

Table S1

Sample ID ¹⁻⁴			
Additional database & ID number	Taxonomy	Species	Age
15188	Cingulata	<i>Doedicurus</i> sp.	
15190	Cingulata	<i>Doedicurus</i> sp.	Lujanian (8.5-128 ka)
15191	Cingulata	<i>Doedicurus</i> sp.	See Table S2 Chapadmalalan
15928	Cingulata	Doedicurinae	(4.5–3.3 Ma) Lujanian (8.5-128
15192	Cingulata	<i>Glyptodon</i> sp.	ka) Lujanian (8.5-128 ka)
15193	Cingulata	<i>Glyptodon</i> sp.	Lujanian (8.5-128 ka) Lujanian
15194	Cingulata	<i>Glyptodon</i> sp.	(8.5-128 ka) Lujanian (8.5-128
15195	Cingulata	<i>Glyptodon</i> sp.	ka) Bonarean (128-400 ka)
15196	Cingulata	<i>Glyptodon</i> sp.	Lujanian (8.5-128 ka)
15197	Cingulata	<i>Glyptodon</i> sp.	
15198	Cingulata	<i>Glyptodon</i> sp.	
16850	Cingulata	<i>Glyptodon</i> sp.	
16851	Cingulata	<i>Glyptodon</i> sp.	Lujanian (8.5-128 ka)
16854	Cingulata	<i>Glyptodon</i> sp.	late Pleistocene (11.7-128 ka)
15199	Cingulata	<i>Panochthus</i> sp.	Chapadmalalan (4.5-3.3 Ma)
17466	Cingulata	<i>Holmesina</i> sp.	
15929	Cingulata	<i>Macrochorobates</i> sp.	
14724	Folivora	<i>Acratocnus odontrigonus</i>	See Table S2
15558	Folivora	<i>Acratocnus ye</i>	
15559	Folivora	<i>Acratocnus ye</i>	
15560	Folivora	<i>Acratocnus ye</i>	See Table S2
15561	Folivora	<i>Acratocnus ye</i>	
15565	Folivora	<i>Acratocnus</i> sp.	
15566	Folivora	<i>Acratocnus</i> sp.	
16846	Folivora	<i>Acratocnus antillensis</i>	modern
16847	Folivora	<i>Acratocnus antillensis</i>	modern
16265	Folivora	<i>Bradypus variegatus</i>	Pleistocene (0.0117-2.6 Ma)
17009	Folivora	<i>Choloepus hoffmanni</i>	late Pleistocene (11.7-128 ka)
17472	Folivora	<i>Diabolootherium nordenskioldi</i>	late Pleistocene (11.7-128 ka)
17473	Folivora	<i>Diabolootherium nordenskioldi</i>	late Pleistocene (11.7-128 ka)
17474	Folivora	<i>Diabolootherium nordenskioldi</i>	late Pleistocene (11.7-128 ka)
17475	Folivora	<i>Diabolootherium nordenskioldi</i>	
17476	Folivora	<i>Diabolootherium nordenskioldi</i>	
14721	Folivora	<i>Eremotherium rusconi</i>	
15546	Folivora	<i>Eremotherium</i> sp.	

