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Archaeofaunal Evidence from the Sites of Khajeriapali, Subulia and Kumersingha in Middle Mahanadi Valley, Odisha

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Abstract

Subulia (Chalcolithic-Iron Age), Khajeriapali, and Kumersingha (both Iron Age) are key sites in Odisha's Middle Mahanadi Valley. These sites have yielded evidence of faunal remains that were analysed by standard archaeozoological methods at Deccan College's Archaeozoology Laboratory, Pune. The results of the analysis are presented in this paper. The faunal assemblage from all three sites is broadly similar in composition. Major domestic animals such as cattle, buffalo, sheep and goats, are present at all three sites indicating the importance of animal husbandry in the regional economy. Other domesticated animals include dog bones from Subulia and Khajeriapali, pig bones from Subulia, and cat bones from Khajeriapali. Remains of the wild fauna such as antelope, deer, and nilgai have been noted at all three sites. Non-mammalian remains such as freshwater turtle and bird bones were recorded in small proportions. Overall, the evidence suggests a subsistence pattern primarily based on livestock rearing, supplemented by limited hunting and exploitation of other faunal resources from the Chalcolithic to the Iron Age in the Middle Mahanadi Valley.

Introduction

The study area designated as the Middle Mahanadi Valley is one of the most significant cultural landscapes for understanding long-term human-environment interactions in eastern India. Geographically, it forms a distinct zone between the Chhattisgarh Plains and the Coastal Plains of Odisha, with the Mahanadi River flowing between the Northern Uplands, an extension of the Chhotanagpur Plateau and the South-Western hilly regions of the Odisha Highlands (Singh 1971: 754-775). Rich in mineral resources and marked by diverse floral and faunal communities, this ecologically varied terrain offered favourable conditions for early human settlement and subsistence diversification (Bhatt 2008: 521-528).

Excavations at several settlements located along the Mahanadi and its tributaries have yielded substantial faunal assemblages, offering direct evidence of animal exploitation patterns (e.g., Behera 2002-03; Behera *et al*. 2015, 2017, 2019). Within this expanding archaeological framework, archaeozoological investigations have focussed on reconstructing subsistence strategies and economic adaptations. Detailed analyses of faunal remains from sites such as Badmal, Kantipuleswar and Kapasira have demonstrated the combined role of domesticated livestock, hunting of wild taxa, and aquatic resource utilisation, in shaping regional subsistence systems (Goyal *et al.* 2014, 2020a, 2020b). These studies highlight the dynamic interplay between environmental availability, technological innovation, and cultural preference in structuring animal-based economies over time.

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Material and Methods

Against this broader background of archaeological discovery and emerging evidence for early agrarian and iron-using communities, the present study examines the faunal assemblages from the sites of Khajeriapali, Subulia and Kumersingha, all located in the Middle Mahanadi Valley (Fig. 1). Excavations at all three sites brought to light a considerable number of animal skeletal remains, that were carefully collected, labelled, and documented, during fieldwork. After cleaning and packing, the material was sent to the Archaeozoology Laboratory at Deccan College, Pune, for detailed study. In the laboratory, the assemblage was examined following standard archaeozoological procedures that combined qualitative observations with quantitative assessment.

The bones were first sorted into broad anatomical categories, for example, axial elements (e.g., skull, vertebrae, and ribs) and appendicular elements (limb bones), and then identified to the lowest possible taxonomic level through comparison with modern reference collections housed at the laboratory. Published osteological identification keys (e.g., Schmid 1972; Miguad 1989; Joglekar *et al.* 1994; Hillson 1996; Pawankar and Thomas 2001; Haraniya *et al.* 2016) were

