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Minerva antiqua (Aves, Strigiformes), an Owl Mistaken for an Edentate Mammal

CÉCILE MOURER-CHAUVIRÉ[1]

ABSTRACT

Minerva antiqua, from the Eocene of the United States, described by R. W. Shufeldt as a strigid owl, was later considered to be an edentate mammal. Study of the type material and of material referred to this species, shows that it is actually a strigiform. The generic name *Minerva* must replace *Protostrix* and *Minerva* becomes the type genus of the family Protostrigidae. *Minerva antiqua* is characterized by the strong development of posterior digits I and II, and by the peculiar shape of the claw of posterior digit I.

Minerva antiqua, de l'Eocène des Etats Unis, a été décrite par R. W. Shufeldt comme un Strigiforme, puis a été considérée comme un Mammifère édenté. L'étude du matériel type et du matériel attribué à cette espèce montre qu'il s'agit bien d'un Strigiforme. Le nom de genre *Minerva* doit remplacer celui de *Protostrix* et *Minerva* devient le genre-type de la famille des Protostrigidae. *Minerva antiqua* est caractérisée par le grand développement des doigts postérieurs I et II et par la forme particulière de la griffe du doigt postérieur I.

INTRODUCTION

In 1913 Shufeldt described, on material from the Eocene Bridger Formation of Wyoming, three species in the genus *Aquila*: *A. antiqua, A. ferox,* and *A. lydekkeri.* The first two are based on phalanges and particularly on claws whose dorsal arc extends strongly over the articulation. The third species includes limb bones and phalanges, among them a claw which presents the same characteristic as the two preceding species. This material is in the vertebrate paleontology collection of the American Museum of Natural History in New York.

In 1915 Shufeldt studied the fossil birds in the Marsh Collection of Yale University and attributed to the species *antiqua* many fossil bones from different localities of the Bridger Formation. He recognized that this species was not an eagle but a large owl, and created for it a new genus, *Minerva,* which he placed in the Strigidae.

In 1933 Wetmore studied the types of *Minerva antiqua, Aquila ferox,* and *Aquila lydekkeri* and stated that the phalanges and claws upon which the species *Minerva antiqua* and *Aquila ferox* were founded came from

[1] Centre de Paléontologie Stratigraphique et Paléoécologie, Université Claude Bernard, 27-43 Boulevard du 11 Novembre, 69622 Villeurbanne, France.

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edentate mammals and that the genus *Minerva* and the two species *antiqua* and *ferox* had to be transferred to the mammals. For the species *lydekkeri,* in the type material of which were many different bones, he selected a tibiotarsus belonging to a strigiform and created a new genus, *Protostrix,* and a new family, Protostrigidae. From the remaining type material, a claw and three phalanges were attributed to an edentate mammal, and other fragments and another claw to undetermined birds (Wetmore, 1933, 1934).

After examining the types of *Minerva antiqua, Aquila ferox,* and *Protostrix lydekkeri* in the American Museum of Natural History and the large amount of material in the Yale University Peabody Museum collection ascribed by R. W. Shufeldt (1915) to *Minerva antiqua,* I conclude that the phalanges and claws originally described do not belong to an edentate mammal but to a bird corresponding to a particular kind of strigiform. The generic name *Minerva* must therefore be restored and the generic name *Protostrix* replaced.

SYSTEMATICS

ORDER STRIGIFORMES (WAGLER, 1830)
FAMILY PROTOSTRIGIDAE WETMORE, 1933

TYPE GENUS: *Minerva* Shufeldt, 1915.

OTHER INCLUDED GENERA: *Eostrix* Brodkorb, 1971.

GENUS *MINERVA* SHUFELDT, 1915

SYNONYMY: *Protostrix* Wetmore, 1933, p. 3.

TYPE SPECIES: *Aquila antiqua* Shufeldt, 1913.

SPECIES INCLUDED IN THE GENUS: *Minerva lydekkeri* (Shufeldt, 1913), new combination; *Minerva leptosteus* (Marsh, 1871), new combination; *Minerva saurodosis* Wetmore, 1921; *Minerva californiensis* (Howard, 1965), new combination.

RANGE: Middle and Upper Eocene of western United States (Wyoming, California).

Minerva antiqua (Shufeldt, 1913)

Aquila antiqua Shufeldt, 1913, p. 297, pl. 55, fig. 26.
Aquila ferox Shufeldt, 1913, p. 297.
Aquila lydekkeri Shufeldt, 1913, p. 298.
Minerva antiqua (Shufeldt, 1913): Shufeldt, 1915, p. 42, pl. XV, figs. 131–136 and 148–154.
Minerva antiqua (Shufeldt, 1913): Howard, 1932, p. 32.
Protostrix lydekkeri (Shufeldt, 1913): Wetmore, 1933, p. 3, fig. 1.
Protostrix lydekkeri (Shufeldt, 1913): Brodkorb, 1971, p. 214.

