Newly Discovered Remains of As Sahabi Anthracotheriidae

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ABSTRACT

The cranial and dental anthracotheriid sample collected from As Sahabi, Libya, by the East Libya Neogene Research Project during 2007 is described. The partial skull 8P17C presents good evidence of this animal`s craniodental morphology, in particular the shape, number, relative location, and series of eruption of its 5 permanent premolars, as well as the morphology of the deciduous 3rd and 4th premolars. Two specimens collected by the Petrocchi expeditions in the 1930's and housed in the National Museum of Libya, Tripoli are described. All anthracothere fossils from As Sahabi are assigned to *Libycosaurus petrocchii* (Bonarelli, 1947).

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INTRODUCTION

A sizable anthracothere sample was collected during the first palaeontological field expedition to As Sahabi, Libya under the renewed East Libya Neogene Research Project (ENLRP). The field season took place from February 1st to March 3rd, 2007. Here we report on the cranial and dental material.

DESCRIPTIONS

Anthracotheriid Material

8P17C - Partial skull with right and left Px/, P1/, dP3/, dP4/ and part of M1/, (Lt P2/ is just erupting); 3P17C - Right mandibular fragment with P/4, M/1, M/2 and part of M/3; 4P17C - Right mandibular fragment with parts of right P/2, P/3, P/4, M/1 and M/2; 23P103A - Right P/1; 23P107A - Left P/4; 16P28B - Right M/2 fragment; 58P24A - Right P3/; 9P16C - Left P3/; 16P38B - Right P4/; 27P14A, germ of Right ?M1/; 4P33C - Left M2/ fragment; 8P99B - Right M2/ fragment; 16P201A - Left M3/ fragment

Skull and Mandible

Specimen 8P17C is a partial skull of a juvenile anthracothere (Figures 1, 2, and 3). In basilar view one observes the maxilla and part of the horizontal parts of the palatine bones, across the transverse palatine sutures. The opening of the left pterygoid fossa is preserved. At the back of the skull parts of both jugal and squamosal bones are present, forming most the right zygomatic arch. The mandibular fossae on both sides, as well as the left external acoustic meatus, are preserved. The anterior part of the frontal portion of the braincase is shown on the internal surface of the left frontal bone.

Both canines are just erupting from their sockets, the right somewhat in advance of the left. There is a small postcanine diastema. An accessory premolar, Px, is present. This is an autapomorphic characteristic of *Libycosaurus* (Pickford, 1991; Lihoreau et al., 2006). It is fully erupted on both sides, just distal to the point of the maximum mediolateral constriction of the maxillae. About 4/5ths of both P1/ crowns are erupted. dP2/ is shed from both sides, and the P2/s are still well inside the alveoli. dP3/ and dP4/ are still in place on both sides, but they are very worn. Both M/1's are fragmented. dP/4 is substantially smaller than dM/1. (The teeth preserved in this and the two following mandibular specimens will be described separately along with the isolated dental material of the sample.)

At the anterior and lateral part of the palate, at the level of P2/, a well developed tubular canal on either side is present. This canal or "tube" leads to a huge single incisive foramen, a characteristic of *Libycosaurus petrocchii* (Pickford, 1991). In frontal view the skull shows a wide area for the premaxillo-maxillary suture anteriorly to both canines, leading to a foramen and a groove. The hard palate exhibits anteriorly a deep long groove in the midline for the attachment of the vomer. Only the posterior parts of the nasals are preserved, with articulation between them as well as with the frontals. The lacrimal and jugal bones complete the orbit, which is open posteriorly. The orbits are located higher than the frontal bone.

Figure 1. Right lateral view of specimen 8P17C, a *Libycosaurus petrocchii* partial skull from As Sahabi. The erupting canine is separated distally from P^x by a diastema, followed by P1, P2, dp3, dp4 and part of M1. P3 and P4 have not yet erupted. Bar scale 1 cm.

