

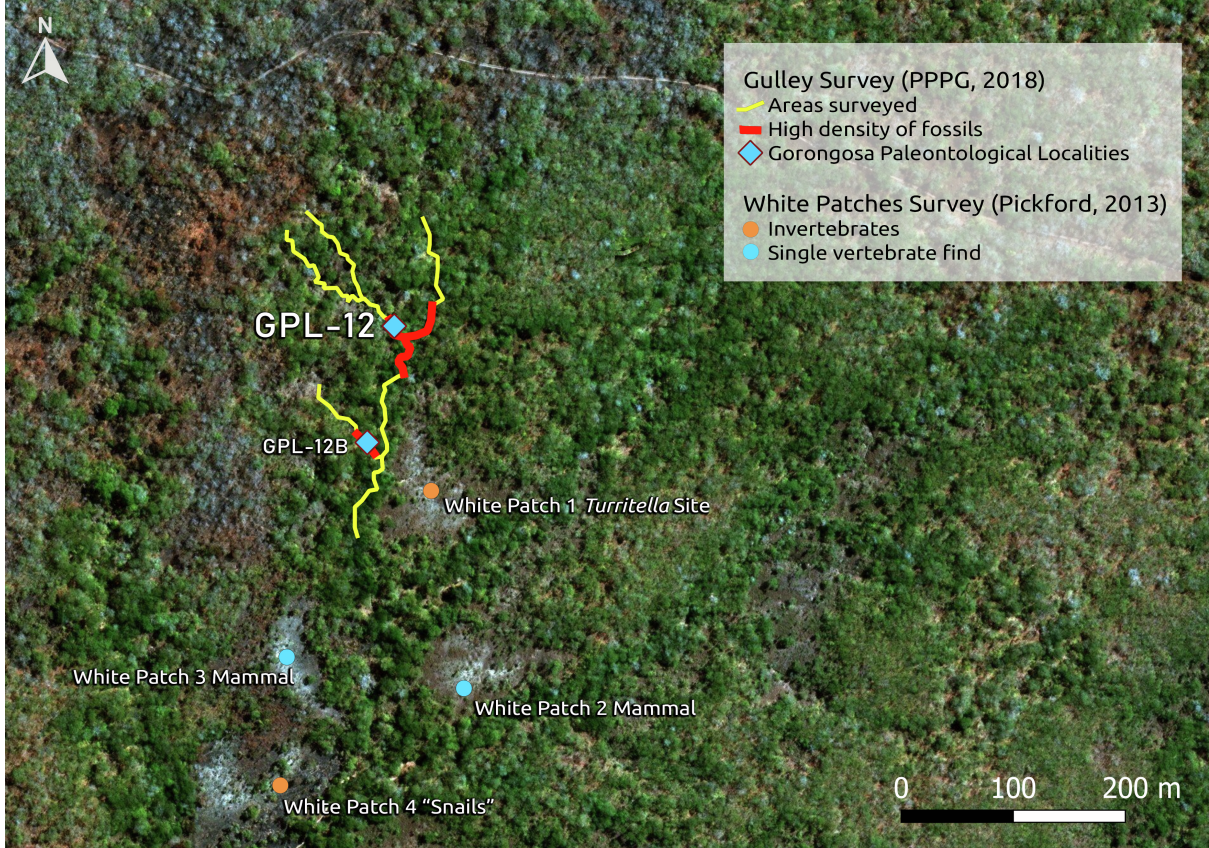
## **Supplemental information**

### **The first Miocene fossils from coastal woodlands in the southern East African Rift**

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Supplemental Information

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**Figure S1.** Map of the extent of GPL-12, and surrounding areas, related to Paleontological excavations (Methods Details).

**Table S1.** Sampling details for rock samples from the lower member of the Mazamba Formation (F=Fossil) and modern (M) sediment samples taken for atmospheric <sup>10</sup>Be dating.

Sample ID	Sample type	Locality/site	Decimal degree		Lithology	Sedimentary environment	Sampling depth below surface
			°S	°E			
Be18-Gor-GPL1NE-1	F	GPL1NE_section base	-18.9288	34.6476	coarse carbonate-cemented sandstone	fluvial, alluvial channel	excavated trench wall
Be18-Gor-GPL1NE-2	F	GPL1NE	-18.9288	34.6476	sandstone	fluvio-deltaic estuarine, central	excavated trench wall
Be18-Gor-GPL1NE-3	F	GPL1NE	-18.9288	34.6476	sandy claystone	basin/swamp	excavated trench wall
Be18-Gor-GPL1NE-4	F	GPL1NE	-18.9288	34.6476	clayey sandstone	fluvio-deltaic, distributary channel	excavated trench wall
Be18-Gor-GPL1NE-5	F	GPL1NE	-18.9288	34.6476	sandy claystone	basin/swamp	excavated trench wall
Be18-Gor-GPL1NE-6	F	GPL1NE_section top	-18.9288	34.6476	sandy clay- to marlstone	estuarine, central basin	excavated trench wall
Be18-Gor-GPL12-0.1	F	GPL12, STP101_section base	-18.9337	34.6456	coarse carbonate-cemented sandstone	fluvial, alluvial channel	excavated trench wall
Be18-Gor-GPL12-1.1	F	GPL12, STP101	-18.9337	34.6456	coarse carbonate-cemented reddish sandstone	fluvio-deltaic estuarine, central	excavated trench wall
Be18-Gor-GPL12-3.1	F	GPL12, STP101	-18.9337	34.6456	brown-beige sandy claystone	basin/swamp	excavated trench wall
Be18-Gor-GPL12-4.1	F	GPL12, STP101	-18.9337	34.6456	brown-beige clayey sandstone	fluvio-deltaic, distributary channel	excavated trench wall
Be18-Gor-GPL12-5.1	F	GPL12, STP101_section top	-18.9337	34.6456	olive-green claystone	estuarine, central basin	excavated trench wall
17-Gor-GPL6-8	F	GPL6 section base	-18.9271	34.6530	clayey sandstone	estuarine, central basin/swamp	excavated section wall
17-Gor-GPL6-3	F	GPL6 section center	-18.9271	34.6530	laminated claystone	estuarine, central basin/swamp	excavated section wall
17-Gor-GPL2-5	F	GPL2 section base	-18.9070	34.6757	clayey olive-brown sandstone	estuarine/marine, lagoonal shelf/barrier	excavated section wall
17-Gor-GPL2-10	F	GPL2 section top	-18.9070	34.6757	olive clayey sandstone	estuarine/marine, lagoonal shelf/barrier	excavated section wall
Be18-Gor-Pu-2	M	Pungwe River	-18.9944	34.3494	sandy clay	fluvial, alluvial floodplain c. 200 m north of river	60 cm, ca. 2-3 m above water level
Be18-Gor-Urem-1.1	M	Urema River	-18.9878	34.5693	dark-brown sandy	fluvial, riverbank	30 cm, at water level
Be18-Gor-Vun-1.1	M	Vunduzi River (?)	-18.4805	34.2103	muddy coarse sand	fluvial, riverbank	water-sediment interface at 1 cm water depth
Be18-Gor-VunS1-1.1	M	Stream S of Vunduzi River	-18.4899	34.2011	sandy mud	fluvial, riverbank	water-sediment interface at 1 cm water depth
Be18-Gor-Muc-1.1	M	Mucuro Mazi River	-18.5187	34.1915	muddy sand	fluvial, riverbank	water-sediment interface at 1 cm water depth
Be18-Gor-LUrem-1.1	M	Lake Urema	-18.9130	34.5178	muddy sand	fluvio-lacustrine, fluvio-deltaic, river-dominated estuary	30 cm, at water level
Be18-Bei-EstRi1-1	M	1st estuary NE Beira	-19.7873	34.9609	muddy sand	shore lagoonal estuary	20 cm, ca. 1 cm above water level
Be18-Bei-SavEst-1	M	Savane River estuary NE Beira	-19.6806	35.1396	organic-rich sandy mud/clay	on mangrove-dominated barrier peninsula	surface at water level
Be18-Bei-SavFor-1	M	Savane River estuary NE Beira	-19.6821	35.1399	organic-rich sandy mud/clay	mangrove forest/swamp on lagoonal barrier peninsula	20 cm, ca. 0.5 m above water level

