Inventum Biologicum: *An International Journal of Biological Research*
2024, Vol. 4, Issue 4, pp. 153-160

Inventum Biologicum

Journal homepage: www.journals.worldbiologica.com/ib

Research paper

Craniofacial Morphology of *Sus scrofa*: Museum Specimens as Key Resources for Taxonomic Studies

Joshua Arul Rocco A. [a], **Azhagu Raj R.** [a] *

[a] *Department of Zoology, St. Xavier's College (Autonomous), Palayamkottai – 627 002, Tamilnadu, India*

ARTICLE INFO

Keywords

Wild boar
Sus scrofa
Skull morphology
Morphometric analysis
Museum specimens
Craniofacial adaptations
Dental morphology

DOI
10.5281/ib-1652724

***Corresponding author**
Azhagu Raj R.

✉ **Email**
drazhaguraj@gmail.com

ABSTRACT

The study of wild boar (*Sus scrofa*) skull morphology offers valuable insights into taxonomy, ecological adaptations, and evolutionary traits. This research utilizes an 80-year-old preserved wild boar skull from the Zoology Museum at St. Xavier's College, Palayamkottai. Museum specimens are vital resources for studying morphology without disturbing contemporary wild populations. Morphometric measurements were conducted using the Dentition and Skull View Methods, focusing on cranial, facial, and maxillary parameters. The wild boar's dental formula (I3/3, C1/1, P4/4, M3/3) and distinct features, such as its elongated dolichocephalic skull, were confirmed. Key measurements included a skull length of 30.7 cm, facial length of 20.1 cm, and cranial index of 50. Comparisons with other mammals, such as blackbuck, camels, and domestic pigs, revealed adaptations to omnivorous diets and sexual dimorphism. The results highlight significant interspecies and intra species variations, reinforcing the importance of skull morphology in taxonomy and species differentiation. Features like prominent canines and bicuspid premolars provide insights into feeding ecology and reproductive roles. This study demonstrates the crucial role of museum specimens in preserving historical data, enabling the analysis of evolutionary patterns over time. Morphometric studies of wild boar skulls contribute significantly to biodiversity research, conservation, and education. Museum collections remain essential repositories for understanding species' ecological roles and evolutionary history, supporting continued research amidst growing conservation challenges.

1. Introduction

Museums and their preserved specimens are important resources for taxonomists and biologists. These specimens, collected decades or centuries ago, allow researchers to study the morphology of animals without disturbing current wild populations. The morphology of preserved specimens offers insights into anatomy, physiology, and evolutionary traits, contributing to our understanding of vertebrate and invertebrate animals across various regions (Remsen, 1995; Suarez & Tsutsui, 2004; Zarrin, 2023). For wild mammals like pigs and boars, studying skull morphology is particularly important, as it provides critical information for taxonomy, species classification, and evolutionary relationships (Hillson, 2005; Groves & Grubb, 2011).

In taxonomic studies, skull morphology plays a vital role by providing measurable traits such as size, and shape, which help differentiate species, and identify subspecies, (Prothero, 2016). The *Sus scrofa* wild boar, exhibit distinct cranial and dental

characteristics that are key to differentiating them from other related species. Such studies also expose differences within and between populations, contributing to a deeper understanding of their ecological adaptations and evolutionary history (Wilson & Mittermeier, 2011).

Museum collections, such as those in the Zoology Museum of St. Xavier's College, Palayamkottai, are particularly valuable for studying wild boar skull morphology. Many of these specimens, including those at SXC, are over 80 years old and provide a window into historical populations. Since collecting new specimens in the wild is heavily restricted due to wildlife conservation laws, researchers increasingly rely on museum specimens to study morphology, including cranial traits. This is mainly important in the context of India, where the Wildlife Protection Act of 1972 prohibits the capture or disturbance of wild animals, particularly those that are threatened or endangered (Menon, 2014). Such legal protections safeguard the conservation of species. Therefore, museum collections remain one of the few accessible and ethical resources for morphometric studies of wild boars and other mammals (Remsen, 1995; Suarez & Tsutsui, 2004).

The importance of skull morphology extends beyond taxonomy. It also provides insights into ecological adaptations, dietary habits, and sexual dimorphism. For example, the *Sus scrofa* prominent tusks of male wild boars, along with dental and cranial measurements, expose both dietary patterns and reproductive roles. Morphological traits such as cranial width, facial length, and nasal index help differentiate wild boar populations and contribute to understanding interspecies and intra-species variation (Kaminski et al., 2005; Hillson, 2005).

The study of wild boar skull morphology through museum specimens is essential for understanding their taxonomy, evolutionary biology, and ecological adaptations. With increasing restrictions on specimen collection in the wild, museums remain critical repositories of knowledge, enabling researchers to explore the biodiversity of past populations while supporting conservation efforts. Such studies confirm that the valuable data preserved in museum specimens continues to help students, educators, and researchers for generations to come (Remsen, 1995; Groves & Grubb, 2011; Zarrin, 2023).

