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The first record of leopard *Panthera pardus* LINNAEUS, 1758 from the Pleistocene of Poland

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Abstract. The first leopard (*Panthera pardus*) from the Pleistocene of Poland was discovered in the sediments of Biśnik Cave. Bones show morphological and metric similarity to large specimens of the modern leopard. This finding provides evidence for the existence of the leopard in late Middle and early Late Pleistocene in Europe north of the Carpathian arch.

Key words: *Panthera pardus*, Carpathian arch, Biśnik Cave.

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I. INTRODUCTION

Apart from the cave lion *Panthera spelaea* GOLDFUSS, 1810 and wildcat *Felis silvestris* SCHREBER, 1775, recorded from numerous Pleistocene sites (BARYCKA 2008), little is known about fossil felids from Poland. Only excavations from Biśnik Cave (still in progress) over the last 18 years have provided very rich felid material (e.g. MARCISZAK and STEFANIAK 2010), among which the remains of leopard were found for the first time in Poland.

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Biśnik Cave is situated near Wolbrom, in the southern part of the Częstochowa Upland (Smoleńsko-Niegowonickie Range, 50°23′N 19°40′E), southern Poland. The cave is among the most important and richest palaeontological and archaeological sites in Central Europe. The 850 cm thick cave sediments include 20 layers (CYREK et al. 2010). Many archaeological artefacts and traces of multiple and frequent human occupancy during the last ca. 300 ka are known from the cave. The geological age is based on thermoluminescence and uranium-thorium dating methods as well as on biostratigraphy and climatostratigraphy (MIROSŁAW-GRABOWSKA 2002; SOCHA 2009; CYREK et al. 2010). These methods have assigned a generally similar age to the sediments (Table I).

Table I

Occurrence of leopard remains in the layers of Biśnik Cave with their stratigraphic position. Stratigraphy according to CYREK et al. (2010). (OIS – oxygen isotope stages, NISP – number of identified specimens, MNI – minimum number of individuals)

Stratigraphy of sediments			Leopard remains	
Layers	Climatostratigraphy	OIS	NISP	MNI
1-12	Holocene-Vistulian	1-5d	–	–
13	Eemian	5e	1	1
14	Warta Glacial	6	–	–
15	Lubawa Interglacial	7	–	–
18	Odra Glacial	8	2	1
19			7	2
19abc	Zbójnian	9?	2	1
20	Pre-Pleistocene/Pliocene	?	–	–

The very rich animal material, collected as a result of an extensive sampling program undertaken during palaeontological and archaeological excavations, includes 97 species of birds and 54 mammal species (Insectivora – 12 species, Chiroptera – 11 species, Rodentia – 24 species, Lagomorpha – 3 species, Carnivora – 14 species, Ungulata – 15 species (WISZNIOWSKA et al. 2002; SOCHA 2009; STEFANIAK & MARCISZAK 2009).

The large mammal assemblage from the layers in which the leopard remains were found (Table I) includes: *Ursus spelaeus* ROSENMÜLLER, 1794, *Ursus arctos* LINNAEUS, 1758, *Crocuta crocuta spelaea* GOLDFUSS, 1823, *Panthera spelaea* GOLDFUSS, 1810, *Lynx* sp., *Felis silvestris* SCHREBER, 1775, *Canis lupus* LINNAEUS, 1758, *Vulpes vulpes*

LINNAEUS, 1758, *Alopex lagopus* LINNAEUS, 1758, *Meles meles* LINNAEUS, 1758, *Martes martes* LINNAEUS, 1758, *Mustela putorius* LINNAEUS, 1758, *Mustela eversmanni* LESSON, 1827, *Mustela erminea* LINNAEUS, 1758, *Mustela nivalis* LINNAEUS, 1766, *Mammuthus primigenius* BLUMENBACH, 1799, *Equus ferus* LINNAEUS, 1758, *Coelodonta antiquitatis* BLUMENBACH, 1807, *Sus scrofa* LINNAEUS, 1758, *Cervus elaphus* LINNAEUS, 1758, *Megaloceros giganteus* BLUMENBACH, 1897, *Capreolus capreolus* LINNAEUS, 1758, *Alces alces* LINNAEUS, 1758 and *Rangifer tarandus* LINNAEUS, 1758 (WISZNIOWSKA et al. 2002; STEFANIAK & MARCISZAK 2009).

