Paleoanthropology

The Garba IV E mandible

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Discovery and geological age of the mandible

The Garba IV mandible from Melka Kunture was found in Level E (see Piperno *et al.* in this volume) during the 1981-82 excavations, while opening an area of 2 square metres. Level E is located below Levels C and D which are rich in fauna and in artefacts. Level E appears to correlate with Level B at Gombore I and the geological age of this mandible would therefore be dated at around 1.5 Ma.

Despite many Lower Pleistocene sites with lithic remains, fossil hominids are rare in the period between 1.8-1.0 Ma. Although the taxonomic status of Lower Pleistocene hominids is still questioned (Wolpoff 1996) the specimens from East Africa are commonly attributed to *H. rudolfensis*, *H. habilis*, *H. ergaster*, *H. cf. erectus*) (Wood and Collard 1999 and references therein). At the edge of Europe, the Dmanisi (Georgia) specimens, dated to ca. 1.7-1.9 Ma are referred to *H. erectus* (Bräuer *et al.* 1996), to *H. ergaster* (Gabounia *et al.* 2000) or to new species *H. georgicus* (Gabounia *et al.* 2002). In the Iberian peninsula, several remains have been identified as hominid at Venta Micena (Granada, Spain) dated to 1.65 Ma (Gibert *et al.* 1983, 1988), but their assignment to the genus *Homo* has been debated (Palmqvist 1997). The Asian Pleistocene hominids have been identified as *H. erectus sensu stricto*. A date of 1.8-1.6 Ma has been suggested for Modjokerto and Sangiran (Java; Swisher *et al.* 1994; Huffman 2001; Larick *et al.* 2001) but this has been contested (Langbroek and Roebroeks 2000; Sémah *et al.* 2000). Early dates have also been assigned to the hominids from the Chinese site of Longgupo (Haung *et al.* 1995) but the identification of the fossils as hominid has been questioned (Schwartz and Tattersall 1996). Thus, sites with currently uncontested dates of greater than 1.0 Ma are few and include the East African sites (Omo, Turkana and Konso-Gardula), Dmanisi and 'Ubeidija in the Levant at ca. 1.5 Ma (Tchernov 1987).

Comparative analysis of the Garba IV mandible will thus include sites where mandibular fossil remains were found. However, we must specify that the individual (physiological) age of this specimen, which belongs to a very young child, limits the possibilities for comparison. For this reason, the comparison is essentially based on dental morphology and is applied to the archaic children belonging to *Homo sensu lato* and to the Neandertal children of the same age group (prior to the eruption of the first permanent molar), which are well represented among the fossils. In dealing with its metric analysis, the averages for present-

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day populations as well as data from children including *Australopithecus sensu lato*, are provided to augment the possibilities for comparison and better accounting for differences.

State of preservation

The specimen comprises part of the right side of the jaw and corresponds to the body of the mandible where, however, the bone is broken on the external surface below the first deciduous molar. In its present form, the vertical ramus and the symphysis are missing. In view of the missing elements it is not possible to reconstruct the shape of the alveolar arcade which was probably not very wide. It is therefore only possible to present a description of the horizontal ramus, in other words of the mandibular corpus.

The dental series that is preserved comprises the first deciduous molar (dm1), which is very worn, and the second deciduous molar (dm2), with all of its cusps intact. In front of the dm1, the alveolus of the deciduous canine has been noted, but the tooth is absent.

On the external (buccal) side of the mandibular corpus a portion of bone is missing below the dm1. This undoubtedly corresponds to the location of the mental foramina which is situated under the dm1 in young children.

On the internal (lingual) surface of the mandibular corpus in the distal part where the bone is broken, the permanent first molar (M1) is visible. The crown of this M1 is complete and well formed and there is a small portion of the root visible. On this face, lateral to the symphyseal region where the bone is broken, the distal parts of two developing permanent teeth (the canine and the lateral incisor) can be seen.

Individual age

The stage of dental development shows that it belonged to a very young child. The individual age of this child may be estimated on the basis of the teeth which are present, by their state of wear, as well as by the stage of dental development.

Before examining these three points, we must briefly recall that the available criteria for the determination of individual age are based on the comparison with modern humans, whose variability is quite wide. Analysis of the maturation of permanent teeth, of dental emergence and also of the level of wear for the determination of individual age varies even in *Homo sapiens sapiens* and is a matter of debate among specialists.

Among fossil populations we do not know the rate of dental growth. This question is still more difficult in the case of an isolated fossil, such as that from Garba IV, since only one individual is available out of an unknown series, without the possibility of referring to other individuals. The hypothesis of a more precocious dental emergence among fossil humans in comparison with modern humans has often been claimed for early humans, Neanderthals (Wolpoff 1979; Dean *et al.* 1986; Smith 1993) as well as *Australopithecus* (Smith 1994).

Regarding the use of dental wear in determining the age of death of human fossils, there is still another difficulty: if we choose to rely, among other factors, on eating habits, we must admit that the habits of fossil populations are unknown to us. These reservations notwithstanding, we propose to estimate the age of this child from Garba IV by comparing it, on the basis of available data, with modern humans.

The observation of the only teeth preserved, the two deciduous molars (dm1 and dm2), indicates a minimum age of two years (the earliest age known in a modern population for the emergence of the second

deciduous molar), and a maximum of five years (the age for the earliest emergence of the permanent first molar in modern human populations). The apex of the dm2 root is not completely closed. Since in modern humans the complete closure of the root takes place circa 1 year after the emergence of the tooth and since there is no observable radicular reabsorbtion on the dm1, all of these elements lead us to conclude that the jaw of Garba IV belonged to an infant whose age can be estimated to be between 2 and 3 years old.

What is surprising is the heavy wear of the dm1 in spite of the fact that the dm2 has barely emerged. The emergence of this latter tooth thus occurred shortly before the death of this child. This may be interpreted in two ways: either the time lapse between the emergence of this fossil's dm1/dm2 was greater than that which we recognize among modern populations, signifying that this child used its dm1 extensively or, if the time lapse is comparable to that among modern populations, this young child consumed very abrasive food from a very young age. This later hypothesis is in contradiction with prolonged breast-feeding of a child that is often assumed for archaic populations (Zilberman *et al.* 2004; see also Zilberman *et al.*, in this volume).

In order to refine our estimate of the age of this specimen we will also call upon roentgenography (X-ray) data concerning calcification states of permanent teeth. Indeed, as has often been emphasized, it is preferable to base a dental age on tooth formation rather than on emergence, since formation is a continuous process through the juvenile years not limited to a few marker events. In humans, it has been established that tooth emergence is more affected by environmental factors than is tooth formation (Eveleth 1986).