2. Materials and Methods

2.1 Study Area

This study focused on wild boar *Sus scrofa* skull preserved in the Zoology Museum of St. Xavier's College, Palayamkottai. These specimens, which are on display at the museum, are almost nine decades old. The Jesuit Fathers of the Madurai Province established the college in 1923. The Department of Zoology and its museum was established in 1927. The college introduced a B.Sc. Zoology degree program in 1957, and M.Sc. Zoology program in 1979.

In the SXC Zoology Museum, mammalian skull specimens are handled carefully to maintain their integrity. Gloves are used to protect both the specimens and handlers from potential contamination or damage (Zarrin, 2023). Ensuring the longevity of these specimens is crucial, as they continue to serve as irreplaceable resources for studying mammalian morphology, including the skulls of wild boars (Suarez & Tsutsui, 2004).

2.2 Morphometric Analysis

The cranial morphology of the *Sus scrofa* wild boar skull was studied using various morphological parameters, assessed through the Dentition Method and the Skull View Method (Choudhary et al., 2013 Choudhary & Singh, 2016;Choudhary et al., 2020), and Choudhary et al., 2021).

2.2.1 Dentition Method

The Dentition method involved counting the number of teeth present in the jaw, focusing on incisors, canines, premolars, and molars. All the measurements were performed using a Vernier Caliper (Model: AERO SPACE, Size: 200 x 0.02 mm, 8" x 0.001 in, Made in China). Photographs were taken with a Samsung Galaxy Camera 2 (Model: EK-GC200, 720 x 1280 pixels, 16.3 MP CMOS sensor, 21x optical zoom). Additional measurements were taken using a thread method, geometrical divider, measuring tape, and ruler.

2.2.2 Skull View Method

The skull view method provides detailed information about the wild boar skull's structure through various parameter measurements. These measurements quantify the skull's shape and size, reflecting adaptations to dietary and environmental factors and revealing sexual dimorphism. The following parameters were analysed, Skull Length (SKL), Skull Width (SKW), Skull Base Length (SKBL), Cranial Length (CRL), Cranial Width (CRW), Cranial Height (CRH), Cranial Cavity (CRC), Facial Length (FAL), Facial Width (FAW), Maxilla Length (MAL), Maxilla Width (MAW), Infraorbital Foramen Distance (IOFD), Premaxilla Length (PML), Premaxilla Width (PMW), Lacrimal Length (LAL), Lacrimal Width (LAW), Nasal Bone Length (NAL), Nasal Bone Width (NAW), Palatine Length (PAL), Palatine Width (PAW), Occipital Length (OCL), Occipital Height (OCH), Intercondylar Width (ICW), Interparacondylar Width (IPCW), Foramen Magnum Height (FMH), Foramen Magnum Width (FMW), Parietal Height (PRH),

Parietal Width (PRW), Frontal Length (FRL), Frontal Width (FRW), Frontal Suture Length (FRSL), And Supraorbital Foramen Distance (SOFD). These measurements were analyzed using statistical methods (Snedecor & Cochran, 1994) to identify distinct morphological characteristics of the wild boar skull.

The skull morphology Skull View Method (Choudhary et al., 2013 Choudhary & Singh, 2016; Choudhary et al., 2020), and Choudhary et al., 2021) of the wild boar was analyzed using various parameters categorized into distinct anatomical regions. Skull parameters included the length (SKL), measured as the distance from the highest points of the parietal bones to the middle of the rostral margin of the incisive bone; width (SKW), measured as the distance between the zygomatic arches; the skull/cephalic index (SKI), calculated as skull width multiplied by 100 and divided by skull length; and the skull base length (SKBL), which is the distance from the dorsal midpoint of the foramen magnum to the cranial margin of the incisive bone.

Cranial parameters focused on cranial length (CRL), measured from the frontonasal suture to the nuchal crest; cranial width (CRW), measured between the bases of the horns; cranial index (CRI), calculated as cranial width multiplied by 100 and divided by cranial length; and cranial height (CRH), defined as the distance from the dorsal rim of the foramen magnum to the origin of the interfrontal suture.

Facial parameters included the facial length (FAL), measured from the frontonasal suture to the incisive bone; facial width (FAW), defined as the distance between the caudal extents of the orbital rims; and the facial index (FAI), calculated as facial width multiplied by 100 and divided by facial length.

Maxilla parameters assessed the length of the maxilla (MAL), measured from the parietofrontal suture to the frontonasal suture; the width of the maxilla (MAW), measured from the interfrontal suture to the rim of the orbit; the infraorbital foramen distance (IOFD), which is the distance between two infraorbital foramina; the distance from the facial tuberosity to the infraorbital foramen (FTIO); and the infraorbital foramen to the root of the superior premolar tooth (IOSP).

