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REMAINS OF ELEPHANTIDAE FROM THE LOWER PLEISTOCENE SITE OF UNTERMASSFELD

1. Introduction

The remains of elephants collected during a number of years at the Untermaßfeld locality are mainly separate bones and their fragments. Regular excavations were started here only in 1982, so the exact burial places of the carpal bones of a big adult male elephant obtained previously, as well as of an ulna and radius, some vertebrae, and a number of fragments, are not known.

In 1982 in square Q 60, a magnum, hamatum and an incomplete tibia of a medium-sized adult individual, were taken. They have a weakly prominent sculpture, and belong to the same individual, probably female. In later years, material was obtained at a location about 20 m from Q 60 square. Here, in 1984, in Q 503 square, a milk tooth was found, but no other remains of small elephant occurred. In 1987-89, in squares located beside each other, bones were dug out which belonged to elephants of different individual ages and sizes. Many of the bones show chewing marks of predators, suggesting that before burial the bones were on the surface for some time, or in shallow water.

At the locality of Untermaßfeld, the remains of no fewer than five elephants were found:
a small elephant of 2.5-3 years of age (pd_4);
a young elephant (humerus with both epiphyses, not completely fused);
a young adult (tibia with a distinct epiphysis suture);
two old animals (two left tibiae with epiphyses fully fused).

Differences in individual age and, probably, the presence of both males and females, are also indicated by varied massivity of the bones and the degree of sculptural development on the bone surface (areas of muscle attachment).

The systematic position of the elephant from Untermaßfeld – *M. trogontherii trogontherii* (Pohlig) – was determined on the basis of the structure of its wrist, and the morphology of the milk tooth and tarsal bones.

The author assumed the following subdivision of the Pleistocene: Lower Pleistocene (1.6-0.8 myr B.P.), Middle Pleistocene (0.8-0.135 myr B.P.), and Upper Pleistocene (0.135-0.01 myr B.P.) (Dubrovo 1991).

The following abbreviations are used:

GIN	Geological Institute of the Russian Academy of Sciences, Moscow
IQW	Forschungsstation für Quartärpaläontologie Weimar der Senckenbergischen Naturforschenden Gesellschaft
GSM	Geological State Museum, Moscow
NSM	National Science Museum, Tokyo
PIN	Palaeontological Institute of the Russian Academy of Sciences, Moscow
TKM	Museum of Regional Ethnography, Temruk
ZIN	Zoological Institute of the Russian Academy of Sciences, St. Petersburg

2. Description of the fossil material

Family Elephantidae Gray, 1821
Genus *Mammuthus* Burnett, 1830
Mammuthus trogontherii trogontherii (Pohlig, 1885)

2.1. Skull and lower jaw

Skull and lower jaw have not yet been found at Untermaßfeld.

2.2. Teeth

True molars and tusks have not yet been found at Untermaßfeld.

The last lower milk tooth – pd_4 sin. IQW 1984/20052 (Mei. 19572)
(Taf. 95)

The tooth is complete, very well preserved, and unworn. It consists of 9 plates and a rather high, wide, but very thin posterior talon (= plate having no root of its own). The plates are parallel, only the ends of the last two ones being inclined forward.

Comparison of the tooth from Untermaßfeld with pd4 of other fossil elephants (Tabl. 1) indicates the following. The low, wide crown of the tooth rules out referral to the genus *Palaeoloxodon*, whose teeth have a narrow, high crown. The tooth described has more plates, higher laminar frequency, and thinner enamel than the pd4 of *Protelephas planifrons* (Falconer et Cautley) or *Archidiskodon meridionalis* (Nesti).

The tooth IQW 1984/20052 (Mei. 19572) differs from the last milk tooth of *Mammuthus primigenius* (Blumenbach) by a lower number of plates, their low frequency, and the relatively low and wide crown. All the characters of the tooth described are within the limits of pd4 of the early form of the trogontherian elephant – *M. trogontherii trogontherii* (Pohlig).

2.1.3. Postcranial skeleton

At Untermaßfeld, not at all bones of the postcranial skeleton were found. The greater part of the bones available are broken, many of them bearing the traces of predator chewing.

Vertebrae

Four vertebrae were found. An axis and two middle thoracic vertebrae are of adult individuals. A last thoracic vertebra belongs to a young animal.

Axis IQW 1980/16113 (Mei. 15624)
(Taf. 96, 1)

The neural arch and cross processes are broken; the body of vertebra is damaged by predators. The vertebral canal is relatively wide.

Measurements (mm) and index (%) IQW 1980/16113 (Mei. 15624)	
1. Preserved width of the cranial articular surface	215
2. Restored width of the cranial articular surface	≤ 250
3. Width of the vertebral canal	92
4. Index 3:2	≥ 36.8

The ratio of the width of the vertebral canal and the cranial articular surface in *Archidiskodon meridionalis tamanensis* Dubrovo from the suburbs of the town of Nogajsk (Garutt 1954) is 25,8%. In mammoths, this index is higher, that is, up to 50%. We cannot speak of an undoubted difference between the *Archidiskodon* and *Mammuthus* genera in this feature, until we obtain more data on the southern elephant. It is interesting to note, however, that in the elephant from Untermaßfeld, this index is higher than that of the Nogajsk *A. meridionalis*. It is similar to that of *Mammuthus*.

Middle thoracic vertebrae IQW 1980/15374 (Mei. 14886) and IQW 1980/15373 (Mei. 14885)
(Taf. 96, 2-4)

One of the middle thoracic vertebrae; rather well preserved. Anterior vertebral disk is completely fused; in the proximal part, the suture between the disk and the body of the vertebra is still discernible. A fragment of thoracic vertebra IQW 1980/15373 (Mei. 14885) belongs to the same individual.