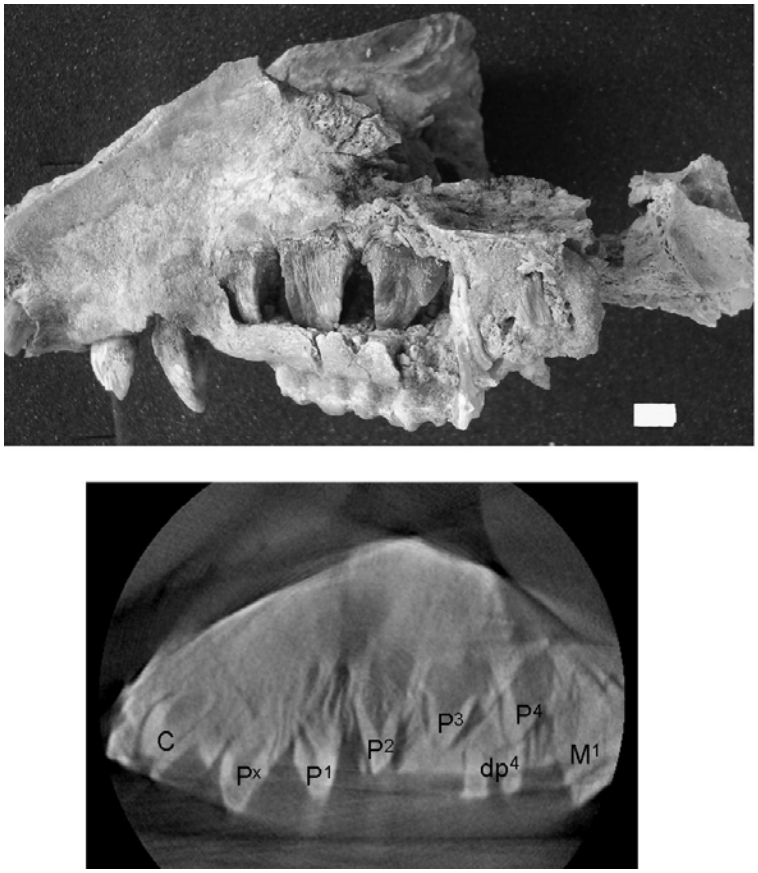
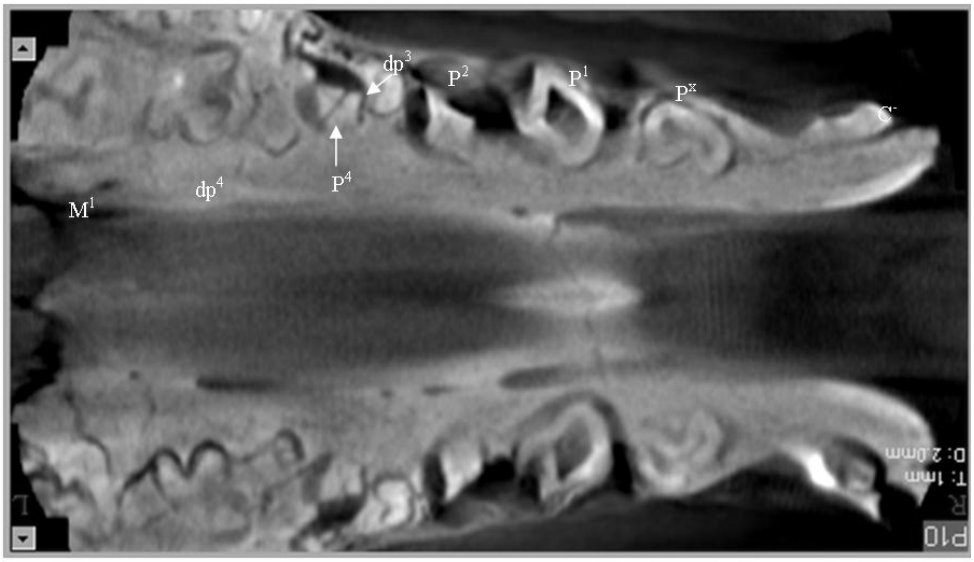


Figure 2. Left lateral view of specimen 8P17C, a *Libycosaurus petrocchii* partial skull from As Sahabi. This is juvenile specimen preserving the deciduous fourth premolar with an emerging permanent P^4 crown in its crypt. This specimen shows bilateral presence of five premolars. Top: a view of the specimen with a window of maxillary bone removed to expose the P^3 and P^4 in their crypts. Bar scale 5 cm. Below: Left lateral CT scan at the same scale with individual teeth identified.



