

Supplementary Materials

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S1. N_e estimates from Indels on TENT, with comparisons to MP-EST* tree.

The highest estimated N_e values ranged from 3,258, 842 to 26,127,434 in the TENT, with higher estimates in more size inclusive partitions (Table S4). Lowest estimated N_e values ranged from 110,471 to 329,562, with higher estimates in more size inclusive partitions. N_e estimates were generally similar in both absolute magnitude and relative rank order in the MP-EST* tree and TENT for those nodes branches that were present in both trees (Tables S5-S9). Notable exceptions, however, include the hoatzin+Cursorimorphae+waterbirds+Telluraves branch which differed by an order of magnitude between the MP-EST* tree and TENT within each indel partition and the Coraciimorphae branch which differed two-fold in most indel size partitions. All of the five highest estimated N_e 's were the same branches in both trees, with the exception of hoatzin+Cursorimorphae+waterbirds+Telluraves and Coraciimorphae. The highest N_e estimates common to both trees and across all indel size partitions was the Columbimorphae branch. Others that tended to rank high, however inconsistently across partitions, included bee-eater+woodpecker, Cursorimorphae, and turaco+bustard. Five branches in each of the MP-EST* tree and TENT are not present in the other; thus, cannot be compared. The lack of congruence in these trees involve rearrangement of very short internal branches and nearly equal levels of gene tree concordance/discordance with respect to these particular branches.

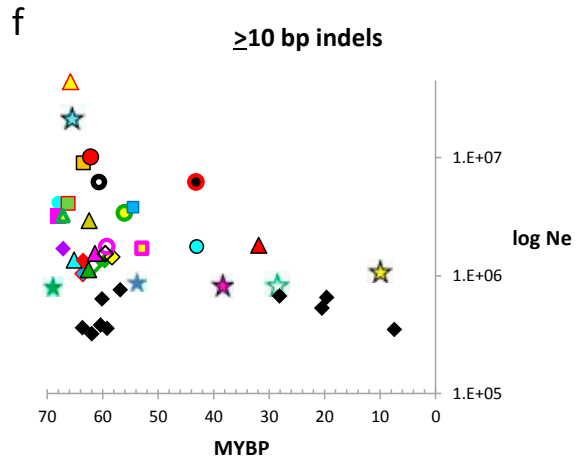
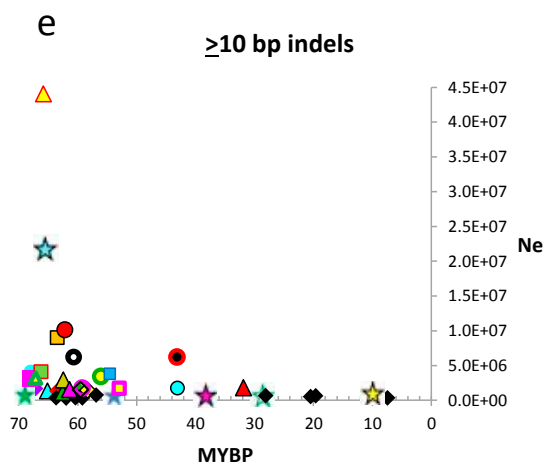
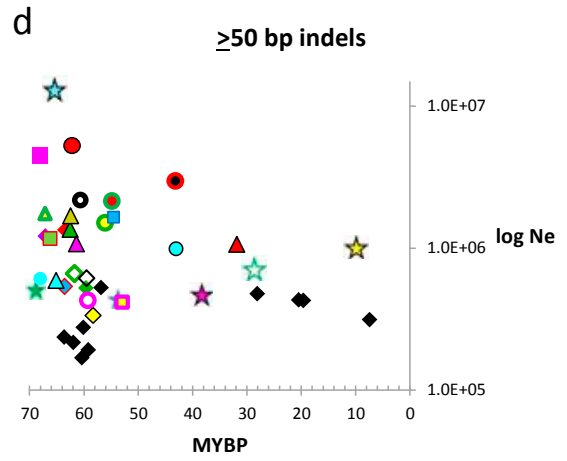
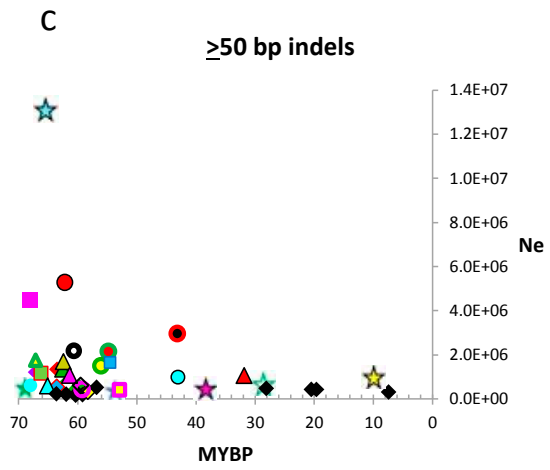
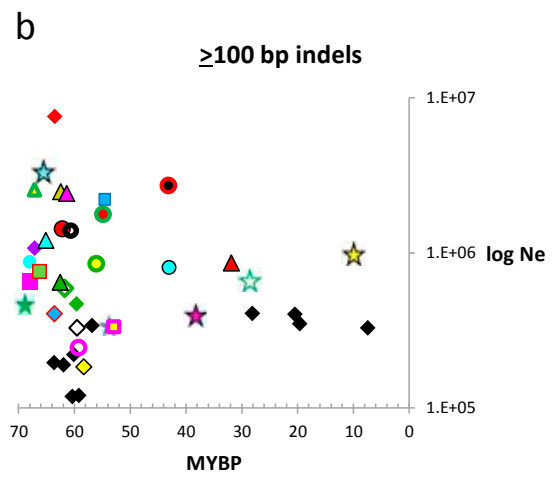
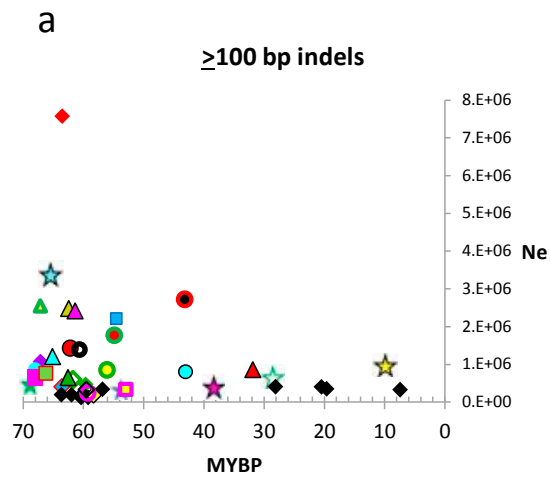
S2. N_e estimates from Gene Trees.

All gene tree analyses showed a distinct spike in estimated N_e near the K - Pg boundary when plotted against MP-EST* and TENT timetrees (Figures S3-S8; Tables S11-S12). Gene tree N_e estimates tended to be higher than indel N_e estimates whether or not they included indels. Indel gene trees yielded higher upper quartile and median N_e estimates than nucleotide gene trees (Table S10) but the difference was not consistent on any given branch, and nucleotide gene trees yielded the highest estimates overall. The highest gene tree N_e estimates were consistently higher using 1938 loci than with 2515 loci (Tables S11, S12). The highest gene tree N_e estimates were slightly higher when made on the MP-EST* tree than on the TENT when the highest scores were branches shared by both trees (Tables S13-S20). Gene trees tended to favor turaco-bustard as the highest estimated N_e when CBL was positive, or Columbimorphae when it was not. Cursorimorphae and bee-eater+woodpecker were also among the highest N_e estimates. Other branches such as hoatzin+Cursorimorphae+waterbirds+Telluraves, Otidimorphae+Columbimorphae, and

waterbird+Telluraves, were high on one tree or the other but not comparable due either to zero CBL or non-recovered on both trees.

S3. Generation Length Sensitivity Analysis

We report the ancestral generation length that would be required to reduce our N_e estimates for each branch into the median and upper quartile of each size partition using the MP-EST* tree and the TENT (Tables S21, S22). The MP-EST* results are reported in the main text so only the TENT results are summarized here. Longer generation lengths were typically implied using short indels, which are characterized by shorter CBL. Among the clades with the highest estimated N_e , Columbimorphae required a generation length of 26.6-69.8 years (yrs) for the upper quartile and 46.4-143.3 yrs. Values for hoatzin+Cursorimorphae+waterbirds+Telluraves ranged from 7.2-52.3 yrs for the upper quartile and 13.0-107.4 yrs for the median. Although turaco+bustard had among the highest estimated N_e in many size partitions, its implied generation lengths were lower: 20.6-24.8 yrs for the upper quartile and 33.6-45.0 yrs for the median.



