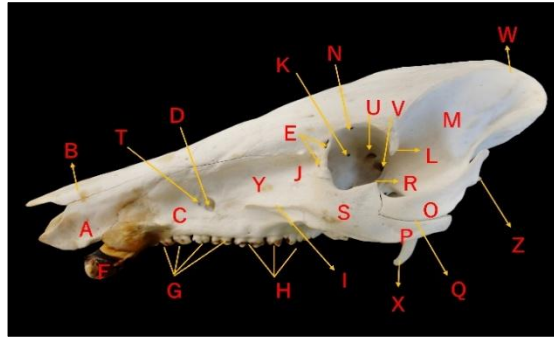


**Fig 2:** Skull of Wild boar - Lateral view. A. Premaxilla bone B. Nasal bone C. Fossa canina D. Infraorbital foramen E. Lacrimal foramina F. Upper canine teeth G. Upper premolars H. Upper molars I. Facial crest J. Muscular fossa K. Ethmoidal foramen L. Orbital process of frontal bone M. Temporal fossa N. Internal opening of supraorbital foramen O. Zygomatic process of temporal bone P. Temporal process of zygomatic bone Q. Zygomatic arch R. Frontal process of Zygomatic bone S. Zygomatic bone T. Opening of Maxilloincisive canal U. Optic foramen V. Foramen Orbitotundum W. Nuchal crest X. Jugular process Y. Maxilla bone Z. External acoustic meatus.

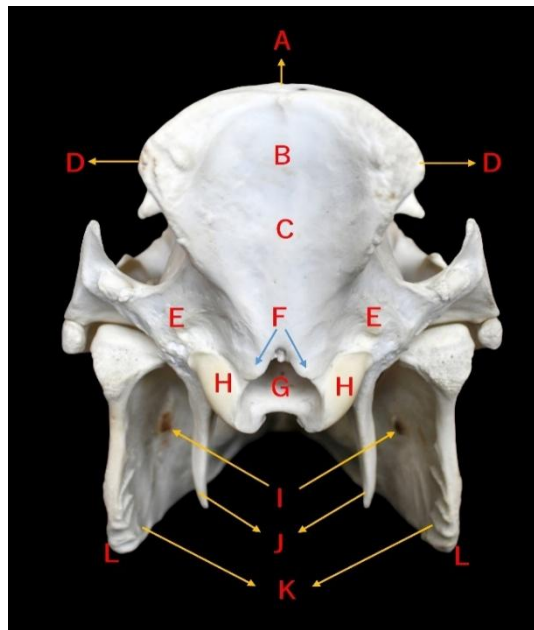


**Fig 3:** Skull of Wild boar - Caudal view. A. Nuchal crest B. Supra occipital C. Occipital fossa D. Occipital process of temporal bone E. Lateral fan shaped projection of ex occipital bone F. Nuchal tubercles G. Foramen magnum H. Occipital condyles I. Mandibular foramen J. Para condylar process K. Ridges on medial side of mandible for muscular attachment L. Angle of mandible.