Premaxilla parameters focused on the maximum length (PML) and width (PMW) of the premaxilla. Lacrimal parameters included the length (LAL), measured from the frontolacrimal suture to the junction between the lacrimal and maxilla bones, and the width (LAW), measured from the frontolacrimal suture to the junction of the lacrimal and malar bones. Nasal parameters measured the nasal bone length (NAL), from the frontonasal suture to the rostral end of the internasal suture; the nasal bone width (NAW), across the naso-maxillary sutures; and the nasal index (NI), calculated as nasal width multiplied by 100 and divided by nasal length.

Palatine parameters included the palatine length (PAL), from the incisive bone's rostral midline to the caudal nasal spine, and the palatine width (PAW), measured at the horizontal plate behind the last molar tooth.Occipital parameters examined the occipital length (OCL), between the external margins of the paracondylar processes; occipital height (OCH), from the base of the occipital condyle to the sagittal crest; intercondylar width (ICW), between the lateral margins of the occipital condyles; and interparacondylar width (IPCW), which is the greatest width between the ventromedial ends of the paracondylar processes. Additionally, the foramen magnum was assessed for height (FMH), width (FMW), index (FMI, calculated as height multiplied by 100 and divided by width), area (FMA, using the formula ≈ π × width × height), and circumference (FMC), measured along the entire rim.

Parietal parameters included the maximum height (PRH) and width (PRW) of the parietal bone, while frontal parameters covered the frontal length (FRL), between the parietofrontal and frontonasal sutures; the frontal width (FRW), measured from the interfrontal suture to the dorsocaudal orbital margin; and the frontal suture length (FRSL), from the parietofrontal to frontonasal sutures. These comprehensive measurements provide valuable insights into the morphological adaptations and taxonomic distinctions of the wild boar.

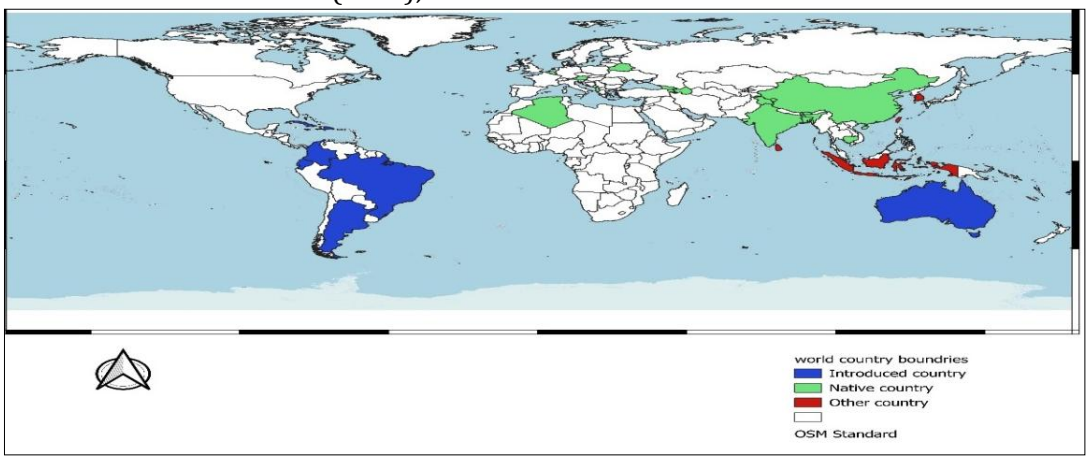

Fig. 1 Global Distribution Status of Wild Boar

3. Results and Discussion

3.1 Global Distribution Status of Wild Boar

Wild boars are found in several countries around the world, such as Albania, Algeria, Andorra, Armenia, Austria, Azerbaijan, Bangladesh, Belarus, Belgium, Bhutan, Cambodia, China, Georgia, and India. Wild boars are native to Eurasia and North Africa, and their natural range includes Western Europe, Russia, Japan, and Southeast Asia. They are also found in areas far from their original distribution, such as Indonesia, Korea, Sri Lanka, and Taiwan.

3.2 Dentition of Sus scrofa

In mammals, the dental formula provides the arrangement, shape, and count of teeth. The mandibular refers to the lower jaw (mandible), while the maxillar**y** refers to the upper jaw (maxilla). The number of teeth present in half of the upper and lower jaws defines the dental formula. The analysis of tusks and the dental formula can also help estimate the age of the skull. In this wild boar *S.scrofa* skull, the morphometric measurements focused on the maxillary region. The dental formula for wild boars is I3/3, C1/1, P4/4, M3/3, for a total of 44 teeth. The prominent canines, which develop into tusks in males, are a distinguishing feature.