	Untermaßfeld IQW 1984/20052 (Mei. 19572)	*M. trogontherii trogontherii* Süßenborn (Guenther 1969)		Suhoj Elancik GIN N704/1-4	*M. primigenius* Jakutien			Salzgitter (Guenther 1981)	
					PIN N778/1	PIN	GSM	N 16	N 31
	pd_4	pd^4	pd_4	pd^4	pd_4	pd^4	pd^4	pd_4	pd^4
1. Number of plates	9	8-11	9-11	–	12	12	12	11	11
2. Tooth length	107	102-152	110-125	–	99	100	>105	115	98
3. Tooth width	62	50-70	45-75	64	39	>50	52	62	53
4. Crown height	62	–	–	–	53?	62	–	83	>56
5. Laminar frequency	9	7-8	8-9	8	12	13	13	–	–
6. Enamel thickness	1.5	1.5	1.5	1	≈ 1	≈ 1	≈ 1	–	–
7. Index 3:2	57.9	46-49	40.9-60.0	–	39.3	50?	–	53.9	54.1
8. Index 4:2	57.9	–	–	–	53.5	62	–	72.2	–
9. Index 3:4	100	–	–	–	73.6	80.6?	–	74.7	–

Tab. 1a The last milk teeth (pd4) of fossil elephants. – Measurements (mm), Indices (%).

	Archidiskodon meridionalis meridionalis (Falconer and Cautley 1846)			Val d'Arno Italy (Friant 1959)		Aksalaâ Ukraine	Morskaâ
						ZIN	GIN N270/7
	pd_4	pd_4	pd^4	pd_4	pd^4	pd_4	pd^4
1. Number of plates	8	7	8	8	7	7	>7
2. Tooth length	119	–	118	–	–	135	>94
3. Tooth width	47	–	63	–	–	66	60
4. Crown height	58	–	>51	–	–	–	67
5. Laminar frequency	–	–	–	–	–	5.5	7
6. Enamel thickness	–	–	–	–	–	2.5	1.5
7. Index 3:2	39.5	–	53.4	–	–	48.9	–
8. Index 4:2	48.7	–	–	–	–	–	–
9. Index 3:4	81	–	–	–	–	–	89.5

Tab. 1b The last milk teeth (pd4) of fossil elephants. – Measurements (mm), Indices (%).

	A. meridionalis tamanensis Tamanian peninsula			*Palaeoloxodon* Ehringsdorf (Guenther 1975)			Japan (Hasegawa 1972)	
	TKM N2853/10	PIN N1249	ZIN N25994				NSM 14230	NSM 14150
	pd_4	pd^4	pd_4	pd^4	pd_4		pd^4	pd_4
1. Number of plates	7	–	8	11	10	9?	11	10
2. Tooth length	111	–	116?	128	150	>94	112	113
3. Tooth width	58	62	44?	33	46	42	32	49.5
4. Crown height	52	83	51?	–	89	81	>50	92
5. Laminar frequency	7	8	7	–	–	–	10?	–
6. Enamel thickness	2	2	1?	1	2	1	≈ 1	–
7. Index 3:2	52.2	–	–	25.9	30.6	–	28.6	43.8
8. Index 4:2	46.9	–	–	–	59.3	–	–	87.4
9. Index 3:4	111.5	74.7	–	–	51.7	51.8	–	53.8

Tab. 1c The last milk teeth (pd4) of fossil elephants. – Measurements (mm), Indices (%).

Measurements (mm)	IQW 1980/15373 (Mei. 14885)	IQW 1980/15374 (Mei. 14886)
1. Length of the vertebra	83	84
2. Maximum width	-	195
3. Width of the anterior articular surface	158	166
4. Width of the posterior articular surface	-	169

The last thoracic vertebra IQW 1980/15415 (Mei. 14927) + IQW 1980/15872 (Mei. 15383)
(Taf. 97, 1-2)
Vertebral disks dropped, and neural arch not fused completely: this vertebra belongs to a very young animal. On both lateral faces, there are well expressed facets anteriorly for articulation with the heads of the last ribs.

Measurements (mm) IQW 1980/15415 (Mei. 14927) + IQW 1980/15872 (Mei. 15383)	
1. Length of the vertebral body (without vertebral disks)	68
2. Width of the vertebral body (without vertebral disks)	118
3. Width of the vertebral canal	51
4. Dimensions of the articular facet for the rib	57 × 37

Scapula sin. IQW 1986/21616 (Mei. 21135)
The bone is broken and chewed by predators.

Measurements (mm) IQW 1986/21616 (Mei. 21135)	
1. Length of scapula	> 770
2. Width of the scapula neck	270
3. Height of the scapular spine	160

The scapular spine is straight and vertical throughout its length. It rises gently from the proximal part of the neck of the scapula. A hook-like process is very well developed; it evidently departed from the scapular spine somewhat lower than the acromion process. Their lateral surfaces were at different levels. The lower edge of the processus hamatus and the scapular spine form an angle of 45°; its anterior edge runs at an angle close to 90°. The details of scapula morphology are very variable even in elephants of the same species. Differences suggested between elephants of different genera in the direction of the scapular spine, the degree of thickness of its outer edge, the shape of the scapula edge, and in the form of the hamatum and acromial processes have not been confirmed (Dubrovo 1982). These features are very liable to age, sexual and individual variation.

Humerus dex. IQW 1988/22447 (Mei. 21966)
(Taf. 101, 1)
The lateral part of the proximal epiphysis is broken, and the anterior parts of the proximal end of bone and of the distal block are damaged. The bone surface is almost smooth; the tuberositas deltoidea is weakly expressed. Only the outer edge of the lateral epicondylus is strongly sculptured. The junctions of epiphyses are clearly discernible. The bone belonged to a young animal.