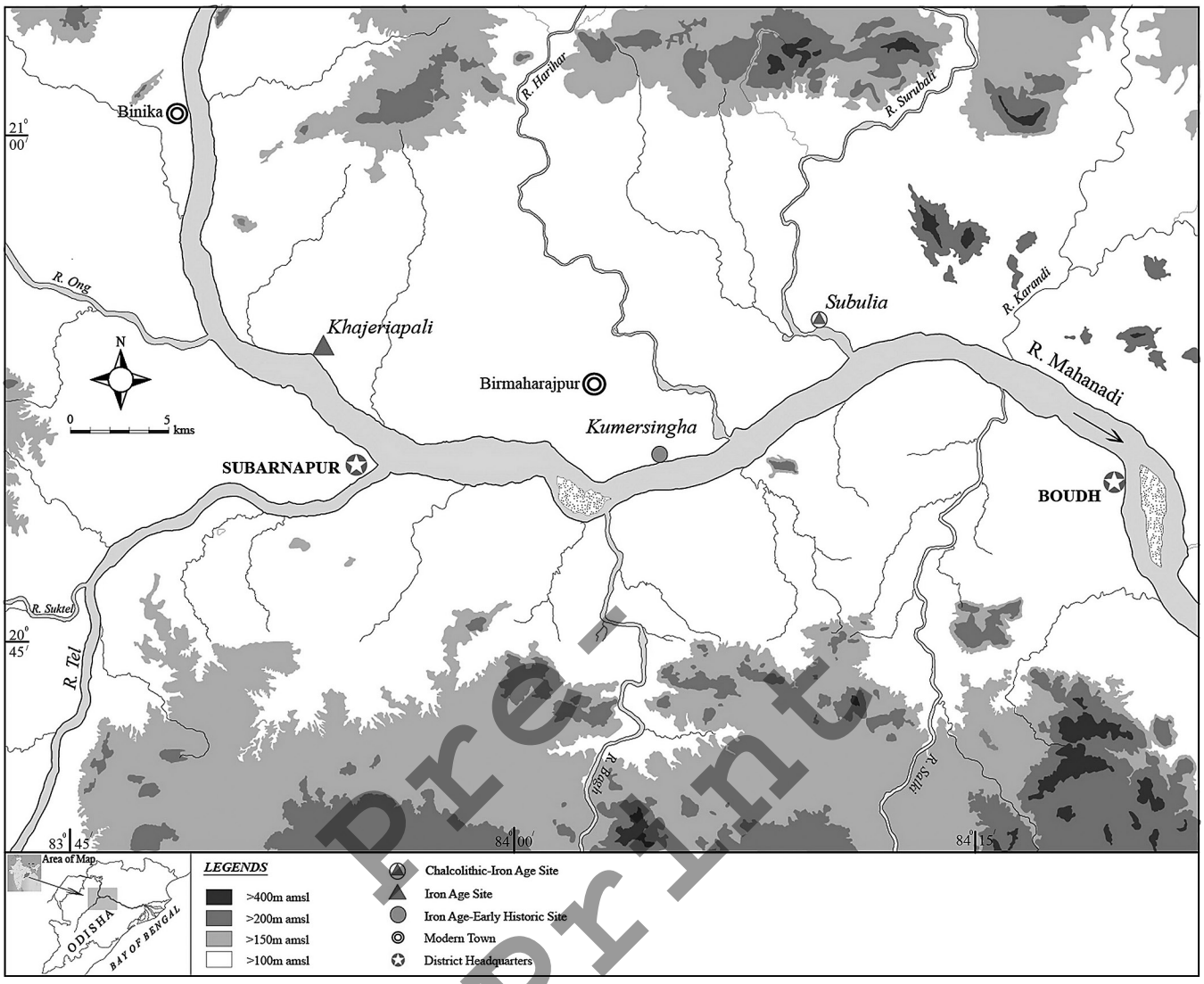

Fig. 1: Map showing the sites of Khajeriapali, Subulia, and Kumersingha

also consulted to support identification. Where clear diagnostic features were absent, closely related taxa were grouped into broader categories such as cattle/buffalo (*Bos/Bubalus*) and sheep/goat (*Capra/Ovis*). Highly fragmented long bone shafts, ribs, and vertebrae that lacked distinguishing traits were classified into size-based groups such as large-, medium-, and small-sized mammals, based on the relative dimensions of the skeletal elements. Each specimen was also examined carefully for signs of pre- and post-depositional modifications, including cut marks, burning or charring, weathering, gnawing, and breakage patterns, to better understand patterns of animal use and site formation processes.

Indeterminate specimens were labelled as Unidentified Fragments (UF), and later classified into three size-based categories: large (UF_L, >5 cm), medium-sized (UF_M, 1-5 cm) and small (UF_S, <1 cm). The unidentified category consists largely of splintered and highly fragmented pieces. Several bone splinters displayed fresh breakage surfaces, likely caused during excavation or subsequent handling. These freshly broken splinters were excluded from the quantitative count to prevent artificial inflation of fragment numbers.

Khajeriapali

The site of Khajeriapali (20° 53′ 23.99″ N; 83° 53′ 31.36″ E) is situated on the left bank of the River Mahanadi, about 2 km south-east of Kapasira village in Subarnapur District, Odisha. The ancient habitation mound lies towards the western part of the present village and measures approximately 150 m north-south and 130 m east-west. The site has been considerably disturbed due to continuous agricultural activities and modern constructions undertaken by the local inhabitants. With a view to understanding the cultural sequence of the site, Khajeriapali was excavated by Sambalpur University during February-March 2000

(Behera 2006). Two trenches, each measuring 2 x 2 m, were laid out: KJP I on top of the mound (excavated to a depth of 1.10 m) and KJP II on the peripheral slope (excavated to a depth of 1.05 m). The excavations revealed a single cultural horizon representing the Early Iron Age (Phase I). The ceramic assemblage reflects a developed tradition with utilitarian and possibly decorative wares. Habitation deposits also yielded pestles, carnelian, and terracotta beads, circular discs, hopscotch pieces, a tanged bone point, copper slag indicating limited metallurgy, and burnt clay lumps with reed impressions from wattle-and-daub structures.

The Faunal Remains

A total of 160 skeletal elements were recovered from the site, which were scientifically analysed (Table 1; Fig. 2). Of these, 102 specimens (63.75%) were identified to varying taxonomic levels (NISP), while the remaining 58 specimens (36.25%) could not be identified.

Table 1: Faunal material examined from Khajeriapali

Cultural Period	Iron Age (Phase I)
NISP	102 (63.75%)
UF_L	10
UF_M	24
UF_S	24
TF	160

The Species

The faunal assemblage at Khajeriapali revealed the presence of several species belonging to both domestic and wild categories. The domestic mammals identified at the site include cattle (*Bos indicus*), buffalo (*Bubalus bubalis*), sheep (*Ovis aries*), goat (*Capra hircus*), dog (*Canis familiaris*) and cat (*Felis catus*). The wild mammals represented in the assemblage include spotted deer (*Axis axis*) and nilgai (*Boselaphus tragocamelus*). Non-mammalian remains are represented by the Indian flapshell turtle (*Lissemys punctata*). In addition to the identified taxa, a substantial number of fragments could not be assigned to specific species and were therefore categorised on the basis of size into large-sized mammals, medium-sized mammals, and small-sized mammals. No evidence of bird, fish, or molluscan remains were recorded in the studied assemblage from Khajeriapali.

Taxonomic and anatomical representation

Among domestic mammals, cattle (*Bos indicus*) are represented by 7 skeletal elements (6.9%), including one isolated mandibular molar, one distal humerus, one proximal femur, one distal calcaneum together with one complete astragalus (KJP1), and two complete first phalanges (KJP7, KJP12) (Table 2; Fig. 3). Several specimens could not be securely distinguished between cattle and buffalo, and were thus grouped as cattle/buffalo (n = 18, 17.6%), comprising two mandibular fragments,

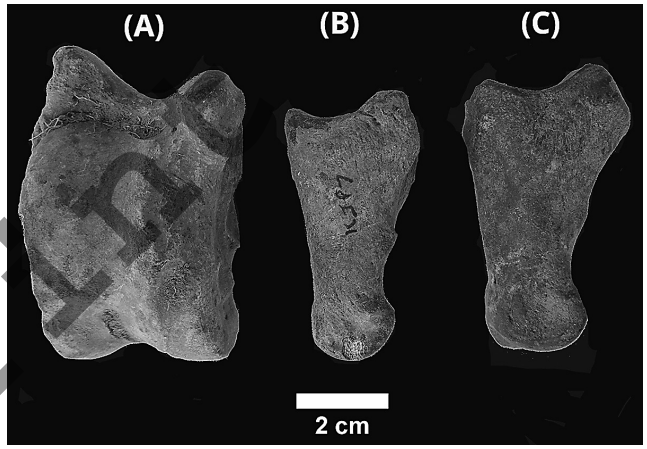

Fig. 3: Skeletal elements of *Bos indicus*: (A) Astragalus, (B)-(C) 1st Phalanges