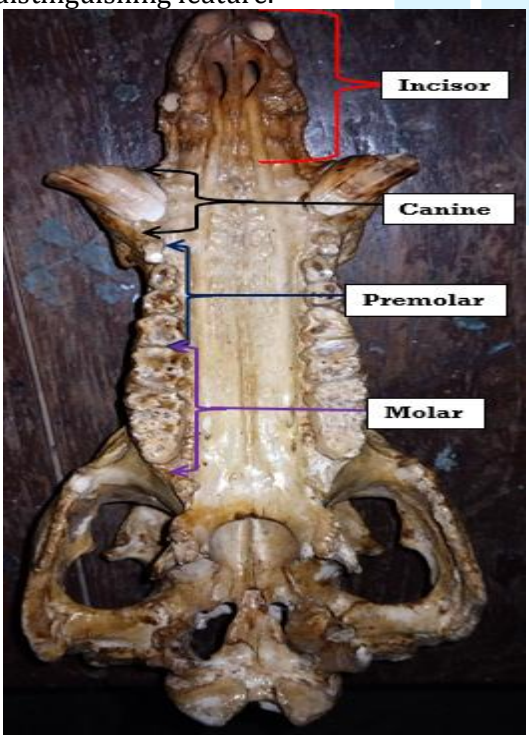

Fig. 2 Dentition in Maxillary region (Upper Jaw) of *Sus scrofa*

3.3 Sus scrofa Teeth Classification and Characteristics

- **Incisors (I)**:
  - Located at the front of the mouth, with 6 teeth in the upper and 6 in the lower jaw.
  - Used for cutting and gnawing.
  - Typically chisel-shaped.
- **Canines (C)**:
  - Positioned behind the incisors, with 2 tusks in both the upper and lower jaws.
  - Used for piercing and tearing.
  - Large, rootless, and grow continuously in males, forming upward-curving tusks.
- **Premolars (P)**:
  - Located behind the canines, with 8 teeth in both the upper and lower jaws.
  - Oval-shaped and assist in grinding and crushing food.
  - Feature bicuspid (two-cusp) patterns, aiding omnivorous diets.
- **Molars (M)**:
  - Located at the back of the mouth, with 6 teeth in both the upper and lower jaws.
  - Trapezoidal-shaped and used for grinding and crushing.
  - Feature polycuspid (four-cusp) patterns, including distobuccal, mesiobuccal, distopalatal, and mesiopalatal cusps (Fig. 3).

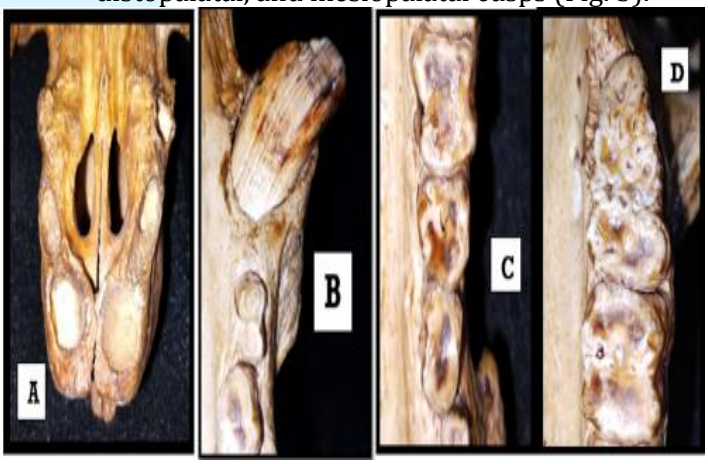

Fig. 3 *Sus scrofa* teeth A: Incisor, B: Canine C: Premolar, D: Molar

By the analysis of the Wild Boar skull, the dental has different partitions to describe the characteristics of Maxillary teeth.

3.3.1 Based on Shape

The incisors in wild boar were usually chisel-shaped. The canine in wild boar has two partitions, which describe the upper and lower tusk. This upper canine was short and grew sideways on a curve upward direction. The premolar in wild boar were oval shaped. The molar in wild boar were trapezoidal shaped.

3.3.2 Based on Cusp

The Premolar cusp in wild boar was bicuspid (two cusps). This is important for an omnivorous diet that includes both plant material and animal matter. The

Molar cusp in wild boar was polycuspid (four cusp) which includes distobuccal cusp, mesiobuccal cusp, distopalatal cusp, and mesiopalatal cusp (Figure 4a & 4b).