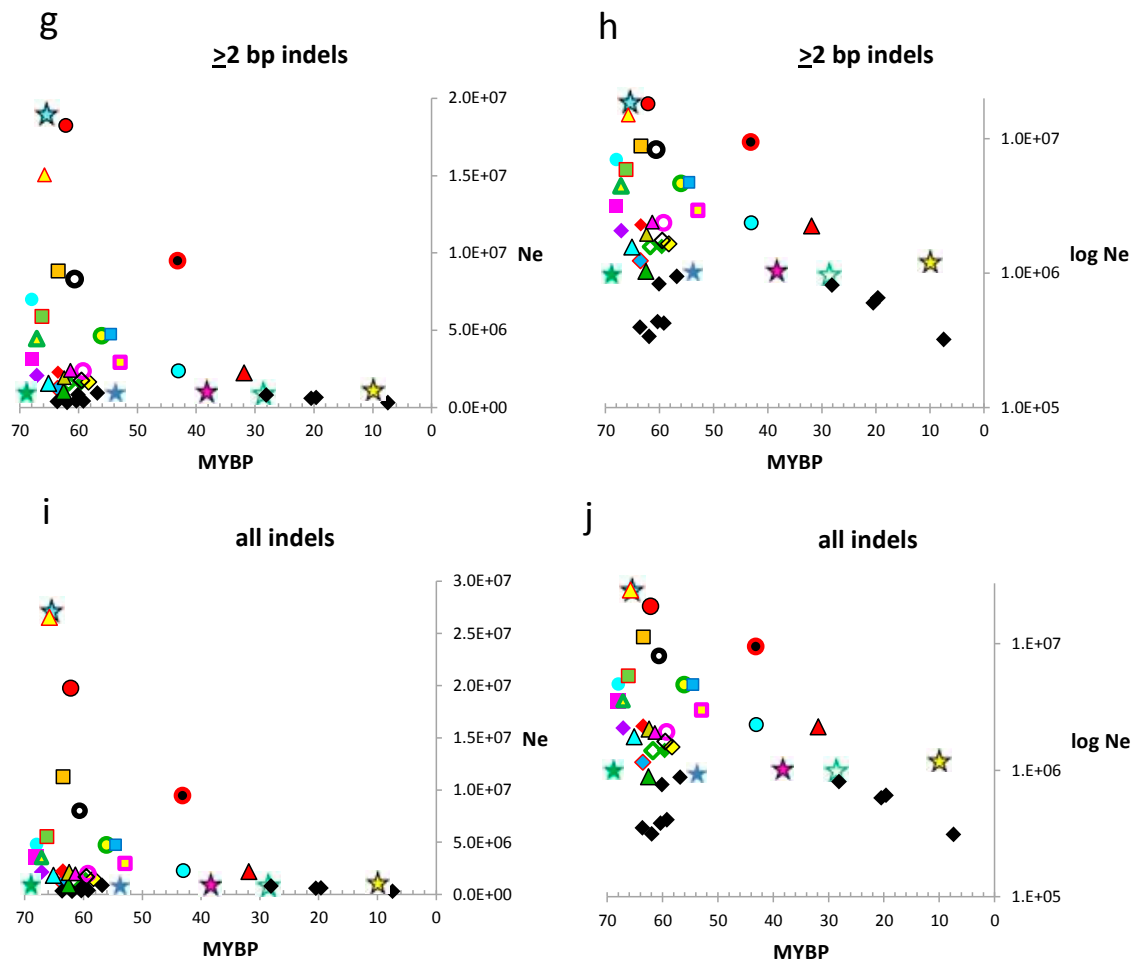
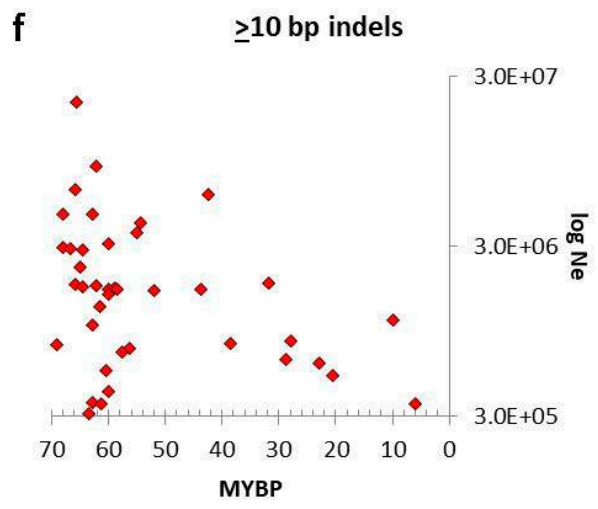
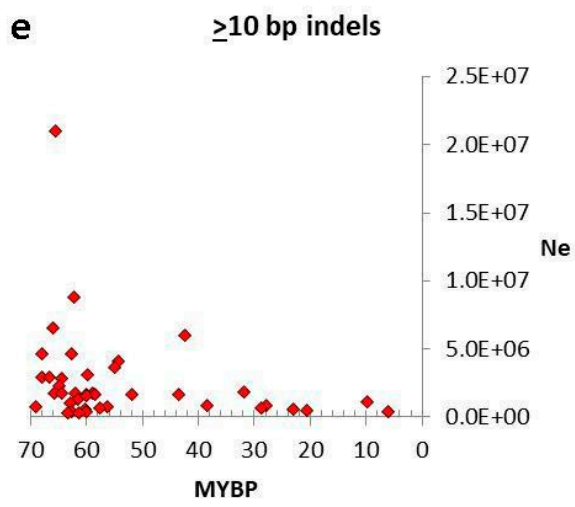
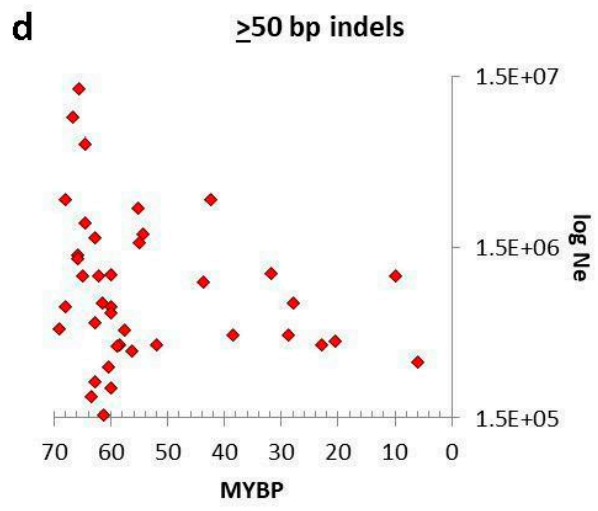
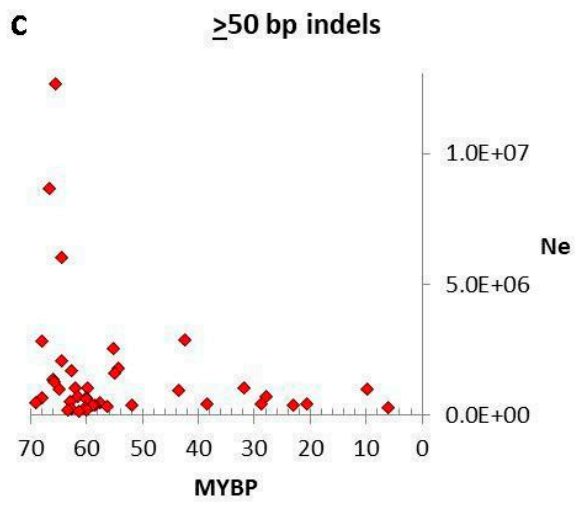
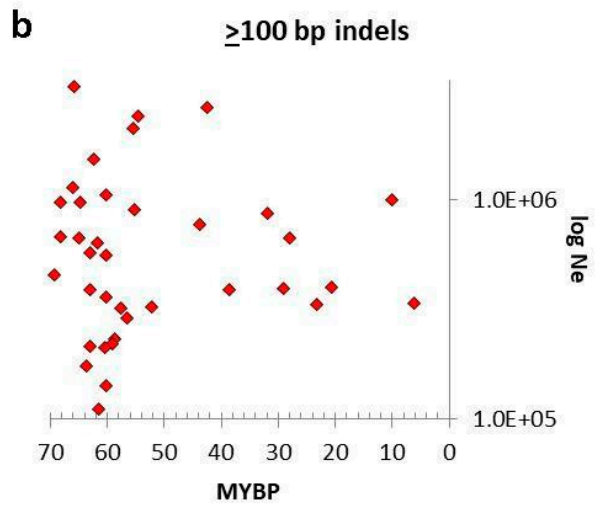
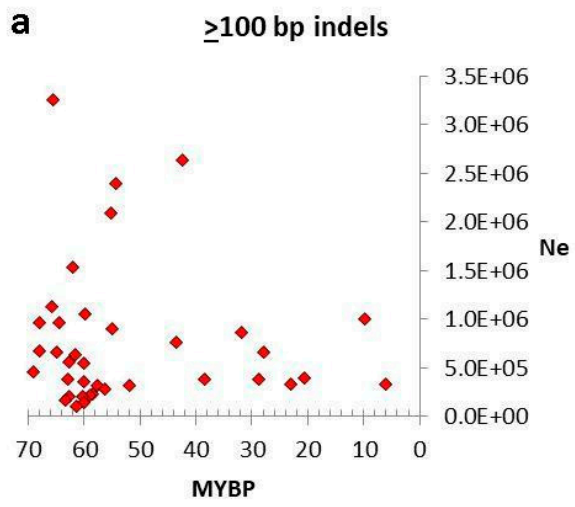


Figure S1. Estimated N_e of size partitioned intronic indels plotted on MP-EST* timetree time scale. (a, b) ≥ 100 bp indel size class; (c, d) ≥ 50 bp indel size class; (e, f) ≥ 10 bp indel size class; (g, h) ≥ 12 bp indel size class; (i, j) all indels size class; (a, c, e, g, i) N_e in linear scale; (b, d, f, h, j) N_e in log scale. Symbols as in Figure 3 of main text. MYBP = million years before present.