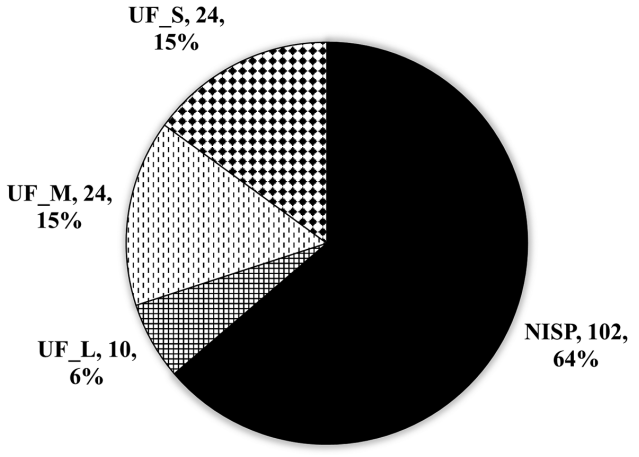

Fig. 2: Pie chart showing level of identification at Khajeriapali

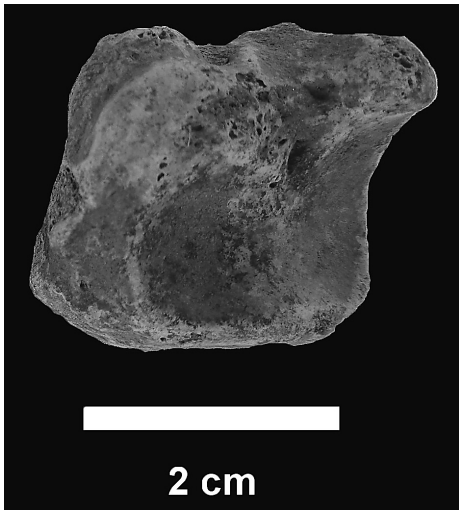

Fig. 4: Centrotarsal of *Capra/Ovis*

Table 2: NISP Count from Iron Age site of Khajeriapali

Species	NISP	NISP %
Bos indicus	7	6.86
Bos/Bubalus	18	17.60
Capra/Ovis	2	1.96
Canis familiaris	1	0.98
Felis catus	1	0.98
Boselaphus tragocamelus	2	1.96
Axis axis	1	0.98
Large-sized Mammal	51	50.00
Medium-sized Mammal	16	15.70
Small-sized Mammal	2	1.96
Lissemys punctata	1	0.98
Total	**102**	**100**

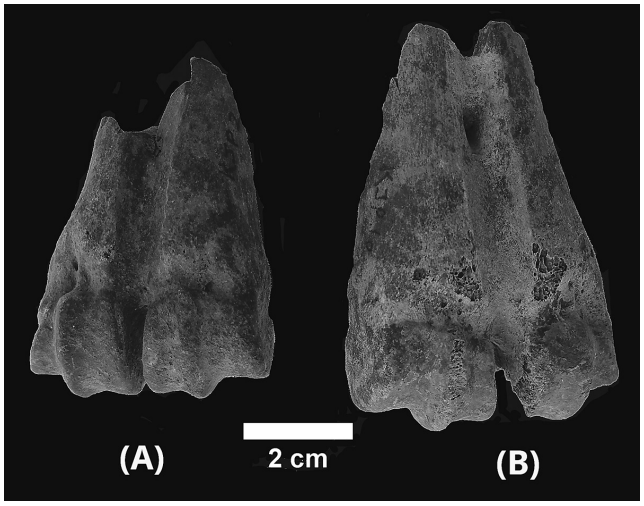

Fig. 7: Metatarsals of nilgai

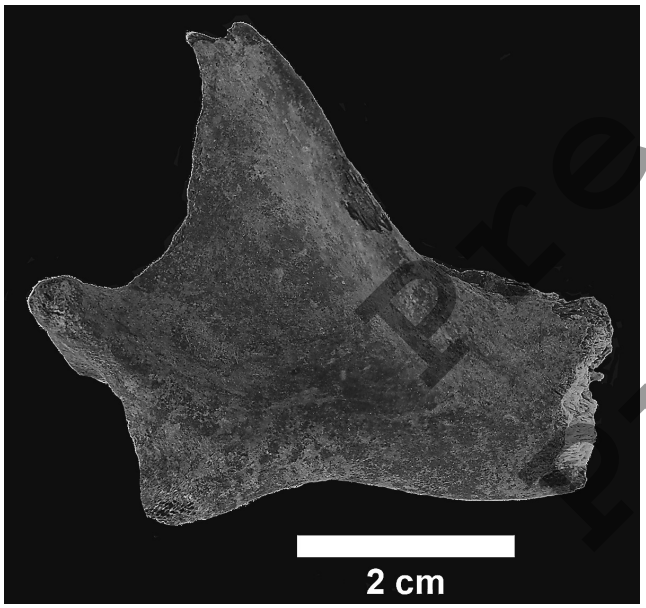

Fig. 5: Mandibular fragment of a dog

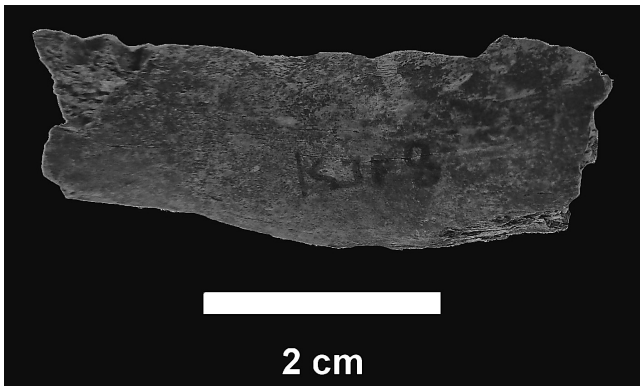

Fig. 6: Right mandibular fragment of a cat

three distal scapulae, three distal humeri, one distal radius, three metacarpals (two proximal, one distal), one pelvic fragment, two femora (one distal, one proximal) (KJP13), one distal calcaneum (KJP5), one sesamoid, and one thoracic vertebra, reflecting cranial, axial, and appendicular elements.