Tooth	Maturation	Level of calcification	Age ♀	Age ♂
M1	complete, beginning of root	Crc; R (¼)	4 years	3 ½ years
I2	complete	Coc; R (¼)	3 ½ years	3 years
C	incomplete	Cr (⅔)	3 ½ years	2 ½ years
P3	individualized cusps	Cco	4 years	3 ½ years
P4	non-individualized cusps	Ci	3 years	2 ½ years

Tab. 1. Maturation of the permanent teeth of Garba IV (from Coenraad *et al.* 1973; Crc: crown complete, Coc: cusp outline complete, Cco: coalescence of cusps, Ci: initial cusp formation, R: root).

The crown of the first molar is visible as a result of a bone fracture on the lingual surface of the body (Figs. 1b; 2a, c, e). This crown is completely formed and there is even part of the root. The height of this root reaches 3.5 mm on the lingual side and 2 mm on the distal side. If we refer to the maturation table of Coenraad *et al.* (1973), this stage corresponds to an individual age for the Garba IV child of between 2 and 3 years.

On the X-ray (roentgenograph; Fig. 1d) the buds of the premolars (P3 and P4) are visible. The crown of the first (P3) is more mature than that of the second; the cusps are already individualized. The development of the M1 and of the P3 in relation to that of the dm2 is more advanced than that among modern children. Concerning the maturation of the lateral incisor, the crown is also complete and the root is visible over a space of 3.6 mm (Figs. 1d; 2d). The calcification of the canine is less advanced, since the crown is complete. The maturation of the crown and of the C (Figs. 1d; 2d) seems to be a bit more advanced than that recognized among children of modern populations.

Generally speaking, data gathered regarding the maturation of permanent teeth permits us to estimate the age of the individual from the Garba IV jaw to be between 2 and 3 years old. If the maturation of this child was comparable to that recognized among modern children (cf. *supra*) as presented by the tables of Coenraad *et al.* (1973), this jaw would have belonged to a girl of three or to a boy of two years and a half.

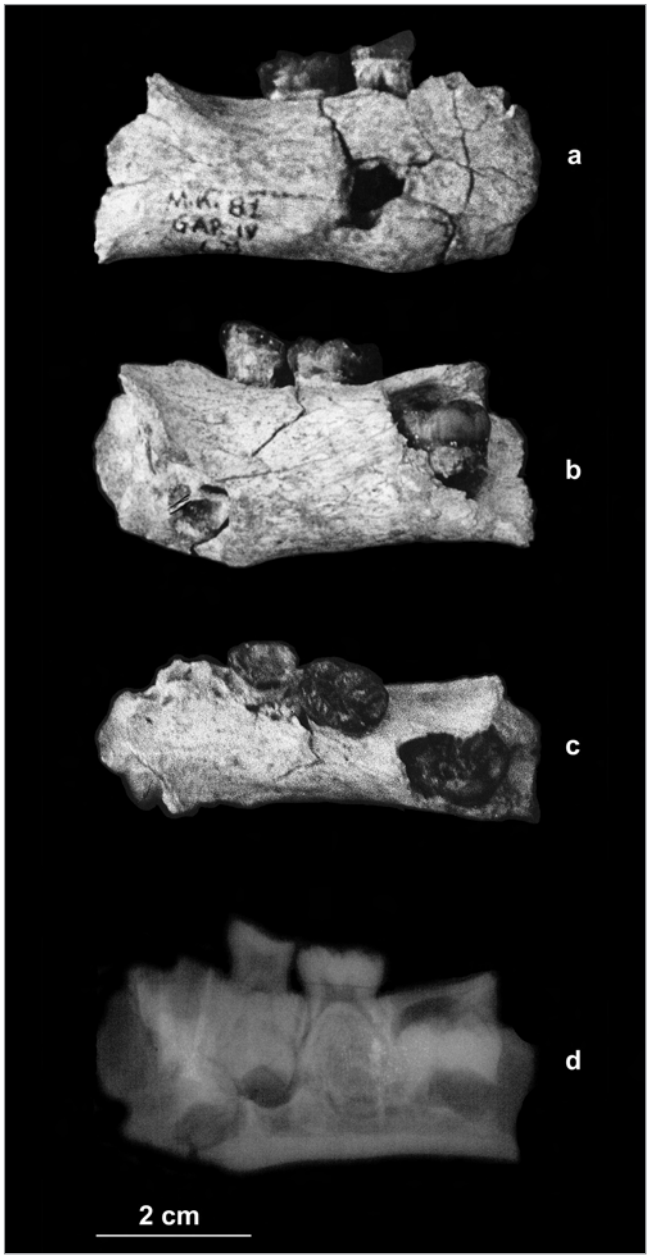


Fig. 1. Mandible of Garba IV: a. buccal view; b. lingual view; c. occluso-lingual view; d. radiography.

Morphology and metric data of the mandibular corpus (*Corpus mandibularis*)

The state of conservation of this specimen makes nearly every kind of metric study impossible. But we can interpret certain characteristics which permit us to respond, at least partially, to the question we have raised: to which evolutionary phase can we relate the human remains of Garba IV?

One is immediately struck by the overall dimensions of this jaw in view of its individual age. Its great size, noticeable in the considerable height and thickness of the body of the mandible and in the well developed tuberculum marginal anterior, immediately distinguishes it from the jaws of modern humans.

The robustness of the mandibular corpus

These are the features that we will describe morphologically and quantify metrically in order to evaluate its large size. The fragmentary state of the Garba IV mandible does not permit us to estimate the length or the width of this specimen. Only the robustness of the jaw may be evaluated by measuring the height and thickness of the mandibular corpus (Tab. 2 and Graph 1). These are evaluated at different points along the mandibular corpus: distally (at the back) in relation to the dm2 (directly before the beginning of the lateral ramus), at the level of the dm2, in the space between the dm1 and dm2, in front of the dm1, at the site of the mental foramina and mesially (in front) at the level of the break.

Measurements	Height	Thickness	Robustness
distally at dm2	21	16**	76,19
at the level of dm2	20,1	14,5	72,13
dm1 (position of mental foramina)	21,5	13,5	62,79
mesially at dm1 (level tub. marg. ant.)	24	12,6	52,5
mesially at tub. marg. ant.	23	12,5	54,34

**falls directly on the *proeminentia lateralis*

Tab. 2. Height, thickness (in mm) and robustness of the mandibular corpus of Garba IV.

The measurements indicated above illustrate that on the preserved part of the mandibular corpus the height hardly changes from back to front. This is a feature that is generally considered to be archaic, contributing to the primitive aspect of this jaw. Inversely, in modern humans the height of the mandibular body diminishes from front to back.

The analysis of these metric data makes it possible to illustrate the great robustness of the Garba IV mandible.

