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ICE AGE SPOTTED HYENAS ?HUNTING OR ONLY SCAVENGING THE CAVE BEAR *URSUS SPELAEUS* ROSENMÜLLER AT THE ICE AGE SPOTTED HYENA OPEN AIR DEN AND PREY DEPOSIT SITE BAD WILDUNGEN-BIEDENSTEG (HESSIA, GERMANY)

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Abstract: Some remarkable cranial and postcranial bones of Upper Pleistocene cave bear *Ursus* cf. *spelaeus* Rosenmüller, 1794 from a *Crocuta crocuta spelaea* (Goldfuss, 1823) hyena den and prey deposit open air site at Biedensteg near Bad Wildungen (Hess) in Northern Germany represent prey remains. The taphonomical study of the bite, chew and nibbling marks being present on all cave bear bones are similar to those found on bones from the hyena Perick Cave den site in Hemer (Sauerland, NW Germany). Fore limb bones such as a scapula, humerus, ulna and a femur fragment, are from a female adult cave bear and belong possibly to one individual. Both fore limbs must have been removed from a carcass, whereas it is unclear whether the carcass was found by the hyaenas in the mammoth steppe or in a cave of the cave bear rich Sauerland mountainous region. It is possible that the female cave bear died naturally. Another possible scenario is an active successful hunting. The cave bear remains indicate that hyaenas have fed on cave bears not only in the caves, such as the Perick Caves in the Sauerland which have impressively proved hundreds of chewn and cracked cave bear bones. The hyenas could have transported from these topographically close related caves their cave bear prey remains to freeland mud deposit sites. If true, this is a unique proof of the feeding strategies of *Crocuta crocuta spelaea* on the cave bears and completes the recently studied knowledge of the palaeoecology of the hyenas and their impact on the taphonomy of cave bear carcasses in Central Europe.

Key words: Cave bear, hyenas, scavenging, open air site, Upper Pleistocene, Northern Germany.

INTRODUCTION

The cave bears *Ursus spelaeus* ROSENMÜLLER, 1794 from Northwest-German have been listed and not well described since the 18th century with the mentioning of thousands of bones from more than ten caves of the Sauerland (cf. Siegfried in 1983; Zygowski in 1988; Hammerschmidt *et al.* in 1995) whereas studies of cave bear populations have started to become more detailed (Diedrich, 2005a).

The few freeland remains of *U. spelaeus* in northern Germany were first described from river gravel deposits and one hyena mud deposit site north of the Sauerland in the Münsterland Bay and in the Weserbergland from only three localities (Diedrich, 2004).

Now new freeland cave bear finds at a very important ice age spotted hyena prey deposit site can be added in a palaeoecological study about the hyaenas *Crocuta crocuta spelaea* (GOLDFUSS, 1823). Their main cave den sites in the northern Sauerland mountainous region were recently described by Diedrich (2004; 2005a). An indirect proof of these ice age carnivores was also shown by chewn, nibbled and gnawn macromammal prey bones at some other freeland sites, where no hyena bones were found (cf. Diedrich, 2005c). A subdividing of hyena den sites from cave bear dens is of importance to understand the palaeoecology of both extinct animals in detail. In particular the question of the feeding habits or specialization of the hyenas onto ice age animals and the possible use of caves of both animals at the same time or even period will become clearer.

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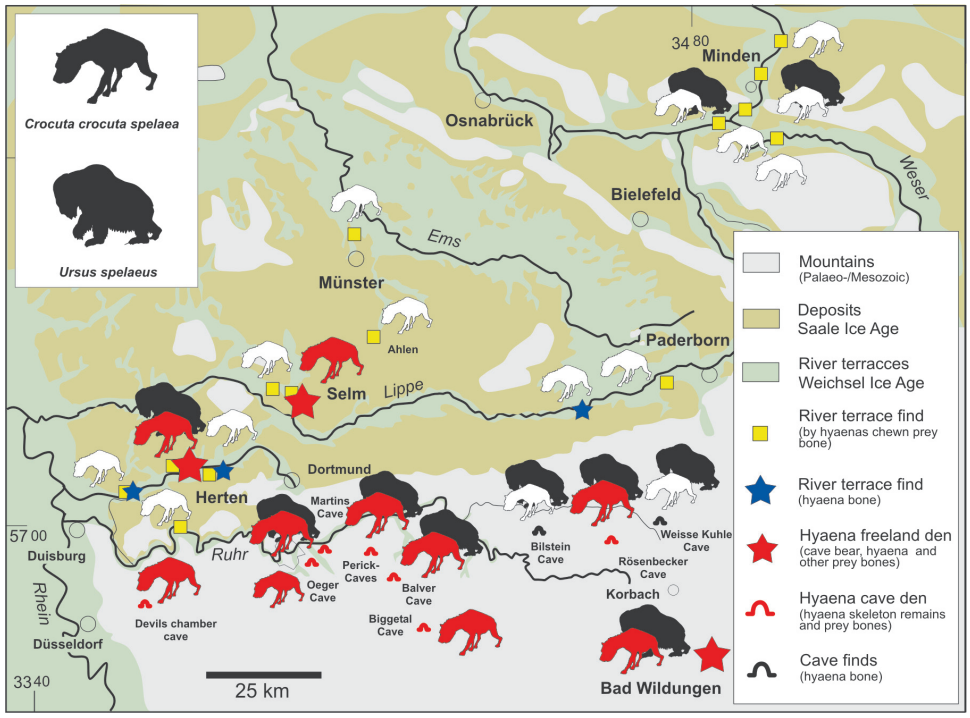