Measurements (mm) and index (%) IQW 1988/22447 (Mei. 21966)	
1. Length from the upper margin of the head to the lower edge of the lateral block	1088
2. Maximum width of the head	189
3. Maximum depth of the head	261
4. Minimum width of diaphysis	139
5. Width of the distal end	350
6. Width of the block	274
7. Index 5:1	32

The lateral epicondylus with a straight right edge slightly protrudes beyond the distal epiphysis. The shape of the upper edge of the lateral epicondylus in elephants may be straight or concave. Some authors (Zalenskij 1903) considered this feature to be diagnostic between elephant genera. However, the shape of the edge of the lateral epicondylus changes with an animal's age. Thus, in young mammoths, the upper edge of the lateral epicondylus is straight; in adults, especially in old males, it becomes concave.
An incomplete head of humerus sin. IQW 1988/22400 (Mei. 21919) with unfused epiphyal suture, evidently belongs to the same individual. An incomplete lower part of humerus dex. IQW 1981/17753 (Mei. 17274) + IQW 1981/17754 (Mei. 17275) and a fragment of the head of humerus IQW 1980/17155 (Mei. 16676) belong to an older animal (fused epiphyses).

Ulna dex. IQW 1980/16119 (Mei. 15630)
This is an incomplete upper part of the bone. The olecranon is broken off, and the articular surfaces for the humerus are partially damaged, the cut separating them being wide and shallow. Tuberositas ulnae is clearly expressed. The epiphysis is fully fused. The bone belongs to an adult animal.

Measurement (mm) IQW 1980/16119 (Mei. 15630)	
1. Width of the proximal end	> 290
2. Width of the lateral articular surface for the humerus block	78
3. Height of the articular surface for radius	29

Radius sin IQW 1981/17757 (Mei. 17278)
The lower end of the bone is broken off, and the posterior and medial sides of the upper epiphysis are impaired. Facies articularis humeri has a small transverse eminence. Facies articularis ulnaris is almost flat. The epiphysis is fused, the lateral surface of the bone being sharply rugged.

Measurements (mm) IQW 1981/17757 (Mei. 17278)	
1. Length	> 370
2. Width of the proximal end	> 130
3. Depth of the proximal end	> 108
4. Height of facies articularis ulnaris	40
5. Width of diaphysis	67
6. Depth of diaphysis	95

The ulna and radius belong to different adult elephants – the former to a smaller one, the latter to a bigger one.

Manus
Out of eight bones which compose an elephant's carpus (Fig. 1) seven were found at Untermaßfeld: only the naviculare is missing. All the bones are of the right side; the colour and preservation is the same in all of them. Many of them are impaired, evidently by a bulldozer. The sutures are not discernible. The bones belong to two individuals somewhat different in sizes.
Hamatum and magnum were found close together in the site. The dimensions of the two bones (the depth and the height at the anterior edge) match. They undoubtedly belong to one and the same individual and, probably, to a female, judging by the indistinct relief of the bone.
The rest of the wrist bones, with a sharp sculpture, belong to a somewhat bigger animal, probably a male. The fact that triquetrum, lunatum and pisiform belong to one and the same individual is proved by the ratio of their heights, just like that of these bones of one individual of *M. primigenius* and *A. meridionalis*. Near the pisiform were found trapezium and trapezoideum, having a very good contact. The fact that these bones belong to one and the same individual is substantiated by the index between pisiform height and height of the trapezoideum: similar to that of mammoth and southern elephant.

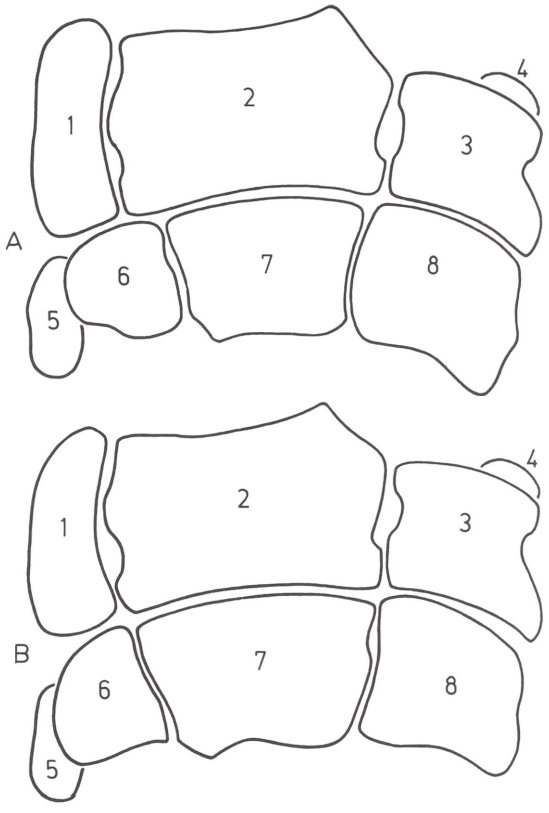

Fig. 1 Structure of elephants carpus. – A Aserial type. – B Serial type. – 1 Naviculare. – 2 Lunatum. – 3 Triquetrum. 4 Pisiforme. – 5 Trapezium. – 6 Trapezoideum. – 7 Magnum. – 8 Hamatum.

Lunatum dex. IQW 1981/17686 (Mei. 17208)
(Taf. 98, 4)
The fore part of the bone is preserved with an inner edge broken off and the lower surface badly impaired. The anterior side has a sharp sculpture.

