

A skeleton of an injured *Coelodonta antiquitatis* from the Late Pleistocene of north-western Germany

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Summary

Remains of an articulated skeleton of *Coelodonta antiquitatis* (Blumenbach 1807) from Late Pleistocene river gravel deposits of the Weser near Petershagen (northwest Germany) are described. A partly healed costal fracture at the middle of the right flank of the skeleton seems to be the result of intra-species fights. Other bones from the woolly rhinoceros site belong to *M. primigenius*, *B. priscus*, *M. giganteus*, *E. ferus przewalskii*, and *R. tarandus*, indicating the presence of a typical Late Pleistocene mammoth steppe fauna. Interesting are the remains of the steppe lion *P. leo spelaea* and an indirect proof of the ice age spotted hyena *C. crocuta spelaea* given by chewing marks. The described articulated woolly rhinoceros skeleton, in comparison with isolated cave and freeland bones of the woolly rhinoceros give new information about the paleobiology, biogeography and taphonomy of these huge ice age animals in north-western Germany. Articulated skeletons of the woolly rhinoceros are extremely rare in the world, mainly as the result of carcass and bone destruction by the ice age spotted hyenas.

Samenvatting

De restanten van een gearticuleerd skelet van *Coelodonta antiquitatis* (Blumenbach 1807), gevonden in laat-pleistocene grindafzettingen van de rivier Weser bij Petershagen (noordwest Duitsland), worden beschreven. Een gedeeltelijk genezen ribbreuk in het midden van de rechterflank van het skelet lijkt het resultaat te zijn van een gevecht tussen soortgenoten. Andere botten van dezelfde wolharige neushoorn site, zoals *M. primigenius*, *B. priscus*, *M. giganteus*, *E. ferus przewalskii*, and *R. tarandus*, wijzen op de aanwezigheid van een typische laat-pleistocene mammoetsteppe-fauna met opmerkelijke resten van de steppe-leeuw *P. leo spelaea* en indirect bewijs van de aanwezigheid van de gevlekte hyena *C. crocuta spelaea* aan de hand van bijtsporen. Het beschreven skelet van een wolharige neushoorn, vergeleken met andere geïsoleerde vondsten uit grotten en openlucht-sites van de wolharige neushoorn geven nieuwe informatie over de paleobiologie, biogeografie en tafonomie van deze grote ijstijdzoogdieren in noord-west Duitsland. Gearticuleerde skeletten van de wolharige neushoorn zijn extreem zeldzaam, hoofdzakelijk als gevolg van karkas- en botdestructie door ijstijdhyanas.

Introduction

Isolated bone remains of the woolly rhinoceros of the Late Pleistocene are commonly known in Germany and Europe from many gravel pits near rivers or submarine sites on the Brown Bank of the North Sea (e.g. Wüst, 1922, Borsuk-Bialynicka, 1973; Heinrich, 1983; Siegfried, 1983). In addition, some carcass remains of a special fossil conservation are known, such as frozen in the permafrost floors of the Wrangle Islands or wax-impregnated in the Czech Republic (e.g. Tikhonov *et al.*, 1999; Koenigswald, 2002).

Most details of *Coelodonta antiquitatis* skeletons, skins and horns were studied at different mummified carcasses. One animal was found impregnated with wax at Starunia in the Ukraine (Kowalski, 2000; Kubiak, 1994). A skull from the permafrost of the Jena river in Jacutia is exposed in the museum of St. Petersburg, and horns from Jakutsk in the mammoth museum (cf. Koenigswald, 2002).

Few articulated skeleton remains are known from central Europe. Two skeletons from Belgium are exposed in the Museum of Natural History at Brussels, but it is unclear if they are composed of different individuals or not. Half a skeleton of a juvenile individual from a Dutch site is present in the collections and the exhibition of the Enschede Museum. Finally, there is an incomplete skeleton of one adult individual excavated in Pohlitz (Löscher, 1906) that is stored in the Museum für Naturkunde, Gera, but which has not been described in detail. The mounted skeleton from Munich (figured in Kahlke, 1955) was lost during World War II. It is unclear if it was a composed animal. A mounted skeleton is present in the Geologisch-Paläontologisches Museum of the Westfälischen Wilhelms-Universität of Münster, Germany, with original bones of different individuals and mixed with *Bison* bones from the Westphalian sites Selm-Ternsche and Herten-Stuckenbusch. An anatomically correct cast based on different individuals was built up



Fig. 1. Mounted skeleton cast of a Late Pleistocene woolly rhinoceros *Coelodonta antiquitatis* exposed in the Museum für Ur- und Ortsgeschichte, Eiszeithalle Quadrat Bottrop. The original bones are from different Westphalian sites in Northwest Germany, especially the sites Herten-Stuckenbusch and Selm-Ternsche.

Afgietsel van een opgezet skelet van een Laat-Pleistocene wolharige neushoorn *Coelodonta antiquitatis*, opgesteld in het Museum für Ur- und Ortsgeschichte in Bottrop. The originele botten komen van diverse Westfaalse sites in noord-west Duitsland, met name van de sites Herten-Stuckenbusch en Selm-Ternsche.

in the Museum für Ur- und Ortsgeschichte, Eiszeithalle Quadrat Bottrop by M. Walders (Fig. 1). The described Pleistocene mammal bone material from the new woolly rhinoceros skeleton site near Petershagen (North-west Germany) was collected between 1977-1980 by F. Brinkmann in the gravel pit Marsch at Lahde (owner Brunkhorst). The skeleton was discovered at August 2nd, 1977, during work in the sand pit but was not systematically excavated. The pit was situated on the western side of the Weser river and is no longer active. The material was given to the collection of the Naturkundemuseum in the years 1978 and 1980. Here, the bones were registered under the numbers 1978/2 and 1980/32. The skull of this new *Coelodonta* skeleton was published (Diedrich, 2004a) without knowledge of the presence of the postcranial material. This was rediscovered in 2004 during reorganization of

the Pleistocene bone collection of the Naturkundemuseum Bielefeld.

At first, the complete skeleton was prepared by the company PaleoLogic. During the preparations some sediment could be isolated for possible future analysis and also some bone material from the pelvis was isolated for a radiocarbon isotope analysis. After sampling, many broken ribs and pelvic bone fragments were joined together and all bones were conserved by synthetic resin on nitro base. Finally, every bone was numbered and catalogued.

The studied material of the woolly rhinoceros bone material from the open air site Selm-Ternsche in the Muenster Basin (Fig. 2) is stored in the collection of the Westfälische Wilhelms-Universität Münster (abbreviation = GPI). The bones from a hyena cave den site (the Perick caves, including the Heinrichscave and the Sundwigcave) at Hemer (Fig. 2) were studied in the collections of the Staatliche Naturhistorische Sammlungen Dresden (abbreviation = SNSD), and the collection in the Heinrichs Cave (abbreviation = HC). For the biogeographical map (Fig. 2) additional small collections of the Dobergmuseum Bünde, Heimatmuseum Löhne, and Museum Wevelsburg Paderborn were included.

Geology and Datation

Sadly, no stratigraphic documentation was made at the gravel pit. The Pleistocene of north-west Germany was generally studied by Skupin *et al.* (1993). The development and deposition of the Emscher, Lippe and Ems rivers in the Muenster Basin during the Saalenian and the Weichselian ice ages were presented by Speetzen (1990) and Skupin & Staude (1995). The river terraces of the Werre and Weser in the Löhne and Minden region were described by Henke (1969). He mentioned a Pleistocene mammal fauna from the Late Pleistocene period. According to him, the Lower terraces of the Werre and the Weser rivers in the region of the skeleton (Löhne to Petershagen) were deposited during the Weichselian ice age. Especially in these levels many gravel pits along the Weser are exploited in the Minden and Petershagen region. Many Pleistocene mammal bones were found, but only a few have been described in more detail (Guerin, 1980; Diedrich, 2004a-e).

