

## A New Eagle (Aves: Accipitridae) from the Mid Miocene Bullock Creek Fauna of Northern Australia

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**ABSTRACT.** A large accipitrine bird of prey is described from the Mid Miocene Camfield Beds, Bullock Creek, Northern Territory, Australia, based on a distal humeral fragment. Comparisons with the larger living Australian eagles show that this bird belongs in *Aquila* rather than *Haliaeetus*. It can be differentiated from living species of *Aquila* by morphology and size, and is here named as a new fossil species. This specimen comprises the oldest record of this genus in Australia, and possibly the oldest in the world.

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The Accipitridae has a relatively rich fossil history worldwide. In Australia, named fossil taxa are restricted to *Pengana robertbolesi* from the Early Miocene (Boles, 1993) and several species described from the Quaternary by C.W. de Vis (1890, 1891, 1892, 1905). Other accipitrids are known (Vickers-Rich, 1991) but await detailed examination. This paper describes a new eagle species from the Accipitridae from the Camfield Beds, Bullock Creek, Northern Territory (Fig. 1). It is part of the Bullock Creek Fauna. These deposits are considered to be Mid Miocene in age (Murray & Megirian, 1992).

### Methods

Anatomical nomenclature follows Baumel & Witmer (1993) and Owre (1967) for identification of muscles insertions on the distal end of the humerus. Measurements follow the methods illustrated by von den Driesch (1976) and were made with vernier calipers accurate to 0.05 mm and rounded to the nearest 0.1 mm. The fossil is lodged in the Queen

Victoria Museum and Art Gallery, Launceston, Tasmania (QVM); comparative material was examined at, or borrowed from, Museum Victoria, Melbourne, Australian Museum, Sydney; and Australian National Wildlife Collection, Canberra. Higher level taxonomy of the Accipitridae follows Lerner & Mindell (2005).

### Comparative material

The Bullock Creek accipitrid is a large-bodied animal, exceeding in size all extant Australian taxa except those in the genera *Aquila* and *Haliaeetus*. Comparisons of the specimen were made with Australian and extralimital species of these genera and of *Hieraetus*, sister genus to *Aquila* and also represented in Australia. Lerner & Mindell (2005) and Helbig *et al.* (2005) found that *Aquila* and *Hieraetus*, as conventionally circumscribed, were polyphyletic relative to each other. Some authors (e.g., Sangster *et al.*, 2005) synonymized the two genera. Louchart *et al.* (2005) found it

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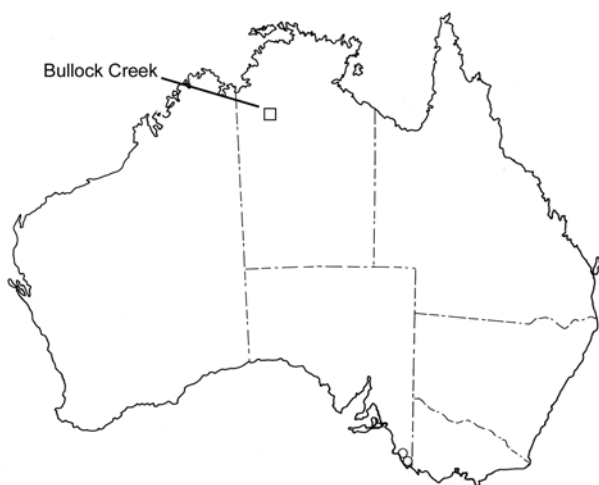


Figure 1. Location of Bullock Creek, Northern Territory, type location of *Aquila bullockensis*.

difficult to separate members of these genera osteologically. Although it is likely that they will be combined, here they are kept separate for ease of reference in the text. The only species examined in this study that is affected by this change is *Hieraaetus fasciatus*, which becomes *Aquila fasciata*. Although living species of *Hieraaetus* are considerably smaller than the fossil, it was shown by Bunce *et al.* (2005) that the recently extinct New Zealand “*Harpagornis moorei*”, considerably larger than any extant species of accipitrid, should be placed in *Hieraaetus*.

Although no detailed evidence has been presented, the suggestion has been made that among the undescribed birds of prey are Old World vultures (Rich & van Tets, 1982; van Tets & Rich, 1990). This title applies to two non-sister clades of accipitrids, Gypaetinae and Aegyptiinae, neither of which occurs in Australia today. Owing to this previous suggestion, representatives of both were included in the comparisons, as was the Osprey (*Pandion haliaetus*: Pandionidae), sister taxon of the Accipitridae.

