New Chrysochloridae (Mammalia) from the middle Eocene of Black Crow, Namibia

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Abstract: Among the fossils extracted from middle Eocene freshwater limestone at Black Crow, Namibia, are a lower molar and a maxilla with three teeth that are interpreted to belong to a primitive Chrysochloridea (Golden Moles). The specimens are too small to belong to *Diamantochloris inconcessus* but are similar in dimensions to a previously listed but un-named chrysochlorid tooth from the site. The material is here attributed to a new genus and species and its significance for understanding the homogeneity of Afrotheria is discussed.

Key words: Golden mole, New genus, New species, Ypresian/Lutetian, Sperrgebiet

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Introduction

In previous papers on Chrysochloridea from Black Crow, Namibia, allusion was made to a second Golden Mole species in the deposits which is smaller than *Diamantochloris inconcessus* Pickford (2015b, 2018a). The small form was left in open nomenclature in the hope of recovering additional material.

The 2019 campaign of acid treatment of limestone from Black Crow resulted in the recovery of several mandibles and maxillae of small mammals, among which there is a maxillary specimen containing three cheek teeth which is here interpreted to belong to this un-named species of fossil golden mole. There is also a small m/3 which is compatible in dimensions and occlusal morphology with the maxillary teeth.

The new material is described and its relationships to other golden moles is interpreted.

Geological context

The geological setting of the Black Crow freshwater limestone has been described on several occasions (Pickford *et al*. 2008a, 2008b, 2014; Pickford, 2015a). Fossils are dispersed rather randomly in the limestone without forming concentrations or fossil-rich layers. The fossils comprise both aquatic and terrestrial taxa, crocodiles dominating in terms of numbers of specimens (mostly isolated teeth) but mammal specimens tend to be more complete. Among the molluscs, only land snails have been found, suggesting a palustral setting which was for some reason (alkalinity?) unsuitable for freshwater snails. There are abundant rhizoliths preserved in the limestone and there are occasional layers of silicified algal mats.

Material and methods

Blocks of limestone from Black Crow were bathed in 7% formic acid without buffer. Once the fossils had been extracted from the limestone they were rinsed in fresh water for 24 hours, dried and consolidated with a solution of plexigum dissolved in acetone. Images were obtained using a Sony Cybershot camera by placing the lense over the eyepieces of a stereo microscope and treating the images with Photoshop Elements15 to increase contrast and remove unwanted background. Scales were added manually.

Abbreviations

BC - Black Crow (Sperrgebiet, Namibia)
GSN - Geological Survey of Namibia, Windhoek

Systematic Palaeontology

Order Chrysochloridea Broom 1915

Family Chrysochloridae Gray 1825

Genus *Damarachloris* nov.

Diagnosis: Protocone of P4/ and upper molars mesio-distally compressed and supported on a large ovoid root, metacone and paracone close to each other, but separated at their apices, metacone much smaller than paracone, metaconule and paraconule suppressed, parastylar hook short, depressions in palate between the protocones of the upper cheek teeth. Anterior margin of orbit above the M1/. Infra-orbital foramen opens above the mesial root of P4/. Post-palatine torus present. Smaller than *Diamantochloris inconcessus*. Trigonids of lower molars strongly mesio-distally compressed. Precingulid of lower molars well-developed and steeply inclined. Talonids of lower molars large comprising three cusplets (hypoconid, hypoconulid and entoconid). Lower molars with two conical roots tilted at different angles. Distal roots of lower molars more robust than mesial roots.

Etymology: The genus name refers to '*Damara'* a region and ethnic group in Namibia and '*Chloris'* Greek Goddess of flowers (hence the greenish connotations of the name, equivalent to the Latin '*Floris'*).

Species *Damarachloris primaevus* nov.

Holotype: GSN BC 2'19, right maxilla containing P4/-M2/, part of the distal alveolus of P3/ and three alveoli of M3/.

