PALÆO VERTEBRATA

New remains of the very small cuckoo, *Chambicuculus pusillus* (Aves, Cuculiformes, Cuculidae) from the late Early or early Middle Eocene of Djebel Chambi, Tunisia

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Abstract: A very tiny cuckoo, *Chambicuculus pusillus*, was recently described after a few fragments of tarsometatarsi from the late Early/early Middle Eocene of Djebel Chambi, Tunisia. New remains, notably a coracoid, confirm the attribution of this genus to the family Cuculidae. This coracoid shows a very elongate and strap-like processus procoracoideus. This morphological feature is present in some recent or extinct taxa but it is more developed in the family Cuculidae. The characteristics of the coracoid and tarsometatarsi show that *Chambicuculus* is morphologically more advanced over the other stem cuculids described in Europe and North America. *Chambicuculus* is the oldest Cuculidae known so far.

Keywords: Fossil bird, Eocene, Cuckoos

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INTRODUCTION

The Paleogene avifauna is still very poorly known in the whole of the African continent. Marine birds are known in the Late Paleocene and the Early Eocene of the phosphate Ouled Abdoun Basin in Morocco. They belong to the Odontopterygiformes (pseudo-toothed birds), the Prophaethontidae and possibly the Phaethontidae (tropicbirds) (Bourdon, 2006; Bourdon *et al*., 2005, 2008a, 2008b, 2010). Odontopterygiformes are also known in the Middle Eocene of Nigeria (Andrews, 1916) and Togo (Bourdon & Cappetta, 2012).

As far as terrestrial birds are concerned, the locality of Glib Zegdou in Algeria, dated from the late Early to early Middle Eocene, has yielded the femur of a bird related to the family Phorusrhacidae, *Lavocatavis africana* (Mourer-Chauviré *et al*., 2011b). The Phorusrhacidae were giant flightless birds mainly known in South America. In Namibia, the locality of Silica South, previously dated from the early Middle Eocene, now considered as late Middle Eocene (Bartonian) (Pickford *et al*., 2014), has yielded the remains of a stem galliform, *Namaortyx sperrgebietensis* (Mourer-Chauviré *et al*., 2011a). Also situated in Namibia, and also dated from the late Middle Eocene, the locality of Eocliff has yielded several remains of a galliform, *Scopelortyx klinghardtensis*, and of a psittaciform, *Namapsitta praeruptorum* (Mourer-Chauviré *et al*., 2015). Unlike the galliforms from Chambi and Silica South, the familial position of which is unknown, *Scopelortyx* belongs to the extinct family Paraortygidae, which was widespread in the northern hemisphere during the Late Eocene to the Oligocene in Europe and North America (Mourer-Chauviré *et al*., 2015).

In the Late Eocene and Early Oligocene localities of the Fayum, Egypt, the avifauna is more diversified and includes birds that can be attributed to 14 orders or families, including two extinct endemic African families, Eremopezidae and Xenerodiopidae (Rasmussen *et al*., 1987, 2001; Stidham & Smith, 2015). Most of the families present in the Fayum deposits correspond to aquatic birds such as cormorants, shoebills, herons, storks, jacanas, rails, cranes, and flamingos.

In Tunisia the localities of Chambi 1 and Chambi 2, dated from the late Early to early Middle Eocene as the locality of Glib Zegdou, have yielded the remains of a small stem galliform, family incertae sedis, *Chambiortyx cristata*, and of a representative of the family Cuculidae, *Chambicuculus pusillus* (Mourer-Chauviré *et al*., 2013). New bird material has recently been extracted from the lacustrine limestones of Chambi 1 and can be ascribed to the same very small cuculiform. This form was previously known only by three distal fragments of tarsometatarsi. The new material not only includes two very incomplete distal fragments of tarsometatarsi, but also an omal part of coracoid and a proximal part of femur. The size of the coracoid and femur, which are very small, matches the size of the tarsometatarsi, which correspond to a very tiny bird. The presence of the coracoid is crucial and substantiates the attribution of the genus *Chambicuculus* to the family Cuculidae.

MATERIAL AND METHODS

The anatomical terminology follows Baumel & Witmer (1993).

The fossil material is deposited in the collection of the "Office national des Mines de Tunis", Tunisia. Marivaux *et al*. (2015) have recently synthetized our current knowledge of the Chambi vertebrate fauna.