15216	Folivora	<i>Glossotherium robustum</i>	Bonarean (128-400 ka)
15214	Folivora	<i>Glossotherium</i> sp.	
15215	Folivora	<i>Glossotherium</i> sp.	Ensenadan (0.4-1.8 Ma)
15217	Folivora	<i>Glossotherium</i> sp.	Lujanian (8.5-128 ka)
15218	Folivora	<i>Glossotherium</i> sp.	Lujanian (8.5-128 ka)
15219	Folivora	<i>Glossotherium</i> sp.	Lujanian (8.5-128 ka)
15222	Folivora	<i>Glossotherium</i> sp.	Ensenadan (0.4-1.8 Ma)
15223	Folivora	<i>Glossotherium</i> sp.	
15224	Folivora	<i>Glossotherium</i> sp.	
15211	Folivora	<i>Lestodon</i> sp.	Lujanian (8.5-128 ka)
15212	Folivora	<i>Lestodon</i> sp.	?Ensenadan (0.4-1.8 Ma)
15213	Folivora	<i>Lestodon</i> sp.	?Ensenadan (0.4-1.8 Ma)
15562	Folivora	<i>Megalocnus zile</i>	
15563	Folivora	<i>Megalocnus zile</i>	
15564	Folivora	<i>Megalocnus zile</i>	
16267	Folivora	<i>Megalonyx jeffersonii</i>	Pleistocene (0.0117-2.6 Ma)
16268	Folivora	<i>Megalonyx jeffersonii</i>	Pleistocene (0.0117-2.6 Ma)
16269	Folivora	<i>Megalonyx jeffersonii</i>	Pleistocene (0.0117-2.6 Ma)
16270	Folivora	<i>Megalonyx jeffersonii</i>	Pleistocene (0.0117-2.6 Ma)
16271	Folivora	<i>Megalonyx jeffersonii</i>	Pleistocene (0.0117-2.6 Ma)
16849	Folivora	<i>Megalonyx jeffersonii</i>	See Table S2
14722	Folivora	<i>Megalonyx jeffersonii</i>	
14719	Folivora	<i>Megalonyx</i> sp.	
17479	Folivora	Megalonychidae	Late Pleistocene (11.7-126 ka)
14713	Folivora	<i>Megatherium urbinai</i>	
15225	Folivora	<i>Megatherium americanum</i>	See Table S2
15226	Folivora	<i>Megatherium</i> sp.	
15227	Folivora	<i>Megatherium</i> sp.	Lujanian (8.5-128 ka)
15228	Folivora	<i>Megatherium</i> sp.	Ensenadan (0.4-1.8 Ma)
16852	Folivora	<i>Megatherium</i> sp.	
16853	Folivora	<i>Megatherium</i> sp.	
16220	Folivora	<i>Mylodon darwinii</i>	
16222	Folivora	<i>Mylodon darwinii</i>	See Table S2
16223	Folivora	<i>Mylodon darwinii</i>	
16224	Folivora	<i>Mylodon darwinii</i>	
15777	Folivora	<i>Mylodon</i> sp.	
15778	Folivora	<i>Mylodon</i> sp.	

15221	Folivora	<i>Mylodon</i> sp.	
15567	Folivora	Mylodontidae	
14717	Folivora	<i>Nothrotheriops shastensis</i>	
14718	Folivora	<i>Nothrotheriops shastensis</i>	
14723	Folivora	<i>Nothrotheriops shastensis</i>	See Table S2
15231	Folivora	Nothrotheridae	Huayquerian (9–5.28 Ma)
14716	Folivora	<i>Neocnus comes</i>	
15547	Folivora	<i>Neocnus comes</i>	
15548	Folivora	<i>Neocnus comes</i>	See Table S2
15549	Folivora	<i>Neocnus comes</i>	
15779	Folivora	<i>Neocnus comes</i>	4391 +/- 42 BP ⁶
15780	Folivora	<i>Neocnus comes</i>	4486 +/- 39 BP ⁶
15781	Folivora	<i>Neocnus dousman</i>	9867 +/- 65 BP ⁶
15782	Folivora	<i>Neocnus glirformis</i>	
16844	Folivora	<i>Neocnus glirformis</i>	
16845	Folivora	<i>Neocnus glirformis</i>	
15550	Folivora	<i>Neocnus</i> sp.	
15551	Folivora	<i>Neocnus</i> sp.	
15552	Folivora	<i>Neocnus</i> sp.	
15553	Folivora	<i>Neocnus</i> sp.	
14715	Folivora	<i>Paramylodon harlani</i>	See Table S2
15229	Folivora	<i>Pliomegatherium</i> sp.	Huayquerian (9.0–5.28 Ma)
15775	Folivora	<i>Parocnus browni</i>	
14714	Folivora	<i>Parocnus serus</i>	
15554	Folivora	<i>Parocnus serus</i>	
15555	Folivora	<i>Parocnus serus</i>	
15556	Folivora	<i>Parocnus serus</i>	See Table S2
15557	Folivora	<i>Parocnus serus</i>	
15776	Folivora	<i>Parocnus serus</i>	>14,200 BP ⁶
16940	Folivora	<i>Pliometanastes protistus</i>	late Miocene (5.33-11.6 Ma)
14720	Folivora	<i>Scelidothorium capellini</i>	
15200	Folivora	<i>Scelidothorium</i> sp.	Ensenadan (0.4-1.8 Ma)
15201	Folivora	<i>Scelidothorium</i> sp.	Ensenadan (0.4-1.8 Ma)
15202	Folivora	<i>Scelidothorium</i> sp.	Ensenadan (0.4-1.8 Ma)
15203	Folivora	<i>Scelidothorium</i> sp.	Ensenadan (0.4-1.8 Ma)
15204	Folivora	<i>Scelidothorium</i> sp.	Ensenadan (0.4-1.8 Ma)