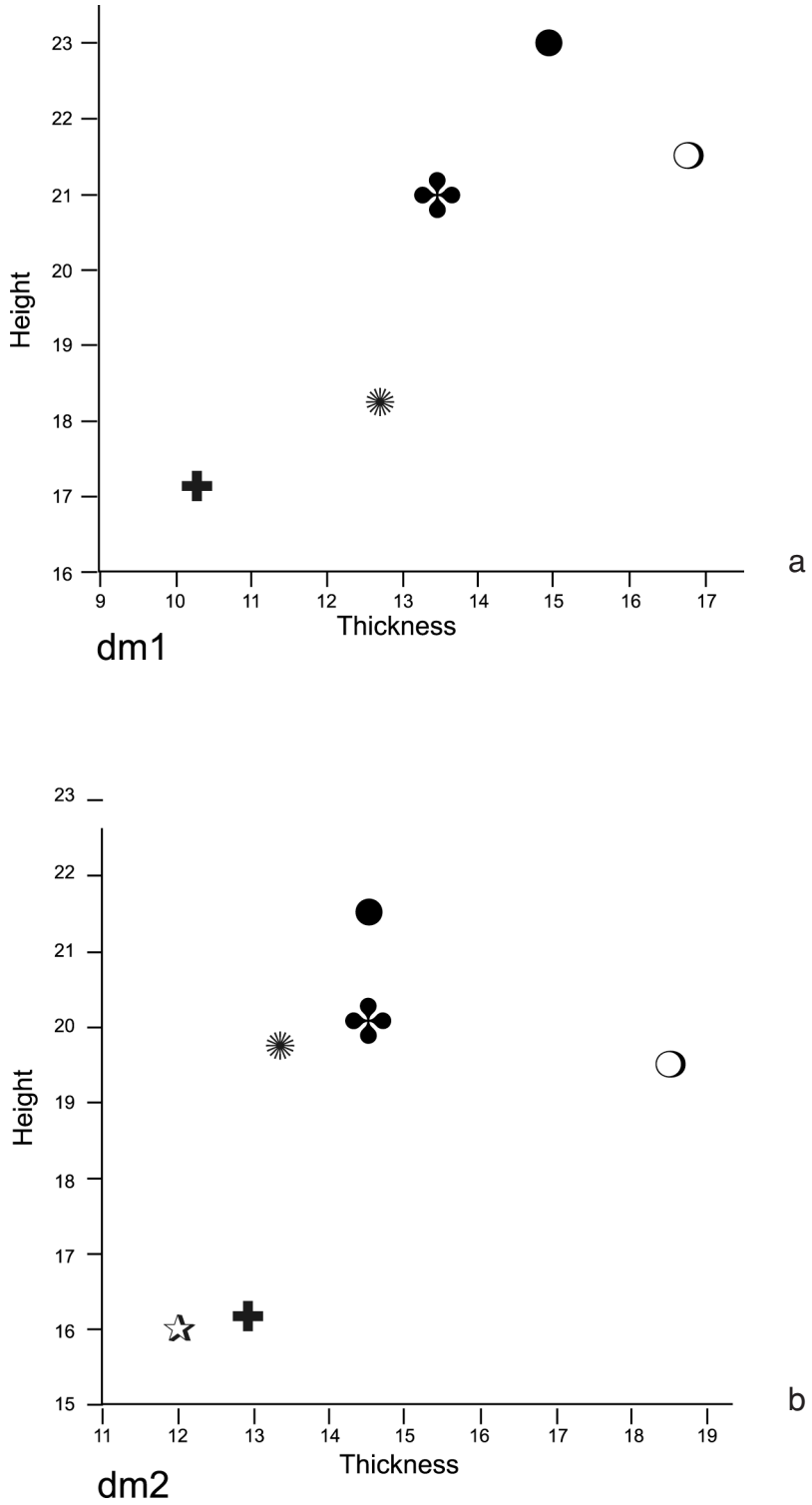
	Height dm1		**Thickness dm1**		**Height dm2**		**Thickness dm2**	
	left	right	left	right	left	right	left	right
Garba IV ✤	**21.5**		**13.5**		**20.1**		**14.5**	
AL 33343b (White and Johanson 1980)			(22.5)		62		20	
Taung 1 (Wood 1991)			13.5	13.5			14	14
SK 61 (Wood 1991)	29	28.5	17.5	18	24	24	18	18
SK 62 (Wood 1991)			(17)	19	23.5	(22)	18	18.5
SK 63 (Wood 1991)			17	18	26.5	(25)	18	18
SK 3978 (Wood 1991)			13	13		19	15	16
ER 1477 ❍ (Wood 1991)	21	22	17	16.5	19	20	19	18
ER 1507 ◆ (Wood 1991)					20		16	
ER-1820 (Wood 1991)					29		23	
MDL 2 (Wood 1991)	27.5/29		-/20		26.5/29.5		21	
Homo habilis (Tobias 1991)								
OH 7					(25.5)		23.6	
OH 13					30.2		16.5	
ER 820 ● (Wood 1991)	22	24	15	15	21	22	15	14
ER 15.000 (Walker and Leakey 1993)					27.2			
Neanderthal children 3/5 years old ✺								
(N=7; Madre-Dupouy 1992)								
Roc de Marsal	17	17.2	12.7	13.2	17.4	17.6	13.2	12.9
Pech de l'Azé	15		11.5					
Chateauneuf I	20.5							
Molare	20.9		12.2					
Archi	18.8		13.6		20.8		11.7	
Engis 2					24		14.5	
Devil's Tower					19		15	
Skhul 1 ✯ (McCown and Keith 1939)					16		12	
Modern human children (3/5 years; N=20)								
✣ (Madre-Dupouy 1992)	17.19		10.32		16.17		12.87	
	(s=1.76)		(s=0.98)		(s=1.59)		(s=1.2)	

Tab. 3. Index of robustness of the mandibular corpus (mm) calculated on the basis of thickness and height at the level of dm1 and dm2.

Morphology of the mandibular corpus

On the external face of the mandibular corpus (Fig. 1a) one notices, behind and below the dm2, a large swelling formed by the *prominentia lateralis*. This corresponds to the point where the anterior edge of the *ramus lateralis*, absent on our fossil, joins the external surface of the corpus at an oblique angle. This *prominentia lateralis* forms a large swelling with poorly delimited contours.

On the posterior part of this eminence the surface of the bone is smooth and slightly concave. On the anterior part, this eminence is divided into two branches. These two branches are not very marked. They are mainly noticeable when touched or slightly illuminated. The upper branch forms a slight *torus lateralis superior* which protrudes moderately and seems to stop in front of the fracture (aligned with the space dm2 and dm1). The lower branch, which is less pronounced than the upper one, does not form a *torus marginalis inferior* in the proper sense of the term, but a thickening on the inferior margin of the jaw, which forms a marginal anterior tubercle (*tuberculum marginalis anterior*) toward the front. This tubercle is just below the dm1. On each side of this tubercle the edge of the inferior margin rises up toward the front just before the



Graph 1. Comparison of the height and thickness of the mandibular corpus on Garba IV E (✤) with other ancient fossil children at level of dm1(a) and dm2 (b): ● KNM ER 820, ❍ KNM ER 1477 (Wood 1991); ✺ European Neanderthal children, N=6 (Madre-Dupouy 1992); ☆ Skhul 1 (McCown and Keith 1939) and ✚ modern children, N=20 (Madre-Dupouy 1992).

fracture and toward the back. On the surface of the mandibular corpus, between these two weak protuberances extending from the eminence, there is a large elongated depression, easily visible below the dm2 up to the missing bone on the surface of the corpus.

