

Supporting Information

Badgley et al. 10.1073/pnas.0805592105

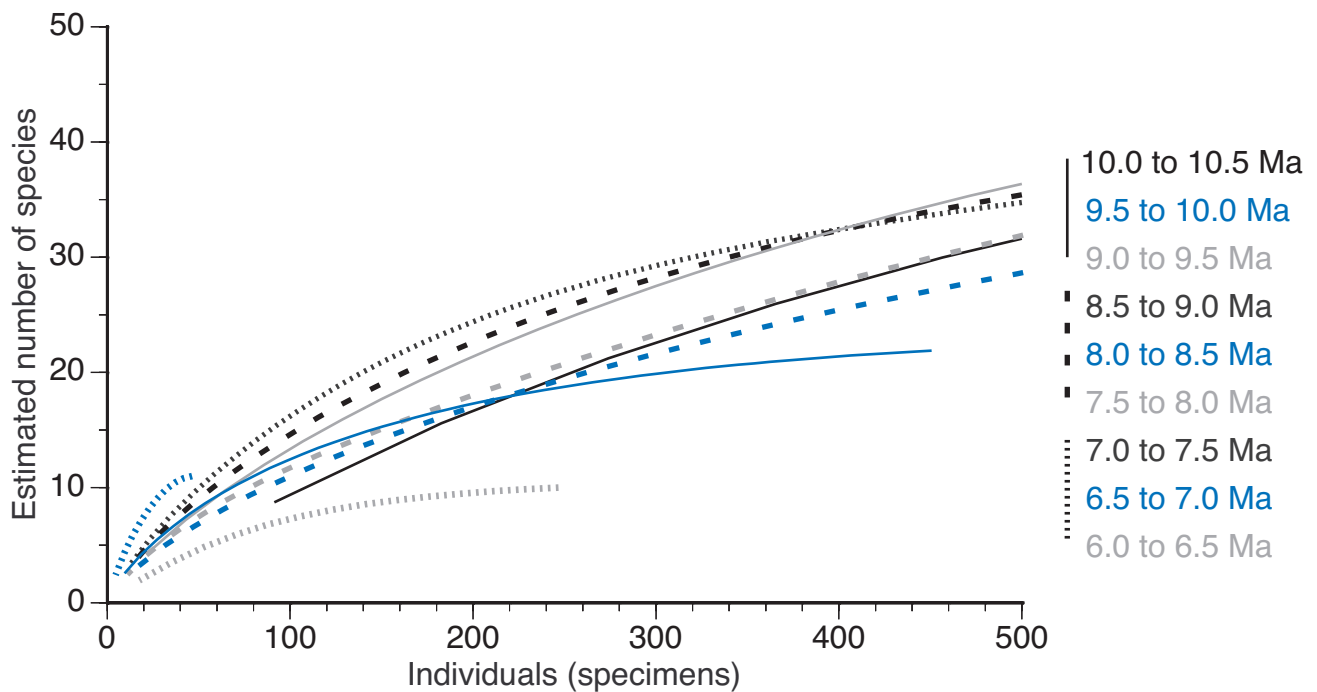


Fig. S1. Rarefaction of species richness in relation to number of catalogued fossil specimens for 0.5-Myr intervals of the Siwalik record from the Potwar Plateau. Each interval contains data for multiple fossil localities. Intervals vary substantially in number of localities and number of specimens, with sample sizes ranging from 50 to 2,700 specimens. Rarefaction curves for nine intervals indicate that species richness was relatively high from 7.0 to 10.5 Ma, with similar trajectories for the species accumulation curves. The two youngest intervals, 6.5–7.0 Ma and 6.0–6.5 Ma, have curves that start to level off at much lower values of species richness, suggesting that the observed decline in species richness reflects an actual diminution, not merely a drop in sample size. We used EstimateS for the rarefaction analysis (Colwell RK (2000) *EstimateS: Statistical Estimation of Species Richness and Shared Species from Samples (Software and User's Guide, Version 7.5)* (<http://niceroy.eeb.uconn.edu/estimates>).