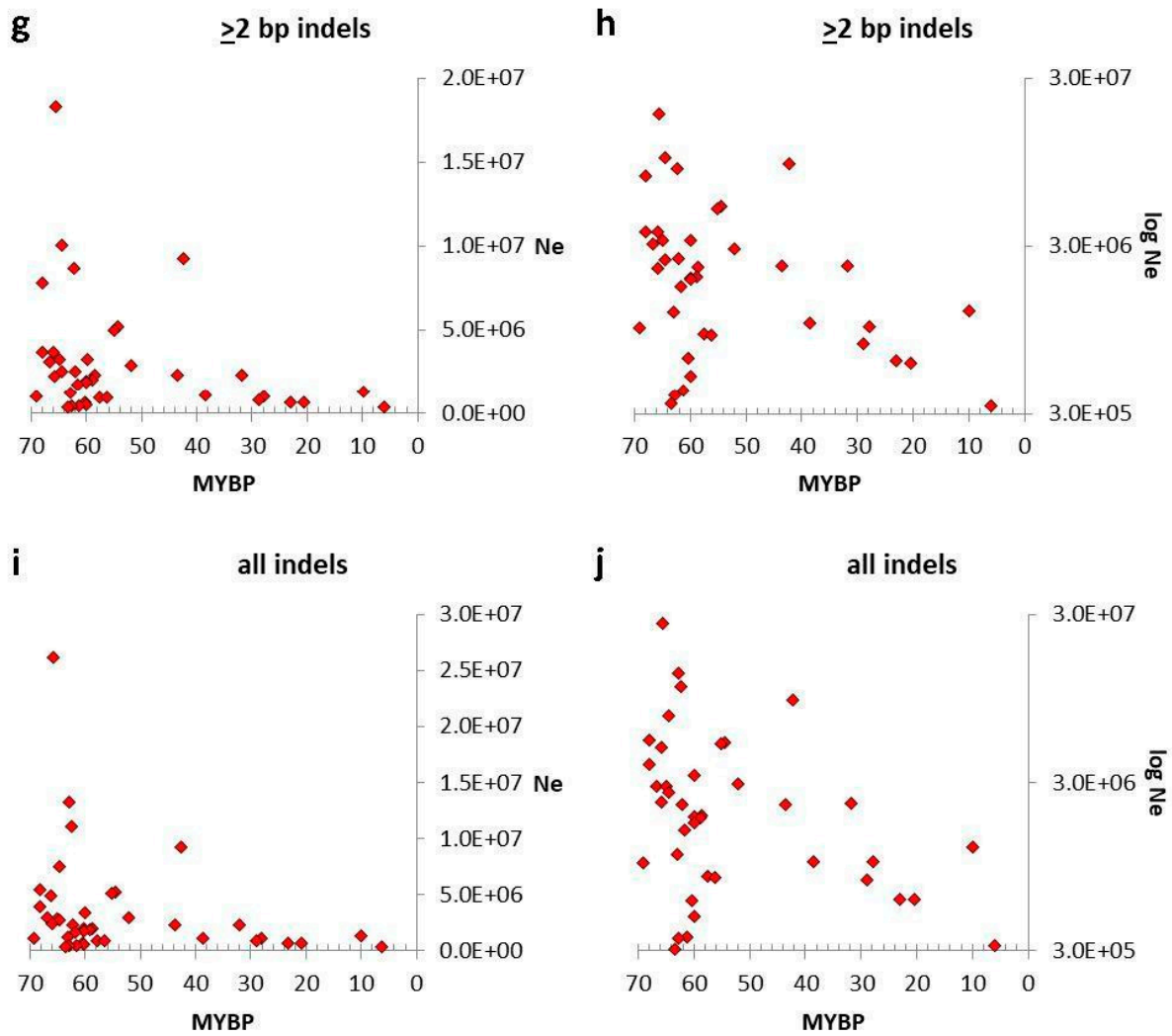


Figure S2. Estimated N_e of size partitioned intronic indels plotted on TENT timetree time scale. (a, b) ≥ 100 bp indel size class; (c, d) ≥ 50 bp indel size class; (e, f) ≥ 10 bp indel size class; (g, h) ≥ 2 bp indel size class; (i, j) all indels size class; (a, c, e, g, i) N_e in linear scale; (b, d, f, h, j) N_e in log scale. MYBP = million years before present.

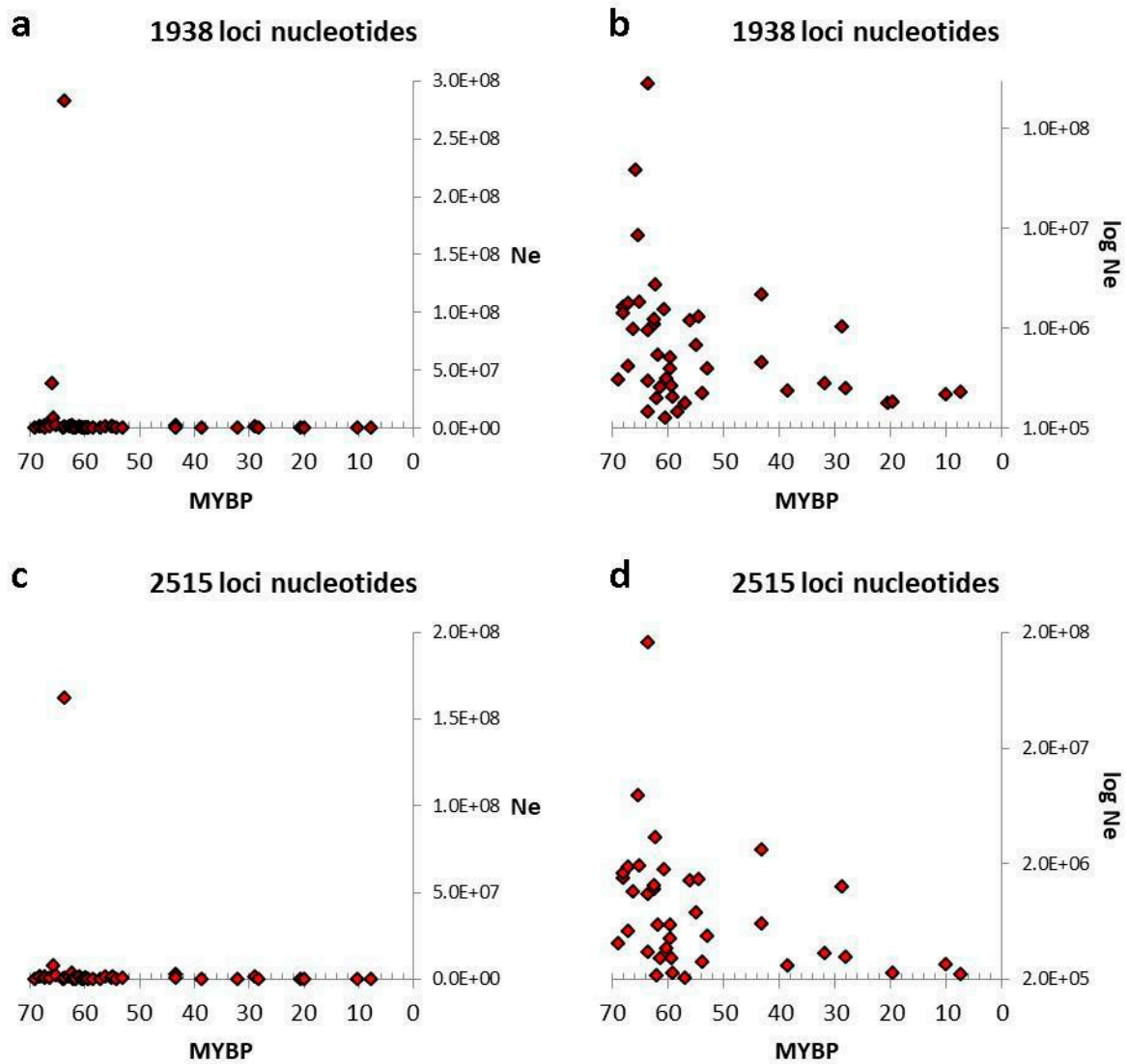
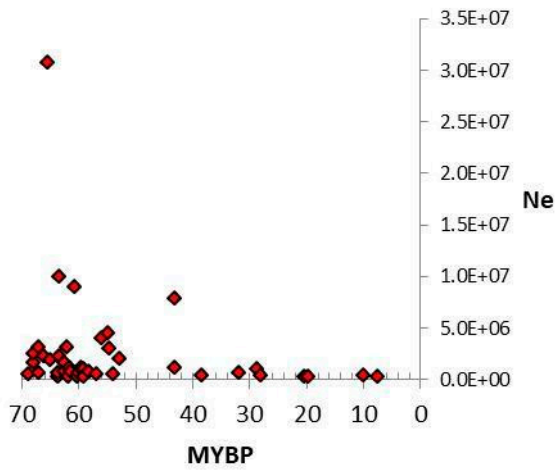
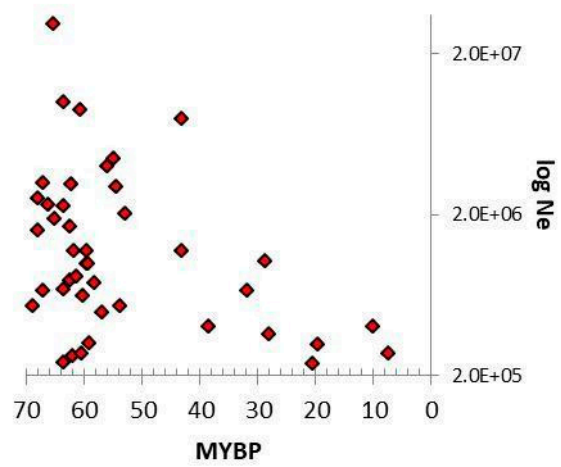


Figure S3. Estimated N_e of nucleotide gene trees plotted on MP-EST* timetree. a, b, dataset of 1938 intronic loci with at least one >100 bp indel (chosen to match indel and combined nt+indel gene tree datasets, but indels not included in these gene trees); c, d, complete dataset of 2,515 intronic loci; a, c, N_e in linear scale; b, d, N_e in log scale. MYBP = million years before present.