Between the slight thickening, corresponding to this small *torus lateralis superior*, and the alveolar edge there is a slight hollow space (situated under dm2 and dm1). The surface is slightly concave, oblique towards the inside and above. This is the continuation of the *sulcus retromolaris*. The alveolar edge is slightly inclined from front to back.

The mental foramina on this jaw cannot be located, since in its place there exists, as previously noted, a very large gap in the bone (Fig. 1a). This gap is situated below the first deciduous molar, which corresponds to the site of this foramen for children. The bone is undoubtedly broken because this region was weakened by the presence of this (these) foramen (foramina). On ER 15000 there is a foramen on the left side and two on the right side situated under the P4.

On the internal face of the mandibular corpus of Garba IV (Fig. 1b) laterally to the symphyseal region where the bone is broken one can observe the remaining oblique surfaces of the post-incisal plane at a height of 16.5 mm. On this internal surface there is neither an observable *proeminentia alveolaris* nor a mylo-hyoid line. Generally this mylo-hyoid line separates the sub-lingual fossa from a sub-mandibular fossa. On our fossil the former does not exist while the latter is large and not very deep below and posterior to the dm2. The extensive development of the mylo-hyoid line is considered to be characteristic of modern humans. It is absent on fossils considered to be *Homo erectus sensu lato* like those from Zoukoudian (Weidenreich 1936).

The lower edge of the mandibular corpus is also thick. Its maximum thickness equals 10.4 mm (in the front, on the level of the fracture, this thickness measures 9.8 mm).

Also, in this view the marginal anterior tubercle (*tuberculum marginalis anterior*) is easily visible. Toward the front of this tubercle, which forms the anterior border of the digastric imprint, there is as already noted a slight sinuosity just before the fracture.

The digastric imprint (*fossae digastrica*) is large (17 x 6.2 mm). It continues below the dm2. It forms a large oval surface oriented toward the back and upward, situated entirely on the lower edge of the bone which, as we have seen, is thick. This disposition, which is very archaic, is reminiscent of that observed on adult fossils such as Sinanthropus and Tighenif III.

It is interesting to note that this jaw belonging to a very young child shows protuberances which are clearly visible, notably on the external face of the jaw and in the marked development of the anterior marginal tubercle. All of these features are found on the other jaws discovered in the Lake Turkana basin. The physiological age of this jaw makes comparisons difficult. Nonetheless, we can see that this mandible constitutes the exact infantile stage in a chronological series which would be continuous with the following mandibles: KNM-ER 820 (juvenile, Leakey and Wood 1973), KNM-WT 15.000 (adolescent, Walker and Leakey 1993), KNM-ER 992 (adult, Leakey and Wood 1973) and KNM-ER 730 (old adult, Day *et al.* 1975).

The teeth

Metric study

Table 4 below presents the mesio-distal (MD or L length) and vestibulo-lingual (VL or width 1) dimensions, as well as the index of robustness (Lx1) of the lower molars of Garba IV.

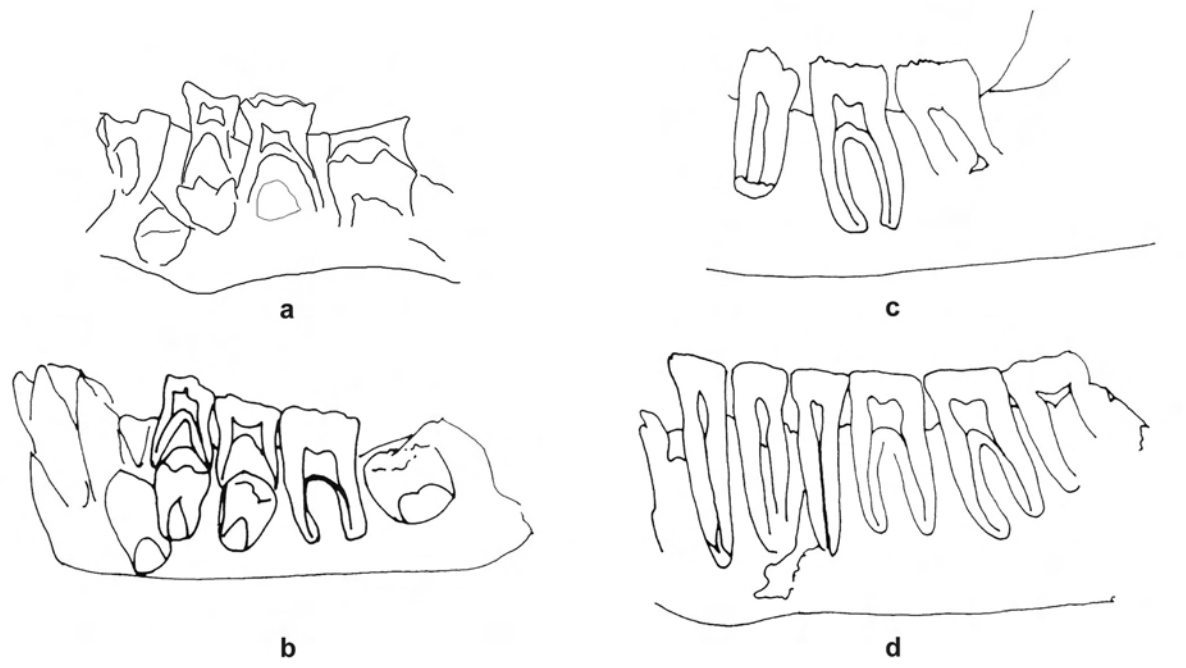


Fig. 2. Tracing from X-rays of the mandibles of Garba IV (a), KMN-ER 820 (b), KMN-WT 15000 (c) and KMN-ER 992 (d), arranged to show longitudinal age series. (b, c and d from Brown and Walker 1993).

	Length (MD)	**Width (BL)**	**Index of robustness (MDxBL)**	**Coronar index (BLx100/MD)**
dm1 ***	8.82	7.56	66.67	85.71
dm2 11,15	8.8	98.12	78.92	
M1 **	(12.4)	(10)	(124)	(80.64)

** tooth still in the bone so these measurements are underestimates;

***very worn tooth for which the measurement is thus approximate -2% error margin.

Tab. 4. The mesio-distal dimensions (MD or L length) and vestibulo-lingual (VL or width 1) and the index of robustness (Lx1) of the lower molars of Garba IV.