Sheep/goat (*Capra/Ovis*) constitute 2% of identified material, represented by a centrotarsal (KJP4) (Fig. 4) and a pelvic fragment; dog (*Canis familiaris*) (KJP11) by a single mandibular fragment (Fig. 5); and cat (*Felis catus*) by a mandibular fragment (Fig. 6). Wild mammals occur in smaller proportions: nilgai (*Boselaphus tragocamelus*) by two distal metatarsals (KJP2, KJP10) (Fig. 7) and spotted deer (*Axis axis*) by an antler fragment (Fig. 8), indicating limited interaction with surrounding wild fauna. Non-mammalian remains consist solely of an Indian flapshell turtle (*Lissemys punctata*) skeletal element (Fig. 9).

Indeterminate specimens lacking diagnostic features were classified by size: large mammals (50%, n = 51; vertebrae, clavicles, long bone fragments, ribs, scapulae, carpals/foot bones); medium mammals (15.7%, n = 16; carpals/foot bones, femora, humeri, long bone fragments, mandibles, ribs, vertebrae); and small mammals (2%, n = 2; vertebrae). The predominance of cattle/buffalo and large fragments underscores the central role of bovids in Early

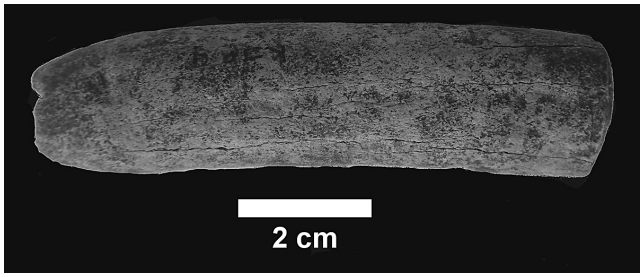

Fig. 8: An antler fragment of spotted deer

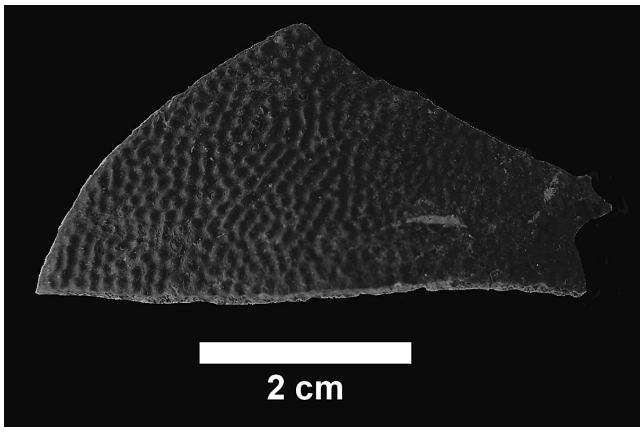

Fig. 9: Carapace fragment of Indian Flapshell Turtle

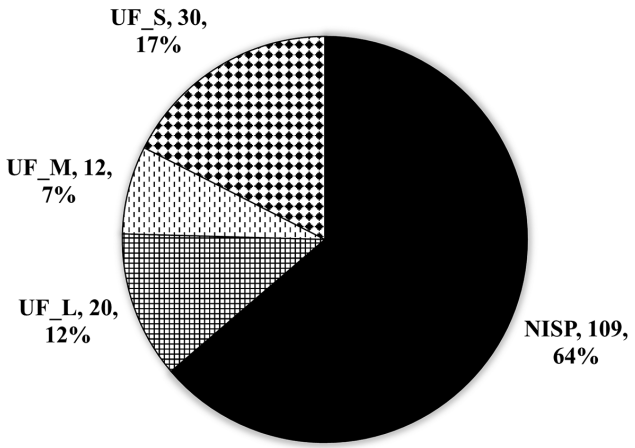

Fig. 10: Pie chart showing level of identification at Subulia

Iron Age Khajeriapali subsistence, with caprines and wild taxa playing minor roles.

Subulia

The archaeological site of Subulia (20° 54′ 13.04″ N; 84° 09′ 25.86″ E) is situated about two km north-east of the present village of Subulia in the Birmaharajpur subdivision of Subarnapur District, Odisha. The site lies on the left bank of the Surubali stream, a tributary of the River Mahanadi, within the middle Mahanadi valley region (Behera and Hussain 2017). The mound measures approximately 275 m east-west and 75 m north-south, with its longest axis running parallel to the stream. Rising nearly 4 m above the present water level, the site occupies a favourable ecological zone marked by fertile agricultural land, pasture tracts and nearby forest resources, creating conditions suitable for sustained habitation and animal husbandry. In order to assess the nature and extent of the habitation deposit, a trial trench measuring 2 × 2 m was excavated at the centre of the mound during February-March 2015, reaching down to the natural soil. The excavation revealed two successive cultural periods. Period I (Late Chalcolithic) and Period II (Iron Age) without any marked occupational hiatus between them.

Period I (Late Chalcolithic), the site's earliest cultural horizon, features slipped and well-burnished ceramics dominated by plain/painted Black-and-Red Ware (BRW), Black Slipped Ware (BSW), Red Slipped Ware (RSW), Chocolate Slipped (Tan) Ware, and plain Red Ware (RW). No permanent architecture survives, but burnt clay lumps with reed impressions indicate wattle-and-daub structures. Associated terracotta objects and limited faunal remains suggest agro-pastoral subsistence. A radiocarbon date of 2630 ± 100 BCE (BS-3849) from the middle level provides a chronological framework for this phase (Behera and Hussain 2017: 37-53).

Period II (Iron Age) directly succeeded the Chalcolithic without a break, featuring dominance of Red Slipped Ware alongside plain Red Ware, Black Slipped Ware, Black-and-Red Ware, and Chocolate Slipped Ware, with reduced burnishing, no white paint, slip-washed surfaces, and appliqué bands on the shoulders. Iron Age levels yielded iron objects/slags, terracotta artefacts, and faunal remains, indicating subsistence continuity across the Chalcolithic–Iron Age transition and gradual cultural evolution at Subulia in the middle Mahanadi Valley.