Table S1. Taxonomically resolved mammalian lineages from the late Miocene, Siwalik record of Pakistan

Sequence in Fig. 1	Family/subfamily	Species	Inferred LAD	LO	FO	Inferred FAD	
1	Rhinocerotidae	<i>Brachypotherium perimense</i>		7.1	16.0		
	Rhinocerotidae	<i>Gaiotherium</i> spp.		7.3	16.0		
	Anthracotheriidae	<i>Microbunodon</i> lineage	8.4	9.2	13.8	14.0	
	Anthracotheriidae	<i>Merycopotamus</i> lineage	2.2	3.3	13.9	>14.0	
	Listriodontinae	<i>Listriodon pentapotamia</i>	10.3	10.3	13.7	14.0	
	Orycteropodidae	<i>Orycteropus</i> spp.	8.1	9.2	13.6	14.0	
	Sivatheriinae	<i>Giraffokeryx-Bramatherium</i> lineage	7.1	7.1	13.6	14.0	
	Galericinae	<i>Galerix rutlandae</i>	8.5	8.7	13.6	13.6	
	Copemyinae	<i>Democricetodon</i> species B	9.3	10.0	13.6	13.6	
10	Gliridae	<i>Myomimus</i> lineage	7.3	7.9	13.6	13.6	
	Rhinocerotidae	<i>Caementodon oettingenae</i>		8.5	13.2		
	Tetraconodontinae	<i>Conohyus sindiensis</i>	10.3	10.3	13.1	14.0	
	Tupaiaidae	Tupaiaidae, spp.	6.5	8.1	13.0	13.6	
	Copemyinae	<i>Democricetodon</i> species D	10.1	10.2	13.0	13.6	
	Copemyinae	<i>Democricetodon</i> species E	10.3	10.4	13.0	13.6	
	Copemyinae	<i>Democricetodon</i> species H	10.1	10.4	13.0	13.6	
	Copemyinae	<i>Democricetodon</i> species G	8.2	8.6	13.0	13.6	
	Dendromurinae	<i>Paradakkamys chinjiensis</i>	10.1	10.4	13.0	13.6	
	Deinotheriidae	<i>Deinotherium</i> spp.	7.9	8.0	12.9	14.0	
20	Chalicotheriinae	<i>Chalicotherium salinum</i>	8.0	8.0	12.9	14.0	
	Tragulidae	<i>Dorcabune anthracotherioides</i>	10.3	10.5	12.8	14.0	
	Crocidae	<i>Crocidae</i> unnamed species 1	5.7	6.4	12.7	13.6	
	Hominoidea	<i>Sivapithecus sivalensis</i>	8.4	8.5	12.3	14.0	
	Copemyinae	<i>Democricetodon</i> species F	8.2	8.6	12.3	13.6	
	Ctenodactylidae	<i>Sayimys chinjiensis</i>	9.4	10.0	12.3	13.6	
	Rhinocerotidae	<i>Alicornops</i> sp.		7.9	11.6		
	Petauristinae	<i>Hylopates</i> unnamed species 2	9.3	10.0	11.5	13.6	
	Dendromurinae	<i>Dakkamys asiaticus</i>	10.1	10.4	11.5	13.6	
	Tachyoryctinae	<i>Kanisamys nagrii</i>	9.4	9.6	11.5	13.6	