The morphology of the teeth (Figs. 1, 2)

The first deciduous molar (dm1)

The row of teeth is not rectilinear, thus the dm1 is in a more buccal position than the dm2. According to White (1977) this may also be observed on *A. afarensis*. This is not the case in the juvenile jaws of Taung or ER 1477, the dm1 and dm2 are continuous from one to the other and the dm2 is not situated bucally in relation to the dm1.

The dm1 is very worn, more so on the distal part of the tooth (on contact with the dm1 superior) than on the mesial part (in contact with the dc superior). This latter is thus the highest part of the tooth. Except for the *fovea anterior*, which is still present, the occlusal surface does not show any other relief. It is slightly concave. The tooth is higher on the lingual side than on its buccal side.

In spite of the extensive wear on this tooth, the dimensions of the crown are large: the mesio-distal diameter is equal to 8.82 mm and the vestibulo-lingual diameter to 7.56 mm. The dimensions of the Garba IV dm1 are not close to those of ER 820, but the tooth is considerably shorter than those of ER

	dm1				dm2			
Fossil Children	MD		BL		MD		BL	
Garba IV (✤)	**(8.82)**		**(7.56)**		**11.15**		**8.8**	
Australopithecus afarensis ▲ N=6 (White 1977, 1980; Johanson *et al.* 1982)	9.4 (sd=5)		7.8 (sd=5)		12 (sd=4)		1 0 . 1 (sd=6)	
Omo (Howell and Coppens 1973) L64-2 (g.)					13.8		12.4	
L567-27 (g.)					11.2		9.3	
L704(2 (g.) ■	12.3		9.5					
222-2744 (g.) ❑	9.9		7.3		12.3		9.8	
KNM ER 820 ● (Wood 1991)	9.1	9.2	7.8	7.6	11.2	11.2	9.4	9.4
KNM ER 1477 ❍ (Wood 1991)	11.9	(11.2)	9.2	8.5	14.3	(14)	11.8	12.4
KNM ER 1507 (g.) ◆ (Wood 1991)	8.8		6.8		11.7		9.3	
Sinanthropus (Weidenreich 1937)	7.7; 9.8		6.6; 7		m=11.3 N=5		m=9.3 N=5	
	N=2		N=2		(❖=10.5-12.2)		(❖=8.4-10.1)	
Jebel-Irhoud 3 (Ennouchi 1969)					11.3		10.4	
European Neanderthal children ✺ (N=14; Madre-Dupouy 1992)	m=8.68; N=14		m=7.32; N=14		m=10.9; N=13		m=9.1; N=13	
Early *Homo sapiens sapiens* children Qafzeh ★ (N=5; Tillier 1999)					11 (sd=6)		9 . 9 (s=6)	
Skhul 1 ☆ (McCown and Keith 1939)	7.4				(10.6)		8.1	
Skhul ✷ (McCown and Keith 1939)						(10.75)		8.7
Children of Spitalfields ❇ (Liversidge and Molleson 1999)	8.01 (s=4.9)		6.86 (s=4.2)		10.01 (s=4.8)		51 (s=3.7)	
	N=75		N=78		N= 86		N=77	
Children of Romano-British, Poundbury ✱ (Liversidge and Molleson 1999)	7.74 (s=4.2)		6.92 (s=4.1)		9.91 (s=5.4)		8.76 (s=4.6)	
	N=28		N=28		N=32		N=32	
Modern children ✚ (Fearne and Brook 1993)	7.61 (s=5.6)		6.69 (s=4.7)		9.55 (s=5.6)		8.86 (s=4.96)	
✣ (Axelsson and Kirveskar 1984)	7.9 (s=4.6)		7.3.2 (s=3.9)		10.03 (s=5.6)		9.06 (s=3.8)	

Tab. 5. Comparison of the mesio-distal (MD) and bucco-lingual (BL) diameters of dm1 and dm2.

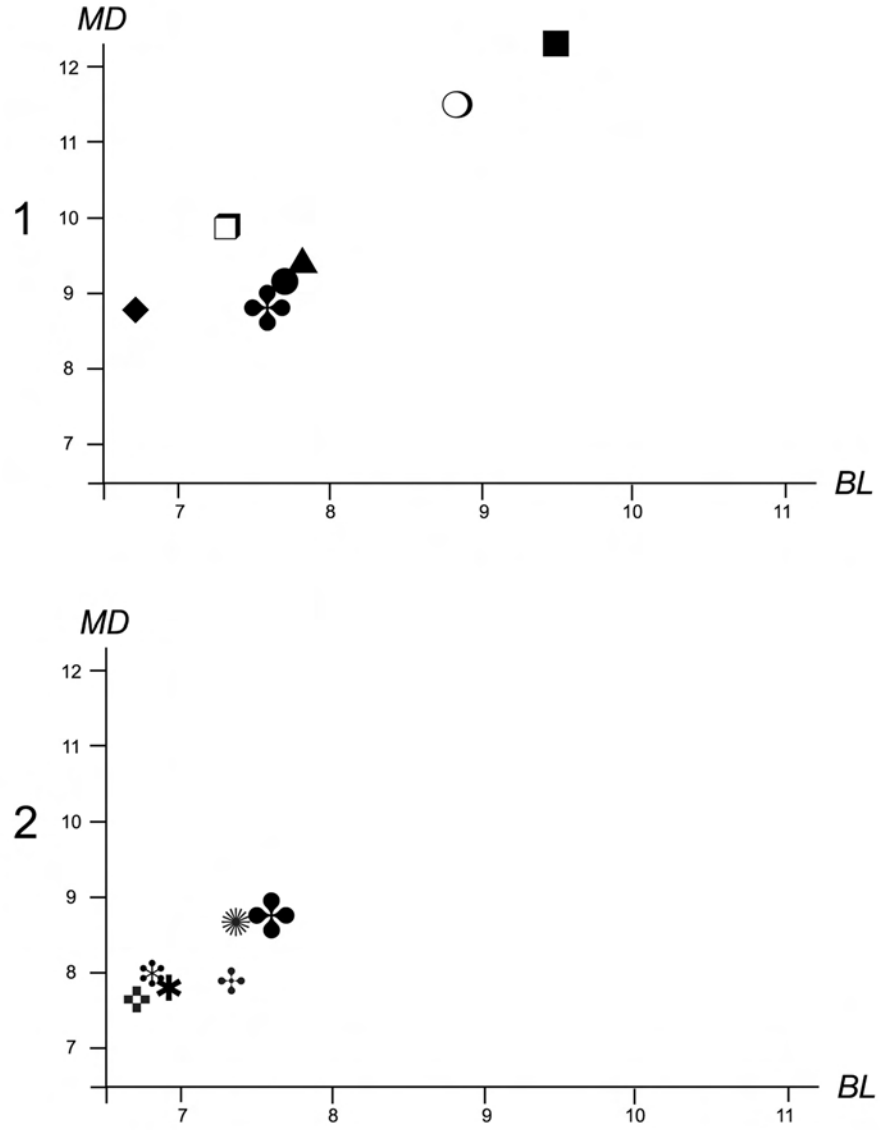
1477. The comparison of these dimensions of the dm1 with those of modern children (Tabs. 4, 5 and Graph 2a-c) shows that this first lower deciduous molar of Garba IV was large in size, both in mesio-distal and bucco-lingual diameters.