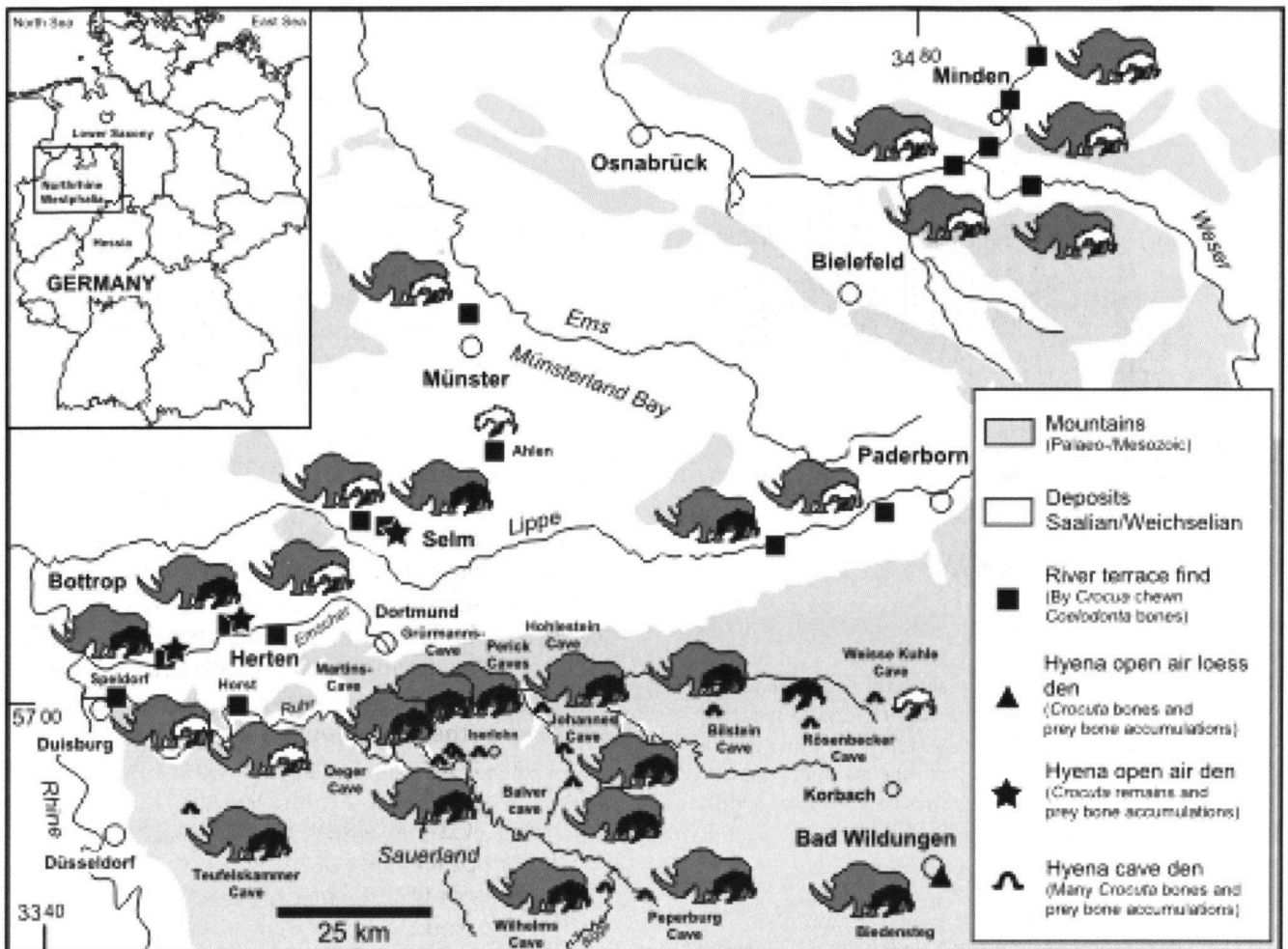


Fig. 2. Geographical position of the site Petershagen where the skeleton of *Coelodonta antiquitatis* was found and other sites with woolly rhinoceros bone remains in north-western Germany (after Diedrich 2004a, c, 2005b, 2008).

Geografische positie van de site Petershagen waar het skelet van *Coelodonta antiquitatis* gevonden is en andere sites met wolharige neushoornbotten in noord-west Duitsland (naar Diedrich 2004a, c, 2005b, 2008).

Paleontology

Family Rhinocerotidae Owen 1845

Genus *Coelodonta* Bronn 1831

Coelodonta antiquitatis (Blumenbach 1807)

Skeleton material

One incomplete skeleton (Fig. 3) from the Late Pleistocene (Weichselian) found in the river gravel and sand pit Marsch (owner Brunkhorst) in Lahde near Petershagen western of the river Weser consisting of 66 partly fragmentary bones (Naturkundemuseum Bielefeld, Nos. 1980/32-41, 1978/2-1-65). All bones are preserved excellently without gnawing marks or evidence of transport, although some parts were fractured and destroyed during work in the pit.

Skull (Figs. 4.1-2): The incomplete, 70 cm in length (the complete length is estimated at 80

cm) skull lacks the complete dentition, maxillas, palatines, one jugular and the lower jaw. Between the orbitals it measures 23 cm. The horn surface of the posterior small horn is present, but the anterior, larger horn attachment surface is only half preserved and broken off by the quarry work. The skull sutures are connected completely and indicate an adult individual. The tongue bone stylohyoideus (No. 1978/2-36) was found, which is quite rare and the first find of this bone in northern Germany. Measurements are given in Table 1.

Forelimbs (Figs. 5.1-9): The scapulae are only represented by distal fragments (Nos. 1978/2-1-14). Both humeri are lacking. The right ulna (No. 1978/2-28) and radius (No. 1978/2-29), the left fragmentary ulna (No. 1978/2-30), the left carpal III (No. 1978/2-31), the right metacarpus III (No. 1978/2-35) and IV (No. 1978/2-34), the left metacarpal II (No.

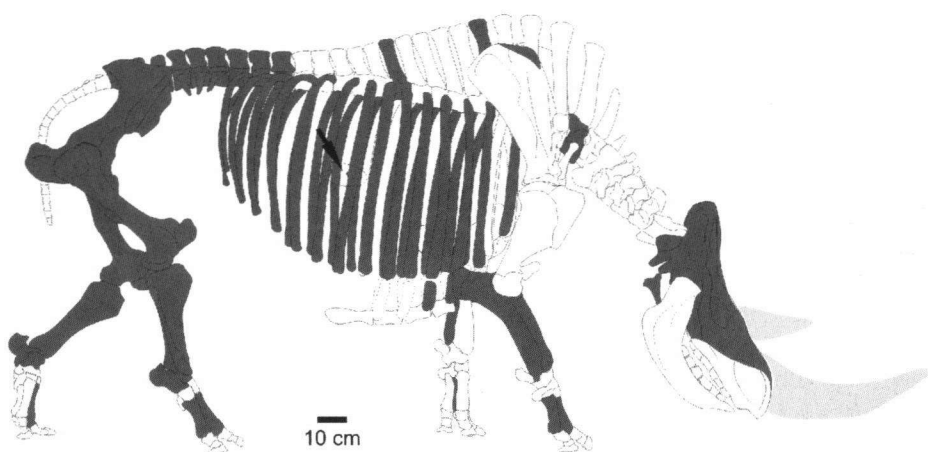


Fig. 3. Skeleton reconstruction of *Coelodonta antiquitatis* redrawn after the skeleton in the Museum für Ur- und Ortsgeschichte, Eiszeithalle Quadrat Bottrop. The bones represented by the skeletal remains from Petershagen are marked. The arrow marks the hitting zone and costal fracture of the right 13th rib.