II. MATERIAL AND METHODS

The material used in this study is deposited at the Department of Palaeozoology, Zoological Institute, University of Wrocław, Poland. Comparative materials, kept at the Department of Palaeozoology, Zoological Institute, University of Wrocław, Poland, and in the Natural History Museum of the same university, included the leopard *Panthera pardus* LINNAEUS, 1758 (n = 74), lion *Panthera leo* LINNAEUS, 1758 (n = 19), Eurasian lynx *Lynx lynx* LINNAEUS, 1758 (n = 24) and *Panthera spelaea* GOLDFUSS, 1810 (n = 1).

Metric measurements were taken point-to-point, using electronic calipers, to the nearest 0.1 mm; each presented value is the mean of three measurements (Fig. 1). The terminology follows SCHMID 1940.

Description of material

The material from Biśnik Cave is not very rich and consists mostly of postcranial bones; most bones are partially broken but the existing parts are well preserved.

In layer 13 only one third phalanx (ZPalUWr/JB/P/06/Pp/7) was found. The keratinized sheath is absent and the rest of the phalanx is rather well-preserved. Measurements: 1 – 9.6 mm, 2 – 10.8 mm, 3 – 7.4 mm.

In layer 18 two specimens were found. The first of these is an upper right canine (ZPalUWr/JB/M/05/Pp/2) with almost half of the crown broken off. The big long root is also worn, but the general shape of the tooth (long, narrow crown and root as well as two longitudinal grooves alongside the crown) agrees with the corresponding features of recent material. The second bone is a second phalanx of the left fifth finger (ZPalUWr/JB/P/08/Pp/5) – the phalanx has the characteristic shape and proportions of cats and this nearly intact bone is relatively massive (measurements: 1 – 26.3 mm, 2 – 11.4 mm, 3 – 10.6 mm, 4 – 10.4 mm, 5 – 7.9 mm, 6 – 8.0 mm).

The most numerous material was found in layer 19. The proximal epiphysis of the right radius (ZPalUWr/JB/M/05/Pp/8) with a fragment of the corpus is only slightly worn. The bone is slender and does not differ in size and morphology from recent *Panthera pardus.* The *fossa caput radii* is very deeply depressed and the depression is surrounded by a fine, easily identifiable articular circumference. The *incisura* and *tuberositas* are especially big and well-developed (measurements: 1 – 26.3 mm, 2 – 18.0 mm). The proximal epiphysis of the left radius (ZPalUWr/JB/W/07/Pp/13) with small fragments of the corpus is preserved (Fig. 2). In preservation and morphology the bone resembles the preceding specimen, except for a pathological change on *tuberositas radii* (see discussion, measurements: 1 – 26.2 mm, 2 – 19.2 mm).