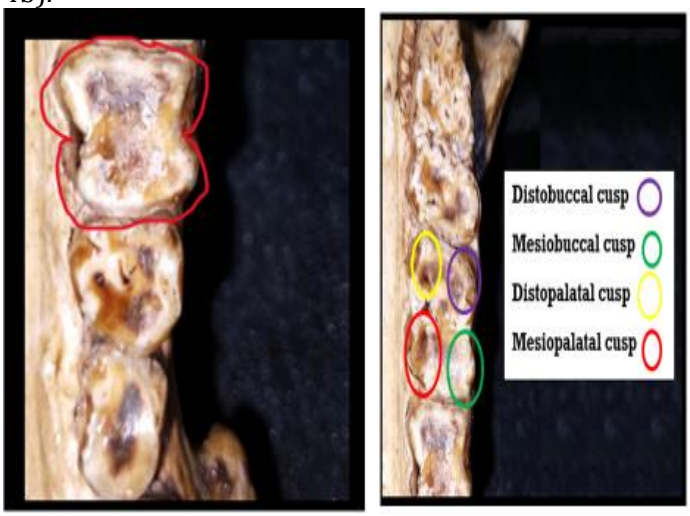

Fig. 4 **(a)** Bicuspid of *Sus scrofa*, **(b)** Polycuspid of *Sus scrofa*

The *S. scrofa* skull of the wild boar is composed of 44 bones, divided into cranial and facial components. The cranial bones, crucial for protecting the brain, include the frontal bone, paired parietal bones, occipital bone, paired temporal bones, sphenoid bone, and ethmoid bone. Meanwhile, the facial bones, which support the structural framework of the skull, consist of the maxilla (upper jaw), mandible (lower jaw), zygomatic bones (cheekbones), nasal bones, lacrimal bones, palatine bones, and vomer. This arrangement is consistent with the cranial structure reported in other mammals such as Ox (Searfoss, 1995), Goat (Choudhary et al., 2020), Chital (Choudhary et al., 2013), and Blackbuck (Choudhary & Singh, 2016). Choudhary et al., 2021

Morphometric analysis revealed that the *S.scrofa* skull is elongated and dolichocephalic (long-headed) (Figure 5& Table 1-5). This feature is comparable to the cephalic index reported in the Kagani goat (Sarma, 2006), blackbuck (Choudhary et al., 2021), and gaur (Vishwakarma et al., 2024), but differs from the brachycephalic skull of Bos gaurus, the mesaticephalic skull of *Equus asinus* (Del Burro, 2014), and the mesocephalic skull of the Malayan sun bear (Kalita et al., 2019).

Table 1 Measurement of Dorsal View in Wild Boar Skull *(S. scrofa)*

Variables	Measurement (cm)
Skull Length (SKL)	30.7
Nasal Width (NAW)	2
Nasal Length (NAL)	19.6
Facial Width (FAW)	19.1
Facial Length (FAL)	20.1
Frontal Width (FRW)	4.7
Frontal Length (FRL)	15.5
Frontal Suture Length (FRSL)	10.6
Cranial Width (CRW)	5.3
Cranial Length (CRL)	10.6
Supraorbital Foramen Distance (SOFD)	3.6

Table 2 Measurement of Ventral View in Wild Boar Skull *(S. scrofa)*

Variables	Measurement (cm)
Skull Length (SKL)	34.5
Skull Width (SKW)	13.5
Skull Base Length (SKBL)	31.5
Palatine Width (PAW)	1.6
Palatine Length (PAL)	17.7
Foramen Magnum Height (FMH)	3.6
Foramen Magnum Width (FMW)	3.4

The skull length and width of the wild boar, measured in a ventral view, were 34.5 cm and 13.5 cm, respectively (Table 2& Figure 5). In comparison, these parameters measured 44.3 cm and 16.9 cm in the donkey (Zhu et al.) and 20.68 cm and 9.54 cm in the blackbuck (Choudhary & Singh, 2015b). The skull index of the wild boar was calculated at 39.13, which is lower than the skull index values reported in Mehraban sheep (53.57 cm, Karimi et al., 2011), blackbuck (46.12 cm, Choudhary & Singh, 2015b), dromedary camel (46.51 cm, Choudhary et al., 2016).

The cranial dimensions of the wild boar, measured dorsally, showed a length of 10.6 cm and a width of 5.3 cm. Comparable measurements in blackbuck were 10.4 cm and 6.13 cm (Choudhary & Singh, 2015b). The cranial index of the wild boar was 50, slightly lower than the cranial index values in Mehraban sheep (52.76, Karimi et al.) and blackbuck (59.00, Choudhary & Singh, 2015b). Facial measurements in the dorsal view showed a length of 20.1 cm and a width of 19.1 cm in the wild boar. In comparison, these parameters were reported as 11.53 cm and 9.3 cm in blackbuck (Choudhary & Singh, 2015b). The facial index of the wild boar was 95.02, which was higher than the facial index of Mehraban sheep (85.44, Karimi et al.) and blackbuck (80.67, Choudhary & Singh, 2015b).

