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An Early Pleistocene Snake Eagle, *Circaetus haemusensis* sp. n. (Aves, Accipitriformes) from Varshets, Northwestern Bulgaria

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Abstract: A new species of Snake Eeagle is described based on seven finds of fore and hind limbs and axial skeleton collected from the middle Villafranchian locality (SCT 12 of MNQ 17) near Varshets, Northwestern Bulgaria.

Keywords: Snake Eagles, Fossil birds, Palearctic Raptors, Early Pleistocene, Bulgaria

Introduction

The genus *Circaetus* Vieillot, 1816, includes 6 recent species, all of them monotypic (Thiollay 1994, Dickinson, Remsen 2013). Most of species inhabit Sub-Saharan Africa and are resident there. Only one, the Short-toed Snake Eagle, *C. gallicus* (Gmelin, 1788), is migratory and breeds in Europe (even in North Europe) and Asia but also winters south of Sahara. Such a distribution suggests an African origin of the Snake Eagles.

The only fossil species of Snake Eagles, *Circaetus rhodopensis* Boev, 2012, has been described from the Late Miocene of Southwestern Bulgaria (Boev 2012). In addition, two other accipitrids have been described in the recent years from this country (Boev 2010, 2011, 2013). The present paper describes the second fossil species of Snake Eagles. No fossils of *Circaetus* spp. are known so far from Europe (Mlíkovský 2002), except those from Bulgaria.

Material and Methods

The material originates from Varshets locality (Montana District, Northwestern Bulgaria). It was collected in 1990-1994 and consists of 7 bones and bone fragments. They represent 7 skeletal elements of the fore and hind limbs and the axial skeleton; these are assigned to one adult specimen because of their size, maturation and degree of preservation. The material was identified through comparative study of four scientific skeleton collections of Accipitridae (84 specimens of 30 recent species, see Appendix 1) deposited at: Vertebrate Animal Department, National Museum of Natural History, Bulgarian Academy of Sciences (VAD-NMNHS) in Sofia (1995-2012); University Claude Bernard Lyon 1, Department of Earth Sciences (UCBL) in Lyon (1994-1995); Natural History Museum (NHM) in Tring, a part of the Natural History Museum, London (1999, 2001, 2003, 2007); Institute of Systematics and Evolution of Animals, Polish Academy of Sciences (ISEAK) in Krakow (1998, 2001). The osteological terminology follows Baumel, Witmer (1993). The associated fauna and the considerations for the dating of the sites are given by Boev (1996, 2000, 2002).

The measurements (Fig. 1) were taken through a caliper gauge of 0.05 mm accuracy, but read to the first digit after the decimal point. “Smaller”, “much smaller”, “larger” or “much larger” in the “Comparison” sections mean that the fossil specimen differs considerably in size from the specimens of the compared species, and thus their taxonomic identity is excluded. The following abbreviations

were used: dex. – dextra; dist. – distalis, distal; f. a. – facies articularis; inc. – incisura; ph. – phalanx; pr. – processus; prox. – proximalis, proximal; sin. – sinistra; and tr. mt. - trochlea metatarsalis.

Order Accipitriformes Vieillot, 1816

Family Accipitridae Vigors, 1824

Subfamily Circaetinae Blyth, 1849

Genus *Circaetus* Vieillot, 1816

***Circaetus haemusensis* sp. n.**

Holotype: humerus sin. distalis NMNHS 252 (Plate I: a-c), collections of the Vertebrate Animals of the National Museum of Natural History, Sofia, Bulgarian Academy of Sciences. Collected by the author between 1990 and 1994.

Paratypes: tarsometatarsus dex. distalis NMNHS 244; synsacrum, corpora vertebrorum NMNHS 150; sternum, pars costalis dex. NMNHS 273; ph. dist. digitus majoris dex. NMNHS 162; ph. 2 digitus 3 pedis dex. NMNHS 243; and phalanx 1 digitus 1 pedis dex. NMNHS 192.

Etymology: The name "haemusensis" is given after the ancient name (Greek) of the Stara Planina Range (the Balkan Mountains), Haemus; the type locality of the new species belongs to its western part.

Measurements of the holotype: Table 1; Fig. 1-A.

Differential diagnosis: Medium sized accipitrid, very similar both in morphology and size to the recent Short-toed Snake Eagle *Circaetus gallicus*, but differing from that species in the distal humerus by: (1) the less developed proc. supracondylaris dorsalis, (2) much wider incisura intercondylaris; (3) more longitudinal orientation, instead inclined, condylus dorsalis; and (4) less protruding condylus ventralis in caudal view.

Preservation of the holotype: The holotype represents a bone fragment, which is almost 1/6th of the total length of the bone.

Locality: Varshets. Vicinity (6 km NNE) of the town of Varshets near the town of Vratsa (Montana District; NW Bulgaria), 43.13 N, 23.17 E; UTM grid: FN 89). 650 m a.s.l. A ponor in a rocky hill.

Horizon: Unconsolidated, unstratified sediments accumulated in the filling of clay terra-rossa. The fossil bones are broken, sometimes forming a kind of bone breccia.

Chronology: Early Pleistocene (middle Villafranchian; SCT 11 (sooner SCT 12) of MNQ 17 zone, dated ca. 2.23-2.40 mya) (Spassov 1997, Nomade et al. 2014).

Description

The seven skeletal elements were preserved in different degree, some are completely preserved, but the others remained as bone fragments, namely: humerus sin. dist. NMNHS 252 (Plate 1: a, b, c) – distal epi-