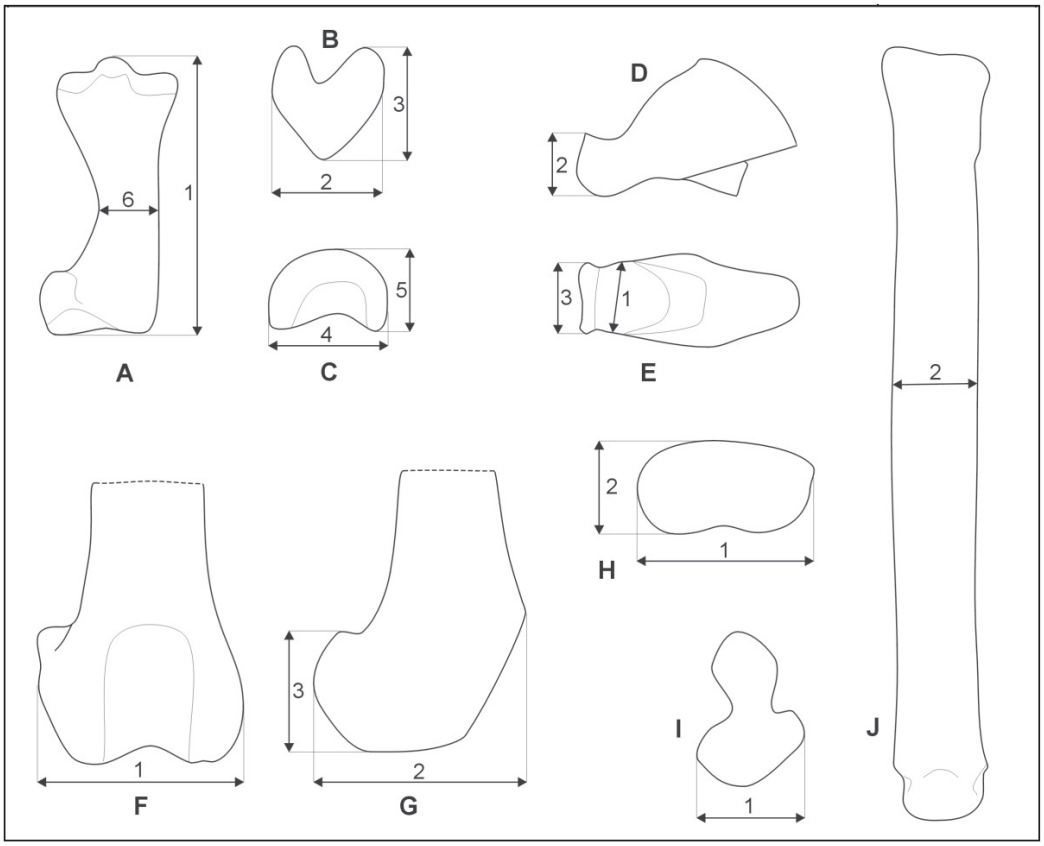

Fig. 1. Measurements: A-C – phalanx 2 (A – dorsal view, B – proximal articulation view, C – distal articulation view: 1 – maximum dorsal length, 2 – maximum width of proximal articulation, 3 – maximum height of proximal articulation, 4 – maximum width of distal articulation, 5 – maximum height of distal articulation, 6 – minimum width of the corpus), D-E – phalanx 3 (D – lateral view, E – dorsal view: 1 – minimum width of the corpus, 2 – maximum length of distal articulation, 3 – maximum width of distal articulation), F-G – femur (F – posterior view of distal epiphysis, G – lateral view of distal epiphysis: 1 – maximum width of the distal epiphysis, 2 – maximum height of the distal epiphysis, 3 – maximum height of the medial condyle), H – radius (distal articulation; 1 – maximum length of *caput radii*, 2 – maximum width of *caput radii*), I-J – metatarsal (I – proximal view, J – dorsal view: 1 – maximum width of proximal articulation, 2 – minimum width of the corpus)

The well-preserved distal epiphysis with a fragment of the corpus of the right femur (ZPalUWr/JB/W/07/Pp/9) in general shape and size agrees with leopard femur anatomy in the following features: a) relatively slender build, b) massive, very big medial and lateral condyles, c) very deep, rather U-shaped *fossa intercondylare*, d) somewhat asymmetrical, highly developed *femur trochlea*, e) rather small, but clearly visible medial and lateral epicondyles (measurements: 1 – 48.3 mm, 2 – 42.7 mm, 3 – 27.9 mm).