Figure 1. Position of the Upper Pleistocene hyena and cave bear den caves (Perick Caves, Martins Cave, Deutmecker Cave, Roesenbeck Cave, Balve Cave etc.), the new freeland site Bad Wildungen-Biedensteg and other open air sites in the Münster Basin. Hyena gnawn bones of *Coelodonta antiquitatis* were found at many non-cave sites being an indirect proof of these animals in the Münster Basin and northern the Wiehengebirge during the mammoth steppe period of the late Weichselian. In the Perick Caves and Martins Cave e.g. hyenas fed strongly on the cave bear carcasses.

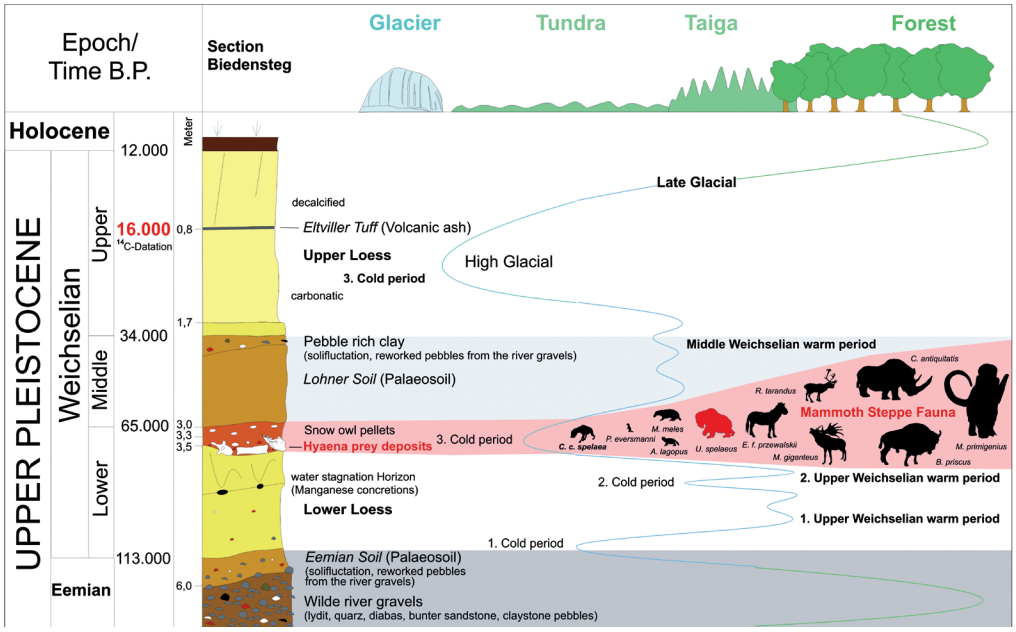

Figure. 2. Generalized section at the Ice Age Spotted Hyena *Crocuta crocuta spelaea* (Goldfuss, 1823) prey deposit site Biedensteg (Bad Wildungen, Hess, NW-Germany). The macrofauna deposited by the hyenas during the Lower Weichselian are dominated by woolly rhinoceros bones, while the rest of the prey fauna is a typical Mammoth steppe fauna consisting of *M. primigenius*, *C. antiquitatis*, *B. priscus*, *M. giganteus, R. tarandus*, *C. elaphus*, *E. f. przewalskii*, *U. spelaeus*, *A. lagopus*, *M. meles*, *P. eversmanni*, *L. lagopus*, *L. timidus* and *C. c. spelaea.*