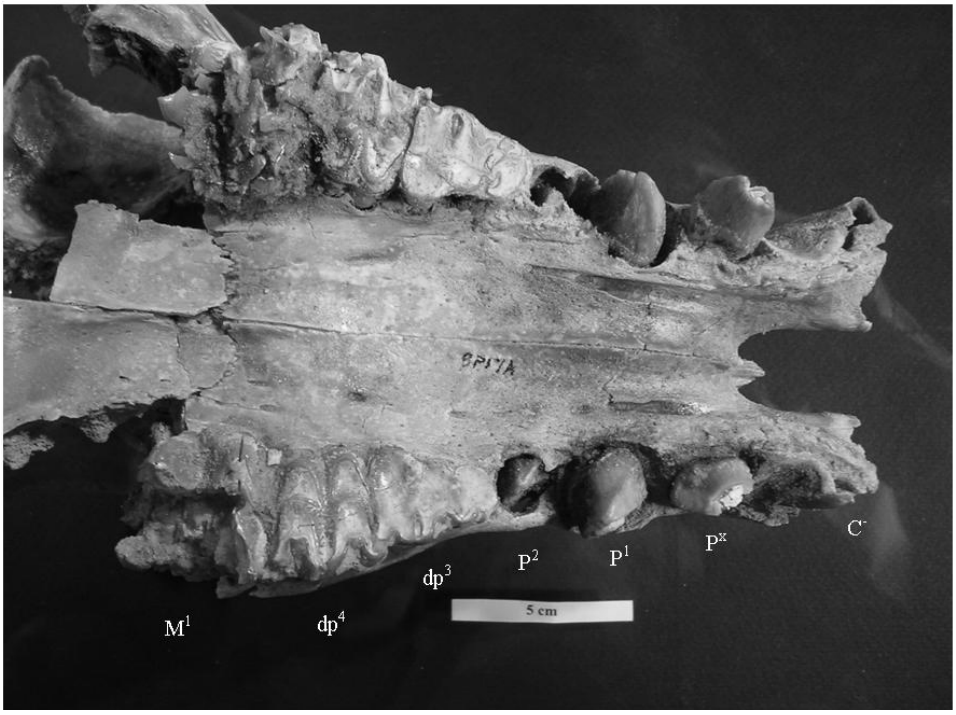


Figure 3. Occlusal view of cranium and maxillary of dentition of *Libycosaurus petrocchii* (8P17C). CT scan (above) and photograph (below) with individual teeth identified. Bar scale 5 cm.

The measured skull dimensions follow Pavlakis (1990) and the dentition dimensions follow Gaziry (1987). The measurements where taken by a Mitutoyo dial caliper (0.02 mm accuracy).

The skull measurements in lateral view are:

Height of the snout at the level anterior to right dP3/ = 88.24 mm

Height of snout anterior to right M1/ (and orbit) = 88.74 mm

Maximum height of the right orbit = 44.00 mm

Elevation of the right supraorbital ridge over the right nasal bone at the nasofrontal suture = 20.40 mm

Minimum height of the right zygomatic arch (in front of the articular fossa) = 23.64+ mm

Antero-posterior diameter of the orbit = 50.12 mm

Measurements in superior view are:

Maximum width of the zygomatic arches = 111.28 X 2 = 222.56 mm

(taken as double the distance of the right zygomatic arch to the median plane).

Maximum width of the nasal bones at the interorbital level = 66.98 mm

Minimum width of the nasal orifice = 40.46 mm

Measurements in palatal view are:

Maximum width of the palate at the level of the canines (at their tips) = 55.90 mm

Maximum width of the palate at the extreme mesiolingual point of Pxs = 40.20 mm

Maximum constriction (at the level of C-Px diastema) = 55.48 mm

-Left C/ - Px diastema = 30.52 mm

Maximum width of the palate at the extreme mesiolingual point of P1/s = 36.76 mm. Maximum width of palate at mesiobuccal angles of dP4/s = 90.50 mm

Minimum width of palate at mesiolingual angles of dP4/s = 47.20 mm

Specimen 3P17C is a right mandibular fragment with P/4, M/1, M/2 and the mesial half of M/3 broken at the mesostyle (Figure 4). The alveoli of P/2 and P/3 are also preserved. The body of the

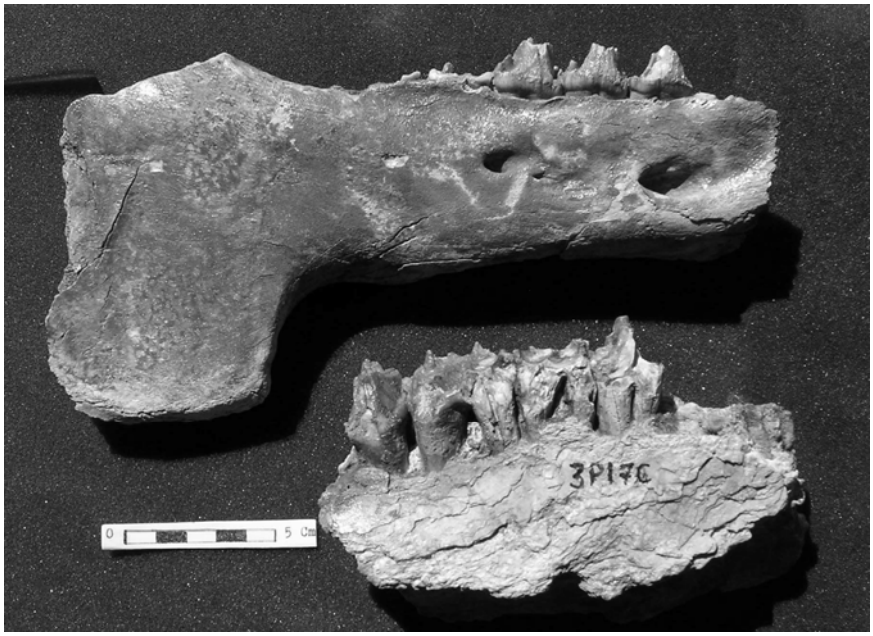


Figure 4. *Libycosaurus petrocchii* mandibular fragments from As Sahabi: 4P17C right hemi-mandible fragment (above), and 3P17C right mandibular fragment (below). Buccal side. Bar scale 5 cm.

mandible is broken transversally at the level of the mental foramen, making it thus impossible to take any height measurement of the mandibular body. Measurements that can be taken are:
Maximum thickness of mandibular body just mesial to M/1 = 30.44 mm
Length of M/1 – M3/ = 98.62 mm (estimated by doubling the maximum length of the preserved M/3 half).
All teeth are extremely tightly packed together and show a high degree of interstitial wear and even overlapping.