**Table S2.** Concentrations of  $^{10}\text{Be}$  and  $^9\text{Be}$  and  $^{10}\text{Be}/^9\text{Be}$  ratios for the Gorongosa samples, related to atmospheric  $^{10}\text{Be}$  dating.

	Samples	Sample weight [g]	Measured ( $^{10}\text{Be}/^9\text{Be}$ ) * $10^{-13}$	Authigenic $^9\text{Be}$ * $10^{16}$ [at.g $^{-1}$ ]	Authigenic $^{10}\text{Be}$ * $10^7$ [at.g $^{-1}$ ]	Authigenic $^{10}\text{Be}/^9\text{Be}$ * $10^{-8}$
Modern	Be18-Gor-Pu-2	0,9593	106,6344 ± 2,1964	5,1161 ± 0,1496	22,6219 ± 0,4653	4,4217 ± 0,3162
	Be18-Gor-Urem-1.1	0,9584	89,1654 ± 1,9579	7,9130 ± 0,2405	18,9476 ± 0,4153	2,3945 ± 0,1795
	Be18-Gor-Vun-1.1	0,9596	15,8407 ± 0,4884	1,6814 ± 0,0095	3,3464 ± 0,1021	1,9902 ± 0,1235
	Be18-Gor-VunS1-1.1	0,9574	86,4330 ± 1,8054	7,5941 ± 0,0724	18,3644 ± 0,3829	2,4182 ± 0,1109
	Be18-Gor-Muc-1.1	0,9585	84,7570 ± 2,1050	2,6621 ± 0,1283	17,9818 ± 0,4458	6,7548 ± 0,7323
	Be18-Gor-Lurem-1.1	0,9624	70,8797 ± 1,7002	3,3840 ± 0,1200	14,9327 ± 0,3574	4,4127 ± 0,3776
	Be18-Bei-EstRi1-1	0,9585	280,9860 ± 5,0466	4,2827 ± 0,0239	59,3875 ± 1,0660	13,8668 ± 0,5213
	Be18-Bei-SavEst-1	0,9583	77,6644 ± 1,8204	2,3125 ± 0,0795	16,4663 ± 0,3852	7,1206 ± 0,5920
	Be18-Bei-SavFor-1	0,9583	75,6599 ± 1,9046	2,6573 ± 0,0655	16,0133 ± 0,4023	6,0262 ± 0,4240
Lower Mazamba Formation	Be18-Gor-GPL1NE-1 (2)	0,9162	1,7757 ± 0,0005	0,0137 ± 0,0569	0,5941 ± 0,0186	0,1894 ± 0,0137
	Be18-Gor-GPL1NE-2	0,9174	0,1918 ± 0,0008	0,0011 ± 0,1369	0,0610 ± 0,0032	0,0096 ± 0,0011
	Be18-Gor-GPL1NE-3	0,9137	1,2693 ± 0,0005	0,0054 ± 0,1006	0,4189 ± 0,0137	0,0728 ± 0,0054
	Be18-Gor-GPL1NE-4 (2)	0,9158	0,0383 ± 0,0018	0,0011 ± 0,0457	0,0125 ± 0,0015	0,0045 ± 0,0011
	Be18-Gor-GPL1NE-5	0,9172	0,0082 ± 0,0024	0,0003 ± 0,0490	0,0027 ± 0,0005	0,0009 ± 0,0003
	Be18-Gor-GPL1NE-6 (2)	0,9151	2,6210 ± 0,0004	0,0196 ± 0,1535	0,8776 ± 0,0272	0,2065 ± 0,0196
	17-Gor-GPL2-5	0,9167	1,5327 ± 0,0005	0,0048 ± 0,0700	0,5178 ± 0,0162	0,0734 ± 0,0048
	17-Gor-GPL2-10 (2)	0,9174	1,9923 ± 0,0006	5,0197 ± 0,1192	0,6586 ± 0,0203	0,1312 ± 0,0102
	17-Gor-GPL6-3	0,9173	0,4146 ± 0,0006	0,0023 ± 0,0873	0,1396 ± 0,0056	0,0269 ± 0,0023
	17-Gor-GPL6-8	0,9192	0,1950 ± 0,0009	0,0040 ± 0,0568	0,0653 ± 0,0041	0,0296 ± 0,0040
	Be18-Gor-GPL12-0.1 (2)	0,9174	0,0464 ± 0,0015	0,0006 ± 0,1541	0,0156 ± 0,0016	0,0027 ± 0,0006
	Be18-Gor-GPL12-1.1	0,9174	0,0103 ± 0,0030	0,0003 ± 0,0754	0,0035 ± 0,0007	0,0008 ± 0,0003
	Be18-Gor-GPL12-3.1 (2)	0,9175	0,4907 ± 0,0006	0,0025 ± 0,0883	0,1649 ± 0,0071	0,0277 ± 0,0025
	Be18-Gor-GPL12-4.1	0,9191	0,0423 ± 0,0019	0,0008 ± 0,1172	0,0141 ± 0,0019	0,0030 ± 0,0008
	Be18-Gor-GPL12-5.1 (2)	0,9168	0,1879 ± 0,0009	0,0011 ± 0,0901	0,0630 ± 0,0037	0,0089 ± 0,0011