Reconstructie van het skelet van *Coelodonta antiquitatis*, nagetekend naar het skelet in het Museum voor Prehistorie en Plaatselijke Geschiedenis in de Ijstijdhal Quadrat te Bottrop. De botten die vertegenwoordigd worden door de resten van Petershagen zijn aangegeven. De pijlen markeren de inslagplek en de ribbreuk van de rechter dertiende rib.

1978/2-32) and IV (No. 1978/2-33) are completely present (Nos. 1978/2-28 to 35). Most of the carpals and all small phalanges are missing. The measurements of the longbones are given in Table 2.

Sternum (Fig. 5.12): One central sternal bone is preserved (No. 1978/2-1-11). This is 7,4 cm in length and 7 cm in height. On the right side a fresh hit mark can be recognized. The bone is triangular in cross section.

Costae (Figs. 6-9): In complete skeletons 19 ribs are present on each side (total = 38). In this skeleton, 28 costae are present, mostly complete and in good condition and it is the best preserved thorax of German woolly rhinoceros remains. 14 ribs are from the right (Nos. 1978/2-38 to 51) and the others from the left

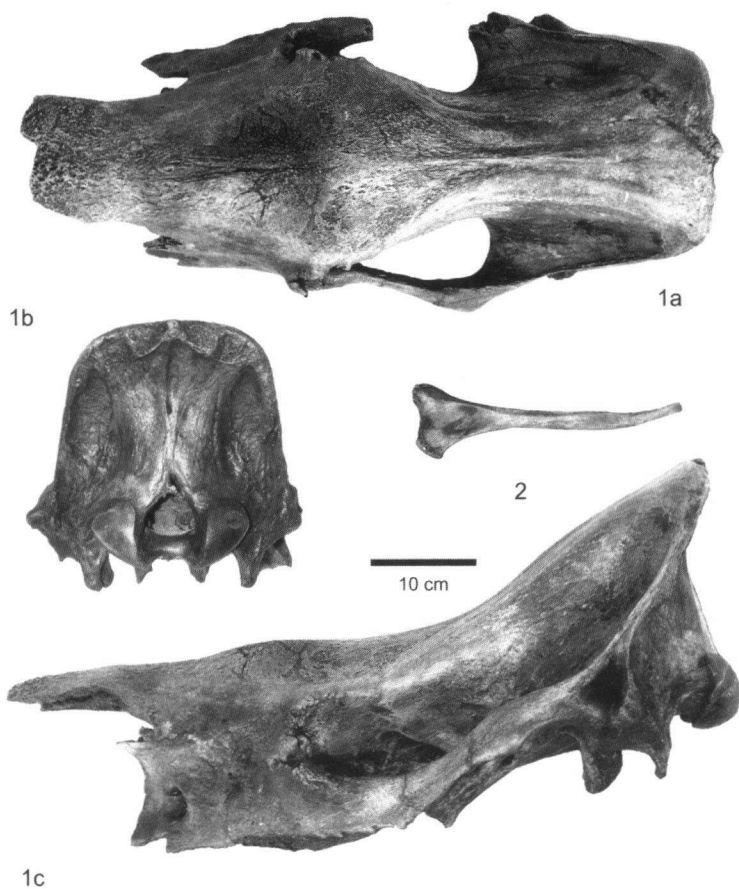


Fig. 4. *Coelodonta antiquitatis*, Late Pleistocene, Petershagen (NW Germany). 1. Incomplete toothless skull (No. 1980/32-41) without rostral parts and maxillae, a) dorsal, b) occipital, c) left view. 2. Tongue bone (stylohyoideum; No. 1978/2-36), distally incomplete, lateral view.

Coelodonta antiquitatis, Laat Pleistoceen, Petershagen (NW Duitsland). 1. Incomplete tandenloze schedel (nr. 1980/32-41) zonder voorkant en bovenkaken, a) boven-, b) achter- en c) zij-aanzicht (linkerkant). 2. Tongbeen (stylohyoideum; nr. 1978/2-36), uiteinde ontbreekt, zij-aanzicht.

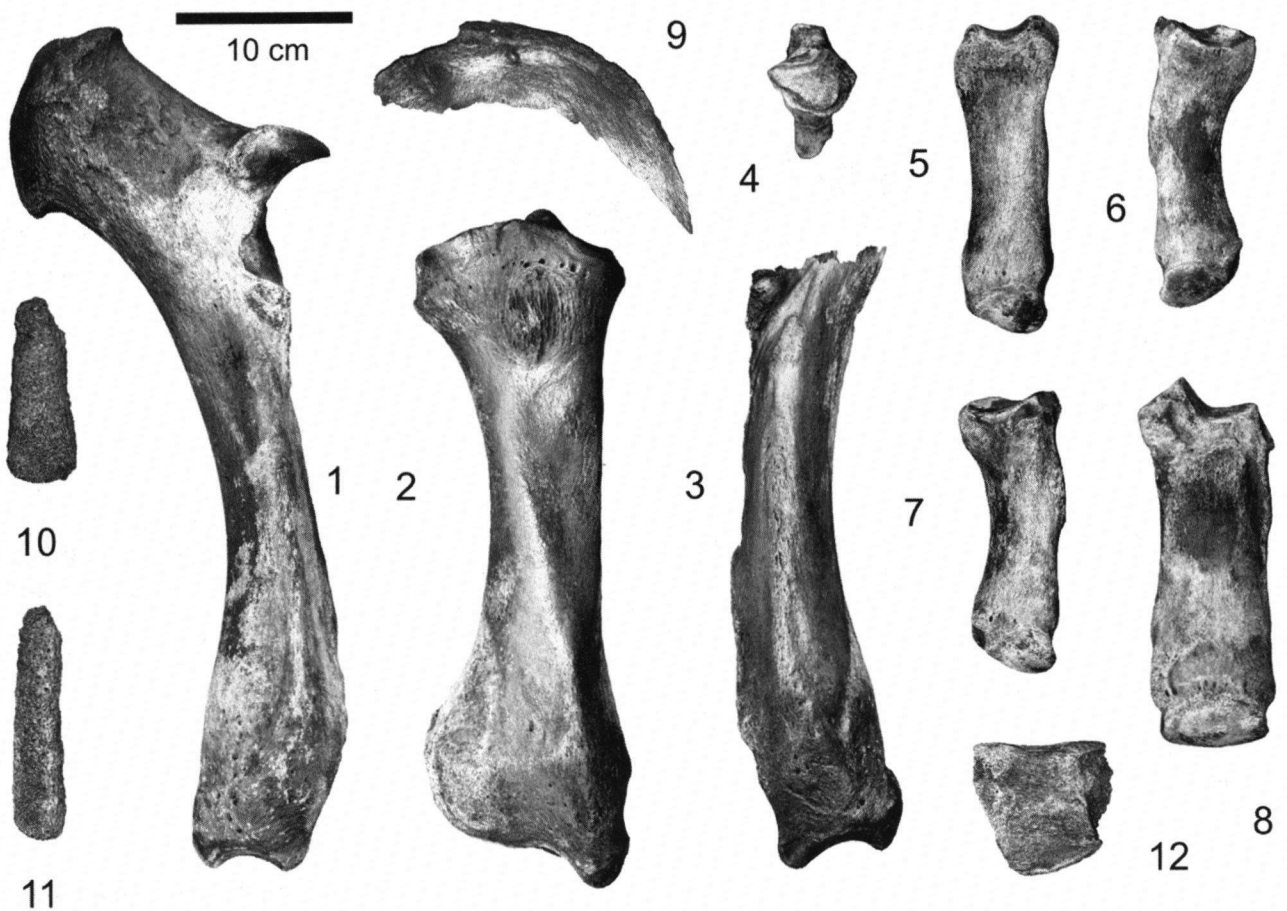


Fig. 5. Forelimb elements of *Coelodonta antiquitatis* from Petershagen. 1) Right ulna (No. 1978/2-28), 2) right radius (No. 1978/2-29), 3) left incomplete ulna (No. 1978/2-30), 4) left carpal III (No. 1978/2-31), 5) left metacarpal II (No. 1978/2-32), 6) left metacarpal IV (No. 1978/2-33), 7) right metacarpal IV (No. 1978/2-34), 8) right metacarpal III (No. 1978/2-35), 9) scapula fragment (No. 1978/2-1-14), 10) intercostal bone (No. 1978/2-1-12 and 13), 11) intercostal bone (No. 1978/2-1-14), and 12) sternal bone (No. 1978/2-1-11). The numbers 1, 3, 9, 11-12 are in lateral view, the numbers 2, 4-8 in anterior view.