MATERIAL

Department of Vertebrate Paleontology Collections of the American Museum of Natural History. AMNH 5163, phalanx 1 of left posterior digit I, complete; phalanx 2 of right posterior digit I, incomplete. Henry's Fork, Wyoming. These two pieces are the holotype of *Aquila ferox.* AMNH 5164, phalanx 2 of left posterior digit I, incomplete. Church Buttes, Wyoming. Holotype of *Aquila antiqua* (Shufeldt, 1913, pl. 55, fig. 26). AMNH 5165, distal left tibiotarsus; proximal left tibiotarsus; two fragments of distal left femur; one fragment of proximal left femur, one external trochlea of left tarsometatarsus; phalanges 1 and 2 of left posterior digit I, articulated; phalanges 1, 2, and 3 of left posterior digit II, articulated. Lower Cottonwood Creek, Wyoming. All these pieces were the holotype of *Aquila lydekkeri.* The distal part of the left tibiotarsus was selected by Wetmore (1933) to become the type of *Protostrix lydekkeri.*

Collections in the Peabody Museum of Natural History, Yale University. YPM 833, proximal part of left carpometacarpus (Shufeldt, 1915, pl. XV, fig. 154b); fragment of distal part of right humerus; fragment of distal part of left tibiotarsus; distal part of right tibiotarsus (Shufeldt, *ibid.,* fig. 154e); distal part of left tarsometatarsus; proximal part of phalanx 2 of left posterior digit I (Shufeldt, *ibid.,* fig. 154g); phalanx 1 of left posterior digit I, deformed (Shufeldt, *ibid.,* fig. 154d); right and left metatarsals I; fragment of phalanx 1 right posterior digit II; two fragments of phalanx 2 posterior digit II (Shufeldt, *ibid.,* fig. 154i); phalanx 3 posterior digit II, incomplete (Shufeldt, *ibid.,* fig. 154a), phalanx 4 posterior digit III, incomplete (Shufeldt, *ibid.,* fig. 154f); phalanx 5 posterior digit IV, incomplete (Shufeldt, *ibid.,* fig. 154c). Dry Creek, Wyoming. YPM 843, phalanx 2 of right posterior digit I (Shufeldt, *ibid.,* fig. 149).

Dry Creek, Wyoming. YPM 846, fragment of right tarsometatarsus; phalanx 1 of right posterior digit I; fragment of phalanx 2 posterior digit II; phalanx 3 posterior digit II, incomplete; fragment of phalanx 3 posterior digit III. Henry's Fork, Wyoming. YPM 847, proximal part of phalanx 2 of right posterior digit I (Shufeldt, *ibid.*, fig. 151). Henry's Fork, Wyoming. YPM 857, phalanx 2 of left posterior digit I, incomplete. Black Fork, Wyoming. YPM 858, phalanx 2 of right posterior digit I, incomplete. Henry's Fork, Wyoming. YPM 861, proximal left tarsometatarsus and fragments of distal part, proximal left femur, distal left femur (Shufeldt, *ibid.*, fig. 136); proximal left tibiotarsus, distal left tibiotarsus (Shufeldt, *ibid.*, fig. 131), phalanx 1 and 2 of left posterior digit I, articulated (Shufeldt, *ibid.*, fig. 134), phalanx 1 of left posterior digit II (Shufeldt, *ibid.*, fig. 132). Tule Spring, Wyoming. YPM 869, distal part of phalanx 1 of posterior digit I; phalanx 4 of posterior digit IV, incomplete. Dry Creek, Wyoming. YPM 871, phalanx 1 of right posterior digit II; fragment of phalanx of posterior digit III or IV. Dry Creek, Wyoming. YPM 876, fragment of phalanx 3 of posterior digit II. Cattail Spring, Wyoming. YPM 879, phalanx 3 of posterior digit II (Shufeldt, *ibid.*, fig. 152a and b). Upper White River, Wyoming. YPM 884, phalanx 1 of right posterior digit I. Locality unrecorded. YPM 886, phalanx 1 of right posterior digit II, almost complete. Sage Creek, Wyoming. YPM 892, phalanx 1 of right posterior digit I, incomplete. Henry's Fork, Wyoming. YPM 1026, phalanx 2 of left posterior digit I, almost complete, rolled (Shufeldt, *ibid.*, fig. 149). Dry Creek, Wyoming.

In addition to the remains of *Minerva antiqua,* the same numbers of the Yale collection contain also some undetermined fragments of reptiles, birds, and mammals.