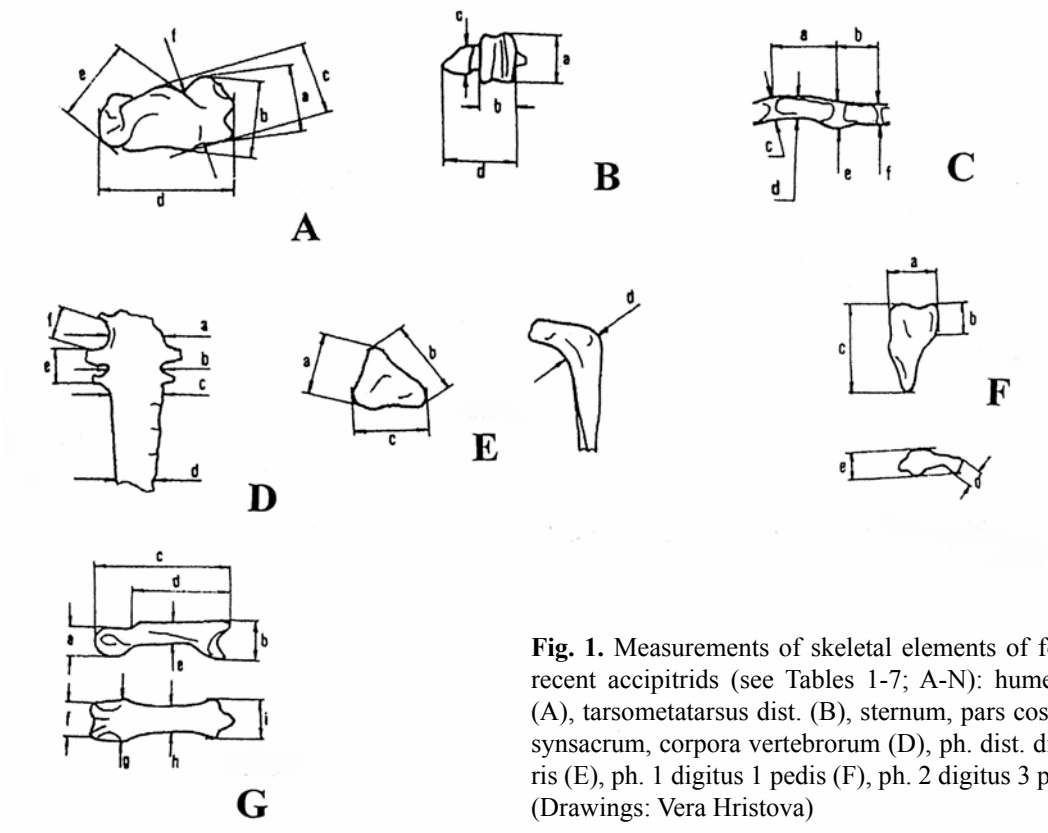

Fig. 1. Measurements of skeletal elements of fossil and recent accipitrids (see Tables 1-7; A-N): humerus dist. (A), tarsometatarsus dist. (B), sternum, pars costalis (C), synsacrum, corpora vertebrorum (D), ph. dist. dig. majoris (E), ph. 1 digitus 1 pedis (F), ph. 2 digitus 3 pedis (G). (Drawings: Vera Hristova)

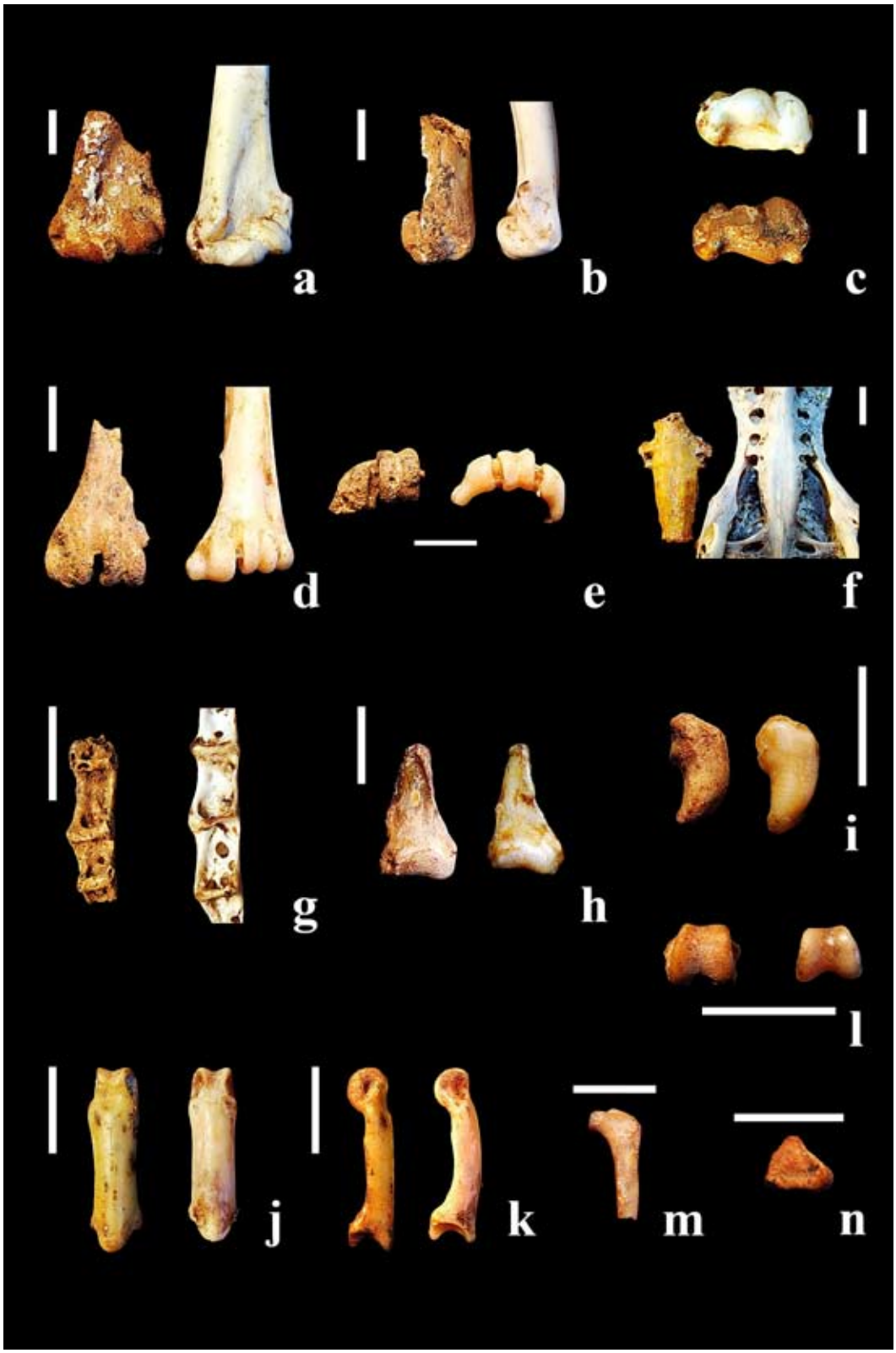

Plate 1. *Circaetus haemusensis* sp. n. (early Pleistocene) Varshets, NW Bulgaria (a-b, d-i: left; c: below) and *Circaetus gallicus* NMNHS 1/1984 (recent) Simitli, SW Bulgaria: humerus sin. distalis NMNHS 252 (holotype): a - medial view; b – dorsal view; c – caudal view; tarsometatarsus dex. distalis pedis NMNHS 244: d – cranial view; e – ventral view; synsacrum, corpora vertebrorum NMNHS 150: f – ventral view; sternum, pars costalis dex. NMNHS 273: g – dorsal view; ph. 1 digitus 1 pedis dex. NMNHS 192: h – caudal view; i – ventral view; ph. 2 digitus 3 pedis dex. NMNHS 243: j – dorsal view; k – lateral view; l – cranial view; ph. distalis digitus majoris dex. NMNHS 162: m – dorsal view; n – cranial view. Scale bare = 5 mm. (Photographs: Assen Ignatov)