	30	Murinae	<i>Progonomys hussaini</i>	9.4	9.6	11.5	13.6
Suinae		<i>Hippopotamodon</i> lineage	7.1	7.2	11.3	11.4	
Tragulidae		<i>Dorcatherium majus</i>	6.9	7.0	11.3	11.4	
Murinae		<i>Karnimata</i> lineage	5.7	6.4	11.3	11.4	
Diatomyidae		<i>Willmus maximus</i>	10.4	11.1	11.1	11.5	
Tragulidae		<i>Dorcatherium</i> small unnamed species	8.6	9.2	11.1	11.2	
Crocidae		<i>Crocidae</i> unnamed species 2	6.5	7.3	11.1	11.2	
Antilopinae		<i>Protragelaphus?</i> sp.		10.7	10.7		
Hipparionini		<i>Hipparion</i> s.l. spp.	3.7	5.8	10.7	10.9	
Tragulidae		<i>Dorcatherium</i> lineage 1	7.1	7.3	10.5	12.0	
40		Lorisidae	<i>Microloris pilbeami</i>		9.2	10.4	
		Tragulidae	<i>Dorcabune nagrii</i>	8.4	8.5	10.4	11.2
		Galericinae	<i>Schizogalerix</i> sp.	9.3	10.2	10.4	11.0
	Ratufini	<i>Ratufa sylvia</i>	8.8	9.2	10.4	11.0	
	Tamiini	<i>Eutamias</i> sp.	6.5	7.0	10.4	11.0	
	Tachyoryctinae	<i>Rhizomyides punjabiensis</i>	10.1	10.2	10.4	11.0	
	Murinae	Murinae, unnamed genus and species 2	9.3	10.0	10.4	11.0	
	Boselaphini	<i>Elachistoceras khauristanensis</i>		7.4	10.4		
	Antilopinae	<i>Gazella lydekeri</i>		6.1	10.2		
	Boselaphini	<i>Selenoportax vexillarius</i>		9.8	10.2		
	50	Suinae	<i>Propotamochoerus hysudricus</i>	6.5	6.8	10.2	10.2
		Antilopinae	<i>Gazella?</i> large sp.		10.1	10.2	
		Boselaphini	<i>Tragoportax pilgrimi</i>		8.9	10.2	
Dolichochoerinae		<i>Schizochoerus gandakasensis</i>	8.1	8.7	10.1	11.2	
Antilopinae		?Antilopinae, small species		6.2	10.0		
Suinae		Small unnamed species 1	9.4	10.0	10.0	11.4	
Tetraconodontinae		<i>Tetraconodon magnus</i>	9.3	9.3	10.0	11.2	
Petauristinae		Petauristinae, unnamed genus and species	9.3	10.0	10.0	10.3	
Hominoidea		<i>Sivapithecus parvada</i>	9.8	10.0	10.0	10.0	
Boselaphini		<i>Sivaceros?</i> <i>vedicus</i>		9.8	9.8		
60		Bovidae	<i>Dorcadoryx</i> unnamed species		9.6	9.7	
		Rhizomyinae	<i>Brachyrhizomys nagrii</i>	9.0	9.2	9.6	9.9
		Boselaphini	<i>Selenoportax falconeri</i>		8.9	9.5	
	Boselaphini	<i>Selenoportax?</i> unnamed species		7.9	9.5		
	Antilopinae	<i>Prostrepsiceros vinayaki</i>		7.9	9.3		