Paratypes: GSN BC Di 2'17, left m/2 (Pickford, 2018a); GSN BC 5'19, right m/3.

Diagnosis: As for genus. Length M1/-M3/ measured at protocones : 3 mm, measured at buccal sides of teeth : 3.3 mm.

Etymology: '*Primaevus'* : Latin for «*primitive*», «*original*», «*first born*» in allusion to the proposition that this the earliest known chrysochlorid in the fossil record.

Description

GSN BC 2'19 is a right maxilla containing P4/-M2/, the alveoli of M3/ and a partial alveolus for the P3/ (Fig. 1). The infra-orbital foramen is large and is located above the anterior root of the P4/. The orbital rim is partly preserved above the molar row, but the anteriormost part of the margin is missing. The distance between the orbit and the infra-orbital foramen is short (ca 2.5 - 3 mm). The root of the zygomatic arch is low down, departing distally from the body of the maxilla just to the rear of the paraconal root of the M3/. Part of the post-palatine torus is preserved disto-lingually to the protoconal root of the M3/. There is a depression in the palatine on its anterior side. A narrow ridge of bone extends anteriorly from the lateralmost part of the post-palatine torus, extending as far as the gap between the P4/ and M1/, where it terminates againt a palatal foramen. There are expansive depressions in the palatal surface of the maxilla between the protocones of the P3/, P4/, M1/, M2/ and M3/ (Fig. 2). The bone surrounding the molar alveoli is dense.

