

THE BIOARCHAEOLOGY OF MEGALITHIC MAHURJHARI: DENTAL AND SKELETAL ADAPTATIONS IN IRON AGE INDIA: PART 1

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Abstract: Mahurjhari is an Iron Age and Early Historic site in the Vidarbha region of western Maharashtra, 15 km. northwest of the city of Nagpur, India. The excavations at Mahurjhari were conducted in 1978-79, by Deccan College and directed by S. B. Deo. Human remains were recovered and subjected to bioarchaeological examination. Dental and skeletal variations at Mahurjhari are described here to better understand the diet, nutrition, health, and biological adaptations of these Iron Age denizens of Vidarbha. Fifteen burials yielded evidence of 28 individuals, yet not all were suited to analysis. Demographic analysis revealed equal representation by sex (5 males, 6 females), though sex was indeterminate for 10 skeletons. Age at death ranged between 10 and 32 years and is similar for both sexes. Dental analysis focused on wear, morphology, crown size, and pathology. Lingual surface abrasion of anterior teeth and micro-chipping of post-canine teeth (66.7 per cent of individuals) are associated with large tooth size. Dental caries are moderate in frequency (53.3 per cent individuals; 7.7 per cent teeth), suggesting a refined diet that included carbohydrates. Dental chipping implies that meat was also part of the diet. Dental crowding and impacted canine and molar teeth indicate that teeth developed in constrained jaw space. Reduced masticatory stress and thorough food processing impacted dental variation. Skeletal robusticity is evident in upper and lower limbs. Humeri lack perforation of the olecranon fossae and femora are bowed and exhibit a developed linea aspera (pilaster). Anterior-posterior bowing of the femoral diaphysis may result from nutritional deficiency in childhood, but in association with a strong pilaster it suggests biomechanical stress as in horseback riding. Mahurjhari is similar to megalithic Kodumanal in demography (few sub-adults), tooth wear (dental chipping) and post-cranial robusticity. Yet differences, including larger tooth size and higher caries at Mahurjhari are also evident.

Keywords: Tooth wear, Dental morphology, Tooth size, Dental pathology, Osteometry, Skeletal morphology, Biological variation

Introduction¹

Mahurjhari is an Iron Age and Early Historic site in the Vidarbha region of western Maharashtra (latitude 21°, 14' East; longitude 79°, 30' North), 15 km. north-west

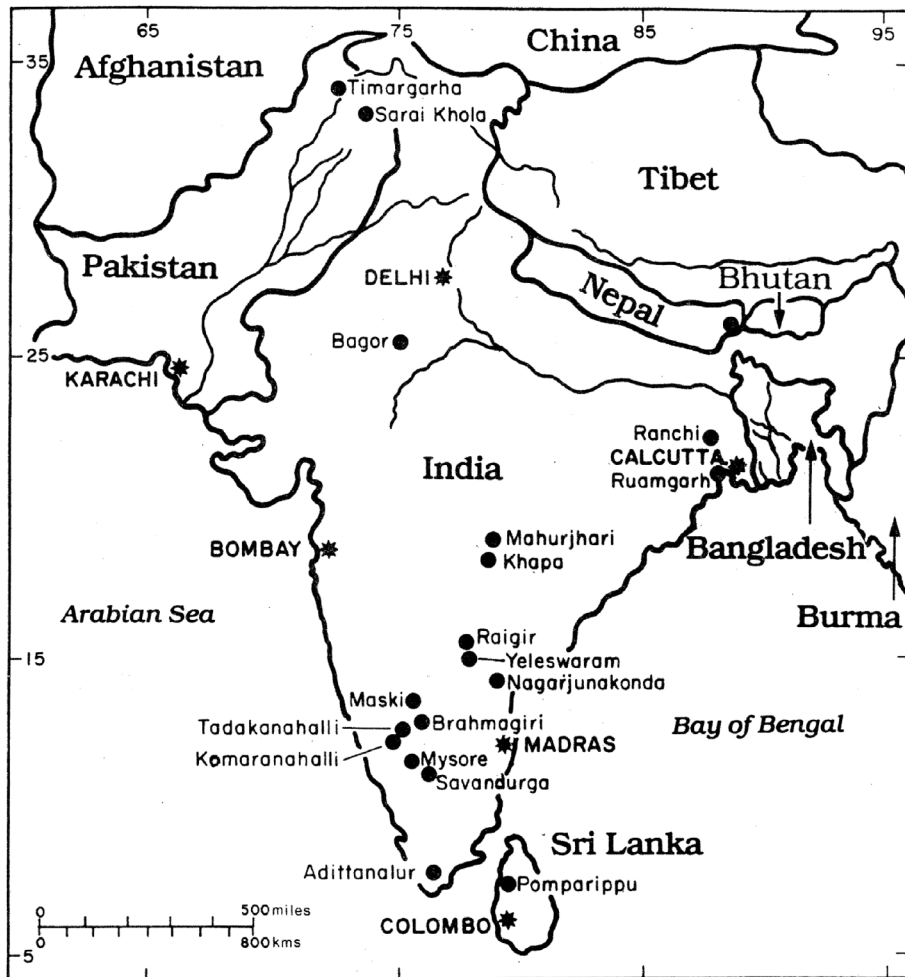


Figure 1: Location map: Iron Age sites with human skeletal remains.

of the city of Nagpur in Nagpur District, India (Fig. 1). The site is marked by 150 or more stone circles of different sizes, each embracing an area containing human burials and pottery. It is virtually a continuation of the adjacent Janipani site which has over 300 stone circles and artifacts associated with the Iron Age and Early Historic Period. In 1855, William Wilson Hunter collected beads, a sculptured clay female figure, and pottery artifacts of which most are now associated with the Early Historic Gupta-Vagataka period at Janipani and Mahurjhari (Deshpandi, 1933). Janipani was visited by J.H. Rivett-Carnac (1879) nearly a century later. However, neither explorer described the stone circles at Mahurjhari across the

road, the construction of which resulted in the loss of some mounds, stone circles and associated cultural contents. Credit for the first published account of South Asian megalithic structures goes to J. Babington (1823) of the Bombay Civil Service in 1820.

The lifeways of these Iron Age village communities included a dependence upon certain domestic plants and animals. These included wheat (*Triticum dicoccum*, *T. compactum*, *T. t. aestivum*, *T. compactum*, *T. aestivum*), and barley (*Hordeum vulgare*). Domesticated and semi-wild fauna included deer (*barasingha*, *Cervus duvaceli*), sheep (*Ovis aries*), Zebu cattle and related species (*Bos bubulus*), and horses (*Equus caballus*). By tracking the seasonal distributions and animals at certain times of the year, these prehistoric peoples underwent migrations often in response to climatic and biotic shifts (Meadow, 1996).

Recent analysis of new faunal remains of wild and domestic mammalian species and of invertebrates from Iron Age and early historic levels at Mahurjhari yielded new insights on subsistence, diet, tool use, and environment of this megalithic population (Deshpande-Mukherjee et al., 2010).

G.A.P. Hunter (1933) published a detailed account of the artifacts he had collected at Mahurjhari in 1933, but the beads, seals, pottery and baked bricks are not directly correlated with the prehistoric stone circles. It was not until the field seasons of 1970-1971, 1971-1972, and 1975-1976, that the megalithic structures of the site were excavated by qualified archaeologists from Nagpur University and Deccan College, Pune (Deo, 1973). The initial field season of 1970 was led by S.B. Deo (1973). Some 28 human skeletons were encountered within the megalithic structures and mounds, each circumscribed by a ring of large boulder-size stones (Fig. 2).



Figure 2: Mahurjhari: megalithic stone circle.



Figure 3: Double burial. Mahurjhari Megalith 9, Burial 6, Locality III (Deo, 1973).

These structures had diameters in the range of 11.30 to 18.20 m. The often fragmented state of skeletal preservation in some of the burials excavated by Deo is illustrated in Figure 3 (double burial number 6, megalith 9, Locality III). A catalogue of the skeletons recovered from these earlier excavations was prepared by Rao (1973; Rao and Vasula, 1985).

The earliest excavation of the site was conducted in the 1970-1972 field seasons (Deo, 1973). Excavations at Mahurjhari were resumed by Deccan College in 1978-79 under the direction of S. B. Deo (Table 1, Appendix A). Lukacs (1981) examined the Mahurjhari dental remains in 1979, shortly after their excavation; while Kennedy analyzed the skeletal remains in 1980 and 1988. These studies included comparative data from other Iron Age sites with prehistoric human skeletal remains discovered within the Indian subcontinent (Kennedy, 1975). Since that time, many new Iron Age and Early Historic sites have yielded additional burials (Muchrif-Tripathy et al., 2011; Walimbe et al., 2011). Two Mahurjhari skeletons were found in a single burial and three in another. Relatively complete supinely extended skeletons were interred in the mounds, although some were severely crushed by the soil overburden. Skulls were positioned to the North and feet pointed South. Habitation areas do not occur within the stone circles and mounds. Along with human and horse (*Equus caballus*) bones and teeth were iron and copper objects, beads of semiprecious stones, horse equipment, a micaceous Red Ware and Black-and-Red Ware. Plant seeds provide further evidence of an agricultural-herding lifeway, but these are scanty at Mahurjhari. This suggests that in the dry environment of the site, which

Table 1: Archaeological context of Mahurjhari burials².

	<i>MHR Excavations 1979</i>	<i>Northwest Quadrant</i>
Burial 1	Megalith Number 7	Date: 18 February 1979
	Material: bone-human	
Burial 2 ¹	MHR Excavations 1978-79	Northeast Quadrant
	Megalith Number 3	Date: 20 February 1979
	Material: bone-cranium	
Burial 3	MHR Excavations 1979	Northwest Quadrant
	Megalith Number 8	Date: 20 March 1979
	Material: bone-mandible	
Burial 3a	MHR Excavations 1979	Northwest Quadrant
	Megalith Number 8	Date: 20 March 1979
	Material: bone-skull of a child?	
Burial 4	MHR Excavations 1979	Southwest Quadrant
	Megalith Number 8	Date: 18 March 1979
	Material: bone-human	
Burial 5	MHR Excavations 1978-79	Southeast Quadrant
	Megalith Number 3	Date: 23 February 1979
	Material: bone-cranium	
Burial 6	MHR Excavations 1979	Southwest Quadrant
	Megalith Number 3	Date: 19 March 1979
	Material: bone-skull	
Burial 6a	MHR Excavations 1979	Southwest Quadrant
	Megalith Number 3	Date: 18 March 1979
	Material: bone-skull (human)	
Burial 7	MHR Excavations 1979	Southwest Quadrant
	Megalith Number 3	Date: 18 March 1979
	Material: bone-mandible (human)	
Burial 8	MHR Excavations 1979	Southeast Quadrant
	Megalith Number 9	Date: 18 March 1979
	Material: bone-skull	
Burial 9	MHR Excavations 1979	Northeast/Southwest Quadrant
	Megalith Number 10	Date: 29 March 1979
	Material: skull with mandible	
Burial 10	MHR Excavations 1979	Southwest Quadrant
	Megalith Number 5	Date: 18 March 1979
	Material: mandible (human)	right half

	<i>MHR Excavations 1979</i>	<i>Northwest Quadrant</i>
Burial 11	MHR Excavations 1979	Northwest Quadrant
	Megalith Number 5	Date: 20 March 1979
	Material: skull bones / mandible	
Burial 13	MHR Excavations 1978-79	Northwest Quadrant
	Megalith Number 29	Date: 20 March 1979
	Material: bone and teeth	

¹Note: Burial 2a does not appear in this list; it identifies a second individual from Burial 2.

²Burial numbers 1 through 13 are referenced in the dental section as MHR 1 through MHR 13.

was not near rivers, streams or lakes, made farming a challenge for the inhabitants. The megalithic structures at Mahurjhari contained funerary goods similar to those found at the Takalghat-Khapa, also in the Vidarbha region. This Iron Age site was radiocarbon dated from the sixth to seventh centuries B.C. (Deo, 1973; Ghosh, 1989: 2: 269). The earliest excavations of Takalghat-Khapa were conducted in 1970-1972 (Deo, 1973).

Of the 28 human skeletons mentioned in the archaeological reports of Mahurjhari, 18 to 20 skeletons were sufficiently preserved and available for study by the authors. They were excavated in 1979. The 15 catalogue numbers given in the Lukacs and Kennedy records are 1, 2, 2a, 3, 3a, 4, 5, 6, 6a, 7, 8, 9, 10, 11, and 13. Details regarding the excavation of burials analyzed in this report are provided in Table 1. Date of excavation, megalith number, quadrant from which skeletal remains were recovered and an initial field identification of skeletal elements are listed. The data in Appendix A (below) were recorded by Lukacs in 1979, from field tags accompanying excavation bags and boxes of human remains from Mahurjahri.

Table 2: Burials listed by megalith

<i>Megalith number</i>	<i>Burial numbers</i>
3	2, 2a, 5, 6, 6a, and 7
5	10 and 11
7	1
8	3, 3a, and 4
9	8
10	9
29	13

In some megaliths more than a single individual was present: Burials 2, 3, 6a and 7 at Megalith 3; Burial numbers 10 and 11 at Megalith 5; Burials 3, 3a, and 4 at Megalith 8. The burials in Megaliths 7, 9, 10, and 29 appear to contain the

graves of single individuals. Table 2 provides a list of burials excavated from each megalith at Mahurjhari. A preliminary catalogue of skeletal elements associated with each burial excavated in 1979 was prepared by Lukacs and is provided in Appendix A. The dentition of the Mahurjhari series was studied by Lukacs in 1979, and an analysis of dental pathology permitted new inferences regarding dietary adaptations and variations in Iron Age India (Lukacs, 1981). Kennedy (2000: 350-352) summarized his observations on the metrical and morphological variables of cranial and postcranial bones from the site.

The present authors describe all of the osseous and dental remains available to them; any additional specimens reported by Rao are not included in this study. This study is divided into two main sections: dental anthropology and human osteology. The investigation of dental variation was conducted and written by Lukacs, while observations and measurements on cranial and post-cranial skeletal remains were made by Kennedy who authored the second section of the report.

PART I: DENTAL ANTHROPOLOGY²

Adaptation and behavior from tooth wear, morphology, odontometry and pathology

In the study of South Asian prehistory evidence derived from attributes of the teeth provide valuable insights into the health status, dietary patterns and biological adaptations of earlier human populations. The monsoon climate of the Indian subcontinent presents extremes in temperature and humidity that have dire consequences for preservation of human skeletal remains (Lukacs, 2007). In human burials from Iron Age megalithic sites of central and southern India, bones are subjected to such forces frequently resulting in fragmented and incomplete skeletons. Due to the greater mineralization of teeth and the higher density of bone in the jaws, teeth and their supporting structures are less severely impacted by detrimental effects on preservation caused by monsoon climates. This difference in preservation makes the dentition of past populations especially informative regarding health and nutrition, biological relationships, and adaptations to past environments.

An earlier analysis of the dental pathology of the Mahurjhari skeletal series included observations on dental caries, enamel hypoplasia, antemortem tooth loss (AMTL) and alveolar recession (Lukacs, 1981). Low rates of AMTL and alveolar recession were associated with moderate caries frequency and several features (canine suppression, impacted M₃, overbite, and dental crowding) that suggest relaxation of functional demands on the masticatory apparatus. This report expands upon this prior analysis by documenting in greater detail the preservation, dental attrition, tooth crown morphology, odontometry, and dental pathology

of the Mahurjhari skeletal series. The motivation for this analysis of the dental anthropology of Mahurjhari is to gain clearer insight into the biological adaptations of the megalith builders of central India. Data presented here fit within a more extensive literature on the bioarchaeology of Iron Age megalith builders as briefly reviewed below.

Reports on the dental anthropology of Iron Age and Megalithic skeletal samples appear frequently in the literature and include observations on dental wear, pathological lesions, tooth size and dental morphology. Typically observations are limited in scope and suffer from small sample size due to incomplete preservation and the isolated nature of dental elements. For example, a descriptive report on human remains from the sites of Borgaon, Khairwada, and Raipur (Vidharba, Maharashtra), includes comments on the dental pathology and odontometry of two specimens, one from Borgaon (megalith 7), another from Raipur (number 2; megalith 1) (Walimbe, 1987-88, 1991). Dental pathology and odontometry were included in Kennedy's (2002) analysis of seven fragmentary and incompletely preserved specimens from the megalithic site of Pochampad (Andhra Pradesh). Skeletal remains recovered from a sarcophagus burial at Kudatini ash-mound in mid-eastern Karnataka (Bellary District), included deciduous and permanent teeth that were measured and observed for morphological traits and pathological lesions (Muschrif-Tripathy et al., 2002). Remains of two individuals, an adult and a child 7 years of age, were excavated from within and nearby a sarcophagus at Kanyathirtham (Cuddapah District, Andhra Pradesh; Walimbe et al., 1991). The developmental stage of tooth calcification of the child and measurements of primary and permanent teeth were included in this report. The rediscovery and description of additional human remains from megalithic Raigir, near Hyderabad (Andhra Pradesh; Kennedy, 1990), added significant new osteometric and dental data to the original series of six calvariae previously described by Kennedy (1965).

Previously undescribed megalithic skeletal series recovered from carin circles, cysts and sarcophagi at Iron Age sites of Agripalli, Kadanpur, Tenner and Veerabyine Kunta, add new data on the skeletal variations and dental adaptations of megalith builders (Walimbe et al., 2011).

Another significant contribution to the advancement megalithic and early historic bioarchaeology in South Asia is the excavation and analysis of 15 individuals from the megalithic site of Kodumanal (Tamil Nadu; Muschrif-Tripathy et al., 2011). The dental anthropology of this series included an analysis of 191 teeth (22 primary and 169 permanent) from 13 individuals which included dental remains. The dental analysis is thorough and includes descriptions of dental attrition, tooth crown morphology, odontometry and dental pathology. The treatment of

'pathology' is broad in scope and includes attention to dental crowding, enamel hypoplasia, maxillary sinusitis, asymmetry of dental development and tartar (calculus) deposits. In addition, all traits were observed in adherence to established international standards of dental anthropology. Dental observations on megalithic skeletons from Kodumanal provide an ideal dataset for the comparative assessment of the Mahurjhari dentition. The comparative analysis is presented following the specimen descriptions, in the Analytic Summary and Comparative Perspectives section of this report.

This analysis of the dental characteristics of the Mahurjhari skeletal series was conducted during the summer of 1979, with support from the Indo-American Fellowship Program. A description and interpretation of the dental pathology of this collection was published previously (Lukacs, 1981), therefore this report focuses primarily on the descriptive and comparative investigation of tooth wear, dental morphology and crown dimensions of the Mahurjhari skeletal series.

The specimens described here were recovered by Dr. S. B. Deo in 1979 during renewed excavations at Mahurjhari. Earlier excavations at this site were conducted in 1970-72 (Deo, 1973), and the final report of those earlier excavations includes preliminary observations on the human skeletal remains and dentition (Rao, 1973). Dental and gnathic structures of the 1979 Mahurjhari skeletal series were unpacked, catalogued and prepared by me and my assistants between June 15 and July 9, 1979. A preliminary catalogue of human skeletal and dental remains was compiled as storage bags and boxes were unpacked and inventoried prior to analyzing the dentition (Appendix A). The non-dental osteological remains, cranial and post-cranial bones, were stored for later analysis by Kenneth A. R. Kennedy. This analysis of dental pathology and morphology and crown dimensions of the teeth was completed between July 11 and August 23, 1979.