**Table S3.** Results of  $^{26}\text{Al}/^{10}\text{Be}$  analyses, related to cosmogenic nuclide dating.

Sample	Depth (cm)	Depth (g.cm <sup>-2</sup> )	Dissolved quartz (g)	<sup>9</sup> Be carrier (10 <sup>19</sup> at.)	<sup>10</sup> Be (10 <sup>5</sup> at.g <sup>-1</sup> )	<sup>26</sup> Al (10 <sup>5</sup> at.g <sup>-1</sup> )	<sup>26</sup> Al/ <sup>10</sup> Be
16-Gor-Muss-7	1500	3750	20,1345	3,0244	9909,71 ± 1328,88	37881,44 ± 14645,17	3,8227 ± 1,5642
16-Gor-Muss-8	1050	2625	20,1432	3,0511	11973,11 ± 1589,53	57683,13 ± 13054,15	4,8177 ± 1,2640

**Table S4.** Model outputs of burial durations and denudation rates, related to cosmogenic nuclide dating.

Sample	Model Without Post-B production		Denud. before B. (m.Ma <sup>-1</sup> )	Model With Post-B. production			
	Denud. before burial (m.Ma <sup>-1</sup> )	Min Burial duration (ka)		Max Burial duration (ka)	Denud. after B. (m.Ma <sup>-1</sup> )	% [ <sup>10</sup> Be] Post-B.	% [ <sup>26</sup> Al] Post-B.
16-Gor-Muss-7	140,04	1 316,25 ± 539,66	1 054,85	971,99 ± 398,52	20,93	84	81
16-Gor-Muss-8	147,30	838,16 ± 220,96	1 746,90	971,99 ± 256,24	20,93	92	92

**Table S5.** List of fossil shark specimens used in the analysis of tooth outlines (n = 598), related to Figure 9. Cappetta 1970 refers to [1].

Specimen Number	n Source/Museum	Locality	Epoch	Species	Reference
MPEG-1131-V	1 Aguilera et al. 2017	Brazil	Early Miocene	† <i>Carcharhinus ackermanni</i>	doi:10.1371/journal.pone.0182740
AMU-CURS-990	1 Carrillo-Briceño et al. 2016	Venezuela	Early Miocene	† <i>Carcharhinus brachyurus</i>	doi:10.5167/uzh-125933
MUN-STRI-43808	1 Carrillo-Briceño et al. 2019	Colombia	Middle Miocene	† <i>Carcharhinus gibbesii</i>	doi:10.5194/bg-16-33-2019
MPEG-1836-V	1 Aguilera et al. 2017	Brazil	Early Miocene	† <i>Carcharhinus perezii</i>	doi:10.1371/journal.pone.0182740
UAP-14.181-14	1 Andrianavalona et al. 2015	NW Madagascar	Miocene	† <i>Carcharhinus priscus</i>	doi:10.1371/journal.pone.0129444
UAP-13.159	1 Andrianavalona et al. 2015	NW Madagascar	Miocene	† <i>Carcharhinus</i> sp.	doi:10.1371/journal.pone.0129444
AMU-CURS-647	1 Carrillo-Briceño et al. 2016	Venezuela	Early Miocene	† <i>Galeocerdo aduncus</i>	doi:10.5167/uzh-125933
AMU-CURS-730	1 Carrillo-Briceño et al. 2016	Venezuela	Early Miocene	† <i>Galeocerdo aduncus</i>	doi:10.5167/uzh-125933
LPN 162	1 Capetta, 1970	France (Montpellier)	Miocene	† <i>Galeocerdo aduncus</i>	Cappetta 1970
LPN 163	1 Capetta, 1970	France (Montpellier)	Miocene	† <i>Galeocerdo aduncus</i>	Cappetta 1970
MUSM 3262	2 Landini et al. 2017	Peru	Late Miocene	† <i>Galeocerdo aduncus</i>	doi:10.1016/j.jsames.2016.12.010
NA	1 Pawellek et al. 2012	Libya	Early Pliocene	<i>Galeocerdo cuvier</i>	doi:10.1127/0077-7749/2012/0272
105Z100	1 Argyriou et al. 2015	Libya	Early Miocene	† <i>Galeocerdo mayumbensis</i>	doi:10.1016/j.jafrearsci.2014.11.008
112Z100	1 Argyriou et al. 2015	Libya	Early Miocene	† <i>Galeocerdo mayumbensis</i>	doi:10.1016/j.jafrearsci.2014.11.008
AMU-CURS-646	1 Carrillo-Briceño et al. 2016	Venezuela	Early Miocene	† <i>Galeocerdo mayumbensis</i>	doi:10.5167/uzh-125933
AMU-CURS-995	1 Carrillo-Briceño et al. 2016	Venezuela	Early Miocene	† <i>Galeocerdo mayumbensis</i>	doi:10.5167/uzh-125933
MPEG-1710-V	1 Aguilera et al. 2017	Brazil	Early Miocene	† <i>Galeocerdo mayumbensis</i>	doi:10.1371/journal.pone.0182740
MPEG-177-V	1 Aguilera et al. 2017	Brazil	Early Miocene	† <i>Galeocerdo mayumbensis</i>	doi:10.1371/journal.pone.0182740
MPEG-1854-V	1 Aguilera et al. 2017	Brazil	Early Miocene	† <i>Galeocerdo mayumbensis</i>	doi:10.1371/journal.pone.0182740