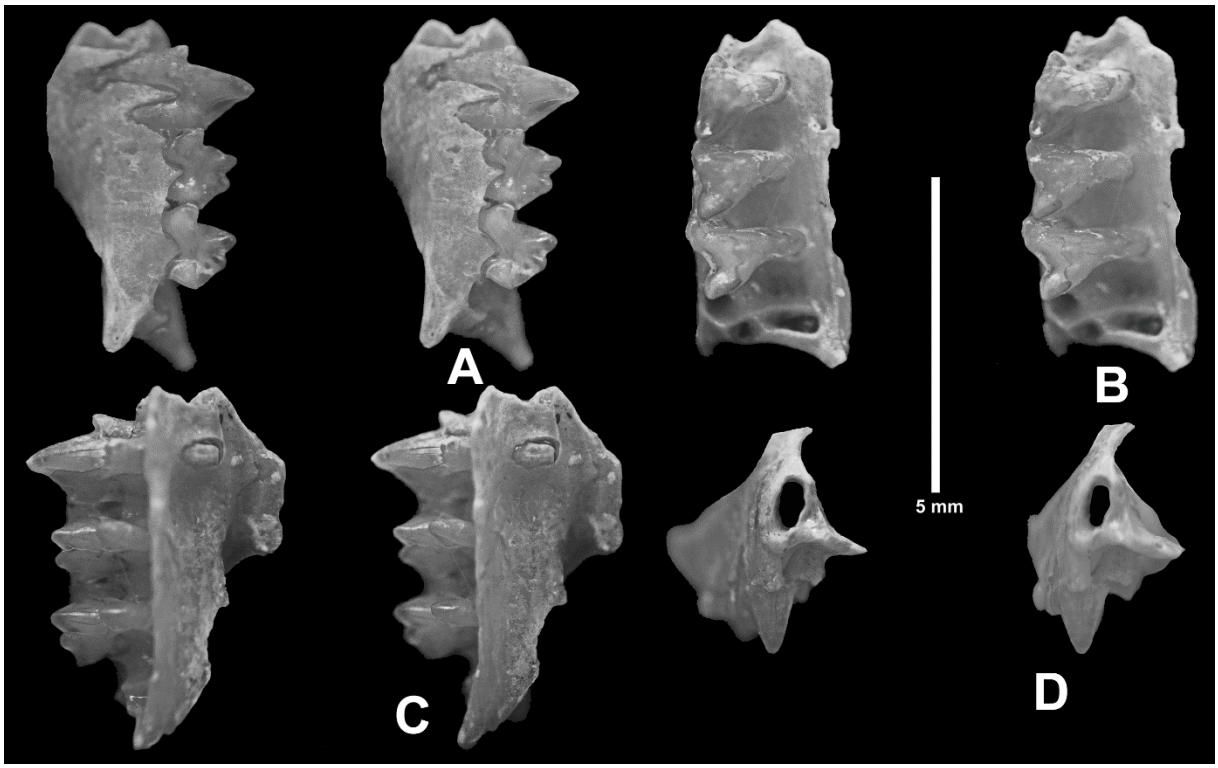

Figure 1. Stereo images of GSN BC 2'19, holotype right maxilla of *Damarachloris primaevus*, nov. gen. nov. sp. from Black Crow, Namibia. A) buccal view, B) occlusal view, C) lingual view, D) anterior view (scale : 5 mm).

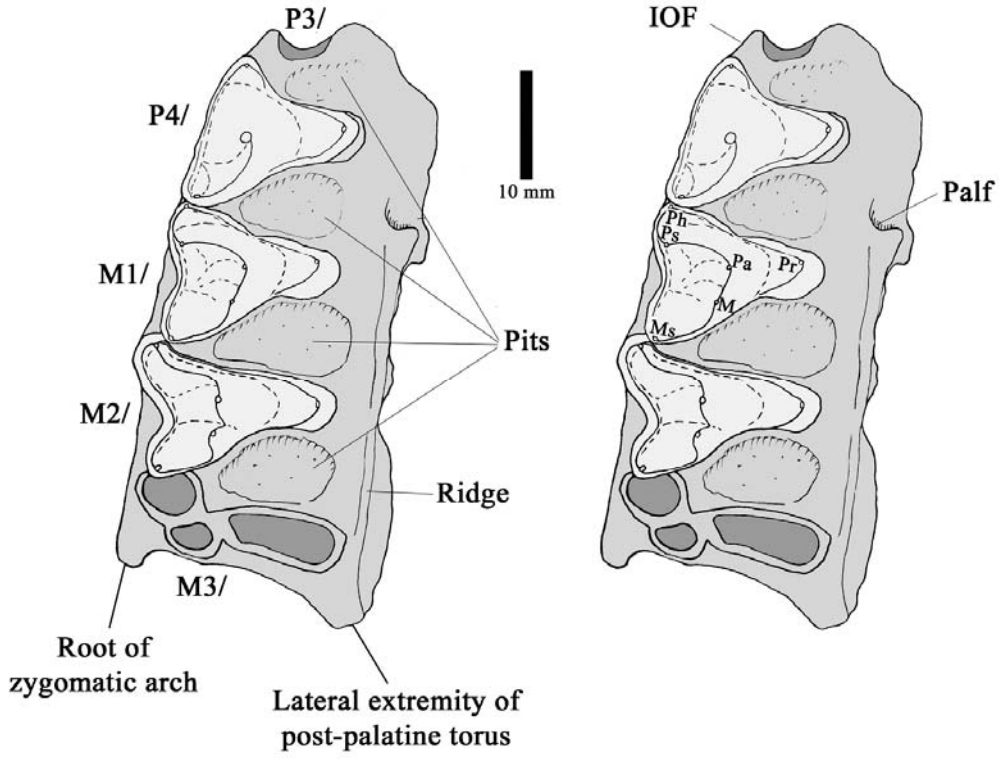

Figure 2. Interpretive sketch of the holotype maxilla of *Damarachloris primaevus*, gen. et sp. nov. from Black Crow, Namibia. IOF - Infraorbital Foramen (on side of maxilla), M - Metacone, Ms - Metastyle, Pa - Paracone, Palf - Palatal foramen, Ph - Parastylar hook, Ps - Parastyle, Pr - Protocone, Light grey - bone, dark grey - dental alveoli, white - teeth (scale : 10 mm).