The first bones in the clay pit site "Ziegeleigrube Biedensteg" in Bad Wildungen (northern Hess, Central Germany, fig. 1, coordinates: lat. 35,1058, long. 56,6550) were discovered in 1932 by F. Pusch who collected and excavated many bones, especially of macro mammals. In 1952, E. Jacobshagen and R. Lorenz found snow owl pellets in a "pellet horizon", but the latter also had two hyena skulls. Jacobshagen described in 1963 this fauna, mainly of the micromammals, whereas Huckriede & Jacobshagen published the first section which was studied with addition of new results by Semmel (1968) and Kulick (1973). Finally Storch (1969) conducted paleontological research on snow owl pellet material.

Since that time the not well determined macrofauna was forgotten and not studied in detail. Therefore a very important Ice Age hyena prey deposit and den freeland site in Europe was not understood, although first thoughts about hyena gnawing and bone deposits were mentioned by Jacobshagen (1963). None of the here described cave bear bones from Biedensteg were described as such, because of non- or misidentification as "*U. arctos*" (cf. Jacobshagen 1963).

At the site at Biedensteg mainly woolly rhinoceros *Coelodonta antiquitatis* bones were found (Diedrich, 2006) and only a few bones of other macromammals such as *Mammuthus primigenius*, *Equus ferus przewalskii*, *Rangifer tarandus*, *Megaloceros giganteus*, *Cervus elaphus*, *Meles meles*, *Alopex lagopus, Putorius eversmanni, Lepus timidus, Lagopus lagopus*, many micromammals and *Crocuta crocuta spelaea* itself. In this study the cave bear remains are described separately because of their special importance.

The material from two old collections, the Kurmuseum Bad Wildungen and the University Marbung (old coll. Jacobshagen, mainly micromammals), including all here figured cave bear remains, are now exposed in the Biedensteg exhibition of the Kurmuseum Bad Wildungen.

GEOLOGY AND DATATION

The geological situation at the hyena deposit site "Lehmgrube Biedensteg" was published by Huckriede & Jacobshagen (1963), Semmel (1968) and Kulick (1973). The overview of the redrawn sketch of the outcrop section with a combination with all published results and new own interpretations about the hyena deposits is newly presented here in fig. 2.

The Wilde river gravels at the base of the section are of the Eemian interglacial period. They consist of red bunter sandstone- and claystone-, lydit-, quartz-, diabas-pebbles. These deposits are overlain by a palaeosoil resulting of solifluctation. In this "Eem-Soil" the river pebbles are resedimented with reddish-brown loess. The Lower Loess is from the early to middle Lower Weichselian and a product of the first maximum Glaciation where in this mountainous region loess was deposited in a mammoth steppe environment. Some snails were found in the Lower Loess by Jacobshagen (1963) whereas the loess soil snail *Pupilla muscornum* (MÜLLER) fits to the climatic and environment interpretation.

In the middle and at the end of the Lower Weichselian a climatic stagnation resulted a palaeosoil along the Wilde river gravels which were at that time on the shore of a small lake. This lake was caused by subsurface salt dissolution and positioned in a doline. The lake was fed by the Wilde river a fact what can be proved by the presence of many aquatic species such as frogs (*Rana agiloides* BRUNNER, 1951) but mainly by salmonid fish (cf. Jacobshagen, 1963) that need fluent water. The lake shore was used by the Ice Age spotted hyenas as mud pit prey deposit sites. Bones from animals of the mammoth steppe macrofauna was deposited here, whereas "bone nests" were mentioned in the publication of Jacobshagen (1963). The sedimentary depression structures in the bone rich loess horizon described by Kulick (1973) as "cryoturbation and channels" also could be at least partially of bioturbation origin and were possibly caused by the hyenas who deposited animal prey remains into the soft soil. The main bones are from *Coelodonta antiquitatis* (BLUMENBACH) as shown in this description. Other animals such as *Mammuthus primigenius* (BLUMENBACH), *Megaloceros giganteus* (BLUMENBACH), *Rangifer tarandus* LINNÉ, *Equus ferus przewalskii* POLJAKOFF, *Bison priscus* (BOJANUS), *Ursus spelaeus* (ROSENMÜLLER), *Meles meles* (LINNÉ), *Alopex lagopus* (LINNÉ) or *Putorius eversmanni* (LESSON), but also snow hare *Lepus timidus* (LINNÉ) are present in the maximum glaciation fauna.