Measurements (mm) IQW 1981/17686 (Mei. 17208)

1.	Height	104
2.	Width	151
3.	Depth	98

The width of the articular facet for the ulna is less than half the width of the facies articularis radialis. They are arranged at somewhat more than a right angle. The lower edge of the anterior side of the bone is straight, without the shallow notch which is present on the lunatum in *Palaeoloxodon* from Jozwin (Poland).
This feature, however, is probably variable, since in *M. primigenius* that notch ranges from very sharp (PIN 1404) to almost indistinct (Trofimov's mammoth). The upper articular facet found on the lateral side of the lunatum of *Palaeoloxodon* is evidently absent on this bone from Untermaßfeld.

Triquetrum dex. IQW 1980/17154 (Mei. 16675)
(Taf. 98, 1-2)
Impaired only slightly.

Measurements (mm) IQW 1980/17154 (Mei. 16675)

1. Maximum height	131
2. Height without hooked process	93
3. Width	222
4. Depth	168
5. Width of the articular surface for the ulna	161
6. Depth of the articular surface for the ulna	141

The hooked process is relatively short and wide (Taf. 98, 1); the facet for pisiform lowers to its middle. The articular surface for hamatum on the distal side of bone, overlaps the hooked process considerably (Taf. 98, 2). The anterior part of this facet is slightly convex and the posterior part quite concave. The facet for Mc 5 is not high, ribbon-like. The facets for the hamatum and for Mc 5 have a contact between each other. The position of the facet for the hamatum is considered by some scientists to be diagnostic of different elephant genera. It has been noted that in *Protelephas*, *Archidiskodon* and *Palaeoloxodon* it does not overlap the hooked process, and the isolated facet was on it. In mammoth and living elephants it is continued on the hooked process (Garutt 1954). There is, however, individual variability in the form and dimension of the facet for Mc 5 (Dubrovo and Jakubowski 1988). The development of the upper articular facet for the lunatum is diagnostic. In *Palaeoloxodon* it is always present; in *Archidiskodon* and *Mammuthus* it is not developed at all. In the triquetrum from Untermaßfeld, the upper facet is absent too, only the lower one being present.

Pisiforme dex. IQW 1981/17685 (Mei. 17207)
(Taf. 98, 3)
This is almost complete, only the middle part of the lateral edge being impaired. The sculpture of the bone surface is very sharp.

	Untermaßfeld IQW 1981/17685 (Mei. 17207)	*M. primigenius* (Dubrovo and Jakubowski 1988)	*A. meridionalis* (Garutt 1954)	*Palaeoloxodon* Jozwin (Dubrovo and Jakubowski 1988)
1. Height	194	159	201	195
2. Maximum proximal width	116	89	109	93
3. Index 2:1	59.7	55.9	54.2	47.7

Tab. 2 The pisiform of fossil elephants. – Measurements (mm), Index (%).

The facet for the triquetrum is relatively short; under its lower edge, there was a sharp roughness which, evidently, decreased to the middle of the bone height. The bone is more massive than the pisiform of *Palaeoloxodon*.

Trapezium dex. IQW 1981/17684 (Mei. 17206)
(Taf. 99, 5)
The bone is damaged on the back side; its fore surface is sharply rugose.
This specimen differs from the trapezium of *Palaeoloxodon* by a considerably lower height : width ratio.

	Untermaßfeld IQW 1981/17684 (Mei. 17206)	*Palaeoloxodon* Jozwin (Dubrovo and Jakubowski 1988)	Upnor (Andrews and Cooper 1928)
1. Maximum height	113	118	96
2. Maximum width	89	63	58
3. Index 1:2	126.9	187.3	165.5

Tab. 3 The trapezium of fossil elephants. – Measurements (mm), Index (%).

Trapezoideum dex. IQW 1981/17683 (Mei. 17205)
(Taf. 99, 3-4)
The posterior end is broken off, the lateral and medial sides being partially damaged. The bone surface has a sharp sculpture.

	Untermaßfeld IQW 1980/17683 (Mei. 17205)	*Mammuthus primigenius* Siberia PIN 1404	PIN 4393	*Archidiskodon meridionalis* Nogajsk (Garutt 1954)	*Palaeoloxodon* Jozwin (Dubrovo and Jakubowski 1988)	Cheichanow
1. Height on the anterior side	80	61	61	83	93	71
2. Maximum width	108	66	72	98	100	71

Tab. 4 The trapezoideum of fossil elephants. – Measurements (mm).

The anterior part of the lateral side is occupied by a single articular facet for the magnum (Taf. 99, 4). In elephants, there are often two anterior facets: the upper and lower ones. On the trapezoideum from Untermaßfeld there is only a very weakly expressed trace of their unification.
The fusion of the anterior articular facets into one is, evidently, more characteristic of *Mammuthus* than of *Palaeoloxodon*. In *Archidiskodon* is noted a narrowing of the posterior end of the bone which was, evidently, absent in trapezoideum from Untermaßfeld.

Magnum dex. IQW 1982/18545 (Mei. 18065)
(Taf. 99, 2)
Badly broken off in the posterior and lower parts. Only a part of the upper articular surface for the hamatum has been preserved on the lateral side. On the medial side, there is one articular facet, along the whole of the height, for the trapezoideum. Of the facets for Mc 2 and Mc 3, only their anterior parts were preserved; the first one is narrower than the second.

Measurements (mm) IQW 1982/18545 (Mei. 18065)
1. Height on the front side 81
2. Maximum width on the front side 98
3. Maximum depth 120

The magnum from Untermaßfeld differs from that of *Palaeoloxodon*, and is similar to that of *Mammuthus*, by the unification of the upper and lower front articular facets for the trapezoideum into one, occupying the whole width in the front part of the medial side of the magnum.

The ratio of the front width of the facets for Mc 3 and for Mc 2, which was considered to be diagnostic for elephants, shows individual variation (Dubrovo and Jakubowski 1988).