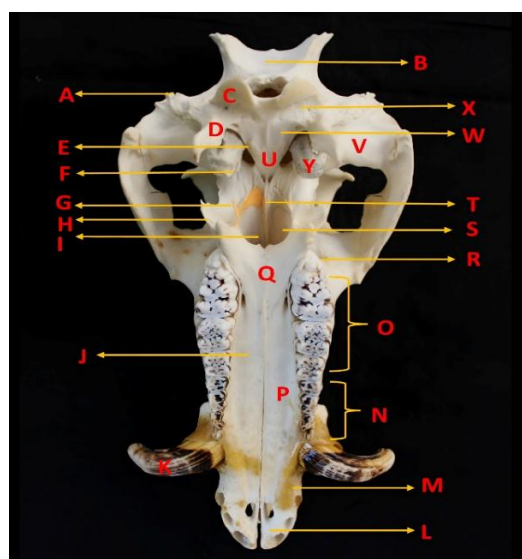


**Fig 4:** Skull of Wild boar - Ventral view. A. External acoustic meatus B. Occipital fossa C. Occipital condyle D. Para condylar process E. Basilar tubercle F. Muscular process G. Pterygoid hamulus H. Pterygoid process of sphenoid bone I. Posterior nares or choanae J. Palatine groove K. Canine teeth L. Palatine process of incisive bone M. Alveolar process of Incisive bone N. Upper premolars O. Upper molars P. Platine process of Maxilla bone Q. Horizontal part of Palatine bone R. Maxillary hiatus S. Perpendicular part of Palatine bone T. Vomer U. Body of Basisphenoid V. Articular condyle for the condylar process of mandible W. Basi occipital X. Condylod fossa Y. Bulla tympanica

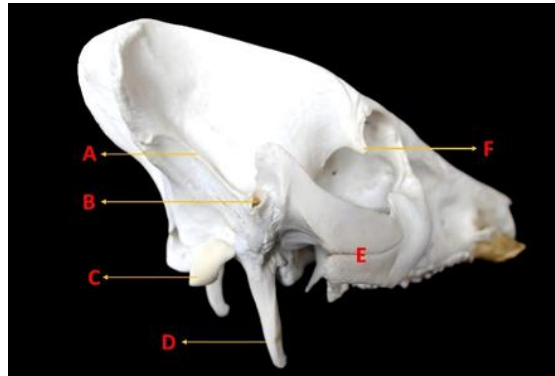


**Fig 5:** Skull of Wild boar - Right oblique view. A. Temporal crest B. External acoustic meatus C. Occipital condyle D. Jugular Process E. Zygomatic arch F. Orbital process of frontal bone.

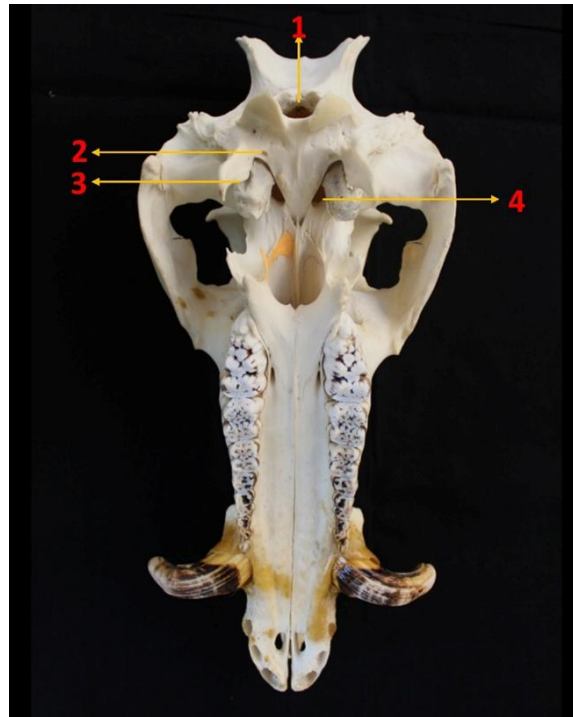


**Fig 6:** Ventral view of Skull of Wild boar 1. Foramen magnum 2. Hypoglossal foramen 3. Stylomastoid foramen 4. Foramen lacerum

### Conclusion

The skull of the wild boar exhibited distinct morphological adaptations characterized by being elongated and narrow compared to the domestic pig. The cranial components were robustly developed, indicating specialization for enhanced masticatory performance. Incompletely formed orbital rim and short but massive zygomatic arch supporting increased bite force and chewing efficiency. The obliquely oriented occipital bone, along with prominent nuchal and jugular processes, supported powerful neck musculature essential for rooting and foraging behaviour. The tympanic part of the wild and domestic pig was highly similar to human middle ear anatomy, making it a frequent part of comparative morphology and surgical training models. The overall cranial configuration thus represents a balance between structural strength and functional efficiency, reflecting both phylogenetic traits and ecological adaptations unique to the wild boar. The present study may be useful in forensic osteology, wildlife pathology and veterinary anatomical education. Thus, the study establishes a useful anatomical baseline for future clinical, diagnostic, pathological and comparative investigations involving the wild boar.

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