DESCRIPTION AND COMPARISONS

Shufeldt described three different species, from three different localities of the same formation, but did not give any distinctive characters among them, except that *Aquila ferox* "was an eagle about the same size as the last (*A. antiqua*), or perhaps rather smaller" (Shufeldt, 1913, p. 298).

For the three species it is possible to measure the width of the proximal end of the phalanx 2 of posterior digit I. The measurements are 6.8 mm. for *A. antiqua,* 5.8 mm. for *A. ferox,* and 7.4 mm. for *A. lydekkeri.* In the Yale material the same width has a range of variation between 6.2 mm. and 6.9 mm. with a mean value of 6.5 mm.

Knowing the variability in dimensions and the great sexual dimorphism of Recent owls, I think these three species can be combined into the same one, which was first described by Shufeldt (1913) as *Minerva antiqua.* The same conclusion has already been expressed by Howard (1932).

Wetmore's statement (1933) that the claws belong to an edentate mammal seems to have been erroneous for the following reasons.

1. These claws are associated, in the American Museum as well as in the Yale collections, with skeletal remains, mainly from the hind limb, which are typically strigiform remains.
2. Not only one but three tibiotarsi exist, all exhibiting the characters which have been set up to define the genus *Protostrix.*
3. Among the remains of YPM 861 it is possible to reconstruct the proximal part of an owl-like tarsometatarsus, with large tarsometatarsal anterior and posterior grooves, and the traces of an unossified supratendinal bridge. The distal fragments of tarsometarsi present several typically owl-like trochleae.
4. YPM 833 includes a great number of phalanges belonging to the left foot of an owl-like bird.
5. The claws of digit I show a strong prolongation of their dorsal arc over the articulation, a condition which does not exist in any modern Strigiformes, but in two cases these claws are articulated with phalanges 1 which are typically avian. The other phalanges and claws found in association with these claws of digit I are also undoubtedly avian.

Comparison Between the Claw of Digit I of *Minerva antiqua* and Claws of Edentate Mammals

I examined the phalanges of Pleistocene and Recent edentates in the collection of the Florida State Museum, Gainesville. In the