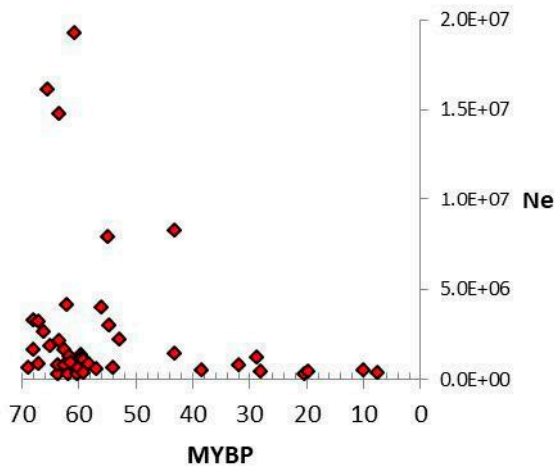
a 1938 loci unweighted indels



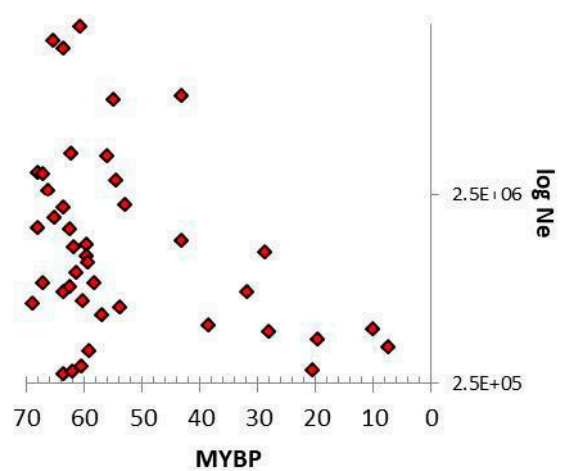
b 1938 loci unweighted indels



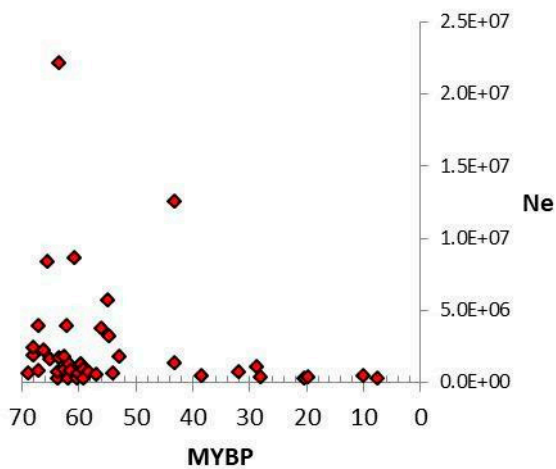
c 2515 loci unweighted indels



d 2515 loci unweighted indels



e 1938 loci weighted indels



f 1938 loci weighted indels

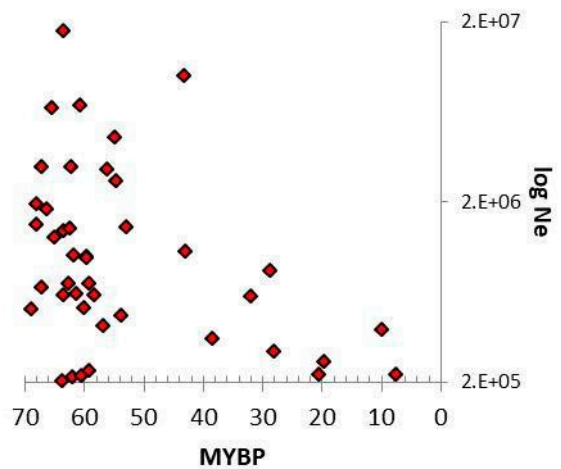
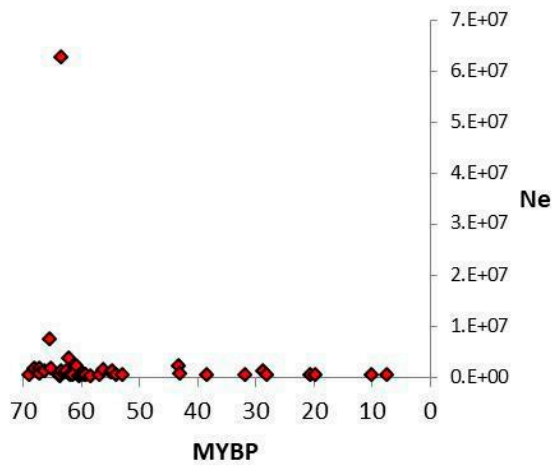
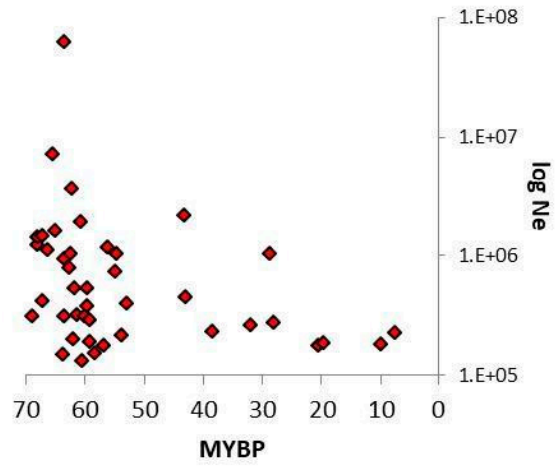


Figure S4. Estimated N_e of indel gene trees plotted on MP-EST* timetree time scale. a, b, unweighted dataset of 1938 intronic loci with at least one >100 bp indel; c, d, complete dataset of 2,515 intronic loci with ≥ 100 bp indels weighted 25x; e, f, dataset of 1938 loci with ≥ 100 bp indels weighted 25x; a, c, e, g, i, N_e in linear scale; b, d, f, h, j, N_e in log scale. MYBP = million years before present.

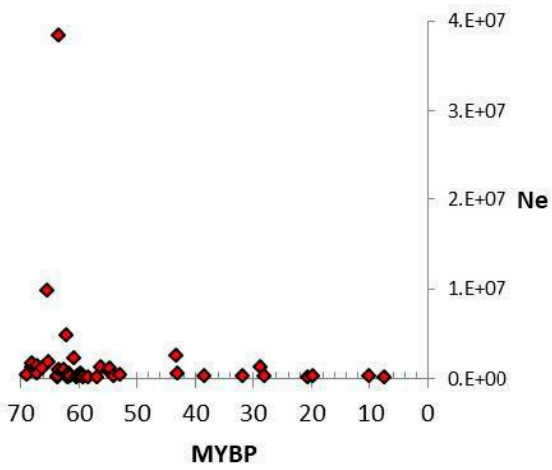
a 1938 loci nts+unweighted indels



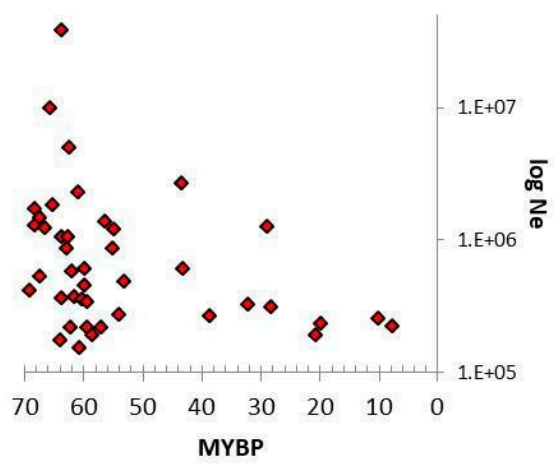
b 1938 loci nts+unweighted indels



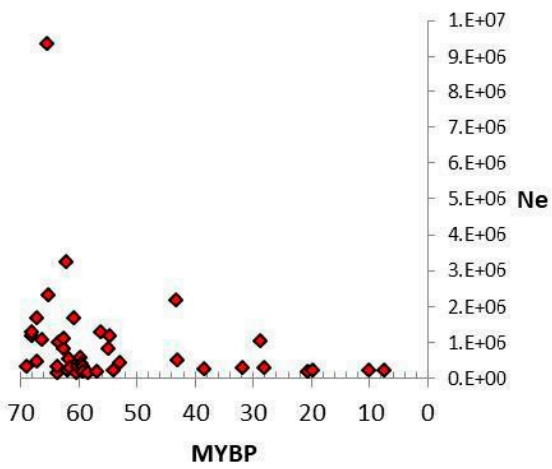
c 2515 loci nts+unweighted indels



d 2515 loci nts+unweighted indels



e 1938 loci nt+weighted indels



f 1938 loci nt+weighted indels

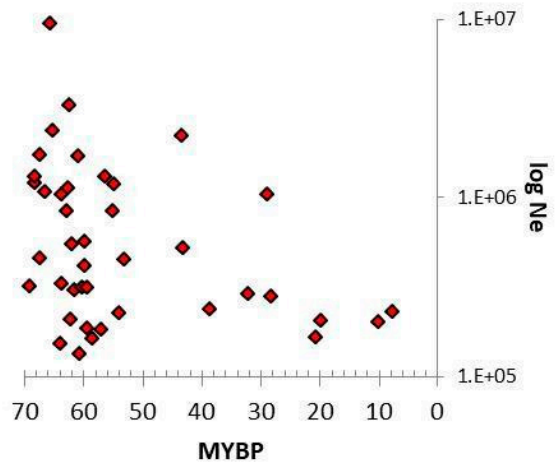


Figure S5. Estimated N_e of gene trees composed of combined nucleotide and indel data plotted on the MP-EST* timetree time scale. a, b, unweighted dataset of 1938 intronic loci with at least one >100 bp indel; c, d, complete unweighted dataset of 2,515 intronic loci with ≥ 100 bp indels weighted 25x; e, f, dataset of 1938 loci with ≥ 100 bp indels weighted 25x; a, c, e, g, i, N_e in linear scale; b, d, f, h, j, N_e in log scale. MYBP = million years before present.

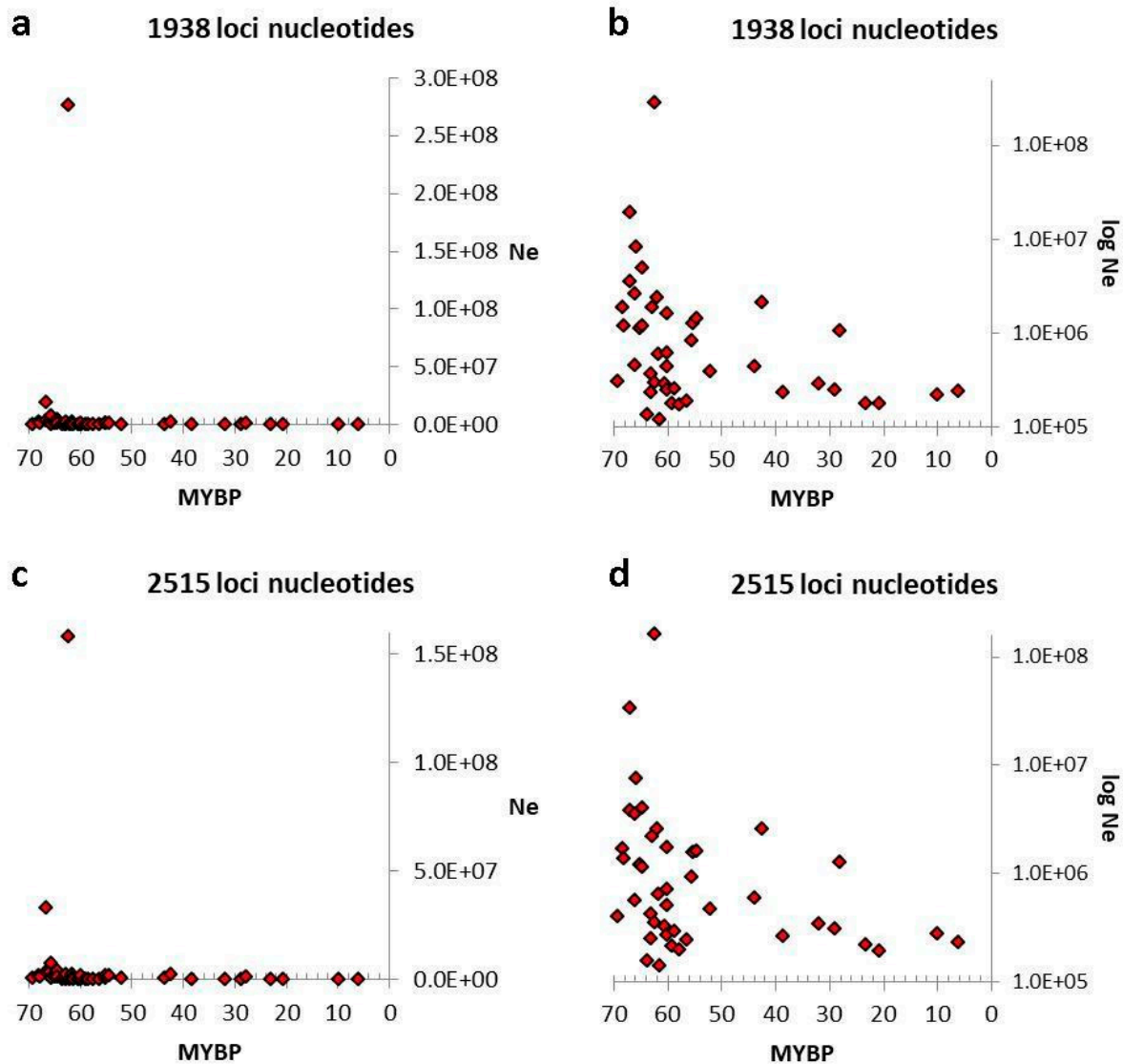
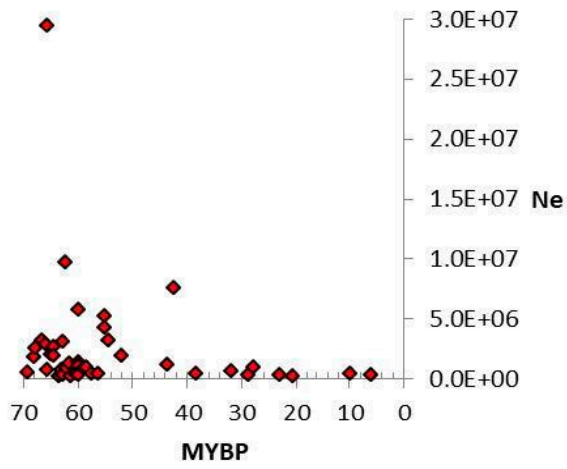
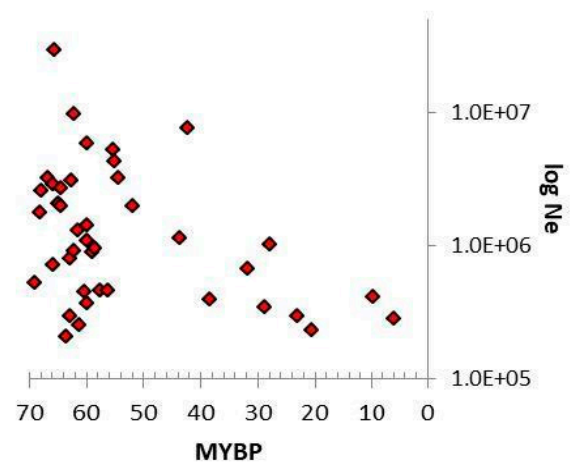