15205	Folivora	<i>Scelidotherium</i> sp.	Ensenadan (0.4-1.8 Ma)
15206	Folivora	<i>Scelidotherium</i> sp.	Ensenadan (0.4-1.8 Ma)
15207	Folivora	<i>Scelidotherium</i> sp.	Ensenadan (0.4-1.8 Ma)
15208	Folivora	<i>Scelidotherium</i> sp.	Lujanian (8.5-128 ka)
15209	Folivora	<i>Scelidotherium</i> sp.	Ensenadan (0.4-1.8 Ma)
15210	Folivora	<i>Scelidotherium</i> sp.	Ensenadan (0.4-1.8 Ma)
15220	Folivora	<i>Scelidodon</i> sp.	Ensenadan (0.4-1.8 Ma)
17480	Folivora	<i>Scelidodon</i> sp.	Pleistocene (0.0117-2.6 Ma)
16957	Folivora	<i>Thalassocnus yancensis</i>	late Pliocene (2.58-3.6 Ma)
16958	Folivora	<i>Thalassocnus yancensis</i>	late Pliocene (2.58-3.6 Ma)
16959	Folivora	<i>Thalassocnus yancensis</i>	early Pliocene (3.6-5.33 Ma)
16960	Folivora	<i>Thalassocnus yancensis</i>	early Pliocene (3.6-5.33 Ma)
GenBank XP_004470764	Cingulata	<i>Dasyus novemcinctus</i>	modern
Uniprot COHJP1/COHJP2	Vermilingua	<i>Cyclopes didactylus</i>	modern
Buckley et al. (2015)	Folivora	<i>Lestodon armatus</i>	"30000 BP"

¹ Ages (epochal, subepochal, SALMA) based on museum catalog data; blank entry indicates no age data was available

² In some collections, specimens here allocated to *Neocnus* sp. or to *N. comes* are generally ascribed to "*Synocnus* sp. A"; specimens here allocated to *Acratocnus* sp. or *A. ye* are sometimes ascribed to "*Habanocnus* sp. A"

³ Regarding specimens selected for MS/MS, lab analyses were conducted at the following facilities:

Megalonyx jeffersonii ID 16849 Chait Laboratory of Mass Spectrometry and Gaseous Ion Chemistry, Rockefeller University

Myiodon darwinii ID 16222, proteomic facility, Univ. Copenhagen; all remaining samples, Advanced Proteomic Facility, Oxford

⁴ Radiocarbon dates as published by Steadman et al. (2005)