physis only; tarsometatarsus dex. dist. NMNHS 244 (Plate 1: d, e) – part of distal epiphysis with tr. mt. II and tr. mt. III; sternum, pars costalis dex. NMNHS 273 (Plate 1: g) - a part between V and VII inc. intercostalis; synsacrum, corpora vertebrorum NMNHS 150 – about 5/6 of corpora vertebrorum with parapophysis IV, V, and VI; total length - 35.5 mm (Plate 1: f); ph. dist. digitus majoris dex. NMNHS 162 (Plate 1: m, n) – distal ending was damaged; ph. 1 digitus 1 pedis dex. NMNHS 192 (Plate 1: h, i) – complete preservation; ph. 2 digitus 3 pedis dex. NMNHS 243 (Plate 1: j, k, l) – complete preservation.

Comparisons

For all skeletal elements no comparison could be made between the late Miocene *Circaetus rhodopensis* from Hadzhidimovo (Bulgaria) and *Aquila kurochkini* from the same age and locality, because of the lacking of analogous skeletal elements.

Although the size alone is not a good criterion for distinguishing species in accipitriforms, considering chronostratigraphic and zoogeographical differences, we may exclude from the comparison the late Pliocene *Aquila bivia* Emslie et Czaplewski, 1999, from Florida, a species that was 10-15% larger than *A. chrysaetos*. Similarly, *A. bullockensis* Gaff and Boles, 2010, which originates from the middle Miocene of Australia, could also be excluded from the comparison, because of the larger size and the considerable geographical and chronostratigraphical distances.

Circaetus haemusensis sp. n. *humerus* sin. dist. NMNHS 252 (Table 1; Fig. 1-A). The specimen differs from Sagitariidae (*Sagittarius serpentarius*) in the the shape of the distal end, which is dorsoventrally wider; in the condylus ventralis being less globular both in cranial and distal views; the shallower sulcus m. scapulotricipitalis; and the processus flexorius being less delveloped distally and caudally than in *S. serpentarius*. The specimen differs from the similar-sized Aquilini in the shallower sulcus musculus scapulotricipitis in caudal view (in Circetini it is wider and shallower), and in the more elongated condylus dorsalis in lateral view. In addition, the specimen differs from: *Aquila heliaca*: in the less protruding, i.e. less spherical lateral profile of condylus dorsalis; *A. clanga*: in the considerably larger size; *A. pomarina*: in the much larger and less protruding pr. flexorius; other large *Aquila* species: in the much wider inc. intercondylaris in the distal end; and *C. gallicus*: similar in morphology, but differ in much larger, less developed pr. supracondylaris dorsalis, and much wider inc. intercondylaris; more longitudinal orientation, instead of inclined, of condylus dorsalis and less protruding condylus ventralis in caudal view (Fig. 2), shallower s. intercondylaris in medial view (Fig. 3).

Circaetus haemusensis sp. n. tarsometatarsus dex. dist. NMNHS 244 (Plate 1: d-e; Table 2; Fig. 1-B). The specimen differs from Sagitariidae (*S. serpentarius*) in the almost twice higher tr. mt. II and its protruding above the tr. mt. III in cranial view, and from Pandionidae (*Pandion haliaetus*) in the symmetrical tr. mt. III and the larger size. The general morphology corresponds to that of the large Accipitridae. In Circetini, tr. mt. III is more sym-

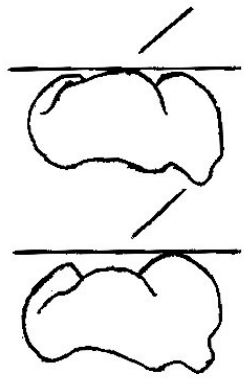

Fig. 2. Comparison of distal humerus (caudal view) in *Circaetus gallicus* (above) and *C. haemusensis* sp. n

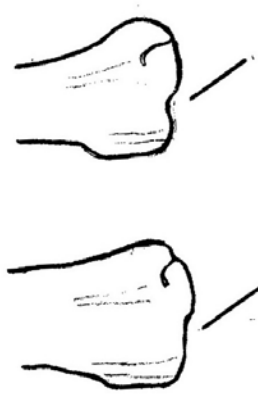

Fig. 3. Comparison of distal humerus (medial view) in *Circaetus gallicus* (above) and *C. haemusensis* sp. n

Table 1. The measurements of humerus distalis in some fossil and recent accipitriform birds (ref. to Fig. 1–A).

Species	a	b	c	d	e	f
Fossil – Varshets						
Circaetus haemusensis sp. n. NMNHS 252	15.1	15.5	15.1	26.7	18.1	12.7
Recent						
C. gallicus NMNHS 1/1984	13.7	13.0	13.1	25.4	17.9	10.4
Aquila heliaca NMNHS 16/2010	17.2	16.4	15.9	30.4	21.7	13.9
A. chrysaetos NMNHS 16/2010	17.1	16.6	18.0	31.0	21.5	13.1
A. pomarina NMNHS 3/1989	12.2	11.6	12.6	23.1	15.7	7.0
A. pomarina NMNHS 4/1996	12.1	12.4	12.4	23.1	16.0	6.2

Fig. 4. Comparison of tmt dex. dist. (lateral view) in Aquilini (left) and Circetini (right). (Drawings: Vera Hristova)

metrical in ventral view, while in Aquilini its lateral condyle is wider than the medial one. In Circetini, in lateral view the profile of tr. mt. III has a sharp transition to diaphysis, while in Aquilini it is gradual (Fig. 4).

The specimen differs from: *Ichthyophaga ichthyaetus*, in less asymmetric tr. mt. III and narrower tr. mt. II; *Polemaetus bellicosus*, in the smaller size and the less asymmetric tr. mt. III; *Spilornis cheela*, in the much smaller size (since all compared skeletal elements of *S. cheela* are larger than those of *C. haemusensis* sp. n., that comparison is ommited below); *Aquila pomarina*, in the larger size and less asymmetrical tr. mt. III; *A. audax*, in the much larger size (since all compared skeletal elements of *A. pomarina* and *A. audax* are smaller than those of *C. haemusensis* sp. n., that comparison is ommited below). *Accipiter gentilis*, in the higher symmetry of tr. mt. III and the larger size; *Aquila chrysaetos*, in the smaller size and the less asymmetric tr. mt. III; *A. rapax*, with the high similarity of the two species, in the slightly more protuberant tr. mt. III in lateral view; *A. heliaca*, in the less parallell latara l and medial conyles of tr. mt. II; *A. nipalensis*, in the less asymmetric tr. mt. III; *A. clanga*, in the larger size, the less asymmetric tr. mt. III in ventral view, the relatively larger tr. mt. II and fovea ligamenti colateralis, and in the prominent ventral contour of the tr. mt. II in cranial view; *A. pennata*, in the larger size and the symmetrical tr. mt. III; *A. fasciata*, in the wider inc. intertrochlearis medialis – a slight difference though the two species are similar; from the very similar *Circaetus gallicus*: in the tr. mt. III, which shows the same asymmetry, but stands slightly higher towards tr. mt. II, and in the larger general size of the bone.