Table 3 Measurement of Lateral View in Wild Boar *(S . scrofa)*

Variables	Measurement (cm)
Premaxilla Length (PML)	4.1
Premaxilla Width (PMW)	1.3
Maxilla Length (MAL)	16.3
Maxilla Width (MAW)	6.1
Lacrimal Length (LAL)	8
Lacrimal Width (LAW)	3.5
Infraorbital Foramen Distance (IOFT)	3.8
Infraorbital Foramen of Superior Premolar (IOSP)	2.5

Table 4 Measurement of Nuchal View in Wild Boar *(S. scrofa)*

Variables	Measurement (cm)
Parietal Height (PRH)	0
Parietal Width (PRW)	5.3
Occipital Height (OCH)	0
Occipital Width (OCW)	6.8
Intercondylar Width (ICW)	6
Interparacondylar Width (IPCW)	0

The nasal length and width of the wild boar, measured dorsally, were 19.6 cm and 2 cm, respectively. By comparison, the nasal dimensions in the Kagani goat were 6.5 cm and 3.2 cm (Sarma), while those in Indian blackbuck were 5.69 cm and 1.29 cm (Choudhary et al., 2015). The nasal index of the wild boar was 10.2, considerably lower than that of Indian mithun (23.56 for males and 23.44 for females). Frontal bone measurements in the wild boar showed a length of 15.5 cm and a width of 4.7 cm, while these measurements in blackbuck were 7.75 cm and 4.81 cm (Choudhary & Singh, 2015b). The frontal index of the wild boar was 30.32, which contrasts sharply with the significantly higher frontal index of the Indian blackbuck (98.71, Choudhary et al., 2015).

The palatine bone of the wild boar, measured ventrally, had a length of 17.7 cm and a width of 1.6 cm, giving it a palatine index of 9.03. In contrast, the same parameters in the Indian blackbuck measured 6.04 cm and 3.23 cm (Choudhary & Singh, 2015b). The foramen magnum, located at the skull base, was large and oval in shape, providing a passage for the spinal cord. The dimensions of the foramen magnum in the wild boar were 3.4 cm in width and 3.6 cm in height, resulting in a foramen magnum index of 94.4. This was slightly lower than the values reported in blackbuck (98.71, Choudhary & Singh, 2015b) and males and females of the one-humped camel (109.3 and 107.37, respectively).

The premaxilla and maxilla of the wild boar, measured in a lateral view, had lengths of 4.1 cm and 16.3 cm and widths of 1.3 cm and 6.1 cm, respectively. These values were smaller compared to the premaxilla (7.23 cm length and 1 cm width) and maxilla (9.29 cm length and 4.83 cm width) in the Indian blackbuck (Choudhary & Singh, 2015b). The premaxilla index and maxilla index of the wild boar were calculated as 31.7 and 37.42, respectively, underscoring the unique craniofacial adaptations of the species. This comprehensive morphometric analysis of the wild boar skull provides valuable comparative insights into craniofacial variations across different mammalian species.

Fig. 5 (a) Wild Boar Skull in Dorsal View; (b) Ventral View; (c) Lateral View; (d) Nuchal View

3.3.3 Dorsal View in Wild Boar Skull

The wild boar skull shows a skull length (30.7 cm) and facial length (20.1 cm), (Table 1& Figure 5) comparable to species like blackbuck (*Antilope cervicapra*), which has a shorter skull length (20.68 cm). The nasal width (2 cm) and cranial width (5.3 cm) are narrower compared to larger mammals like dromedary camels (*Camelus dromedarius*), where nasal and cranial dimensions are proportionately larger.

3.3.4 Ventral View in Wild Boar Skull

The skull length (34.5 cm) and skull width (13.5 cm) Table 2 and Figure 5 align with medium-sized mammals, falling between measurements for blackbuck (20.68 cm, 9.54 cm) and domestic pigs. The foramen magnum height (3.6 cm) and width (3.4 cm) are larger than blackbuck (~2 cm) but smaller than camels.

3.3.5 Lateral View in Wild Boar Skull

The maxilla length (16.3 cm) and infraorbital foramen distance (3.8 cm) Table 3 and and Figure 5 are consistent with omnivorous dietary adaptations. In contrast, ruminants like goats and blackbuck exhibit smaller maxilla lengths (~9.29 cm). The lacrimal length (8 cm) and width (3.5 cm) support its functionality for vision-related anatomy in wild boars.

3.3.6 Nuchal View in Wild Boar Skull.

The wild boar's occipital width (6.8 cm) and intercondylar width (6 cm) Table 4, and Figure 5 reflect robust nuchal musculature compared to smaller ungulates like blackbuck. The absence of parietal height and inter-paracondylar width in the wild boar may indicate variations in skull shape compared to grazing species.

3.3.7 Index Values in Wild Boar Skull.

The cranial index (50) and facial index (95.02) reflect a dolichocephalic (long-headed) skull type (Table 5& Figure 5), consistent with other omnivores but differing from the brachycephalic skulls of domestic pigs. The nasal index (10.2) and frontal index (30.32) indicate a narrow nasal structure and moderate frontal width. Ventral indices like the skull index (39.13) and palatine index (9.03) reveal adaptations for chewing and feeding, while the foramen magnum index (94.4) highlights spinal alignment suited to the species' mobility.