Additionally there are many steppe environment typical micromammal rodents such as *Lemmus lemmus* (LINNÉ), *Dicrostonyx henseli* (Hinton), *Microtus gregalis* (PALLAS), *Alactaga saliens* (GMELIN) or birds such as *Lagopus lagopus* (LINNÉ) listed with many other species by Jacobshagen (1963). Also the hyena *Crocuta crocuta spelaea* (GOLDFUSS, 1823) itself is present with skulls, postcranial and many coprolithes (Diedrich, 2007). The bioturbation interpretation would fit into the "hyena prey deposit site", but cannot be studied or proved anymore because of the refilled clay pit Biedensteg. In the section (fig. 2) such depressions are figured here as hyena

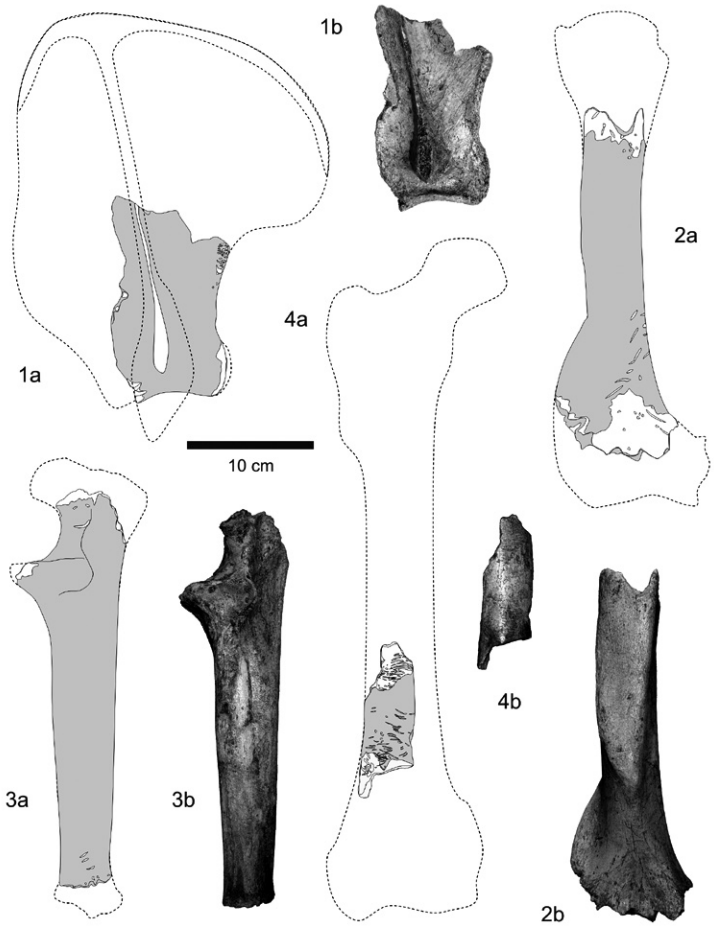

Figure 3. *Ursus spelaeus* Rosenmüller 1794 bones from the ice age spotted hyena prey deposit open air den site Biedensteg near Bad Wildungen (NW Germany). The bones from the adult animal seemed to belong to one adult female individual. **1.** Left scapular fragment (No. Bi-52/227), lateral. **2.** Right humerus shaft (No. Bi-52/2), cranial. **3.** Left ulnar shaft (No. Bi-52/241), lateral. **4.** Right (?) femora shaft fragment and "nibbling stick" (No. Bi-52/242), cranial.

bone depots. Possibly a later cryoturbation, fitting into the environment and climatic situation of that time, was responsible for the secondary overprint of the primary sediment structures.

The "pellet horizon" is figured differently in the publications (cf. Jacobshagen *et al.* 1963; Kulick, 1973). For sure the pellets are not only from snow owls, because they do not feed on anures or fishes. The high amount of frog bones must have resulted from some other large water birds and other predators which also left pellets and bone remains at the lake shore. The section of Kulick (1973) indicates that the pellets and the macromammal bones are mixed in a single horizon. A proof of that are caliche concretions around hyena coprolites in which also micromammal bones and teeth are cemented. The "hyena prey deposit site" and the "pellet horizon" are from the same period and are dated relatively into the late Middle Lower Weichselian (65.000-90.000 BP, see. fig. 2). Therefore the complete micro- and macrofauna and its taphonomy have to be newly studied to understand the lake and its surroundings and climatic situation of a mammoth steppe environment.