Specimen 4P17C is a right mandibular fragment with parts of P/2, P/3, P/4, M1/ and M/2 (Figure 4). The specimen preserves most of the right mandibular body, from the level of P/1 to the close to the mandibular angle. The mandibular ramus is broken at the level of M/3, the latter being absent. Only the M/3 alveolus is preserved. Both M/2 and M/1 are broken off and only their roots are preserved in their alveoli. P/2 to P/4 are also broken, with most of their lingual half missing. P/1 is presented by only its roots. Two mental foramina are present at the exterior surface of the mandibular body. The one at the level of P/2 measures about 1.5 cm length and 7.54 mm maximum width. The second, at the level just mesial to M/1, measures 5.22 X about 7 mm. Maximum height of the mandibular body at the level of the mesial edge of P/2 is 53.36 mm and at the level mesial of M/3 is 63.62 mm. Maximum width mesial to M/2 is 32.18 mm. Estimated length of the molar tooth row is 88.2 mm. The length of the premolar row measures about 84 mm. The flair at the mandibular angle measures 8+ cm antero-posteriorly and is located 5 cm lower than the rest of the mandibular body.

Dentition

Upper Teeth — Deciduous

The following deciduous teeth are present in the anthracothere sample from As-Sahabi: Right and left dP3/, dP4/, all on the 8P17C partial skull (Figures 2, 3).
(1) dP/3 is triangular in cross section (the apex located mesially), preserving three very worn lophs, separated by transverse styles. The two mesial lophs were single cuspid. The distal third probably had two cusps (Gaziry, 1987). The tooth has three roots. Dimensions are given in Table 1.
(2) dP4/ presents a molariform occlusal area tooth pattern. The molariform pattern of dP4/ in *Libycosaurus* was evident from the previously collected As-Sahabi material (Gaziry, 1978, Fig. 4, p. 292), and first noted by Black (1972). It is rectangular in shape, being wider than longer. Both dP4/s are very worn and tightly packed between dP/3 and M1/. They show the typical tetracuspid selenodont anthracothere molar occlusal pattern, without, however, so deep a median transverse valley and strong cingulum around the cusps as the permanent molars exhibit. dP4/, besides being almost identical to M1/ (except for being about one third smaller in length and width than M1/), is different than the permanent P4/. Both P3/ and P4/ have entirely different morphology than their corresponding deciduous premolars (see Discussion). Dimensions are given in Table 1.

Upper Teeth — Permanent

Both left and right upper canines on the 8P17C skull are just erupting, revealing only their tips from their small alveoli openings. The right alveolus is about 6 mm

Table 1. Dimensions in mm, of *Libycosaurus petrochii* deciduous teeth sample from As Sahabi.

	L	W_{ant}	W_{post}
8 P17C Rt dP3/	24.08	12.10	19.82
8 P17C Lt dP3/	22.92	11.48	18.02
8 P17C Rt dP4/	21.22	22.50+	24.00
8 P17C Lt dP4/	20.22	23.00	22.68

in diameter, while the left canine alveolus is exposed laterally for about 1.5 cm.

A feature of *Libycosaurus*, rare in Mammalia, is the possession of an accessory fifth premolar, the Px, clearly shown on the 8P17C partial skull (Figure 3). Both left and right Pxs are fully erupted (measurements in Table 2). They are unicusped with their long axis turning mesiolingually. The degree of such an orientation increases towards the last premolar (P4/), to make room for the unusual number of five premolars. The single cusp presents a steep mesial ridge and a more gradually sloping distal one. The latter is decorated with two denticulated tubercles right on the ridge. There is a weak cingulum all around the distal half of the tooth.

(1) The P1/`s on the 8P17C skull show the typical *Libycosaurus* morphology, being single-cuspid with four well delineated crests. The apex of the protocone is tilted slightly lingually. The distobuccal crest is the longest, having a less steep slope than the other three ridges. It bears 3 large tubercles on its ridge, instead of the 2 and much less pronounced tubercles shown on the Pxs. The tubercles decrease in size down the distal ridge. There is a weak buccal cingulum and a strong lingual cingulum, which becomes more pronounced distally.

(2) The Lt P2/ is just erupting at the skull fragment 8P17C. It is more exposed laterally, revealing in essence the morphology of an enlarged P1/ in three dimensions. It is more vertically oriented to the teeth row than the P1/s. The disto-lingual side of the single cusp is steeper than the buccal. The mesio-buccal ridge is the longest (and less steep) of the four. It is decorated with extra cuspules or indentations, as is the pattern of all *Libycosaurus* anterior single-cusped premolars. The cingulum is stronger than that of P1/, both distobucally and especially distolingually.

Table 2. Dimensions in mm of *Libycosaurus petrochii* premolar sample from As Sahabi.