The Faunal Remains

The Subulia faunal assemblage totals 171 animal skeletal specimens (TF) from Chalcolithic and Iron Age phases, with 109 (63.74%) identified to taxon (NISP) and 62 (36.26%) as unidentified fragments (UF) (Table 3; Fig. 10). The Chalcolithic period dominates, yielding 160 specimens (93.57% of the total assemblage): 102 identified specimens (63.75%) and 58 unidentified specimens (36.25%). The category of unidentified animal specimens includes 20 large (UF_L), 12 medium (UF_M), and 26 small (UF_S).

Table 3: Summary of identification at Subulia

Cultural Period	NISP	UF				TF	NISP%
		UF_L	UF_M	UF_S	Total		
Chalcolithic Period	102	20	12	26	58	160	63.75
Iron Age	7	-	-	4	4	11	63.64
Total	**109**	**20**	**12**	**30**	**62**	**171**	**63.74**

Table 4: NISP counts at Subulia

Species	Chalcolithic Period		Iron Age	
	NISP	NISP %	NISP	NISP %
Bos indicus	4	3.90	-	-
Bos/Bubalus	10	9.80	-	-
Capra/Ovis	19	18.60	-	-
Sus domesticus	3	2.94	-	-
Canis familiaris	3	2.94	-	-
Boselaphus tragocamelus	1	0.98	-	-
Antilope cervicapra	1	0.98	-	-
Hysterix indica	-	-	1	14.30
Large-sized Mammal	18	17.60	6	85.70
Medium-sized Mammal	40	39.22	-	-
Small-size Mammal	2	1.96	-	-
Bird	1	0.98	-	-
Total	**102**	**100**	**7**	**100**

The Iron Age period yielded just 11 specimens (6.43% of the total assemblage): 7 identified specimens (63.64%) and 4 unidentified fragments (36.36%). All unidentified Iron Age fragments were small-sized. Thus, the Chalcolithic phase overwhelmingly dominates the faunal record at Subulia in terms of both identified and unidentified remains.

The Species

The Subulia faunal assemblage reveals domestic mammals including cattle (*Bos indicus*), buffalo (*Bubalus bubalis*), sheep (*Ovis aries*), goat (*Capra hircus*), dog (*Canis familiaris*), and pig (*Sus domesticus*), alongside wild taxa such as nilgai (*Boselaphus tragocamelus*), blackbuck (*Antilope cervicapra*), and Indian crested porcupine (*Hystrix indica*) (Table 4). Avian remains indicate bird exploitation, though specific identifications remain elusive. Similar to Khajeriapali, the faunal assemblage from Subulia also includes several animal skeletal elements that could not be assigned to specific species. These fragments were therefore classified into large-, medium-, and small-sized mammalian categories based on size.

Taxonomic and anatomical representation in different phases

As mentioned, analysis of the faunal remains from both the cultural periods was undertaken. A detailed description of faunal material from different periods is given below (Table 4).

Chalcolithic Period

The moderate identification rate (63.75%) during Subulia's Chalcolithic phase indicates fair bone preservation, though extensive fragmentation reduced taxonomic precision for 36.25% of specimens, particularly affecting diagnostic zone survival.

Among domestic mammals during this period at Subulia, cattle (*Bos indicus*) are represented by four fragments: a distal scapula, two humeri, and one first phalanx. Indeterminate cattle/buffalo (*Bos/Bubalus*) fragments total 10, including distal ends of two scapulae, one humerus, two pelvic fragments, two proximal metacarpals, two distal metapodials, and one proximal metatarsal, spanning cranial, axial, and appendicular regions. Sheep/goat (*Capra/Ovis*) dominate with 19 elements: one maxillary fragment, three mandibular molars (SBL11), one hyoid, three scapulae (SBL1, SBL15, SBL16) (Fig. 11), four humeri, one ulna, one pelvic fragment, one distal metacarpal, one metapodial, one calcaneum (Fig. 12A), and two third phalanges. Pig (*Sus*

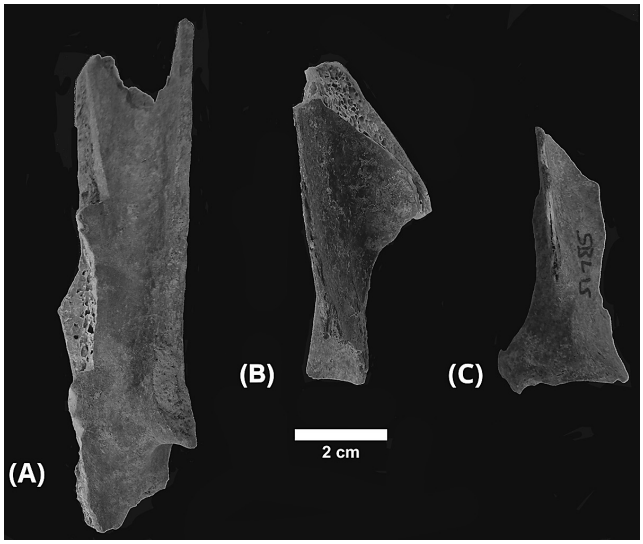

Fig. 11: Three fragments of scapula of *Capra/Ovis*

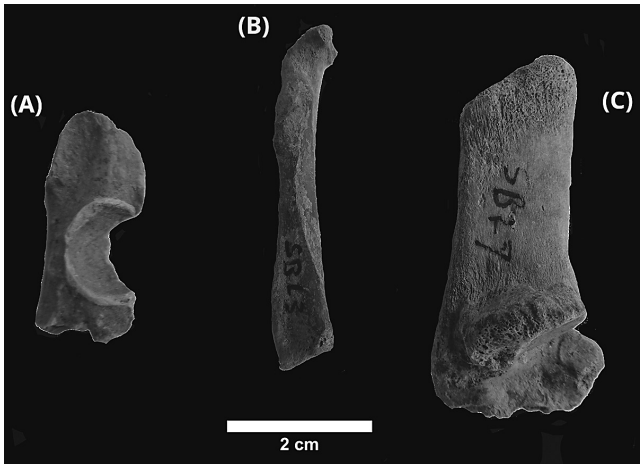

Fig. 12: (A) *Capra/Ovis* calcaneum, (B) Coracoid bone of a bird, (C) Pelvic fragment of a porcupine