The bone rich horizon is overlain by another palaeosoil, in that case the "Lohner Soil", which can be found in the region at different sections (Semmel, 1968; Kulick, 1973). After their interpretations a solifluctation of Loess and Wilde river gravel material took place in the Middle Weichselian warmer period (cf. fig. 2). It seems, that some mammal species, which are also described from the "bone rich horizon" are from that time. *Vulpes vulpes* and *Meles meles* are the dominating faunal elements, besides *Lepus europaeus* and *Cervus elaphus*. This warm period

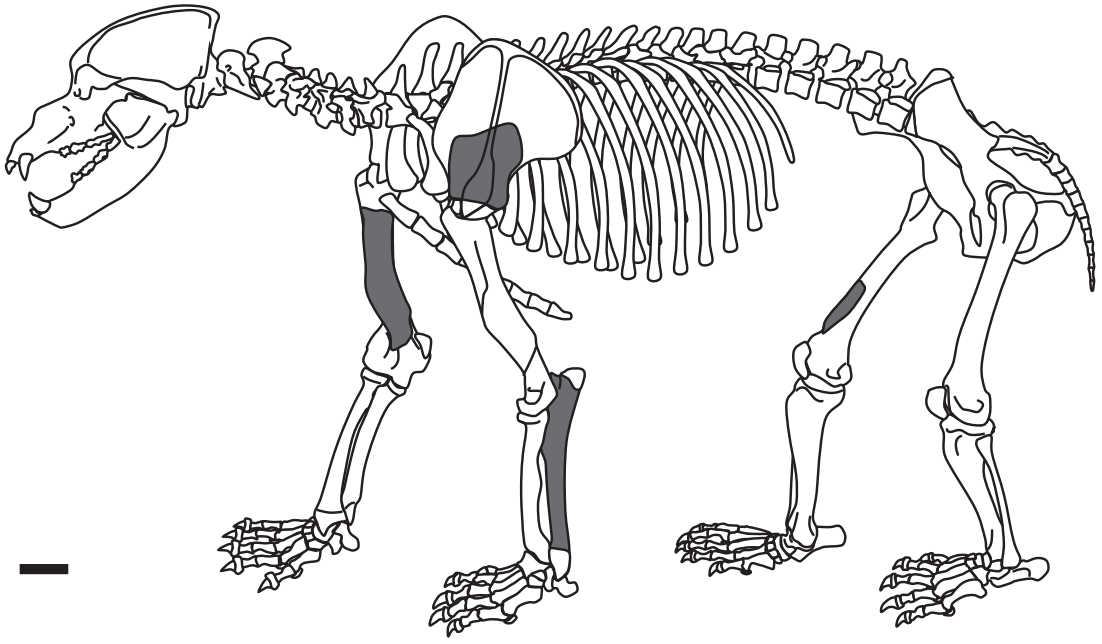

Figure 4. Present bones (grey) of an adult female *Ursus spelaeus* ROSENMÜLLER, 1794 from the Ice Age spotted hyena prey deposit open air site Biedensteg near Bad Wildungen (NW Germany).

fauna fits to *Meles/Vulpes* den sites in loess soils, in front of which they often left some prey bones. The large cave systems are often up to some meters deep burrowed and would have reached therefore the "bone rich horizon" of the hyena prey deposits. It seems obvious, that such *Meles/Vulpes* cave systems have caused a faunal mixing of the arctic and warm period mammal fauna, which was not excavated and documented in detail. This problem was not discussed in JACOBSHAGEN (1963).

Finally the Upper Loess was sedimented, whereas the upper part was decalcified during the Holocene period. The "Eltviller Tuff" is a one to two centimetres thin layer in the Upper Loess and the only dated horizon with an age of 20.000 BP (SEMMEL, 1968). This proves an interpretation of the Upper Loess of its sedimentation during the Maximum Glaciation (fig. 2).

PALAEONTOLOGY

Family: Ursidae GRAY, 1825

Genus: *Ursus* LINNÉ, 1758

Ursus spelaeus ROSENMÜLLER, 1794

Material: The five cave bear bones and fragments are listed in Tab. 1 and are all figured here (figs. 3, 4).

The left scapula (fig. 3.2) of an adult female animal lacks all distal parts, which seemed to be cracked off by the hyenas. The small diameter of the glenoid with 7.5 cm fits into female cave bear scapulae of that Lower Weichselian time. Hyena gnawing and bite marks are visible at the glenoid.