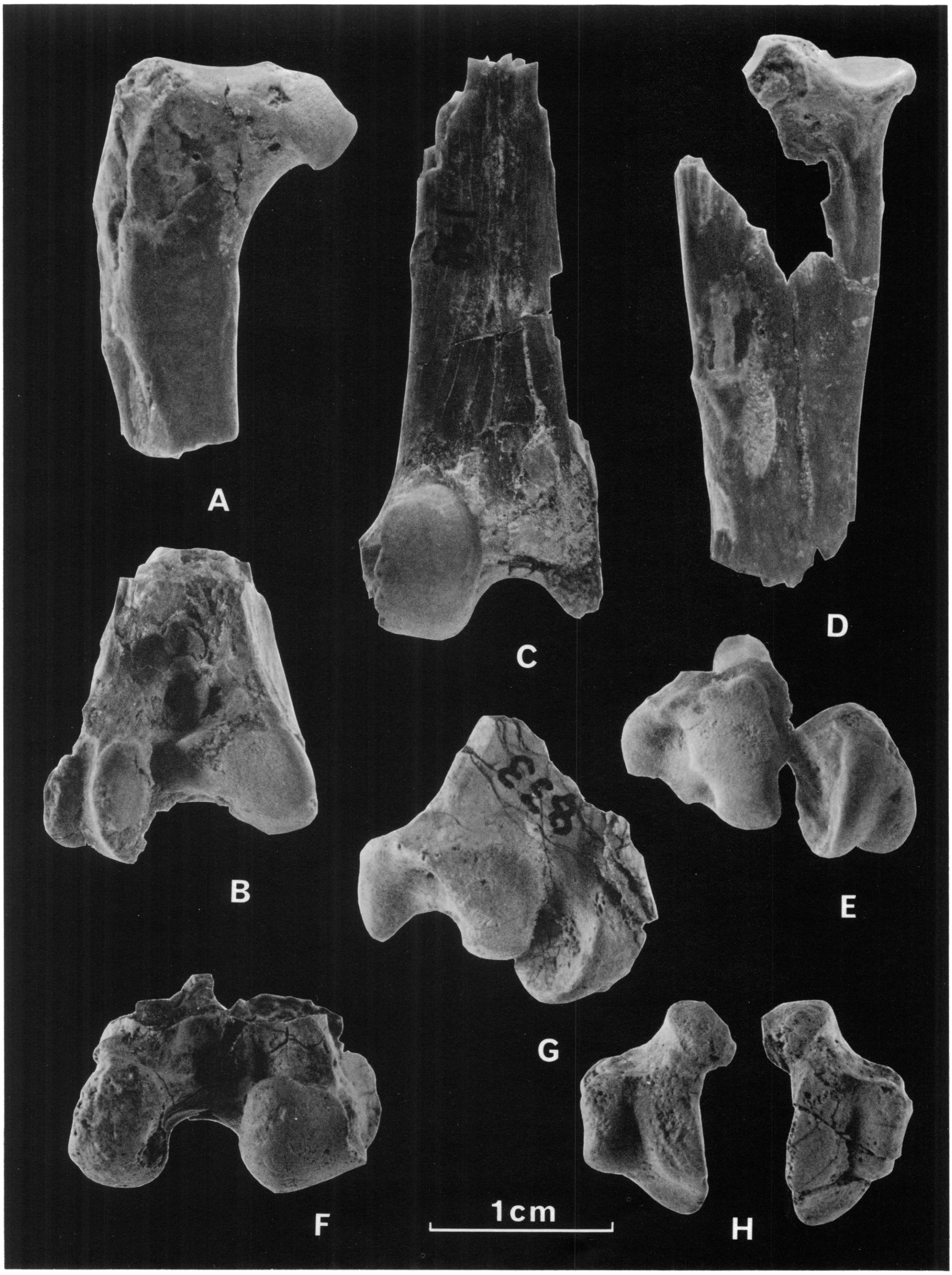

FIG. 1. *Minerva antiqua* Shufeldt, Peabody Museum Collection, Yale University. A. Proximal left femur, no. 861, posterior view. B. Distal left femur, no. 861, posterior view. C. Distal left tibiotarsus, no. 861, anterior view. D. Proximal left tarsometatarsus, no. 861, anterior view. E. Distal left tarsometatarsus, no. 861, internal and middle trochleae. F. Distal right tibiotarsus, no. 833, anterior view. G. Distal left tarsometatarsus, no. 833, internal and middle trochleae. H. Left and right metatarsals I, no. 833, articular view.

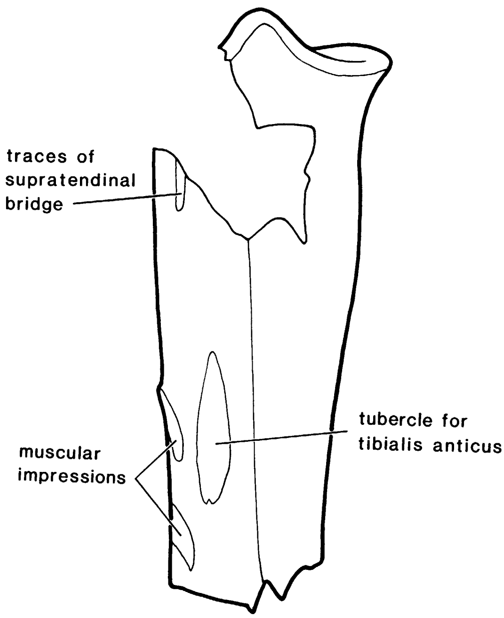

FIG. 2. *Minerva antiqua* Shufeldt, Peabody Museum Collection, Yale University. Schema of the proximal left tarsometatarsus, no. 861.

edentates the distal part of phalanx 2 is very compressed, with a deep articular furrow, V-shaped in section. This distal part is more compressed than the distal part of phalanx 1 of digit I of *Minerva antiqua.*

The dorsal surface of phalanx 3 extends over the articulation by a sort of hook (apophysis extensoris; Ballmann, 1973), but it projects less than in *Minerva.*

Particularly in raptorial birds, under the articular facet of the claws, on the ventral surface, the apophysis flexoris (Ballmann, 1973) protects strongly. It is directed downward and clearly separated from the body of the claw. In the edentates this apophysis is broad, flattened, and extends under along the ventral surface of the claw. In *Minerva* the apophysis flexoris of the claw of digit I is typically avian.

In the edentates the section across the claw is generally triangular in shape, with a strongly marked dorsal sharp edge, two lateral sharp edges, and a flattened ventral surface. The dorsal sharp edge is divided at the distal end by a narrow median groove, as often in mammals. In the genus *Myrmecophaga* the anterior claws have, in addition, a ventral sharp edge and a rather rhombic section. In *Minerva antiqua* there is never any sharp edge on the dorsal surface of the claws. On the claw of digit I there is a sharp edge on the ventral surface. This one is asymmetrical and situated on the internal side of the toe. (In the description of phalanges, I consider digit I of the foot as if it were directed forward, parallel to other digits, and not directed backward, as it actually is.)

I also compared the phalanges of *Minerva antiqua* with those of its contemporary palaeanodont edentates, which could have been found in the same fossil localities, and are conserved in the collection of the American Museum. They are very small, not exceeding a length of 10 mm. to 18 mm., whereas the complete claws of digit I of *Minerva antiqua* measure up to 33 mm.