Fig. 13: Metapodia of domestic pig

Fig. 14: Metapodia of dog

domesticus; 2.94%) is represented by two metapodials (Fig. 13) and one mandibular fragment. Dog (*Canis familiaris*; 2.94%) is represented by three metapodials (Fig. 14). Wild taxa are rare: nilgai (*Boselaphus tragocamelus*; 0.98%) by one metacarpal and blackbuck (*Antilope cervicapra*; 0.98%) likewise represented by a single element (SBL8); bird remains (0.98%) by a coracoid fragment (SBL3) (Fig. 12B). General level categories comprise 18 large-sized, 40 medium-sized, and 2 small-sized mammals (ribs, vertebrae, cranial fragments, long bone shafts). Overall, the Chalcolithic assemblage reflects livestock dominance, especially cattle and sheep/goat, supplemented by pigs, with minimal wild exploitation; the range of elements across taxa indicates on-site butchery and consumption.

Iron Age Period

The Iron Age levels at Subulia yielded only 7 skeletal elements – a sparse assemblage comprising 6 large-sized mammal rib fragments (85.71% of total) that lacked diagnostic features for further taxonomic assignment, and a single pelvic fragment of Indian crested porcupine (*Hystrix indica*; 14.29% NISP) (Fig. 12C). This minimal recovery likely reflects limited site occupation or post-depositional loss during the Iron Age, contrasting sharply with the Chalcolithic dominance and underscoring subsistence continuity reliant on larger bovids alongside opportunistic wild resource use.

Kumersingha

The archaeological site of Kumersingha (20° 51′ 54.0″ N; 84° 05′ 00.0″ E) is situated on the left bank of the River Mahanadi, about 6 km from the Chalcolithic site of Khameswaripali and nearly four kilometres southeast of Birmaharajpur in Subarnapur District, Odisha. The site, first reported by P.C. Rath in 1947, lies on the eastern side of the present village and has been periodically affected by floods of the Mahanadi (Behera 2002-03). The mound is roughly oblong in shape, measuring about 175 × 100 m, with its longer axis running east-west parallel to the river, and rises approximately 4-5 m above the surrounding plains. With a view to understanding the nature and cultural sequence of the settlement, three trial trenches, KMS-I (3 × 2.5 m), KMS-II (2.5 × 2.5 m) and KMS-III, were excavated in different parts of the mound. Excavation in all the trenches was carried down to the natural soil, consisting of compact yellowish silty clay mixed with calcium carbonate nodules and ferricretes. The archaeofaunal assemblages were primarily recovered from KMS-I and KMS-III trenches, indicating sustained subsistence activities during the principal occupational phases. On the basis of stratigraphy and associated cultural materials, the sequence is broadly divisible into three major periods: Early Iron Age (Period IA), Middle Iron Age (Period IB) and Late Iron Age/Early Historic (Period

IC) phases, reflecting gradual ceramic and technological developments.

Period IA yielded rich ceramics: wheel-turned Black-and-Red Ware, Black Slipped Ware, Red Slipped Ware, and plain Red Ware, slipped, burnished, and with white paint, appliqué, incision, and graffiti. Other finds include an iron nail, pottery discs, a stone pestle, reed-impressed clay lumps, butchery-marked faunal remains, and cereal impressions indicating wattle-and-daub dwellings and agriculture. Period IB continues with refined Black-and-Red/Black Slipped Ware bowls/dishes and new dish-on-stands; graffiti resembles early Brahmi. Iron chisels, axes, stone mullers, carnelian beads, pottery discs, faunal remains, and reed-impressed clay persist. Period IC shows gradual evolution: declining Black-and-Red Ware, dominant Red/Red Slipped/fine Black Slipped Ware (no paint, rare graffiti), more iron (nails, chisels, spearheads, clamps, drills, nail parers), glass bangles, carnelian/quartz beads, sling balls, and pottery discs. The cumulative evidence suggests that the settlement underwent progressive cultural change through the Early, Middle and Late Iron Age phases and was abandoned eventually towards the close of Period IC.

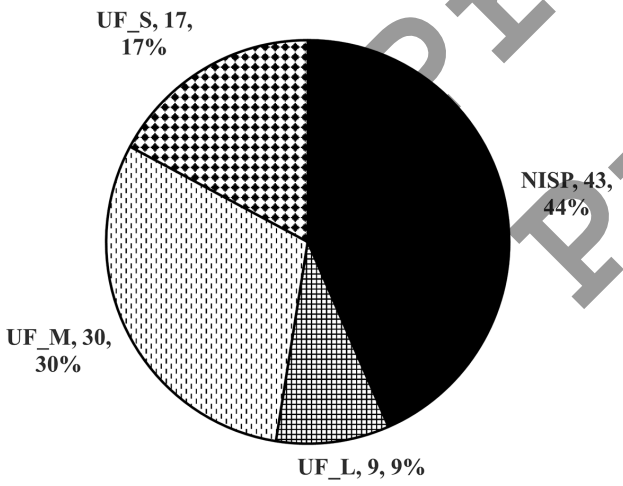

Fig. 15: Pie chart showing level of identification at Kumersingha

The Faunal Remains

The Kumersingha faunal assemblage totals 165 animal skeletal specimens (TF), of which 109 specimens (66.06%) were identified (NISP), while 56 (33.94%) remained unidentified (Table 5; Fig. 15).

The Species

The faunal assemblage from Kumersingha revealed the presence of domestic mammals along with categories of large-, medium-, and small-sized mammals. The domestic mammals identified at the site include cattle (*Bos indicus*), buffalo (*Bubalus bubalis*), sheep (*Ovis aries*), and goats (*Capra hircus*). Due to overlapping morphological characteristics, sheep and goat bones were grouped under *Capra/Ovis* where precise identification was not possible. The only wild mammalian species identified at the site was nilgai (*Boselaphus tragocamelus*).

Taxonomic and Anatomical Representation in different phases

A detailed description of faunal material from different periods is given below (Table 6).

