A PATHOLOGIC STRAIGHT-TUSKED ELEPHANT FEMALE FROM NEUMARK NORD (GERMANY)

Federica Marano1 & Maria Rita Palombo1,2
1Università degli Studi di Roma Sapienza, Roma
2Università degli Studi di Roma Sapienza, IGAG - CNR, Roma

ABSTRACT: Marano F. & Palombo M.R., A pathologic straight-tusked elephant female from Neumark Nord. The elephant bones collected during more than ten years (1985-1996) in the interglacial (MIS 7 or MIS 5) lacustrine deposits exposed in the open-cast lignite mine of Neumark Nord (Germany), represent one of the most outstanding samples of straight-tusked elephants in the Pleistocene of Europe. In 1994, a skeleton of an adult female (E8 HK 2007:55) was found in nearly anatomical connection. The postcranial bones were almost all preserved, the skull was partially destroyed, and the tusks and mandible were missing. Wearin stage of molars and fusion of bones, as well as the pelvis morphology indicate a 39-40 years old female for which a height at the shoulders of about 2.9 m and a weight of about 5000 kg have been calculated. The most peculiar traits of this female are the serious scoliosis that affected its vertebral column and the invasive arthritis that deformed its femur and pelvis girdle on the right side.


Key Words: Palaeoloxodon, Age, Sex, Body Mass, Pathology, Pleistocene, Germany.

Parole-chiave: Palaeoloxodon, Età, Sesso, Massa corporea, Patologie, Pleistocene, Germania.

1. INTRODUCTION

The site of Neumark Nord is one of the richest in remains of palaeoloxodont elephants and undoubtedly the richest in Central Europe. Since the early 80’s, an extraordinary rich sample of fossil remains was retrieved from the lacustrine deposits exposed in the open-cast lignite mine of Neumark Nord 1 (Sachsen-Anhalt, Middle East Germany) (MANIA, 2010) (Fig. 1). At Neumark-Nord 1, a long stratigraphical succession documents the environmental evolution of an endorheic basin during a complete interglacial climatic cycle. The lacustrine deposits have been supposed to be late Middle Pleistocene in age (MIS 7) on the basis of vegetational data, indicating subcontinental, mild climatic conditions (GRÜBE, 2003; SEIFERT-EULEN, 2010), as well as of the presence of Apodemus maastrichtiensis, a species present at Weimar-Ehringsdorf but not recorded from the Eemian deposits of the area (HEIRICH, 2001, 2010). This chronology has been questioned by some authors, who considered the interglacial to be the Eemian (MIS 5e) (KOLFSCHOTEN, 2000; KOENIGSWALD, 2007, BOETTGER et al., 2009 and references in those papers). Recently ESR dating of few samples might support an Eemian age (SCHÜLER, 2010), whilst data obtained by amino-acid racemisation of the “intra-crystalline” fraction of Bithynia tentaculata opercula are consistent with a late Middle Pleistocene age (PENKMAN, 2010). The lacustrine sediments lie with no hiatus over a ground moraine ascribed to the “Drenthe-glaciation” by MANIA (1999), and are overlaid by thick loess layers, then the succession is closed by muddy interglacial sediments and glacial deposits, respectively, thought to be Eemian and Weichselian in age (MANIA, 1999, 2004) (Fig. 2). The rich palaeontological record comes from the first interglacial cycle, and counts about two hundreds of plant species, invertebrates, insects, and a diversified vertebrate fauna, including several, more or less complete, skeletons of large mammals (elephants, rhinoceroses, fallow deer, red deer, aurochs as well as some carnivores such as wolf, lion and spotted hyaena). Elephant remains were retrieved from 6 fossil-bearing layers within the lower, middle and upper »gyttja«, which represent successive episodes within the small lake fill-
F. Marano & M.R. Palombo

94

Taking into account the place the remains were collected from, their dimensions as well as the progression in tooth eruption and epiphyseal fusion, the minimum number of elephant individuals found at Neumark Nord could be nearly 70, though the calculated number would be overestimated, because of the difficulty to assessing the skull fragments, and largely incomplete bones from “bone beds”, which were seriously damaged by excavators (Palombo et al., 2010).

According to the research performed to date, the morphology and biometry of skulls, tusks, molars and postcranial bones indicate that the specimens fall within the variability of European straight-tusked elephants (see e.g. Osborn, 1942; Trevisan, 1949; Maccagno, 1962; Aguirre, 1968-1969; Beden, 1969; Knock, 1991; Tsoukalas & Villa, 1998; Davies, 2002; Palombo et al., 2010).