Circaetus haemusensis sp. n. sternum, pars costalis dex. NMNHS 273 (Plate 1: g; Table 3; Fig. 1-C). The specimen differs from Pandionidae (*P. haliaetus*) in the bigger dimensions and the thicker tabula sterni. The general morphology corresponds to that of the large Accipitridae. Furthermore, the specimen differs from: *H. leucocephalus*: in the much smaller size; *S. coronatus* and *I. ichthyaetus*: in the much smaller size; I. humilis: in the thicker tabula sterni and the bigger size; *A. pennata*: in the much larger size; *A. pomarina* and *A. nipalensis*: in the shorter inc. intercostalis ultima (VII); *A. rapax* and *A. nipalensis*: in

Table 2. The measurements of tarsometatarsus distalis in some fossil and recent accipitriforms (ref. to Fig. 1–B)

Species	**a**	**b**	**c**	**d**
Fossil – Varshets				
Circaetus haemusensis sp. n. NMNHS 244	8.5	6.0	7.2	14.3
Recent				
Circaetus gallicus NMNHS 1/1984	6.0	5.3	5.6	13.2
A. chrysaetos NHM 1930.3.24.260	10.3	6.8	8.3	16.1
A. chrysaetos NHM 1996.69.21	11.1	7.9	9.0	20.4
A. clanga NHM 1952.3.205	7.0	5.6	5.8	13.1
A. clanga NHM 1972.1.58	7.5	5.4	5.9	13.0
A. fasciata NHM 1847.10.21.50	8.5	5.7	6.4	15.6
A. fasciata NHM 1898.12.13.1	ca. 7.9	ca. 5.8	ca. 6.7	15.8
A. fasciata NHM 1998.90.4	7.6	6.0	6.4	13.0
A. gentilis ISEAK A 3950/82	6.1	4.3	4.9	12.0
A. heliaca NHM 1954.30.48	8.6	6.8	7.0	16.7
A. nipalensis NHM 1952.3.58	8.3	6.7	6.5	14.0
A. pennata ISEAK A 3742/80	5.0	3.5	3.4	9.2
A. pomarina NHM 1898.5.7.5	6.5	5.3	5.5	12.2
A. rapax ISEAK A 3931/82	9.0	5.8	6.5	16.4
I. ichthyaetus NHM 1845.1.12.20	9.2	7.2	7.0	16.4
P. bellicosus NHM 1954.9.1	11.4	7.8	9.1	18.0

the smaller dimmensions and the proportional differences as the narrower tabula sterni in the sternocostal part, i.e. the narrower inc. intercostalis; *A. verreauxii*: in the much smaller size; *A. clanga*: in the thicker transversal intercostal edges, thicker tabula sterni (measurement "d"), the less concave inc. intercostalis in lateralis view, the larger difference between inc. intercostalis V and VI, i. e. correlation "a : b"; *A. chrysaetos* and *P. bellicosus*: in its smaller size; *A. heliaca*: in the smaller size and the less laterally curved inc. intercostalis VI, the stronger medial curving of tabula sterni at the inc. intercostalis ultima; *Aquila* spp.: in the shorter inc. intercostalis ultima (VII); *A. fasciata*: in the narrower inc. intercostalis ultima (measurement "b"), otherwise being very similar; *C. cinereus*: in the larger size; *C. gallicus*: in the smaller measurement "b", the thicker transversal intercostal edges, and the larger differences between the widths of the inc. intercostalis and their articular processus, otherwise being very similar.

Circaetos haemusensis sp. n. synsacrum, corpora vertebrorum NMNHS 150 (Plate 1: f; Table 4; Fig. 1-D). The specimen differs from: *T. ecaudatus*: in the thicker parapophysis, and the deeper sulcus ventralis synsacri; *P. bellicosus*: in the smaller size and deeper sulcus ventralis synsacri; *A. heliaca*: in the slightly smaller size, and shallower sulcus ventralis synsacri; *A. chrysaetos*: in the smaller size and the round section of corpora vertebrorum; *A. rapax*: in the narrower distal (caudal) part of corpora vertebrorum (measurement "d"); *A. nipalensis*: in the more protruding, instead of flat, and perpendicular, instead of slightly caudally directed VI parapophysis; *A. vereauxii*: in the thinner and protruding in its transverse section, instead of flat and wide, parapophysis VI; *A. clanga*: in the thinner and protuberant instead of wide and flatten VI parapophysis on the preserved fragment; *A. pomarina*: in the the presence of a clearly seen longitudinal groove, the wider parapophysis V, and the more caudal position of the parapophysis VI; *A. fasciata*: in the position of the smaller (VI) parapophysis immediately after the wider one (V), and in the absence of a groove on the VI parapophysis; and from *C. gallicus*: in the thicker base of the V para-

Table 3. The measurements of sternum, pars costalis dex. in some fossil and recent accipitriforms (ref. to Fig. 1–C)