Early Iron Age (Period IA)

Seven identified specimens mark this phase (Table 6), with buffalo (*Bubalus bubalis*) represented by a second

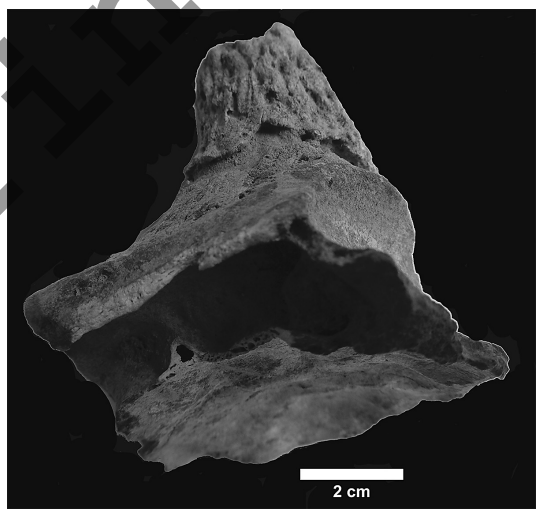

Fig. 16: Cranial fragment with a horn core of a nilgai

Table 5: Summary of identification at Kumersingha

Cultural Period	NISP	UF				TF	NISP %
		UF_L	UF_M	UF_S	Total		
Early Iron Age	7	2	3	7	12	19	36.84
Middle Iron Age	23	2	19	-	21	44	52.27
Late Iron Age/ Early Historic	13	5	8	10	23	36	36.11
Total	**43**	**9**	**30**	**17**	**56**	**99**	**43.43**

Table 6: NISP count from different phases at Kumersingha

Species	Early Iron Age		Middle Iron Age		Late Iron Age/Early Historic	
	NISP	%	NISP	%	NISP	%
Bos indicus	-	-	-	-	2	15.38
Bos/Bubalus	5	71.43	11	47.83	3	23.08
Bubalus bubalis	1	14.29	-	0.00	-	0.00
Capra/Ovis	-	0.00	1	4.35	-	0.00
Boselaphus tragocamelus	1	14.29	-	-	-	-
Large-sized mammal	-	-	10	43.48	8	61.54
Medium-sized mammal	-	-	1	4.35	-	0-
Grand Total	**7**	**100**	**23**	**100**	**13**	**100**

phalanx (KMS3) and *Bos/Bubalus* (n = 5) by one humerus, two metacarpals, one tibia, and one second phalanx. Nilgai (*Boselaphus tragocamelus*) appears via one cranial fragment with a horn core (Fig. 16). The dominance of appendicular elements (humerus, metacarpal, tibia, phalanx) alongside cranial material signals limb processing, on-site butchery, and consumption.

Middle Iron Age (Period IB)
Twenty-three identified specimens (Table 6) reflect intensified activity, dominated by *Bos/Bubalus* (n = 11): seven maxillary molars, one mandible, one mandibular molar, one distal humerus, and one tibia. Sheep/goat (*Capra/Ovis*) is limited to one maxillary molar (KMS4); large-sized mammals (n = 10) include two cranial fragments, one long bone fragment, five ribs, one thoracic vertebra, and one vertebra; medium mammals are represented by one humerus. Cranial (mandibles/molars) and post-cranial (humerus, ribs, vertebrae) elements confirm carcass processing and meat consumption within the habitation.

Late Iron Age/Early Historic (Period IC)
Thirteen identified specimens (Table 6) feature cattle (*Bos indicus*) with one tibia (KMS1) and one second phalanx; *Bos/Bubalus* by one maxillary molar, one scapula, and one tibia. Large mammals include five long bone fragments, one radius-ulna, one rib, and one vertebra. Long bone/limb prevalence suggests systematic disarticulation and marrow extraction.

Overall, the anatomical distribution across the Early, Middle, and Late Iron Age/Early Historic phases, comprising cranial elements such as mandibles and molars along with appendicular bones including humerus, tibia, metacarpals, ribs, and vertebrae, clearly reflects primary butchery, meat consumption, and disposal of food refuse within the settlement area. The continued predominance of buffalo and cattle throughout the sequence indicates a stable agro-pastoral subsistence system at Kumersingha, with particularly intensified faunal utilization during the Middle Iron Age phase.

Bone Modifications
A total of 25 identified specimens from the three sites show evidence of various types of bone modification (Table 7). The highest frequency of modified bones is recorded at Subulia (n = 21), followed by Kumersingha (n=3), while only one modified specimen has been identified from Khajeriapali (n = 1).

Two types of charring were noted on the animal skeletal elements: partial charring and completely charred bones. Completely charred bones form the dominant category of thermal modification and were largely confined to Subulia. In the Chalcolithic phase, these include two humerus shaft fragments and one distal end of a metacarpal of *Capra/Ovis* and one metacarpal of *Antilope cervicapra*, along with seven ribs and three long bone fragments of medium-sized mammals. On the other hand, at the Iron Age level, only four rib fragments of large-sized mammals were found completely charred. Although at Kumersingha, one distal tibia of *Bos indicus* was completely charred, but at Khajeriapali no completely charred specimens were recovered. The predominance of completely charred bones at Subulia suggests repeated or intensive use of fire at this site.

Partially charred specimens are few in number. In the Chalcolithic phase at Subulia, a single vertebral fragment of the medium-sized mammal category shows evidence of partial charring. In the Late Iron Age/Early Historic phase at Kumersingha, partial charring was observed on the proximal end of a second phalanx and on a shaft fragment of a tibia, indicating limited or low-intensity exposure to fire.

Evidence of carcass processing activities in the form of cut marks was noted. Cut marks are present on a humerus of *Capra/Ovis* from the Chalcolithic phase at Subulia, which also displays complete charring. Two metapodials of pig (SBL5 and SBL6) from the same phase exhibit cut marks on the shaft without associated burning. A metacarpal of *Antilope cervicapra* (SBL8) evidences cut marks (Fig. 17A), while a long bone fragment of the medium-sized mammal (SBL9) category bears complete charring along with a distinct row of cut marks (Fig.