	L	**W**
8 P17C Rt Px/	15.58	10.70
8 P17C Lt Px /	15.98	9.88
8 P17C Rt P1/	20.30	13.16
8 P17C Lt P1/	17.02	14.50
58P24A Rt P3/	31.20	27.84
9P16C Lt P3/	30.08+	25.22
16P88B Rt P4/	20.78	22.50
23P103A Rt P/1	17.72	12.68
4 P17C Rt P/2	21.08	-
4 P17C Rt P/3	22.96	-
3 P17C Rt P/4	23.18	16.72+
4 P17C Rt P/4	23.78	18.74+
23P107**A** Lt P/4	25.60	17.50

(3) Three P3/s are present in the sample: 58P24A, a right P3/, and 9P16C, a left P3/ , are isolated, while the 8P17C left P3/ (germ) has been artificially exposed laterally by an 1cm wide section over the left dP3/ and dP4/ area of the skull fragment. The P3/s are wider than P2/s, (see dimensions in Table 1). 58P24A is a fully grown, totally unworn unerupted right P3 (Figure 5). The fact that this isolated 3rd premolar bears no wear at all reveals its tooth morphology in every detail. The two ridges of the single cusp along the length axis of the tooth, the mesial and the distal, both carry a spectacular array of denticulations. There are three large ones on the distal ridge and three smaller on the mesial. The highest cuspule on the distal ridge is clearly delineated by moderately deep valleys which run down from the protocone mesially, and from the lower cuspule distally. These reach the level of the cingulum. The buccal ridge of the protocone is razor sharp, and terminates vertically on the cingulum. The lingual side of the protocone cusp bears no ridge. The cingulum is well developed all around the tooth. It is much pronounced at the distolingual and mesiobuccal parts of the diamond-shaped tooth perimeter. In these two parts of the cingulum exist many indentations, covering parts of the two foveae located medially to the cingulum. Judging from the odd appearance of this

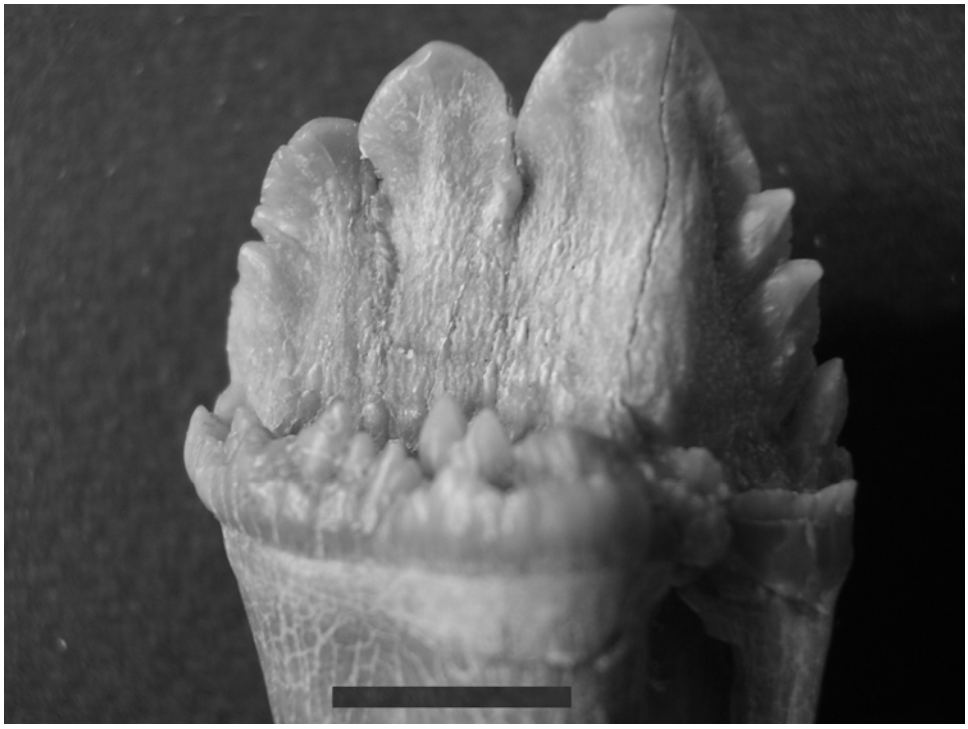


Figure 5. 58P24A *Libycosaurus petrocchii* right P3/ from As Sahabi with characteristic indentations. Lingual side. Bar scale 1 cm.

unworn premolar (Figure 5), one may sympathize with Bonarelli (1947) who, being tricked by these so many serrations, identified such teeth as belonging to a dinosaur. The artificially partially exposed P3/ on the skull fragment 8P17C documents the described morphology, as well as the increasing number of indentations (up to 5) on the serrated distal ridge. The corresponding deciduous tooth with the triangular shape is the dP3/ and the next molariform tooth distally is the dP4/. The substantially worn 9P16C left P3/ shows the two roots characteristic of the P3/s, as well as the concave wear pattern of the major (i.e., the distal) ridge.