Species	**a**	**b**	**c**	**d**	**e**	**f**
Fossil – Varshets						
Circaetus haemusensis sp. n. NMNHS 273	7.3	5.3	5.4	4.3	5.3	4.3
Recent						
C. gallicus ISEAK A 3348/77	7.4	6.7	5.5	3.6	6.0	5.5
C. gallicus UCBL 108/2	7.2	7.3	5.5	4.9	6.0	5.2
C. gallicus NHM 1863.7.30.11	5.6	5.2	5.6	4.9	5.1	5.0
C. cinereus NHM 1850.15.39	5.7	4.0	3.6	3.0	3.4	2.6
A. chrysaetos NHM 1919.12.10.1206	9.0	10.2	6.3	5.8	7.1	8.9
A. chrysaetos NHM 1996.69.21	9.8	11.9	5.7	5.0	6.0	7.0
A. clanga ISEAK A 2454/71	6.7	8.6	5.0	3.9	5.4	5.1
A. clanga NHM 1952.3.205	10.4	6.9	4.6	3.8	5.0	3.8
A. clanga NHM 1972.1.58	9.2	9.0	5.6	4.3	5.5	3.9
A. clanga NHM 1981.74.4	7.7	5.6	6.0	4.4	5.0	4.6
A. fasciata NHM 1851.8.25.39	8.4	8.5	6.1	4.5	5.8	5.5
A. fasciata NHM 1952.1.180	7.9	7.4	5.2	4.3	5.0	3.6
A. heliaca NHM 1954.30.48	10.1	7.9	6.8	5.4	6.5	5.7
A. nipalensis NHM 1952.3.58	8.6	7.3	5.4	5.0	5.8	4.8
A. nipalensis NHM 1980.11.4	9.6	7.9	6.4	4.9	5.8	4.2
A. pomarina ISEAK A 5087/92	8.5	8.2	5.3	3.7	5.1	4.6
A. pomarina NHM 1995.23.1	9.2	10.0	5.0	3.5	5.0	4.8
A. pomarina NHM 1995.27.1	8.6	8.9	5.0	3.6	4.9	3.2
A. rapax ISEAK A 3931/82	7.7	9.0	7.4	6.8	7.7	7.0
A. verreauxii NHM 1860.4.23.7	9.3	8.0	7.0	6.0	6.8	6.0
I. humilis NHM 1924.1.24.3	7.0	6.7	3.7	2.5	4.3	4.5
I. ichthyaetus NHM 1845.1.12.20	8.0	7.5	-	-	-	4.1
P. bellicosus NHM 1954.9.1	10.1	11.3	7.2	6.3	7.4	7.0
P. haliaeetus NHM 1900.11.30.32	6.6	6.2	4.5	3.5	3.9	3.4

Table 4. The measurements of synsacrum, corpora vertebrorum in some fossil and recent accipitriforms (ref. to Fig. 1–D)

Species	**a**	**b**	**c**	**d**	**e**	**f**
Fossil – Varshets						
Circaetos haemusensis sp. n. NMNHS 150	10.4	12.1	12.2	8.1	7.1	5.2
Recent						
C. gallicus NHM1863.7.30.11	9.3	11.7	11.2	9.4	7.7	2.8
C. gallicus UCBL 108/1	10.3	12.2	12.1	8.0	7.3	3.1
C. gallicus ISEAK A 3348/77	8.3	10.1	11.0	8.2	7.2	3.8
A. chrysaetos NHM 1930.3.24.260	14.0	15.5	15.4	11.9	9.4	5.6
A. chrysaetos NHM 1996.69.21	11.8	19.0	14.4	11.6	10.0	5.8
A. clanga 1981.74.4	9.8	11.4	11.4	9.7	9.5	4.5
A. clanga ISEAK A 2454/71	9.7	10.8	11.0	9.4	6.9	4.5
A. clanga NHM 1952.3.205	8.2	8.1	9.7	9.8	8.9	ca. 7.5
A. clanga NHM 1972.1.58	11.1	11.0	11.7	9.8	8.4	4.6
A. clanga UCBL 89/1	10.7	11.5	11.6	8.2	6.0	3.6
A. fasciata NHM 1847.10.21.50	11.4	12.0	12.3	9.4	6.5	3.9
A. fasciata NHM 1898.12.13.1	11.3	12.5	13.0	9.8	7.5	4.5
A. fasciata NHM 1952.1.180	12.2	13.1	12.7	10.0	7.5	3.8
A. fasciata NHM 1954.30.45	11.8	12.7	12.5	9.4	8.0	4.5
A. fasciata UCBL 91/1	12.5	12.9	12.8	10.6	6.0	3.4
A. heliaca NHM 1845.1.12.8	11.8	13.3	13.0	9.3	6.4	3.8
A. heliaca NHM 1954.30.48	11.2	12.8	13.1	10.1	8.2	4.5
A. nipalensis 1980.11.4	11.0	11.9	12.2	9.4	7.0	3.7
A. nipalensis NHM 1952.3.58	11.3	11.4	13.0	10.4	6.8	4.1
A. pomarina ISEAK A 4953/91	9.5	11.0	11.2	9.3	7.3	4.9
A. pomarina ISEAK A 5087/92	9.7	10.9	10.8	-	4.0	7.0
A. pomarina NHM 1845.1.12.11	10.5	12.6	12.1	8.5	7.5	4.7
A. pomarina NHM 1898.5.7.5	8.9	10.0	9.7	7.0	6.9	4.7
A. pomarina NHM 1995.23.1	9.2	11.1	11.5	ca. 9.2	7.1	4.0
A. rapax ISEAK A 3931/82	11.2	12.8	12.3	10.9	7.7	5.0
B. buteo UCBL 93/10	9.1	9.7	10.1	7.4	5.2	-
P. bellicosus NHM 1954.9.1	12.6	14.8	14.2	12.2	9.4	5.2
T. ecaudatus NHM 1871.9.28.4	10.5	12.6	12.0	-	-	-

pophysis and the base of the last parapophysis, the wider (5.2 against 3.1 mm) foramen, closed by the wide parapophysis (measurement "f"), and the protruding, instead of flat, parapophysis VI, otherwise the two species are very similar.

Circaetus haemusensis sp. n. ph. dist. digitus majoris dex. NMNHS 162 (Plate 1: m-n; Table 5; Fig. 1-E). The specimen differs from Pandionidae (*P. haliaetus*) not only metrically, but also in the missing sharp longitudinal edges and the absence of clear relief on the f. a., in the shallower relief, and the wider angle (over 90°) between the surface of f. a. and the longitudinal axis of the ph. The general morphology corresponds to that of the large Accipitridae. Furthermore, the specimen differs from: *H. leucocephalus*: in its smaller dimensions and the less developed relief of f. a.; *S. coronatus*: in the much smaller size; *P. bellicosus*: in the smaller size and the more irregular triangle shape of f. a.; *A. nipalensis*: in the smaller dimensions and the less developed relief of f. a.; *A. clanga*: in its slightly larger size, thicker shaft of the ph., slightly wider lateral surface, shallower relief of f. a.; *A. pomarina*: in the shallower relief of f. a.; *A. heliaca*: in its smaller size (especially the measurement "d"), and the shallower relief of the f. a.; *A. chrysaetos*: in its smaller size and the less marked fovea on the lateral tip of the f. a.; *A. fasciata*: in the sharper curving of the dorsal edge at the proximal end in lateral view, and the more closed arc of the f. a. in cranial view; *C. cinereus* and *C. cinerascens*: in its larger size and the robust structure of the bone; *C. gallicus*: with the great metrical and morphological resemblance – in the less developed articular faces, more protruded in medial view instead of concaved proximal part from f. a.