Notes made during the course of study included the state of preservation of the dental and gnathic structures, dental morphology and pathology, dental attrition and crown dimensions. The report on dental anthropology of Mahurjhari is divided into two main sections, descriptive and comparative. The descriptive section presents individual data for each specimen in the Mahurjhari skeletal series. The comparative section summarizes and then compares the data on dental wear, morphology, odontometry, and dental pathology with data from other prehistoric skeletal series in South Asia, including Kodumanal.

The dental sample on which this study is based consists of 211 permanent teeth from sixteen individuals. The representation of teeth by jaw, tooth class and specimen is provided in Table 3. This dental sample is heavily biased in favor of post-canine teeth; premolar and molar teeth comprise 74.4% (157/211) of the sample. By

contrast, anterior teeth - incisors and canines - make up just 25.6% (54/211). This uneven distribution of dental elements is significantly different from the expected proportion of anterior vs. posterior teeth ($\chi^2=9.438$, 1 df; $p = 0.0021$). Post-canine teeth are over-represented compared with expectation and compared with the proportion of anterior teeth. This is an important consideration as anterior and post-canine teeth are differentially susceptible to cariogenesis and accurate estimates of caries prevalence should be presented separately for anterior and posterior teeth (Duyar and Erdal, 2002).

Dental and gnathic remains alone do not provide conclusive or precise age and sex estimates for all specimens and must be interpreted with caution and in conjunction with evidence derived from the skeleton. Details on demographic aspects of this series are provided

Table 3: The Mahurjhari Dental Sample by Specimen, Tooth Class and Jaw

Specimen Number	Jaw	Tooth Class				Number of teeth per jaw	Total teeth per specimen
		Incisor	Canine	Premolar	Molar		
1	U	4	2	4	3	13	29
	L	4	2	4	6	16	
2	U	0	0	0	2	2	15
	L	3	2	3	5	13	
2(a)	U	0	0	1	2	2	4
	L	0	0	0	2	2	
3	U	3	2	4	6	15	23
	L	0	1	2	5	8	
3(a)	U	2	1	3	4	10	18
	L	3	1	1	3	8	
4	U	0	1	0	0	1	8
	L	1	0	2	4	7	
5	U	0	0	1	1	2	7
	L	0	1	2	2	5	
6	U	0	0	0	6	6	10
	L	0	0	0	4	4	
6(a)	U	2	1	2	4	9	16
	L	0	2	1	4	7	
7	U	1	1	2	3	7	21
	L	3	1	4	6	14	
8(a)	U	0	1	2	4	7	11
	L	0	0	0	4	4	
8(b)	U	1	0	1	1	3	3
	L	0	0	0	0	0	

Specimen Number	Jaw	Tooth Class				Number of teeth per jaw	Total teeth per specimen
		Incisor	Canine	Premolar	Molar		
9	U	1	2	4	3	10	15
	L	0	1	2	2	5	
10	U	0	0	0	0	0	5
	L	0	1	2	2	5	
11	U	1	1	0	5	7	17
	L	0	0	4	6	10	
13	U	1	0	1	2	4	9
	L	0	0	1	4	5	
Subtotals	U	16	12	25	45	98	
	L	14	12	28	59	113	
Grand Total		30	24	53	104	211	7.03

by Kennedy in the skeletal analysis section of this study. The dental data independently suggest that specimens MHR 3 and MHR 6(a) are female and that specimen MHR 2 is male; observations consistent with determination of sex from the skeleton (see Summary of Osteological Analysis, below).

Methodology

The analysis of tooth wear, morphology, odontometry, and pathology follow different yet interdependent sets of methods. Tooth wear includes removal of dental tissues (enamel and dentine) from the crown and includes attrition (tooth - tooth contact) and abrasion (tooth contact with food, foreign elements in food, or non-food items). Normal tooth wear affects both occlusal and interproximal surfaces of the crown and is a gradual incremental process resulting in a smooth, cupped or rounded surface (Hillson, 1996; Kieser, 1990). Tooth wear is described qualitatively with attention given to formation of enamel wear facets, exposure and wear of dentine, and penetration of the pulp chamber. Micro-fracture of enamel or dental chipping is defined as failure of enamel to sustain high pressure stress resulting in a jagged, irregularly shaped scar or chip in the enamel surface (Scott and Winn, 2011). Dental chipping was systematically observed and the affected tooth, the size and the location of chipped enamel was recorded. Unique patterns of occlusal surface wear, or unusual patterns of wear on adjacent teeth, isomers, or antimeres are described and possible causal factors are considered.

Morphological traits of the tooth crown were documented when preservation of the outer enamel permitted accurate assessment of morphological detail. Observations of anterior tooth morphology were limited by the combined effects of poor preservation and dental wear. Shoveling of maxillary incisors followed a

four grade classification: full, semi-, trace, absent (Hrdlička, 1920). Basic traits of maxillary and mandibular molar teeth were classified according to established standards. Variation in hypocone size in maxillary molar teeth was evaluated according to Dahlberg's (1951) graded four-fold classification (full-sized hypocone = 4; a reduced, but large hypocone = 4-, hypocone represented by a small cusplet = 3 +; and hypocone absent = 3). Mandibular molar cusp number is the total number of prominent independent cusps on the occlusal surface of the tooth crown. Fissure patterns were classified into one of three options, Y, +, and X according to Hellman's (1928) distinction of the primitive *Dryopithecus* (Y) groove from the plus (+) groove pattern. Recognition of the X pattern follows Jørgensen's (1955) recommendation in his study of Danes and Dutchmen. These classifications of tooth morphology are consistent with current standards, and a concordance for different scales of gradation may be found in (Scott and Irish, 2017; Scott and Turner, 1997; Turner et al., 1991).

Odontometric methods of determining tooth crown size include two key measurements: mesiodistal (MD) and buccolingual (BL) dimensions. Often referred to as length, the MD dimension is the maximum distance of the crown parallel to the occlusal and labial surfaces of the crown. The buccolingual dimension, or crown breadth, is measured at right angles to the MD dimension. MD and BL are conventionally recorded in millimeters (mm). These primary odontometric variables are combined into compound variables or indices to provide rough approximations of tooth crown size and shape. The crown area (CA) an estimate of occlusal surface area is the product of length and breadth (MD x BL) and is noted in millimeters squared (mm²). Two additional composite indicators of tooth crown shape are the crown module $[(MD+BL) / 2]$ or the average of length and breadth measurements, and crown index $[(BL/MD) \times 100]$ or breadth divided by length multiplied by 100 (Kieser 1990). The analysis of dental pathology followed procedures similar to those recommended by Hillson (2008) and Lukacs (2012). The systematic specimen descriptions that follow are organized in a sequence that gives attention to: a) state of preservation, b) assessment of dental wear, c) morphological traits, d) odontometry, and e) dental pathology.

Specimen Descriptions

Specimen 1 (MHR 1)

Preservation: The teeth of this individual are well-preserved though the maxilla and mandible have suffered moderate post-mortem deformation. All sixteen teeth of the lower jaw are present though RM₁ exhibits extensive decay of the crown and LM₁ was severely damaged post-mortem. Warping of the symphyseal region and

lateral eversion of the horizontal rami produces and unnaturally broadly arched mandibular arcade.

The maxilla was subject to the same diagenetic factors as the mandible, but since three of the molar teeth are missing (RM^2 , RM^3 , and LM^3) post-mortem warping appears greater than in the mandible. The anterior portion of the maxilla, especially in the sub-nasal region, is depressed and alveolar bone has broken away revealing the roots of the anterior teeth. This sub-nasal deformation is post-mortem and resulted in labial displacement of the crowns of anterior teeth, particularly of RI^1 and LI^1 . This produces an artificial appearance of alveolar prognathism and incisor procumbency.

Tooth wear: The degree of dental wear exhibited by this individual is quite low and suggests an age at death between 18 and 30 years - young adult. Minimal amounts of dentine are exposed on the occlusal surfaces of molar teeth. The left half of the dental arcade is more worn than the right and may be related to caries of RM_1 and subsequent shift of masticatory function to the left side of the dental arcade. The wear differential, left *vs.* right, is most clearly evident in central incisors, canine and first molar teeth.

The lingual surface of maxillary incisor teeth exhibit evidence of moderate dental wear. Enamel is missing and dentine exposed over much of the lingual surface of the LI^1 , RI^1 and RI^2 . This includes large areas of dentine exposure in the region of the basal tubercle. Though an overbite may have been present in this individual, the exaggerated degree of anterior tooth wear cannot be explained by occlusion alone. The labial surface of lower incisors exhibit no corresponding evidence of heavy dental attrition. This wear pattern is similar to that described by Turner and Machado (1983) as 'lingual surface attrition of maxillary anterior teeth' (LSAMAT). In conjunction with high caries, this wear pattern was associated with carbohydrate consumption in an archaic Brazilian skeletal series. A unique occupational or habitual use of the maxillary incisors may be responsible for the unusual labial surface wear of these teeth.

Several chipped teeth are present in this specimen, all maxillary: RP^3 , RP^4 , and LM^1 . In each case the enamel chip / scar is on the buccal aspect of the tooth crown and along the margin of the occlusal surface. In LM^1 the scar is on the mesio-buccal cusp and is of moderate size.

Morphology: Mandibular incisors are completely normal in their anatomical features. Shoveling, lingual tubercles and ridges are absent. The medial margins of RLI_1 are inverted. This appears to be natural but the possibility of post-mortem deformation cannot be excluded with certainty. Mandibular canines are incisiform and lack robustness, tubercles and lingual ridges. Mandibular premolars are

Table 4: Morphology of Mandibular Molars (cusp number / groove pattern)

Specimen Number	Left			Right		
	M3	M2	M1	M1	M2	M3
1	5 / X	4 / --	-- / --	-- / --	4 / +	4 / --
2	5 / +	4 / +	5 / Y	5 / Y	4 / Y	-- / --
2a	-- / --	4 / +	-- / --	-- / --	-- / --	-- / --
3	4 / X	4 / +	4 / Y	5 / Y	4 / +	-- / --
3a	-- / --	-- / --	5 / +	5 / Y	5 / +	-- / --
4	-- / --	4 / X	5 / Y	5 / Y	4 / +	-- / --
5	-- / --	-- / --	-- / --	-- / --	4 / +	4 / +
6	-- / --	4 / +	-- / --	4 / Y	4 / +	4 / +
6a	6 / X	-- / --	-- / --	5 / Y	4 / Y	6 / X
7	4 / +	4 / +	5 / Y	5 / Y	5 / Y	4 / +
8a	-- / --	4 / X	5 / Y	5 / Y	5 / Y	-- / --
9	-- / --	4 / +	5 / --	-- / --	-- / --	-- / --
10	-- / --	-- / --	5 / Y	-- / --	-- / --	-- / --
11	4 / X	4 / +	5 / Y	5 / Y	4 / Y	4 / +
13	-- / --	4 / +	5 / Y	-- / --	4 / +	4 / +

approximately round in outline and bicuspid. The lingual cusps are smaller in RLP₃ than in RLP₄. The distal margin of LP₄ is affected by heavy interstitial (approximal) wear from LM₁.

The first lower molars preserve no morphological features; the right crown is destroyed by caries, the left crown badly damaged post-mortem. RLM₂ are rectangular in outline. LM₂ exhibits four cusps but since the central forea of the crown is affected by caries the groove pattern cannot be discerned. The occlusal surface of RM₂ is well-preserved and has four cusps and a plus (+) groove pattern. Right and left mandibular third molar teeth are asymmetric in size, orientation of the crown and in morphology (see Fig. 4). The crown of RM₃ is particularly unusual; the buccolingual diameter is greater than the mesiodistal crown diameter and though four distinct cusps are present, their arrangement is atypical. No typical occlusal groove pattern can be discerned. The occlusal surface of LM₃ exhibits a cross (X) groove pattern and five cusps. Cusp number and groove pattern of mandibular molars are listed in Table 4 for MHR 1 and all Mahurjhari specimens.

Maxillary incisors exhibit a trace of shoveling as lingual ridges on the distal margins of right and left central incisors. These ridges are best discerned when viewed from the incisive edge. Wear of the lingual surfaces of maxillary incisors has



Figure 4: MHR 1. a) maxillary and b) mandibular (b) dentition. Note lingual surface attrition of maxillary anterior teeth and chipping of the buccal surfaces of RP^3 and RP^4 , and of the mesio-buccal cusp of LM^1 . Hypocone size reduction from LM^1 to LM^2 is evident. In the mandible (b) crowding of anterior teeth, carious destruction of RM_1 and large caries in LM_2 are visible. Note asymmetry in morphology and shape of third molar crowns.

erased evidence of a more developed expression of shovel-shape. This wear pattern is discussed in greater detail below and precludes assessment of lingual tubercle development and interruption grooves in the central incisor teeth. Maxillary lateral incisors are not shovel-shaped, but lingual surface wear makes judging this trait's expression difficult. A faint crease is visible at mid-crown on the mesial aspect of lingual surface of LI^2 and is evidence of a marginal interruption groove. This trait cannot be assessed with certainty in the RI^2 , due to lingual surface wear. Maxillary canines are moderately robust and normal in crown morphology. Faint traces of lingual ridges are evident on the mesial and distal margins of LC^1 but are absent

on RC¹. Maxillary premolars are all bicuspid with buccal cusps larger and more elevated than lingual cusps. They are oval in outline and exhibit no exceptional morphological features.

Maxillary molar teeth are all four-cusped and quadrilateral in outline. Well-developed hypocones are present on the RLM¹ and are classified as grade (4) of Dahlberg. The LM² is compressed anterior-posteriorly and has a smaller hypocone than LM¹. Both these factors contribute to a compressed shape of the crown - buccolingually broad and mesiodistally narrow. Morphological data for maxillary molars of MHR 1 are presented in Table 5, together with data for all Mahurjhari specimens with discernible upper molar morphology.

Table 5: Crown Morphology of Maxillary Molar Teeth Cusp Number and Hypocone Size

Specimen Number	Left			Right		
	M3	M2	M1	M1	M2	M3
1	--	3+	4	4	--	--
2	4	--	--	--	4	--
3	3	3	4	4	3	3
3a	--	3+	4	4	3+	--
5	3	--	--	--	--	--
6	3+	4-	4	4	3+	3+
6a	4-	3	4-	4-	--	--
7	--	4-	--	--	4-	3+
8	--	3+	4	4	3+	--
9	--	--	--	4	4-	4-
11	3	3	--	4	4-	3
13	--	--	--	--	3+	3

Odontometry: The dental crown dimensions and indices for MHR1 are provided in Table 6, along with odontometric data for all specimens with measurable tooth crowns. Tooth crown indices are listed in Table B-1 (Appendix B). The unusual coronal shape of RM₃ is reflected in its aberrant dental index value (90.00). A statistical and comparative analysis of these data follows the specimen descriptions section of this report.

Pathology: The maxillary dentition of MHR 1 is free from caries, but there are several instances of caries in the mandibular teeth. The most conspicuous case is a large carious lesion on the central fovea of the occlusal surface of LM₂. This has proceeded to destroy much of the dentine in this region of the tooth. Two additional

Table 6 (cont'd): Tooth Crown Measurements: Mesiodistal (MD) and Buccolingual (BL)

spec no		MHR 7		MHR 8A		MHR 9		MHR 10		MHR 11		MHR 13	
tooth		MD	BL	MD	BL	MD	BL	MD	BL	MD	BL	MD	BL
maxilla													
I ¹	R	--	--	--	--	--	--	--	--	--	--	--	--
	L	--	--	--	--	--	--	--	--	--	--	--	--
I ²	R	--	--	--	--	--	--	--	--	7.3	6.2	--	--
	L	7.3	--	--	--	6.0	6.2	--	--	--	--	6.8	6.3
C ¹	R	--	--	--	--	6.7	8.0	--	--	7.3	8.5	--	--
	L	7.9	8.7	8.2	9.1	--	8.0	--	--	--	--	--	--
P ³	R	--	--	7.4	9.8	6.4	9.2	--	--	--	--	--	--
	L	--	--	--	--	--	9.3	--	--	--	--	--	--
P ⁴	R	6.0	10.0	7.5	9.9	6.2	9.0	--	--	--	--	6.5	9.6
	L	7.2	9.6	--	--	--	--	--	--	--	--	--	--
M ¹	R	--	--	10.6	12.3	10.8	11.1	--	--	10.2	11.3	--	--
	L	--	--	10.7	12.1	--	--	--	--	--	--	--	--
M ²	R	8.8	10.4	10.0	11.1	8.5	10.0	--	--	9.7	11.5	9.3	10.7
	L	8.8	10.2	10.4	10.9	--	--	--	--	9.3	10.8	--	--
M ³	R	8.9	11.5	--	--	9.7	10.7	--	--	8.6	10.2	8.7	11.6
	L	--	--	--	--	--	--	--	--	8.8	11.0	--	--
mandible													
I ₁	R	5.6	6.4	--	--	--	--	--	--	--	--	--	--
	L	5.6	6.4	--	--	--	--	--	--	--	--	--	--
I ₂	R	--	--	--	--	--	--	--	--	--	--	--	--
	L	--	--	--	--	--	--	--	--	--	--	--	--
C ₁	R	--	--	--	--	--	--	--	--	--	--	--	--
	L	7.0	8.0	--	--	6.3	7.6	--	--	--	--	--	--
P ₃	R	7.2	8.1	--	--	--	--	--	--	6.9	7.4	6.9	8.3
	L	7.2	8.5	--	--	6.6	8.3	--	--	7.0	7.5	--	--
P ₄	R	7.5	7.6	--	--	--	--	--	--	7.3	8.0	--	--
	L	6.9	8.0	--	--	7.3	8.6	--	--	7.1	8.2	--	--
M ₁	R	11.8	10.7	11.9	10.6	--	--	--	--	11.7	10.8	--	--
	L	11.2	10.4	11.9	10.6	11.0	10.7	11.4	10.4	11.8	10.5	11.4	10.5
M ₂	R	10.8	10.3	12.2	10.2	--	--	--	--	10.7	10.1	10.5	10.2
	L	10.5	9.9	11.9	9.9	10.1	9.6	--	--	11.0	10.3	10.6	10.2
M ₃	R	11.0	9.4	--	--	--	--	--	--	11.3	10.1	10.3	10.2
	L	10.8	9.4	--	--	--	--	--	--	11.1	10.3	--	--

sites of the nascent carious activity are the buccal surfaces of RM₂ and LM₃. These teeth exhibit small carious lesions in the buccal furrow of the crown. The entire crown of RM₁ was destroyed by caries. The smooth, cup-shaped appearance of the roots which are preserved in their normal anatomical position indicate carious destruction of the crown. Some slight degree of alveolar resorption has occurred along the posterior margin of RM₁ and the anterior margin of RM₂. This resorption may or may not be related to the carious decay of RM₁. Gross enamel hypoplasia is clearly evident in the maxillary and mandibular dentition of this specimen. The canine teeth of both upper and lower jaws are most severely affected, but lateral incisors and premolars are affected, though to a lesser degree.

Specimen 2 (MHR2)

Dental and gnathic remains of two individuals were preserved in Burial 2, for convenience these have been labeled MHR 2 and MHR 2a.

Preservation: The state of preservation of MHR 2 is good and though the mandible was found in six separate pieces, it is nearly complete (Fig. 5). The specimen consists of a complete mandible, four isolated lower molar teeth and two isolated upper molar teeth. The six mandibular fragments could easily be reconstructed into a nearly complete lower jaw.