The P4/ has a low protocone supported by a surprisingly robust root. The protocone is mesio-distally compressed being considerably shorter than the buccal side of the tooth. The postprotocrista and preprotocrista are well-developed and course towards the buccal side of the tooth, but there is no sign of metaconule or paraconule. The paracone is tall and pointed with a well-developed postcrista curving distally and buccally to terminate in a small, low metatsylar tubercle, there being no distinct metacone. The preprotocrista is weak to absent, the mesial surface of the paracone being conical. There is a low parastyle with crista descending disto-lingually and disto-buccally from its apex. The buccal shelf is narrow and the buccal cingulum subtle.

The M1/ and M2/ have comparable crown elements, but the M2/ is slightly bucco-lingually broader than the M1/ and mesio-distally longer. In contrast, judging from the alveoli, the M3/ was extremely compressed mesio-distally, such that the metaconal root is only a short distance behind the line joining the protoconal and paraconal roots. In all three molars the protoconal root is mesio-distally compressed but bucco-lingually enlarged, being by far the largest of the three roots of each tooth, despite the reduced dimensions of the cusp that it supports.

The M1/ has a low protocone which is mesio-distally compressed, with pre- and postcrista extending buccally towards the base of the paracone and metacone respectively. There is no sign of paraconule or metaconule in this tooth. The preprotocrista ends in the midline of the tooth, but buccally there is a cingular extension reaching towards the parastylar hook. The paracone is the largest and tallest cusp and close to it, on its disto-buccal side, is the metacone, between which run the postparacrista and the premetacrista. The preparacrista curves mesio-buccally terminating at the parastyle, which has a precrista reaching anteriorly towards the parastylar hook. The metacone has a distally directed postcrista which curves buccally to terminate at the metastyle. Between the parastyle and the metastyle there is a cingular rim forming a margin to an expansive buccal depression between the paracone-metacone pair and the buccal cingulum.

The M2/ is constructed along similar lines to the M1/, but the crown is slightly broader bucco-lingually and appreciably longer mesio-distally.

Table 1. Measurements (in mm) of the teeth of *Damarachloris primaevus* from Black Crow, Namibia.

Tooth	Mesio-distal length	Bucco-lingual breadth
GSN BC 2'19, right P4/	1.5	1.36
GSN BC 2'19, right M1/	1.4	1.30
GSN BC 2'19, right M2/	1.9	1.31
GSN BC 2'19, right M3/ alveolus	0.7	1.8
GSN BC Di 2'17, left m/2	0.93	0.67
GSN BC 5'19, right m/3	1.3	0.77

The left lower molar (GSN BC Di 2'17) was described previously (Pickford, 2018a) (Fig. 3). The root are tilted slightly lingually and the distal one is more robust than the mesial one while the mesial one is tilted slightly more than the distal one.