Right P4 (ZPalUWr/JB/M/05/Pp/3) is much worn and almost half of it – the whole anterior part – is missing. A fragment of the paracone and the metastyle with a much worn upper part are present. The carnassial blade is so deeply worn in the area adjoining the juncture of the paracone and metacone that the dentine is exposed. The buccal surface of

Fig. 2. Left radius ZPalUWr/JB/W/07/Pp/13 of *Panthera pardus* from Biśnik Cave (lateral view). Note well visible porous excrescence on *tuberositas radii*. Scale bar: 50 mm.

the tooth is depressed and the metastyle is oriented buccaly. The blade has a relatively weakly-developed cingulum, only slightly marked bucco-lingually. The massive posterior root, oriented lingually, is only slightly worn (posterior width of the crown – 8.2 mm). The second right P4 (ZPalUWr/JB/M/05/Pp/11) from the same layer has a morphology, size and wear very similar to the preceding one; only the posterior root is less massive (posterior width of the crown – 8.7 mm).

The right third metatarsal (ZPalUWr/JB/W/07/Pp/12) has a distal articulation with the lower half of the oval diaphysis broken off. The present proximal articulation is long and asymmetrical. Although the total length could not be measured, the bone is rather slender and the general proportions are very similar to modern, big specimens of leopard (measurements: 1 – 4.4 mm, 2 – 12.4 mm). The last bone from this layer is the third phalanx (ZPalUWr/JB/P/00/Pp/6) which is missing the keratinized sheath but the rest of the phalanx is well-preserved (measurements: 1 – 9.5 mm, 2 – 7.3 mm, 3 – 9.4 mm).

Two second phalanges are known from layer 19a: a right fourth finger (ZPalUWr/JB/W/08/Pp/4), with degree of preservation, shape and metrics (1 – 29.1 mm, 2 – 12.5 mm, 3 – 11.9 mm, 4 – 11.9 mm, 5 – 8.5 mm, 6 – 7.8 mm) almost identical with the preceding specimen from layer 18. The second specimen is a second phalanx of the left third finger (ZPalUWr/JB/P/08/Pp/10). It differs from the other two in greater total length and more slender build (measurements: 1 – 31.0 mm, 2 – 11.3 mm, 3 – 11.3 mm, 4 – 10.9 mm, 5 – 8.2 mm, 6 – 6.9 mm).

III. DISCUSSION

No substantial differences in the morphology of teeth and bones were found between the studied remains and the extant *Panthera pardus*. The measurements of the leopard from different layers are also within the range of variation of recent leopard from Asia and Africa. Three fragments of long bones from layer 19, which may belong to a single individual, indicate a relatively big animal, and their metrics fall within the upper range of size variation of the recent large subspecies of leopard. For example the lengths and widths of the epiphysis of radii from the Biśnik Cave are 26.3 x 18.0 mm and 26.2 x 19.2 mm, while the same values for recent leopards are as follows: length Min = 20.4 mm, Max = 26.1 mm, Mean = 24.3 mm, SD = 1.54 (n = 17) and width Min = 15.2 mm, Max = 19.2 mm, Mean = 18.0 mm, SD = 1.31 (n = 17). The same applies to the maximum width of the distal epiphysis of femur: 48.3 mm for the fossil bone and Min= 44.4 mm, Max = 48.9 mm, Mean = 46.7 mm, SD = 1.68 (n = 12) for recent material.

The maximum dorsal length / minimum width ratio of the corpus of second phalanges varies among big cat species. However, leopard phalanges are similar to lynx phalanges in their total length and appearance. The ratios of both species overlap slightly and this feature cannot be used to unambiguously distinguish between fossil remains of the two species. *Panthera pardus* usually has a thicker corpus and this is the main feature distinguishing its phalanges from those of lynx.

It is possible to separate phalanges of leopard and lynx only when dealing with a medium or big leopard and small or medium lynx. Three second phalanges from the Biśnik Cave are big bones, clearly corresponding to those of modern big leopards (Fig. 3).