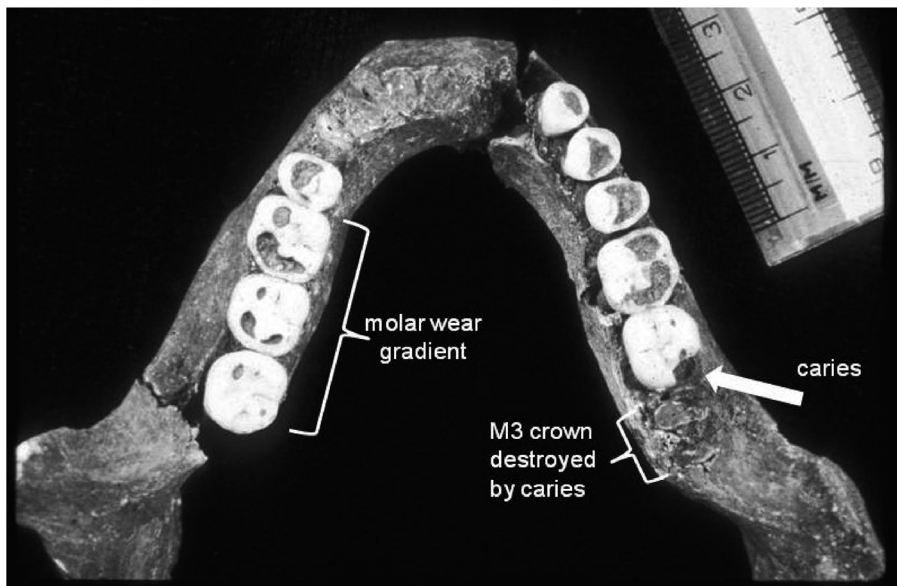


Figure 5: MHR 2. mandible, superior view. Note: state of preservation, wear gradient of left molar row, disto-buccal caries of RM₂, missing RM₃ due to extensive caries (only roots remain).

- 1) Right horizontal and ascending ramus retaining the crown of RM_2 and the roots of RM_3 . The coronoid process and mandibular condyle were broken away post-mortem.
- 2) Right horizontal ramus retaining the crown of RC_1 , RP_3 , RP_4 , and RM_1 .
- 3) Left mandibular corpus with the roots of LI_1 , LI_2 , LC_1 and LP_3 clearly visible and the crown of LP_4 , LM_1 , LM_2 and LM_3 in position. This fragment is broken at the distal margin of the LM_3 .
- 4) Left gonial region and posterior margin of the left ascending ramus.
- 5) Anterior border of the left ascending ramus with the coronoid process well-preserved.
- 6) Left mandibular condyle.

The left ascending ramus and mandibular corpus have suffered minimal post-mortem distortion. The right corpus is damaged inferior to RC_1 , the inferior border of the corpus in this region is dislodged and anteriorly displaced relative to the alveolar border. The damage in this area precludes an accurate reconstruction of the symphyseal portion of this specimen. Isolated dental elements preserved with MHR 2 include two maxillary teeth (RM^2 , LM^3) and four mandibular teeth (RI_1 , LI_1 , LI_2 , LC_1).

Tooth wear: The mandibular teeth of specimen MHR 2 are worn in a predominantly lingual to buccal direction, and the degree of attrition is moderate to heavy. Large patches of dentine are exposed on the buccal cusps of RP_3 , RP_4 , RM_1 , LP_4 , LM_1 and LM_2 . Right and left mandibular first molar teeth also have dentine exposed on their disto-lingual cusps, these have coalesced with the buccal dentine patches. The RM_2 and LM_3 are much less heavily abraded than the other molar teeth resulting in a clear attrition gradient. This gradient is more clearly evident in the left than the right molar row, in part due to the effect of caries in RM_2 and RM_3 .

Mandibular anterior teeth also exhibit conspicuous attrition on their occlusal surfaces with broad patches of dentine exposed on the incisive edges of canine and incisor teeth. The two maxillary molar teeth preserved with this individual are less worn than the lower molars and are just beginning to exhibit dentine on their mesio-lingual (LM^3) and disto-lingual (RM^2) cusps. Chipping of tooth enamel is conspicuously present on the margins of the occlusal surface of molar teeth. The disto-lingual aspect of RM_1 and LM_2 are affected and in LM_3 the distal edge of the occlusal surface is also chipped (Fig. 5).

Morphology: The mandibular incisors and canines are morphologically simple and do not exhibit lingual ridges or tubercles. The canines show incipient development of marginal lingual ridges along the distal border of R and LC_1 ; yet such ridges are absent from lower incisors.

RP₃ is triangular in outline, while the shape of RP₄ and LP₄ is ovate. Other morphological features of the premolar teeth could not be assessed due to attrition. Cusp numbers and groove pattern of lower molar teeth are presented in Table 4, together with data for other specimens in this series. The presence of five cusps in the LM₃ and of a Y groove pattern in RM₂ are noteworthy. Maxillary molars (RM² and LM³) both exhibit well-developed hypocones; category (4) of Dahlberg. This degree of expression in MHR 2 can be compared with the range of hypocone development in maxillary molar teeth of other specimens in this series in Table 5.

Odontometrics: Dental crown dimensions and indices for MHR 2 are provided in Table 6. Crown indices are given in Table B-2 (Appendix B). A statistical and comparative analysis of these data is presented later in this report.

Pathology: Two pathological conditions are evident in the dentition of the adult specimen MHR 2, caries and alveolar resorption. The effects of caries are evident on the crowns of three molar teeth; one upper (LM³) and two lower (RM₂ and RM₃). The mesio-buccal margin of LM₃ was affected by caries which destroyed a large area of dentine near the cemento-enamel junction. The bulk of the disto-buccal portion of this tooth has been destroyed by cariogenic action. The area affected extends from the cemento-enamel junction to the apex of the disto-buccal cusp. The third instance of the caries in MHR 2 is in the RM₃, the anterior half of whose crown was destroyed by caries. The posterior half of the crown of RM₃ exhibits a large carious lesion and the anterior root of this tooth is cup-shaped. This evidence clearly suggests that carious decay destroyed the anterior moiety of the crown.

Alveolar resorption is evident on the internal aspect of the mandible in the region of the second and third molar teeth. The degree of resorption is slight to moderate and is present bilaterally. It may be attributable to heavy masticatory stress as evidenced in the heavy pattern of attrition.

Specimen 2a (MHR 2a)

Preservation: Specimen 2a consists of three mandibular fragments: a) a right mandibular corpus retaining the alveoli of RC₁ through RM₂ with an impacted RM₃, b) a symphyseal fragment preserving the alveoli of RI₁, RI₂ and LI₁ thru LP₃, and c) a segment of the left corpus preserving the roots of P₄ and M₁, the crown of LM₂, and the anterior alveolar wall on LM₃ (Fig. 6). Post-mortem breakage has destroyed the right gonial region along a line parallel to the mylohyoid line inferior to RM₂ and RM₃. The inferior border of the corpus is preserved from LP₃ alveolus to the RM₂ alveolus. Two isolated teeth, maxillary RP³ and LM¹ are also present.

Tooth wear: The occlusal and posterior surfaces of the crown of RM₃ are completely unworn, no enamel wear facets are discernible. The LM₂ has small

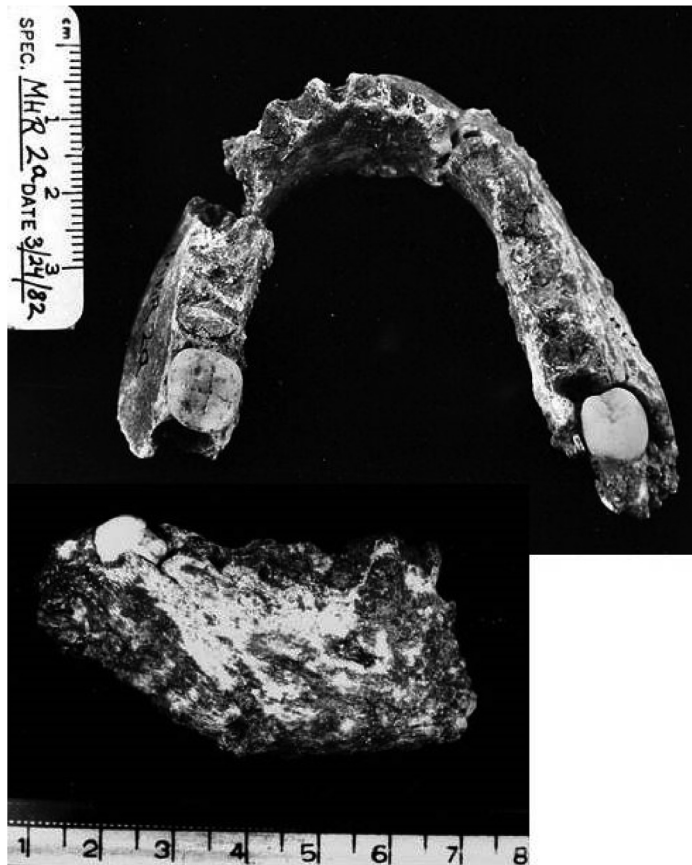


Figure 6: MHR 2a. above - superior view of mandible, most teeth missing post-mortem.
LM₂ and impacted RM₃. below - lateral view of right mandibular corpus,
note anterior inclination of tooth.

dentine exposures on the buccal cusps, while the lingual cusps exhibit enamel wear facets only.

Morphology: The crown of RM₃ is small and exhibits a reduced disto-lingual cusp. Four cusps are present and the groove pattern of this tooth is Y. The occlusal pattern of LM₂ is plus (+) 4, and the maxillary M¹ has a slightly reduced hypocone (4-).

Odontometrics: Accurate measurement of RM₃ was precluded because of its impacted status; data for the other three teeth are given in Table 6. Crown indices are provided in Table B-2 (Appendix B).

Pathology: The RM₃ of specimen MHR 2a is malpositioned (Fig. 6). The tooth is erupting with its occlusal surface facing anteriorly. It is inclined nearly 45° toward

the posterior surface of RM_2 (though this tooth and all others except LM_2 have been lost post-mortem).

Specimen 3 (MHR 3)

Preservation: The dental and gnathic structures of MHR 3 are well-preserved despite moderate post-mortem deformation. The mandible is missing both coronoid processes and mandibular condyles, but the ascending rami are present. The mandible is preserved in four pieces (Fig. 7a) that were easily reconstructed: 1) right gonial region and ascending ramus, 2) right corpus and symphyseal region retaining



Figure 7: MHR 3. a) superior / anterior view of mandible. note: post-mortem damage to symphysis and post-mortem fracture between LM_1 and LP_4 . b) superior view of left tooth row. note cusp number and occlusal groove patterns, large enamel chip from disto-buccal aspect of M_1 crown.

the crowns of RM₂, RM₁, LC₁, LP₃, and LP₄ (this fragment suffered post-mortem warping anterior and inferior of the symphyseal region), 3) left mandibular corpus with crowns of LM₁, LM₂ and LM₃, and 4) left gonial region and ascending ramus.

The maxillary fragment of MHR 3 is less well-preserved, most upper teeth are represented by isolated dental elements. The left maxilla retains LP⁴, LM¹, LM² and LM³. Most of the maxilla is crushed toward the mid-sagittal plane and the bones of the palate are missing. From the alveolar border the maxilla extends superiorly to the inferior margin of the left orbit. A small portion of the zygomatic process of the malar bone is preserved as well. Isolated maxillary teeth of MHR 3 include: RI¹, RC¹, RP³, RP⁴, RM¹, RM², RM³, LI¹, LI², LC¹ and LP³. The only tooth missing from the maxillary dental arcade is RI².

Tooth wear: The degree of dental attrition in MHR 3 is low, perhaps because of the young age of this individual. Most teeth show signs of enamel wear, and where dentine has been exposed, the area of exposure is very small. Pinholes and small craters of dentine are present on the apices of the cusps of canines, premolars and first molar teeth. Thin lines of dentine are evident along the occlusal edges of R and LI¹.

Evidence of dental chipping is prevalent in the molar and premolar teeth of MHR 3. Seven teeth of this specimen exhibit one or more enamel chips on the occlusal surface; affected teeth include: maxillary RLP³, RP⁴, RM¹, LM² and mandibular - LM₁, RM₂. A large enamel chip has been detached from the disto-buccal margin of LM₁ (Fig. 7b), and the bulk of the lingual cusp of LP⁴ has been chipped from the crown. Most other cases of dental chipping are characterized by the removal of smaller enamel chips though the scars are similar in their jagged appearance and irregular shape.

Morphology: Lower incisor teeth are missing from this specimen and the LC₁ tooth is normal in its morphological characteristics. The left lower premolars are small in size. LP₃ is bicuspid though the lingual cusp is no more than a small tubercle just recognizable as a separate cuspule. LP₄ is circular in outline, has a prominent lingual cusp and two occlusal pits, mesial and distal, are easily distinguished. Occlusal surface groove patterns of molar teeth are: RM₁ and LM₁ (Y), RM₂ and LM₂ (+), LM₃ (X). These morphological details can be compared with data for the lower molar teeth of other Mahurjhari specimens in Table 4.

Maxillary central incisor teeth of MHR 3 show moderate development of the shovel-shape trait, best regarded as the semi-shovel condition of Hrdlička (1920). Dentine is clearly involved in the shoveling of the central incisors, and basal tubercles are also present on the lingual surface of the central incisor teeth. The canine teeth do not exhibit accessory tubercles or ridges. All four maxillary premolar teeth are bicuspid, oval in outline and lack notable morphological features.

Hypocone expression of R and LM¹ were grade 4 and second and third molars (right and left) exhibited grade 3 hypocones (Table 5). Absence of a hypocone in the second molar teeth of this individual is an unusually great reduction in cusp size, especially when the first molar teeth exhibit a full-sized (grade 4) hypocone.

Odontometry: Dental crown dimensions and indices for MHR 3 are given in Table 6. Descriptive statistics and a comparative analysis of dental dimensions is presented below.

Pathology: The dentition of this specimen is caries-free. Faint traces of gross enamel hypoplasia are present on the labial surface of the maxillary central incisors. No other pathological conditions could be discerned in the dentition of MHR 3.

Specimen 3a (MHR 3a)

Preservation: This specimen consisted of very fragmentary cranial, maxillary and mandibular bones. The mandible is badly damaged but retains two molar teeth protruded anteriorly from beneath the dorso-ventrally crushed cranium. Bregma rests very close to the anterior margin of the foramen magnum in this badly damaged cranium. Four gnathic fragments were carefully dislodged from the cranium; two maxillary fragments, retaining two molar teeth each, and two mandibular fragments. The left mandibular corpus fragment retains a single molar (M₁), the right corpus also retains one molar (M₁), and one incisor tooth which is displaced from its original anatomical position post-mortem. These maxillary and mandibular fragments are poorly preserved.

The right mandibular fragment includes the inferior margin of the mandibular notch but the coronoid process and mandibular condyle are missing. The ascending ramus is highly fragmented but the numerous small pieces of bone are held together by matrix and preservative. Morphological detail of mandibular anatomy and the alveolar margin are difficult to assess because of heavy post-mortem damage. The left mandibular fragment is smaller and less well-preserved. It retains 2 cm. posterior to the distal surface of LM1 and 1cm. anterior of the mesial surface of this tooth.

The two maxillary fragments also preserve little recognizable anatomical detail. The right maxillary fragment retains RM¹ and RM²; the left fragment retains LM¹ and LM². Isolated dental elements that belong to specimen MHR 3a include six maxillary teeth (LI¹, LP³, RI¹, RC¹, RP³, and RP⁴) and five mandibular teeth (RI₁, RC₁, RP₄, RM₂, and LI₁).

Tooth wear: No dentine is exposed on the occlusal surfaces of the teeth of MHR 3a whose dentition is minimally worn. In several teeth wear facets can be discerned on the enamel surface of the crown indicating that attrition and abrasion were occurring.

Two teeth, RM₁ and RC₁ exhibit enamel chipping of the type described above in Specimen MHR 3. The mesio-buccal cusp of RM₁ features large enamel chip that has exposed the underlying dentine. This feature is clearly not normal attrition or abrasion, but a traumatic fracturing of the enamel due to the inclusion of hard items in the diet. The case of dental chipping in the RC₁ is less conspicuous than that found in RM₁. A small enamel chip has been removed from the lingual aspect of the apex of the cusp.

Morphology: Mandibular incisors present standard anatomical features, though the RI₂ exhibits a slight degree of shoveling. The right mandibular canine is incisiform, no marginal ridging or tubercles are present. Mandibular RP₄ has two lingual cusps, each being the terminus of a bifurcated occlusal ridge. Three occlusal pits are present in this specimen but lingual grooves are absent. All three lower molar teeth have five cusps but occlusal surface groove patterns vary; both LM₁ and RM₂ exhibit a plus (+) pattern and RM₁ has a Y pattern on its occlusal surface. In Table 4 (above) these data can be compared with cusp number and groove pattern for lower molar teeth of other specimens from Mahurjhari.

The maxillary central incisors display a trace of the shovel-shape trait and their basal tubercles are marked by a faint longitudinal groove. No accessory cusps were present on maxillary molar teeth. First maxillary molars exhibit grade 4 hypocone development bilaterally and the second molars are grade as 3+ in Dahlberg's classification (Table 5). Maxillary canine and premolar teeth are normal in size, shape and morphology and preserve no unusual or notable features.

Odontometrics: Dental crown diameters and indices for specimen MHR 3a are given in Table 6. The buccolingual diameter of RI₂ is not given since this tooth was firmly cemented in matrix, but measurement of its mesiodistal diameter was possible. Crown indices are listed in Table B-3 (Appendix B). A statistical and comparative analysis of these data are presented later in this report.

Pathology: There is no evidence of disease in any of the teeth or gnathic structures of specimen MHR 3a. The young age at death of this individual (estimated at 12.5-13.5 years on the basis of root calcification processes) may be partially responsible for the healthy appearance of its masticatory apparatus.

Specimen 4 (MHR 4)

This specimen did not come to my attention in 1979 and was studied for the first time on a subsequent research visit to Deccan College in the Spring of 1982.

Preservation: Specimen MHR 4 consists of isolated dental elements only; no gnathic structures of this specimen are known to be preserved. The eight teeth of this individual include one maxillary tooth, LC¹ and seven mandibular teeth RP₃,

RM₁, RM₂, LI₁, LP₃, LM₁ and LM₂. All dental crowns are well-preserved though some teeth have broken roots or their roots are completely missing.

Tooth wear: Dental wear in this individual is minimal. Though enamel faceting is present in the LC¹, RLP₃, and RLM₂, no dentine has been exposed on these teeth. RM₁ is slightly more heavily worn than LM₁, which has a small crater of dentine exposed on its mesio-buccal cusp. The RM₁ has small dentine patches exposed on four cusps, only the disto-lingual lacks dentine exposure. Dental chipping is not present in the dentition of MHR 4.

Morphology: The LC¹ preserves a very small distal accessory ridge, but is normal in all other respects. The mandibular LI₁ is also normal, lacking marginal ridges and tubercles. The R and LP₃ are similar morphologically, both have small lingual cusps, continuous occlusal sulci and one occlusal pit. Lower first molar teeth, right and left, exhibit the *Dryopithecus* pattern (Y-5) on their occlusal surfaces. The second molars are four-cusped, but asymmetrical in groove pattern; the RM₂ has an (X) and the LM₂ a Y groove pattern. Table 4 compares these data with details of lower molar occlusal morphology in other specimens from Mahurjhari.

Odontometry: Dental crown diameters for Mahurjhari specimen 4 are provided in Table 6; indices are listed in Table B-5 (Appendix B). Statistical analysis of these data and comparative study of the results are presented later in this report.

Pathology: The eight isolated teeth of MHR 4 provide no evidence of dental disease.