⁵ ID numbers: for access to samples, contact corresponding author

Additonal Information		Screening results		
Location	Element	MADLI-ToF/SDS PAGE	AAR results	MS/MS
Rio Salado, Buenos Aires, Argentina	scute	Poor	Good	
Camet Norte, Buenos Aires, Argentina	pelvis? frag.	Poor	Good	
Camet Norte, Buenos Aires, Argentina	scute	Good	Good	Y
Mar del Plata, Buenos Aires, Argentina	middle phalanx	Poor	Poor	
Caracaraña, Santa Fé, Argentina	mandible frag.	Poor	Poor	
Buenos Aires, Argentina	humerus	Poor	Poor	
Buenos Aires, Argentina	femur	Good	Good	Y
Buenos Aires, Argentina	pelvis	Poor	Good	
Buenos Aires, Argentina	calcaneus	Good	Good	
Regimiento Militar Gala 601, Buenos Aires, Argentina	scute	Poor	Poor	
Camet Norte, Buenos Aires, Argentina	scute	Poor	Good	
Forest Reserve, Trinidad	osteoderm	Poor	Poor	
Forest Reserve, Trinidad	osteoderm	Poor	Poor	
Forest Reserve, Trinidad	maxilla	Poor	Poor	
Camet Norte, Buenos Aires, Argentina	scute	Poor	Poor	
La Brea, Talara, Peru	Isolated Scute	Poor	Poor	
Mar del Plata, Buenos Aires, Argentina	scute	Poor	Poor	
Nesophontes Cave, Utuado, Puerto Rico	phalanx	Poor	Poor	
Trouing de la Scierie, Haiti	petrosal frag.	Good	Good	
Trouing Marassa, Haiti	mandible	Good	Good	Y
Trouing Ismay, Haiti	petrosal frag.	Good	Good	
Trouing Ismay, Haiti	skull frag.	Good	Good	
Trouing Marassa, Haiti	mandible	Good	Good	Y
Trouing Marassa, Haiti	petrosal frag.	Good	Good	
Cantera J-4 No. 1, Matanzas, Cuba	humerus	Poor	Poor	
Cantera J-4 No. 1, Matanzas, Cuba	humerus	Poor	Poor	
Costa Rica	petrosal	Good	N/A	
Costa Rica	phalanx	Good	N/A	
Cueva Rosello, Peru	long bone frag.	Poor	Poor	
Pozo Hondo I, Cueva Jatun Uchco, Peru	radius	Poor	Poor	
Cueva Jatun Uchco, Peru	mandible	Poor	Poor	
Cueva Jatun Uchco, Peru	ribs	Poor	Poor	
Pozo Hondo I, Cueva Jatun Uchco, Peru	pelvis	Poor	Poor	
El Patillo, Panama	phalanx	Poor	Poor	
Waccasassa, Florida, USA	vertebra	Poor	Poor	

Quequén Grande, Buenos Aires, Argentina	skull	Good	Good	Y
Quequén Salado, Buenos Aires, Argentina	metapod	Poor	Poor	
unknown	mandible	Poor	Poor	
Río Salado, Santa Fé, Argentina	tibia	Poor	Poor	
San Pedro, Buenos Aires, Argentina	skull	Poor	Poor	
Camet Norte, Buenos Aires, Argentina	mandible	Poor	Poor	
Río de la Plata, Buenos Aires, Argentina	femur	Poor	Good	
unknown	astragalus	Poor	Poor	
unknown	atlas	Poor	Poor	
Luján, Buenos Aires, Argentina	tibia	Poor	Poor	
Punta Hermengo, Buenos Aires, Argentina	mandible	Poor	Poor	
Punta Hermengo, Buenos Aires, Argentina	tibia	Poor	Poor	
Trou Gallery; I`le de la Tortue, Haiti	fibula	Poor	Good	
Trou Gallery; I`le de la Tortue, Haiti	patella	Poor	Poor	
Trou Gallery; I`le de la Tortue, Haiti	pelvis frag.	Good	Poor	Y
Port Kennedy, Pennsylvania, USA	petrosal	Poor	Good	
Port Kennedy, Pennsylvania, USA	middle phalanx	Poor	Poor	
Port Kennedy, Pennsylvania, USA	middle phalanx	Poor	Good	
Port Kennedy, Pennsylvania, USA	carpus/tarsus	Poor	Poor	
Port Kennedy, Pennsylvania, USA	metapodial	Poor	Good	
Newburgh, Orange Co., New York, USA	pelvis	Good	Good	Y
Amercian Falls, Idaho, USA	jaw	Poor	Poor	
Red Hill Cave, Arizona, USA	cervical vertebra	Poor	Poor	
Cueva Jatun Uchco, Peru	tibia	Poor	Poor	
Ocucaje, Ica, Peru	humerus	Poor	Good	
Bariloche, Río Negro, Argentina	rib (assoc. with skull)	Good	Good	Y
unknown	astragalus	Poor	Poor	
Camet Norte, Buenos Aires, Argentina	mandible	Good	Good	
Olivos, "toscas del Río de la Plata", Buenos Aires, Argentina	mandible	Poor	Poor	
Forest Reserve, Trinidad	distal phalanx	Poor	Poor	
Forest Reserve, Trinidad	molar	Poor	Poor	
Cueva del Medio, Última Esperanza, Chile	scapula	Good	Good	
Cueva del Medio, Última Esperanza, Chile	caudal vertebra	Good	Good	Y
Cueva del Medio, Última Esperanza, Chile	thoracic vertebra	Good	Good	
Cueva del Medio, Última Esperanza, Chile	metapodial?	Good	Good	
El Trebol, Río Negro, Argentina	rib	Good	Good	
El Trebol, Río Negro, Argentina	long bone frag	Good	Good	