A right humerus shaft (fig. 3.3) lacks the joints as a result of strong hyena chewing. At the ends and in the lower middle of the shaft bite marks are present (fig. 3.3). The small diameter of the bone shaft (4.9 cm) and the

Table 1
Bone material list of *Ursus spelaeus* ROSENMÜLLER, 1794 from the freeland prey deposit site. Bad Wildungen-Biedensteg (Hessia, NW-Germany).

No.	Coll.-No.	Bone type	Commentary	left	right	Age	Bite marks	Original	Collection
1	52/227	Scapula	Without distal part	x		Adult	x	x	Rudolf-Lorenz-Stiftung
2	52/2	Humerus	Shaft		x	Adult	x	x	Rudolf-Lorenz-Stiftung
3	52/241	Ulna	Incomplete	x		Adult	x	x	Rudolf-Lorenz-Stiftung
4	52/14	Femur	Fragment		?	Adult	x	x	Rudolf-Lorenz-Stiftung

proportions fits to femora dimensions of female cave bears of the Lower Pleistocene.

From one left incomplete ulna (fig. 3.4) the distal parts and joints were chewn by the hyenas, which also left some bite marks. In the middle of the shaft the 5 cm in maximum with ulna fits more to smaller female cave bear ulnae.

Finally a fragment of a femur (fig. 3.5) with strong chewing indicate the cracking of the femur shaft by the hyenas and further use of the bone fragment as a "nibbling stick". The fragment does not allow a clear identification of a male or female.

Discussion: The postcranial bones of adult animals seem to belong to one skeleton of a female adult cave bear, whereas this can not be proven for the femora fragment. This fragment was compared to some hundred femur fragments from the Perick Caves hyena den, and to complete femora of that site. The thickness of the bone compact layer, the internal structures and the form do fit mostly to the cave bear. Compared bone fragments and complete bones of Bovidae, Cervidae from the Perick Caves are different in the thickness and internal structures, for sure also mammoth and rhinoceros bones. Also in the Perick Caves some cave bear femur fragment nibbling sticks are present (Diedrich, 2005a), which are very similar to the nibbling stick of Bad Wildungen-Biedensteg.

DISCUSSION

The site Bad Wildungen Biedensteg is one of the best studied yet little known open air hyena prey deposit and loess den sites in Europe. The use of that place over longer periods is documented by the presence of hyena bone and skull material, but also by their many coprolites and massive chewing, gnawing and nibbling marks on nearly all macromammal bones that were found at that site.

As shown for the main prey, the woolly rhinoceros *Coelodonta antiquitatis* (BLUMENBACH), on the one hand there must have been animals, which died or were killed by carnivores at the margin of the ancient small lake. On these carcasses the hyenas scavenged strongly and destroyed by this the skeleton articulations. One nice example is a female adult woolly rhinoceros carcass.

On the other hand prey remains were transported into the mud close to the Wilde river or small lake at Bad Wildungen. From this study of the non-cave bear material a mixture of prey deposit and lake hunting site can be figured out for the hyena site Bad Wildungen Biedensteg.

On the other hand prey remains were hidden in the mud close to the Wilde river or small lake at Bad Wildungen. From this study of the non-cave bear material a mixture of prey deposit and lake hunting site can be figured out for the hyena den site Bad Wildungen Biedensteg.

But what happened to the cave bears exactly? Certainly there must have been one female animal that was at least eaten by hyenas. Typically only massive bones such as skull fragments or longbones were left by hyenas. The presence of longbone remains indicate, such as for the woolly rhinoceros female carcass, that the bear seems to have died close to the lake or Wilde river or even at the hyena prey depot. At small lakes many large mammals would search for water, died sometimes here a natural death but were hunted here also by large carnivores.

For sure some different scenarios can be speculated on now. In the freeland at Biedensteg the female cave bear died possibly naturally or was hunted by carnivores such as the steppe lion or the hyenas.

This is the most spectacular scenario, but is not unusual, if compared to the hunting strategies of the recent spotted hyenas. The last possibility is a transportation of cave bear carcass material from caves of the Sauerland region and deposit of those at Biedensteg. This is not strongly provable, but the strong cave bear scavenging at e.g. the Perick Caves in the Sauerland give the impulse for such a theory.

At least the most logical theory seems to be, that a female cave bear searched for fresh water at the Biedensteg lake or Wilde river. Here the animal died however, and was at least scavenged by hyenas. These left only the most massive bones such as longbones.

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