The following species were used for comparison in this study: (Aegyptiinae) *Necrosyrtes monachus*, *Gyps fulvus*, *G. coprotheres*, *Sarcogyps calvus*, *Aegypius monachus*, (Gypaetinae) *Neophron percnopterus*, (Aquilinae) *Aquila audax*, *A. chrysaetos*, *A. fasciata*, *Hieraaetus morphnoides*, *H. pennatus* and (Haliaetinae) *Haliaetus leucogaster*, *H. albicilla* and *H. leucocephalus*, Pandionidae (*Pandion haliaetus*).

## Systematic paleontology

### Family Accipitridae (Vigors, 1824)

The Bullock Creek humerus can be distinguished from that of both groups of Old World vultures because it possesses a shallower fossa m. brachialis, more bulbous processus flexorius and a relatively broader condylus dorsalis. *Pandion* differs by its reduced epicondylus dorsalis, more excavated fossa m. brachialis, narrower fossa olecrani and narrower condyles. The two species of *Hieraaetus* examined show almost no differences from species of *Aquila*. Other than a somewhat more pronounced gap between the processus flexorius and condylus ventralis (in

distal view), the only significant character is one of size (see also Louchart *et al.*, 2005).

Species of *Aquila* (based on *A. audax*, *A. chrysaetos* and *A. fasciata*) and *Hieraaetus* (*H. morphnoides* and *H. pennatus*) can be distinguished from those of *Haliaetus* (*H. leucogaster*, *H. leucocephalus*) by the same suite of distal humeral characters (Fig. 2): (1) the ventral side of the distal end, including the epicondylus ventralis, projects further ventrally, in cranial view, (2) the fossa olecrani is shallower (deeper, more defined in *Haliaetus*); (3) the scar for M. pronator superficialis (proximal to the tuberculum supracondylare ventrale) is deeper and more circular (slightly shallower, less defined circle); (4) the incisura intercondylaris is excavated distally, in cranial view (not visible in specimen of *A. fasciata*) (not excavated); (5) the processus flexorius is round and protruding distally in cranial view and caudally in medial view (base less rounded, not projecting as far distally or medially); (6) the tuberculum supracondylare ventrale is attenuated proximodorsally (rounded dorsally); and (7) the ratio of shaft width to distal width is less (greater) (Table 1; Fig. 3).

The Bullock Creek humerus agrees with those of extant species of *Aquila* in all these character states. It more closely resembles these species than those of *Hieraaetus morphnoides* and *H. pennatus* by having a reduced gap between the processus flexorius and condylus ventralis. Accordingly, the fossil is assigned to *Aquila*.

### Genus *Aquila* Linnaeus, 1758

The Bullock Creek taxon can be distinguished from the extant species *A. audax*, *A. chrysaetos* and *A. fasciata* on differences in size and morphology applicable to all three. It is therefore assigned to a new species.

### *Aquila bullockensis* n.sp.

Fig. 4

**Holotype.** distal end of right humerus, QVM:2000:GFV:154.

**Locality and stratigraphy.** Bin 23, Bullock Creek (Fig. 1); Camfield Beds.

**Age.** Mid-Miocene, 11–5mya.

**Etymology.** Bullock Creek is the type locality, and “ensis” (Latin) means “belonging to”.

**Diagnosis.** The Bullock Creek humerus is distinguished from *Aquila audax*, *A. chrysaetos* and *A. fasciata* by the following features:

The tuberculum supracondylare ventrale is flat in the fossil, but sits along the side of a raised shelf in *A. audax*, *A. chrysaetos* and *A. fasciata*, making the latter taxa relatively craniocaudally deeper compared to the length of the processus flexorius.

The two attachments of M. extensor metacarpi radialis proximal of the epicondylus dorsalis lie adjacent to each other in a dorsoventral line nearly perpendicular to the long axis of the shaft. In *A. audax* and *A. chrysaetos*, both pits are prominent and separate. In the fossil and *A. fasciata*, there is a single pit dorsally and a rugose scar ventrally.

The sulcus scapulothoracicus is deeper than in *A. audax* and *A. chrysaetos* because the dorsal bordering ridge is more strongly developed. The condition in *A. fasciata* is similar to that of the fossil, although this may be size related.