In the palaeanodont genus *Metacheiromys,* from the Eocene of the Bridger Formation, the posterior claws are small, short, and cone-shaped. The anterior claws are more developed. They are strongly compressed laterally, with a cutting edge on the dorsal surface. At the distal end this edge is divided by a median groove. The proximal articular surface is rounded, slightly depressed in the middle, and non-ridged. The apophysis flexoris is flattened. In lateral view the claw is not regularly curved.

In the genus *Palaeanodon,* from the Paleocene, the claws always have a cutting edge on the dorsal surface. The section may be triangular or rhombic, as in modern edentates. The apophysis flexoris is more or less flattened, but it extends downward along the body of the phalanx, and is less projecting than in *Minerva.* The apophysis extensoris extends over the articulation by a hook, but this one is also less projecting than in *Minerva.* Finally, the proximal articular surface shows a weak median ridge, far less developed than in *Minerva.*

COMPARISON BETWEEN *MINERVA ANTIQUA* AND MODERN AND FOSSIL STRIGIFORMES

Carpometacarpus: The proximal carpometacarpus has been badly crushed. The alular metacarpal does not project far upward and seems to terminate in a globular, rounded processus extensorius.

Femur (fig. 1A and B): The two proximal

and distal fragments of femur are somewhat smaller than in a modern *Bubo virginianus* and do not exhibit any important morphological difference.

Tibiotarsus (fig. 1C and F): The distal fragments of tibiotarsi correspond to the diagnosis of the genus *Protostrix.* The internal condyle is strongly widened on the anterior face as well as on the posterior face. In the Recent strigids the internal condyle is widened on the posterior face, but not wider than the external condyle on the anterior face. Both condyles project about the same distance forward; that is the distinctive character between the genera *Minerva* (=*Protostrix*) and *Eostrix* (Brodkorb, 1971). Contrary to the condition in most of the modern strigids, there is practically no supracondylar fossa on the anterior face, with only a very small fossa above the internal condyle. On the internal face there is a median tubercle (internal ligamental prominence) and a small fossa situated before this tubercle, in the concavity of the condyle. Such a tubercle exists in some Recent strigids but the fossa does not occur. Finally, in *Minerva,* in internal view, the internal condyle projects farther forward than in modern Strigiformes.

Tarsometatarus (fig. 1D, E, and G): The proximal tarsometatarsus has only a part of its articular surface. The external cotyla is prolonged by an external calcaneal ridge of the hypotarsus, which is directed perpendicularly to the anterior face of the bone, and not obliquely. The general shape of the proximal surface is rectangular. The intercotylar area is narrow. There are two broad tarsometatarsal grooves, anterior and posterior, as in the Strigidae and Phodilidae, while there is no posterior groove at the proximal part in Tytonidae. The anterior groove is symmetrical, as in the Tytonidae and Phodilidae, whereas in the Strigidae it is much deeper in the internal side.

The traces of an unossified supratendinal bridge can be seen, as in the Tytonidae and Phodilidae, whereas in the Strigidae this bridge is almost always ossified.

The tubercle for tibialis anticus is situated closer to the internal side, and there are, at the same level, some strong muscular impressions on the internal face of the bone. In the modern strigids the tubercle for tibialis anticus is situated in the median axis of the bone and there are no muscular impressions on the internal face. These muscular impressions can be correlated with the strong development of digits I and II (fig. 2).

The trochlea for digit II is much shorter than the trochlea for digit III, which is a character of the family Protostrigidae, whereas in the Strigidae the trochleae for digits II and III have about the same length, and in the Tytonidae and Phodilidae the trochlea for digit II extends slightly more distal than the trochlea for digit III. The trochlea for digit III is proportionally narrower and the wing of the trochlea for digit II is proportionally larger than in Recent Strigiformes. In modern owls as well as in *Eostrix,* on the posterior face, the trochlea for digit III has two wings situated on each side of the articular groove, and the external wing is much stronger than the internal one. In *Minerva* the two wings are symmetrical and equal. The above characters can also be seen on the distal tarsometatarsus of *Minerva* (*Protostrix*) *leptosteus* recently published by Rich (1982).

Another family of owls has been described from the Paleocene of Colorado: Ogygoptyngidae Rich and Bohaska, 1981, with the only genus *Ogygoptynx* Rich and Bohaska, 1976, known by a tarsometatarsus. This tarsometatarsus differs from that of *Minerva* in having the proximal end shaped like a parallelogram with unequal angles, not rectangular, a tubercle for tibialis anticus situated in the axis of the shaft, not nearer to the internal side, a trochlea for digit II decidedly more elongate than the trochlea for digit III.