UAP-13.167	1 Andrianavalona et al. 2015	NW Madagascar	Miocene	† <i>Galeocerdo mayumbensis</i>	doi:10.1371/journal.pone.0129444
UAP-13.172	1 Andrianavalona et al. 2015	NW Madagascar	Miocene	† <i>Galeocerdo mayumbensis</i>	doi:10.1371/journal.pone.0129444
MPEG-781-V	1 Aguilera et al. 2017	Brazil	Early Miocene	† <i>Hemipristis serra</i>	doi:10.1371/journal.pone.0182740
MUN-STRI-34790	2 Carrillo-Briceño et al. 2019	Colombia	Middle Miocene	† <i>Hemipristis serra</i>	doi:10.5194/bg-16-33-2019
MUN-STRI-41132	1 Carrillo-Briceño et al. 2019	Colombia	Middle Miocene	† <i>Physogaleus contortus</i>	doi:10.5194/bg-16-33-2019
AMU-CURS-648	1 Carrillo-Briceño et al. 2016	Venezuela	Early Miocene	† <i>Physogaleus contortus</i>	doi:10.5167/uzh-125933
AMU-CURS-719	1 Carrillo-Briceño et al. 2016	Venezuela	Early Miocene	† <i>Physogaleus contortus</i>	doi:10.5167/uzh-125933
MUSM 3261	1 Landini et al. 2017	Peru	Late Miocene	† <i>Physogaleus contortus</i>	doi:10.1016/j.jsames.2016.12.010
EMRG-Chond-T-76	59 Vertebrate Collection, University of Vienna	USA (North Carolina)	Early Miocene	† <i>Galeocerdo aduncus</i>	doi:10.1017/pab.2021.6
NA	6 Haimuseum Aathal Switzerland	Germany	Miocene	† <i>Galeocerdo aduncus</i>	doi:10.1017/pab.2021.6
KM_DJ.033	3 Haimuseum Aathal Switzerland	Germany	Oligocene	† <i>Galeocerdo aduncus</i>	doi:10.1017/pab.2021.6
2012/0017/0240	14 Natural History Museum Vienna	USA (Florida)	Miocene	† <i>Galeocerdo aduncus</i>	doi:10.1017/pab.2021.6
UF 116830	2 Florida Museum of Natural History	USA (Florida)	Middle Miocene	† <i>Galeocerdo aduncus</i>	doi:10.1017/pab.2021.6
UF 217131	5 Florida Museum of Natural History	USA (Florida)	Middle Miocene	† <i>Galeocerdo aduncus</i>	doi:10.1017/pab.2021.6
UF 231021	1 Florida Museum of Natural History	USA (Florida)	Middle Miocene	† <i>Galeocerdo aduncus</i>	doi:10.1017/pab.2021.6
UF 232403	16 Florida Museum of Natural History	USA (Florida)	Middle Miocene	† <i>Galeocerdo aduncus</i>	doi:10.1017/pab.2021.6
UF 232425	1 Florida Museum of Natural History	USA (Florida)	Middle Miocene	† <i>Galeocerdo aduncus</i>	doi:10.1017/pab.2021.6
UF 234253	1 Florida Museum of Natural History	USA (Florida)	Middle Miocene	† <i>Galeocerdo aduncus</i>	doi:10.1017/pab.2021.6
UF 240484	7 Florida Museum of Natural History	USA (Florida)	Late Miocene	† <i>Galeocerdo aduncus</i>	doi:10.1017/pab.2021.6
UF 278633	1 Florida Museum of Natural History	USA (Florida)	Middle Miocene	† <i>Galeocerdo aduncus</i>	doi:10.1017/pab.2021.6
UF 28780	4 Florida Museum of Natural History	USA (Florida)	Middle Miocene	† <i>Galeocerdo aduncus</i>	doi:10.1017/pab.2021.6
UF/TRO 15237	1 Florida Museum of Natural History	USA (Florida)	Late Miocene	† <i>Galeocerdo aduncus</i>	doi:10.1017/pab.2021.6
24756	3 NMNH, Washington, D.C.	USA (North Carolina)	Miocene	† <i>Galeocerdo aduncus</i>	doi:10.1017/pab.2021.6
287850	27 NMNH, Washington, D.C.	USA (North Carolina)	Miocene	† <i>Galeocerdo aduncus</i>	doi:10.1017/pab.2021.6
KF-17E	1 Patnaik et al. 2014	India (Gujarat)	Early Miocene	† <i>Galeocerdo bigelowi</i>	doi:10.1017/pab.2021.6
NA	1 Lawley 1881	Italy (Tuscany)	Pliocene	† <i>Galeocerdo capellini</i>	doi:10.1017/pab.2021.6
IGM 5854	1 Universidad Nacional Autónoma de México	Mexico	Pliocene	† <i>Galeocerdo capellini</i>	doi:10.1017/pab.2021.6
1281	25 Universidad Nacional Autónoma de México	Mexico	Pliocene	† <i>Galeocerdo capellini</i>	doi:10.1017/pab.2021.6
S216(P49)	1 Müller 1999	USA (North Carolina)	Early Miocene	† <i>Galeocerdo casei</i>	doi:10.1017/pab.2021.6