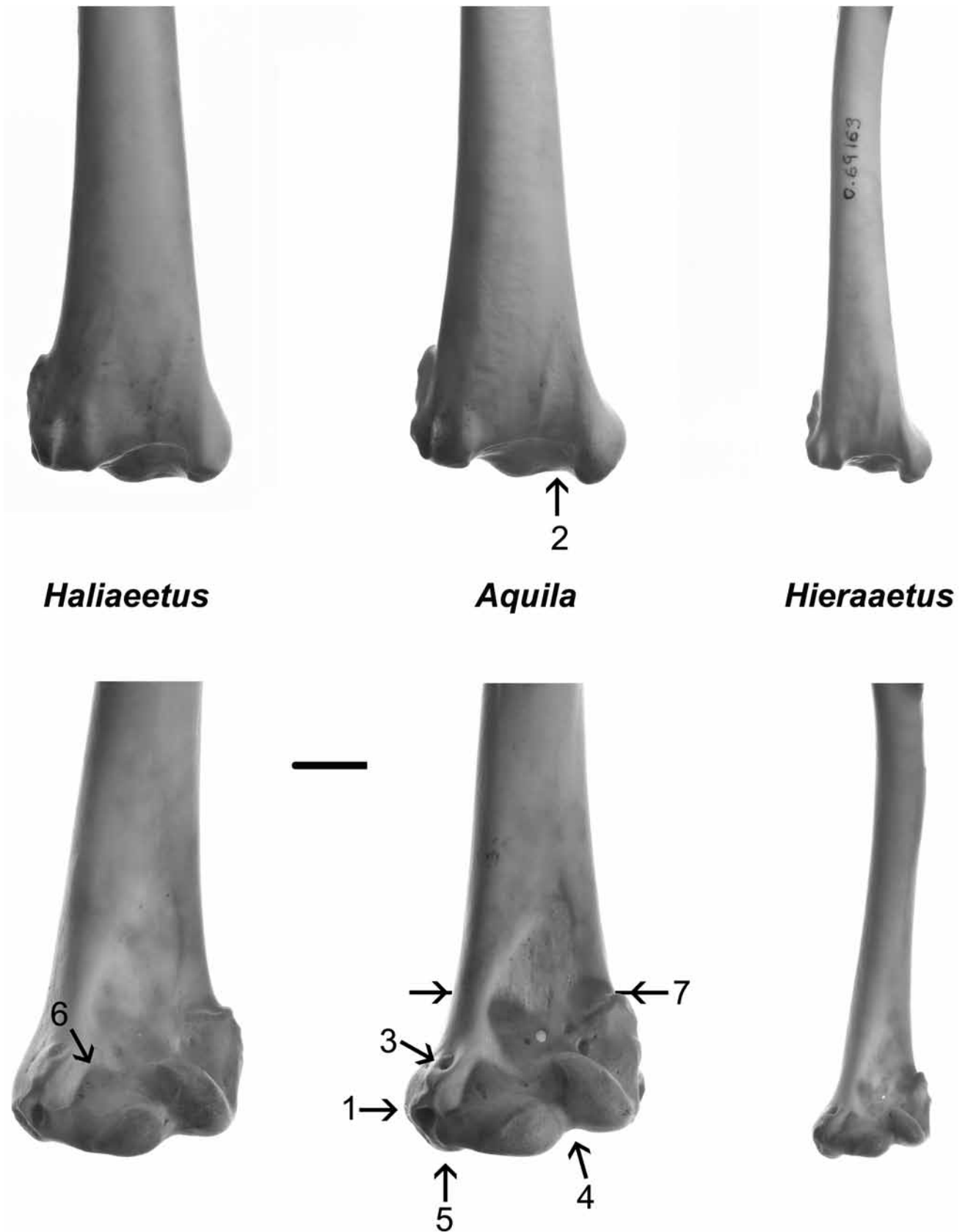


Figure 2. Distal humeri of extant Australian eagles; upper, caudal view; lower, cranial view. (A), *Haliaeetus leucogaster*. (B), *Aquila audax*. (C), *Hieraaetus morphnoides*. Bar equals 10 mm. Numbers refer to characters used to separate *Haliaeetus* from *Aquila-Hieraaetus* (see text). Character 7 show the points at which the shaft width measurement was taken proximal of the epicondylus dorsalis.