This paper is aimed at assessing the ontogenetical age, sex and body size as well as to briefly describe the pathological bones of an almost complete skeleton found in the October 1994 in the fossiliferous level 6.1, at a distance of about 150 m from the coastline of the lake basin (Fig. 2, 3). At the time of discovery, the skull was still in articulation with the vertebrae, the pelvis was in anatomical position, while the long bones were disarticulated and partially dislocated. The exceptionally well preserved stomach contents, with the remains of its last meal, were found under the chest (Grübe et al., 2010). The skull is partially destroyed, the maxilla is well preserved and the molari-form teeth are located in the alveoli, while tusks and jaw are missing. The postcrania1 bones are almost all preserved except for carpal and metacarpal bones, while the tarsals are represented by calcaneus, astragalus, navicular, cuboid, right mesocuneiform and ec-tocuneiform bones, some sesamoids are also present (Fig. 4). This specimen (E8: HK 2007: 55) is stored in the Landesmuseum für Vorgeschichte in Halle Saale (Germany).

2. METHODS

The completeness of the remains has made it possible to determine both age and gender, as well as body mass and shoulder height of the studied E8 individual.

The age was inferred according to the progression in tooth eruption and wear of plates of the upper molars, adapting to these teeth the method tested by Laws (1986) on the lower molars of extant African elephants (Loxodonta africana) and also applied to fossil species (Roth, 1984; Haynes, 1991). The status of the epiphyseal-diaphyseal junction of long bones has also been taken into account (Roth, 1984; Haynes, 1991).

About the gender determination, several features have been regarded as of potential information about the sex of a proboscidean, e.g. body size, length and stoutness of long bones, morphology and size of skull and teeth (molars and tusks), atlas and epistropheum, pelvis and carpal bones (see Palombo & Villa 2003, and references therein). The gender of E8 elephant was inferred based on the morphology and dimensions of the pelvis girdle, which have been demonstrated to be particularly appropriate and have been largely applied to determine the gender in fossil proboscideans (Kroll 1991, Lister 1996; Gölich, 2000; Palombo & Villa, 2003).

Body mass was considered as the best proxy of body size, according to Gingerich et al. (1982). Body mass of proboscideans has been estimated using different allometric equations (e.g. Roth 1990, Palombo & Giovannazzo, 2005; Christiansen, 2004). Here, we calculated the body mass of E8 by means of the regression equations proposed by Christiansen (2004), regarded as the most appropriate when either the actual shoulder height or the inferred circumference of manus are not available. Measurements were taken only on the left long bones because of the pathology affecting the right hind leg of E8 elephant.

The stature was inferred combining the results of direct measurements of the forelimb (but acropodial bones) and the equation proposed by Osborn (1942), this because of the poor preservation of the humerus, for which only the functional medial length is available.

3. DESCRIPTION AND RESULTS

3.1 Main morphological features

Skull - According to the preserved fragments of skull, the nuchal fossa was deep and showed rough surface (Fig. 5b), the frontal bones flat and rather developed antero-posteriorly. The fan, is moderately expanded; the tusk-sockets are rather small and gently bent towards the lateral side (Fig. 5e), the premaxillary fossa becomes rapidly shallow, broad and somewhat convex towards the distal end of the fan (Fig. 5c). Maxillary bones have a thin and short pyramidal process, the last molariform teeth (see below) were not completely...
erupted, and residual, small alveoli are present on both sides.

Teeth - The not completely erupted molariform teeth have 8 plates in use, while a not evaluable number of plates, all fused together, occupy the entire free portion of alveoli, whose posterior portion is well ossified. The lateral side of the alveoli is locally broken, enabling us to see how the roots of molars are completely formed and fused to the plates (Fig. 5d). Accordingly, the teeth have been regarded as last molars (M₃) (MARANO, 2009), consistently with the degree of ephyseal-diaphyseal fusion of long bones (see below).

The morphology and dimension of the molars fall in the range of south European straight-tusked elephant populations. The molars are narrow and high crowned, the occlusal surface is ovate and slightly convex, plates are slightly bowed out on the lateral side, in the less worn plate, the enamel occlusal figures are formed by a large oval central loop and two small lateral loops. At an intermediate wear stage, the enamel figures show a moderate mediad expansion. The enamel is thin, crinkled, densely and regularly folded, and the folds extend on the entire length of the enamel figure.

Stylohyoideum - In both right and left stylohyoi-
deum the posterior ramus is broken, the superior ramus, the less developed, is moderately elongated, and the inferior ramus is slender, gently curved upwards and backwards, without any evident lateral deflection; in anterior view it shows a gently concave lateral outline.