Specimen 5 (MHR 5)

Preservation: Dental and gnathic remains of this individual are few and poorly preserved. A single edentulous left mandibular corpus fragment is preserved, but has suffered heavily from post-mortem damage. Seven isolated dental elements are preserved: maxillary RP³ and LM³; and mandibular: RC₁, P₃, P₄, M₂, and M₃. However four of these are incomplete, having lost their roots post-mortem (RP³, RP₃, RM₃ and LM³).

Most teeth in the Mahurjhari skeletal series are preserved in the normal bright white color of enamel. Several teeth from MHR 5 have a brownish-orange, grey and milky-white colored stain over the dental crown. The RP³ crown is most severely affected, but RM₂ and RM₃ are affected as well, though to a lesser extent. Whether this discoloration reflects the effect of local soil conditions that acted on the teeth post-mortem or alternatively reflects dietary preferences cannot be ascertained at present. However, dental fluorosis is the most likely cause (see Postscript).

Tooth wear: Although well-developed enamel wear facets are present on many of the teeth of MHR 5, especially RM₂ and RM₃, the dentine remains unexposed. This

suggests that the enamel on these teeth is quite thick. Two teeth, RP_4 and RM_2 , exhibit evidence of dental abrasion in the form of enamel chipping. The margin of the disto-lingual cusp of RM_2 and the distal margin of the occlusal surface of RP_4 are chipped.

Morphology: The RC_1 is incisiform and the crown and root form a distinct concave curve on the distal surface (when viewed from the lingual perspective). The mandibular premolars are small, round in outline and have small lingual cusps. The two lower molars of this specimen (RM_2 and RM_3) both have 4 cusps and plus (+) occlusal groove patterns (see Table 4).

Odontometrics: Dental dimensions for MHR 5 are presented in Table 6, while crown indices are given in Table B-6 (Appendix B). Descriptive statistics and a comparative analysis of these data are presented below.

Pathology: Dental caries were not found in the dentition of MHR 5, but faint traces of gross enamel hypoplasia could be discerned near the cemento-enamel junction of five teeth (RC_1 , RP_3 , RP_4 , RM_2 and RP^3). No other evidence of dental pathology could be found in the dentition of this individual.

Specimen 6 (MHR 6)

Preservation: Dental and gnathic remains of this specimen are very fragmentary and include a dozen small mandibular pieces and ten isolated teeth. One mandibular fragment is recognizable as part of the right gonial region; it preserves the mylohyoid canal and pterygoid ridging is evident on its medial surface. Isolated teeth include six maxillary (RM^1 , RM^2 , RM^3 , LM^1 , LM^2 , LM^3) and four mandibular (RM_1 , RM_2 , RM_3 and LM_2) dental elements. All dental crowns are well-preserved and morphological details of occlusal surface anatomy are easily observed.

Tooth wear: Upper and lower second and third molar teeth exhibit enamel wear facets, but no dentine has been exposed on their occlusal surfaces. Upper and lower first molars exhibit one or two small dentine patches. The two buccal cusps of RM_1 and the lingual cusps of RLM^1 are affected. Small interstitial (approximal) wear facets are present on the mesial and distal surfaces of the molar teeth of MHR 6 as in other Mahurjhari specimens.

Though all teeth of MHR 6 are isolated from their supporting structures, three pieces of evidence suggest that RM_3 was partially impacted or erupting abnormally with its occlusal surface tilted anteriorly: 1) The distal approximal wear facet of RM_2 is abnormal. Rather than a flat vertical plane of contact, the crown exhibits a semi-circular crescent-shaped wear facet.

2) The mesial approximal wear facet of RM_3 is also abnormal. Rather than the typical flat horizontal plane of contact, one finds that the mesial marginal ridge of this tooth, shaped like a crescent and convex anteriorly, is worn and fits the unusual wear facet on the distal surface of RM_2 . 3) The occlusal surface of RM_3 is unworn but

two enamel wear facets are present on the disto-buccal cusp. These features result from the occlusion of the RM^3 antagonist in the upper jaw with the malpositioned RM_3 . Enamel chips from the distal surface of RM_2 (adjacent to the interproximal wear facet) and the distal surface of RM^3 (a large portion of the distal crown enamel has been removed), may be traumatic consequences of the malocclusion of the posterior right molar rows. The possibility of post-mortem damage cannot be excluded with certainty, though these enamel fractures are consistent with a diagnosis of masticatory dysfunction due to malocclusion.

Small enamel chips of the type discussed above in MHR specimens 2, 3 and 3a were found in four molar teeth of MHR 6 (LM^1 , RM^1 , RM_1 , and RM_2). In all cases the chips removed were small and located on the margin of the occlusal surface. The flake scar on the mesio-buccal cusp of RM^1 extends several mm. down the buccal surface of the crown from the cusp apex. In LM^1 a small chip is missing from the mesio-lingual cusp, while in RM_1 both the mesio-lingual cusp and the distal marginal rim of the occlusal surface are affected. A small enamel chip was spalled from the mesio-lingual cusp of the RM_2 as well.

Morphology: All four lower molar teeth of MHR 6 are four-cusped. A Y groove pattern is present on the occlusal surface of RM_1 ; RLM_2 and RM_3 all exhibit plus (+) groove patterns. The occlusal surface of RM_3 is crenulated but the groove pattern is clearly discernable. No unusual anatomical variations are present in the mandibular or maxillary molar teeth of this individual.

Maxillary molar teeth of MHR 6 exhibit a range of development in hypocone size, RLM_1 are class 4, LM^2 is 4 - (minus) and RM^2 and RLM^3 are all class 3 in Dahlberg's classification. These morphological details can be compared with data for lower and upper molar teeth of other Mahurjhari specimens in Tables 4 and 5, respectively (above).

Odontometry: Dental crown measurement for MHR 6 are provided in Table 6. Crown indices are listed in Table B-7 (Appendix B). These data are statistically analyzed and compared with other prehistoric skeletal series of South Asia in the next section of this report.

Pathology: Most teeth of MHR 6 are free from dental disease. However, two teeth, R and LM^3 have carious lesions in the central fovea of their occlusal surfaces. The degree of destruction of enamel and dentine is greater in RM^3 but the caries in LM^3 penetrates more deeply into the dentine.

Specimen 6a (MHR 6a)

Preservation: This specimen consists of well preserved dental and gnathic remains. Several small fragments of the upper and lower jaws were unidentifiable. Four

larger fragments include: 1) a left mandibular condyle, 2) left mandibular corpus, 3) right mandibular corpus and 4) right maxillary fragment. The left mandibular corpus is the poorest preserved of these large jaw fragments. Broken into eight smaller pieces the corpus was reconstructed in the laboratory after removal from the matrix. The gonial region is broken, the roots of LM₁ and LM₂ are visible and the alveolar region of LP₃ and LP₄ is preserved but damaged post-mortem. The left third molar is in process of eruption.

The right mandibular fragment is the best preserved gnathic element of MHR 6a and retains the best preserved teeth of this specimen. Four teeth (RP₄ through RM₃) are present in proper anatomical positions. Post-mortem damage has broken away pieces of the medial and lateral walls of the corpus exposing the roots of RM₃, RP₄ and RM₁. The mandibular symphysis preserves genial tubercles of moderate size and the mental eminence is median, suggesting that MHR 6a may be female.

The right maxillary fragment is damaged but retains the crowns of RM¹ and RP⁴. The alveoli of RP³ and RC¹ are present but filled with matrix, and the distal wall of the alveolus of RI² is preserved. The lingual alveolus of RM³ is preserved but the crown of that tooth is missing. Nine isolated teeth are preserved with MHR 6a including seven maxillary teeth (RI¹, RP³, LI², LC¹, LM¹, LM², LM³) and two mandibular teeth (RC₁ and LC₁).



Figure 8: MHR 6a. mandible, superior view. Note: extensive post-mortem tooth loss, asymmetric morphology of third molar teeth, crenulated crown morphology of RM₃.

Tooth wear: The third lower molar teeth of this individual are erupted but their occlusal surfaces have not reached the occlusal plane of RM_1 and RM_2 . The young age of this individual estimated at 20-25 years at death may account for the minimal degree of tooth wear. Small patches of dentine exposure are visible on the mesio-buccal cusp of RM_1 and the mesio-lingual cusps of RM^1 . The RI^1 also exhibits a thin line of dentine exposure on its incisive edge, but all other teeth of this specimen have no dentine exposed.

Morphology: The incisors, canines and premolar teeth of MHR 6a present no unusual or notable anatomical variations. The occlusal surface morphology of R and LM_3 is extensively crenulated, but has an X groove pattern, and six cusps (Fig. 8). In each case the extra cusp is C-6, the entoconulid or *tuberculum sextum*, which is asymmetrically expressed - more fully on the RM_3 than on the LM_3 . The occlusal surface pattern of RM_2 is Y-4, the *Dryopithecus* groove is associated with a reduction in cusp number from five to four. The RM_1 exhibits a well preserved though slightly worn Y-5 occlusal pattern. These data are presented in Table 4, together with similar data for other specimens in this skeletal series.

Three of the four maxillary molar teeth (RLM^1 and LM^3) exhibit the 4 - (minus) grade of hypocone development. By contrast, the LM^2 essentially lacks a hypocone and is grade 3. The only case of an enamel extension in the Mahurjhari dental sample occurs on buccal surface of LM^3 . The extension is in the inter-radicular area and extends a several millimeters below the CEJ. The reddish discoloration of the lingual and distal surfaces of this tooth (LM^3) and the black color of the intercuspatal grooves are inconsistent with the bright white enamel of the other teeth referred to as MHR 6a, and most of the Mahurjhari dentition. While LM^3 may be from a separate individual, it could also be discolored by localized effects of soil chemistry or dental fluorosis (see Postscript).

Odontometrics: Measurements of the dental crown of specimen MHR 6a are provided in Table 6, for crown indices see Appendix B, Table B-8). The unusually large size of LM^3 is indicated by its large crown area (133.20 mm²). A statistical summary and comparative analysis of these metrical data is presented below.

Pathology: Two pathological conditions are present in the dentition of MHR 6a: caries and an impacted RC^1 . The caries occurs on the occlusal surface of LM^3 at the base of the disto-lingual cusp. The RC^1 is unerupted and malpositioned. The apex of the cusp of this tooth is projected toward the alveolus of RI^2 , and the root extends posteriorly and superiorly toward the partition separating the nasal aperture from the maxillary sinus. Figure 9 provides photographic (Fig. 9a anterior, 9b lateral) and radiographic (Fig. 9c) images of the misplaced RC^1 .

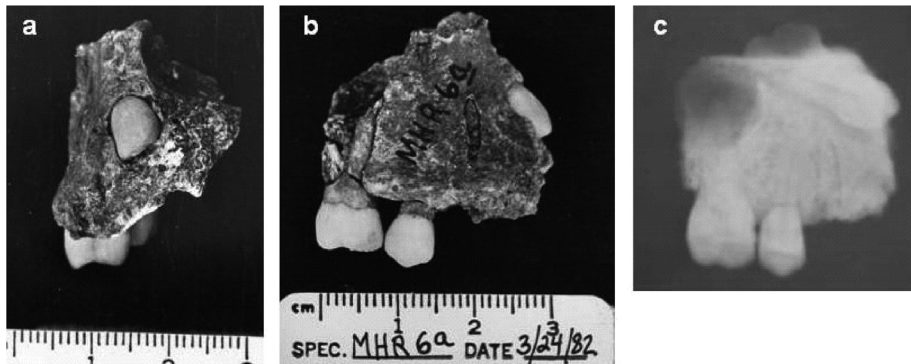


Figure 9: MHR 6a. right maxilla fragment. a) anterior view, b) right lateral view, c) radiograph from right lateral perspective. Note unerupted and misplaced RC¹ embedded in maxilla, long axis of tooth inclined anterior inferiorly (see text for detail).

Specimen 7 (MHR 7)

Preservation: The state of preservation of MHR 7 is poor; the specimen consists primarily of isolated teeth and two jaw fragments. One is an endentulous left maxillary fragment, the teeth of which were lost post-mortem. The right mandibular corpus fragment is better preserved and retains the crowns of RP₃, RP₄, and RM₁ in proper anatomical position.

The left maxillary fragment is small and badly damaged. The root of the zygoma is present, the canine fossa is present and the palate shallow. A cross-sectional view of the roots of LP⁴ and the medial root of LM¹ is possible. The maxilla anterior to LP⁴ is badly damaged and no dental roots are preserved. The right mandibular fragment is also badly damaged but the symphyseal region is preserved. The mental eminence is preserved and its medial placement suggests that MHR 7 might be female. The genial tubercles are present and moderately developed.

Dental elements preserved with MHR 7 consist mainly of isolated teeth, some of which lack roots. Seven maxillary teeth are present including RP⁴, fragments of RM¹ crown, RM², RM³, LC¹, LP⁴, and LM². Eleven isolated mandibular teeth are present including RI₁, RI₂, RM₂, RM₃, LI₁, LC₁, LP₃, LP₄, LM₁, LM₂, and LM₃. When these isolated teeth are added to the three preserved in the right corpus fragment, MHR 7 yields a total tooth count of 21.

Tooth wear: The dentition of MHR 7 is characterized by moderate to heavy attrition. Though the third molar teeth (upper and lower) of this individual are unworn, most other teeth exhibit some degree of dentine exposure. The maxillary left central incisor is heavily worn on the mesial half of its lingual surface. The left molar row reveals a well developed wear gradient. Dentine is exposed on all cusps

of LM₁, except the mesio-lingual cusp, on LM₂ three cusps are worn through to the dentine, though the exposed area is small, and the LM₃ has no dentine exposed, however enamel wear facets are present on the disto-buccal cusp.

Dental chipping as noted in several specimens above is also present in the lower molar teeth (LM₁ and RM₂) of MHR 7. A large enamel chip is missing from the disto-lingual cusp of RM₂ and smaller, but easily discernible, chips have been removed from the disto-lingual cusp of LM₁ and the mesio-lingual cusp of RM₂.

Morphology: Mandibular incisors and canines are normal and exhibit no noteworthy anatomical features. The lingual cusps of R and LP₃ are small and connected to the buccal cusps by a prominent occlusal ridge. The posterior occlusal pit is distinct but the anterior pit terminates in a lingual groove bilaterally. The R and LP₄ exhibit one prominent lingual cusp. The median occlusal sulcus is continuous and not interrupted by the occlusal ridge. Right and left lower first molar teeth both exhibit the *Dryopithecus* or Y - 5 pattern, R and LM₃ and LM₂ all have the plus (+) groove pattern and four cusps, and the RM₂ exhibits a Y - 4 occlusal pattern. These data are presented in Table 4 for comparison with similar data for other Mahurjhari specimens. Only three maxillary molar teeth are preserved with MHR 7. The R and LM² both display a 4 - (minus) grade of hypocone development, while RM³ is grade 3 (see Table 5)

Odontometrics. Dental crown measurements are given in Table 6 for specimen MHR 7, while crown indices are listed in Table B-9 (Appendix B). A statistical and comparative analysis of these data is presented below.

Pathology: Carious lesions are absent from the preserved dentition of MHR 7. Diseases of the supporting structures, alveolar resorption and dental abscesses, cannot be judged since the alveolar margin has been badly damaged post-mortem. The maxillary and mandibular RM3s of this specimen have an unusually thick layer of cementum. The degree of hypercementosis is clearly evident when compared with the absence of extra cementum on the roots of M1 and M2. In addition, the crowns of both right third molars (upper and lower) have minor accumulations of calculus on their occlusal surfaces. The intercuspatal area of the mesial portion of the crown of RM₃ is affected, as are the occlusal and buccal surfaces of RM³. Whether or not these two conditions (hypercementosis and coronal calculus) are functionally inter-related and reflect the result of malocclusion or temporomandibular joint dysfunction cannot be assessed with certainty.

Specimen 8a (MHR 8a)

Preservation: This specimen consists of three large gnathic elements, one maxillary and two mandibular that retain teeth and several smaller jaw fragments whose teeth

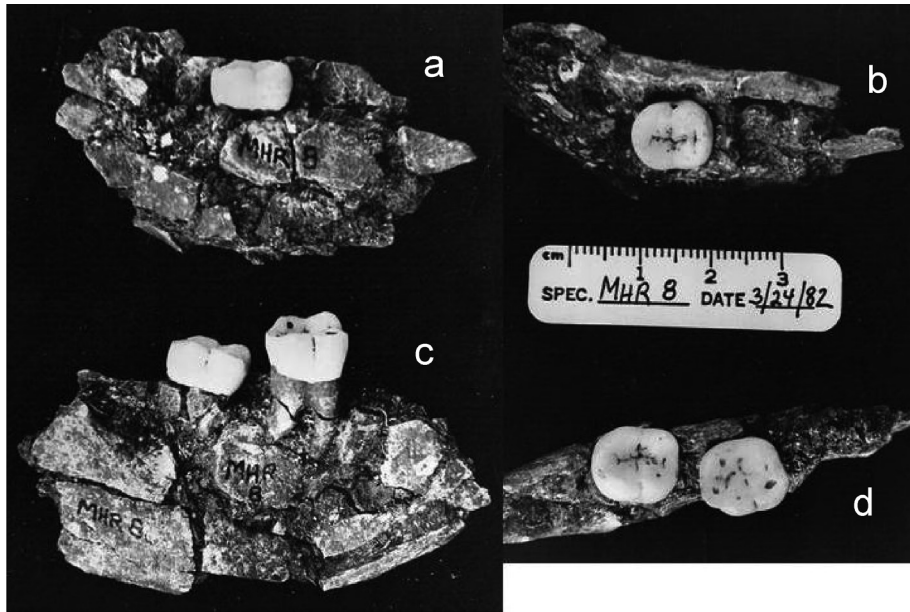


Figure 10: MHR 8. mandibular corpus fragments. left corpus viewed from medial (a) and superior (b) perspectives; right corpus viewed from lateral (c) and superior (d) perspectives.

were lost post-mortem. Two individuals appear to be represented in the teeth and jaw fragments preserved here, for convenience these will be labeled MHR 8a and MHR 8b.

The more complete specimen is MHR 8a which consists of the three large jaw fragments and six isolated tooth crowns. The maxillary and mandibular jaw fragments of MHR 8a are much affected by post-mortem deformation and warping. The right mandibular fragment is compressed toward the mid-sagittal plane, both the medial and lateral walls of the mandibular corpus are highly fragmented, and the root of the ascending ramus is present. Two molar teeth, RM_1 and RM_2 , are retained in this jaw fragment (Fig. 10). The left mandibular fragment is more severely damaged by post-mortem destruction. The lateral wall of the corpus has been displaced superiorly and the medial wall displaced inferiorly. One tooth LM_2 is retained in this jaw fragment. The occlusal surface of this tooth is level with the lateral alveolar border (Fig. 10a). This is an artifact of post-mortem damage, making it appear as though this tooth is in the process of erupting.

The maxilla of MHR 8a is severely compressed toward the mid-sagittal plane. The distance between the lingual surfaces of RM^1 and LM^2 , the only two teeth retained in the maxilla, is about $\frac{1}{2}$ cm. The loss of all other teeth is no doubt attributable to the severe degree of post-mortem compression. Isolated teeth that

belong to MHR 8a include five maxillary (RP³, RP⁴, RM², LM¹, and LC¹) and one mandibular tooth (LM₁).