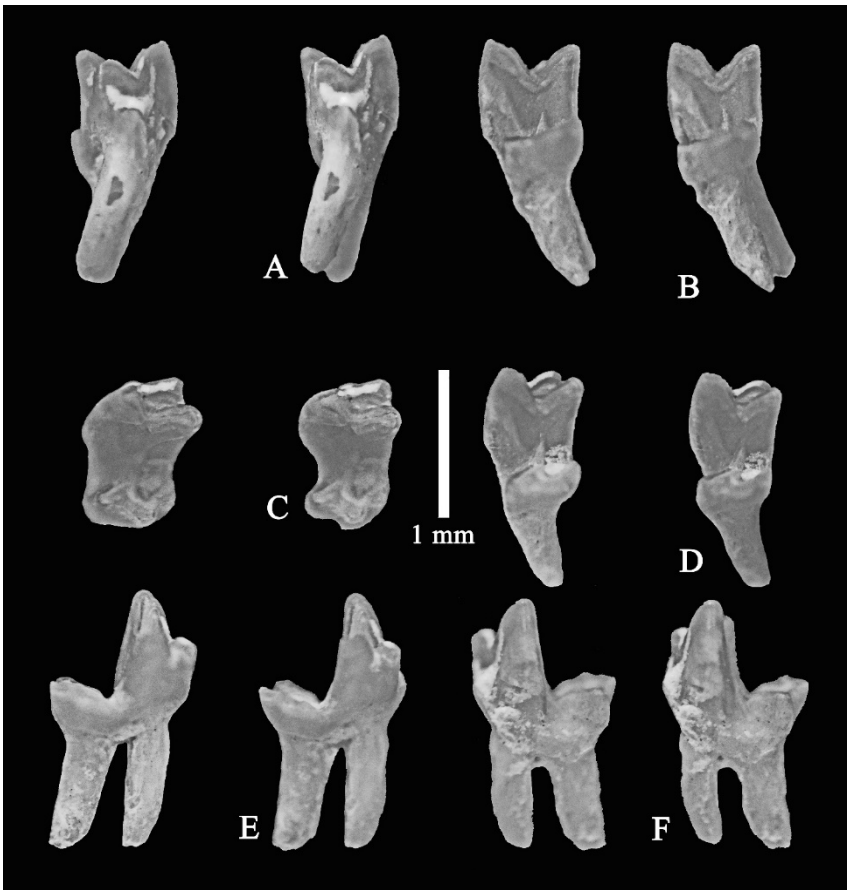

Figure 3. Stereo images of GSN BC Di 2'17, paratype left lower molar of *Damarachloris primaevus* from Black Crow, Namibia. A) mesial view, B) distal view, C) occlusal view, D) oblique disto-occlusal view, E) lingual view, F) buccal view (scale : 1 mm).

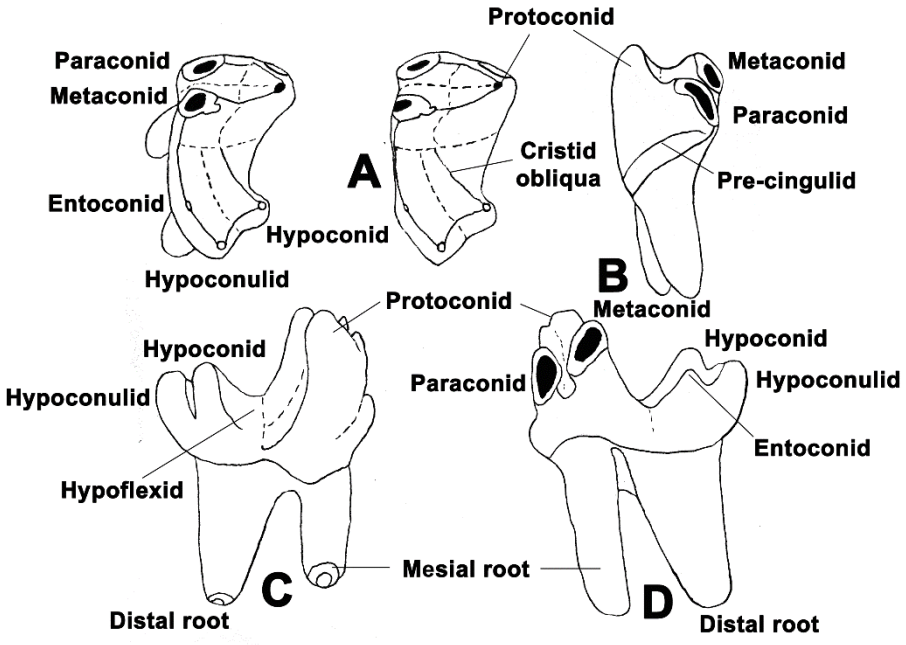

Figure 4. Interpretive sketches of right m/3 of *Damarachloris primaevus*, gen. et sp. nov. from Black Crow, Namibia (Middle Eocene). A) stereo occlusal view, B) anterior view, C) buccal view, D) lingual view. Length of tooth : 1.3 mm.