Postcranial skeleton - The vertebral column pos-
sesses 7 cervical, 19 thoracic (including ribs as well), 4 lumbar, 5 sacral vertebrae, while the maximum number of caudal vertebrae is unknown. The morphology of the limb bones and pelvis girde is consistent with those known for the European straight-tusked elephants (e.g. MACCAGNO 1962, TREVISAN 1949, KROLL 1991, TSOUKA-
LA ET LISTER 1998): the humerus is characterized by a large and angled deltoid tuberosity and a more or less deep deltoid fossa; the ulna is massive with a robust olecranon and wide distal articular surface; the left fe-
mur has a relatively short neck, angled on the diaphysis of about 40°, the diaphysis is moderately twisted as is commonly found in femora of adult individuals; the tibia possesses a weak cnemial crest, the distal epiphysis is smaller than, but nearly as massive as the proximal epiphysis. The general shape of the tarsal bones does not substantially differ from that of the actually quite var-
iable European straight tusked elephants (TREVISIAN, 1949; KROLL, 1991; FERRETTI, 2008). The pelvis shows a gently curved lateral profile of the ileum wing, less rounded than in Elephas maximus, but more rounded than in Loxodonta africana africana and Mammutthus primigenius (see PALOMBO & VILLA 2003 for a discus-
sion). With the latter two species, the pelvis of E8, as well as that of straight tusked elephants, shares a ileum with a more transversally elongated wing.

3.2 Age, sex, body size

Age - The peculiar progression in displacement of the molariform teeth, characterizing elephants, provides a particularly useful means for determining their age. Accordingly, the first step in determining the age of E8 elephant was assessing the age on the basis of the eruption progress and the degree of wear of its upper molariform teeth. In E8 both molariform teeth (M₃) are not completely erupted, furthermore, the M₂ were already ex-
served. The stage of wear of M3 is not particularly advanced: the occlusal surface (120 mm of length) counts 8 plates, showing a complete fused enamel loops in the first five plates (Fig. 5a). According to the pattern of age proposed by Lawis (1986) for the lowers molars, but taking into account the similar progression in the both lower and upper molariform teeth often shown by straight-tusked elephants, and in particular observed in the Neumark Nord rich sample (Palombo et al., 2010), the E8 specimen falls in the Lawis’s XXII age group, which corresponds to an age ranging from 37 to 40 years.

The age inferred on the basis of the progression and wear of molars is consistent with the epiphyseal fusion of the axial and limb bones (Roth, 1984). The vertebral border of the scapula and the caput femuris, indeed, are almost completely fused, showing no or faint traces of ongoing ossification (Fig. 6).

Gender - The morphology of the pelvis girdle is consistent with that of a female: it is characterized by a wide and rounded pelvic aperture with a transverse diameter of 540 mm, reduced thickness of the ischium and flattened ilium. The ratio of the maximum diameter of the pelvic aperture versus the minimum width of ilium is 3.1, while that of the diagonal height of the pelvic aperture versus the minimum width of ilium is 3.4. Both values fall with in the variability range of females (Lister, 1996; Palombo & Villa, 2003; Kroll, 1991), the values of the same ratios being significantly lower in males.
Body size - The estimated body mass ranges from 8511.39 kg to 3162.27 kg. The first value was calculated on the basis of the minimum circumference of the diaphysis of the humerus, the second on the basis of the maximum length of the tibia, yielding an average body mass of about 9900 kg. The body mass calculated by using the minimum circumference of the ulna, which gives the best prediction thanks to the high correlation coefficient and low error rate, is approximately 4900 kg, falling close to the maximum body mass of extant African and Asian females (Haynes, 1991).

The shoulder height, inferred by directly measuring the forelimb long bones and taking into account the possible height of the missing more than 250 cm, while it is about 290 cm by using the equation proposed by Osborn (1942). Accordingly, E8 should be of about 10% higher than a female of Loxodonta africana of about the same age (Laws, 1996; Haynes, 1991).

3.3 Pathology
Some of the elephant bones found at Neumark-Nord show anomalous ossification/growth, which is most frequent among vertebrae and teeth. In some vertebrae, such as the atlas, the ossification is incomplete and in some caudal vertebrae the neural channel is open at the top, while in others, such as the lumbar sacral vertebrae, arthritis or arthrosis had caused hyperossification.
and anomalous fusion of vertebral bodies.