(4) The P4/ is represented in the recent As-Sahabi sample by specimen 16P88B, an isolated right P4/. In addition, the germ left P4/ has been exposed on the 8P17C partial skull. The latter verifies that the fifth permanent premolar, the P4/, is nesting inside the molariform dP4/. While the dP4 has a typically molar (i.e., tetracuspid selenodont) occlusal morphology, P4/ is bicuspid. Actually P4/ looks like a half molar. It has a trapezoid cross section with the smaller parallel side lingually. It is wider than long, and judging from the way the germ P4/ is sited inside the alveolus, it is not shifted mesiolingually like the rest of the premolars. Apparently, the bicuspid P4/ fits between the long single-cusped P3/

anteriorly and the large square-shaped M1/ posteriorly, by becoming shorter and wider, a common solution for P4/s, seen also in hippos (Pavlakis, 1990). The two cusps are well-developed, and the whole crown is tilted slightly anteriorly (a useful character for orienting isolated P4/s). The protocone is located lingually and is slightly smaller than the buccal paracone, a cusp which Gaziry (1987) called a metacone. Strong ridges leave the apices of both cusps, one mesio- and the other disto-bucally, ending on the strong cingulum. Those of the protocone end in the midline, thus raising the rim of the cingulum even higher. The two ridges of the paracone end bucally, each one on an accessory cuspule, before looping around the mesial ridge anteriorly and the distal posteriorly to meet the cingulum, exactly like the S-shape looping of the buccal ridges and the cingulum, seen in the molars. The tooth bears two roots.

(5) M1/s are *in situ* in both sides of the 8P17C partial skull, but their crown areas are badly fragmented, so no accurate measurements can be taken. An estimate of left M1/ size is included in Table 1, for comparison with the molariform dP4/. 27P14A is the complete crown of a germ Rt M1/. Given that it is a germ tooth, 27P14A is possible that it can be a 2nd molar. The entire crown is lacking any wear, so the molar morphology of the occlusal surface can be seen in full detail (Figure 6). It bears four cusps: protocone (mesiolingually), paracone (mesiobuccally), metaconule (distolingually, called hypocone by Gaziry, 1987) and metacone (distobuccally). In cross-section, the molars are square, with the mesial half wider and more lingually positioned than the distal half. The protocone is larger than the metaconule, consequently the anterolingual molar root is larger than the posterolingual (*contra*

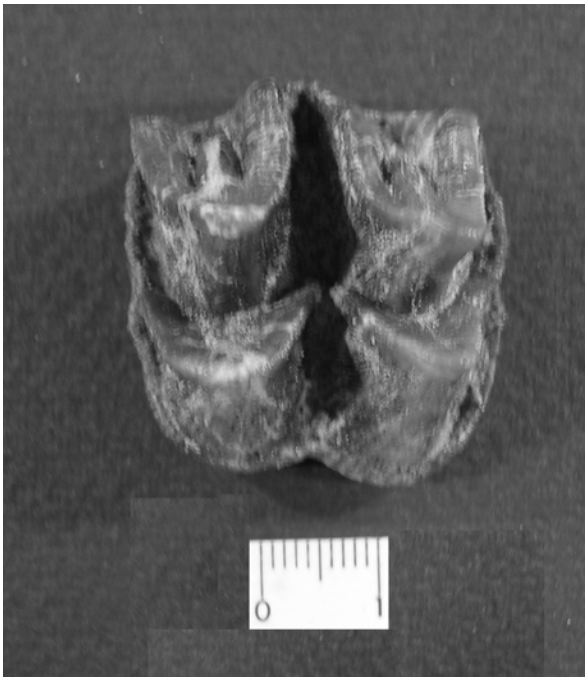


Figure 6. 27P14A, a *Libycosaurus petrocchii* upper ?right first molar germ from As Sahabi. Scale 1 cm.

Gaziry, 1987:295). The occlusal pattern is clearly selenodont, with two sharp ridges leaving each of the four cusp apices, the one going mesiobucally and the other distobucally. The transverse valley is straight and cuts the molar deep in half, to the level of the cingulum. The longitudinal valley is much shallower than the transverse. It consists of two semicircles, delineating the concave buccal aspect of protocone and metaconule. The cingulum is strong mesially and distally and in both cusps, its buccal half is incorporating the outer ridges of protocone and metaconule, thus doubling their size. The buccal ends of the adjacent ridges of paracone and metacone create a loop like strong mesostyle, while the distal and mesial ridges form a parastyle and a metastyle. These three styles fill the gaps of a continuous sharp edge that runs buccally in all three upper molars. Now, if we add to this continuous sharp edge the second cutting line of the molars, located lingually to the first, and mostly if we expand anteriorly these cutting ridges to the serrated longitudinal ridges of the five premolars all the way to the canines and the anterior dentition, we realize that we are dealing in *Libycosaurus* with an extremely efficient food-cutting and grinding machine, whose adaptational and paleoecological dimjensions are not yet fully understood.

(6) The M2/s sample consists of two isolated permanent teeth: 4P33C a left M2/ missing the mesial part anteriorly to the protocone and metacone apices, and 8P99B a right M2/ missing a flake of its protocone (mesiolingually). Basically M2/s represent a non-allometric size increase over the M1/ morphology. They are simply bigger than M1/s. The mesial and distal cingula in M2/s have the same thickness throughout their lengths.

(7) Specimen 16P201A is a left M3/. It is recognised from its large size (Table 3).