Elementen van de voorpoot van *Coelodonta antiquitatis* van Petershagen. 1) Rechter ulna, 2) rechter spaakbeen, 3) linker, incomplete ellepijp, 4) linker derde carpaalbotje, 5) linker 2de middenhandsbeen, 6) linker 4de middenhandsbeen, 7) rechter 4de middenhandsbeen, 8) rechter 3de middenhandsbeen, 9) schouderbladfragment, 10) tussenribsbeen, 11) tussenribsbeen, en 12) borstbeen. De nummers 1, 3, 9, 11-12 zijn in zij-aanzicht, de nummers 2, 4-8 in vooraanzicht. Voor museumnummers, zie het Engelstalige onderschrift.

side (Nos. 1978/2-52 to 65). The most cranial short ones are lacking. On the right side the ribs No. 6 to 19 are present. The 12th rib is incomplete; the 13th rib lacks its distal part. The 13th right rib (No. 1978/2-45) shows a fracture during its healing process. The anterior ribs are more straight, short and flat and change to strongly curved ribs, round in cross section. The last two ribs (18th and 19th) have only one developed rib head, which is flat; all others

possess two heads, the anterior of which is more round.

On the left side the 4th costal lacks the distal part. From the 5th to the 18th rib most are complete. Rib 8 is damaged in the upper part. The ribs 12, 13, 16-18 are lacking their proximal joints. Rib 15 is distally incomplete. All rib joints are fused completely, fitting the adult age of the animal. Only two ossified intercostals were

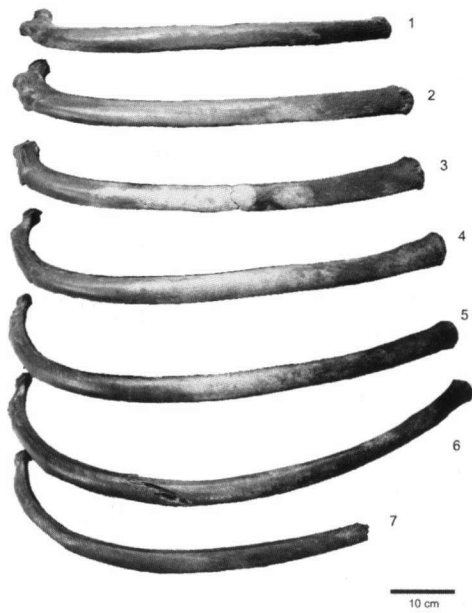


Fig. 6. *Coelodonta antiquitatis* van Petershagen. Anterior part of the right rib cage. 1. 6th rib (No. 1978/2-38), 2. 7th rib, (No. 1978/2-39), 3. 8th rib, (No. 1978/2-40), 4. 9th rib, (No. 1978/2-40), 5. 10th rib, (No. 1978/2-41), 6. 11th rib (No. 1978/2-42), 7. 12th rib (No. 1978/2-43).

Coelodonta antiquitatis van Petershagen. Voorste deel van de rechter ribbenkast. 1-7 respectievelijk de 6de, 7de, 8ste, 9de, 10de, 11de en 12de rib. Voor de museumnummers, zie het Engelstalig onderschrift.



Fig. 7. Same individual as fig. 6. Posterior part of the right rib cage. 1. 13th rib with fracture and callus healing (No. 1978/2-45), 2. 14th rib (No. 1978/2-46), 3. 15th rib (No. 1978/2-47), 4. 16th rib (No. 1978/2-48), 5. 17th rib (No. 1978/2-49), 6. 18th rib (No. 1978/2-50), 7. 19th rib (No. 1978/2-51).

Zelfde individu als fig. 6. Achterste deel van de rechter ribbenkast. 1-7 respectievelijk de 13de rib met breuk en callusvormige wondgenezing, 14de, 15de, 16de, 17de, 18de en 19de rib. Voor de museumnummers, zie Engelstalig onderschrift.

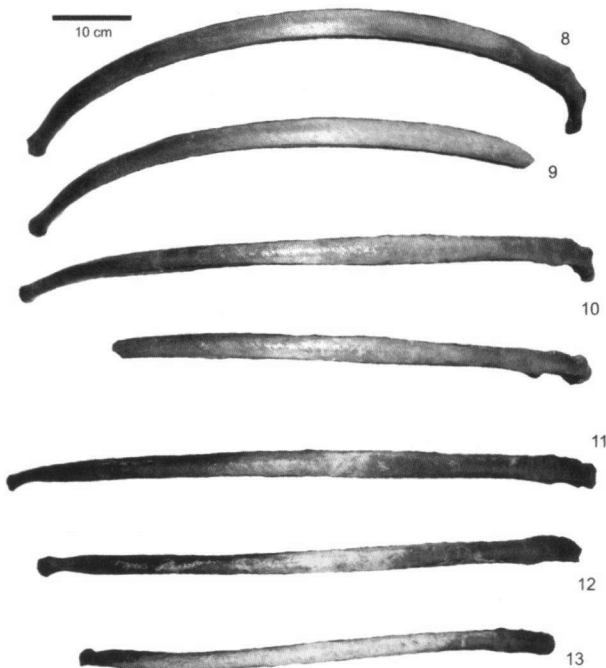


Fig. 8. Same individual as fig. 6. Anterior part of left rib cage. (Nos. 1978/2-52 to 57).

Zelfde individu als fig. 6. Voorste deel van de linker ribbenkast (nrs. 1978/2-52 to 57).

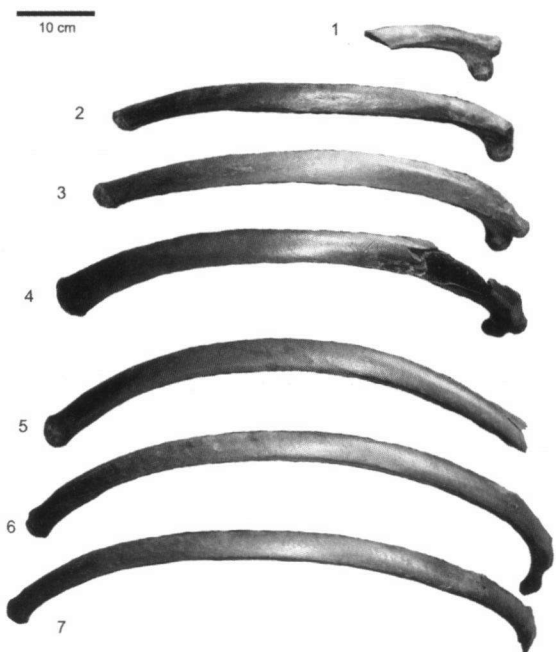


Fig. 9. Same individual as fig. 6. Posterior part of the left rib cage (Nos. 1978/2-58 to 65).