Tooth wear: The teeth of MHR 8a are not heavily worn. Three small dentine patches are present on the occlusal surfaces of R and LM₁, but maxillary first molar teeth have only one small patch of dentine exposed. Maxillary premolar teeth have no dentine exposed but enamel facets are present. Interstitial (approximal) attrition is very slight in this specimen. Enamel chipping is present on the posterior-lingual margin of the occlusal surface of LM¹. Other teeth of this individual do not exhibit enamel chipping.

Morphology: Mandibular first and second molar teeth are bilaterally symmetrical, R and LM₁ both have the *Dryopithecus* occlusal surface pattern (Y-5), and RM₂ exhibits 4 cusps and the plus (+) groove pattern, LM₂ also has 4 cusps but exhibits the X groove pattern (Table 4). Maxillary premolar teeth are oval in outline, bicuspid but preserve no unusual morphological features. Maxillary first and second molar teeth are also bilaterally symmetrical in hypocone expression with R and LM¹ display grade 4 and R and LM² exhibit a 3 + grade of expression (Table 5). Two small pits are present on the lingual surface of the mesio-lingual cusp of LM¹, a single pit occurs in the same location on the crown of RM¹. These enamel blemishes may represent a very weak expression of Carabelli's trait in Specimen MHR 8a.

Odontometrics: Dental crown diameters for Mahurjhari specimens 8a are given in Table 6. The crown indices derived from these crown measurements are listed in Table B-10 (Appendix B). These data are statistically and comparatively analyzed later in this report.

Pathology: The extensive post-mortem damage of alveolar bone precludes any accurate assessment of periodontal disease or dental abscesses. One tooth of MHR 8a, LM₂, has a small caries present in the buccal pit of the crown. Only a small amount of decay has occurred, the lesion is in the incipient stages of development.

Specimen 8b (MHR 8b)

Preservation: Three teeth from Mahurjhari burial 8 appear different from the teeth of MHR 8a in color, enamel thickness and degree of attrition. For this reason these three teeth (RI², P⁴ and Rdm²) have been given the label MHR 8b and are treated as a separate individual. In actuality though the teeth allocated to MHR 8b could each have been derived from a different individual. Only the crowns of these teeth are preserved, the roots have been broken away post-mortem.

Tooth wear: None of the three teeth referred to as MHR 8b show evidence of dental attrition.

Morphology: The RI² does not exhibit any lingual marginal ridges, nor are marginal interruptions or lingual tubercles present. The incisive edge of the tooth has a well developed median mammalon. The upper premolar is bicuspid and oval in outline but otherwise normal in its morphological features. The Rdm² has a well developed hypocone but no other distinguishing anatomical features are present.

Odontometrics: Dental crown dimensions for these three teeth are presented in Table 6 and in Table B-10 of Appendix B. Two of these Rdm² and P⁴ have been excluded from the statistical computation of the second part of this report because of uncertain identification and the small sample of deciduous teeth preserved.

Pathology: Two of these teeth RI² and P⁴, show varying degree of gross enamel hypoplasia. The more severe case is P⁴, which has a deep groove encircling the crown midway between the apex of the cusp and the cemento-enamel junction (CEJ). This apparently indicated a single severe interruption in the calcification process. The RI² also exhibits evidence of gross enamel hypoplasia, but the interruptions in calcification were less severe, though more frequent, than in the premolar tooth.

Specimen 9 (MHR 9)

Preservation: This burial contains two badly damaged jaw fragments, one maxilla and one mandible. The maxillary fragment retains the damaged crowns of eight teeth RM², RM¹, RP³, RC¹, LI², LC¹, LP³, and LP⁴. The roots of two other teeth (an incisor and RM³) are present. The bulk of the cortical bone of the maxilla has eroded away due to post-interment weathering (Fig. 11a). The palate has been compressed toward the mid-sagittal plane. The mandible of MHR 9 has also suffered severe post-mortem deformation, but in this instance the gonias were displaced in a lateral direction. Compression of medial and lateral walls of the left mandibular corpus is severe; the right corpus is less crushed by post-mortem forces. The left corpus fragment retains LC₁, P₄, M₁, and M₂. The mandibular symphysis is poorly preserved provides no information regarding the sex of this individual. Three isolated teeth occur with this specimen, two maxillary (RP⁴ and RM³) and one mandibular (LP₃).

Tooth wear: The severity and the pattern of dental attrition exhibited by MHR 9 are unique in the Mahurjhari skeletal series. Six maxillary teeth, RP³, RC¹, LI², LC¹, LP³, and LP⁴, are all very heavily worn. Dentine is exposed over the entire occlusal surface of these teeth and is surrounded by a thin, elevated ridge of enamel. In some teeth, attrition has reduced the original height of the crown by half. This consistently heavy attrition of anterior teeth contrasts dramatically with the lesser degree of wear on the occlusal surfaces of the molar teeth. The RM¹ is comparatively unworn and exhibits a small patch of dentine only on the hypocone. The RM², which would normally be worn less than RM¹ is slightly more heavily worn—exhibiting two

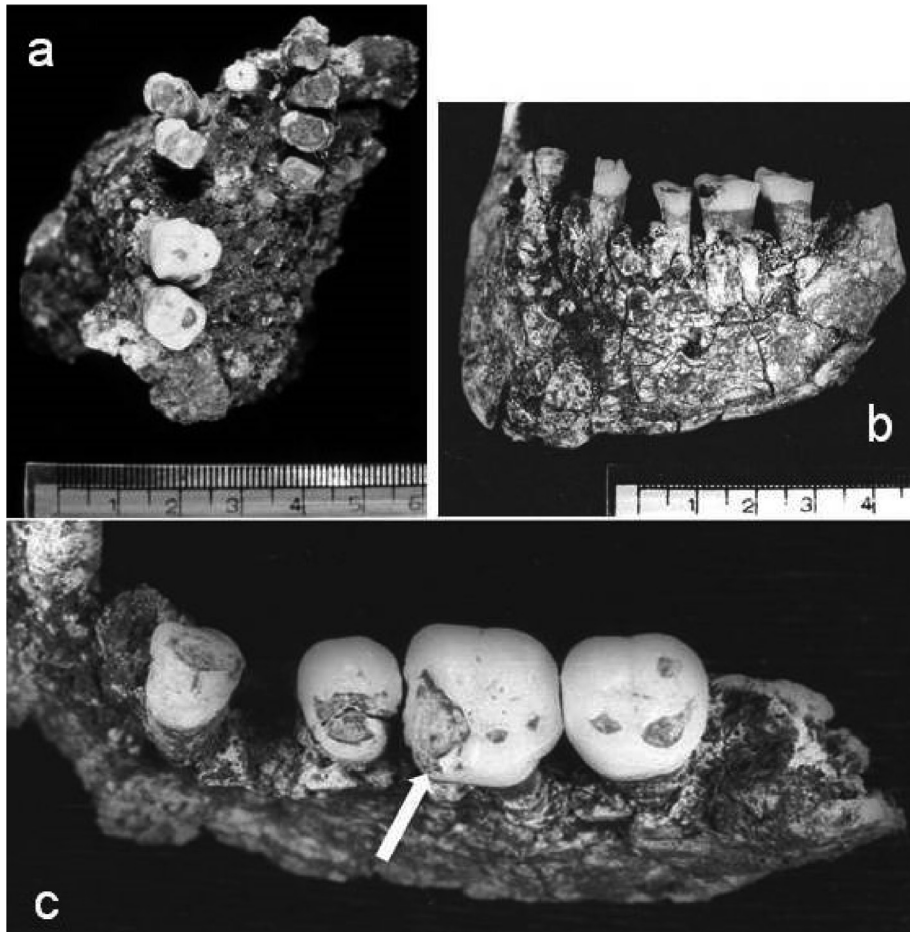


Figure 11: MHR 9. a) maxillary dentition, occlusal view. Note post-mortem deformation and wear differential of anterior and premolar *vs.* molar teeth. b) anterior $\frac{3}{4}$ view of mandible showing deformation to symphysis, c) lower left tooth row: note notch wear of distal LP₄ and mesial LM₁, and micro-chipping of mesio-buccal rim of LM₁ enamel (white arrow).

small dentine patches. All molar teeth are clearly much less worn than the anterior teeth and premolar teeth.

Finally, the lower LP₄ and LM₁ are worn in a notch-like manner suggesting the habitual grasping of an object, like a pipe or mouthpiece of a hookah, between the teeth (Fig. 11c). The posterior half of the crown of LP₄ and the anterior half of the crown of LM₁ are more heavily worn than the remainder of the crown. The wear in this region is inclined buccally (lingual to buccal). Though age may play a role in explaining the pattern of dental attrition in MHR 9, the disparity in wear between

anterior teeth (and premolars) on one hand and molar teeth on the other implicates habitual use of the anterior teeth as tools in non-dietary activities. Enamel chipping, common in other Mahurjhari specimens, also occurs in numerous teeth of MHR 9. The more conspicuous cases occur on the occlusal margin of the mesio-buccal cusp of RM^2 and on the disto-buccal portion of the crown of RP^4 . In some cases clear separation of pre- from post-mortem enamel chipping in MHR 9 is difficult.

Morphology: Morphological details are difficult to discern in the dentition of MHR 9 because of the heavy degree of dental attrition. The few observations that could be made include cusp numbers and groove patterns of molar teeth. Lower molar teeth preserved cusp numbers better than groove patterns; LM_1 is five cusped but wear made the groove pattern of this tooth indeterminate. The LM_2 is four cusped and exhibits a plus (+) occlusal groove pattern (Table 4).

Hypocone development in RM^1 is grade 4, and both RM^2 and RM^3 were graded 4- (minus) in Dahlberg's classification (Table 5). A small metaconule is present on the distal margin of the occlusal surface of RM^3 , but RM^1 and RM^2 lack this minor morphological variant.

Odontometrics: Dental crown diameters for specimen MHR 9 are given in Table 6, but these figures must be viewed with caution. Metrical values for the molar teeth can be regarded as accurate reflections of crown diameter. The high degree of occlusal wear on the anterior teeth of this specimen makes mesio-distal crown measurements for premolars, canines and incisors inappropriate for anthropological comparisons. Bucco-lingual diameters (or labiolingual), are made nearer the cervix of the crown and are therefore less affected by wear and more accurate than mesiodistal diameters of anterior teeth. Crown indices for MHR 9 are presented in Appendix B, Table B-11.

Pathology: Post-mortem destruction of alveolar bone once again precludes assessment of periodontal disease and dental abscesses. The only case of dental caries in MHR 9 is a small lesion in the central forea of the crown of RM^3 . No other dental diseases were found in specimen MHR 9.

Specimen 10 (MHR 10)

Preservation: This burial contained a few highly fragmented dental and gnathic remains of a single individual. Several small chips of bone from the jaws are present, together with two broken tooth crowns and a mandibular fragment containing one complete and two damaged tooth crowns. The small left mandibular corpus fragment retains the undamaged crown of LM_1 , the posterior two-thirds of the crown LP_4 and the lingual half of the crown of LM_2 . The medial corporal wall is present, but the lateral wall was broken away post-mortem, exposing the roots of LP_4 and LM_1 .

Two isolated teeth, both of which have suffered severe post-mortem damage, are identified as LP₃ and LC₁. Post-mortem damage primarily involves the removal of large pieces of enamel which reveals the underlying dentine.

Tooth wear: Two teeth of MHR 10 are heavily worn over the preserved portion of their occlusal surfaces (LC₁ and LP₃). The LP₄ exhibits heavy dental attrition on the buccal cusp, but the two lingual cusps of this tooth are much less affected by attrition. Only three cusps of LM₁ have dentine exposed on them, the mesio-lingual cusp exhibits enamel faceting and wear of the hypoconulid cannot be accurately assessed due to the presence of caries. As in MHR 9, a significant attritional differential exists between the molar teeth, which are less worn, and the anterior teeth (canines and premolars) which exhibit significantly heavier dental wear. The wear differential observed here for MHR 10 is comparable to that described above for MHR 9, though the overall degree of wear is slightly less.

Morphology: Anatomical details of the dental crown cannot be observed in the preserved portion of LC₁ and LP₃ due to the high degree of dental attrition. Two lingual cusps are discernable on the crown of LP₄, making this tooth tricuspid. The lower left molar clearly exhibits the *Dryopithecus* or Y-5 occlusal surface pattern. Though the fifth cusp, or hypoconulid, is partially destroyed by dental caries there is no doubt regarding occlusal pattern of this tooth (see data in Table 4).

Odontometrics: Due to the extent of post-mortem damage to the teeth of MHR 10 the crown dimensions of only one tooth LM₁ could be recorded. The crown dimensions and indices of this tooth are provided below:

Mesiodistal diameter	Buccolingual diameter	Crown Area	Crown Index	Crown Module
11.4	10.4	118.56	109.62	10.90

Pathology: Dental caries is the only pathology discernible in the dentition of MHR 10. The lesion occurs on the hypoconulid, disto-buccal cusp, of LM₁ and is small in size when viewed from an occlusal perspective. If examined from the distal surface of the tooth, the extent of carious decay is considerably greater. The affected area measures about 4.5 mm transversely (in a buccolingual direction) across the posterior surface of the crown and the lesion penetrates deeply into the dentine.

Specimen 11 (MHR 11)

Preservation: This burial includes two mandibular fragments and seven isolated maxillary teeth. The left mandibular fragment retains LM₁, LM₂, and LM₃ in a good state of preservation. The positioning of these teeth has been modified by post-mortem warping that has caused a posterior tilting of the occlusal surfaces of LM₁ and LM₂; LM₃ is minimally affected.

Right and left mandibular corpora have suffered substantial post-mortem damage, much of the cortical bone is missing and that which remains is badly fragmented. The teeth in both right and left mandibular fragments are held in place by matrix. The right mandibular corpus and the anterior portion of the left corpus are preserved as one piece (Fig. 12a). The only teeth on the left corpus are LP₃ and LP₄, but on the right side five teeth are retained (RP₃ through RM₃).

The seven isolated maxillary teeth preserved with specimen MHR 11 include RI², RC¹, and five molar teeth (RM¹, RM², RM³, LM², LM³).

Tooth wear: The pattern and degree of dental attrition in MHR 11 is typical for a young adult in the Mahurjhari skeletal series. All mandibular teeth exhibit some dentine exposure except for the R and L third molars (upper and lower) which have modest enamel wear facets only. The second maxillary molar teeth (R and L) have dentine exposed only on their mesio-lingual cusps, but the mandibular second molars have dentine exposed on two buccal cusps, the left being slightly more worn than the right. Dental attrition of RI² involves both enamel and a line of dentine along the occlusal surface. The pattern of wear in this tooth is indicative of overjet. The RC¹ also exhibits a moderately heavy degree of wear; the plane of wear is obliquely angled toward the distal margin of the crown.

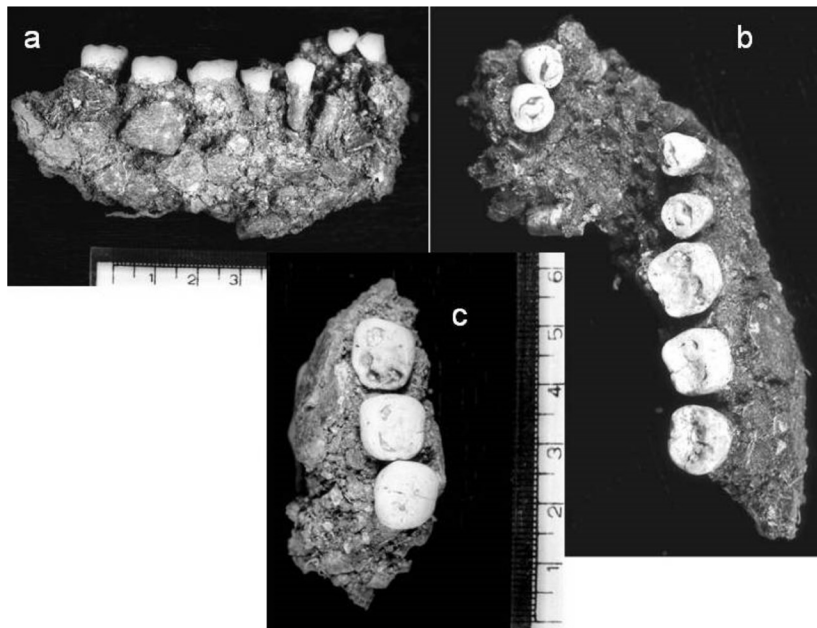


Figure 12: MHR 11. mandible: a) right lateral view of corpus, b) superior view with premolar teeth (left and right) and right molar row present, and c) small fragment with left molar row. Note molar tooth wear gradient (M1, M2, M3).

Morphology: Lower fourth premolars are bilaterally tricuspid, exhibiting two lingual cusps; the mesial one being larger than the distal. Five cusps are present on both first lower molar teeth and the groove pattern is Y-shaped. R and LM₃ are four cusped and exhibit the cross (X) groove pattern. Though both lower second molar teeth are four cusped, RM₂ has a Y groove pattern and LM₂ a plus (+) groove pattern (see Table 4).

Three maxillary molar teeth LM², RM³, LM³ are tricuspid and classified as grade 3 in Dahlberg's system of hypocone classification (see Table 5). RM¹ is quadricuspid with a fully developed hypocone (grade 4) and RM² exhibits a reduced hypocone (grade 4-). The maxillary canine and lateral incisor are worn too heavily to yield any significant details of morphology.

Odontometrics: Dental crown measurements for specimen MHR 11 are reported in Table 6 while crown indices are given in Table B-12 (Appendix B). These data are statistically and comparatively evaluated in the next section of the report.

Pathology: Though the dental supporting structures are too heavily damaged by post-mortem forces to detect the presence of diseases such as abscesses or periodontal disease, the dental crowns of MHR 11 are free from caries and gross enamel hypoplasia.

Specimen 13 (MHR 13)

Preservation: This burial is devoid of gnathic remains and consists of nine isolated teeth. Though several of these teeth lack roots, all the dental crowns are in a good state of preservation. The four maxillary teeth include LI², RP⁴, RM² and RM³; the five mandibular teeth LM₁, LM₂, RP₃, RM₂, and RM₃.

Tooth wear: The degree of dental attrition in MHR 13 is low in all teeth except LM₁, whose occlusal surface has five medium-sized dentine patches. This individual appears to have been a young adult from the low degree of dental attrition. Most other teeth of this specimen exhibit wear facets on the enamel only.

Two teeth (LM₁ and LM₂) exhibit enamel chipping of the type observed in other Mahurjhari specimens. The LM₂ has had a small enamel chip flaked from the buccal margin of the hypoconid, and the LM₁ has had two small flakes of enamel removed from the hypoconulid or disto-buccal cusp.

Morphology: The maxillary left lateral incisor has a trace of distal marginal ridging and two small pits in the basal cingulum. The RP⁴ is oval in outline, bicuspid and exhibits no unusual anatomical traits. The lingual cusp of RP₃ is small, the occlusal ridge separates the median sulcus into two occlusal pits.

In occlusal morphology, lower second molar teeth (right and left) exhibit a plus (+) four pattern, as does the RM₃. The *Dryopithecus* pattern (Y-5) is present

in the LM1 though the groove pattern is difficult to discern because of mild dental attrition. The maxillary RM² is quadricuspid, but the hypocone is reduced to a small tubercle (grade 3+); RM³ is tricuspid (grade 3) and neither of these teeth exhibit other notable morphological features.

Odontometrics: Dental crown measurements for specimen MHR 13 are presented in Table 6, while crown indices are given in Table B-13 (see Appendix B). These data are statistically summarized and compared with other samples below.

Pathology: Dental caries are present in incipient form in two second lower molars of MHR 13 (R and LM₂). The lower right second molar has a carious pit in the central fovea of the crown, while the left antimere has a smaller carious lesion located in the occlusal groove lateral to the central fovea.