Table 5 Index Value of Wild Boar

Skull View Index	Variables	Value
Dorsal	Cranial Index (CRI)	50
	Facial Index (FAI)	95.02
	Nasal Index (NI)	10.2
	Frontal Index (FRI)	30.32
Ventral	Skull Index (SKI)	39.13
	Palatine Index (PAI)	9.03
	Foramen Magnum Index (FMI)	94.4
Lateral	Premaxilla Index (PMI)	31.7
	Maxilla Index (MAI)	37.42
	Lacrimal Index (LAI)	43.75

The premaxilla index (31.7), maxilla index (37.42), and lacrimal index (43.75) in the lateral view suggest intermediate adaptations between omnivorous and carnivorous mammals, aiding in feeding and sensory efficiency. These measurements highlight the ecological and taxonomic significance of skull morphology in wild boars. Their cranial and dental structures reflect omnivorous dietary habits, distinct from specialized herbivores like blackbuck and carnivores like canids. Such morphometric studies are vital for unique wild boars from related species and understanding their evolutionary adaptations.

4. Conclusion

This study highlights the critical role of museum specimens in understanding the taxonomy, ecology, and evolution of wild mammals, particularly the wild boar (*Sus scrofa*). The complete morphometric analysis of the preserved wild boar skull revealed valuable insights into cranial and dental adaptations, sexual dimorphism, and interspecies variations. Comparative studies with other mammals further highlighted the boar's evolutionary adaptations to omnivorous diets and environmental pressures. This work highlights the importance of skull morphology in taxonomy and species identification, strengthening the need for careful preservation and handling of museum collections. Future studies should expand these analyses to incorporate a wider range of specimens, aiding in a deeper understanding of evolutionary trends and ecological adaptations across diverse mammalian taxa.

Abbreviations

SKL	Skull Length
SKW	Skull Width
SKBL	Skull Base Length
CRL	Cranial Length
CRW	Cranial Width
CRH	Cranial Height
CRC	Cranial Cavity
FAL	Facial Length
FAW	Facial Width
MAL	Maxilla Length
MAW	Maxilla Width
IOFD	Infraorbital Foramen Distance
PML	Premaxilla Length
PMW	Premaxilla Width
LAL	Lacrimal Length
LAW	Lacrimal Width
NAL	Nasal Bone Length
NAW	Nasal Bone Width
PAL	Palatine Length
PAW	Palatine Width
OCL	Occipital Length
OCH	Occipital Height
ICW	Intercondylar Width
IPCW	Interparacondylar Width
FMH	Foramen Magnum Height
FMW	Foramen Magnum Width
PRH	Parietal Height
PRW	Parietal Width
FRL	Frontal Length
FRW	Frontal Width
FRSL	Frontal Suture Length
SOFD	Supraorbital Foramen Distance

Author Contributions

All authors contributed to the study conception and design. Joshua A.R., conducted the investigation and curated the data, performed the formal analysis, validated the results, Azhagu Raj. conceptualized the study, designed the methodology, supervised the project, reviewed, and edited the manuscript.

Acknowledgements

The authors sincerely express their gratitude to the Head of the Department of Zoology and the laboratory assistants at the Zoology Museum, St. Xavier's College, Palayamkottai, for their invaluable support and encouragement throughout this study. Special thanks are extended to K. S. Vignesh Kumar, Bachelor of Dental Surgery, Rajas Dental College and Hospital, Tirunelveli, as well as Ms. Devadharshini, Master of Wildlife Biology, and Dr. Sathish Kumar, AVC College, Mayiladuthurai, for their support. The authors also acknowledge the assistance of ChatGPT AI language tools in enhancing the clarity and readability of this manuscript.

Conflict of the Interest

The authors declare that they have no conflict of interest.

Funding Information

This study has not received any external funding.

Data materials availability

Data that support the findings of this study are embedded within the manuscript.