Córdoba, Argentina	tibia	Good	Good	
Tarija, Bolivia	astragalus	Poor	Poor	
Rampart Cave, Arizona, USA	humerus	Poor	Good	
Rampart Cave, Arizona, USA	tibia	Poor	Good	
Rampart Cave, Arizona, USA	femur	Good	Good	Y
Huayquerias del Este, Mendoza, Argentina	rib (assoc. with skull)	Poor	Poor	
Trou Diable (St Michaels cave), Haiti	femur	Poor	Poor	
Trou Diable (St Michaels cave), Haiti	mandible	Poor	Poor	
Trouing de la Scierie, Haiti	mandible	Good	Good	Y
Trouing Marassa, Haiti	pelvis	Good	Good	
Trouing Ismays, Haiti	humerus shaft	Good	Good	
Trouing Deron, Haiti	pelvis frag.	Good	Good	Y
Trouing Marrasa, Haiti	tibia	Poor	Good	Y
Cantera J-4 No. 1, Matanzas, Cuba	skull, zygomatic	Poor	Good	
Cantera J-4 No. 1, Matanzas, Cuba	humerus	Poor	Poor	
Cantera J-4 No. 1, Matanzas, Cuba	humerus	Poor	Poor	
Trouing Marassa, Haiti	humerus	Good	Good	
Trouing Marassa, Haiti	humerus	Good	Good	
Trouing Marassa, Haiti	tibia	Good	Good	
Trouing Jeremie #5, Haiti	mandible	Good	Good	
Roseburgh, Oregon, USA	femur	Good	Good	Y
Río Paraná, Entre Ríos, Argentina	mandible	Poor	Poor	
Las Breas de San Felipe, Cuba	femur	Poor	Poor	
Trou Diable (St Michaels cave), Haiti	humerus	Poor	Poor	
Trou Zombie, Haiti	femur	Poor	Poor	
Trou Gallery; l'le de la Tortue, Haiti	squamosal	Poor	Good	
Trouing Marassa, Haiti	humerus epiphysis	Good	Good	Y
unknown (Marcano collection)	femur	Poor	Poor	
Trou Gallery; l'le de la Tortue, Haiti	femur	Poor	Poor	
McGehee farm, Florida, USA	distal femur	Poor	Poor	
Tabladita, Tarija, Bolivia	jaw	Poor	Poor	
Punta Piedras, Buenos Aires, Argentina	fibula	Poor	Poor	
Olivos, "toscas del Río de la Plata", Buenos Aires, Argentina	astragalus	Poor	Poor	
Arroyo El Moro, Buenos Aires, Argentina	phalanx	Good	Good	Y
Olivos, "toscas del Río de la Plata", Buenos Aires, Argentina	tibia	Poor	Poor	
Olivos, "toscas del Río de la Plata", Buenos Aires, Argentina	mandible	Poor	Poor	

Olivos, "toscas del Río de la Plata", Buenos Aires, Argentina	mandible	Poor	Poor	
Río de la Plata, Buenos Aires, Argentina	phalanx	Poor	Poor	
Río de la Plata, Buenos Aires, Argentina	astragalus	Poor	Poor	
Camet Norte, Buenos Aires, Argentina	humerus	Poor	Poor	
Mar del Plata, Argentina	mandible	Poor	Poor	
Mar del Plata, Argentina	femur	Poor	Poor	
San Pedro, Buenos Aires, Argentina	fibula	Poor	Poor	
Cueva Rosello, Peru	femur	Good	Good	Y
Pisco, Peru	long bone frag.	Poor	Poor	
Pisco, Peru	long bone frag.	Poor	Poor	
Pisco, Peru	long bone frag.	Poor	Poor	
Pisco, Peru	long bone frag.	Poor	Poor	
not provided	n/a	n/a	n/a	
AMNH 99199, Loreto, Peru	long bone frag.	n/a	n/a	
Arroyo del Vizcaino, Uruguay	n/a	n/a	n/a	