Analytic Summary and Comparative Perspectives

The specimen descriptions and data on dental attributes provided above are summarized here to give a synthetic characterization of the Mahurjhari dentition. Condensed qualitative and statistical assessments of the preservation, dental attrition, tooth crown morphology, odontometry and dental pathology of the Mahurjhari dental sample provide the foundation for comparisons with other samples. The objective is to better understand biological adaptations and patterns of behavior at Mahurjhari from the nature of variations observed in dental attributes. A summary assessment of specimen preservation and each aspect of dental variation is followed with a comparative analysis and interpretation. This analysis facilitates a characterization of the Mahurjhari dentition with variations in preservation and expression of dental attributes in other Iron Age and megalithic skeletal samples reported from central and peninsular India. Significant similarities and differences in diet, health and biological adaptations between Mahurjhari and other samples are enumerated and discussed.

Preservation: Several points summarizing patterns in the state of preservation of the Mahurjhari skeletal series are relevant to the assessment of dental variation in wear, morphology, tooth size and pathology that follows. Specimen descriptions and photographic documentation presented above reveal that while many teeth are preserved in anatomical position in the maxilla and mandible, an equally large number of teeth have been displaced from the jaw by post-burial forces of nature (climatic extremes, soil compaction, chemical erosion, etc). This results in an approximately equal mix of isolated teeth and teeth 'in position', a pattern of preservation that has implications for all aspects of dental analysis. Measurements of the same tooth will vary depending on whether it is isolated or 'in position' in the jaw, because of the relative ease or difficulty of placement of calipers - especially in

measuring the mesio-distal dimension. In the Mahurjhari sample maxillae are less frequently as well preserved as mandibles and thus retain fewer teeth 'in position'. This pattern of preservation may result in a size difference between upper and lower teeth due to the method of measurement applied to isolated or 'in place' dental elements. State of preservation in conjunction with application of measurement will inadvertently cause upper teeth to appear somewhat larger than mandibular teeth.

When isolated teeth comprise a significant portion of the dental sample being studied observations on tooth wear and occlusion are limited. For example, dental crowding and malpositioned, rotated or impacted teeth are difficult to judge when teeth are not anchored 'in position' in the jaw. However, in some cases close examination of wear facets on adjacent teeth may provide sufficient clues to allow an investigator to reconstruct the spatial relationship of teeth in life as improperly positioned or impacted. The description of unusually positioned wear facets in MHR 6 were interpreted as evidence of impaction or malposition of RM₃; providing an example of the challenges of analyzing specimens represented exclusively by isolated teeth.

The fragmented nature of the alveolar bone in many specimens precludes accurate assessment of many conventionally studied pathological variables. These include lesions that develop in and around the cervix or roots of teeth, including: periodontal disease (alveolar recession; periodontitis) and periapical voids (abscesses and granulomas).

Dental Wear: Observation on tooth wear in the Mahurjhari specimen descriptions include new and previously unreported types of wear, including: a) lingual surface wear of maxillary anterior teeth, b) significant disparity in degree of dental wear between anterior and posterior teeth or between right and left sides of the dental arcade, and c) chipping of tooth enamel from the perimeter of the occlusal surface. The main features of these dental wear patterns are summarized and interpreted below yielding valuable new insights regarding masticatory behavior among Iron Age inhabitants of Mahurjhari:

- (a) *Lingual surface wear of maxillary anterior teeth* (LSAMAT) is an unusual pattern of dental wear that is best manifest in MHR 1 (Fig. 4). It is also evident, though less extensively, in incompletely preserved maxillary anterior teeth of MHR 7. This unusual wear pattern has been characterized as "...progressive wearing with age of upper anterior lingual tooth surfaces without corresponding lingual or labial wear on any lower teeth (Turner and Machado, 1983: 126)." In the initial description of this type of dental wear, it was reported to be common in males and females of an archaic Brazilian group in association with high frequency of caries. The combined presence of LSAMAT and caries was

interpreted to result from an abrasive, high carbohydrate diet such as manioc. LSAMAT dental wear has subsequently been found together with high caries rates in an archaic sample from Cerro Mangote, Panama (Irish and Turner, 1987) and more recently, in an historical series from Senegal west Africa (Irish and Turner, 1997). The presence of LSAMAT in the Mahurjhari dental sample is the first recognition of this wear pattern in a South Asian skeletal series. It implies either a coarse or fibrous component of the diet or a habitual non-dietary use of the maxillary anterior teeth, but in both scenarios the mandibular anterior teeth are not involved.

- (b) *Wear differentials.* Two different yet significant disparities in rate of tooth wear were discerned. In one, the observed wear differential is between anterior teeth and molars, in the other the disparity in degree of wear is between right and left side of the dental arcade. The greater degree of wear in anterior teeth *versus* post-canine teeth (especially molars) clearly indicates that some individuals frequently used their anterior teeth in more activities than exclusively for the purpose of ingesting food. The strong differential between heavy wear of incisors and canines contrasts dramatically with the lighter degree of wear in the molar teeth is present in MHR 9 and 10. This suggests the use of anterior teeth as a mechanism for gripping or manipulating materials or objects in occupational activities and is a dental wear feature more commonly found in foragers than intensive food producers (Hinton 1981).

Significant wear differential between antimeres, suggests that mastication in some individuals habitually favored either the right or left side of the dental arcade. The disparity in degree of wear by side was observed in MHR 1 and MHR 9, though the cause of asymmetric wear differs. In MHR 1, dental pathology - loss of the RM₁ crown due to extensive caries, likely initiated chewing on the left side resulting in greater wear on the occlusal surfaces of teeth on the left than the right. In MHR 9, the localization of wear exposing dentine on the left side (LP₄ and LM₁) is likely due to idiosyncratic left-side preference in non-masticatory behavior, such as gripping a pipe stem, or the mouthpiece of a hookah or musical instrument.

- (c) *Enamel chipping and micro-fracture.* An analysis of antemortem dental chipping shows that 66.7% (10/15) of the individuals and 14.7% (32/211) of the total sample of teeth from Mahurjhari are affected. The pattern of enamel chipping by specimen and tooth type is given in Table 7a. The bottom lines reveal the frequency of enamel micro-fracture scars among specimens with one or more visible chip scars, and the frequency of chipping by tooth type in the total Mahurjhari dental sample. Examples of enamel chipping are provided in Figure

Table 7a: Distribution and Frequency of Enamel Chipping by Specimen and Tooth Class

<i>Specimen number</i>	<i>Age</i>	<i>I^l</i>	<i>C</i>	<i>P</i>	<i>M</i>	<i>total</i>	
		+ / n	+ / n	+ / n	+ / n	+ / n	%
1	young adult	0 / 8	0 / 4	2 / 8	1 / 7	3 / 29	
2	mature adult	0 / 3	0 / 2	0 / 3	4 / 7	4 / 15	26.7
3	young adult	0 / 3	0 / 3	3 / 6	4 / 11	7 / 23	30.4
3a	young adult	0 / 5	1 / 1	0 / 4	1 / 7	2 / 18	11.1
5	adult	0 / 0	0 / 0	1 / 3	1 / 3	2 / 7	28.6
6	adult	0 / 0	0 / 0	0 / 0	4 / 4	4 / 10	40.0
7	mid-adult	0 / 4	0 / 2	0 / 6	2 / 9	2 / 21	9.5
8a	young adult	0 / 0	0 / 1	0 / 2	1 / 8	1 / 11	9.1
9	older adult	0 / 1	0 / 3	2 / 6	2 / 5	4 / 15	6.7
13	young adult	0 / 1	0 / 0	0 / 2	2 / 6	2 / 9	22.2
spec with chipped	various	0 / 17	1 / 12	8 / 32	22 / 32	31 / 158	
		0.0%	8.3%	25.0%	68.8%	19.6%	
all teeth	various	0 / 30	1 / 24	8 / 53	22 / 104	31 / 211	
% chipped		0.0%	4.2%	15.1%	21.2%	14.7%	

1) key to abbreviations. I = Incisor; C = Canine; P = Premolar; M = Molar

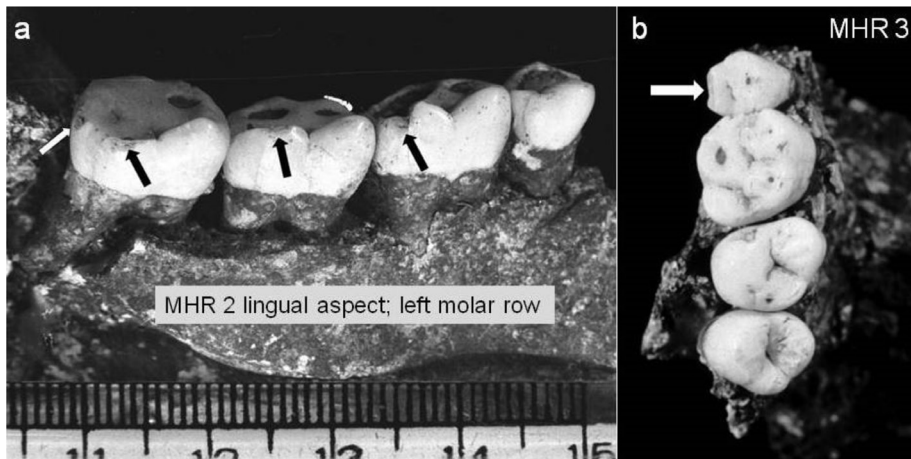


Figure 13: Enamel chipping. a) MHR 2: multiple ante-mortem enamel chips scars along the lingual aspect of the left molar row (arrows). b) MHR 3: large enamel chip from lingual aspect of LP⁴ (arrow).

and Spain (Scott and Winn, 2011). The localization of these enamel chip scars on post-canine teeth, and their absence from anterior teeth, suggests a dietary cause as proposed by prior studies (Turner and Cadien, 1969; Scott and Winn, 2011). If the enamel chipping resulted primarily from the use of teeth as tools in occupational endeavors, the distribution of scars would be localized on anterior teeth. Enamel chipping suggests that tough, hard items were regularly incorporated into the Mahurjhari diet, though the precise cause of chipping cannot be specifically determined from the scars themselves. Contaminants in food, such as small hard seeds, minute bone fragments in meat, or gnawing of bone are possibilities to be considered. The bones of wild and domestic mammals at Mahurjhari show evidence of charring and cut marks, indicating consumption of meat from numerous species (Deshpande-Mukherjee et al., 2010); an observation that lends support to the dietary hypothesis for enamel chipping. The large size of the Mahurjhari molar teeth (discussed below) agrees well with these evidences of heavy masticatory stress. Large teeth are better suited to the effective mastication of tough, hard items and they are less likely to be damaged. The heavy attrition seen in the dentition of some individuals, the prevalence of enamel chipping in the post-canine dentition, and the large size of molar teeth are all related aspects of subsistence on a diet of coarse and tough food or bone fragments contained in meat.

Dental Morphology: The observed frequency of shoveling of maxillary incisors is low. Eight specimens preserved one or more maxillary lateral incisor teeth and

The frequency of occurrence of morphological features of maxillary and mandibular molar teeth is summarized in Table 7 (b, c, d). The frequency, in percent, is given for each variant of each morphological trait; the number of teeth exhibiting the feature is given over the total number of teeth examined. The frequency of occurrences of hypocone size variants are given in Table 7a. In this case, 87.5 percent

	grades of trait expression							
cuspid size	4		4 -		3+		3	
tooth	L	R	L	R	L	R	L	R
M ²	0.0 (0 / 8)	11.1 (1 / 9)	25.0 (2 / 8)	33.3 (3 / 9)	37.5 (3 / 8)	44.4 (4 / 9)	37.5 (3 / 8)	11.1 (1 / 9)
M ³	16.7 (1 / 6)	16.7 (1 / 6)	16.7 (1 / 6)	33.3 (2 / 6)	16.7 (1 / 6)	33.3 (2 / 6)	50.0 (3 / 6)	50.0 (3 / 6)

	grades of trait expression					
groove	Y		+		X	
tooth	L	R	L	R	L	R
M ₁	88.9 (8 / 9)	100.0 (9 / 9)	11.1 (1 / 9)	0.0 (0 / 9)	0.0 (0 / 9)	0.0 (0 / 9)
M ₂	0.0 (0 / 9)	36.4 (4 / 11)	100.0 (9 / 9)	63.6 (7/11)	0.0 (0 / 9)	0.0 (0 / 11)
M ₃	0.0 (0 / 6)	0.0 (0 / 6)	33.3 (2 / 6)	66.7 (4 / 6)	66.7 (4 / 6)	33.3 (2 / 6)

	grades of trait expression					
<i>cuspth n</i> ¹	6		5		4	
<i>tooth</i>	<i>L</i>	<i>R</i>	<i>L</i>	<i>R</i>	<i>L</i>	<i>R</i>
M ₁	0.0 (0 / 10)	0.0 (0 / 9)	90.0 (9 / 10)	88.9 (8 / 9)	10.0 (1 / 10)	11.1 (1 / 9)
M ₂	0.0 (0 / 11)	0.0 (0 / 12)	0.0 (0 / 11)	8.3 (1 / 12)	100.0 (11 / 11)	91.7 (11 / 12)
M ₃	16.7 (1 / 6)	14.3 (1 / 7)	33.3 (2 / 6)	0.0 (0 / 7)	50.0 (3 / 6)	85.7 (6 / 7)

1) n = number

of maxillary right first molar teeth showed the grade 4 of this trait, an actual count of seven out of the total of eight teeth examined. Table 7a shows that first molars are predominantly quadricuspid (grade 4) but a few instances of slight hypocone reduction (grade 4-) occur. The existence of several tritubercular second molars, 11.1 percent of right and 37.5 percent of left, indicates significant reduction in hypocone size in the Mahurjhari series. In general though, both second and third maxillary molar teeth are very variable in their expression of hypocone size. Although all four grades of the trait are found in third molars, the three-cusped form (grade 3) occurs most frequently in both right and left antimeres.

These observations of hypocone size indicate that first molars are more stable in their expression of this trait while second and third molars exhibit greater variability. This observation is in agreement with Butler's Field Concept of dental differentiation and variation. Secondly, reduction in hypocone size is greater in third molars than in second molars and greater in second molars than in first molars. This observation confirms the theory that dental reduction is occurring differentially and affects the more posteriorly located teeth in each tooth class.

The frequency of lower molar occlusal groove patterns is presented in Table 7b. The first mandibular molar teeth, being evolutionarily more conservative than second and third molars, exhibit the primitive Y-pattern more frequently than both second and third molars. The Y pattern does not occur in third molar teeth and occurs infrequently in second molar teeth.

Cusp number frequencies for lower molar teeth are given in Table 7c. The only teeth that have six cusps are third molars. First molars are predominately five-cusped (88.9 percent of right and 90 percent of left), though four-cusped first molars occur with a frequency of 10 to 11 percent. Once again, third molar teeth are most variable in the expression of cusp number, exhibiting four cusps most frequently, and six- and five-cusped forms less frequently.

Accessory cusps are infrequent in the Mahurjhari dental sample. Special note should be made of the absence of Carabelli's tubercle in this dental sample.

Odontometry: Descriptive statistics are presented for primary and composite odontometric data, then tooth size of the Mahurjhari dentition is compared with prehistoric South Asian and living Asian samples. Mean mesiodistal (MD) and buccolingual (BL) crown diameters with sample sizes and standard deviations are given in Table 8. Mean values are reported independently for right and left antimeres, though the differences are small. Mean crown indices, with sample sizes, and standard deviations are presented in Table 9. The computation of indices follows the methods recommended by Kieser (1990) and Wolpoff (1971). The subsequent analysis focuses on tooth size (crown area) by individual tooth and for compound

Table 8: Mean crown diameters of permanent teeth.

tooth	side	Maxilla				Mandible			
		Mesiodistal (MD)		Buccolingual (BL)		Mesiodistal (MD)		Buccolingual (BL)	
		0 (n)	sd	0 (n)	sd	0 (n)	sd	0 (n)	sd
I1	R	8.85 (4)	0.35	7.43 (4)	0.21	5.65 (4)	0.24	6.10	0.24
	L	8.77 (3)	0.50	7.37 (3)	0.23	5.54 (5)	0.25	6.02	0.33
I2	R	7.45 (2)	0.21	6.45 (2)	0.35	6.40 (3)	0.85	6.25	0.49
	L	6.90 (6)	0.52	6.38 (5)	0.25	6.15 (2)	0.07	6.40	0.14
C	R	7.35 (4)	0.47	8.35 (4)	0.26	6.84 (5)	0.47	7.82	0.47
	L	7.78 (5)	0.37	8.45 (6)	0.57	6.76 (5)	0.28	7.86	0.21
P3	R	6.86 (8)	0.37	9.21 (8)	0.36	7.01 (7)	0.33	7.94	0.43
	L	6.97 (3)	0.06	9.15 (4)	0.19	6.83 (6)	0.24	7.90	0.40
P4	R	6.66 (8)	0.47	9.41 (8)	0.38	7.31 (7)	0.27	8.16	0.45
	L	6.90 (3)	0.36	9.07 (3)	0.61	7.00 (6)	0.18	8.30	0.60
M1	R	10.59 (8)	0.49	11.55 (8)	0.43	11.46 (9)	0.39	10.77	0.34
	L	10.49 (7)	0.43	11.60 (7)	0.32	11.33 (10)	0.40	10.67	0.30
M2	R	9.32 (9)	0.54	11.33 (9)	0.94	11.08 (12)	0.50	10.33	0.28
	L	9.16 (8)	0.59	11.23 (8)	0.61	10.89 (11)	0.54	10.27	0.39
M3	R	8.85 (6)	0.43	11.32 (6)	0.72	10.67 (7)	0.77	10.27	0.58
	L	9.63 (6)	0.96	11.63 (6)	1.13	10.92 (6)	0.76	10.10	0.49

summary values for maxillary, mandibular and total tooth crown size. Tooth crown area receives attention in this analysis because it is an estimate of biting surface area which is believed to reflect the functional adaptive competence of the masticatory apparatus. Coarse, tough and abrasive diets requiring forceful mastication preserve large tooth size in a population through the evolutionary process of natural selection. Soft, refined and highly processed foods relax selection for large tooth size and result in smaller teeth through the process of dental reduction in crown areas.