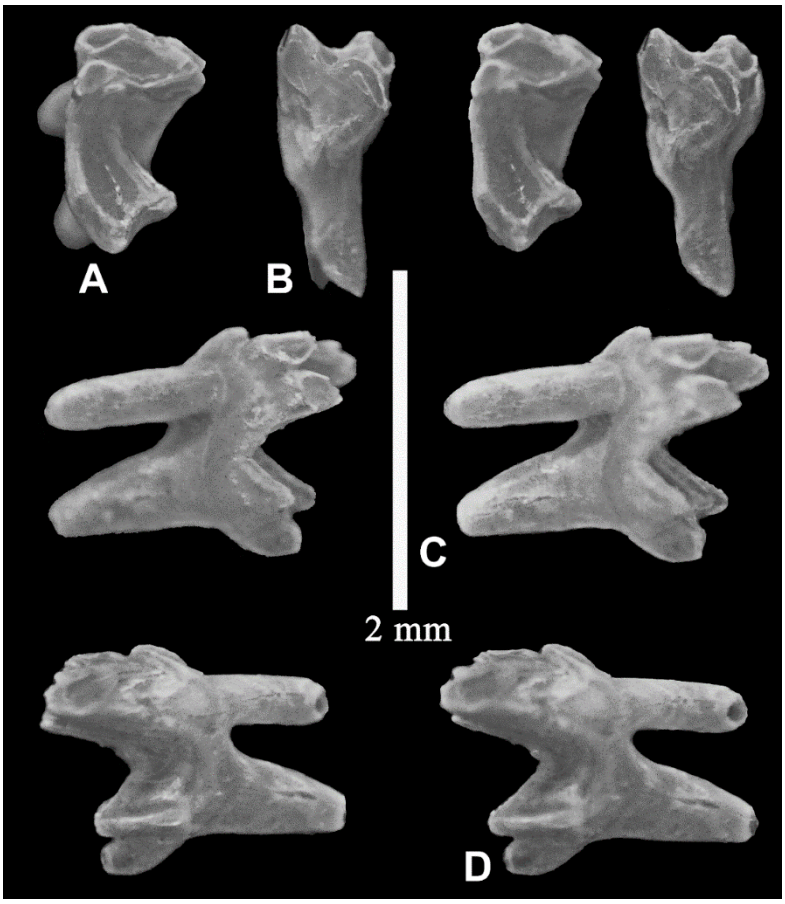

Figure 5. Stereo images of GSN BC 5'19, paratype right m/3 of *Damarachloris primaevus* from Black Crow, Namibia. A) occlusal view, B) mesial view, C) lingual view, D) buccal view (scale : 2 mm).

GSN BC 5'19, a right lower molar has a mesio-distally compressed trigonid, with the paraconid close to the protoconid with a slit between them (Fig. 4, 5). The protoconid is slightly taller than the metaconid and the paraconid is slightly lower than the metaconid. There is a slanting mesial cingulid. The talonid is tricuspid, with a large hypoconulid distally, a tall hypoconid on the buccal side and a small entoconid, all joined to each other by crests. The cristid obliqua descends anteriorly from the hypoconid, terminating at the base of the trigonid in the midline of the tooth. The talonid is lower than the trigonid, the hypoconid being about half the height of the protoconid.

The roots of this tooth are interesting in that the anterior one is smaller than the distal one and it is tilted slightly lingually compared to the more vertically oriented distal root.

Discussion

The maxilla of *Damarachloris primaevus* has several features that align it with the chrysochlorid from Eocliff (*Namachloris arenatans*) (Pickford, 2015c, 2018a). The root of the zygomatic arch takes off in line with the parastyle of the M3/ and is directed distally, there is a post-palatine torus with a depression in the palatine anterior to it, the infraorbital foramen is large and is close to the anterior rim of the orbit and there are depressions in the palate in between the protocones of the P3/, P4/, M1/, M2/ and M3/. In addition there is a subtle ridge of bone extending anteriorly from the lateral end of the post-palatine torus, reaching the level of P4/ where it terminates in a small palatal foramen.