Hamatum dex. IQW 1982/18546 (Mei. 18066)
(Taf. 99, 1)
The bone is broken off in the lower part of the posterior side. The sculpture of the front surface of the bone is of small wrinkles, not sharp. The lateral height is much greater than the medial one. The anterior parts of the articular surface for Mc 3, and the lateral part of the facet for Mc 4, are much lower compared to the level of the anterior edge of the facet for Mc 5.

	Untermaßfeld IQW 1982/18546 (Mei. 18066)	*Mammuthus primigenius* Frankleben IQW 1989/23062 (Frankl. 22581)	Siberia PIN 1404	*Archidiskodon meridionalis* (Garutt 1954)	*Palaeoloxodon* Jozwin (Dubrovo and Jakubowski 1988)	Gröbern
1. Height at the front side	86	74	88	113	114	116
2. Maximum width at the front side	129	102	125	141	167	161
3. Maximum depth	106	94	–	–	167	166
4. Index 1:2	66.7	72.5	70.4	80	68.2	69.9

Tab. 5 The hamatum of fossil elephants. – Measurements (mm), Index (%).

The relative width of the hamatum from Untermaßfeld is more than that of *Archidiskodon* and is similar to that of *Palaeoloxodon* and *Mammuthus*.

Metacarpal 3 dex. IQW 1981/17713 (Mei. 17235)
There is a preserved fragment of the anterior side without a proximal end and with a partially broken off distal one. The surface has a very distinct relief.

Measurements (mm) IQW 1981/17713 (Mei. 17235)
1. Length 226
2. Maximum width of diaphysis 97

Phalanx II IQW 1980/16779 (Mei. 16300)
(Taf. 99, 6)
Well preserved; the bone has a sharp sculpture and the sutures are indiscernible.

Measurements (mm) IQW 1980/16779 (Mei. 16300)
1. Width 75
2. Height 55

Pelvis sin. IQW 1980/16120 (Mei. 15631)
(Taf. 97, 3)
A fragment of os ischii with part of the acetabulum and a part of the articular surface for the head of the femur is preserved. The medial part of the acetabulum has not been preserved on the pelvic bone from Untermaßfeld, therefore the degree of convergence of the lateral and medial margins of the acetabulum cannot be established. The ventral width of the incisura acetabuli is 30 mm.

	Untermaßfeld IQW 1980/16120 (Mei. 15631)	*M. trogontherii* (Zakrevskaâ 1936)	*M. primigenius* (Zalenskij 1903) ZIN N 5316	(Dubrovo 1982) ZIN N 7911 left	right
1. Width of the incisura acetabili	30?	13	3	17	6
2. Height of the branch of the os ischii	100	93	86		
3. Width of the branch of the os ischii	72				

Tab. 6 The pelvis of fossil elephants. – Measurements (mm).

A relatively shallow acetabulum, and maybe a considerable width of its incisura, may be noted as characteristic features of the elephant pelvic bone from Untermaßfeld. The latter feature was considered diagnostic by some authors (Leith Adams 1877-1881; Zalenskij 1903). For the mammoth, however, this has not been substantiated. Even in one individual from the Lena River, the width differs greatly on the right and left sides of the pelvis (Tab. 6). The way the incisura acetabuli ends is, evidently, more characteristic. It either opens immediately into the oval hole or into the flat surface of the os ischii, which protrudes its process into the oval hole. The latter is characteristic of the genus *Mammuthus* and occurs also in the elephant from Untermaßfeld. In the *Palaeoloxodon* from Gröbern near Halle, the acetabulum is very deep, with a narrow cut which opened immediately into the oval hole.
In the Untermaßfeld collection, there is also a part of the right ala ossis ilii IQW 1980/16172 (Mei. 15683).

Femur IQW 1982/18571 (Mei. 18091) and IQW 1987/21960 (Mei. 21479)
There are two incomplete heads of femurs. Judging by a different height of the heads over the upper edge of the fovea capitis, the bones probably belonged to different individuals. Both of the bones bear traces of chewing by hyenas, in the distal parts, which suggests that the heads were not fused yet.

Measurements (mm) IQW 1982/18571 (Mei. 18091)
Diameter of the head 170

Patella dex. IQW 1980/16183 (Mei. 15694)
A proximal part has been preserved. The bone was evidently wide but thin. The anterior and lateral surfaces are very uneven, with sharp sculpture. Probably, the patella belonged to an adult animal with a well developed muscularity.

Measurements (mm) IQW 1980/16183 (Mei. 15694)
1. Length preserved 93
2. Width 133
3. Depth > 87

Tibia sin. IQW 1989/22849 (Mei. 22368)
(Taf. 101, 2)
This bone is almost complete; only the proximal end is partially damaged. Epiphyses are completely adherent.
In addition, there are three left tibiae with proximal ends broken off, and two upper tibia ends partially destroyed: a right one IQW 1981/17758 (Mei. 17279) and a left one IQW 1982/18572 (Mei. 18092).

	Untermaßfeld		*Mammuthus trogontherii* (Zakrevskaâ 1936)	*Mammuthus primigenius* (Garutt 1954)		*Archidiskodon meridionalis* (Pavlova 1931)	(Garutt 1954)	*Palaeoloxodon* (Andrews and Cooper 1928)
	IQW 1989/22849 (Mei. 22368)	IQW 1981/17763 (Mei. 17284)		ZIN 7911	ZIN 5316			
1. Bones length	886	–	690	675	590	750	–	1020
2. Width of the proximal end	320	–	220	256	220	240	340	281
3. Width of distal end	242	195	–	195	169	140	198	–
4. Depth of distal end	192	152	–	151	135	–	201	–
5. Width of diaphysis	130	123	–	108	92	–	135	–
6. Index 2:1	36.1	–	31.9	37.9	37.3	32	–	27.5
7. Index 3:1	27.3	–	–	28.9	28.6	18.7	–	–
8. Index 4:3	79.3	77.9	–	77.4	73.9	–	101.5	–

Tab. 7 The tibia of fossil elephants. – Measurements (mm), Indices (%).