Table 3. Dimensions in mm of *Libycosaurus petrochii* molar sample from As Sahabi.

	L	**tr_1**	**tr_2**	**tr_3**
8 P17C Lt M1/	27.38+	30.80+	-	-
27P14A germ Rt ?M1/	30.48	31.26	30.98	31.02
4P33C Lt M2/ frag.	-	-	32.68	34.98
8P99B Rt M2/ frag.	34.58	35.64	32.00	34.10
16P201A Lt M3/ frag.	39.82+	46.64+	42.76	47.32
3 P17C Rt M/1	23.36	15.98	14.14	15.60
3 P17C Rt M/2	39.96	23.40+	22.78	24.56
16P28B Rt M/2	32.52	21.00+	21.14	23.04
3 P17C Rt M/3 frag.	44+	26.28	25.10	-

Lower Teeth

(1) An isolated right P/1, 23P103A, is single-cusped, with subrectangular cross - section at the crown base. The large protoconid cone is concave lingually and convex buccally. It exhibits a wear facet distally, which ends on a small talonid. The cusp has two ridges lingually, one mesial and the other distal, as well as one distal ridge buccally. The lingual ridges are serrated. The mesial bears two cuspules, and the distal one. The cingulum is stronger lingually. P/1 has two roots. Another P/1 is preserved only by its roots *in situ* on the mandibular fragment 4 P17C. It is followed by three more premolars distally.

(2) A fragmented right P/2 missing almost half its lingual crown is present on the *4 P17C* Rt mandibular fragment. It shows the unicuspid, subrectangular cross section and the convex bucal cusp surface form of the P/1. The talonid is larger than in P/1, but substantially smaller than in P/3. It bears small cuspules on its rim.

(3) The 4P17C right mandibular fragment preserves the Rt P/3, missing the buccal $1/4^{th}$ of its crown. It has one large cusp, the protoconid, but it is more rectangular in cross section than P/1 or P/2. The talonid measures 6.52 mm in length and is larger than the talonid in the premolars anterior to it. The cingulum is more developed mesially and buccally than in the anterior premolars, bearing also a larger cuspule on its midline.

(4) There are 3 P/4s in the recent As Sahabi anthracothere sample: a complete isolated left P/4, 23P107A, one right on the 3P17C mandibular fragment with damaged its lingual surface, and a right P/4 on the 4P17C right mandibular fragment, missing almost half of its mesial part. P/4 presents the typical trigonid and talonid occlusal tooth morphology. The trigonid anteriorly bears three well-developed cusps, the larger protoconid bucally, the paraconid mesiolingually and the metaconid distolingually. The paraconid is equal size to metaconid. The descending mesial protoconid ridge is completely united since halfway with the descending buccally mesial paraconid ridge, thus outlining the mesial rim of a deep intratricuspid fovea. The distal protoconid ridge continuous lingually leaving the mesoconid anteriorly. It ends on the lingual cingulum creating thus another small valley distally to mesoconid, with its distobuccal and distolingual ridges. The trigonid measures 8.58 mm maximum length and has a strong cingulum distally bearing three cuspules on it. The anterior cingulum is also strong and serrated. On the mesial ridge of the paraconid there is one large indentation lower on the ridge. P/4 has two roots. On 3P17C right mandible, the P/4 is squeezed between P/3 and M/1.

(5) 3P17C and 4P17C right mandibular fragments preserve right M/1s. The former is complete, while the latter is broken from its roots. 3P17C is rectangular in cross section. It is worn out extensively. It has four roots.

(6) Specimen 16P28B is a complete isolated right M/2 with minimum wear. In addition, on the mandibular fragment 3P17C there is *in situ* a complete M/2 with a medium

amount of wear. On the right mandibular fragment 4P17C only the roots of the M/2 are preserved. M/2 is rectangular in cross section, and the occlusal surface bears four cusps. The protoconid and hypoconid, the two buccal cusps, show greater degree of wear than the lingual (Med, Entd). The buccal cusps have a V-shaped wear facet, while the lingual cusps preserve their cones as on specimen 16P28B, or show a much smaller wear facet as on 3P17C. The transverse valley is deep bucally but is substantially higher and shallower lingually. There is a cingulum anteriorly, bucally and posteriorly, but not lingually. The transverse valley ends bucally on a developed cingulum with cuspules.

(7) Specimen 3P17C is a right mandibular fragment which preserves only the anterior part of the M/3 to the transverse valley. It is less worn than M/2, the anterior cingulum is stronger than on the M/2 and it is larger than the M/2.

DISCUSSION

The anthracothere cranial sample described here offers valuable information to the systematics of the Anthracotheriidae from As Sahabi. The partial skull 8P17C in particular, presents dental and cranial morphology that firmly identifies it as *Libycosaurus petrocchii* (Bonarelli, 1947). Furthermore, it presents definitive evidence of its dental formula, especially the number of premolars it possesses and the replacement of deciduous teeth by permanent dentition (Figure 3). From a CT scan of 8P17C and subsequent exposure of the left buccal aspect of the non-erupted P3/ and P4/ we verified the following anatomy. Distal to the premaxillary-maxillary suture the first erupting tooth is the canine, followed by a diastema and by four unicuspid serrated premolars (Px/-P3/). The premolars increase distally in size and diagonal position relative to the mesial-distal axis. P4/ is triangular in cross-section with the apex located lingually. The dP3/ is tricuspid and triangular in cross-section with the apex located mesially. The dP4/ is molariform with four cusps in a typical selenodont molar occlusal configuration.