A distinct cervical line between the root and the crown clearly divides the two parts of the tooth which are different in color. Bucally, the bifurcation of the root is visible. It is relatively low, approximately 28 mm after the neck of the tooth and then, as can be seen from the X-rays, the two roots are clearly separated (Fig. 1d).

The surface of the tooth presents numerous irregularities in the enamel surface. On the buccal and lingual sides this irregularity is shown by the presence of very small pits. Furthermore, on the buccal side, mesially, one also notices wrinkling of the dental enamel. From the cervical margin, six small ridges are directed up to the worn occlusal ridge of the crown. This irregularity of the enamel is also visible on the dm2 and on the part of the M1 crown that is visible.

The second deciduous molar (dm2)

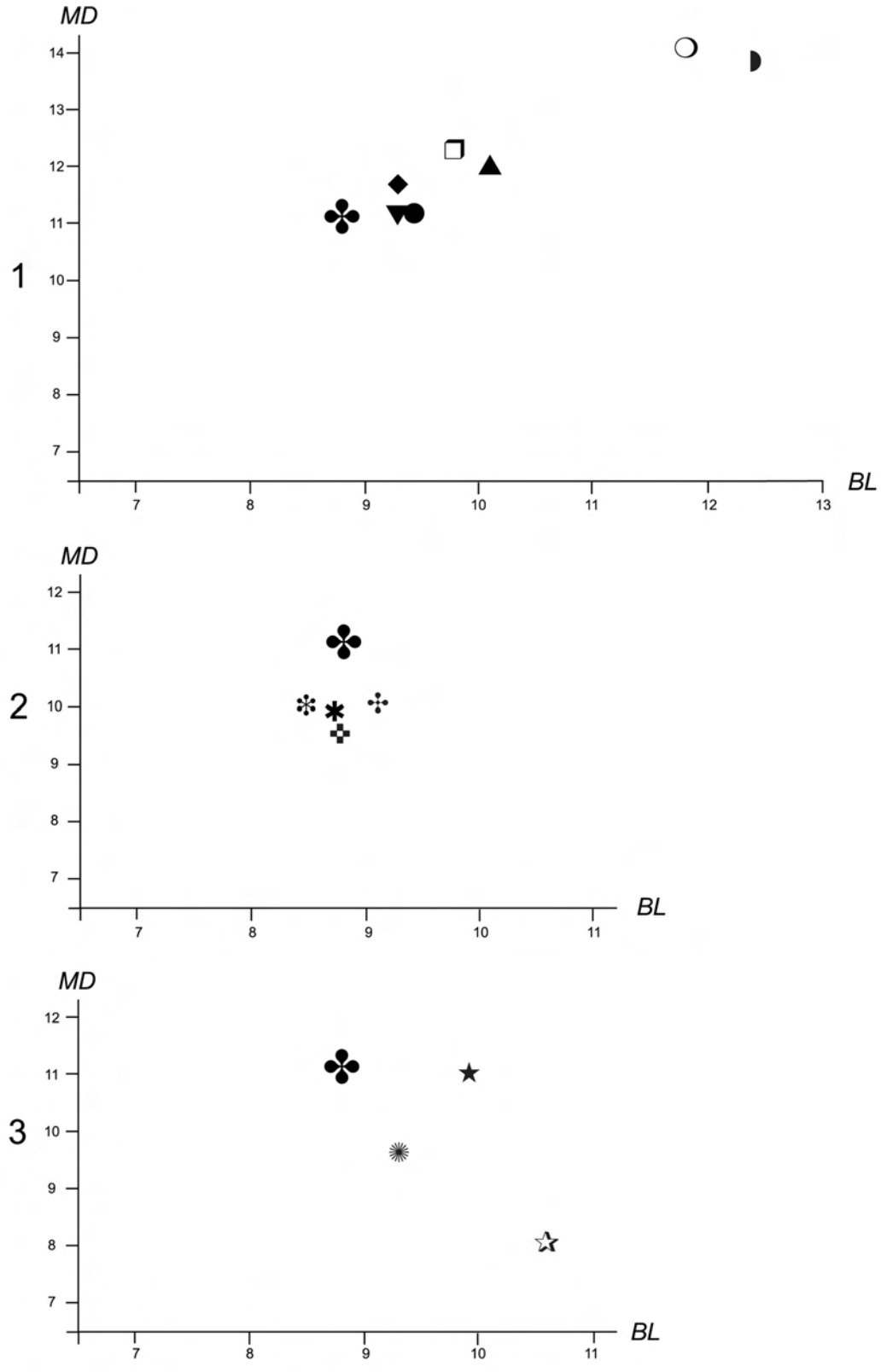
This deciduous molar does not show any occlusal wear to the naked eye. The tooth is lower than the dm1. A slight wear facet due to contact with the upper teeth on the protoconid (with dm1) and the hypoconid (with the dm2) appears only on the buccal edge on the buccal side and on the medial side, with the aid of a magnifying glass. The contact surface is larger on the latter.



Graph 2. Comparison of the mesio-distal (MD) and bucco-lingual (BL) diameters of the dm1 (first deciduous molar) of Garba IV E (✤) with the other juvenile fossils: ▲ *Australopithecus afarensis*, N=6 (White 1977, 1980; Johanson *et al.* 1982); ❑ Omo 222-2744; ■ Omo L704-2 (Howell and Coppens 1973); ● KNM ER 820, ❍ KNM ER 1477, ◆ KNM ER 1507 (Wood 1991); ✺ European Neanderthal children, N=14 (Madre-Dupouy 1992); ☆ Skhul 1 (McCown and Keith 1939) and modern children: ✤ (Fearne and Brook 1993), ✣ (Axelsson and Kirveskar 1984), ✱ ❊ (Romano-British children from Poundbury and Spitalfields children: Liversidge and Molleson 1999).

As in the dm1, the crown and the root are clearly distinguished by a cervical line which is slightly concave toward the edge of the crown, but there is no enamel cingulum separating the two parts of the tooth which are of different colors.

The dimensions of the crown are as follows: the mesio-distal diameter is equal to 11.1 mm and the vestibulo-lingual diameter to 8.8 mm. The index of robustness is equal to 98.12 (Tabs. 4, 5 and Graph 3). The general form of the tooth is thus rectangular. It is longer than it is wide and this is due to the development of the well-marked and lingually directed talonid, with a posterior fovea which is well developed.