Table 5. The measurements of ph. dist. digitus majoris dex. in some fossil and recent accipitriforms (ref. to Fig. 1–E)

Species	**a**	**b**	**c**	**d**
Fossil – Varshets				
Circaetus haemusensis sp. n. NMNHS 162	5.9	6.5	6.5	3.7
Recent				
C. gallicus NHM 1954.30.63	5.5	6.0	6.4	4.1
C. gallicus NHM 1930.3.24.261	6.3	6.6	6.7	3.7
C. gallicus NHM 1863.7.30.11	6.0	7.0	6.5	4.2
C. gallicus NHM 1955.4.7	4.2	5.9	6.0	3.8
C. gallicus UCBL 108/1	6.2	6.8	6.5	4.0
C. gallicus UCBL 108/2	6.7	6.8	6.5	4.0
C. cinereus NHM 1850.15.39	5.2	5.4	5.5	4.0
C. cinerascens NHM 1954.30.64	4.1	5.1	5.5	3.2
A. chrysaetos NHM 1996.69.21	9.7	8.8	9.0	8.9
*A. chrysaetos*NHM 1930.3.24.260	7.9	7.9	8.5	5.4
A. clanga NHM 1952.3.205	5.1	5.8	6.2	4.1
A. clanga NHM 1972.1.58	5.5	5.8	6.6	4.3
A. clanga NHM 1981.74.4	7.0	6.6	7.0	4.4
A. clanga UCBL 89/1	5.5	5.6	6.0	4.1
A. fasciata NHM1898.12.31.1	6.4	6.2	5.6	4.0
A. heliaca NHM 1954.30.48	7.3	6.6	7.4	6.6
A. nipalensis NHM 1980.11.4	7.5	7.1	6.6	5.1
A. pomarina NHM 1898.5.7.5	5.8	6.2	5.8	3.6
A. verreauxii NHM 1860.4.23.7	7.1	8.0	8.5	5.0
H. leucocephalus NHM 1930.3.24.262	8.0	8.7	9.0	5.0
P. bellicosus NHM 1954.9.1	8.0	7.8	8.4	5.5
P. haliaetus UCBL 109/2	7.0	7.8	7.1	7.2
T. ecaudatus NHM 1871.9.28.4	7.3	7.2	7.0	5.0

Circaetus haemusensis sp. n. ph. 1 digitus 1 pedis dex. NMNHS 192 (Plate 1: h-i; Table 6: Fig. 1-F). The specimen differs from Pandionidae (*P. haliaetus*) in the more massive ph. and the shallower relief of f. a. distalis. The general morphology corresponds to that of the large Accipitridae. Furthermore, the specimen differs from: *I. ichthyaetus*: in the considerably smaller size; *P. bellicosus*: in the considerably smaller size, straight (not medially curved) nontrochlear part of the ph.; *H. albicilla*: in the much smaller size; *T. ecaudatus*: in the shorter and the gradually widening instead of steep, sharply widening of the ph.; *A. clanga* in the more robust proximalis half of the ph., in the wider tendineal grove on the caudal surface of the bone, and in the less developed protrudence (1), as well as the shorther elongated part, the smaller size, and the blunter and shorter proximal part; *A. nipalensis*: in the smaller size, and the less developed art. condyle; *A. vereauxii*: in the much smaller size; *A. heliaca*: in the smaller size and the straight but less bent shaft of the ph., smaller size and the more gracile proximal part.; *A. chrysaetos*: in its smaller dimensions and the more concaved phalangeal trochlea in ventral view; *A. pomarina*: in the more robust, instead of gracile, phalangeal body; *A. fasciata*: in the shorter proximal (thinner) part, and the rounded, instead of sharpened, proximal articulatar surface; *C. cinereus* and *C. cinerascens*: in the larger size and the robust structure of the bone; *C. gallicus*: with the high similarity of the two species – in the relatively slightly larger total length (measurement "c"). As may be seen from Table 6, the total length of the phalanx of No 192 is smaller than that measurement in the true eagles (the larger species of *Aquila*) by 10% to 20% and even more. This strongly agrees with the statement of Lerner (2007), who specified that *Circaetus* spp. have "relatively short toes".

Circaetus haemusensis sp. n. ph. 2 digitus 3 pedis dex. NMNHS 243 (Plate 1: j-l; Table 7; Fig. 1-G). The specimen differs from Sagitariidae (*S. serpentarius*) in the longer intercostal cuttings, and from Pandionidae (*P. haliaetus*) in the larger size and the absence of a keel on the dorsal side of the proximal end of the ph. The general morphology corresponds to that of the large Accipitridae.

Table 6. The measurements of ph. 1 digitus 1 pedis dex. in fossil and recent accipitriforms (ref. to Fig. 1–F)

Species	**a**	**b**	**c**	**d**	**e**
Fossil – Varshets					
Circaetus haemusensis sp. n. NMNHS 192	10.0	6.3	17.4	3.1	4.9
Recent					
C. gallicus NHM 1863.7.30.11	9.2	8.0	17.2	ca. 5.4	-
C. gallicus UCBL 108/1	8.8	5.7	14.0	3.1	4.6
C. gallicus NHM 1930.3.24.261	9.0	6.2	15.3	-	4.7
C. gallicus NHM 1954.30.63	8.0	4.5	15.2	3.4	ca. 4.6
C. gallicus NHM 1955.4.7	8.8	5.4	15.0	ca. 3.3	5.8
C. cinereus NHM 1850.15.39	8.4	ca. 5.8	14.3	-	ca. 4.3
C. cinerascens NHM 1954.30.64	8.8	6.0	15.1	-	ca. 5.3
A. chrysaetos NHM 1930.3.24.260	13.9	10.0	24.1	3.9	6.5
A. chrysaetos NHM 1996.69.21	15.8	10.7	21.6	4.6	7.3
A. clanga NHM 1952.3.205	9.8	5.1	18.3	3.1	4.1
A. clanga NHM 1972.1.58	9.6	-	18.4	2.8	-
A. clanga NHM 1981.74.4	11.2	ca. 6.2	19.3	3.9	5.5
A. clanga UCBL 89/1	9.5	4.5	18.4	2.8	4.6
A. fasciata NHM 1952.1.180	11.3	9.0	22.0	ca. 3.0	-
A. fasciata NHM 1998.90.4	10.3	7.1	19.4	3.6	5.1
A. heliaca NHM 1954.30.48	11.8	11.9	20.8	3.6	6.1
A. nipalensis NHM 1952.3.58	11.6	7.6	18.6	3.1	5.2
A. nipalensis NHM 1980.11.4	12.0	6.8	ca. 18.8	3.6	5.5
A. pomarina NHM 1995.23.1	9.1	ca. 5.6	11.7	2.8	4.5
A. verreauxii NHM 1860.4.23.7	15.5	ca. 10.4	29.5	4.4	7.0
H. leucocephalus NHM 1930.3.24.262	14.7	11.0	23.0	4.5	7.0
I. ichthyaetus NHM 1845.1.12.20	14.4	10.0	27.5	4.4	7.9
P. bellicosus NHM 1984.101.1	16.4	14.5	28.4	5.3	8.4
T. ecaudatus NHM 1871.9.28.4	10.7	-	22	-	-