Zelfde individu als fig. 6. Achterste deel van de linker ribbenkast (nrs. 1978/2-58-65).

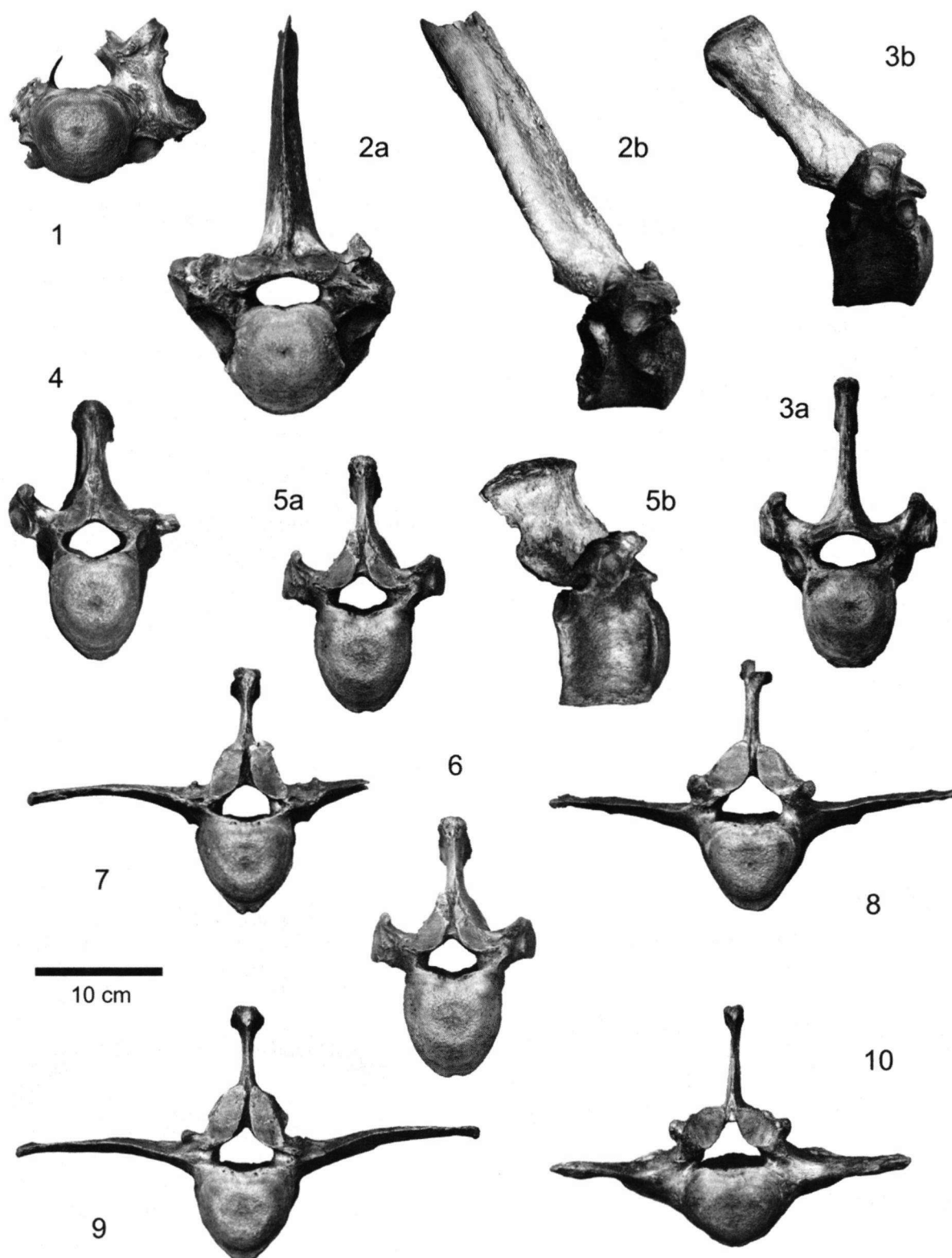


Fig. 10. *Coelodonta antiquitatis* from Petershagen. Thoracic vertebrae: 1. 3rd, incomplete (No. 1978/2-1), 2. 5th, incomplete (No. 1978/2-2), 3. 10th (No. 1978/2-3), 4. 17th, incomplete (No. 1978/2-5), 5. 18th, incomplete (No. 1978/2-4), 6. 19th (No. 1978/2-6). Lumbar vertebrae: 7. 1st (No. 1978/2-7), 8. 2nd (No. 1978/2-8), 9. 3rd (No. 1978/2-9), 10. 4th (No. 1978/2-10). Numbers 1, 2a, 3a, 4, 5a, 6-10 in anterior view, numbers 2b, 3b, 5b seen from the right.

Coelodonta antiquitatis van Petershagen. Borstwervels, 1-6, respectievelijk de 3de (incompleteet), de 5de (incompleteet), de 10de, de 17de (incompleteet), de 18de (incompleteet), en de 19de. Lendenwervels, 7-10, respectievelijk de 1ste, de 2de, de 3de, en de 4de. De nummers 1, 2a, 3a, 4, 5a, 6-10 zijn van voren gezien, de nummers 2b, 3b, 5b van rechts.

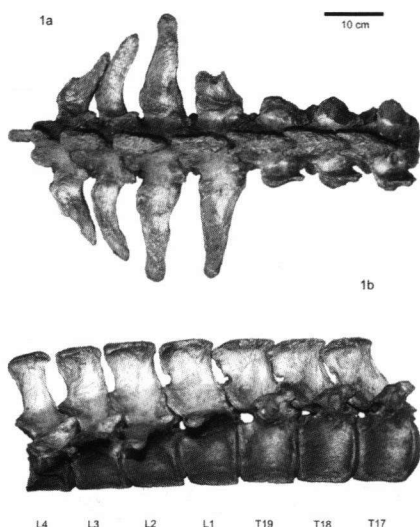


Fig. 11. *Coelodonta antiquitatis* from Petershagen. Posterior part of the articulated vertebral column consisting of all four lumbar (L1-4) and the last three thoracic (T17-19) vertebra (Nos. 1978/2-4 to 10); a. dorsal view, b. right lateral view.

Coelodonta antiquitatis van Petershagen. Achterste deel van de gearticuleerde wervelkolom, bestaande uit alle vier lendenwervels (L1-4) en de laatste drie borstwervels (T17-19); a. gezien van boven, b. gezien van rechts.

found (Figs. 5.10-11). Length and width data of the costae are given in Table 3.

Vertebrae (Figs. 10-11): A complete vertebral column of the woolly rhinoceros count 7 cervical, 19 thoracic, 4 lumbar and 20 caudal vertebra (total = 50). The skeleton from Petershagen lacks all cervical and caudal vertebrae. There are only ten thoracic vertebrae (Nos. 1978/2-1 to 6) present (3, 5, 10 and 17-19), being damaged in some parts. Only the last seven vertebrae are articulated. Vertebrae 17 and 18 are distally incomplete at their left transverse processes. The thoracic vertebra No. 19 has no fractures. All four lumbar vertebrae were found (Nos. 1978/2-7 to 10). The first is incomplete, lacking the distal part of the left transverse processes. All other lumbar vertebrae are complete. Their main data are given in Table. 4.

Pelvis (Fig. 12): This is nearly complete with a strong fresh fracture at the right ileum and ischium. The sacrum is missing and was not completely fused to the ileum bones. All other pelvic bones are fused (Nos. 1978/2-37). This is another prove for the adult age. Important measurements are given in Table. 5.