Graph 3. Comparison of the mesio-distal (MD) and bucco-lingual (BL) diameters of the dm2 (second deciduous molar) of Garba IV E (✤) with the other juvenile fossils: ▲ *Australopithecus afarensis*, N=6 (White 1977, 1980; Johanson *et al.* 1982); ❑ Omo 222-2744; ▼ Omo L567-27; ◗ Omo L64-2 (Howell and Coppens 1973); ● KNM ER 820, ❍ KNM ER 1477, ◆ KNM ER 1507 (Wood 1991); ✺ European Neanderthal children, N=14 (Madre-Dupouy 1992); ☆ Skhul 1 (McCown and Keith 1939) and modern children: ✣ (Fearne and Brook 1993), ✣ (Axelsson and Kirveskar 1984), ✱ ❊ (Romano-British children from Poundbury and Spitalfields children: Liversidge and Molleson 1999).

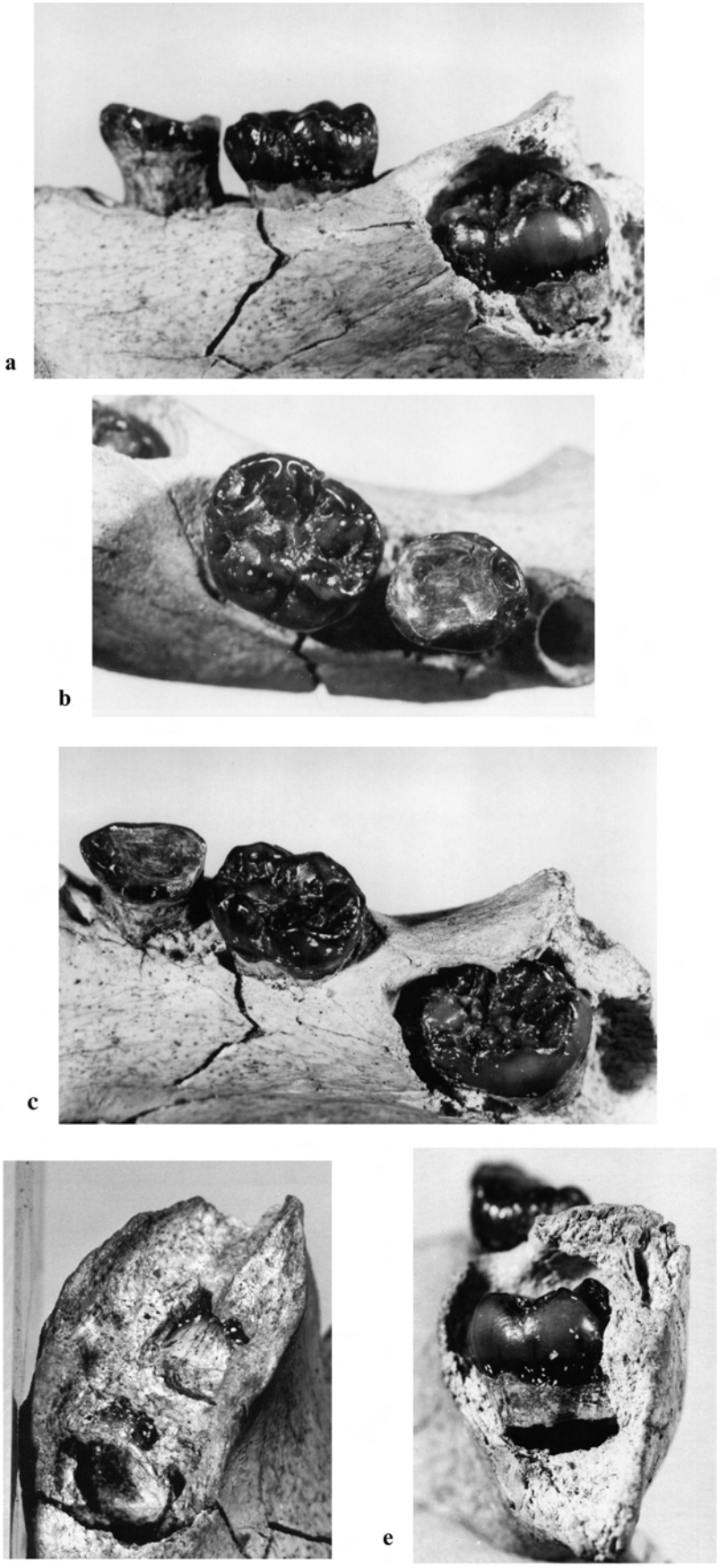


Fig. 3. Mandible of Garba IV: a. lingual view with dm1, dm2 and M1; b. occlusal view of dm1 and dm2; c. occluso-lingual view with dm1, dm2 and M1; d. mesial view of the mandible with I2 and C; e. distal view of the mandible with M1.

As we can see, the robustness of the crown makes it possible to place the lower second deciduous molar of Garba IV among the large teeth.

The bucco-lingual diameter is almost the same on the mesial and distal part of the tooth (throughout its length). This tooth is very similar to those of ER 820, but the one of ER 1477 is, with regard to the bucco-lingual diameter, larger on the distal than on the mesial part.

The whole of the tooth is bucco-lingually inclined and the lingual cusps (metaconid and entoconid) are taller than the buccal cusps (protoconid and hypoconid), although the height of the crown is greater on the buccal than on the lingual side (protoconid: 5.7 mm, hypoconid: 5.4 mm; metaconid: 5 mm; entoconid 4.9 mm; hypoconulid 4.2 mm). Medio-distally, the tooth is also oriented lingually. Thus, the hypoconulid, smaller than the other two buccal cusps, is situated more lingually than the protoconid and hypoconid, in a distal position, almost on the midline of the crown.

Observed in buccal view, the tooth is rounded in the mesio-distal and vertical directions. The protoconid and the hypoconid appear well separated from each other by a buccal groove which runs along three quarters of the height of the crown. In this view the hypoconulid is situated lingually to the two other cups and is well demarcated from the hypoconid by a deep notch. The lingual face is less curved than the buccal, especially vertically. The cusps are also less well separated than on the buccal face since, as opposed to this latter, there is no vertical groove. Thus, only the tops of the cusps are well separated, the upper edge of the tooth forms an M with its vertical sides far apart. This morphology may be observed on the dm2 of ER 820.

The occlusal face shows the five basic cusps which are all well developed and clearly separated from each other. At the front of the tooth there exists an idiosyncratic anterior fovea and one notices on the mesial marginal ridge a wrinkling of the surface which forms three small tubercles. These wrinkles recall those observed on the dm1. This morphology observed on the dm2 of Garba is very similar to the one found on WT 15000. Indeed, the authors (Brown and Walker 1993) have described a “beading along the mesial marginal ridges of the M1 and M2”.

The anterior *fovea* is smaller than the posterior fovea. Since the tooth is relatively wrinkled, the medio-distal grooves have a relatively complex form. It begins after the anterior *fovea* separates the metaconid from the protoconid. Then this groove is directed lingually and separates the metaconid which comes into contact with the hypoconid. Following this, this groove bifurcates into two branches, one which is oriented toward the top of the entoconid and the other which underlines and delimits the hypoconulid and separates it from the hypoconid. The entoconid and the hypoconulid are connected by a groove which is bucco-lingually directed and unites them and individualizes the posterior *fovea*.