S217(P49)	1 Müller 1999	USA (North Carolina)	Early Miocene	† <i>Galeocerdo casei</i>	doi:10.1017/pab.2021.6
P.30501	1 Natural History Museum London	USA (Alabama)	Early Eocene	† <i>Galeocerdo clarkensis</i>	doi:10.1017/pab.2021.6
P.30465-7	1 Natural History Museum London	USA (Alabama)	Early Eocene	† <i>Galeocerdo clarkensis</i>	doi:10.1017/pab.2021.6
NA	25 Haimuseum Aathal Switzerland	USA (South Carolina)	Late Eocene	† <i>Galeocerdo clarkensis</i>	doi:10.1017/pab.2021.6
UF 65552	1 Florida Museum of Natural History	USA (Florida)	Middle Miocene	<i>Galeocerdo cuvier</i>	doi:10.1017/pab.2021.6
NA	3 Haimuseum Aathal Switzerland	USA (Florida)	Miocene	<i>Galeocerdo cuvier</i>	doi:10.1017/pab.2021.6
NA	5 Haimuseum Aathal Switzerland	USA (North Carolina)	Late Miocene	<i>Galeocerdo cuvier</i>	doi:10.1017/pab.2021.6
NA	2 Florida Museum of Natural History	USA (North Carolina)	Pliocene	<i>Galeocerdo cuvier</i>	doi:10.1017/pab.2021.6
NA	1 Florida Museum of Natural History	USA (South Carolina)	Early Pliocene	<i>Galeocerdo cuvier</i>	doi:10.1017/pab.2021.6
NA	1 Florida Museum of Natural History	USA (North Carolina)	Miocene	<i>Galeocerdo cuvier</i>	doi:10.1017/pab.2021.6
EJ-XX-427	1 Florida Museum of Natural History	USA (Florida)	Miocene	<i>Galeocerdo cuvier</i>	doi:10.1017/pab.2021.6
UF/TRO 11181	1 Florida Museum of Natural History	USA (Florida)	Early Pliocene	<i>Galeocerdo cuvier</i>	doi:10.1017/pab.2021.6
UF/TRO 15482	3 Florida Museum of Natural History	USA (Florida)	Early Pliocene	<i>Galeocerdo cuvier</i>	doi:10.1017/pab.2021.6
UF/TRO 14220	3 Florida Museum of Natural History	USA (Florida)	Early Pliocene	<i>Galeocerdo cuvier</i>	doi:10.1017/pab.2021.6
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UF 227304	1 Florida Museum of Natural History	USA (Florida)	Early Pliocene	<i>Galeocerdo cuvier</i>	doi:10.1017/pab.2021.6
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UF/TRO 3801	3 Florida Museum of Natural History	USA (Florida)	Early Pliocene	<i>Galeocerdo cuvier</i>	doi:10.1017/pab.2021.6
UF/TRO 3876	3 Florida Museum of Natural History	USA (Florida)	Early Pliocene	<i>Galeocerdo cuvier</i>	doi:10.1017/pab.2021.6
UF/TRO 5438	4 Florida Museum of Natural History	USA (Florida)	Early Pliocene	<i>Galeocerdo cuvier</i>	doi:10.1017/pab.2021.6
UF/TRO 5603	1 Florida Museum of Natural History	USA (Florida)	Early Pliocene	<i>Galeocerdo cuvier</i>	doi:10.1017/pab.2021.6
UF/TRO 5679	1 Florida Museum of Natural History	USA (Florida)	Early Pliocene	<i>Galeocerdo cuvier</i>	doi:10.1017/pab.2021.6
UF/TRO 5700	2 Florida Museum of Natural History	USA (Florida)	Early Pliocene	<i>Galeocerdo cuvier</i>	doi:10.1017/pab.2021.6
UF/TRO 5745	2 Florida Museum of Natural History	USA (Florida)	Early Pliocene	<i>Galeocerdo cuvier</i>	doi:10.1017/pab.2021.6
UF/TRO 8604	1 Florida Museum of Natural History	USA (Florida)	Early Pliocene	<i>Galeocerdo cuvier</i>	doi:10.1017/pab.2021.6
UF/TRO 8935	1 Florida Museum of Natural History	USA (Florida)	Early Pliocene	<i>Galeocerdo cuvier</i>	doi:10.1017/pab.2021.6
UF/TRO 9227	2 Florida Museum of Natural History	USA (Florida)	Early Pliocene	<i>Galeocerdo cuvier</i>	doi:10.1017/pab.2021.6
EMRG-Chond-J-9	38 Vertebrate Collection, University of Vienna	Southeast Asia	Extant	<i>Galeocerdo cuvier</i>	doi:10.1017/pab.2021.6
EMRG-Chond-J-10	41 Vertebrate Collection, University of Vienna	Southeast Asia	Extant	<i>Galeocerdo cuvier</i>	doi:10.1017/pab.2021.6
EMRG-Chond-J-16	45 Vertebrate Collection, University of Vienna	nd	Extant	<i>Galeocerdo cuvier</i>	doi:10.1017/pab.2021.6
DGM 653-P	1 dos Reis 2005	Brasil (Pará)	Miocene	<i>Galeocerdo cuvier</i>	doi:10.1017/pab.2021.6
NA	1 Davis 1888	New Zealand	Middle Miocene	† <i>Galeocerdo davisi</i>	doi:10.1017/pab.2021.6
NA	14 Haimuseum Aathal Switzerland	Morocco (Ad Dakhla)	Late Eocene	† <i>Galeocerdo eaglesomei</i>	doi:10.1017/pab.2021.6
CGM 60025	1 Underwood et al. 2011	Egypt	Middle Eocene	† <i>Galeocerdo eaglesomei</i>	doi:10.1017/pab.2021.6
PAL 13577	1 Natural History Museum London	Nigeria	Middle Eocene	† <i>Galeocerdo eaglesomei</i>	doi:10.1017/pab.2021.6
P.13578	1 Natural History Museum London	Nigeria	Middle Eocene	† <i>Galeocerdo eaglesomei</i>	doi:10.1017/pab.2021.6
P.13579	1 Natural History Museum London	Nigeria	Middle Eocene	† <i>Galeocerdo eaglesomei</i>	doi:10.1017/pab.2021.6
P.13580	1 Natural History Museum London	Nigeria	Middle Eocene	† <i>Galeocerdo eaglesomei</i>	doi:10.1017/pab.2021.6
P.13581	1 Natural History Museum London	Nigeria	Middle Eocene	† <i>Galeocerdo eaglesomei</i>	doi:10.1017/pab.2021.6
P.13582	1 Natural History Museum London	Nigeria	Middle Eocene	† <i>Galeocerdo eaglesomei</i>	doi:10.1017/pab.2021.6
P.13583	1 Natural History Museum London	Nigeria	Middle Eocene	† <i>Galeocerdo eaglesomei</i>	doi:10.1017/pab.2021.6
P.13586	1 Natural History Museum London	Nigeria	Middle Eocene	† <i>Galeocerdo eaglesomei</i>	doi:10.1017/pab.2021.6
P.13588	1 Natural History Museum London	Nigeria	Middle Eocene	† <i>Galeocerdo eaglesomei</i>	doi:10.1017/pab.2021.6
P.13589	1 Natural History Museum London	Nigeria	Middle Eocene	† <i>Galeocerdo eaglesomei</i>	doi:10.1017/pab.2021.6
P.13591	1 Natural History Museum London	Nigeria	Middle Eocene	† <i>Galeocerdo eaglesomei</i>	doi:10.1017/pab.2021.6
P.13592	1 Natural History Museum London	Nigeria	Middle Eocene	† <i>Galeocerdo eaglesomei</i>	doi:10.1017/pab.2021.6
P.13593	1 Natural History Museum London	Nigeria	Middle Eocene	† <i>Galeocerdo eaglesomei</i>	doi:10.1017/pab.2021.6
P.73677	1 Natural History Museum London	Morocco (Ad Dakhla)	Late Eocene	† <i>Galeocerdo eaglesomei</i>	doi:10.1017/pab.2021.6
L.U. 211	1 Tewari et al. 1960	India (Gujarat)	Early Miocene	† <i>Galeocerdo gajensis</i>	doi:10.1017/pab.2021.6