Figure S6. Estimated N_e of nucleotide gene trees plotted on TENT timetree. (a, b) dataset of 1938 intronic loci with at least one >100 bp indel (chosen to match indel and combined nt+indel gene tree datasets, but indels not included in these gene trees); (c, d) complete dataset of 2,515 intronic loci; (a, c) N_e in linear scale; (b, d) N_e in log scale. MYBP = million years before present. **Figure S7.** Estimated N_e of indel gene trees plotted on TENT timetree time scale. (a, b) unweighted dataset of 1938 intronic loci with at least one >100 bp indel; (c, d) complete dataset of 2,515 intronic loci with ≥ 100 bp indels weighted 25x; (e, f) dataset of 1938 loci with ≥ 100 bp indels weighted 25x; (a, c, e, g, i) N_e in linear scale; (b, d, f, h, j) N_e in log scale. MYBP = million years before present.

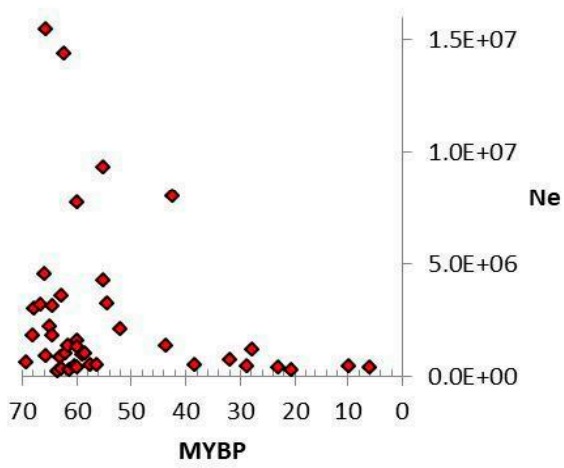
a 1938 loci unweighted indels



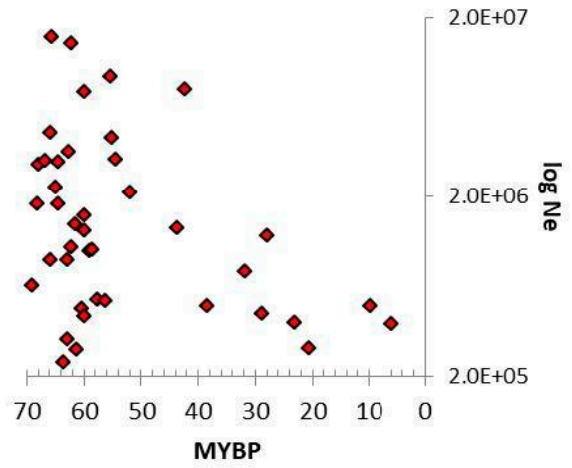
b 1938 loci unweighted indels



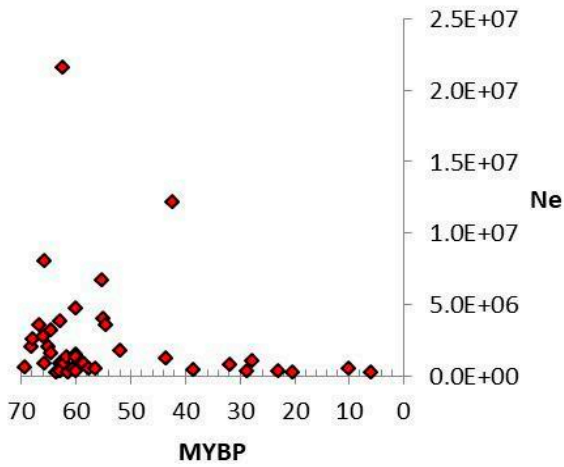
c 2515 loci unweighted indels



d 2515 loci unweighted indels



e 1938 loci weighted indels



f 1938 loci weighted indels

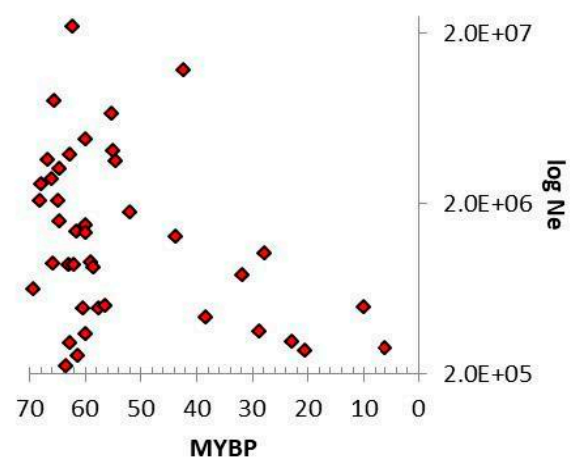
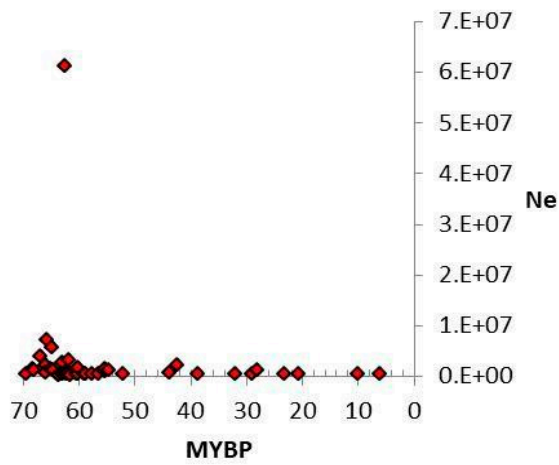
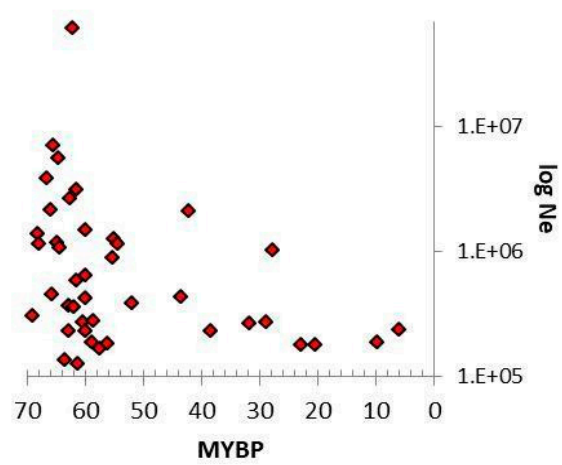


Figure S7. Estimated N_e of indel gene trees plotted on TENT timetree time scale. (a, b) unweighted dataset of 1938 intronic loci with at least one >100 bp indel; (c, d) complete dataset of 2,515 intronic loci with ≥ 100 bp indels weighted 25x; (e, f) dataset of 1938 loci with ≥ 100 bp indels weighted 25x; (a, c, e, g, i) N_e in linear scale; (b, d, f, h, j) N_e in log scale. MYBP = million years before present.