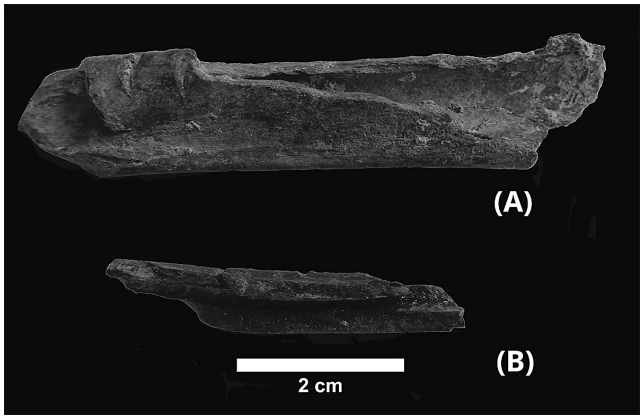

Fig. 17: Cut and charred marks on (A) a metacarpal of *Antilope cervicapra* and (B) a long-bone fragment of a medium-sized mammal

17B). From Khajeriapali, the only modified specimen is an Iron Age humerus fragment of *Bos/Bubalus* showing cut marks without evidence of charring. No cut-marked specimens were identified from Kumersingha. In addition to charring and cut marks, grinding-related working traces were identified on an antler of *Axis axis* (KJP9) from the Khajeriapali site (also see Fig. 8).

Osteometry

Recording bone measurements constitutes an important component of archaeozoological research, as systematically documented measurements provide a reliable basis for assessing the body size of past animal populations (Joglekar 2011). Accordingly, wherever preservation permitted, skeletal elements recovered from Khajeriapali, Subulia and Kumersingha were measured following the standard archaeozoological guidelines outlined by Driesch (1976). All measurements were recorded in millimetres using a digital calliper with a least count of 0.01 mm. The recorded data is presented in Table 9.

Only one estimation of cattle withers height could be derived, based on the medial length of an astragalus and calculated using the formula proposed by Zalkin (1970). The astragalus specimen recovered from the Iron Age level at Khajeriapali yielded an estimated withers height of 100.83 cm.

Discussion and Conclusion

The present study analysed a relatively small faunal sample from trial trenches and limited-scale excavations at Subulia, Khajeriapali, and Kumersingha in the Middle Mahanadi Valley. These restricted excavation areas limit the volume and diversity of recovered material, constraining detailed quantitative analyses of herd

Table 7: Bone modifications observed at Khajeriapali, Subulia and Kumersingha

Bone Modification/Sites	Subulia		Khajeriapali		Kumersingha	
	Frequency	%*	Frequency	%*	Frequency	%*
Completely Charred	18	16.5	-	-	1	2.30
Partially Charred	1	0.9	-	-	2	4.70
Cut Mark	5	4.6	1	0.98	-	-

*With respect of total NISP of each site

Table 9: Measurements from SBL, KJP and KMS

Reg No.	Trench	Depth (in cm)	Species	Bone	Measurements (in mm)
KJP1	KJP-I	0-10	*Bos indicus*	Astragalus	GLl=59.1, GLm=55.1, Bd=36.3, Dm=29.4, Dl=31.4
KJP2	KJP-I	0-10	*Boselaphus tragocamelus*	Metatarsal	Bd=38.0, Td=21.9
KJP3	KJP-I	0-10	*Bos indicus*	M1	Bp=25.9, Tp=32.5
KJP4	KJP-I	0-10	*Capra /Ovis*	Centrotarsal	Tp=23.9
KJP7	KJP-II	20-30	*Bos indicus*	First Phalanx	GL=50.3, Bp=21.8, Tp=25.5
KJP9	KJP-II	20-30	*Axis axis*	Antler	TL=80.5
KJP10	KJP-II	20-30	*Boselaphus tragocamelus*	Metatarsal	Bd=40.7, Td=21.2
KJP12	KJP-II	30-50	*Bos indicus*	First Phalanx	GL=53.8, Bp=22.71, Tp=25.5, Bd=20.9
SBL11	SBL	150-160	*Capra/Ovis*	M1/M2	L=27.4, W=17.2
SBL12	SBL	180-190	*Bos Indicus*	First Phalanx	GL=53.2, Bp=21.9, Tp=26.5, Bd=21.4
KMS4	KMS-I	110	Capra/Ovis	M1/M2	L = 16.1, W =10.2

L: Length, W: Width, GL: General Length, Bp: Breadth of Proximal end, Bd: Breadth of distal end, Td: Thickness of distal end; GLl: Greatest length of lateral side, GLm: Greatest length of medial side, Dl: Depth of lateral side, Dm: Depth of medial side, TL: Total length

composition, age structure, and economic specialisation. Interpretations thus remain preliminary, awaiting refinement from future large-scale excavations.

Despite these constraints, comparative faunal evidence reveals a coherent developmental pattern in human-animal relationships across the region. A comparison of the faunal spectra from Subulia, Khajeriapali, and Kumersingha reveals both continuity and shifts in taxonomic representation from the Chalcolithic to the Iron Age in the Middle Mahanadi Valley. The Chalcolithic phase at Subulia reflects an early village farming economy with a diverse spectrum, dominated by bovids (cattle/buffalo) and caprines (sheep/goat), supplemented by pigs, dogs, and minor wild taxa like nilgai and blackbuck, supported by on-site butchery (cut marks) and cooking (charring). This composition suggests a mixed agro-pastoral subsistence system with only minor reliance on hunting. In contrast, Iron Age assemblages across the sites show increasing concentration on large bovids and narrowing taxonomic diversity. Subulia's Iron Age sample remains extremely limited and taxonomically restricted to porcupine, likely due to deposition or preservation issues rather than economic shifts. Khajeriapali yields the largest Iron Age assemblage, dominated by large bovids, with caprines in smaller proportions. Kumersingha mirrors this bovine dominance across Early, Middle, and Late phases, with marginal caprines and virtually absent wild taxa; the Middle Iron Age phase indicates intensified bovid exploitation and possible agro-pastoral specialisation.

Overall, this modest dataset from small-scale excavations significantly advances understanding of animal exploitation trajectories in the Middle Mahanadi Valley. It documents a progressive shift from diversified Chalcolithic agro-pastoralism to structured Iron Age livestock orientation, mirroring broader settlement stability and economic evolution. Future work promises deeper insights into these adaptive dynamics.

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