Hind limbs (Fig. 13): Both hind limbs are less completely present, whereas all tarsals and phalanges are missing. Both femora (Nos. 1978/2-18 and 21), tibiae (Nos. 1978/2-19 and 22), fibulae (Nos. 1978/2-20 and 23), and calcanii (Nos. 1978/2-15 and 16), are preserved, but only the left astragal (Nos. 1978/2-17). There are four metatarsi, the right III (No. 1978/2-27), the IV (No. 1978/2-26), the left II (No. 1978/2-24), and the III (No. 1978/2-25) being all complete. Measurements of the hind limb bones are given in Table 6.

Single bones additional to the skeleton

Two humeri Nos. 1980/32-17 and 1978/2-65 (juvenile), four pelvic fragments Nos. 1978/2-64, 1978/2-77, 1980/32-9 and 1980/32-8 (gnawn by hyenas), radius No. 1978/2-77c (gnawn by hyenas), femur No. 1978/2-76 (gnawn by hyenas, tibia No. 1978/2-77e, two cervical vertebrae Nos. 1978/2-66 and 1980/32-34, three costae Nos. 1980/32-28-30. The material is differently preserved and could therefore be well separated from the bone material of the individual skeleton.



Fig. 12. *Coelodonta antiquitatis* from Petershagen. Pelvis without sacrum and fresh fractures at the ilium and ischium (No. 1978/2-37), ventral view.

Coelodonta antiquitatis van Petershagen. Bekken zonder heiligbeen en met verse fracturen aan het ilium en ischium (nr. 1978/2-37), onderaanzicht.

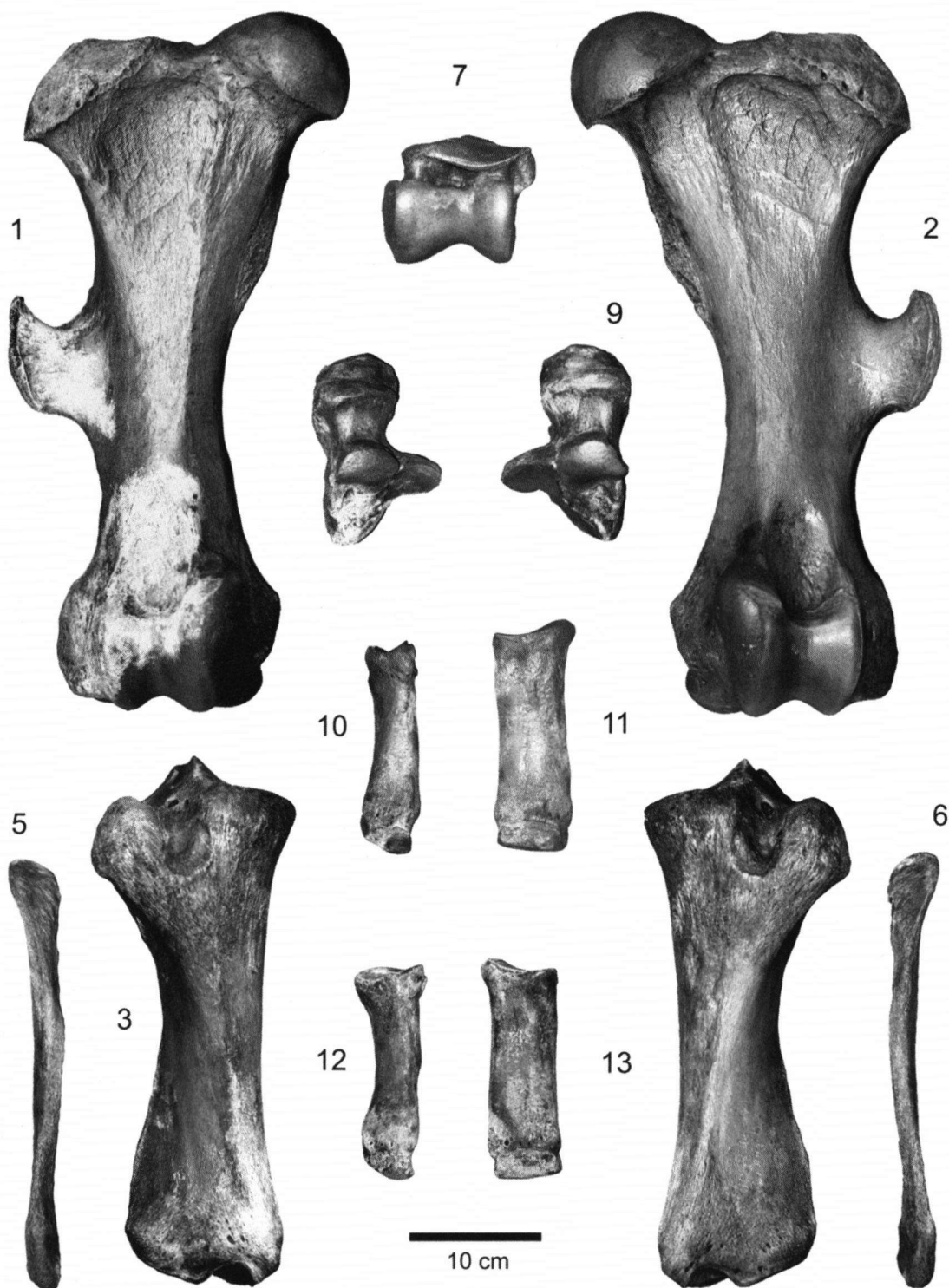


Fig. 13. *Coelodonta antiquitatis* from Petershagen, hind limbs. 1. Right femur (No. 1978/2-18), 2. left femur (No. 1978/2-21), 3. right tibia (No. 1978/2-19), 4. left tibia (No. 1978/2-22), 5. right fibula (No. 1978/2-20), 6. left fibula (No. 1978/2-23), 7. right astragalus (No. 1978/2-17), 8. right calcaneus (No. 1978/2-15), 9. left calcaneus (No. 1978/2-16), 10. left metatarsus II (No. 1978/2-24), 11. left metatarsus III (No. 1978/2-25), 12. right metatarsus IV (No. 1978/2-26), 13. right metatarsus III (No. 1978/2-27). Numbers 1-6 and 10-13 are in anterior view, numbers 7-9 in dorsal view.

Coelodonta antiquitatis van Petershagen, achterpoten. 1-2. Rechter en linker dijbeent, 3-4. rechter en linker scheenbeent, 5-6. rechter en linker kuitbeent, 7. rechter sprongbeent, 8-9. rechter en linker hielbeent, 10. linker 2de middenvoetsbeent, 11 en 13. linker en rechter 3de middenvoetsbeent, 12. rechter 4de middenvoetsbeent. Nummers 1-6 en 10-13 in vooraanzicht, nummers 7-9 in bovenaanzicht. Voor museumnummers, zie het Engelstalig onderschrift.

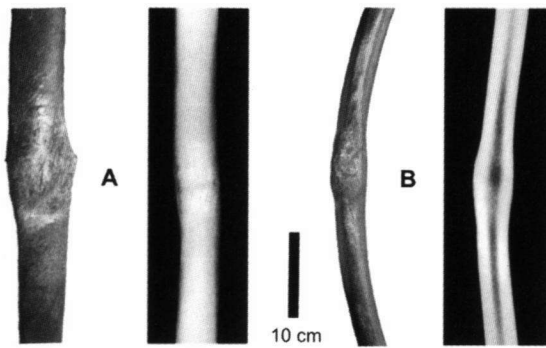


Fig. 14. The 13th right rib (No. 1978/2-45) with fracture and a healing process consisting of callous tissue. A = lateral view besides X-ray photograph of medial view; B = cranial view besides X-ray photograph of the same view.