DJ.033	1	Haimuseum Aathal Switzerland	USA (Texas)	Eocene	† <i>Galeocerdo latidens</i>	doi:10.1017/pab.2021.6
DJ.033	3	Haimuseum Aathal Switzerland	Great Britain	Eocene	† <i>Galeocerdo latidens</i>	doi:10.1017/pab.2021.6
NA	6	Haimuseum Aathal Switzerland	Togo	Late Eocene	† <i>Galeocerdo latidens</i>	doi:10.1017/pab.2021.6
NA	1	Haimuseum Aathal Switzerland	Morocco (Ad Dakhla)	Late Eocene	† <i>Galeocerdo latidens</i>	doi:10.1017/pab.2021.6
NA	3	Haimuseum Aathal Switzerland	UK (Sussex)	Eocene	† <i>Galeocerdo latidens</i>	doi:10.1017/pab.2021.6
NA	1	D. J. Kemp	UK (Hampshire)	Eocene	† <i>Galeocerdo latidens</i>	doi:10.1017/pab.2021.6
NA	2	D. J. Kemp	UK (Hampshire)	Eocene	† <i>Galeocerdo latidens</i>	doi:10.1017/pab.2021.6
DTK 14-19/9/85	2	D. J. Kemp	UK (Hampshire)	Eocene	† <i>Galeocerdo latidens</i>	doi:10.1017/pab.2021.6
DTK:2000.95.12.1	3	D. J. Kemp	UK (Hampshire)	Eocene	† <i>Galeocerdo latidens</i>	doi:10.1017/pab.2021.6
CGM 60026	1	Underwood et al. 2011	Egypt	Eocene	† <i>Galeocerdo latidens</i>	doi:10.1017/pab.2021.6
NA	10	Haimuseum Aathal Switzerland	USA (Florida)	Miocene	† <i>Galeocerdo mayumbensis</i>	doi:10.1017/pab.2021.6
UF 232399	4	Florida Museum of Natural History	USA (Florida)	Middle Miocene	† <i>Galeocerdo mayumbensis</i>	doi:10.1017/pab.2021.6
UF/TRO 6017	6	Florida Museum of Natural History	USA (Florida)	Middle Miocene	† <i>Galeocerdo mayumbensis</i>	doi:10.1017/pab.2021.6
UF/V 4963	1	Florida Museum of Natural History	USA (Florida)	Early Miocene	† <i>Galeocerdo mayumbensis</i>	doi:10.1017/pab.2021.6
UF/V 4988	1	Florida Museum of Natural History	USA (Florida)	Early Miocene	† <i>Galeocerdo mayumbensis</i>	doi:10.1017/pab.2021.6
UF/V 5118	1	Florida Museum of Natural History	USA (Florida)	Early Miocene	† <i>Galeocerdo mayumbensis</i>	doi:10.1017/pab.2021.6
UF/V 2676	1	Florida Museum of Natural History	USA (Florida)	Early Miocene	† <i>Galeocerdo mayumbensis</i>	doi:10.1017/pab.2021.6
UF/V 4181	2	Florida Museum of Natural History	USA (Florida)	Early Miocene	† <i>Galeocerdo mayumbensis</i>	doi:10.1017/pab.2021.6
NRPS-P12007	5	Swedish Museum of Natural History	New Guinea	Miocene	† <i>Galeocerdo mayumbensis</i>	doi:10.1017/pab.2021.6
N653-PDGM-DNPM	1	da Silva Santos & Travassos 1960	Brasil (Pará)	Early Miocene	† <i>Galeocerdo paulinoi</i>	doi:10.1017/pab.2021.6
334960	3	NMNH, Washington, D.C.	USA (Maryland)	Middle Miocene	† <i>Galeocerdo triqueter</i>	doi:10.1017/pab.2021.6
DJ.034	2	Haimuseum Aathal Switzerland	USA (Georgia)	Eocene	† <i>Hemipristis curvatus</i>	doi:10.1017/pab.2021.6
NA	3	Haimuseum Aathal Switzerland	Morocco (Ad Dakhla)	Late Eocene	† <i>Hemipristis curvatus</i>	doi:10.1017/pab.2021.6
NA	6	Haimuseum Aathal Switzerland	USA (Arkansas)	Early Pliocene	† <i>Hemipristis serra</i>	doi:10.1017/pab.2021.6
7-298	1	Haimuseum Aathal Switzerland	USA (California)	Miocene	† <i>Hemipristis serra</i>	doi:10.1017/pab.2021.6
NA	1	Lerliche 1910	France (Paris Basin)	Oligocene early	† <i>Physogaleus acutus</i>	doi:10.1017/pab.2021.6
PAL366457	1	NMNH, Washington, D.C.	USA (Alabama)	Early Eocene	† <i>Physogaleus alabamensis</i>	doi:10.1017/pab.2021.6
5361/15	1	Malyskhina et al. 2013	Ukraine (Crimea)	Middle Eocene	† <i>Physogaleus alabamensis</i>	doi:10.1017/pab.2021.6
KM EZ-AF GA/Ca7-194	1	Haimuseum Aathal Switzerland	nd	Eocene	† <i>Physogaleus alabamensis</i>	doi:10.1017/pab.2021.6
EMRG-Chond-T-74	21	Vertebrate Collection, University of Vienna	Morocco (Ad Dakhla)	Eocene	† <i>Physogaleus alabamensis</i>	doi:10.1017/pab.2021.6
NA	2	Haimuseum Aathal Switzerland	USA (New Jersey)	Early Miocene	† <i>Physogaleus contortus</i>	doi:10.1017/pab.2021.6
EMRG-Chond-T-75	26	Vertebrate Collection, University of Vienna	USA (North Carolina)	Early Miocene	† <i>Physogaleus contortus</i>	doi:10.1017/pab.2021.6
P.9083-4	2	Natural History Museum London	Argentina	Late Oligocene	† <i>Physogaleus contortus</i>	doi:10.1017/pab.2021.6
NA	1	Florida Museum of Natural History	USA (Florida)	Miocene	† <i>Physogaleus contortus</i>	doi:10.1017/pab.2021.6
UF 227864	1	Florida Museum of Natural History	USA (Florida)	Early Pliocene	† <i>Physogaleus contortus</i>	doi:10.1017/pab.2021.6
UF 228424	1	Florida Museum of Natural History	USA (Florida)	Middle Miocene	† <i>Physogaleus contortus</i>	doi:10.1017/pab.2021.6
UF 231020	1	Florida Museum of Natural History	USA (Florida)	Middle Miocene	† <i>Physogaleus contortus</i>	doi:10.1017/pab.2021.6
UF 231225	3	Florida Museum of Natural History	USA (Florida)	Middle Miocene	† <i>Physogaleus contortus</i>	doi:10.1017/pab.2021.6
UF 240509	1	Florida Museum of Natural History	USA (Florida)	Late Miocene	† <i>Physogaleus contortus</i>	doi:10.1017/pab.2021.6
UF 28779	7	Florida Museum of Natural History	USA (Florida)	Middle Miocene	† <i>Physogaleus contortus</i>	doi:10.1017/pab.2021.6
UF/V 9977	1	Florida Museum of Natural History	USA (Florida)	Early Miocene	† <i>Physogaleus contortus</i>	doi:10.1017/pab.2021.6
UF/TRO 11514	1	Florida Museum of Natural History	USA (Florida)	Middle Miocene	† <i>Physogaleus contortus</i>	doi:10.1017/pab.2021.6
UF/TRO 14490	1	Florida Museum of Natural History	USA (Florida)	Middle Miocene	† <i>Physogaleus contortus</i>	doi:10.1017/pab.2021.6
UF/TRO 14631	3	Florida Museum of Natural History	USA (Florida)	Middle Miocene	† <i>Physogaleus contortus</i>	doi:10.1017/pab.2021.6
UF/TRO 15103	2	Florida Museum of Natural History	USA (Florida)	Middle Miocene	† <i>Physogaleus contortus</i>	doi:10.1017/pab.2021.6
UF/TRO 15236	1	Florida Museum of Natural History	USA (Florida)	Late Miocene	† <i>Physogaleus contortus</i>	doi:10.1017/pab.2021.6
UF/TRO 15241	1	Florida Museum of Natural History	USA (Florida)	Middle Miocene	† <i>Physogaleus contortus</i>	doi:10.1017/pab.2021.6
UF/TRO 15442	5	Florida Museum of Natural History	USA (Florida)	Middle Miocene	† <i>Physogaleus contortus</i>	doi:10.1017/pab.2021.6
UF/TRO 9881	2	Florida Museum of Natural History	USA (Florida)	Middle Miocene	† <i>Physogaleus contortus</i>	doi:10.1017/pab.2021.6