No peculiarities in the morphology of the tibiae from Untermaßfeld were established. The relative width of the proximal end is very similar to that of *Mammuthus* and *Archidiskodon*. It is, evidently, somewhat greater than in palaeoloxodon elephants. The tibia of the elephant from Untermaßfeld differs from this bone in *Archidiskodon* by a relatively wider distal end as compared to its depth.

Fibula sin. IQW 1981/17679 (Mei. 17201)
A part of the diaphysis and distal epiphysis were connected by a rock to the tibia 1981/17763 (Mei. 17284). The medial side of the epiphysis is badly damaged; only a part of the articular facet for the talus is preserved. The lateral side has a sharp sculpture. The epiphysis is completely fused.

Measurements (mm) IQW 1981/17679 (Mei. 17201)	
1. Preserved length	425
2. Depth of the distal end	132
3. Width of the diaphysis in the middle part	36
4. Depth of the diaphysis in the middle part	48

Pes
Only three bones of the tarsus and one second phalanx have been found.

Calcaneus dex. IQW 1988/22488 (Mei. 22007)
(Taf. 100, 1)
The bone is very big. Its outer end is slightly broken off and its lower surface is damaged; the articular facets for fibula and cuboideum have not been preserved.

The tuber calcanei is well developed, its surface being very uneven which indicates that a strong musculature was attached. The coracoid facet, evidently, had the usual shape for elephants. The sustentacular facet is relatively narrow, with a sharp narrowing in the middle part.

	Untermaßfeld IQW 1988/22488 (Mei. 22007)	*M. primigenius* PIN	IQW 1989/23062 (Frankl. 22581)
1. Maximum length	280	209	194
2. Length of the body	155	124	–
3. Length of the processus coracoideus	156	105	105
4. Maximum width	213	162	135
5. Maximum depth	174	–	–
6. Width of the tuber calcanei	145	94	84
7. Depth of the coracoid facet	>92	67	74
8. Depth of the sustentacular facet	125 (?)	92	92
9. Width of the coracoid facet	100	–	–

Tab. 8 The calcaneus of fossil elephants. – Measurements (mm).

Talus dex. IQW 1989/22847 (Mei. 22366)
The upper surface is badly damaged. The bone is big, and belongs to an adult animal.

	Untermaßfeld IQW 1989/22847 (Mei. 22366)	*M. trogontherii* (Zakrevskaâ 1936)	*A. meridionalis* Moldova PIN	*M. primigenius* Ûribej PIN N 3941
1. Maximum width	208	155	216	123
2. Maximum depth	188 (?)	110	188	120
3. Width of coracoid facet	106	55	120	48
4. Depth of coracoid facet	147	118	133	82
5. Width of the sustentacular facet	60?	60	56?	41
6. Depth of the sustentacular facet	134	85	122?	75
7. Width of the facet for naviculare	150	>150	116	95
8. Diameter of the facet for naviculare	87	70	95	61

Tab. 9 The talus of fossil elephants. – Measurements (mm).

The coracoid facet is almost flat; it and the articular surface for the tibia form a right angle. The talus of *M. primigenius* from Gydan peninsula has a similar structure. In *A. meridionalis* from Moldova, these two articular surfaces are divided by a gentle furrow with large nutrient holes. The sustentacular facet is convex in both directions, forming a narrow kidney-shape. The facet for the naviculare is convex in both directions. In the talus of the Ûribej mammoth and of *A. meridionalis* from Moldova Dubrovo (1982) noted a different proportion of the sizes of the coracoid and sustentacular articular surfaces. In the former, the two squares are almost equal, and in the latter, the coracoid facet surface is almost twice as large. On the talus from Untermaßfeld, the square of the sustentacular facet is about two-thirds the size of the coracoid facet square. To clear up the diagnostic significance of proportion of these facets, we need much more material.
In addition, the collection includes an incomplete right talus IQW 1988/22497 (Mei. 22016), very badly preserved, belonging to a smaller individual.

Naviculare sin. IQW 1989/22846 (Mei. 22365)
(Taf. 100, 2)
The bone is almost complete. Its lower surface is slightly damaged, only the borders of facies articularis cuboidea being distinct.

	Untermaßfeld IQW 1989/22846 (Mei. 22365)	*M. trogontherii* (Zakrevskaâ 1936)	*M. primigenius* (Garutt 1954) ZIN N 16283	*A. meridionalis* Nogajsk (Garutt 1954)
1. Maximum width	187	130	136	181
2. Maximum depth	143	90	91	127
3. Front height	52	40	37	51

Tab. 10 The naviculare of fossil elephants. – Measurements (mm).

The differences in the structure of the naviculare between various taxa of elephants have not been established yet. For the bone from Untermaßfeld we may note its big size, strong protrusion of the processus talocaudalis, and a sharp difference between the medial and lateral widths of the facies articularis talares.
The processus talocaudalis also protrudes strongly in *M. trogontherii* from Novogeorgievsk (Zakrevskaâ 1936); on the naviculare of *M. primigenius* from the Ûribej River and in *A. meridionalis* from Nogajsk (Garutt 1954) it is developed much weaker. The depth of the medial part of facies articularis talares in the elephant from Untermaßfeld is much less than that of its lateral part; on the naviculare of the mammoth from the Ûribej river and the southern elephant from Nogajsk, they are nearly equal.

Phalanx II IQW 1982/18550 (Mei. 18070)
The bone is complete, weakly sculptured, and no sutures are observed.