De 13de rib (no. 1978/2-45) met breuk en een genezingsproces bestaande uit calleus weefsel. A = buitenaanzicht gecombineerd met een röntgenfoto van de binnenzijde; B = vooraanzicht gecombineerd met een röntgenfoto van dezelfde kijkrichting.

Discussion

Only a few originally articulated skeletons of *C. antiquitatis* have been described so far. In Europe, incomplete skeletons are present in Belgium and the Netherlands. In eastern Germany, a skeleton of one individual is exposed in the Museum für Naturkunde, Gera, but it is not described in detail.

In north-west Germany, this is the first time a skeleton that is preserved for two thirds is described and figured. In the site area at the Weser river near the Minden gravel pits only some isolated bones were listed earlier by Guerin (1980), and Diedrich (2004a). Isolated woolly rhinoceros bones are common in the region of Löhne, Minden and Petershagen (Fig. 2). Articulated skeletons were so far unknown. The skeleton from Petershagen must have originally been embedded completely articulated and was partly destroyed by the work in the gravel pit. It seems, that the excavating machine has cracked bones or moved the body part of the scapular region, therefore all cervical and many anterior thoracic vertebrae, the scapulae and humeri are lacking. Some bones, especially the ribs and the pelvis expose fresh crack marks that were produced during the workings. Nearly all small bones such as carpals, tarsal

and phalanges are missing, surely a result of non-collecting.

The proportions of the skull fall into the variability of female *Coelodonta antiquitatis* (cf. Borsuk-Bialynicka, 1973). Skulls of males and females were also compared in the collections of the Museum für Ur- und Ortsgeschichte, Eiseithalle Bottrop and Geologisch-Paläontologisches Museum der Westfälischen Wilhelms-Universität Münster. Here the male skulls (e.g. skull from the site Haltern) measures approximately 30 cm in width of the orbital region. The adult females are less in width with approximately 25 cm, whereas the measurements of 23 cm width at the Petershagen skull fall into their variability. Exact sex determinations are not possible at the moment with the measurements of the nearly complete pelvis. Only a few of them are well preserved and no statistical analysis of the few articulated skeleton remains have been published. In the extant Indian rhinoceroses there are sexual dimorphisms in the pelvis, in contrast to the African black rhinoceros (Guerin, 1980).

The lack of the dentition gives no data to the exact individual age. The connected sutures at the skull (compare juvenile individual in Siegfried 1975), and nearly all completely connected sutures of the postcranial bones (except the non-fusion of the pelvic and the sacrum), represent an individual of adult reproductive age. The pelvis indicates that it is not a high adult or senile animal.

The healing fracture of the 13th right rib (Fig. 14) is unique in *C. antiquitatis* skeleton finds. The neighbouring 12th unfractured rib shows also some posterior lateral callous reactions. Therefore a strong hit into the middle right body flank seemed to be the cause for the rib cracking during the woolly rhinoceros life. This must have happened some days and not more than four weeks before the death of the woolly rhinoceros, because the fracture healing process was still well in progress. The position of this wound in the middle of the right flank suggests intra-specific fights like the ones that occur today in the African rhinoceros species (cf. e.g. Grzimek, 1997). Such fights can easily cause bone fractures, when the heavy and colossal animals attack each other. Of course, it could also be speculated that the hit was the result of an human hunting attack, which would make the find much more spectacular. The position of

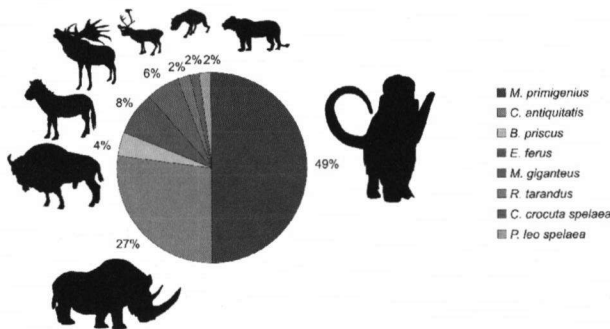


Fig. 15. The percentage of the accessory mammal bones at the Petersshagen site of the *C. antiquitatis* (n = 52, without the skeleton material). The spotted hyena is indirectly documented by gnawing marks at woolly rhinoceros bones.

Het aandeel van andere zoogdierbeenderen in de site Petersshagen van het *C. antiquitatis* skelet (n = 52, zonder het neushoornskelet zelf). De gevlekte hyena is indirect gedocumenteerd op basis van knaagsporen op de wolharige neushoornbotten.

the fracture would surely fit to a spear attack to hit the heart. Such an attempt to kill a rhinoceros by a Neandertal or early modern Late Palaeolithic human was in this case unsuccessful, because the hit was too much in the centre of the body and would not have killed the animal, but the wound was at least too severe for the animal to survive such an attack for a long time.

Although the animal was attacked, by its own species or even by humans, it survived a short period of time and was possibly trying to stay close to the river and muddy areas. Modern wounded rhinoceroses or elephants are using muddy areas, in which they lay down (Grzimek, 1997). The mud is useful for cooling and closing the wound against insects and bacteria. Sometimes it can happen, that the large animals are trapped in the mud, especially old and non-healthy individuals. The woolly rhinoceros of Petersshagen must have died in the swamp area of the old Weser river and was possibly trapped there to death. This might also explain why no carnivores reached the animal to destroy the carcass.

From the pit at Petersshagen, 52 other Pleistocene mammal bones (Fig. 15) of *M. primigenius*,

B. priscus, *M. giganteus*, *E. ferus*, *R. tarandus*, and *P. leo spelaea* were collected during 1978 to 1980. Most of them are mammoth bones of *Mammuthus primigenius* (49%), followed by the woolly rhinoceros *Coelodonta antiquitatis* (27%). Other large mammals are present with 4-8%, whereas the carnivore steppe lion *Panthera leo spelaea* and the Ice Age spotted hyena are rare (2% each). Additional to the *C. antiquitatis* skeleton remain there are three large bones, gnawed by the ice age spotted hyena *C. crocuta spelaea*. The rest of the fauna of the Petersshagen site consists of some bone remains of *Megaloceros giganteus*, *Bison priscus*, *Equus ferus przewalskii* and *Rangifer tarandus*; the presence of *Crocota crocuta spelaea* is proven indirectly by the presence of gnawing marks. Not far away, in gravel pits near Minden-Dankersen and Löhne

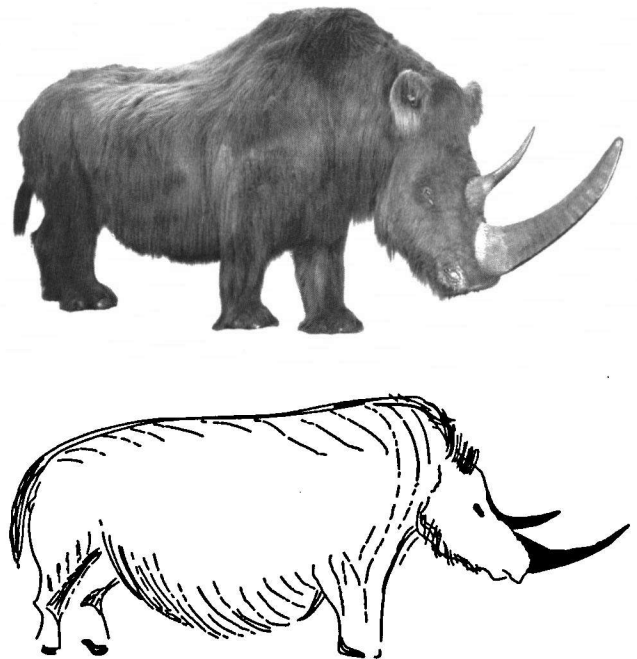


Fig. 16. Top: Reconstruction of the Late Pleistocene woolly rhinoceros *Coelodonta antiquitatis* by D. Luksch. Below: Cave art of a Late Paleolithic woolly rhinoceros *Coelodonta antiquitatis* in the cave Font-de-Gaume, Southwest France drawn by hunters of the Magdalenian IV (15,000 B.P.) (redrawn after Capitan *et al.*, 1910).