The skeleton of E8 shows some malformations which certainly have affected the quality of life and habits of the elephant. The most peculiar traits of this specimen are the serious scoliosis that affected its vertebral column and the invasive arthritis that deformed its femur and pelvis on the right side (Fig. 7). In the vertebral column, the last thoracic vertebrae arch toward right, while the lumbar and sacral ones arch toward left. As a result the vertebral column is markedly twisted. In the pelvic girdle, the right acetabulum is anomalously large and shows a conspicuous hyperossification along its edge, while the ilium shaft is sclerosed (Fig. 7, 8). The right femur, 7% shorter than the left, was deformed by arthritis (Fig. 9): the caput femoris is elongated and abnormally bent, the neck length strongly reduced. Conversely, no evident anomalies affected either the distal epiphysis or the zeugopodium and acropodium. Both arthritis and arthrosis are, actually, common among older, domesticated Asian elephants. In domesticated Asian elephants, most of pathological ossifications are due to goad injuries caused by keepers. Several cases have also been reported for zoo elephants too. It seems that young animals tolerate traumatic injuries without much difficulty but, when they grow older, the problems reappear. Thus it would take a long time before arthritis effects become clear.

4. DISCUSSION

Morphological features shown by E8 and results obtained by biometrical analysis, contribute to a better understanding of the morphological and dimensional variability of European straight-tusked elephants.

Although several data concur, to designating Palaeoloxodon as a bona fide elephantine genus, closely related to but separated from Elephas (INOUZUKA & TAKAHASI, 2004; SHISHIKI et al., 2007; PALOMBO & FERRETTI, 2010), in the literature, there are different opinions about the nomenclature for Eurasian “Straight-tusked elephants”. Disagreements essentially center on the taxonomic status (genus or subgenus) ascribed to “Palaeoloxodon”, as well as on the number of species regarded as present in Eurasia. The European straight-tusked elephants have been considered as belonging either to the Asian species “Elephas namadicus” or, as one bona fide species, Elephas antiquus/Palaeoloxodon antiquus.
Alternatively, both these species have been considered present in Europe. Two morphotypes have been recently described by SAEGUSA & GILBERT (2008): the Italian "namadicus-like" morphotype (showing an extreme developed parieto-frontal crest, nearly reaching the external choanae), and the "German-Stuttgart" morphotype (characterized by a weak development of the parieto-frontal crest).

Although the parieto-frontal and nuchal crests of E8 skull were seriously damaged during the recovery, some preserved large fragments indicate that its forehead could have been wide and gently convex. Accordingly, the morphology of the preserved parieto-frontal part of the skull of E8 seems to confirm the peculiar development of the parieto-frontal crest, shown by some adult males from Neumark Nord (PALOMBO et al., 2010), which differentiates the skulls of Central Europe (especially from Germany) from those of Southern Europe. Although the development of the parieto-frontal crest of the skulls from Neumark Nord are variable, they are mainly characterized by a moderately extended forehead and by a dorsally positioned parieto-frontal crest, as observed in skulls ascribed by SAEGUSA & GILBERT (2008) to the "Stuttgart" morphotype. Accordingly, most of the German palaeloxodon populations do not present the morphological "namadicus" traits shown by the Italian continental adult elephants ascribed by SAEGUSA & GILBERT (2008) to this morphotype e.g. skulls from La Polledrara Cecanibbio, (P ALOMBO et al., 2010). Moreover the concordance among dimensional data, pelvis morphology and help. We are grateful to the anonymous reviewers for their comments on the manuscript.

ACKNOWLEDGEMENTS

We are indebted to Prof. H. Meller for inviting one of us (Maria Rita Palombo) to study the elephants from Neumark Nord. We thank everyone at the Landesmuseum für Vorgeschichte of Halle for granting us access to the fossil material in their care and for their kindness and help. We are grateful to the anonymous reviewers for their comments on the manuscript.

REFERENCES


GRÜBE R. (2003) - Plaztlliche Nahrungsreste der fossilien
Elefanten und Nashorn aus dem Interglazial von Neumark - Nord (Geiseieltal). Veröffentlichungen des Landesamtes für Archäologie Sachsen-Anhalt, 57 (1) pp. 221-236.


A pathologic straight-tusked elephant female …


TREVISAN, L. (1949) - *Lo scheletro di Elephas antiquus Italiquus di Fonte Campanile (Viterbo).* Paleonto­graphia Italica 44 (1948), pp. 2-78.


Ms. ricevuto il 25/05/2010
Testo definitivo ricevuto il 8/10/2010

Ms. received: May 25, 2010
Final text received: October 8, 2010