Metatarsal I (fig. 1H): The articular surface for phalanx 1 is not laterally compressed as in modern owls. Its general shape is oval, rather broad, with a shallow median groove. The upper part, which is fastened to the tarsometatarsus by ligaments, lacks the pointed shape of Recent Strigiformes, but has the shape of a rounded knob.

Phalanx 1 of posterior digit I (fig. 3A, B, F, G, H, and I): This phalanx shares the same general features of Recent owls but is proportionally shorter and broader, with a broad proximal articular surface. At the proximal end, it shows a tubercle directed backward and situated on the internal side. At the distal part is present a deep, compressed, and narrow articular groove.

Phalanx 2 (claw) of posterior digit I (fig.

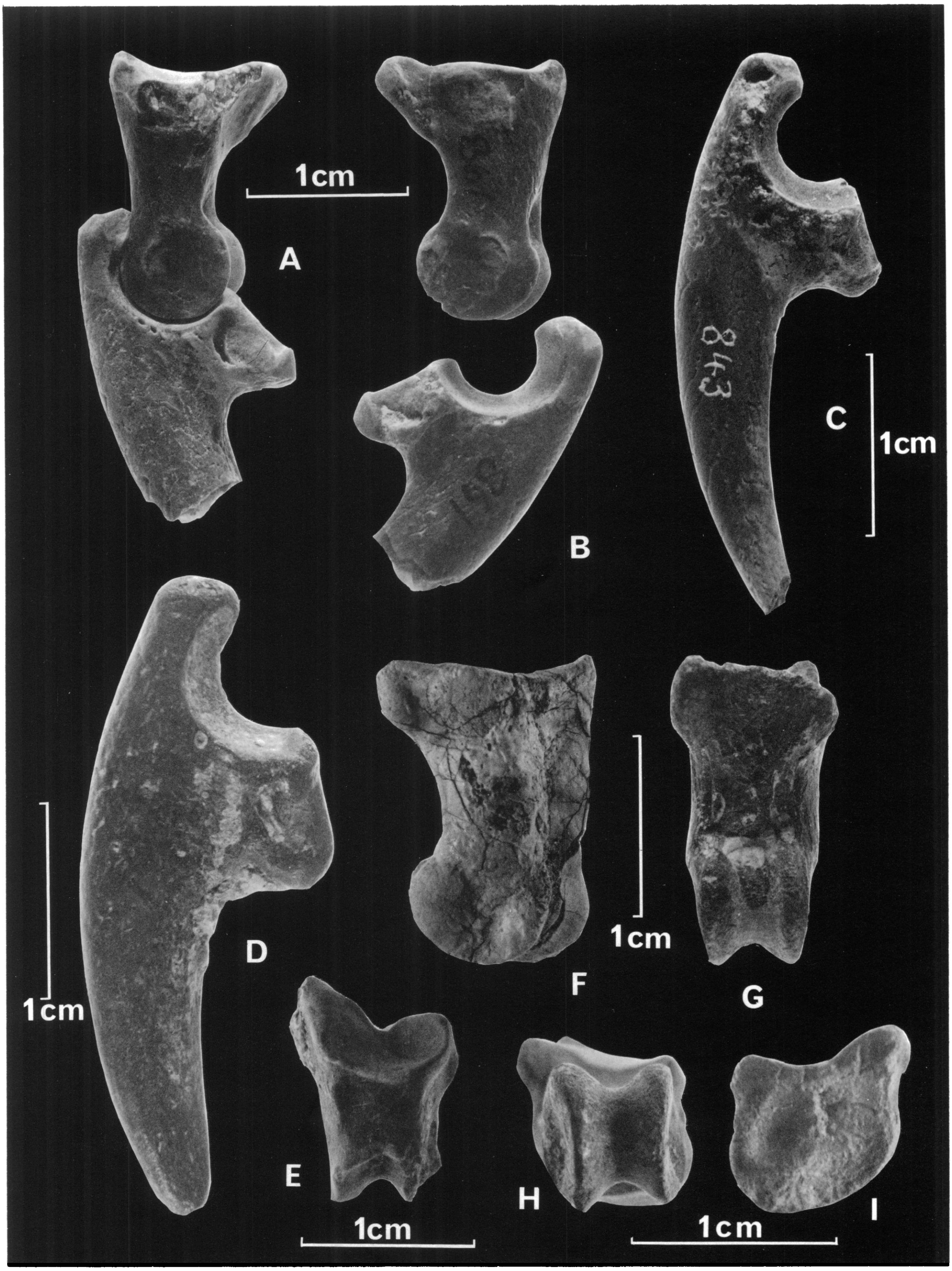

FIG. 3. *Minerva antiqua* Shufeldt, Peabody Museum Collection, Yale University. A. Phalanges 1 and 2 of posterior left digit I, articulated, no. 861, internal view. B. The same phalanges, external view. C. Phalanx 2 of posterior left digit I, no. 843, internal view. D. Phalanx 2 of posterior left digit I, no. 1026, internal view. E. Phalanx 1 of posterior left digit II, no. 861, anterior view. F. Phalanx 1 of posterior left digit I, no. 833, external view. G, H, and I. Phalanx 1 of posterior right digit I, no. 884: G. Posterior view. H. Distal view. I. Proximal view.