Measurements (mm) IQW 1982/18550 (Mei. 18070)
1. Maximum width 62
2. Maximum length 52

3. Systematical position of the elephant from Untermaßfeld

The study of a tooth (pd_4), found at Untermaßfeld shows that its referral to *Palaeoloxodon*, *Protelephas*, *Archidiskodon meridionalis meridionalis* or *Mammuthus primigenius* is completely eliminated. It is also different, though rather less so, from the last milk teeth of *A. meridionalis tamanensis*. It is very close to the pd_4 of *M. trogontherii trogontherii* in all characters. The ranges of variation in diagnostic characters of different elephant taxa are well established for their last molars. We have data on only a small number of milk teeth. Therefore, for confirmation of the determination of the systematic position of the elephant from Untermaßfeld as *M. trogontherii trogontherii*, we use all diagnostical characters which can be observed on the material of this locality.
The main generic difference in the structure of the postcranial skeleton of elephants is the type of wrist structure (Fig. 1). It is aserial for the genera *Mammuthus* and *Palaeoloxodon* (Dubrovo and Jakubowski 1988); a serial carpus is characteristic for *Archidiskodon* and recent elephants (Garutt 1954). The lunatum in the aserial wrist is much larger than the magnum (Fig. 1A); in the serial carpus they have nearly the same width (Fig. 1B). Therefore, for determination of the type of wrist-structure it is necessary to know the width of lunatum and magnum in one and the same individual.

As we have already noted, the lunatum and magnum found in Untermaßfeld belong to two animals of different sizes.

Calculation of the sizes of missing wrist bones in both these individuals is possible by establishing the correlation of bone sizes in the elephant's carpus. As standards, data on four mammoths and three palaeoloxodon elephant skeletons were taken. All the measurements were made by the author according to a single methodology (Dubrovo and Jakubowski 1988). Published data on these genera and on *Archidiskodon* were also considered.

The most constant proportions in the wrist of one individual of the elephant turned out to be the ratio of widths hamatum-triquetrum, hamatum-lunatum, trapezoideum-hamatum, magnum-trapezoideum and magnum-triquetrum. With these available data it is possible to calculate the value limits of triquetrum, trapezoideum and lunatum of a the smaller elephant from Untermaßfeld, the hamatum and magnum of which were found. On the basis of the width index hamatum-triquetrum, equal in the studied genera to 68-84% [n = 10 (number of studied specimens, all measurements are given in mm)], the width of triquetrum of this animal was 153-189. By the width index magnum-triquetrum 47-64% (n = 7), the size of the triquetrum is from 154 to 206. The size of trapezoideum of that individual by the width index trapezoideum-hamatum 48-62% (n = 7) was from 63 to 74 and by index trapezoideum-magnum 61-79% (n = 8) it is 58-77.

As we can see, the sizes, obtained on the bases of different correlations, are very similar. Therefore, for the determination of the width of lunatum of the smaller individual, we can use the width index hamatum-lunatum, equal to 93-103% (n = 7). The calculated width of the lunatum as 125-139 exceeds considerably the width of magnum (98 mm) of the same animal.

Magnum width of the bigger individual was calculated by the width index magnum-triquetrum: 47-64% (n = 7). It was 104-140. The width of this bone was also calculated by the width index magnum-tibia. Its width was 122-127. The complete width of the broken lunatum of the bigger animal – from 154 to 184 – was calculated as well.

Thus, according to all data in both individuals of elephant from Untermaßfeld, the lunatum is considerably wider than the magnum. Both wrists were of aserial structure.

The established aseriality of the wrist of the elephant from Untermaßfeld eliminates its belonging to the genus *Archidiskodon*.

Two genera with aserial wrist structure, *Mammuthus* and *Palaeoloxodon*, have many differences in details of morphology and bone proportions in the postcranial skeleton (Dubrovo 1982; Dubrovo and Jakubowski 1988). Owing to the preservation of partial remains from Untermaßfeld, only some of these characters can be used for the determination of the elephant genus from that locality. All of them indicate the referral of the elephant from Untermaßfeld to the genus *Mammuthus*. First, the absence of the upper facet for the articulation of lunatum and triquetrum is typical for *Mammuthus*. Second, that genus has (Dubrovo and Jakubowski 1988) a big, massive pisiforme and feeble lowering of the lateral part of its facet for the triquetrum, marked in the elephant from Untermaßfeld as well. Third, two facets for the magnum – upper and lower – anteriorly on the lateral side of trapezoideum, are fused into one (Taf. 99, 4). In *Palaeoloxodon* there are two separate facets. Finally, the way the incisura acetabuli in the pelvis ends is the same in the elephant from Untermaßfeld and in *Mammuthus*, and differs from *Palaeoloxodon*.

All available data on the morphology of pd_4 and the postcranial skeleton of the elephant from Untermaßfeld indicate that it belongs to the genus *Mammuthus*. It is *M. trogontherii trogontherii*.

4. Biostratigraphical position and ecological character of the elephant from Untermaßfeld

The nominative subspecies of trogontherian elephant, *M. trogontherii trogontherii*, to which the Untermaßfeld elephant belongs, is a typical representative of the first half of the Middle Pleistocene fauna of Europe and the Asian part of Russia. The localities with the biggest samples of its remains are: Süßenborn in Germany (Guenther 1969) and Kolkotova Balka (= Tiraspol) in Moldova [Nikiforova (ed.) 1971].

The geological age of the sediments containing the fossil remains has been established for these localities, the whole of the faunal assemblage studied in detail. The complex of mammals, as well as invertebrates, substantiates the correctness of geological correlations for localities with *M. trogontherii trogontherii* remains from these districts.