SYSTEMATIC PALEONTOLOGY

Order Cuculiformes Wagler, 1830

Family Cuculidae Leach, 1820

Chambicuculus pusillus Mourer-Chauviré *et al*., 2013

The new material includes the following remains: CBI-1-561 Left coracoid, omal part; CBI-1-562 Right femur, proximal part; CBI-1-563 Distal fragment of shaft of right tarsometatarsus, with trochlea metatarsi IV; CBI-1-564 Distal fragment of shaft of left tarsometatarsus, with trochlea metatarsi III.

Description and comparisons

The coracoid (Fig. 1)

In the members of the family Cuculidae, the coracoid shows a processus procoracoideus that is wide and flattened in dorsoventral direction, and strongly developed in mediolateral direction. This processus is particularly developed in the recent genus *Cuculus*, but also in the other genera of this family (Fig. 2). It tends to come closer to the processus acrocoracoideus. Two families were previously included in the order Cuculiformes, the Cuculidae (cuckoos) and the Musophagidae (turacos), but phylogenetic analyses based on genomic sequence data show that these two families belong to two different orders, the Cuculiformes and the Musophagiformes (Jarvis *et al*., 2014). In the musophagiform coracoid the processus procoracoideus fuses with the processus acrocoracoideus, thereby forming a ring which surrounds the sulcus m. supracoracoidei.

On the Chambi coracoid the foramen nervi supracoracoidei is absent, the cotyla scapularis is a shallow depression, the processus acrocoracoideus ends in sternal direction in a small point, and there is no pneumatic foramen under the medial ledge of the processus acrocoracoideus. All these morphological characteristics are present in the family Cuculidae. The processus procoracoideus ends in medial direction in two lobes, a small one in omal direction, and a wider one in medial direction.

The femur (Fig. 1)

The femur CBI-1-562 does not show many particular morphological characteristics. The femoral head is relatively small and medially projecting. The crista trochanteris does not run beyond the facies articularis antitrochanterica in proximal direction, but it is projecting in dorsal direction. These characteristics are present in the Cuculiformes and differ from the Musophagiformes. In the recent turacos the femoral head is wider, stouter, and less projecting medially, and the crista trochanteris, slightly projecting proximally, shows a pneumatic foramen on the dorsal surface.

The fragments of tarsometatarsi

These fragments show the same characteristics as the fragments CBI-1-541 and CBI-2-1001, upon which the description of *Chambicuculus pusillus* was based (Mourer-Chauviré *et al*., 2013).

Measurements (in mm)

Coracoid: length as preserved, 5.5; proximal width from the facies scapularis to the tip of processus procoracoideus, 2.6; with of shaft, 0.9.

Femur: length as preserved, 7.3; proximal width, 2.9.

Comparisons with stem Cuculidae and related forms

The genus *Eocuculus* Chandler, 1999, has been attributed to Cuculidae by Chandler (1999) and considered as ?Cuculidae by Mayr (2006). It is known by the species *Eocuculus cherpinae*, from the Late Eocene of North America (USA; Chandler, 1999) and *Eocuculus* cf. *cherpinae*, from the Early Oligocene of France (Mayr, 2006). The coracoid is known in a specimen on a slab, which is tentatively referred to *Eocuculus*, and which comes from the same area as *Eocuculus* cf. *cherpinae* (Mayr, 2008). On this specimen the processus procoracoideus is long and narrow, but on the slab its medial extremity is covered by the proximal part of the humerus and it is not possible to see whether the processus was as elongate as in *Chambicuculus* (Mayr, 2008, fig. 4, A and D). The coracoid is unknown in *Neococcyx mccorquodalei*, from the Late Eocene (Mayr, 2009) of Canada (Weigel, 1963), but it is known in *Cursoricoccyx geraldinae*, from the Early Miocene of Colorado (Martin & Mengel, 1984). In this species the processus procoracoideus is long but not as extensive as in *Chambicuculus*. The shape of the processus acrocoracoideus is similar to that of the members of the recent subfamily Neomorphinae, while in *Chambicuculus* this shape is identical to that of the members of the recent subfamily Cuculinae.

The very tiny bird, *Pumiliornis tessellatus*, from the Early Eocene (Lenz *et al*., 2015) of Messel, Germany, was previously considered as related to the genus *Eocuculus* (Mayr, 2008; 2009;

Figure 1. *Chambicuculus pusillus*, **a-b**: left coracoid, omal part, CBI-1-561, dorsal view (a) and ventral view (b); **c-d**: right femur, proximal part, CBI-1-562, dorsal view (c) and ventral view (d). Scale bars = 1 mm.