If the crown area of all upper and lower teeth from one side of the dental arch are summed, the total crown area for the Mahurjhari sample is 1219.9 mm² (right) and 1220.0 mm² (left). Two comparisons are used to help interpret tooth size (crown area) at Mahurjhari. The first analysis compares Mahurjhari with recently published data for Kodumanal, a megalithic skeletal sample from a site 60

Table 9: Mean crown indices of permanent teeth.

tooth	side (n)	Crown Area		Crown Index		Crown Module	
		0	sd	0	sd	0	sd
maxilla							
I1	R (4)	67.25	2.69	119.20	3.53	8.14	0.26
	L (3)	64.64	5.44	118.97	4.38	8.07	0.35
I2	R (2)	48.09	4.00	115.59	3.08	6.95	0.28
	L (5)	43.60	4.93	106.82	5.92	6.60	0.38
C	R (4)	61.45	5.50	87.98	3.99	7.85	0.35
	L (5)	66.61	7.53	91.23	2.75	8.16	0.47
P3	R (8)	63.31	5.56	74.49	2.64	8.04	0.34
	L (3)	65.40	1.87	76.51	1.17	8.03	0.12
P4	R (8)	62.72	5.50	70.86	5.23	8.04	0.32
	L (3)	62.71	7.41	76.16	1.19	7.98	0.49
M1	R (8)	122.38	8.92	91.71	3.94	11.07	0.40
	L (7)	121.72	7.85	90.39	2.41	11.04	0.35
M2	R (9)	105.91	13.16	82.54	5.41	10.33	0.66
	L (8)	102.79	7.67	81.88	7.46	10.19	0.38
M3	R (6)	100.05	6.17	78.55	7.51	10.08	0.34
	L (6)	112.31	17.71	83.27	10.10	10.63	0.83
mandible							
I1	R (4)	34.45	1.52	92.78	6.43	5.88	0.13
	L (5)	33.39	2.90	92.15	4.41	5.78	0.26
I2	R (2)	37.68	7.39	95.85	3.72	6.13	0.60
	L (2)	39.36	0.42	96.13	3.22	6.28	0.04
C	R (5)	53.64	6.87	87.47	3.06	7.33	0.45
	L (5)	53.17	3.45	85.99	1.96	7.24	0.38
P3	R (7)	55.80	5.32	88.40	3.52	7.48	0.35
	L (6)	54.00	3.78	86.65	4.67	7.37	0.26
P4	R (7)	59.63	3.37	89.94	6.55	7.74	0.23
	L (6)	58.10	4.48	84.40	6.28	7.65	0.32
M1	R (9)	123.37	6.40	106.46	4.06	11.11	0.29
	L (10)	119.83	5.27	106.27	5.07	11.00	0.24
M2	R (11)	114.54	6.71	107.38	4.81	10.70	0.32
	L (12)	111.96	8.14	106.08	5.21	10.58	0.39
M3	R (7)	109.63	10.27	104.16	9.30	10.47	0.49
	L (6)	110.45	11.92	108.12	6.00	10.51	0.57

kms east of Coimbatore (Munshrif-Tripathy et al., 2011). Mean crown area for each tooth of the Kodumanal (KOD) series was computed from Tables 4.5a and 4.5b, respectively (Munshrif-Tripathy et al., 2011, pgs 78-81). Values for the left side crown area was used in computing the mean (and standard deviation), but if unavailable, the right side was used; a standard practice used to enhance sample size. For the Mahurjhari sample, the side (right or left) with the larger sample size was used in the comparison, if side had equal sample size, the side with the lower standard deviation was selected. The results of this analysis are presented in Table 10 and Figure 14. Significant differences in tooth crown area were found in ten of 16 or 62.5% of the inter-site comparisons. These differences are starred on the bar chart (Fig. 14) and actual probability values are given in the middle column of Table 10, and mean crown sizes of MHR teeth are consistently larger than KOD. These differences are easily visualized in Figure 14, which shows the greatest distinctions are in maxillary and mandibular molar teeth, lower canine and premolars, and the central maxillary incisor. The bottom line of Table 10 shows that in total crown area

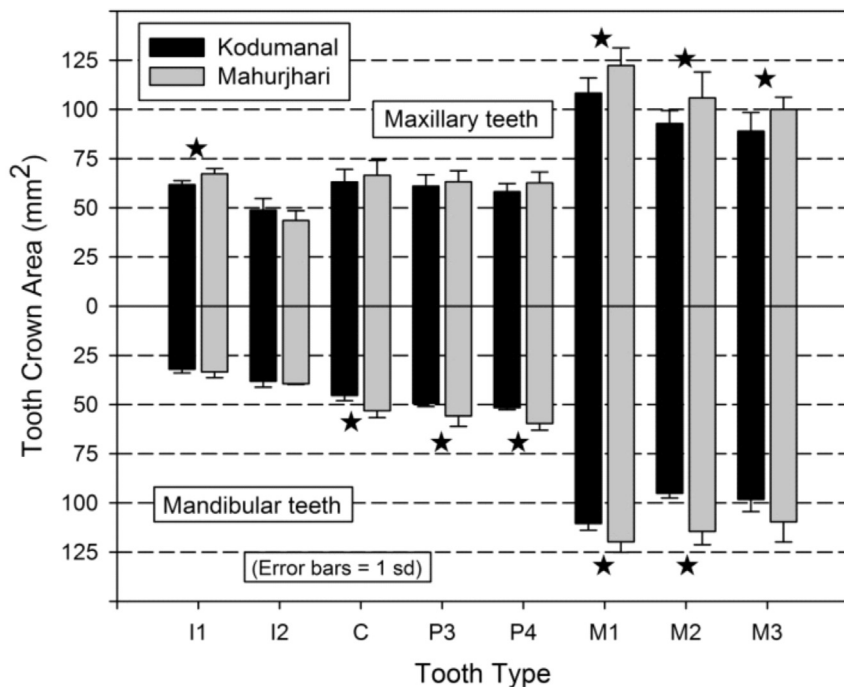


Figure 14: Mean tooth crown areas (mm²) of maxillary (above guideline) and mandibular teeth (below guideline) of Mahurjhari and Kodumanal compared. Note MHR frequently larger than Kodumanal in mean crown area. Error bars = 1 standard deviation; stars indicate significant differences ($\alpha < 0.05$) in crown size. (see Table 10 for data and statistics).

MHR (1217.2 mm²) is 113.8 mm² larger than the KOD total tooth size (1103.4 mm²). Analysis of tooth crown area by Brace (1980) showed that differences of 50 mm² are likely to be statistically significant (at $\alpha = 0.05$), while differences greater than 100 mm² are interpreted to be highly significant ($\alpha = 0.01$). The mandibular teeth contribute more to the overall crown size difference, with MHR mandibular teeth 65.1 mm² greater than KOD, while the maxillary crown area for MHR is 48.7 mm² larger than KOD. Sample sizes are small overall, reducing the power of statistical tests for differences in sample means. However, based on the samples studied the Mahurjhari dentition is larger in crown surface area than that from Kodumanal.

Table 10: Tooth crown areas compared (mm²): Kodumanal (KOD) and Mahurjhari (MHR)

site	KOD	n	sd	p	MHR	n	sd
maxilla							
I1	61.8	3	2.1	0.0335	67.3	4	2.7
I2	48.8	5	6.0	0.1440	43.6	5	4.9
C	63.2	3	6.3	0.1779	66.6	5	7.5
P3	61.0	7	5.8	0.4490	63.3	8	5.6
P4	58.2	8	4.1	0.0847	62.7	8	5.5
M1	108.3	7	7.7	0.0063	122.4	8	8.9
M2	92.9	8	6.5	0.0401	105.9	5	13.2
M3	88.9	6	9.6	0.0373	100.1	6	6.2
max	583.1				631.9		
mandible							
I1	31.97	3	1.97	0.4942	33.4	5	2.9
I2	38.13	4	3.06	0.6069	39.4	2	0.4
C	45.35	4	2.69	0.0081	53.2	5	3.5
P3	49.44	7	1.51	0.0096	55.8	7	5.3
P4	51.58	6	0.99	0.0002	59.6	7	3.4
M1	110.46	7	3.39	0.0010	119.8	10	5.3
M2	95.09	7	2.37	0.0001	114.5	12	6.7
M3	98.23	4	6.19	0.0778	109.6	7	10.3
mand	520.2				588.3		
total	1103.4				1217.2		

The second analysis views Mahurjhari tooth crown areas in comparison with prehistoric South Asian skeletal samples from a wide range of temporal settings, subsistence systems and cultural associations. Composite or summary crown areas for maxillary and mandibular teeth and for total crown area are provided in Table 11 and Figure 15. This analysis is methodologically rigorous because data for all

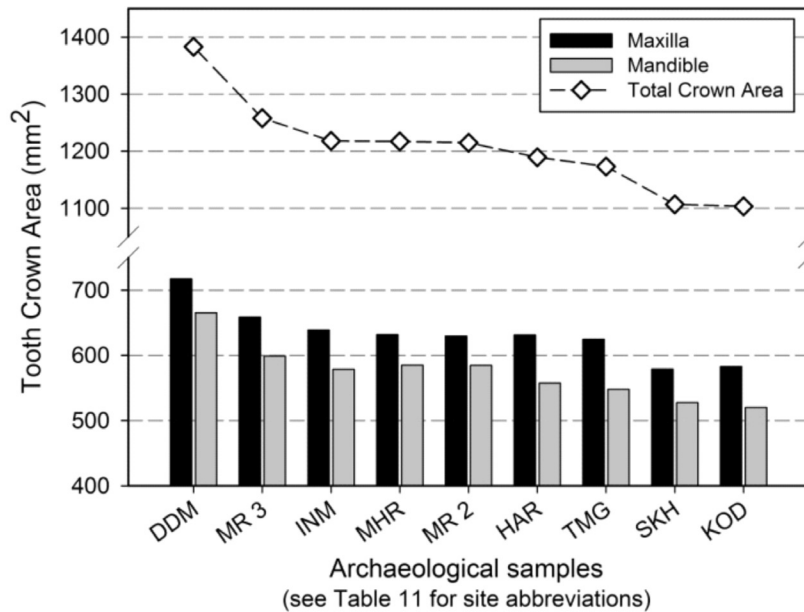


Figure 15: Aggregate tooth crown areas (mm^2) for selected prehistoric sites in South Asia. Total crown area - top (line and symbol graph); Bar chart (below) shows maxillary (black bar) and mandibular (grey bars) tooth crown areas. (see Table 11 for data).

Table 11: Comparison of composite crown areas (sexes pooled)

Site name	code	culture	Tooth Crown Area (mm^2)			data source
			Maxilla	Mandible	total	
Damdama	DDM	Mesolithic	717.6	665.4	1383.0	Lukacs, 2004
Mehrgarh 3	MR 3	Neolithic	658.7	599.3	1258.0	Lukacs, 1986
Inamgaon	INM	Chalcolithic	639.0	579.0	1218.0	Lukacs, 1985
Mahurjhari	MHR	Iron Age	631.9	585.3	1217.2	this report
Mehrgarh 2 ¹	MR 2	Chalcolithic	629.7	584.9	1214.6	Lukacs & Hemphill, 1991
Harappa	HAR	Bronze Age	631.4	557.8	1189.2	Hemphill et al., 1991
Timargarha	TMG	Iron Age	624.9	548.2	1173.1	Lukacs, 1983
Sarai Khola	SKH	Iron Age	579.1	527.8	1106.9	Lukacs, 1983
Kodumanal	KOD	Iron Age	583.1	520.2	1103.3	Muschrif-Tripathy et al, 2011

(1) pooled sex mean crown areas for MR 2, were derived by calculating weighted mean of male and female mean crown areas.

other samples (except Kodumanal) are from samples measured and analyzed by Lukacs. Key sites are arranged in descending order of total crown area (dashed line and symbol plot) from left to right in Fig. 15. The different contribution that

maxillary teeth (larger) and mandibular teeth (smaller) make to total tooth size is shown in the bar chart. Note that Mesolithic foragers (Damdama) of the Ganga plain and early farmers of Neolithic Baluchistan have larger teeth than more recent samples from India and Pakistan that are associated with iron, such as Kodumanal (Tamil Nadu) and Sarai Khola (Punjab) (Lukacs and Pal, 2016). What is especially noteworthy in this plot is that megalithic Mahurjhari is most similar in overall tooth size to chronologically earlier sites with more basic Mesolithic and Neolithic technologies (Lukacs, 1984).

If attention is focused on the crown size of molar teeth, the molar crown area for Mahurjhari is 672.3 mm^2 a value similar to figures for Bellan Bandi Palassa (Sri Lanka; 675.88 mm^2 to Bhimbetka (central India; 677.97 mm^2). These figures are among the largest known for prehistoric South Asian populations, while at the small end of the molar size spectrum are Harappans (595.20 mm^2) and the inhabitants of Mohenjo-daro (607.14 mm^2). Other Iron Age samples for which molar crown area values are known have smaller molar teeth than the Mahurjhari sample, notably Pomparippu (Sri Lanka; 625.50 mm^2), Sarai Khola (Pakistan; 616.49 mm^2), and Kodumanal (604.0 mm^2). The large size of the Mahurjhari teeth is evident in the broad comparative assessment of molar crown size conducted by Munshrif-Tripathy and colleagues (2011; p. 83, Table 4.6), and is best interpreted in conjunction with extensive evidence of post-canine enamel chipping documented above.

A few final remarks help contextualize Mahurjhari tooth crown size in Asian and Australasian perspective. Brace (1980) reports total tooth crown areas of from 1300 mm^2 to 1500 mm^2 for modern Australian aborigines. Modern Asian populations, Chinese and Malaysians, have smaller total crown areas of approximately 1100 mm^2 to 1200 mm^2 (Brace, 1978). These figures provide a basic framework for interpreting the 1220 mm^2 total crown area for Mahurjhari.

Dental Pathology: This analysis confirms and adds new insight to the initial assessment of pathological dental lesions at Mahurjhari (Lukacs, 1981). Given limitations due to state of preservation, observations of dental health are primarily focused on lesion of the teeth rather than the jaws. One or more dental caries were found in 53.3% of the individuals studied ($n=15$), and in 7.7% of the teeth ($n=196$). Caries occur primarily in the molar tooth class, of which 15.3% ($n=98$) were affected. These observations indicate a subsistence pattern that included processed carbohydrate foods of a cariogenic nature. Evidence of disrupted patterns of growth and development comes from the presence of linear enamel hypoplasia in the permanent teeth of four individuals. Impacted and malpositioned molar teeth, crowding of anterior mandibular incisors, and evidence suggestive of occlusal

overbite, indicate that the Mahurjhari dentition was in process of adapting to relaxation of masticatory stress. A diet that permits a reduction in occlusal force results in different types of occlusal variation as documented in the Mahurjhari series. This observation agrees with the modest level of wear on molar teeth, yet contrasts with the large size (crown area) of the dentition. The presence of dental chipping may result from contaminants in food, such as small flakes of bone or stone, that accidentally yet repetitively caused micro-fracture of the margins of the occlusal surface. Enamel chipping is not conclusive evidence of a forceful masticatory apparatus, foreign objects in highly processed modern human diets can cause fractures of the tooth crown.

Conclusions From Dental Anthropology²

- (1) The pattern of dental wear and the occurrence of dental chipping further indicates the coarse and abrasive nature of the Mahurjhari diet. Analysis of dental wear yields evidence of hard objects in the diet and distinctive wear of maxillary anterior teeth. The presence of impacted molar teeth in two individuals, a malpositioned maxillary canine in another, and dental crowding suggests relaxation of natural selection on masticatory function. This leads to the inference that aspects of malocclusion at Mahurjhari may result from changing patterns of subsistence and diet.
- (2) Morphological features of the Mahurjhari dentition do not clearly link this skeletal series with any specific biological population. The absence of Carabelli's trait decreased the likelihood of recent or direct European affinities, and the low expression of maxillary incisor shoveling suggests distant affinities with central or East Asian populations. The small sample size for which reliable crown morphology can be determined hinders firm conclusions regarding the biological affinities of this Mahurjhari sample.
- (3) Assessment of tooth crown area of the Mahurjhari dentition reveals its large size in comparison with other prehistoric South Asian skeletal series. Individual tooth crown size areas in the Mahurjhari sample are frequently and significantly larger in size than teeth from Kodumanal. In a pan-South Asia comparison, total crown (and its components, maxillary and mandibular crown areas) show greater similarity to Chalcolithic series, than to other Iron Age groups. The large molar tooth size may indicate that the people of Mahurjhari practiced a mixed-subsistence economy, and that their diet included both products of agriculture and fruits of the hunt. Hunters and gatherers have been shown to have larger teeth than people who have practiced agriculture for several millennia. In this analysis it is crucial to recall that tooth size is a stable biological attribute and

one that is slow to change in response to changes in diet and food preparation techniques. Large tooth size in the Mahurjhari sample may lag behind recent changes subsistence and dietary. Large teeth in small jaws gives rise to dental crowding and impacted molar teeth that have been observed in this series.

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Appendix A

Catalog of Human Skeletal Remains from Iron Age Mahurjhari (1979).

prepared July 1979; by John R. Lukacs

Deccan College Post-Graduate & Research Institute, Poona

This catalogue provides an inventory of skeletal elements from burials at the megalithic Iron Age site of Mahurjhari. The list enumerates complete and fragmentary bones from each burial as they were inventoried during the preliminary identification process. Archaeological and locality data were retrieved from field tags accompanying specimen bags and boxes shipped from the field to Deccan College osteology laboratory (see also Table 1 of the text).

Burial number 1 (MHR 1)

MHR excavation 1978-79

NW quadrant; megalith no. 7

date: 18/2/1979

material: human bone

- (a) skull w/ mandible & maxilla
- (b) tibia (right)
- (c) tibia & fibula (left)
- (d) humerus (right)
- (e) humerus (left)
- (f) radius (right)
- (g) radius (left)
- (h) femur (right)
- (i) femur (left)
- (j) fibula (right)
- (k) astragalus & calcaneus
- (l) phalanges (left)

Burial number 2 (MHR 2)

MHR excavations 1978-79

NE quadrant; megalith no. 3

date: 20/2/1979

material: bone (w/ cranium)

- (a) mandible & isolated teeth
- (b) radius (left)
- (c) radius (right)
- (d) ulna (right)
- (e) ulna (left)
- (f) humerus (right)

- (g) humerus (left)
- (h) femur (right); fgts 3, 4
- (i) femur (left); fgts 1, 2, 3, 4 & 5
- (j) tibia (left); fgts 3, 4 & 5
- (k) tibia and fibula (right); fgts. 1, 2, 3 & 4 (in three boxes)
- (l) phalanges & bone fragments
- (m) fragment of cranium
- (n) femur (?) no element id on tag
- (o) tibia (?) no element id on tag

Burial number 3 (MHR 3)

MHR excavation 1978-79

NW quadrant; megalith no. 8

date: 20/3/1979

material: human bone & mandible

- (a) mandible, maxillary fgts, isolated teeth
- (b) tibia (left)
- (c) femur (right), pcs. 1 & 2
- (d) femur (left)
- (e) radius & ulna (left) fragments
- (f) clavicle (left)
- (g) hip bone w/ head of femur (left)
- (h) fibula (right)
- (i) tibia & fibula (left)
- (j) tibia (right)
- (k) tarsals & metatarsals (right)
- (l) part of clavicle (right)
- (m) radius & ulna (right)
- (n) carpals & phalanges (right)
- (o) humerus (right)
- (p) humerus (left)
- (q) humerus shaft bone (right)

Burial number 3a (MHR 3a)

MHR excavations 1978-79

NW quadrant; megalith 8

date: 20/3/1979

material: bone - skull of child(?)