The great biostratigraphic significance of *M. trogontherii trogontherii* is conditioned by knowledge of its restricted stratigraphic distribution, as well as by the fact that elephant taxa have been established whose remains are characteristic of more ancient and younger sediments. More ancient in phylogenetic and geological terms were Upper Pliocene - Early Pleistocene *Archidiskodon* elephants. *Archidiskodon meridionalis vestinus* Azzaroli in Western Europe and *A. meridionalis tamanensis* Dubrovo in Eastern Europe and Asia, may be regarded as immediate predecessors of the trogontherian elephant. They are Early Pleistocene subspecies of southern elephant, and inhabited savannah biotopes. In the Middle Pleistocene, *M. trogontherii trogontherii* was replaced by the khozarian elephant *M. trogontherii chosaricus* Dubrovo (Dubrovo 1966), similar already in its morphology with woolly mammoth and, without doubt, adapted to rather severe climatic conditions.

During the period of existence of *M. trogontherii trogontherii*, judging by the composition of the accompanying faunal complex, the climate was still relatively warm, although some forms adapted to cold environmental conditions already have started to appear. The molar structure of the nominative subspecies of the *trogontherii* elephant (a large number of high plates arranged rather densely, narrow enamel) suggests their fitness to chew coarse herbaceous vegetation. It was an inhabitant of steppe biotopes. Its living conditions seem to have been very favourable: *M. trogontherii trogontherii* is one of the largest representatives of Elephantinae.

Judging by the size of the long bones and carpal bones, the elephants from Untermaßfeld reached large size. To determine the elephant's growth, we use Garutt's data (Garutt 1954, 1964), according to which the length of the humerus in *Mammuthus* is about 34%, and that of the tibia about 21.4% of the height of the skeleton at the back. The height of the animal's body was 20-25 cm more.

Humerus IQW 1988/22447 (Mei. 21966) of the young elephant from Untermaßfeld is 1088 mm long. The height of this animal's skeleton was 3.2 m and that of the animal about 3.5 m.

Tibia IQW 1989/22849 (Mei. 22368) with completely adhered epiphyses and a distinct relief, being 886 mm long, belongs to an old male. The elephant's height, figured out, was about 4.4 m, and the height of the skeleton was 4.14 m.

The smallest tibia of an adult individual belonging, evidently, to a female. IQW 1981/17763 (Mei. 17284) was about 700 mm long. That is, the height of the skeleton was about 3.3 m, and that of the body about 3.5 m.

Thus, the males of *M. trogontherii trogontherii* from Untermaßfeld reached a height of 4.4 m and females 3.5 m. The males' height in this subspecies from Mosbach and Azov is even more – 4.5 m. Locations very rich in remains of *M. trogontherii trogontherii*, in Europe, suggest great size of its population on that territory.

The presence of *M. trogontherii trogontherii* in the faunal assemblage of Untermaßfeld permits us to date this locality as the first half of the Middle Pleistocene, or maybe as the very late Lower Pleistocene. The geological age of Untermaßfeld cannot be more ancient than one million years ago, since in sediments dated about 1.2 myr B.P., there are finds of *Archidiskodon*. These are locations of *A. meridionalis tamanensis*, Nogajsk and Zevahova Gora in southern Ukraine (Dubrovo 1964). For the second half of the Middle Pleistocene; the later subspecies of *trogontherii* elephant, *M. trogontherii chosaricus*, is characteristic.

The presence of the *M. trogontherii trogontherii* remains at Untermaßfeld suggests an existence of steppe biotopes with rich vegetation in this area at the end of the Lower or the beginning of the Middle Pleistocene.

Summary

The remains of elephants from the Untermaßfeld locality near Meiningen belong to five individuals of different ages. The structure of the single milk tooth, a pd_4, the aserial structure of the carpus and a num-

ber of morphological features of the bones, have made it possible to determine the systematic position of the elephant as *M. trogontherii trogontherii*. The elephant's dimensions are very large. On the basis of the dimensions of the humerus and tibia of different individuals, the height of an adult male was 4.4 m and that of a female 3.5 m.
The presence of the nominative subspecies of trogontherian elephant determines the geological age of the locality as the first half of the Middle Pleistocene or maybe the very late Lower Pleistocene. In earlier times in Eurasia the southern elephants were characteristic, whilst during the second half of the Middle Pleistocene, the late subspecies of the trogontherian elephant, *M. trogontherii chosaricus*, is typical.
M. trogontherii trogontherii was an inhabitant of steppes. Its presence in the Untermaßfeld fauna suggests that in this area, during that time, there were steppe biotopes.

Zusammenfassung
Die Elefantenreste aus der Fundstelle Untermaßfeld bei Meiningen gehören zu fünf Individuen unterschiedlichen Alters. Die Struktur des einzigen Milchzahnes, eines pd_4, der aseriale Bau des Carpus und weitere morphologische Merkmale der Knochen ermöglichen eine systematische Zuordnung der Reste zu *Mammuthus trogontherii trogontherii*. Die Dimensionen dieses Elefanten waren sehr groß. Anhand der Größe von Humerus und Tibia verschiedener Individuen wurde eine Höhe von 4,40 m für ein männliches und 3,50 m für ein weibliches Tiere ermittelt.
Das Vorkommen der Nominatunterart des Steppenmammuts läßt auf ein frühmittelpleistozänes oder spätunterpleistozänes Alter der Fundstelle schließen. Für den unmittelbar älteren Zeitabschnitt waren Südelefanten charakteristisch. Kennzeichnend für die zweite Hälfte des Mittelpleistozäns ist die späte Unterart *Mammuthus trogontherii chosaricus*.
Mammuthus trogontherii trogontherii war ein Steppenbewohner. Sein Auftreten in der Untermaßfelder Fauna läßt daher für den genannten Zeitraum in diesem Gebiet Steppenbiotope vermuten.

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