**Table S6.** Linear Discriminant Analysis of shark teeth, related to Figure 9.

a) LDA Shark genera (6 PCs)										
Genera Confusion Matrix										
	<i>Carcharhinus</i>	<i>Galeocerdo</i>	<i>Hemipristis</i>	<i>Physogaleus</i>						
<i>Carcharhinus</i>	0.571428571	0	0.224489796	0						
<i>Galeocerdo</i>	0	76.58843537	0.044217687	6.741496599						
<i>Hemipristis</i>	0.108843537	0.360544218	0.880952381	0.197278912						
<i>Physogaleus</i>	0	1.962585034	0.891156463	11.42857143						
Accuracy	0.89									
Cohen's Kappa	0.6652854									
Gorongosa fossil predictions (posterior probabilities)										
	<i>Carcharhinus</i>	<i>Galeocerdo</i>	<i>Hemipristis</i>	<i>Physogaleus</i>						
Gorongosa_A_PPG2019-P-129	0.00%	97.53%	0.02%	2.45%						
Gorongosa_B_PPG2019-P-127	0.00%	96.04%	1.81%	2.16%						
b) LDA using <i>Galeocerdo</i> & <i>Physogaleus</i> genera (4 PCs)										
<i>Galeocerdo</i> & <i>Physogaleus</i> Confusion Matrix										
	<i>Galeocerdo aduncus</i>	<i>Galeocerdo capellini</i>	<i>Galeocerdo clarkensis</i>	<i>Galeocerdo cuvier</i>	<i>Galeocerdo eaglesomei</i>	<i>Galeocerdo mayumbensis</i>	<i>Physogaleus alabamensis</i>	<i>Physogaleus contortus</i>		
<i>Galeocerdo aduncus</i>	11.03759398	0.285714286	1.255639098	3.597744361	0.045112782	0	1.436090226	0.996240602		
<i>Galeocerdo capellini</i>	0	0.116541353	0	0.165413534	0.007518797	0	0.011278195	0		
<i>Galeocerdo clarkensis</i>	0.206766917	0.007518797	0.078947368	0.063909774	0.105263158	0	0.15037594	0		
<i>Galeocerdo cuvier</i>	6.469924812	3.763157895	0.578947368	34.27067669	0.545112782	0.80075188	0.639097744	0.296992481		
<i>Galeocerdo eaglesomei</i>	0.308270677	0.109022556	0.218045113	0.815789474	4.07518797	0.387218045	0.684210526	0		
<i>Galeocerdo mayumbensis</i>	0	0.229323308	0.304511278	0.289473684	0.184210526	4.827067669	0	0		
<i>Physogaleus alabamensis</i>	1.015037594	0	1.72556391	0.646616541	0.30075188	0	3.721804511	0.236842105		
<i>Physogaleus contortus</i>	0.511278195	0	0.34962406	0	0	0	0.12406015	12.0037594		
Accuracy	0.7022556									
Cohen's Kappa	0.5994338									
Gorongosa fossil predictions (posterior probabilities)										
	<i>Galeocerdo aduncus</i>	<i>Galeocerdo capellini</i>	<i>Galeocerdo clarkensis</i>	<i>Galeocerdo cuvier</i>	<i>Galeocerdo eaglesomei</i>	<i>Galeocerdo mayumbensis</i>	<i>Physogaleus alabamensis</i>	<i>Physogaleus contortus</i>		
Gorongosa_A_PPG2019-P-129	12.36%	16.61%	11.22%	27.80%	13.72%	12.54%	5.75%	0.00%		
Gorongosa_B_PPG2019-P-127	35.43%	1.01%	28.05%	8.16%	6.62%	0.19%	20.42%	0.12%		
c) LDA using <i>Galeocerdo</i> species (4 PCs)										
<i>Galeocerdo</i> species confusion Matrix										
	<i>Galeocerdo aduncus</i>	<i>Galeocerdo capellini</i>	<i>Galeocerdo clarkensis</i>	<i>Galeocerdo cuvier</i>	<i>Galeocerdo eaglesomei</i>	<i>Galeocerdo mayumbensis</i>				
<i>Galeocerdo aduncus</i>	17.06132075	0.429245283	3.382075472	3.844339623	0.023584906	0				
<i>Galeocerdo capellini</i>	0	0.367924528	0.051886792	0.731132075	0.04245283	0				
<i>Galeocerdo clarkensis</i>	0.273584906	0.018867925	0.54245283	0.113207547	0.533018868	0				
<i>Galeocerdo cuvier</i>	6.806603774	4.443396226	0.981132075	44.33962264	0.768867925	1				
<i>Galeocerdo eaglesomei</i>	0.386792453	0.113207547	0.235849057	0.716981132	4.985849057	0.872641509				
<i>Galeocerdo mayumbensis</i>	0	0.287735849	0.466981132	0.254716981	0.25	5.674528302				
Accuracy	0.729717									
Cohen's Kappa	0.5749247									
Gorongosa fossil predictions (posterior probabilities)										
	<i>Galeocerdo aduncus</i>	<i>Galeocerdo capellini</i>	<i>Galeocerdo clarkensis</i>	<i>Galeocerdo cuvier</i>	<i>Galeocerdo eaglesomei</i>	<i>Galeocerdo mayumbensis</i>				
Gorongosa_A_PPG2019-P-129	9.43%	12.75%	11.14%	31.04%	18.08%	17.54%				
Gorongosa_B_PPG2019-P-127	47.18%	0.11%	37.04%	2.52%	13.09%	0.07%				