2011). But, according to new data, *Pumiliornis* is no longer considered to be close to Cuculiformes but it is considered as a stem group representative of Psittacopasseres, the clade including Psittaciformes and Passeriformes (Mayr, 2015). The coracoid of *Pumiliornis* shows a processus procoracoideus wide in omosternal direction, and medially elongate, but not as elongate as in *Chambicuculus* (Mayr, 1999, fig. 4, b-c; 2008, fig. 4, E; 2011, fig. 2, C). In addition it shows on the ventral side of the omal part "an elevation of approximately triangular shape" (Mayr, 1999: 78) a character which is not observed in *Chambicuculus*.

DISCUSSION

Chambicuculus is older than the other extinct forms of Cuculiformes known so far. Its tarsometatarsus shows a canalis interosseus distalis covered by a roof on the dorsal surface, which is a plesiomorphic characteristic (Mayr *et al*., 2003). In the modern Cuculidae, this canalis is not roofed, but dorsally open. However this tarsometatarsus also shows an apomorphic characteristic, i.e. the presence of a sehnenhalter, or trochlea accessoria, on the trochlea metatarsi IV. This sehnenhalter, well-developed, plantarly and slightly medially oriented, indicates that *Chambicuculus*, like the present-day Cuculidae, was zygodactyl. With the exception of its plesiomorphic canalis interosseus distalis, *Chambicuculus* appears more advanced than the more recent genus *Eocuculus*. In *Eocuculus*, indeed, the foot was not zygodactyl but probably only semizygodactyl. In addition, in *Eocuculus* the trochlea metatarsi IV extends as far distally as the trochlea metatarsi II, and it reaches the mid-section of the trochlea metatarsi III, while in the living Cuculidae, and in *Chambicuculus*, the trochlea metatarsi IV is situated more proximally than the base of the trochlea metatarsi III and it is much shorter than the trochlea metatarsi II.

The shape of the coracoid, especially the strap-like and medially elongate processus procoracoideus (very similar to that of the modern Cuculinae) is also a derived characteristic of the family Cuculidae (Fig. 2). In some other groups of extinct or recent birds there is also a processus procoracoideus strongly developed and extending medially, as for example in some Zygodactylidae (Mayr, 1998, pl. 7, fig. 12), in some Upupiformes (Phoeniculidae), in some Alcediniformes (Meropidae), in the Coraciiformes s. s. (Coraciidae and Brachypteraciidae) or in some Piciformes (Galbulae), but it is more medially elongate in the Cuculidae than in any of these groups. This indicates that, as early as in the Early or Middle Eocene, the Cuculidae had acquired some of their morphological characteristics, and that the here described African form was more derived than the more recent forms known in Europe and North America. *Chambicuculus* is the earliest member of the family Cuculidae known so far.

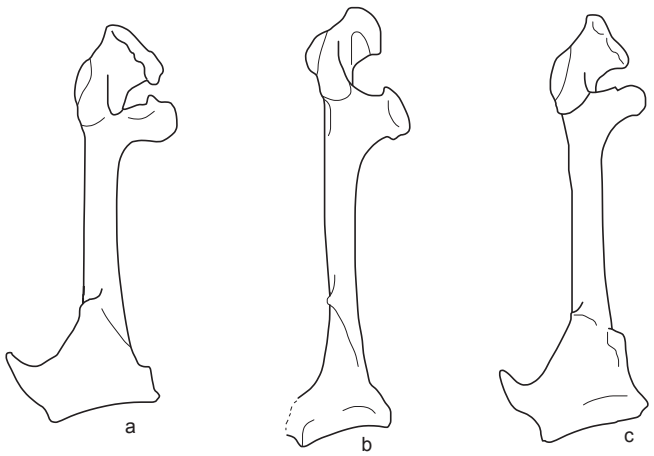

Figure 2. Left coracoids of recent Cuculidae, in dorsal view. **a**: *Cuculus canorus*; **b**: *Centropus senegalensis*; **c**: *Clamator glandarius*.

Cuculiformes represent a very ancient group of birds. Phylogenetic analyses based on genomic sequence data suggest that Cuculiformes belong to the same clade as Musophagiformes and Otidiformes (Jarvis *et al*., 1914; Prum *et al*., 2015). The lineages leading to these three groups would have diverged shortly after the Cretaceous/Palaeogene boundary (Jarvis *et al*., 2014), or during the Palaeocene (Prum *et al*., 2015). The fossil record of the Cuculidae is poor but the occurrence of a cuculid in the Early to Middle Eocene confirms the great antiquity of this family.

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