The roots supporting the protocones of the upper molars are bucco-lingually expanded but mesio-distally compressed as in other chrysochlorids, despite the fact that the protocones that they support are reduced in dimensions. The metacone and paracone are

close together, more so than in *Diamantochloris*, imparting a more developed zalambdodont morphology to the crowns.

The lower molars have mesio-distally compressed trigonids and relatively large talonids and the roots are tilted with respect to each other and to the crown, much as in *Namachloris* and *Diamantochloris*. The distal root of the molars is larger than the mesial one, despite the fact that the talonids are lower and less voluminous than the trigonids.

All these peculiarities of the maxilla and teeth of *Damarachloris primaevus* appear to be linked to enhanced seismic transmission and reception, with the teeth and maxilla playing a role in the transmission of sound energy from the individual's vocal chords (and possibly dental chatter?) to the surrounding ground and for the reception of seismic vibrations from the ground, transmitting the energy received by the head via the dense parts of the maxillary bone and tooth roots towards the inner ear. In summary, *Damarachloris* appears to have been using its head as a sounding board for transmitting and receiving seismic and sound energy to and from the surrounding ground.

It remains to be determined whether the distal part of the mandible in *Damarachloris* was lingually bent as in *Diamantochloris* and *Namachloris*, but the tilted roots and the differential development of the distal roots of the molars suggest that when found its mandible will show a bent distal half.

As an assemblage, the Middle Eocene Black Crow mammals, both large and small, reveal a degree of endemism in the southern extremities of the African continent (Afrotheres, *Namalestes*) but with signs of faunal interchanges with the rest of Africa and with the northern continents, including North America (rodents, primates). The chrysochlorids strengthen this impression of endemism.

A great deal more is to be learnt from the Black Crow deposits about the evolution and composition of Middle Eocene mammalian faunas of Africa. To some extent, study of the Black Crow biota is rectifying a bias in the African fossil record of the period which has, until recently, been focussed largely on faunas from the northern margins of the continent. By the Late Eocene, the Eocliff tufas of the Sperrgebiet, Namibia, indicate faunal interchanges (rodents in particular) with South America (Pickford, 2018b).

Conclusions

A small insectivoran from the Middle Eocene limestones at Black Crow, Namibia, is interpreted to be a primitive member of the Chrysochloridea (Golden Moles). The trigonids of the lower molars are mesio-distally compressed as in extant Golden Moles and are tall, slotting into depressions in the palate situated betwen the protocones of the upper cheek teeth. The protocones of the upper molars are mesio-distally compressed and are supported by robust roots, again as in extant Golden Moles. There are other signs of affinities to this order of mammals, including the presence of a post-palatine torus, and the roots of the lower molars are tilted at different angles.

However, the talonids of the lower molars are tricuspid, comprising a large hypoconid, a hypoconulid and a moderately developed entoconid. The cristid obliqua is elongated and descends from the hypoconid to the midline of the crown at the base of the trigonid. In the upper molars the paracone and metacone are distinct but closely joined to each other, and the parastylar hook is small.

The dental and maxillary morphology of *Damarachloris primaevus* appear to indicate that the superfamily Chrysochloridea is remote from other Afrotheres and indeed from other Afroinsectiphilians such as tenrecoids and Tubulidentata. It would appear to be closer in lower molar talonid morphology to some Eurasian and North American «insectivorans» than to any of the Afrotheres and tenrecoids. If *Damarachloris* is indeed a Chrysochloridea, then it calls into question the homogeneity of the Afrotheria as currently understood. If not then one would be in the presence of an interesting case of convergent evolution. Further discoveries, especially of the cranial and postcranial skeleton should throw light on these questions.

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