The specimen Bonarelli named *Libycosaurus petrocchii* is a very similar skull fragment to 8P17C (Bonarelli, 1947, Fig. 1, p. 25). It is a juvenile skull and preserves four unicuspid strongly serrated premolariform teeth and two tetracuspid molariform teeth. It presents the tooth row Px/-M2/ (Lihoreau, *et al.,* 2006, Supplement) instead of the C/-M1/ present in 8P17C. The first tooth in the holotype is the Px/ and not the C/, since there is no diastema with the adjacent premolar distally, as opposed to the teeth series in 8P17C.

Black in 1972 came close to recognising *Libycosaurus* as a valid anthracothere genus “were it not for the intermediate [to *Merycopotamus*] Tunisian sample” (Black, 1972:25). Based on the then known anthracothere material from As Sahabi, he noted that it differs from the Asian *Merycopotamus* by presenting bigger and more serrated upper premolars, molars with a rounded mesostyle labially formed by the paracone – metacone crest, and high V-shaped molar cusps without protoconules. He referred the As Sahabi anthracothere material to an African species

of *Merycopotamus*, a younger descendent of the Late Miocene Tunisian *Merycopotamus anisae*, using the taxon "*Libycosaurus" petrocchii* (Black, 1972). In his 1978 review of the Anthracotheriidae, Black referred the As Sahabi antheracothere to *Merycopotamus petrocchii* (Bonarelli, 1947), and used *Libycosaurus petrocchii* as a synonym (Black, 1978). Gaziry (1987) also referred new anthracothere material recovered at As Sahabi by the ISRP to *Merycopotamus petrocchii*. Pickford (1991:1515) in his revision of the Neogene Anthracotheriidae of Africa, formally recognised the genus *Libycosaurus* as a large anthracothere with four-cuspidate upper molars in which the loop-like mesostyles are undivided. *L. petrochii* was characterised as a large anthracothere species with four-cuspid upper molars, in which the mesostyle forms a prominent loop. He included in this taxon the then known As Sahabi material, as well as undescribed skull fragments and a mandible from Chad (Coppens, 1972). Later, in 2002, *Libycosaurus petrochii* was recognised in Chad, at Toros Menalla, in the middle section (Anthracotheriid Unit), along with *Sahelanthropus tchadensis* and a terrestrial vertebrate faunal sample (Vignaud, 2002; see Boaz, this volume).

A new *Libycosaurus* species (in addition to *L. petrocchii* and *L. anisae*), *L. algeriensis* of Middle Miocene age from eastern Algeria, was established by Ducrocq, *et al.* (2001). Recently, Pickford (2006) examined the morphometric variation of the available *Libycosaurus* samples. *L. algeriensis* (Middle Miocene of Nementcha, eastern Algeria) is the older species and the specimens fall at the low end of the range of variation of the *L. anisae* sample from the Beglia Formation (Late Miocene, ca. 12-11 ma, from eastern Tunisia). He considers it likely that *L. algeriensis* is a synonym of *L. anisae*. The youngest species is *L. petrocchii* (Late Miocene of As Sahabi and Chad). It falls above the known range of variation of *L. anisae* in almost all metric features. *L. petrocchii* is here considered to represent a distinct species from the Beglia sample, larger but similar in morphology.

On the matter of five premolars, Pickford (1991) first recognised the series of five premolars in *L. anisae* (Tunisia) and *L. petrochii* (Libya and Chad). He reported that "in every specimen in which the appropriate part of the maxilla is preserved, it is evident that *Libycosaurus* possessed five upper premolars" (Pickford, 1991:1519). In a note, however, added in proof, he stated that the anteriormost of these five premolariform teeth is the canine.

While the priority of *Libycosaurus* over *Merycopotamus* for the North African anthracotheres was established by Pickford in 1991, the confusion over the number of upper premolars remained. Pickford (1994) still considered the anteriormost of the five premolariform tooth as the canine. Lihoreau, *et al.* (2006) established the presence of five premolars based on microtomographic analysis.

The *L. petrocchii* 8P17C cranium offers information that decisively clarifies the number of premolars, the sequence of permanent tooth eruption, the replacement of deciduous with permanent teeth, and that the first tooth that erupts distally to the premaxillary -maxillary suture is the canine.

It presents non-serrated contour ridges, and a distally curved long axis, as is also shown on the palatal view of specimen 2P24A (Gaziry, 1987:293, Figure 6). Further information about the morphology of *L. petrocchii*, such as size range and sexual dimorphism, is expected to result from the analysis of the new postcranial anthracothere sample from As Sahabi following this study. This will further clarify the species' taxonomy, biochronology, and palaeoecology.

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