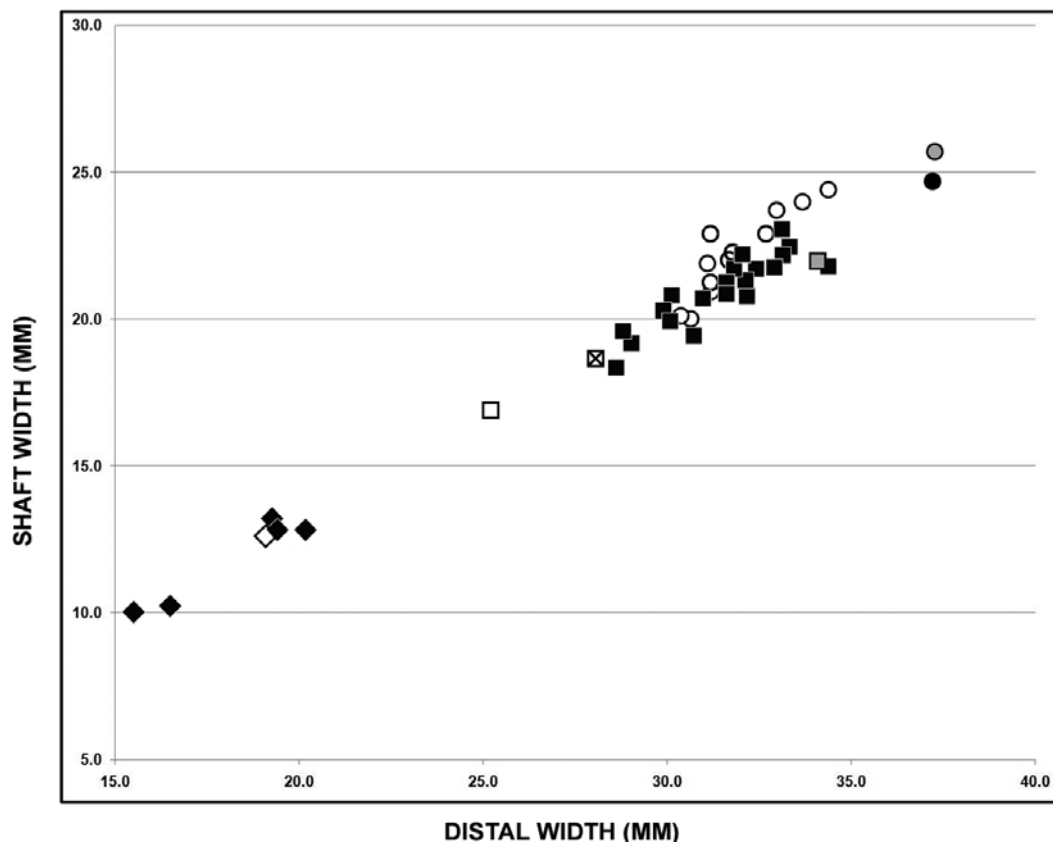


Figure 3. Shaft and distal widths (mm) of Bullock Creek humerus compared to those of extant eagles. Squares, *Aquila*: crossed, *A. bullockensis*; black, *A. audax*; grey, *A. chrysaetos*; open, *A. fasciata*. Diamonds, *Hieraaetus*: black, *H. morphnoides*; open, *H. pennatus*. Circles, *Haliaeetus*: black, *H. albicilla*; grey, *H. leucocephalus*; open, *H. leucogaster*.

The epicondylus dorsalis in the fossil does not project as far dorsally as in *A. audax*, *A. chrysaetos* and *A. fasciata*.

The fossil is smaller than specimens of *A. audax* and *A. chrysaetos*, but larger than that of *A. fasciata* examined here (Table 1; Fig. 3). Louchart *et al.* (2005) provided distal width measurements for several living species of *Aquila*. In this feature, *A. bullockensis* is larger than *A. fasciata* and *A. rapax* (Tawny Eagle) and smaller than *A. chrysaetos* and *A. heliacaladelberti* (Spanish/European Imperial Eagles). It is in the range of *A. nipalensis* (Steppe Eagle). The distal depth of the humerus of *A. bullockensis* (14.1 mm) is well outside the range of *A. nipalensis*, as given by Louchart *et al.* (2005) (14.9–16.5 mm; n = 5). As many species of the Accipitridae in general, and *Aquila* in particular, display sexual dimorphism, however, size is not useful in distinguishing between taxa, and the fossil is only somewhat smaller than the smallest individuals of *A. audax*.