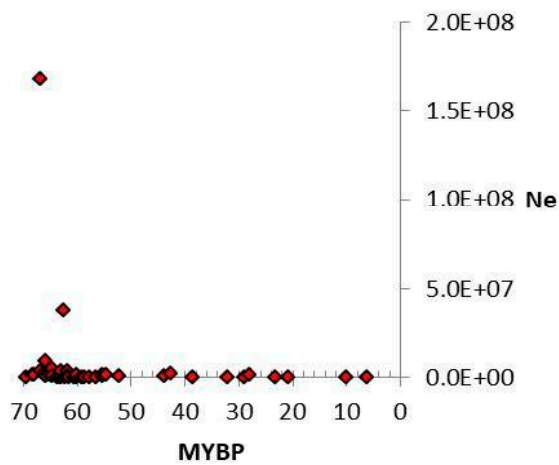
a 1938 loci nt+unweighted indels



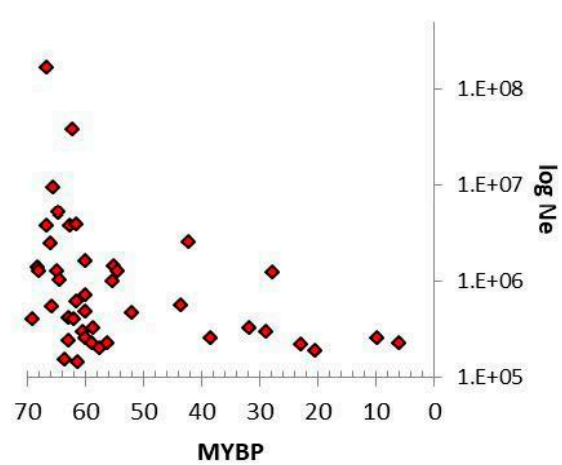
b 1938 loci nt+unweighted indels



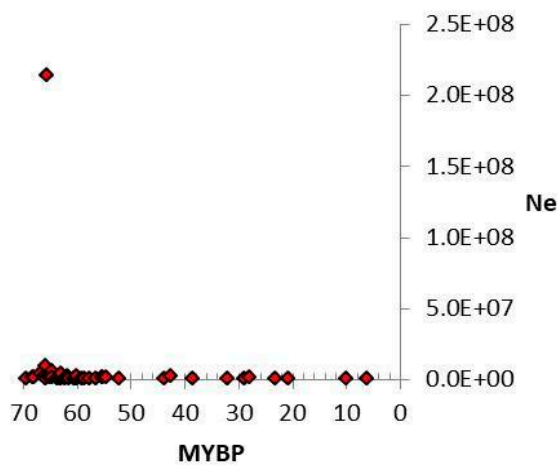
c 2515 loci nt+unweighted indels



d 2515 loci nt+unweighted indels



e 1938 loci nt+weighted indels



f 1938 loci weighted nt+indels

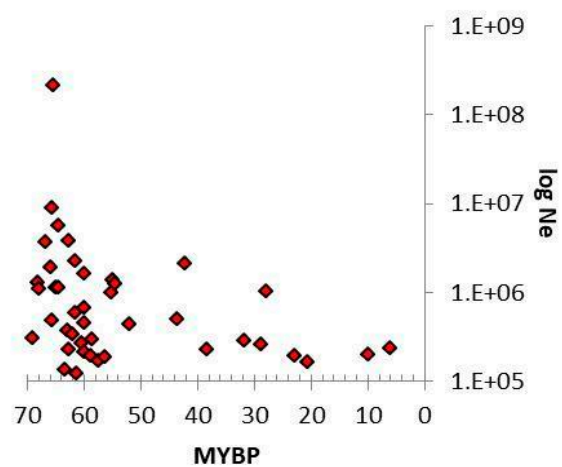


Figure S8. Estimated N_e of gene trees composed of combined nucleotide and indel data plotted on the TENT timetree time scale. (a, b) unweighted dataset of 1938 intronic loci with at least one >100 bp indel; (c, d) complete unweighted dataset of 2,515 intronic loci with ≥ 100 bp indels weighted 25x; (e, f) dataset of 1938 loci with ≥ 100 bp indels weighted 25x; (a, c, e, g, i) N_e in linear scale; (b, d, f, h, j) N_e in log scale. MYBP = million years before present.

Table S1. Ancestral State Reconstruction of Generation Length.

Clade	MP-EST*			ExaML TENT			Clade	MP-EST*			ExaML TENT		
	Gen Len	95% CI	95% CI	Gen Len	95% CI	95% CI		Gen Len	95% CI	95% CI	Gen Len	95% CI	95% CI
Accipitriformae	9.02	5.96-12.08	9.07	6.17-11.97			ibis+egret+pelican	10.46	7.31-13.60	10.33	7.20-13.45		
Aequornithia	10.05	7.48-12.61	9.93	7.42-12.43			mesite+sandgrouse	7.51	3.86-11.17	7.57	3.91-11.23		
Afroaves	NA		8.69	6.35-11.03			Neoaves	8.17	5.64-10.70	8.26	5.76-10.76		
Australaves	8.10	5.55-10.66	8.46	5.95-10.97			Neognathae	8.31	3.57-13.06	8.38	3.69-13.08		
bee-eater+woodpecker	7.63	3.49-11.77	7.76	3.66-11.86			Neornithes	8.90	3.16-14.64	8.99	3.27-14.72		
Caprimulgiformae	7.95	4.90-11.00	7.70	4.51-10.90			Oscines	5.41	2.09-8.72	5.43	2.14-8.72		
Columbea	8.13	5.44-10.81	8.21	5.54-10.88			Otidimorphae	8.02	5.25-10.79	7.89	5.03-10.75		
Columbimorphae	7.83	4.70-10.95	7.91	4.82-11.01			Otidimorphae+Caprimulgiformae	NA		8.07	5.57-10.58		
Coraciiformae	8.12	5.48-10.77	8.39	5.68-11.11			owl+Accipitriformae	8.62	5.14-12.10	NA			
Coraciiformae+mousebird	8.16	5.33-10.98	8.40	5.53-11.27			owl+Coraciiformae	NA		8.55	6.04-11.05		
Coraciiformae+Australaves	8.25	5.87-10.62	NA				Palaeognathae	9.90	3.78-16.03	9.83	3.75-15.92		
cuckoo+bustard*	NA		NA				parrots	7.58	3.46-11.69	7.64	3.53-11.75		
Cursorimorphae	9.25	6.43-12.08	8.67	5.92-11.42			Passerea	8.20	5.83-10.58	8.31	6.02-10.61		
Cursorimorphae+waterbirds	9.19	6.89-11.49	NA				Passerea minus Otidimorphae	8.33	6.04-10.61	NA			
eagles	16.80	14.36-19.24	16.92	14.74-19.10			Passeriformes	5.88	2.11-9.65	5.97	2.21-9.72		
egret+pelican	10.34	6.92-13.77	10.21	6.76-13.66			Passerimorphae	7.44	4.08-10.81	7.62	4.23-11.01		
Eupasseriformes	5.65	1.99-9.30	5.70	2.08-9.33			Pelecaniformes	10.55	7.58-13.51	10.40	7.44-13.36		
falcon+Passerimorphae	7.90	5.06-10.74	8.19	5.35-11.03			penguins	15.20	11.50-18.90	14.99	11.10-18.88		
finch+zebrafinch	4.22	1.59-6.84	4.22	1.62-6.81			Phaethontimorphae	9.34	6.13-12.54	9.14	5.91-12.37		
fulmar+penguins	11.16	8.22-14.10	11.09	8.17-14.01			Phoenicopterimorphae	9.13	4.79-13.47	9.05	4.88-13.22		
fulmar+penguins+Pelecaniformes	10.65	7.94-13.36	10.50	7.84-13.15			swift+hummingbird ("Apodiformes")	6.55	2.05-11.05	6.47	2.00-10.94		
Galliformes	6.39	1.94-10.85	6.39	2.02-10.76			Telluraves	8.49	6.19-10.78	8.67	6.42-10.93		
Galloanseres	7.45	2.09-12.81	7.45	2.14-12.76			Telluraves+waterbirds	NA		8.92	6.77-11.06		
hoatzin+Cursorimorphae	NA		8.60	6.18-11.03			trogon+hornbill+bee-eater+woodpecker	8.36	5.18-11.54	8.58	5.37-11.79		
hoatzin+Cursorimorphae+waterbirds	8.88	6.65-11.11	NA				turaco+bustard	7.77	4.49-11.06 ^a	7.66	4.34-10.98		
hoatzin+Cursorimorphae+waterbirds+Telluraves	8.65	6.49-10.82	8.61	6.39-10.82			waterbirds	9.46	7.08-11.84	9.25	6.98-11.53		
hornbill+bee-eater+woodpecker	8.62	6.07-11.18	8.81	5.33-12.30									

* recovered by ASTRAL; not in MP-EST* or TENT ExaML trees

Table S2. Generation Lengths of Species Studied¹.

species	years	species	years	species	years
<i>Acanthisitta chloris</i>	3.5	<i>Cuculus canorus</i>	7	<i>Nestor notabilis</i>	12
<i>Anas platyrhynchos</i>	6.6	<i>Dryobates pubescens</i>	4.7	<i>Nipponia nippon</i>	10.1
<i>Anrostomus carolinensis</i>	5.6	<i>Egretta garzetta</i>	6.6	<i>Opisthocomus hoazin</i>	5.5
<i>Apaloderma vittatum</i>	7.3	<i>Eurypyga helias</i>	5.7	<i>Pelecanus crispus</i>	11
<i>Aptenodytes forsteri</i>	20.4	<i>Falco peregrinus</i>	6.8	<i>Phaethon lepturus</i>	11.1
<i>Balearica regulorum</i>	15.1	<i>Gallus gallus</i>	5	<i>Phalacrocorax carbo</i>	11.3
<i>Buceros rhinoceros</i>	18.4	<i>Gavia stellata</i>	9.8	<i>Phoenicopterus ruber</i>	15
<i>Calypte anna</i>	4.8	<i>Geospiza fortis</i>	4.3	<i>Podiceps cristatus</i>	7.1
<i>Cariama cristata</i>	6.7	<i>Haliaeetus albicilla</i>	17.5	<i>Pterocles gutturalis</i>	5.6
<i>Cathartes aura</i>	9.9	<i>Haliaeetus leucocephalus</i>	17.2	<i>Pygoscelis adeliae</i>	12
<i>Chaetura pelagica</i>	5.35	<i>Leptosomus discolor</i>	5.6	<i>Struthio camelus</i>	16.8
<i>Charadrius vociferus</i>	5.2	<i>Manacus vitellinus</i>	5.2	<i>Taeniopygia guttata</i>	3
<i>Chlamydotis macqueenii</i>	6.6	<i>Meleagris gallopavo</i>	7	<i>Tauraco erythrolophus</i>	3.3
<i>Colius striatus</i>	2.7	<i>Melopsittacus undulatus</i>	3.3	<i>Tinamus guttatus</i>	6.8
<i>Columba livia</i>	5.8	<i>Merops nubicus</i>	6.2	<i>Tyto alba</i>	6.2
<i>Corvus brachyrhynchos</i>	7.3	<i>Mesitornis unicolor</i>	4.2		

¹ source: International Union for Conservation of Nature and Natural Resources 2019; accessed 11/26/2019

Table S4. Estimated N_e on TENT.