TABLE 1

***Minerva antiqua*, Measurements (in Millimeters) of the Claws**[a]

Measurement	AMNH 5163	AMNH 5164	AMNH 5165	YPM 833	YPM 843	YPM 846	YPM 847	YPM 857	YPM 858	YPM 861	YPM 1026
Phalanx 2 posterior digit I											
1. Preserved length	—	25.0	—	18.5	32.5	—	13.0	15.0	22.0	20.0	33.0
2. Proximal width	5.8	6.8	7.4	6.9	±6.5	—	6.5	6.2	6.5	6.3	6.5
3. Depth from apophysis extensoris to apophysis flexoris	14.7	15.8	14.4	16.3	15.3	—	15.9	—	—	16.7	17.2
4. Width below ap. flex.	—	4.7	5.0	—	4.8	—	—	4.5	4.5	5.0	5.4
5. Depth below ap. flex.	—	7.2	8.0	±8	6.7	—	—	6.7	6.6	7.4	8.3
											YPM 879
Phalanx 3 posterior digit II											
1. Preserved length	—	—	—	19.8	—	15.0	—	—	—	—	17.5
2. Proximal width	—	—	6.9	6.6	—	6.3	—	—	—	—	6.3
3. Depth from apophysis extensoris to apophysis flexoris	—	—	13.5	12.7	—	13.4	—	—	—	—	12.5
4. Width below ap. flex.	—	—	5.0	4.7	—	±5	—	—	—	—	4.4
5. Depth below ap. flex.	—	—	7.5	6.7	—	6.8	—	—	—	—	7.2
											YPM 869
Phalanx 4 posterior digit III											
1. Preserved length	—	—	—	12.5	—	—	—	—	—	—	15.4
2. Proximal width	—	—	—	5.2	—	—	—	—	—	—	5.2
3. Depth from apophysis extensoris to apophysis flexoris	—	—	—	—	—	—	—	—	—	—	11.0
4. Width below ap. flex.	—	—	—	5.4	—	—	—	—	—	—	6.1
5. Depth below ap. flex.	—	—	—	3.7	—	—	—	—	—	—	±4
Phalanx 5 posterior digit IV											
1. Preserved length	—	—	—	10.6	—	—	—	—	—	—	—
2. Proximal width	—	—	—	5.0	—	—	—	—	—	—	—
3. Depth from apophysis extensoris to apophysis flexoris	—	—	—	10.3	—	—	—	—	—	—	—
4. Width below ap. flex.	—	—	—	3.6	—	—	—	—	—	—	—
5. Depth below ap. flex.	—	—	—	5.2	—	—	—	—	—	—	—

[a] AMNH, Amer. Must. Nat. Hist., Dept. Vert. Paleont., New York. YPM, Yale Peabody Mus., New Haven.

TABLE 2
***Minerva antiqua*, Measurements (in Millimeters) of Other Phalanges**[a]

Measurement	AMNH 5163	AMNH 5165	YPM 833	YPM 846	YPM 861	YPM 871	YPM 884	YPM 886	YPM 892
Phalanx 1 posterior digit I									
1. Maximum length	16.4	18.8	18.2	19.4	17.1	–	16.9	–	17.7
2. Proximal width	8.9	9.6	±8.8	9.3	–	–	8.8	–	–
3. Proximal depth	10.5	–	±12	–	±11.7	–	10.3	–	–
4. Distal width	6.3	6.8	–	6.4	6.0	–	6.4	–	6.4
5. Distal depth	8.4	8.9	7.8	8.5	8.0	–	7.6	–	8.3
6. Width in the middle	6.9	7.4	–	6.9	6.3	–	6.7	–	6.7
7. Depth in the middle	5.9	5.9	–	5.8	5.5	–	5.4	–	6.0
Phalanx 1 posterior digit II									
1. Maximum length	–	13.4	–	–	13.5	±13	–	13.4	–
2. Proximal width	–	±9	9.4	–	9.5	9.4	–	9.5	–
3. Proximal depth	–	–	9.6	–	9.6	9.8	–	9.4	–
4. Distal width	–	–	–	–	±6.3	6.5	–	–	–
5. Distal depth	–	–	–	–	6.9	6.9	–	±7	–
6. Width in the middle	–	7.2	–	–	7.1	7.3	–	6.9	–
7. Depth in the middle	–	6.0	–	–	6.2	5.7	–	6.1	–
Phalanx 2 posterior digit II									
1. Maximum length	–	31.0	–	–	–	–	–	–	–
2. Proximal width	–	±8	–	7.9	–	–	–	–	–
3. Proximal depth	–	±8.6	±9	8.1	–	–	–	–	–
4. Distal width	–	6.6	6.0	–	–	–	–	–	–
5. Distal depth	–	7.2	7.1	–	–	–	–	–	–
6. Width in the middle	–	6.1	–	–	–	–	–	–	–
7. Depth in the middle	–	5.3	–	–	–	–	–	–	–