Confusion matrix entries are average cell counts across the 200 resamples

**Table S7.** List of fossil hyracoid mandibular specimens used in comparative sample, related to Figure 12.

<b>Specimen</b>	<b>Museum</b>	<b>Online repository</b>	<b>Genus</b>	<b>Species</b>	<b>doi/ark</b>
KA1-1190	Ditsong National Museum of Natural History	Morphosource	<i>Procavia</i>	<i>Procavia transvaalensis</i>	doi:10.17602/M2/M5459
G7052	Ditsong National Museum of Natural History	Morphosource	<i>Procavia</i>	<i>Procavia</i> sp.	doi:10.17602/M2/M5470
H.5281.B	University Museum of Zoology, Cambridge	Morphosource	<i>Dendrohyrax</i>	<i>Dendrohyrax arboreus</i>	doi:10.17602/M2/M48250
RU18568	National Museums of Kenya		<i>Afrohyrax</i>	<i>Afrohyrax</i> sp.	
ZP349	National Museums of Kenya		<i>Afrohyrax</i>	<i>Afrohyrax championi</i>	
RU15198(A)	National Museums of Kenya		<i>Afrohyrax</i>	<i>Afrohyrax championi</i>	
DPC2150	Duke Lemur Center Division of Fossil Primates	Morphosource	<i>Saghatherium</i>	<i>Saghatherium humarum</i>	ark:/87602/m4/M103969
DPC18145	Duke Lemur Center Division of Fossil Primates	Morphosource	<i>Saghatherium</i>	<i>Saghatherium bowni</i>	ark:/87602/m4/M31737
DPC17675	Duke Lemur Center Division of Fossil Primates	Morphosource	<i>Thyrohyrax</i>	<i>Thyrohyrax meyeri</i>	ark:/87602/m4/M81579
DPC13282	Duke Lemur Center Division of Fossil Primates	Morphosource	<i>Saghatherium</i>	<i>Saghatherium bowni</i>	ark:/87602/m4/M83288
DPC2763	Duke Lemur Center Division of Fossil Primates	Morphosource	<i>Thyrohyrax</i>	<i>Thyrohyrax domorictus</i>	ark:/87602/m4/M103971
DPC15384	Duke Lemur Center Division of Fossil Primates	Morphosource	<i>Saghatherium</i>	<i>Saghatherium bowni</i>	
DPC5283	Duke Lemur Center Division of Fossil Primates	Morphosource	<i>Megalohyrax</i>	<i>Megalohyrax eocaenus</i>	ark:/87602/m4/M104021
DPC12048	Duke Lemur Center Division of Fossil Primates	Morphosource	<i>Saghatherium</i>	<i>Saghatherium bowni</i>	ark:/87602/m4/M81573

**Table S8.** List of fossil hyracoid lower third molars used in comparative sample, related to Figure 13.

Specimen	Museum	Online	Taxon	doi/ark notes
ZP1508	NMK		<i>Bunohyrax</i> aff. <i>fajumensis</i>	cast
RU15198(A)	NMK		<i>Afrohyrax championi</i>	
DPC7369	Duke Lemur Center	Morphosource	<i>Thyrohyrax domoricus</i>	ark:/87602/m4/M104159
RU18568	NMK		<i>Afrohyrax</i> sp.	
ZP349	NMK		<i>Afrohyrax championi</i>	cast
ZP347	NMK		<i>Afrohyrax championi</i>	cast
ZP1211	NMK		<i>Thyrohyrax domoricus</i>	cast
WK18206(A)	NMK		<i>Afrohyrax championi</i>	
DPC2763	Duke Lemur Center	Morphosource	<i>Thyrohyrax domoricus</i>	ark:/87602/m4/M103971
DPC18145	Duke Lemur Center	Morphosource	<i>Sagatherium boweni</i>	ark:/87602/m4/M31737
DPC2150	Duke Lemur Center	Morphosource	<i>Sagatherium humarum</i>	ark:/87602/m4/M103969
DPC5283	Duke Lemur Center	Morphosource	<i>Megalohyrax eocaenus</i>	ark:/87602/m4/M104021
DPC12048	Duke Lemur Center	Morphosource	<i>Sagatherium boweni</i>	ark:/87602/m4/M81573
NW22558 (C)	NMK		<i>Meroehyrax kyongoi</i>	
DPC17675	Duke Lemur Center	Morphosource	<i>Thyrohyrax meyeri</i>	ark:/87602/m4/M81579
DPC15384	Duke Lemur Center	Morphosource	<i>Sagatherium boweni</i>	
DPC13282	Duke Lemur Center	Morphosource	<i>Sagatherium boweni</i>	ark:/87602/m4/M83288
ZP1255	NMK		<i>Parapliohyrax mirabilis</i>	cast
BN802 (H)	NMK		<i>Parapliohyrax ngororaensis</i>	
LP22529	NMK		<i>Thyrohyrax microdon</i>	
KA1–1190	Ditsong NMNH	Morphosource	<i>Procavia transvaalensis</i>	doi:10.17602/M2/M5459
G7052	Ditsong NMNH	Morphosource	<i>Procavia</i> sp.	doi:10.17602/M2/M5470
NK41304	NMK		<i>Dendrohyrax</i> cf. <i>validus</i>	
NK36934	NMK		<i>Dendrohyrax</i> cf. <i>validus</i>	
H.5281.B	University Museum of Zoology, Cambridge	Morphosource	<i>Dendrohyrax arboreus</i>	doi:10.17602/M2/M48250

**Table S9.** Divergence time estimates and posterior support for the hyracoid phylogeny, related to Figure 14.

Node Number	Minimum bound for the Age 95% highest posterior density interval (HPD) [Ma]	Maximum bounds for the Age 95% highest posterior density interval (HPD) [Ma]	Mean divergence time [Ma]	Posterior support
1	12	23	17.5	0.4
2	16	26.6	21.3	0.72
3	28.1	32.1	30.1	0.74
4	33.9	36.1	35	0.68
5	34.1	38.4	36.3	0.74
6	35.1	41	38	0.29
7	33.9	35.8	34.9	0.9
8	34.1	37	35.5	0.65
9	33.9	35.7	34.8	0.98
10	34.7	38.7	36.7	0.98
11	33.9	37.4	35.7	0.92
12	35.6	40.9	38.3	0.82
13	28.2	34.7	31.4	0.4
14	33.9	36.7	35.3	0.42
15	33.9	35.5	34.7	0.99
16	34.4	38.7	36.5	0.81
17	36.3	42.2	39.3	0.25
18	37	43.6	40.3	0.21
19	33.9	36	35	0.68
20	34	38	36	1
21	37.7	45	41.4	1
22	39.4	47.6	43.5	0.49
23	41.8	49.9	45.8	1
24	47.8	54.8	51.3	0.92
25	56	59.6	57.8	1

## Supplemental References

[1] Cappetta, H. (1970). Les Sélaciens du Miocène de la région de Montpellier. *Palaeovertebrata Mémoire extraordinaire*, 1-139.