Furthermore, this specimen differs from: *T. ecaudatus*: in the smaller, but thicker ph.; *P. bellicosus*: in the smaller size and the less parallel condyles of the distalis facies articularis; *A. pennata*: in the almost twice larger size, otherwise being very similar; *A. chrysaetos*: in the deeper groves on the ventralis side of the ph. directed towards the trochlea; *A. nipalensis*: in the smaller length of the ph.; *A. verreauxii*: in the stronger constriction of the distalis end of the ph., above the ph. trochlea; *A. heliaca*: in the lesser dorso-ventralis constriction of the ph.'s body at the trochlear part; *A. clanga*: in the well-developed assymetry of the proximal art. end in cranial view and the wider art. parts (measurements "g" and "i"; Table 14), the dorso-vent. flat distalis half of the ph., otherwise being similar; *A. fasciata*: in the smaller length (measurements "c" and "d"); *A. pomarina*: in the missing foramen nutritium on the ventralis side, the deeper concavity on the lateral side of the profile of f. a.; *C. gallicus*: in the less protruding dorsal side, with a high similarity otherwise.

Discussion

The above-presented finds allow some definite taxonomic determination. Although only two of the finds were intact and complete, without damages, they could most likely be assinged to the Snake Eagles of the genus *Circaetus*. Since no other fossil taxa have been described in the genus (Mlíkovský 2002), the late Miocene *C. rhodopensis* is the only species known so far (Boev 2012). *C. rhodopensis* is known only by its carpometacarpus. The species is similar in size to *C. haemusensis* sp. n., but its bone finds are incomparable to these of *C. haeumusensis* sp. n.. In addition, the chronostratigraphic difference is considerable, about 5.25 mya. The present material from Varshets proves the continuity of the existence of the Snake Eagles on the territory of SE Europe (at least on the Balkans) during the late Neogene – early Quaternary. Before the description of *C. rhodopensis*, the coexistence of both genera, *Aquila* and *Circaetus*, was not known for the Neogene of Europe (Mlíkovský 2002, Boev 2012), while the present

Table 7. The measurements of ph. 2 digitus 3 pedis dex. in some fossil and recent accipitriforms (ref. to Fig. 1–G)

Species	a	b	c	D	e	f	g	h	i
Fossil – Varshets									
Circaetus haemusensis sp. n. NMNHS 243	4.7	5.5	22.1	ca.17.4	3.4	5.5	6.3	5.0	6.5
Recent									
	4.3	5.9	20.1	ca. 16.5	3.3	5.4	5.9	5.0	6.0
C. gallicus NMNHS 1/1984									
C. gallicus NHM 18637.30.11	4.6	6.0	20.5	ca. 16.1	3.4	5.4	5.5	4.6	5.9
A. chrysaetos NHM 1898.5.7.3	5.1	6.9	27.0	21.0	4.1	6.3	6.9	5.5	7.2
A. chrysaetos NHM 1930.3.24.260	5.4	6.9	26.7	21.5	6.5	7.0	5.8	5.6	7.4
A. chrysaetos NHM 1996.69.21	5.2	6.0	23.2	18.1	4.8	6.1	6.8	5.4	6.9
A. chrysaetos UCBL 86/5	5.1	6.5	22.6	ca.17.7	3.8	6.2	6.5	5.4	7.0
A. clanga NHM 1952.3.205	4.0	6.2	20.8	17.0	3.8	5.2	5.0	4.6	5.1
A. clanga NHM 1972.1.58	4.2	6.4	21.2	17.7	-	5.1	5.3	4.5	5.8
A. clanga NHM 1981.74.4	4.3	5.9	22.7	18.4	3.5	5.2	5.5	4.6	5.8
A. clanga NHM 1995.24.1	4.4	5.6	21.5	17.7	3.2	4.4	5.2	4.5	5.6
A. fasciata NHM 1898.12.13.1	5.0	6.2	25.8	20.9	3.7	5.7	6.3	5.2	6.5
A. fasciata NHM 1996.69.22	4.2	5.6	23.9	19.0	3.3	5.2	5.8	4.7	5.9
A. heliaca NHM 1954.30.48	4.6	6.0	22.7	17.0	3.6	5.5	6.2	5.3	7.4
A. monachus UCBL 84/1	6.7	9.6	22.7	ca.22.1	5.3	8.2	8.3	6.4	8.8
A. pomarina ISEAK A 2062/69	4.2	5.0	20.0	16.2	2.9	4.8	5.0	3.7	5.3
A. pomarina NHM 1995.23.1	4.1	5.4	18.1	13.4	3.3	4.4	4.7	3.8	5.3
A. verreauxii 1860.4.23.7	5.0	6.0	24.7	ca. 19.4	4.3	5.8	7.2	5.7	7.0
H. leucocephalus NHM 1930.3.24.262	4.8	5.8	21.8	17.0	4.2	6.4	6.7	5.4	6.5
N. percnopterus UCBL 82/1	4.4	6.2	22.1	18.6	3.8	4.3	4.9	3.7	5.4
P. bellicosus NHM 1954.9.1	5.2	6.6	25.7	20.6	4.7	5.9	7.4	5.6	7.3
T. ecaudatus NHM 1871.9.28.4	-	-	25.0	-	-	-	-	4.0	5.8

data confirm their coexisting in Europe in the early Pleistocene as well. In the middle Villafranchian the Snake Eagles coexisted with the true eagles (*Aquila* Brisson, 1760).

The raptor ornithocoenosis in the Varshets locality so far includes *Falco bakalovi* Boev, 1998, *Gyps bochenskii* Boev, 2010, and *Aquila kurochkini* Boev, 2013. All of them, along with *C. haemusensis* sp. n., are an indication of the rich early Pleistocene paleo-ornithocoenosis of this locality. The presence of Snake Eagles shows that the climate was relatively warm and dry, where openland landscape dominated. The existence of that paleoenvironment type is also supported by the presence of numerous species of birds and other terrestrial vertebrates, among them: bustards (*Otis* aff. *khosatzkii* Bocheński and Kurochkin, 1987), swifts (*Apus baranensis* Janossy, 1977), larks (*Melanocorypha*, *Eremophila* and *Alauda*), goldfinches (*Carduelis*), starlings (*Sturnus*), magpies (*Pica*), choughs (*Pyrrhocorax* cf. *pyrrhocorax* and *P.* cf. *graculus*), and even ptarmigans (*Lagopus balcanicus* Boev, 1995). A small Perdicinae species, *Chauvireria balcanica* Boev, 1997, was the most numerous "openland" bird in the locality (Boev 2007).