Boven: Reconstructie van een Laat-Pleistocene wolharige neushoorn *Coelodonta antiquitatis* door D. Luksch. Onder: Grotkunst van een Laat-Pleistocene wolharige neushoorn *Coelodonta antiquitatis* in de grot Font-de-Gaume, zuidwest Frankrijk, getekend door jagers van het Magdalenien IV (15.000 voor heden) (nagetekend van Capitan *et al.*, 1910).

(Henke, 1969), the finds of *Ovibos moschatus* and *Ursus spelaeus* (Diedrich, 2004d, e) indicate the typical Weichselian (Late Pleistocene) mammal fauna of the mammoth steppe and close contact to a mountainous region with caves (cf. Siegfried 1983; Koenigswald, 2002).

Interesting to mention is a well-preserved humerus of a very juvenile woolly rhinoceros. One, by hyena chewed, femur lacks the joints and can be compared to preservations of humeri from the hyena den (the Perick Caves, Sauerland) and a humerus found in Minden-Dankersen close to the *C. antiquitatis* skeleton site (cf. Diedrich, 2004a). Two more gnawed bones, like pelvic fragments, were found in Petershagen, too. The same nibbling marks are present at woolly rhinoceros bones from the hyena Perick Cave den (Diedrich, 2005b, 2008). Hyenas must have been present in the region, whereas the bones could have been transported over some short distances at least by the river. The presence of the carnivores is of importance, because they normally have a great impact on carcass destruction of large mammals.

There are no gnaw or nibbling marks at the woolly rhinoceros skeleton from Petershagen, in contrast to three other bones from other individuals of the same gravel pit site. This and the completeness of the skeleton of Petershagen indicates the preservation as a carcass, without destruction by ice age spotted hyenas *Crocuta crocuta spelaea* or other carnivores or humans. This is extremely rare in the Late Ice Age, because many isolated bones found at open air sites in northern Germany expose gnaw or nibbling marks. Others were reworked and transported by the rivers and were rolled. *C. antiquitatis* was one of the most important preys of these Ice Age carnivores (cf. Diedrich & Žák, 2006). This was recently proved for the hyena cave den Perick Caves and other caves of the northern Sauerland of northwest Germany (Diedrich, 2008).

The woolly rhinoceros was hunted by the humans of the Ice Ages in the Middle and Late Palaeolithic periods (Guerin & Faure, 1983). There is no direct proof, but cave (Fig. 16) and mobile art and the bone remains at Palaeolithic

sites indicate successful hunting (e.g. Capitan *et al.*, 1910; Guerin & Faure, 1983).

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Table 1. Measurements of the skull (in cm).

Tabel 1. Maten van de schedel (in cm).

	Cranium 1980/32-41
total length (incomplete)	68
smallest maxillar width	15
smallest width between entorbital	23.2
occipital width	20
height basion	24
lateral length os incisivum	15.5
width processus jugulares	16
width euryon	24.5

Table 3. Measurements of the ribs (in cm); ri = right, le = left.

Tabel 3. Maten van de ribben (in cm); ri = rechts, le = links.

Element	No.	total length	total width midway
costa 5 (le)	1978/2-53	60.2	4
costa 6 (ri)	1978/2-38	66.2	4.4
costa 7 (ri)	1978/2-39	72.5	5.3
costa 8 (ri)	1978/2-40	75	5.2
costa 9 (ri)	1978/2-41	78.7	4.4
costa 10 (ri)	1978/2-42	80.3	4.2
costa 11 (ri)	1978/2-43	85.5	3.9
costa 12 (le)	1978/2-44	85.5	3.8
costa 13 (ri)	1978/2-45	-	3.7
costa 14 (ri)	1978/2-46	83.5	3.4
costa 15 (ri)	1978/2-47	80.5	3.2
costa 16 (ri)	1978/2-48	78.2	3
costa 17 (ri)	1978/2-49	72	2.7
costa 18 (ri)	1978/2-50	64.5	2.4
costa 19 (ri)	1978/2-51	53.1	1.9

Table 2. Measurements of the forelimb bones (in cm); ri = right, le = left.

Tabel 2. Maten van de beenderen van de voorpoot (in cm); ri = rechts, le = links.

Element	No.	total length	smallest width	proximal width	max width midway	distal width	width proc. anconaeus
ulna (ri)	1978/2-28	49.9	5.1	-	-	8.8	13
radius (ri)	1978/2-29	39.4	6.4	12.4	-	11.4	-
carpale III (le)	1978/2-31	4	-	-	5.4	-	-
metacarpus II (le)	1978/2-32	16.8	4	5.5	-	5.2	-
metacarpus III (ri)	1978/2-35	19.5	5.5	7.2	-	6.4	-
metacarpus IV (ri)	1978/2-34	15.8	3.7	5.6	-	6	-

Table 4. Measurements of the vertebrae (in cm) / Tabel 4. Maten van de wervels (in cm).

Element	No.	vertebra height	length vertebral centre	width vertebral centre	height vertebral centre	width proc. spinosus	width proc. transversus
thoracic vertebra 3	1978/2-1	-	8.5	7.5	6.5	-	-
thoracic vertebra 5	1978/2-2	-	7	8.5	6.6	-	14.8
thoracic vertebra 10	1978/2-3	22.4	6.9	6.4	6.7	5.7	13.2
thoracic vertebra 17	1978/2-5	16.8	7.5	6.4	6.5	7.7	-
thoracic vertebra 18	1978/2-4	16.9	7.1	6	6.6	7.4	11
thoracic vertebra 19	1978/2-6	16.8	7.3	7.3	6.2	8.3	11.3
lumbar vertebra 1	1978/2-7	17.8	7.5	6.6	6.2	6.7	33
lumbar vertebra 2	1978/2-8	17.2	7.3	6.5	6.3	6.5	34.1
lumbar vertebra 3	1978/2-9	16.4	6.3	6.7	6.2	5.7	28.5
lumbar vertebra 4	1978/2-10	16.4	5.6	7.7	6.1	5.5	24.1

Table 5. Measurements of the pelvis (in cm) / Tabel 5. Maten van het bekken (in cm).

	pelvis 1978/2-37
total length	138.1
smallest width	26
proximal width	116.1
distal width	32
acetabular distance	42.6
smallest width ilium	5.5
smallest width ischium	5.9
diametre acet. foram.	11.7
diametre pelvic entrance	27.2
diametre acetabulum	11.6

Table 6. Measurements of the hind limb bones (in cm); ri = right, le = left / Tabel 6 Maten van de beenderen van de achterpoot (in cm); ri = rechts, le = links.

Element	No.	total length	smallest width	proximal width	distal width	mtw	hpt	lmt
femur (ri)	1978/2-18	51.5	9.5	24	16.3	15.8	9.2	-
tibia (ri)	1978/2-19	38.2	7.2	14.8	11.1	-	-	-
fibula (ri)	1978/2-20	31.4	-	-	-	-	-	-
calcaneus (ri)	1978/2-15	14.2	-	-	-	9	-	-
astragalus (ri)	1978/2-17	9	-	-	-	10.3	-	7.2
metatarsus II (le)	1978/2-24	15.3	3	3.5	4.3	-	-	-
metatarsus III (ri)	1978/2-27	16.4	4.8	6	5.6	-	-	-
metatarsus IV (ri)	1978/2-26	14.8	3	5.5	5.1	-	-	-