[a] AMNH, Amer. Mus. Nat. Hist., Dept. Vert. Paleont., New York. YPM, Yale Peabody Mus., New Haven.

3A, B, C, and D): This phalanx is characterized by the strong development of the apophysis extensoris over the articular surface which continues on to this process. The articular surface is strongly compressed laterally. The apophysis flexoris is not situated in the axis of the claw but obliquely. There is a sharp edge on the internal side of the ventral surface. In the modern owls the proximal part is also compressed, but the apophysis extensoris extends only slightly, the apophysis flexoris is symmetrical and situated in the axis of the claw, there is no edge, and the section of the body is elliptical. Finally, in *Minerva antiqua,* the claw of digit I is proportionally much stronger than in a modern strigid of comparable size.

Phalanx 1 of posterior digit II (fig. 3E): This phalanx is rather different from that of modern owls and looks rather similar to that in an Accipitriforme. In the modern owls, at the proximal end, there is a strong point, directed forward, and situated on the lateral side of the dorsal surface. Such a point does not exist in *Minerva.* In the modern owls, on the proximal part of the ventral surface, there are two points directed backward, a broad one on the internal side and a narrower one on the external side. In *Minerva* only the broad point on the internal side is found. The distal end appears rather similar in *Minerva* and modern owls, with a broad articular groove for the tendon of phalanx 2, but this groove is deeper anteriorly in *Minerva.* Proportionally, this phalanx is shorter in *Minerva* than in Recent Strigiformes.

Phalanx 2 of posterior digit II: In *Minerva* this phalanx resembles the corresponding one of Recent strigids, but at the distal end the articular groove is shallower and the phalanx is proportionally more elongated.

Phalanx 3 (claw) of posterior digit II: This

TABLE 3
***Minerva antiqua*, Measurements (in Millimeters) of Tibiotarsus**[a]

Measurement	AMNH 5165[b]	YPM 833	YPM 861
1. Distal width	15.9	15.8	—
2. Maximal depth of internal condyle	13.1	12.8	±12
3. Maximal thickness of internal condyle	6.3	6.8	±6
4. Maximal depth of external condyle	12.8	—	—
5. Maximal thickness of external condyle on anterior face	4.1	4.9	—
6. Width of anterior intercondylar fossa	4.6	4.1	—
7. Width of posterior intercondylar fossa	8.3	±7	±8

[a] AMNH, Amer. Mus. Nat. Hist., Dept. Vert. Paleont., New York. YPM, Yale Peabody Mus., New Haven.
[b] Type of *Protostrix lydekkeri.*

phalanx resembles a normal one of modern Strigiformes, as the apophysis extensoris does not form a projecting hook as in digit I. However, it is more laterally compressed and the apophysis flexoris shows a more prominent median ridge. On the ventral surface there is a flattened part, with an edge on each side, also more marked than in Recent owls.

Other phalanges: The other phalanges are represented only by little fragments. The claws of digit III are recognizable by the presence of an edge on one of the sides; in the modern owls this edge is on the internal side. The claw of digit IV is represented by a proximal part. These claws of digits III and IV are more laterally compressed and proportionally much more reduced than the corresponding ones of Recent strigids.

CONCLUSIONS

The different elements of the skeleton of *Minerva antiqua* are comparable in size to those of the great horned owl, *Bubo virginianus,* or slightly smaller, but the relative proportions of the toes are very different. The digit I of *Minerva* must have been much stronger, the digit II must have been about the same size as in *Bubo,* but with a shorter phalanx 1 and a longer phalanx 2, whereas the digits III and IV must have been much weaker. This can be correlated with an adaptation perhaps for hunting a certain type of prey and catching it between the claws of digits I and II, or maybe for burrowing in the ground by using more particularly the two claws of the digits I.

Minerva antiqua must have been widespread during the Eocene. If one takes into account the more largely represented elements and the different localities, one finds a minimal number of nine individuals. *Minerva antiqua* might have been abundant at the time when the Bridger Formation was deposited, but the abundance might also be correlated with a particular process of fossilization.

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