Sequence in Fig. 1	Family/subfamily	Species	Inferred LAD	LO	FO	Inferred FAD
	Reduncini	<i>Dorcadoxa porrecticornis</i>		8.0	9.3	
	Rhizomyinae	<i>Brachyrhizomys pilgrimi</i>	5.7	8.0	9.3	10.3
	Rhizomyinae	<i>Brachyrhizomys tetracharax</i>	5.7	7.9	9.3	10.3
	Murinae	<i>Progonomys debruijini-Mus auctor</i> lineage	5.7	6.4	9.3	9.9
70	Tragulidae	<i>Dorcatherium nagrii</i>	2.2	6.8	9.3	9.5
	Tachyoryctinae	<i>Kanisamys sivalensis</i>	7.3	7.3	9.3	9.5
	Rhizomyinae	<i>Brachyrhizomys micrus</i>	8.2	9.2	9.2	10.3
	Rhizomyinae	<i>Brachyrhizomys blacki</i>	8.2	9.2	9.2	10.3
	Manidae	<i>Manis</i> sp.	2.2	6.9	9.2	9.9
	Murinae	<i>Parapodemus</i> sp.	7.3	7.9	9.2	9.9
	Antilopinae	Antilopinae, large unnamed genus and species		8.7	9.3	
	Lorisidae	<i>Nycticeboides simpsoni</i>		7.8	9.1	
	Suinae	Small unnamed species 2	2.2	7.4	8.9	9.2
	Giraffinae	<i>Giraffa punjabiensis</i>	2.2	7.2	8.9	9.1
	Boselaphini	<i>Selenoportax giganteus</i>		7.1	8.8	
80	Boselaphini	<i>Tragoportax</i> sp. nov.		7.2	8.7	
	Petauristinae	<i>Hylopetes</i> unnamed species 1	5.7	7.3	8.7	9.1
	Gerbillinae	<i>Abudhabia pakistanensis</i>	8.2	8.6	8.6	8.6
	Rhinocerotidae	<i>Rhinoceros</i> aff. <i>sivalense</i>		8.5	8.5	
	Rhizomyinae	<i>Brachyrhizomys choristos</i>	8.2	8.2	8.4	8.5
	Boselaphini	<i>Tragoportax punjabicus</i>		6.2	8.4	
	Boselaphini	<i>Tragoportax salmontanus</i>		6.4	8.4	
	Reduncini	<i>Kobus</i> sp. 1		7.7	8.1	
	Murinae	<i>Parapelomys</i> lineage	5.7	6.4	8.1	8.5
	Antilopinae	<i>Prostrepsiceros?</i> , large sp.		8.1	8.1	
90	Hystriinae	<i>Hystrix sivalensis</i>	7.2	7.3	8.0	8.0
	Tragulidae	<i>Dorcatherium</i> unnamed species 2	6.5	6.8	7.8	7.8
	Leporidae	Leporidae, unnamed genus and species	5.7	6.4	7.8	7.8
	Tachyoryctinae	<i>Eicooryctes kaulialensis</i>	6.5	7.1	7.8	7.8
	Colobinae	<i>Presbytis sivalensis</i>	6.5	7.1	7.6	7.8
	Tachyoryctinae	<i>Protachyoryctes tatroti</i>	6.5	6.9	7.3	7.8
	Tragulidae	<i>Dorcatherium</i> unnamed species 3	7.3	7.3	7.3	7.7
	Boselaphini	<i>Pachyportax?</i> sp.		7.2	7.3	
	Reduncini	<i>Kobus</i> sp. 2		6.4	7.3	
	Tachyoryctinae	<i>Rhizomyides sivalensis</i>	5.7	6.4	7.1	7.1
100	Murinae	Murinae, unnamed genus and species 1	5.7	6.4	6.4	7.2
	Crocidurinae	<i>Crocidura</i> unnamed species 3	5.7	6.4	6.4	7.1
	Suinae	<i>Sus</i> sp.	2.2	3.3	6.4	6.8
	Hippopotamidae	<i>Hexaprotodon sivalensis</i>	2.2	3.5	5.9	6.1
	Tragulidae	Tragulidae, unnamed genus and species 4	2.2	3.3	5.9	6.1
	Suinae	<i>Potamochoerus</i> sp.	2.2	5.4	5.8	5.8