clade	MRCA	≥ 100 bp	≥ 50 bp	≥ 10 bp	≥ 2 bp	all
Neoaves	69.2	455,878	497,299	788,913	971,555	983,549
Columbea	68.1	969,276	676,646	4,616,664	7,764,614	5,311,164
Passerea	67.9	673,244	2,857,599	2,939,658	3,628,496	3,796,627
Otidimorphae+Caprimulgimorphae	66.7	undef	undef	undef	undef	undef
hoatzin+Cursorimorphae+waterbirds+Telluraves	66.7	undef	8,671,779	2,905,730	3,067,072	2,833,264
hoatzin+Cursorimorphae	65.9	undef	1,370,522	6,514,167	3,629,075	4,789,556
Galloanseres	65.8	1,133,702	1,285,495	1,792,062	2,191,490	2,277,371
Columbimorphae	65.6	3,258,842	12,597,535	21,020,914	18,278,800	26,127,434
waterbirds+Telluraves	65.4	undef	undef	undef	undef	undef
Otidimorphae	64.9	665,161	1,021,397	2,258,216	3,207,899	2,798,017
Cursorimorphae	64.6	967,672	6,047,507	2,872,542	9,984,411	7,386,931
waterbirds	64.5	undef	2,095,690	1,728,721	2,468,445	2,610,031
Telluraves	63.5	174,476	201,318	314,900	338,832	304,676
Caprimulgimorphae	62.9	390,216	545,016	1,041,244	1,212,233	1,115,139
Aequornithia	62.8	213,440	243,454	362,046	380,971	352,973
Afroaves	62.8	568,605	1,720,211	4,613,096	undef	13,178,914
turaco+bustard	62.3	undef	undef	8,810,974	8,614,327	11,006,615
Australaves	62.1	1,530,834	1,031,594	1,780,475	2,492,362	2,174,732
owl+Coraciimorphae	61.6	undef	undef	undef	undef	undef
mesite+sandgrouse	61.6	638,278	714,229	1,320,941	1,698,610	1,539,306
fulmar+penguins+Pelecaniformes	61.4	110,471	157,088	354,414	406,533	354,782
Accipitriformae	60.3	210,724	299,336	557,574	645,170	592,447
Phaethontimorphae	60.0	555,971	621,124	1,583,426	1,873,789	1,696,962
falcon+Passerimorphae	60.0	359,868	672,813	1,683,098	1,922,282	1,848,349
fulmar+penguins	60.0	141,239	225,220	419,086	498,930	476,563
Coraciimorphae	59.9	1,051,512	1,036,962	3,101,776	3,208,384	3,274,734
Pelecaniformes	58.9	219,043	398,900	1,712,793	1,965,111	1,815,993
Coraciimorphae minus mousebird	58.6	231,747	406,048	1,669,153	2,244,810	1,900,335
ibis+egret+pelican	57.6	320,021	495,599	713,251	890,593	827,106
Phoenicopterimorphae	56.3	289,472	371,307	751,315	875,392	808,468
egret+pelican	55.2	2,097,806	2,549,896	undef	undef	undef
trogon+hornbill+bee-eater+woodpecker	55.1	904,287	1,600,960	3,630,082	4,948,849	5,051,569
Passerimorphae	54.5	2,401,615	1,793,395	4,133,449	5,160,835	5,168,919
hornbill+bee-eater+woodpecker	52.0	324,854	404,956	1,664,078	2,849,400	2,912,604
swift+hummingbird ("Apodiformes")	43.7	766,158	940,200	1,682,104	2,258,147	2,184,009
bee-eater+woodpecker	42.3	2,637,162	2,877,711	6,019,089	9,203,751	9,204,302
Passeriformes	38.5	387,433	459,064	808,839	1,029,298	1,008,146
Eupasseriformes	31.8	864,740	1,069,200	1,818,662	2,264,170	2,214,305
parrots	28.9	391,061	458,529	645,201	783,034	780,546
Galliformes	27.9	664,589	715,961	834,173	989,360	1,006,619
penguins	23.0	331,223	405,307	619,027	621,700	600,099
oscines	20.5	397,277	426,599	524,853	594,506	597,331
finch+zebrafinch	9.9	1,001,174	1,025,346	1,110,402	1,235,500	1,228,097
eagles	6.0	336,240	321,082	358,298	329,562	318,368

gray area – corresponds to Paleocene epoch

undef – cannot be calculated due to zero coalescent branch length (CBL)

red highlighted values – greater than or equal to upper quartile

green highlighted values – greater than or equal to median

outline – deviation for observed trend of increasing N_e estimates for more inclusive sets of indels

Table S5. Rank Ordered N_e Estimates >100 bp Indels

MP-EST*	MP-EST*	TENT	TENT
7,577,755	waterbirds	Columbimorphae	3,258,842
3,397,326	Columbimorphae	bee-eater+woodpecker	2,637,162
2,719,920	bee-eater+woodpecker	Passerimorphae	2,401,615
2,547,649	Passerea minus Otidimorphae	egret+pelican	2,097,806
2,477,913	Coraciimorphae+Australaves	Australaves	1,530,834
2,415,922	Australaves	Galloanseres	1,133,702
2,211,450	Passerimorphae	Coraciimorphae	1,051,512
1,771,397	egret+pelican	finch+zebrafinch	1,001,174
1,429,457	Cursorimorphae	Columbea	969,276
1,391,856	Coraciimorphae	Cursorimorphae	967,672
1,203,937	hoatzin+Cursorimorphae+waterbirds	trogon+hornbill+bee-eater+woodpecker	904,287
1,072,286	Galloanseres	Eupasseriformes	864,740
990,644	finch+zebrafinch	swift+hummingbird ("Apodiformes")	766,158
874,551	Columbea	Passerea	673,244
859,505	Eupasseriformes	Otidimorphae	665,161
851,569	trogon+hornbill+bee-eater+woodpecker	Galliformes	664,589
805,096	swift+hummingbird ("Apodiformes")	mesite+sandgrouse	638,278
758,394	Otidimorphae	Afroaves	568,605
675,283	Galliformes	Phaethontimorphae	555,971
649,572	Passerea	Neoaves	455,878
646,358	owl+Accipitriformae	oscines	397,277
591,358	mesite+sandgrouse	parrots	391,061
469,189	Phaethontimorphae	Caprimulgimorphae	390,216
468,816	Neoaves	Passeriformes	387,433
407,088	parrots	falcon+Passerimorphae	359,868
405,168	Caprimulgimorphae	eagles	336,240
402,051	oscines	penguins	331,223
396,584	Passeriformes	hornbill+bee-eater+woodpecker	324,854
349,603	penguins	ibis+egret+pelican	320,021
343,977	Phoenicopterimorphae	Phoenicopterimorphae	289,472
340,398	ibis+egret+pelican	Coraciimorphae minus mousebird	231,747
333,925	hornbill+bee-eater+woodpecker	Pelecaniformes	219,043
328,344	falcon+Passerimorphae	Aequornithia	213,440
328,240	eagles	Accipitriformae	210,724
244,745	Coraciimorphae minus mousebird	Telluraves	174,476
221,203	Accipitriformae	fulmar+penguins	141,239
196,051	Telluraves	fulmar+penguins+Pelecaniformes	110,471
189,686	Aequornithia	Otidimorphae+Caprimulgimorphae	undef
184,213	Pelecaniformes	hoatzin+Cursorimorphae+waterbirds+Telluraves	undef
120,354	fulmar+penguins	hoatzin+Cursorimorphae	undef
118,644	fulmar+penguins+Pelecaniformes	waterbirds+Telluraves	undef
undef	hoatzin+Cursorimorphae+waterbirds+Telluraves	waterbirds	undef
undef	turaco+bustard	turaco+bustard	undef
undef	Cursorimorphae+waterbirds	owl+Coraciimorphae	undef

red highlighted values - within UQ of size partition

green highlighted values - within 3rd quartile of size partition

blue highlighted text - branches not present in other tree

undef - cannot be calculated due to zero CBL

Table S6. Rank Ordered N_e Estimates ≥ 50 bp Indels.

MP-EST*	MP-EST*	TENT	TENT
13,132,865	Columbimorphae	Columbimorphae	12,597,535
5,282,209	Cursorimorphae	hoatzin+Cursorimorphae+waterbirds+Telluraves	8,671,779
4,480,370	Passerea	Cursorimorphae	6,047,507
2,968,018	bee-eater+woodpecker	bee-eater+woodpecker	2,877,711
2,180,997	Coraciimorphae	Passerea	2,857,599
2,153,144	egret+pelican	egret+pelican	2,549,896
1,751,738	Passerea minus Otidimorphae	waterbirds	2,095,690
1,688,208	Coraciimorphae+Australaves	Passerimorphae	1,793,395
1,651,390	Passerimorphae	Afroaves	1,720,211
1,507,628	trogon+hornbill+bee-eater+woodpecker	trogon+hornbill+bee-eater+woodpecker	1,600,960
1,354,148	owl+Accipitrimorphae	hoatzin+Cursorimorphae	1,370,522
1,343,280	waterbirds	Galloanseres	1,285,495
1,215,856	Galloanseres	Eupasseriformes	1,069,200
1,169,523	Otidimorphae	Coraciimorphae	1,036,962
1,073,930	Australaves	Australaves	1,031,594
1,062,727	Eupasseriformes	finch+zebrafinch	1,025,346
1,014,562	finch+zebrafinch	Otidimorphae	1,021,397
987,984	swift+hummingbird ("Apodiformes")	swift+hummingbird ("Apodiformes")	940,200
727,481	Galliformes	Galliformes	715,961
661,725	mesite+sandgrouse	mesite+sandgrouse	714,229
613,876	falcon+Passerimorphae	Columbea	676,646
610,519	Columbea	falcon+Passerimorphae	672,813
591,441	hoatzin+Cursorimorphae+waterbirds	Phaethontimorphae	621,124
536,986	Caprimulgimorphae	Caprimulgimorphae	545,016
527,155	ibis+egret+pelican	Neoaves	497,299
524,172	Phaethontimorphae	ibis+egret+pelican	495,599
511,412	Neoaves	Passeriformes	459,064
477,320	parrots	parrots	458,529
469,906	Passeriformes	oscines	426,599
441,221	Phoenicopterimorphae	Coraciimorphae minus mousebird	406,048
431,725	oscines	penguins	405,307
428,822	Coraciimorphae minus mousebird	hornbill+bee-eater+woodpecker	404,956
427,799	penguins	Pelecaniformes	398,900
416,264	hornbill+bee-eater+woodpecker	Phoenicopterimorphae	371,307
335,472	Pelecaniformes	eagles	321,082
313,442	eagles	Accipitrimorphae	299,336
276,446	Accipitrimorphae	Aequornithia	243,454
236,062	Telluraves	fulmar+penguins	225,220
216,360	Aequornithia	Telluraves	201,318
191,916	fulmar+penguins	fulmar+penguins+Pelecaniformes	157,088
168,709	fulmar+penguins+Pelecaniformes	Otidimorphae+Caprimulgimorphae	undef
undef	turaco+bustard	waterbirds+Telluraves	undef
undef	hoatzin+Cursorimorphae+waterbirds+Telluraves	turaco+bustard	undef
undef	Cursorimorphae+waterbirds	owl+Coraciimorphae	undef

red highlighted values - within UQ of size partition
green highlighted values - within 3rd quartile of size partition
blue highlighted text - branches not present in other tree
undef - cannot be calculated due to zero CBL

Table S7. Rank Ordered Ne Estimates >10 bp Indels.