References

1. Abdo, M., Taher, R., Erasha, A., & Fericean, L. (2023). Comparative morphological and computed tomographical measurements of the orbit in cattle and pig eyes. *International Journal of Morphology, 41*(1).
2. Ahrestani, F. S., & Karanth, K. U. (2014). Gaur (*Bos gaurus CH Smith, 1827*). In M. Melletti & J. Burton (Eds.), *Ecology, evolution and behaviour of wild cattle* (pp. 174–193). Cambridge University Press.
3. Choudhary, O. P., & Singh, I. (2015a). Applied anatomy of the maxillofacial and mandibular regions of the Indian blackbuck (*Antilope cervicapra*). *Journal of Animal Research, 5*(3), 497–500.
4. Choudhary, O. P., & Singh, I. (2015b). Morphometrical studies on the skull of Indian blackbuck (*Antilope cervicapra*). *International Journal of Morphology, 33*(3), 868–876.
5. Choudhary, O. P., & Singh, I. (2016). Morphological and radiographic studies on the skull of Indian blackbuck (*Antilope cervicapra*). *International Journal of Morphology, 34*(2), 775–783.
6. Choudhary, O. P., Kalita, P. C., Arya, R. S., Kalita, A., & Doley, P. J. (2020). A morphometrical study on the skull of goat (*Capra hircus*) in Mizoram. *International Journal of Morphology, 38*(5).
7. Choudhary, O. P., Kalita, P. C., Doley, P. J., & Kalita, A. (2017). Applied anatomy of the head region of the Indian wild pig (*Sus scrofa*) and its clinical value during regional anesthesia. *Journal of Animal Research, 7*(2), 339–344.
8. Choudhary, O. P., Kalita, P. C., Doley, P. J., Kalita, A., & Arya, R. S. (2019b). Morphological studies on the cranial bones of Mizoram goats. *Indian Journal of Small Ruminants, 25*(1), 128–130.
9. Choudhary, O. P., Kalita, P. C., Gundemir, O., Kalita, A., & Doley, P. J. (2021). Sex-wise morphometrical studies on the skull bones of Indian mithun (*Bos frontalis*). *Indian Journal of Animal Research, 55*(8), 960–966.
10. Choudhary, O. P., Kalita, P. C., Kalita, A., & Doley, P. J. (2016). Applied anatomy of the maxillofacial and mandibular regions of the dromedary camel (*Camelus dromedarius*). *Journal of Camel Practice and Research, 23*(1), 127–131.
11. Choudhary, O. P., Kalita, P. C., Konwar, B., Doley, P. J., Kalita, G., & Kalita, A. (2019a). Morphological and applied anatomical studies on the head region of local Mizo pig (Zovawk) of Mizoram. *International Journal of Morphology, 37*(1), 196–204.
12. Choudhary, O. P., Mathur, R., Joshi, S., Beniwal, G., & Dangi, A. (2013a). Gross and biometrical studies on carpals of chital (*Axis axis*). *Veterinary Practitioner, 14*(1), 36–39.
13. Choudhary, O. P., Mathur, R., Joshi, S., Beniwal, G., & Dangi, A. (2013b). Gross and biometrical studies on scapula of chital (*Axis axis*). *Veterinary Practitioner, 14*(2), 224–227.
14. Choudhary, O. P., Singh, I., Bharti, S. K., Khan, I. M., Mohd, K. I., Sathapathy, S., & Mrigesh, M. (2015). Gross and morphometrical studies on the mandible of blackbuck (*Antilope cervicapra*). *International Journal of Morphology, 33*(2), 428–432.
15. del Burro, E. M. D. C. (2014). A morphometric study on the skull of donkey (*Equus asinus*). *International Journal of Morphology, 32*(4), 1306–1310.
16. Groves, C. P., & Grubb, P. (2011). *Ungulate taxonomy.* Johns Hopkins University Press.
17. Hillson, S. 2005. Teeth (2nd Edition). – Cambridge, Cambridge University Press (Cambridge Manuals in Archaeology). *PalArch's Journal of Archaeology of Egypt / Egyptology*, *4*(1), 01-02.
18. Kalita, P. C., Singh, T. S., Choudhary, O. P., Debroy, S., Kalita, A., & Doley, P. J. (2019). Morphological and applied anatomical studies on the head region of Malayan sun bear (*Helarctos malayanus*). *Journal of Animal Research, 9*(5), 753–758.
19. Kaminski, G., Brandt, S., Baubet, E., & Baudoin, C. (2005). Life-history patterns in wild boars (*Sus scrofa*): Implications for population dynamics. *Canadian Journal of Zoology, 83*(8), 949–957.
20. Mayer, J. J. (2009). Wild pig physical characteristics. In *Wild pigs: Biology, damage, control techniques and management* (pp. 25–50). Savannah River National Laboratory, United States Department of Energy.
21. Menon, V. (2014). *Indian mammals: A field guide.* Hachette India.
22. Prothero, D. R. (2016). *Vertebrate Evolution.* From Origins to Dinosaurs and Beyond. CRC Press.
23. Remsen, J. V. (1995). The importance of continued collecting of bird specimens to ornithology and bird conservation. *The Condor, 97*(3), 739–749.
24. Sarma, K. (2006). Morphological and craniometrical studies on the skull of Kagani goat (*Capra hircus*) of Jammu region. *International Journal of Morphology, 24*(3), 449–455.
25. Searfoss, G. (1995). *Skulls and bones: A guide to the skeletal structures and behavior of North American mammals.* Stackpole Books.
26. Suarez, A. V., & Tsutsui, N. D. (2004). The value of museum collections for research and society. *BioScience, 54*(1), 66–74.
27. Vishwakarma, R., Sharma, C. P., Mondol, S., Habib, B., Bhandari, B., Mishra, R., ... & Nigam, P. (2024). Preliminary study on cranial measurements and sexual dimorphism in skull bones of gaur (*Bos gaurus gaurus*, Smith 1827). *Anatomia, Histologia, Embryologia, 53*(3), e13031.
28. Wilson, D. E., & Mittermeier, R. A. (Eds.). (2011). *Handbook of the mammals of the world. Vol. 2: Hoofed mammals.* Lynx Edicions.