The principal transverse groove, coming from the buccal face, is not very deep on the occlusal face, but it separates the protoconid from the hypoconid. This groove rises on the lingual side and separates the tops of the metaconid and the entoconid.

The bifurcation of the root is below the neck of the tooth and is visible only by radiography. The two roots are not completely developed (Fig. 1d).

The permanent molar (M1)

Although it is inside the bone, a fracture on the lingual side makes it possible to observe the first permanent molar. It can thus be studied, mainly in its distal and lingual parts. The tooth is embedded in the bone and the dimensions of the crown cannot be taken with precision. The approximate measurements are as follows: the mesio-distal diameter is 12.4 mm and the vestibulo-lingual diameter is 10 mm. The index of robustness is thus equal to 124. In spite of their imprecision, the comparison of these values with those of the permanent molars of other fossils (Tab. 6) shows that the first permanent lower molar is large. As we

have seen there is a developing root. The height of this root reaches 3.5 mm on the lingual side and 2 mm on the distal side.

From the standpoint of morphology, this first molar, larger than the dm2, assumes the shape of the latter and the occlusal surface is complicated by wrinkling of the enamel. The basic cusps are all well individualized. The distal part of the tooth shows a very large posterior fovea, which is well separated by a narrow ridge of enamel which runs between the hypoconulid and the entoconid. As on the dm2, the entoconid is well demarcated from the metaconid and these two cusps seem to be higher than the buccal ones. This tooth is low. Its height is quite close to that of WT 15000 (ER 992). For Tobias (1991), the height of the crown is a trait which clearly differentiates *Homo erectus* (*sensu lato*) from *Homo habilis* and *A. africanus*. On these latter specimens the height is average, while the teeth of *Australopitecus robustus* are high.

As in the dm2, the hypoconulid is more lingually situated than the protoconid and the hypoconid.

It is thus interesting to note that in the distal view the swelling of the tooth is due to the entoconid and the hypoconulid. This feature can be observed on the M1 of ER 820.

Fossils	**MD**	**BL**
Garba IV	**c.12.4**	**c.10**
Homo habilis (Tobias 1991)		
OH 7 (g.)	14.1	12.5
OH 13 (d.)	13.0	11.6
"Early" *Homo*		
Dmanisi 211 (Gabounia and Vekua 1995)	13.2/13	12.3/12.5
ER-WT 15.000 (Brown and Walker 1993)	12.7/12.4	11.1/11
Homo erectus Turkana basin		
N=7 (Brown and Walker 1993)	12.4	11.04
"*Sinanthropus*" (Weidenreich 1936) N=13	12.47	11.8
"Ancient European fossils"		
Mauer (Condemi *et al.* 1997)	11.8	11.2
Arago 2 (Lumley and Lumley 1982)	11	10.9
Arago 13 (" ")	13.8	13
Atapuerca N=6 (Bermudez de Castro 1986)	11.3	10.7
Montmaurin (Billy and Vallois 1977)	11.8	10.5
European Neanderthal children	m=11.6	m=10.4
(N=10; Tillier 1999)	s=0.7	s=0.7
Homo sapiens sapiens children	m=12.1	m=11.5
Qafzeh (N=6; Tillier 1999)	s=0.8	s=0.7
Skhul 1 (McCown and Keith 1939)	10.7	9.3
Skhul 9 (McCown and Keith 1939)	c.11.7	c.10.3
Modern human adults (N=106)	m=10.72	m=10.9

Tab. 6. Comparison of the mesio-distal (MD) and bucco-lingual (BL) diameters of the permanent M1.

Indeed, on *Homo habilis*, Tobias (1991) has shown that it is only the hypoconulid which produces the swelling. This is therefore a major difference.

As on the temporary molars, there are irregularities in the enamel surface. It has been noted for some time that the molars of fossil humans have a more wrinkled occlusal surface than those of modern humans. This trait has been the object of study by several paleontologists. The first extensive study was undertaken by Gorjanovic Kramberger (1909). He provided a very detailed description of the grooves visible on the molars of the Krapina Neanderthals. Since these grooves were well developed on the molars of

the Pongids and absent on modern humans, this author considered them to be a primitive trait of Hominids. Weidenreich (1936) adopted the position of Gorganovic-Kramberger, underlining that the very marked wrinkling on *Sinanthropus* diminished on the Neanderthals and disappeared, except for sporadic occurrences on modern humans. More recently, Tobias (1986) considered this trait to be one of the signs of hypoplasia of the dental enamel (see Zilberman *et al.* in this volume).

Conclusions

The Garba IV mandible belongs to a child whose age at death can be estimated to be between 3 and 4 years. Considering this young age, one is immediately struck by the overall dimensions of this jaw. Its great size immediately distinguishes it from modern humans, notably from the considerable height and thickness of the body of the mandible.

It is interesting to note that the mandible shows protuberances which are clearly visible, notably on the external face as well as a marked development of the anterior marginal tubercle.

All of these features are found on the other mandibles discovered in the Lake Turkana basin. The physiological age of this specimen makes comparisons difficult. Nonetheless, we can affirm that it constitutes the exact infantile stage in a chronological series which would be continuous with the following jaws: KNM-ER 820 (juvenile, Leakey and Wood 1973), KNM-WT 15.000 (adolescent, Walker and Leakey 1993), KNM-ER 992 (adult, Leakey and Wood 1973) et KNM-ER 730 (old adult, Day *et al.* 1975).

From a morphological standpoint, we have shown that in regard to morphology as well as to size the teeth are very close to those of ER 820 and 15000. The teeth of Garba IV are complicated by the presence of wrinkling of the enamel. This is particularly evident on the mesial edge of the anterior fovea of the dm1 and dm2. On the dm2 these wrinkles end on the occlusal surface with three small tubercles. It is interesting to note that attention has been drawn to this morphology by Walker and Leakey in regard to the lower molars of KMN-WT 15.000. For these authors, it is a trait which makes it possible to relate this fossil to others from the Turkana basin (KMN-ER 820, 992, 1502 and 1507).

In conclusion, the jaw of Garba IV can be placed in the group of Lower Pleistocene hominids known from the Turkana basin of East Africa. Concerning their specific taxonomic identification, these hominids have been referred to by some authors as an *ergaster*; others have questioned the validity of this species (Wolpoff 1996). Recently, Asfaw *et al.* (2002) in a study of the Daka fossil from the Bouri formation in Ethiopia, dated to 1.0 Ma, have also disputed the limitation of *Homo erectus* to Asia. It is now clear that the exchange between Africa and Eurasia was more intense in both directions than was previously thought and that the fossils from both places were similar. It may be that fossils have exhibited particularized features only in peripheral areas, such as Java.

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