- (a) crushed body w/ cranium & mandible

Burial number 4 (MHR 4)

MHR excavation 1978-79

SW quadrant; megalith no. 8

date: 18/3/1979

material: bone (human)

- (a) human bone pieces
- (b) human skull pieces
- (c) femur (left)
- (d) human bone fragments (totally destroyed)
- (e) tibia in pieces (? side)
- (f) radius in pieces (? side)
- (g) no cranial or dental remains with material from burial 4

Burial number 6 (MHR 6)

MHR Excavations 1978-79

SW quadrant; megalith no. 3

date: 19/3/1979

material: bone (skull)

- (a) badly crushed skull w/ isolated maxillary teeth
- (b) scapula bone (right)
- (c) tibia (right)
- (d) tibia (left)
- (e) femur (right)
- (f) femur (left)
- (g) humerus (left; pcs. 1 & 2)

Burial number 6a (MHR 6a)

MHR excavation 1978-79

SW quadrant; megalith no. 3

date: 18/3/1979

material: bone - human (skull)

- (a) complete mandible
- (b) maxillary fragt, w/ isolated upper teeth
- (c) humerus (left)
- (d) femur (left)
- (e) human bone pieces disturbed (3 boxes)
- (f) tibia and ulna (? side)

Burial number 7 (MHR 7)

MHR excavation 1978-79

SW quadrant; megalith 3

date: 18/3/1979

- (a) damaged mandible, isolated maxillary teeth
- (b) clavicle pieces (right)
- (c) clavicle pieces (right)
- (d) human skull pieces

Burial number 8 (MHR 8)

MHR excavation 1978-79

SE quadrant; megalith no. 9

date: 18/3/1979

material: bone - skull

- (a) mandibular & maxillary fgts. damaged
- (b) human bone fragments

Burial number 9 (MHR 9)

MHR excavation 1978-79

NE / SW quadrant; megalith no. 10

date: 29/3/1979

material: skull w/ mandible

- (a) skull (damaged), mandible & maxilla present
- (b) femur, pieces (?side)

Burial number 10 (MHR 10)

MHR excavation 1978-79

SW quadrant; megalith no. 5

date: 18/3/1979

material: mandible (human) right half

- (a) mandible - incomplete & fragmentary
- (b) no post-cranial bone known from this burial

Burial number 11 (MHR 11):

MHR excavation 1978-79

NW quadrant; megalith no. 5

date: 20/3/1979

material: skull bone fgts, w/ mandible

- (a) crushed cranium w/ isolated maxillary teeth
- (b) complete mandible
- (c) femur (right) fragments

Burial number 13 (MHR 13)

MHR excavation 1978-79

NW quadrant; megalith no. 29

date: 20/3/1979

material: bones & teeth

- (a) isolated dental elements, no post-cranial bone known from this burial

Appendix B

Tooth crown measurements (in mm.) and crown indices (Crown Area, Crown Index, and Crown Module for each specimen with teeth preserved.

<i>Side / Tooth</i>	<i>MD^l</i>	<i>BL</i>	<i>CA</i>	<i>CI</i>	<i>CM</i>
maxilla					
RM1	10.5	11.3	118.65	92.92	10.9
RP4	7.0	9.3	65.00	75.27	8.15
RP3	6.7	9.1	60.97	73.63	7.90
RC	7.7	8.3	63.91	92.77	8.00
RI2	7.6	6.7	50.92	113.43	7.15
RI1	9.2	7.4	68.08	124.32	8.30
LI1	9.3	7.5	69.75	124.00	8.40
LI2	7.4	6.8	50.32	108.82	7.10
LC	7.5	8.4	63.00	89.29	7.95
LP3	7.0	9.1	63.70	76.92	8.05
LP4	7.0	9.2	64.40	76.09	8.10
LM1	10.4	11.3	117.52	92.04	10.85
LM2	8.5	11.4	96.9	74.56	9.95
mandible					
RM3	9.9	11.0	108.90	90.00	10.45
RM2	11.2	10.2	114.24	109.80	10.70
RP4	7.7	8.2	63.14	93.90	7.95
RP3	7.0	7.6	53.20	92.11	7.30
RC	6.8	7.9	53.72	86.08	7.35
RI2	6.1	6.5	39.65	93.85	6.30
RI1	5.5	5.9	32.45	93.22	5.70

<i>Side / Tooth</i>	<i>MD¹</i>	<i>BL</i>	<i>CA</i>	<i>CI</i>	<i>CM</i>
LI1	5.5	6.0	33.00	91.67	5.75
LI2	6.2	6.3	39.06	98.41	6.25
LC	6.7	7.7	51.59	87.01	7.20
LP3	6.9	7.7	53.13	89.61	7.30
LP4	7.0	8.4	58.80	83.33	7.70
LM2	11.1	10.5	116.55	105.71	10.80
LM3	10.3	10.3	106.09	100.00	10.30
1) Abbreviations: MD = mesiodistal; BL= buccolingual;CA=Crown Area; CI=Crown Index; CM=Crown Module; U= upper jaw (maxilla); L=lower jaw (mandible).					

Table B-1: Odontometric data: MHR 1

<i>side / tooth</i>	<i>MD¹</i>	<i>BL</i>	<i>CA</i>	<i>CI</i>	<i>CM</i>
MHR 2 maxilla					
RM2	9.9	12.6	124.74	78.57	11.25
RM1	10.0	13.5	135.00	74.07	11.75
mandible					
RM2	11.5	11.0	126.50	104.55	11.25
RM1	11.4	11.5	131.10	99.13	11.45
RP4	7.1	9.1	64.61	78.02	8.10
RP3	7.6	8.6	65.36	88.37	8.10
RC	6.8	7.5	51.00	90.67	7.15
RI1	5.5	6.2	34.10	88.71	5.85
LI1	5.5	6.2	34.10	88.71	5.85
LI2	6.1	6.5	39.65	93.85	6.30
LC	6.9	8.1	55.89	85.19	7.50
LP4	6.8	9.2	62.56	73.91	8.00
LM1	11.1	11.3	125.43	98.23	11.20
LM2	10.9	10.9	118.81	100.00	10.90
LM3	12.0	10.8	129.60	111.11	11.40
MHR 2A maxilla					
RP3	7.4	9.5	70.30	77.89	8.45
LM1	10.2	11.6	118.32	87.93	10.90
mandible					
LM2	10.7	10.2	109.14	104.90	10.45
1) Abbreviations: MD = mesiodistal; BL=buccolingual; CA=Crown Area; CI=Crown Index; CM=Crown Module; U= upper jaw (maxilla); L=lower jaw (mandible).					

Table B-2: Odontometric data: MHR 2 and 2a.

<i>side / tooth</i>	<i>MD¹</i>	<i>BL</i>	<i>CA</i>	<i>CI</i>	<i>CM</i>
maxilla					
RM3	8.6	11.8	101.48	72.88	10.20
RM2	8.8	12.1	106.48	72.73	10.45
RM1	11.3	11.8	133.34	95.76	11.55
RP4	6.8	9.2	62.56	73.91	8.00
RP3	6.6	8.7	57.42	75.86	7.65
RC	7.7	8.8	67.76	87.50	8.25
RI1	8.6	7.4	63.64	116.22	8.00
LI1	8.7	7.5	65.25	116.00	8.10
LI2	6.7	6.2	41.54	108.06	6.45
LP3	7.0	9.3	65.10	75.27	8.15
LP4	6.5	8.4	54.60	77.38	7.45
LM1	10.9	11.8	128.62	92.37	11.35
LM2	8.8	12.0	105.60	73.33	10.40
LM3	8.6	11.0	94.60	78.18	9.80
Mandible					
RM2	11.0	10.4	114.40	105.77	10.70
RM1	11.4	10.8	123.12	105.56	11.10
LC	6.9	7.9	54.51	87.34	7.40
LP3	6.7	7.7	51.59	87.01	7.20
LP4	6.9	7.4	51.06	93.24	7.15
LM1	11.0	10.9	119.90	100.92	10.95
LM2	10.3	10.2	105.06	100.98	10.25
LM3	9.9	9.7	96.03	102.06	9.80
1) Abbreviations: MD = mesiodistal; BL= buccolingual; CA=Crown Area; CI=Crown Index; CM=Crown Module; U= upper jaw (maxilla); L=lower jaw (mandible).					

Table B-3: Odontometric data: MHR 3

<i>side / tooth</i>	<i>MD¹</i>	<i>BL</i>	<i>CA</i>	<i>CI</i>	<i>CM</i>
maxilla					
RM2	9.2	11.0	101.20	83.64	10.10
RM1	9.9	11.4	112.86	86.84	10.65
RP4	6.5	9.0	58.50	72.22	7.75
RP3	6.7	8.8	58.96	76.14	7.75
RC	7.7	8.6	66.22	89.53	8.15

<i>side / tooth</i>	<i>MD¹</i>	<i>BL</i>	<i>CA</i>	<i>CI</i>	<i>CM</i>
RI1	8.5	7.2	61.20	118.06	7.85
LI1	8.3	7.1	58.93	116.90	7.70
LP3	6.9	8.9	61.41	77.53	7.90
LM1	10.2	11.4	116.28	89.47	10.80
LM2	9.1	11.0	100.00	82.73	10.50
mandible					
RM2	11.0	9.9	108.90	111.11	10.45
RM1	10.7	10.4	111.28	102.88	10.55
RP4	7.2	8.1	58.32	88.89	7.65
RC	6.7	7.5	50.25	89.33	7.10
RI2	7.2	--	--	--	--
RI1	6.0	5.9	35.40	101.69	5.95
LI1	5.9	6.0	35.40	98.33	5.95
LM1	10.7	10.5	112.35	101.90	10.60
1) Abbreviations: MD = mesiodistal; BL= buccolingual; CA=Crown Area; CI=Crown Index; CM=Crown Module; U= upper jaw (maxilla); L=lower jaw (mandible); -- = no data.					

Table B-4: Odontometric data: MHR 3a.

<i>side / tooth</i>	<i>MD¹</i>	<i>BL</i>	<i>CA</i>	<i>CI</i>	<i>CM</i>
maxilla					
LC	7.3	7.6	55.48	96.05	7.45
mandible					
RM2	11.3	10.6	119.78	106.60	10.95
RM1	11.8	11.0	129.80	107.27	11.40
RP3	6.5	7.6	49.40	85.52	7.05
LI1	5.2	5.5	28.60	94.55	5.35
LP3	6.6	7.7	50.82	85.71	7.15
LM1	11.8	11.0	129.80	107.27	11.40
LM2	11.6	10.8	125.28	107.41	11.20
1) Abbreviations: MD = mesiodistal; BL= buccolingual; CA=Crown Area; CI=Crown Index; CM=Crown Module; U= upper jaw (maxilla); L=lower jaw (mandible).					

Table B-5: Odontometric data: MHR 4.

<i>side / tooth</i>	<i>MD¹</i>	<i>BL</i>	<i>CA</i>	<i>CI</i>	<i>CM</i>
maxilla					
RP3	7.0	9.3	65.10	75.21	8.15
LM3	10.2	10.3	105.06	99.03	10.25
mandible					
RC	6.3	7.6	47.88	82.89	6.95
RP3	7.0	8.0	56.00	87.50	7.50
RP4	7.0	8.0	55.20	86.25	7.45
RM2	10.4	10.2	106.80	104.96	10.30
RM3	9.5	9.8	93.10	96.94	9.65
1) Abbreviations: MD = mesiodistal; BL= buccolingual; CA=Crown Area; CI=Crown Index; CM=Crown Module; U= upper jaw (maxilla); L=lower jaw (mandible).					

Table B-6: Odontometric data: MHR 5.

<i>side / tooth</i>	<i>MD¹</i>	<i>BL</i>	<i>CA</i>	<i>CI</i>	<i>CM</i>
maxilla					
RM3	8.6	12.1	104.06	71.07	10.35
RM2	9.7	12.6	122.22	76.98	11.15
RM1	11.2	12.0	130.98	93.33	11.60
LM1	11.1	11.8	130.98	94.07	11.45
LM2	8.9	11.8	105.02	75.42	10.35
LM3	9.1	12.0	109.20	75.83	10.55
mandible					
RM1	11.1	10.7	118.77	103.74	10.90
RM2	10.9	10.4	113.36	104.81	10.65
RM3	11.2	10.9	122.08	102.75	11.05
LM2	11.1	10.5	116.55	105.71	10.80
1) Abbreviations: MD = mesiodistal; BL= buccolingual; CA=Crown Area; CI=Crown Index; CM=Crown Module; U= upper jaw (maxilla); L=lower jaw (mandible).					

Table B-7: Odontometric data: MHR 6

<i>side / tooth</i>	<i>MD¹</i>	<i>BL</i>	<i>CA</i>	<i>CI</i>	<i>CM</i>
maxilla					
RI1	9.1	7.7	70.07	118.18	8.40
LI2	7.2	6.4	46.08	112.50	6.80
RP3	6.7	9.3	62.31	72.04	8.00
LC	7.7	8.2	63.14	93.90	7.95
LM1	9.9	11.2	110.88	88.39	10.55
LM2	9.5	11.7	111.15	81.20	10.60
LM3	11.1	12.0	133.20	92.50	11.55
RP4	6.8	9.3	63.24	73.12	8.05
RM1	10.2	11.2	114.24	91.07	10.70
mandible					
RM3	11.5	10.5	120.75	109.52	11.00
RM2	11.5	10.4	119.60	110.58	10.95
RM1	11.3	10.4	117.52	108.65	10.85
RP4	7.5	8.1	60.75	92.59	7.80
RC	7.6	8.6	65.36	88.37	8.10
LC	--	--	--	--	--
LM3	11.4	10.1	115.14	112.87	10.75
1) Abbreviations: MD = mesiodistal; BL= buccolingual; CA=Crown Area; CI=Crown Index; CM=Crown Module; U= upper jaw (maxilla); L=lower jaw (mandible); -- = no data.					

Table B-8: Odontometric data: MHR 6a.

<i>side / tooth</i>	<i>MD¹</i>	<i>BL</i>	<i>CA</i>	<i>CI</i>	<i>CM</i>
maxilla					
RM3	8.9	11.5	102.35	77.39	10.20
RM2	8.8	10.4	91.52	84.62	9.60
RP4	6.0	10.0	60.00	60.00	8.00
LC	7.9	8.7	68.73	90.80	8.30
LP4	7.2	9.6	69.12	75.00	8.40
LM2	8.8	10.2	89.76	86.27	9.50
LI2	7.3	--	--	--	--
mandible					
RM3	11.0	9.4	103.40	117.02	10.20
RM2	10.8	10.3	111.24	104.85	10.55
RM1	11.8	10.7	126.26	110.28	11.25
RP3	7.2	8.1	58.32	88.89	7.65

<i>side / tooth</i>	<i>MD¹</i>	<i>BL</i>	<i>CA</i>	<i>CI</i>	<i>CM</i>
RP4	7.5	7.6	57.00	98.68	7.55
RI2	6.5	6.6	42.90	98.48	6.55
RI1	5.6	6.4	35.84	87.50	6.00
LI1	5.6	6.4	35.84	87.50	6.00
LC	7.0	8.0	56.00	87.50	7.50
LP3	7.2	8.5	61.20	84.70	7.85
LP4	6.9	8.0	55.20	86.25	7.45
LM1	11.2	10.4	116.48	107.96	10.80
LM2	10.5	9.9	103.95	106.06	10.20
LM3	10.8	9.4	101.52	114.89	10.10
1) Abbreviations: MD = mesiodistal; BL= buccolingual; CA=Crown Area; CI=Crown Index; CM=Crown Module; U= upper jaw (maxilla); L=lower jaw (mandible); -- = no data.					

Table B-9: Odontometric data: MHR 7.

<i>side / tooth</i>	<i>MD¹</i>	<i>BL</i>	<i>CA</i>	<i>CI</i>	<i>CM</i>
MHR 8a maxilla					
RM2	10.0	11.1	111.00	90.09	10.55
RM1	10.6	12.3	130.38	86.18	11.45
RP4	7.5	9.9	74.25	75.76	8.70
RP3	7.4	9.8	72.52	75.51	8.60
LC	8.2	9.1	74.62	90.11	8.65
LM1	10.7	12.1	129.47	88.43	11.40
LM2	10.4	10.9	113.36	95.41	10.65
mandible					
RM2	12.2	10.2	124.44	119.61	11.20
RM1	11.9	10.6	126.14	112.26	11.25
LM1	11.9	10.5	114.45	113.33	11.20
LM2	11.9	9.9	117.81	120.20	10.90
MHR 8b maxilla					
RI2	7.3	5.8	42.34	125.86	6.55
P4	6.4	8.5	54.40	75.29	7.45
Rdm2	9.7	10.2	98.94	95.10	9.95
1) Abbreviations: MD = mesiodistal; BL= buccolingual; CA=Crown Area; CI=Crown Index; CM=Crown Module; U= upper jaw (maxilla); L=lower jaw (mandible); -- = no data.					

Table B-10: Odontometric data: MHR 8a and MHR 8b.

<i>side / tooth</i>	<i>MD¹</i>	<i>BL</i>	<i>CA</i>	<i>CI</i>	<i>CM</i>
maxilla					
RM3	9.7	10.7	103.79	90.65	10.20
RM2	8.5	10.0	85.00	85.00	9.25
RM1	10.8	11.1	119.88	97.30	10.95
RP4	6.2	9.0	55.80	68.89	7.60
RP3	6.4	9.2	58.88	69.57	7.80
RC	6.7	8.0	53.60	83.75	7.35
LI2	6.0	6.2	37.20	96.77	6.10
LC	--	8.0	--	--	--
LP3	--	9.3	--	--	--
LP4	--	--	--	--	--
mandible					
LM2	10.1	9.6	96.96	105.21	9.85
LM1	11.0	10.7	117.70	102.80	10.85
LP4	7.3	8.6	62.78	84.88	7.95
LP3	6.6	8.3	54.78	79.52	7.45
LC	6.3	7.6	47.88	82.89	6.95
1) Abbreviations: MD = mesiodistal; BL= buccolingual; CA=Crown Area; CI=Crown Index; CM=Crown Module; U= upper jaw (maxilla); L=lower jaw (mandible); -- = no data.					

Table B-11: Odontometric data: MHR 9.

<i>side / tooth</i>	<i>MD¹</i>	<i>BL</i>	<i>CA</i>	<i>CI</i>	<i>CM</i>
maxilla					
RM3	8.6	10.2	87.72	84.31	9.40
RM2	9.7	11.5	111.55	84.35	10.60
RM1	10.2	11.3	115.26	90.27	10.75
RC	7.3	8.5	62.05	85.88	7.90
RI2	7.3	6.2	45.26	117.74	6.75
LM2	9.3	10.8	100.44	86.11	10.05
LM3	8.8	11.0	96.80	80.00	9.90
mandible					
RM3	11.3	10.1	114.13	111.88	10.70
RM2	10.7	10.1	108.07	105.94	10.40
RM1	11.7	10.8	126.36	108.33	11.25
RP4	7.3	8.0	58.40	91.25	7.65
RP3	6.9	7.4	51.06	93.24	7.15
LP3	7.0	7.5	52.50	93.33	7.25
LP4	7.1	8.2	58.22	86.59	7.65
LM1	11.8	10.5	123.90	112.38	11.15

<i>side / tooth</i>	<i>MD¹</i>	<i>BL</i>	<i>CA</i>	<i>CI</i>	<i>CM</i>
LM2	11.0	10.3	113.30	106.80	10.65
LM3	11.1	10.3	114.33	107.77	10.70
1) Abbreviations: MD = mesiodistal; BL=buccolingual; CA=Crown Area; CI=Crown Index; CM=Crown Module; U= upper jaw (maxilla); L=lower jaw (mandible).					

Table B-12: Odontometric data: MHR 11.

<i>side / tooth</i>	<i>MD¹</i>	<i>BL</i>	<i>CA</i>	<i>CI</i>	<i>CM</i>
maxilla					
LI2	6.8	6.3	42.84	107.94	6.55
RP4	6.5	9.6	62.40	67.71	8.05
RM2	9.3	10.7	99.51	86.92	10.00
RM3	8.7	11.6	100.92	75.00	10.15
mandible					
RP3	6.9	8.3	57.27	83.13	7.60
RM2	10.5	10.2	107.10	102.94	10.35
RM3	10.3	10.2	105.06	100.98	10.25
LM1	11.4	10.5	119.70	108.57	10.95
LM2	10.6	10.2	108.92	103.92	10.30
1) Abbreviations: MD = mesiodistal; BL=buccolingual; CA=Crown Area; CI=Crown Index; CM=Crown Module; U= upper jaw (maxilla); L=lower jaw (mandible).					

Table B-13: Odontometric data: MHR 13.