### Description

Measurements: distal width 27.7 mm; width of shaft proximal to epicondylus dorsalis 18.5 mm; greatest width of brachial depression 9.4 mm; distal depth through condylus dorsalis 14.1 mm. The specimen preserves the distal end of the humerus, with the shaft broken above the fossa m. brachialis. In lateral view, the shaft is anteroposteriorly curved. In addition to those cited above, the fossil has the following features. The fossa m. brachialis is round

and deep distally, and pointed proximally. The incisura intercondylaris is deep, narrow, and distally excavated in cranial view. The scars for M. pronator profundus and M. flexor carpi ulnaris on the epicondylus ventralis lie side by side; the former is noticeably deeper. In caudal view, the sulcus humerotricipitalis is shallow and wide. The sulcus scapulotricipitalis is narrow, with both sides of the groove at equal height in distal view. The fossa olecrani is shallow. In caudal view, the processus flexorius is bulbous, extending laterally from the shaft (Fig. 4).

### Discussion

Milne-Edwards (1871, 1892) described several species that he placed in *Aquila*. These were subsequently moved by Lambrecht (1933) to a new genus, *Aquilavus*. Since then, a number of fossils have been initially described in *Aquila*, with many since transferred to other genera, some not even in the Accipitridae. Of those paleospecies that appear correctly assigned, the oldest are *A. delphinensis* and *A. pennatoides*, both described by Gaillard (1938) from Middle/Late Miocene deposits of Grive-Saint-Alban, France. *Eutolmaëtus edwardsi* Sharpe, 1899 (= the original name, *Aquila minuta* Milne-Edwards, 1871, is preoccupied), from Middle-?Late Miocene of SW Europe belongs to either *Aquila* or *Hieraaetus*. Younger species are *A. bivia* (Late Pliocene of southern United States; Emslie & Czaplewski, 1999) and ?*Aquila fossilis* (Middle/Late Pleistocene of Monte Reale, Sardinia, Italy; Giebel, 1847). There are also



Figure 4. Distal right humerus of *Aquila bullockensis* (holotype QVM:2000:GFV:154). Left, caudal view; right, cranial view. Bar equals 10 mm.

**Table 1.** Distal width (DW) and shaft width (SW) measured just proximal of the processus epicondylus dorsalis (mm) and the ratio SW:DW for the fossil and extant species of *Aquila*, *Hieraaetus* and *Haliaeetus*.

	n	distal width		shaft width		ratio SW:DW	
		range	mean±sd	range	mean±sd	range	mean±sd
<i>Aquila bullockensis</i>	1	27.7		18.5		0.67	
<i>Aquila fasciata</i>	1	25.2		16.9		0.67	
<i>Aquila chrysaetos</i>	1	34.1		22.0		0.65	
<i>Aquila audax</i>	23	28.6–34.4	31.3±1.5	18.4–23.1	20.9±1.2	0.63–0.70	0.67±0.02
<i>Hieraaetus morphnoides</i>	5	15.5–20.4	18.2±2.1	10.0–13.2	11.8±1.6	0.62–0.68	0.65±0.03
<i>Hieraaetus pennatus</i>	1	19.1		12.6		0.66	
<i>Haliaeetus leucogaster</i>	12	30.4–33.7	31.9±1.3	20.0–24.4	22.2±1.5	0.66–0.73	0.69±0.02
<i>Haliaeetus leucocephalus</i>	1	37.2		24.7		0.66	
<i>Haliaeetus albicilla</i>	1	37.3		25.7		0.69	

identifications of pre-Quaternary fossils only to generic level (*Aquila* sp.) from the Miocene and Pliocene of several sites in Europe (Salotti *et al.*, 2000; Mlíkovský, 2002). Fossil Pleistocene taxa of *Aquila* were discussed by Louchart *et al.* (2005). Unfortunately, none of the Tertiary paleospecies is represented by a humerus, and therefore it is not possible to compare the Bullock Creek fossil with any these.

Whether *A. bullockensis* represents an ancestor to *A. audax* is a matter for speculation with such limited fossil material. It comprises the oldest record of this genus in Australia, and possibly the oldest in the world. Other accipitrine material is known from the Camfield Beds deposits, but has not yet been studied. At least one specimen, an ulna, may represent this taxon.

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