Species are listed in the order that they appear in Fig. 1. LAD, last appearance datum; LO, last occurrence; FO, first occurrence; FAD, first appearance datum. The inferred FAD and LAD are based on 80% confidence intervals (1). Taxa currently in revision do not have estimated ranges.

1. Barry JC, et al. (2002) Faunal and environmental change in the Late Miocene Siwaliks of Northern Pakistan. *Paleobiology* 28:1–71.

Table S2. Lineages corresponding to sequence (left to right) in Fig. 3

Sequence in Fig. 3	Species/lineage	Dietary habit	Inferred last appearance, Ma	Inferred first appearance, Ma
1	<i>Dorcabune anthracotherioides</i>	Frugivore/browser	10.3	14.0
2	<i>Selenoportax vexillarius*</i>	Frugivore/browser	9.8	10.2
3	<i>Sivapithecus parvada</i>	Frugivore/omnivore	9.8	10.0
4	<i>Tetraconodon magnus</i>	Frugivore/omnivore	9.3	11.2
5	<i>Selenoportax falconeri*</i>	Frugivore/browser	8.9	9.5
6	<i>Microbunodon</i> lineage	Frugivore/browser	8.4	14.0
7	<i>Sivapithecus sivalensis</i>	Frugivore/omnivore	8.4	14.0
8	<i>Dorcabune nagrii</i>	Frugivore/browser	8.4	11.2
9	<i>Schizocoerus gandakasensis</i>	Frugivore/browser	8.1	11.2
10	<i>Dorcatherium</i> unnamed sp 3	Frugivore/browser	7.3	7.7
11	<i>Dorcatherium</i> lineage 1	Frugivore/browser	7.1	12.0
12	<i>Hippopotamodon sivalense</i>	Frugivore/omnivore	7.1	11.4
13	<i>Dorcatherium majus</i>	Frugivore/browser	6.9	11.4
14	<i>Propotamochoerus hysudricus</i>	Frugivore/omnivore	6.5	10.2
15	<i>Dorcatherium nagrii</i>	Frugivore/browser	2.2	9.5
16	<i>Listriodon pentapotamiae</i>	Browser	10.3	14.0
17	<i>Conohyus sindiensis</i>	Browser	10.3	14.0
18	<i>Tragoportax pilgrimi*</i>	Browser	8.9	10.2
19	<i>Chalicotherium salinum</i>	Browser	8.0	14.0
20	<i>Deinotherium</i> spp.	Browser	7.9	14.0
21	<i>Elachistoceras khauristanensis*</i>	Browser/frugivore	7.4	10.4
22	<i>Giraffokeryx-Bramatherium</i> lineage	Browser	7.1	14.0
23	<i>Presbytis sivalensis</i>	Browser	6.5	7.8
24	<i>Dorcatherium</i> unnamed sp 2	Browser/frugivore	6.5	7.8
25	<i>Giraffa punjabiensis</i>	Browser	2.2	9.1
26	<i>Nycticeboides simpsoni*</i>	Omnivore	7.8	9.1
27	<i>Potamochoerus</i> sp.	Omnivore	2.2	5.8
28	<i>Dorcadoxa porrecticornis*</i>	Mixed feeder	8.0	9.3
29	<i>Kobus</i> sp. 1*	Mixed feeder	7.7	8.1
30	<i>Tragoportax salmontanus*</i>	Mixed feeder	6.4	8.4
31	<i>Selenoportax giganteus*</i>	Mixed feeder	7.1	8.8
32	<i>Hystrix sivalensis</i>	Mixed feeder	7.2	8.0
33	<i>Pachyportax</i> sp.*	Mixed feeder	7.2	7.3
34	<i>Kobus</i> sp. 2*	Mixed feeder	6.4	7.3
35	<i>Gazella lydekkeri*</i>	Mixed feeder	6.1	10.2
36	<i>Tragoportax punjabicus*</i>	Mixed feeder	6.2	8.4
37	<i>Merycopotamus</i> lineage	Mixed feeder	2.2	>14.0
38	Tragulidae, unnamed genus and species 4	Mixed feeder	2.2	6.1
39	<i>Kanisamys sivalensis</i>	Grazer	7.3	9.5
40	<i>Eicooryctes kaulialensis</i>	Grazer	6.5	7.8
41	<i>Hipparion</i> sensu lato spp.	Grazer	3.7	10.9
42	<i>Hexaprotodon sivalensis</i>	Grazer	2.2	6.1

All lineages are species except for hipparionine equids, currently under revision. The dietary habit of each species is based on general dental morphology, microwear data (if available), mesowear data (if available), and carbon-isotopic values. Lineages noted with * are represented by observed (not estimated) first and last occurrences.