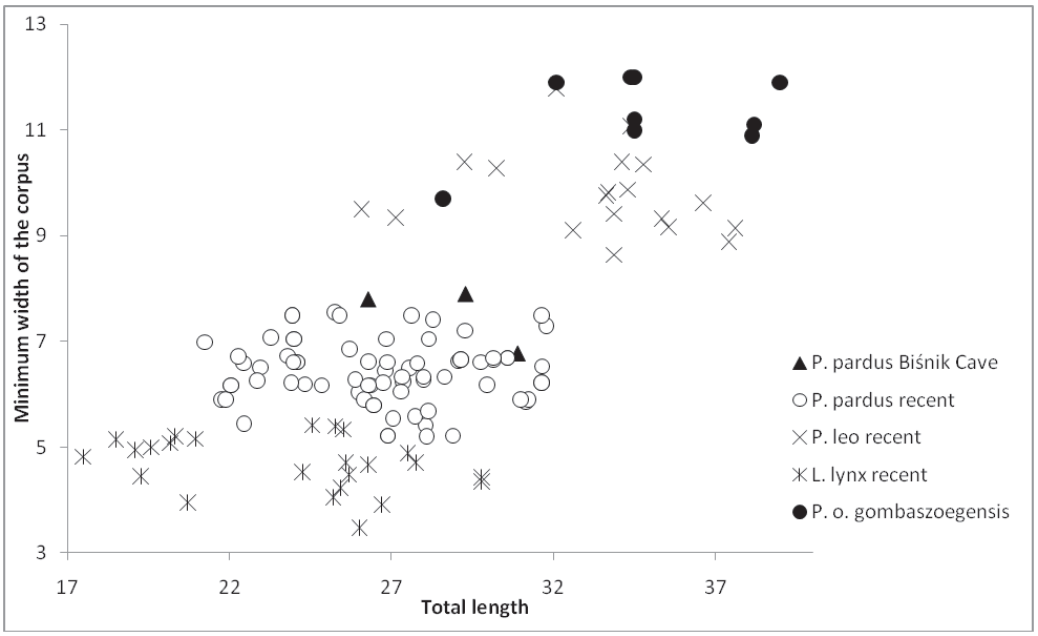

Fig. 3. Maximum dorsal length / minimum width ratio of the corpus of second phalanx in different cat species. Data of the *Panthera onca gombaszoegensis* – from ARGANT 1991, n = 5 and LANGLOIS 2002, n = 4, the other measurements – this work.

On the other hand, these phalanges are smaller and much less robust than those of *Panthera onca gombaszoegensis* KRETZOI, 1938 and *Panthera leo* (Fig. 3; ARGANT 1991, LANGLOIS 2002). Based on their morphology and large size, they represent the 3rd (ZPalUWr/JB/P/08/Pp/5 and ZPalUWr/JB/P/08/Pp/10) and 4th (ZPalUWr/JB/W/08/Pp/4) digit, either from the fore or hind limb.

One bone from the described collection shows pathological changes. They are visible as a porous excrescence on *tuberositas radii* of the left radius (ZPalUWr/JB/W/07/Pp/13) (Fig. 2). It covers most of the articulation surface, and is ca. 24.5 mm long and 15.0 mm wide. Due to the break of the corpus exactly on the border of the excrescence, it can clearly be seen how deep it spreads into the bone. The growth penetrates neither the internal spongy nor the compact bone (Fig. 2). These features exclude bone cancer, which usually enters the inner parts of bone. No traces of injury (bites, fractures) were observed. Because only a small part of the bone is preserved, it is difficult to conjecture about the reasons for this pathology.

The leopard is one of the most successful species among large carnivores which should be linked with adaptability to habitats, opportunistic hunting behavior and the fact that this cat consumes any animal it can hunt down. Leopards were widely distributed across most of Europe. Like in the past, in modern times they occupy many varied habitats, ranging from evergreen rainforests to semideserts. The leopard is able to live very high in mountains but usually avoids open tundra so it seems rather unexpected that this species could survive in open, cold "mammoth steppe" (SPASSOV & RAYCHEV 1997; FISCHER 2000; TESTU 2006). Most localities of this species are known from the central and southern part of Europe and Biśnik Cave is the only known site with leopard remains located north of the Carpathians. Although localities with a similar northern latitude are known from Western Europe (SCHMID 1940; FISCHER 2000), the new record from Biśnik Cave shows that in the late Middle Pleistocene and early Late Pleistocene the leopard was present north of the Carpathian arch.

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