The Snake Eagles are of probable African origin, but both fossil species came from the Southeast Europe – the Balkans (Bulgaria). At present, this region is one of the richest in Europe in terms of its herpetofauna, a feature that probably existed long ago, even back in the Pliocene – early Pleistocene. Snakes, lizards and skinks were the main prey of *C. haemusensis* sp. n., as is the case in the modern Snake Eagles. The fossil bone finds of those reptiles are abundant in the deposits from the locality of Varshets. Thousands of snake vertebrae, along with mandibles and other, although rare, cranial fragments, have been collected so far.

The reptilian paleofauna of Varshets is still incompletely examined, but the preliminary identifications of Dr. Madelaine Böhme (Senckenberg Center for Human Evolution and Palaeoenvironment, Univ. Tübingen) have shown eight species of Squamata (Sauria and Serpentes), one species of Testudines (*Testudo* sp., cf. *graeca*/*hermanni*), *Anguis* cf. *fragilis*, Serpentes fam. indet. 1, and Serpentes fam. indet. 2 (Spassov 1999). Dr. Böhme determined "7 amphibian and reptile species" (Spassov 2003); and in addi-

tion: *Lacerta* sp. (large), *Lacerta* sp. (small), *Eremias* sp., *Testudo* sp., Colubridae, Viperidae, *Natrix* sp., *Eryx* sp., *Anguis* sp. (det. M. Böhme – 2008; unpubl. data). The latest statements of Dr. Nikolay Tzankov (NMNHS) also confirm the presence of a rich and diverse herpetofauna in the locality, including the first Bulgarian record of monitor lizards (Varanidae Merrem, 1820; N. Tzankov – pers. comm.).

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Appendix 1: The examined specimens belonging to recent species in the *Accipitriformes*

Bald Eagle *Haliaetus leucocephalus* (Linnaeus, 1766): NHM 1930.3.24.262; Bateleur *Terathopius ecaudatus* (Daudin, 1800): NHM 1871.9.28.4; Black Kite *Milvus migrans* Boddaert, 1783): ISEAK A 3926/82; Bonelli's Eagle *Aquila fasciata* (Vieillot, 1822): NHM 1952 1.180, NHM 1996.69.22, NHM 1998.90.4, NHM 1847.10.21.50, NHM 1898.12.13.1, NHM 1996.90.4, NHM 1847.10.21.50, NHM 1851.8.25.39, NHM 1898.12.13.1, NHM 1952.1.180, NHM 1954.30.45, NHM 1996.69.22, NHM 1998.90.4, NHM 1898.12.31.1, NHM1952.1.180, UCBL 91/1; Booted Eagle *Aquila pennata* (Gmelin, 1788): ISEAK A 3742/80, ISEAK A 3712/80; Brown Snake Eagle *Circaetus cinereus* (Vieillot, 1818): NHM 1850.15.39; Cinereous Vulture *Aegypius monachus* (Linnaeus, 1766) UCBL 84/1; Common Buzzard *Buteo buteo* (Linnaeus, 1758): UCBL 93/10; Crested Serpent Eagle *Spilornis cheela* Latham, 1790: NHM 1881.1.17.58; Crowned Eagle *Stephanoaetus coronatus* (Linnaeus, 1766): NHM 1872.10.251; Eastern Imperial Eagle *Aquila heliaca* Savigny, 1809: NHM 1845.1.12.8, NHM 1954.30.48; Egyptian Vulture *Neophron percnopterus* (Linnaeus, 1758): ISEAK A 2864/73, UCBL 82/1; European Honey Buzzard *Pernis apivorus* Linnaeus, 1758): ISEAK A 3968/83, ISEAK A 4508/88; Golden Eagle *Aquila chrysaetos* (Linnaeus, 1758): NHM 1869.12.22.10, NHM 1896.9.30.2, NHM 1896.9.30.2, NHM 1898.5.7.3, NHM 1919.12.10.1206, NHM 1930.3.24.260, NHM 1996.69.21, ISEAK A 1305/63, ISEAK A 1305/65, UCBL 86/5; Greater Spotted Eagle *Aquila clanga* Pallas, 1811; NHM 1981.74.4, NHM 1952.3.205, NHM 1972.1.58, NHM 1981.74.4, NHM 1995.24.1, UCBL 89/1; Grey-headed Fish Eagle *Ichthyophaga ichthyaetus* (Horsfield, 1821): NHM 1845.1.12.20; Indian Spotted Eagle Aquila hastata (Lesson, 1834): NHM 1995.22.1; Lesser Fish-Eagle *Ichthyophaga humilis* (Müller and Schlegel, 1841): NHM 1924.1.24.3; Lesser Spotted Eagle *Aquila pomarina* Brehm, 1831: NHM 1845.1.12.11, NHM 1898.5.7.5, NHM 1995.22.1, ISEAK A 2062/69, ISEAK A 4953/91; Long-crested Eagle *Lophaetus occipitalis* (Daudin, 1800): NHM 1293.11.12.349; Martial Eagle *Polaemetus bellicosus* (Daudin, 1800): NHM 1954.9.1, NHM 1984.101.1; Northern Goshawk *Accipiter gentilis* (Linnaeus, 1758): ISEAK A 3950/82; Ornate Hawk-Eagle *Spizaetus ornatus* (Daudin, 1800): NHM 1952.1.77; Osprey *Pandion haliaeetus* (Linnaeus, 1758): NHM 1900.11.30.32, NHM 1955.22.5, ISEAK A 2367/71, UCBL 109/2; Secretarybird *Sagittarius serpentarius* (J. F. Miller, 1779): NHM; Short-toed Snake Eagle *Circaetus gallicus* (Gmelin, 1788): NHM 1863.7.30.11, NHM 18637.30.11, NHM 1930.3.24.261, NHM 1954.30.63, NHM 1955.4.7, NHM1863.7.30.11, ISEAK A 3348/77, UCBL 108/1, UCBL 108/2, UCBL 108/2; Steppe Eagle *Aquila nipalensis* (Hodgson, 1833): NHM 1980.11.4, NHM 1952.3.58, NHM 1980.11.4; Tawny Eagle *Aquila rapax* (Temminck, 1828): ISEAK A 3931/82; Verreaux's Eagle *Aquila verreauxii* Lesson, 1830: 1860.4.23.7, NHM 1860.4.23.7; Wedge-tailed Eagle *Aquila audax* (Latham, 1802): NHM 1954.30.50, and Western Banded Snake Eagle *Circaetus cinerascens* von Müller, 1851: NHM 1954.30.64.