MP-EST*	MP-EST*	TENT	TENT
44,060,394	hoatzin+Cursorimorphae+waterbirds+Telluraves	Columbimorphae	21,020,914
21,914,195	Columbimorphae	turaco+bustard	8,810,974
10,155,141	Cursorimorphae	hoatzin+Cursorimorphae	6,514,167
9,031,477	turaco+bustard	bee-eater+woodpecker	6,019,089
6,225,441	Coraciimorphae	Columbea	4,616,664
6,207,978	bee-eater+woodpecker	Afroaves	4,613,096
4,165,487	Columbea	Passerimorphae	4,133,449
4,110,278	Otidimorphae	trogon+hornbill+bee-eater+woodpecker	3,630,082
3,806,154	Passerimorphae	Coraciimorphae	3,101,776
3,418,456	trogon+hornbill+bee-eater+woodpecker	Passerea	2,939,658
3,214,055	Passerea minus Otidimorphae	hoatzin+Cursorimorphae+waterbirds+Telluraves	2,905,730
3,180,435	Passerea	Cursorimorphae	2,872,542
2,924,806	Coraciimorphae+Australaves	Otidimorphae	2,258,216
1,807,652	Eupasseriformes	Eupasseriformes	1,818,662
1,767,594	swift+hummingbird ("Apodiformes")	Galloanseres	1,792,062
1,762,770	Coraciimorphae minus mousebird	Australaves	1,780,475
1,710,543	hornbill+bee-eater+woodpecker	waterbirds	1,728,721
1,694,981	Galloanseres	Pelecaniformes	1,712,793
1,542,437	Australaves	falcon+Passerimorphae	1,683,098
1,535,662	falcon+Passerimorphae	swift+hummingbird ("Apodiformes")	1,682,104
1,440,445	Pelecaniformes	Coraciimorphae minus mousebird	1,669,153
1,354,046	hoatzin+Cursorimorphae+waterbirds	hornbill+bee-eater+woodpecker	1,664,078
1,348,805	waterbirds	Phaethontimorphae	1,583,426
1,336,269	Phaethontimorphae	mesite+sandgrouse	1,320,941
1,223,838	mesite+sandgrouse	finch+zebrafinch	1,110,402
1,120,487	owl+Accipitrimorphae	Caprimulgimorphae	1,041,244
1,098,723	finch+zebrafinch	Galliformes	834,173
1,038,896	Caprimulgimorphae	Passeriformes	808,839
892,781	Phoenicopterimorphae	Neoaves	788,913
847,596	Galliformes	Phoenicopterimorphae	751,315
827,942	Passeriformes	ibis+egret+pelican	713,251
811,302	Neoaves	parrots	645,201
758,666	ibis+egret+pelican	penguins	619,027
671,643	parrots	Accipitrimorphae	557,574
653,379	penguins	oscines	524,853
635,425	Accipitrimorphae	fulmar+penguins	419,086
531,160	oscines	Aequornithia	362,046
380,633	fulmar+penguins+Pelecaniformes	eagles	358,298
362,023	Telluraves	fulmar+penguins+Pelecaniformes	354,414
357,116	fulmar+penguins	Telluraves	314,900
349,773	eagles	Otidimorphae+Caprimulgimorphae	undef
321,754	Aequornithia	waterbirds+Telluraves	undef
undef	egret+pelican	owl+Coraciimorphae	undef
undef	Cursorimorphae+waterbirds	egret+pelican	undef

red highlighted values - within UQ of size partition

green highlighted values - within 3rd quartile of size partition

blue highlighted text - branches not present in other tree

undef - cannot be calculated due to zero CBL

Table S8. Rank Ordered N_e Estimates ≥ 2 bp Indels.

MP-EST*	MP-EST*	TENT	TENT
19,055,555	Columbimorphae	Columbimorphae	18,278,800
18,239,180	Cursorimorphae	Cursorimorphae	9,984,411
15,054,264	hoatzin+Cursorimorphae+waterbirds+Telluraves	bee-eater+woodpecker	9,203,751
9,492,580	bee-eater+woodpecker	turaco+bustard	8,614,327
8,829,909	turaco+bustard	Columbea	7,764,614
8,305,384	Coraciimorphae	Passerimorphae	5,160,835
7,005,794	Columbea	trogon+hornbill+bee-eater+woodpecker	4,948,849
5,892,615	Otidimorphae	hoatzin+Cursorimorphae	3,629,075
4,752,189	Passerimorphae	Passerea	3,628,496
4,660,342	trogon+hornbill+bee-eater+woodpecker	Coraciimorphae	3,208,384
4,464,287	Passerea minus Otidimorphae	Otidimorphae	3,207,899
3,149,023	Passerea	hoatzin+Cursorimorphae+waterbirds+Telluraves	3,067,072
2,928,964	hornbill+bee-eater+woodpecker	hornbill+bee-eater+woodpecker	2,849,400
2,403,159	Australaves	Australaves	2,492,362
2,372,913	swift+hummingbird ("Apodiformes")	waterbirds	2,468,445
2,370,713	Coraciimorphae minus mousebird	Eupasseriformes	2,264,170
2,288,597	waterbirds	swift+hummingbird ("Apodiformes")	2,258,147
2,250,463	Eupasseriformes	Coraciimorphae minus mousebird	2,244,810
2,072,770	Galloanseres	Galloanseres	2,191,490
1,941,010	Coraciimorphae+Australaves	Pelecaniformes	1,965,111
1,753,894	falcon+Passerimorphae	falcon+Passerimorphae	1,922,282
1,652,642	Pelecaniformes	Phaethontimorphae	1,873,789
1,581,309	Phaethontimorphae	mesite+sandgrouse	1,698,610
1,573,745	mesite+sandgrouse	finch+zebrafinch	1,235,500
1,566,421	hoatzin+Cursorimorphae+waterbirds	Caprimulgimorphae	1,212,233
1,238,184	Caprimulgimorphae	Passeriformes	1,029,298
1,222,505	finch+zebrafinch	Galliformes	989,360
1,053,608	Passeriformes	Neoaves	971,555
1,040,220	Phoenicopterimorphae	ibis+egret+pelican	890,593
1,032,415	owl+Accipitrimorphae	Phoenicopterimorphae	875,392
1,005,280	Galliformes	parrots	783,034
999,127	Neoaves	Accipitrimorphae	645,170
947,299	ibis+egret+pelican	penguins	621,700
833,282	Accipitrimorphae	oscines	594,506
815,124	parrots	fulmar+penguins	498,930
656,199	penguins	fulmar+penguins+Pelecaniformes	406,533
601,651	oscines	Aequornithia	380,971
436,608	fulmar+penguins+Pelecaniformes	Telluraves	338,832
425,154	fulmar+penguins	eagles	329,562
396,571	Telluraves	Otidimorphae+Caprimulgimorphae	undef
338,573	Aequornithia	waterbirds+Telluraves	undef
321,720	eagles	Afroaves	undef
undef	egret+pelican	owl+Coraciimorphae	undef
undef	Cursorimorphae+waterbirds	egret+pelican	undef

red highlighted values - within UQ of size partition
green highlighted values - within 3rd quartile of size partition
blue highlighted text - branches not present in other tree
undef - cannot be calculated due to zero CBL

Table S9. Rank Ordered Ne Estimates all indels.

MP-EST*	MP-EST*	TENT	TENT
27,237,715	Columbimorphae	Columbimorphae	26,127,434
26,538,881	hoatzin+Cursorimorphae+waterbirds+Telluraves	Afroaves	13,178,914
19,760,224	Cursorimorphae	turaco+bustard	11,006,615
11,282,066	turaco+bustard	bee-eater+woodpecker	9,204,302
9,493,148	bee-eater+woodpecker	Cursorimorphae	7,386,931
8,020,706	Coraciimorphae	Columbea	5,311,164
5,555,172	Otidimorphae	Passerimorphae	5,168,919
4,792,114	Columbea	trogon+hornbill+bee-eater+woodpecker	5,051,569
4,759,634	Passerimorphae	hoatzin+Cursorimorphae	4,789,556
4,757,074	trogon+hornbill+bee-eater+woodpecker	Passerea	3,796,627
3,553,004	Passerea	Coraciimorphae	3,274,734
3,531,328	Passerea minus Otidimorphae	hornbill+bee-eater+woodpecker	2,912,604
2,993,933	hornbill+bee-eater+woodpecker	hoatzin+Cursorimorphae+waterbirds+Telluraves	2,833,264
2,295,007	swift+hummingbird ("Apodiformes")	Otidimorphae	2,798,017
2,229,417	waterbirds	waterbirds	2,610,031
2,200,900	Eupasseriformes	Galloanseres	2,277,371
2,153,999	Galloanseres	Eupasseriformes	2,214,305
2,113,830	Coraciimorphae+Australaves	swift+hummingbird ("Apodiformes")	2,184,009
2,006,918	Coraciimorphae minus mousebird	Australaves	2,174,732
1,983,968	Australaves	Coraciimorphae minus mousebird	1,900,335
1,839,830	hoatzin+Cursorimorphae+waterbirds	falcon+Passerimorphae	1,848,349
1,686,437	falcon+Passerimorphae	Pelecaniformes	1,815,993
1,527,236	Pelecaniformes	Phaethontimorphae	1,696,962
1,432,083	Phaethontimorphae	mesite+sandgrouse	1,539,306
1,426,151	mesite+sandgrouse	finch+zebrafinch	1,228,097
1,215,180	finch+zebrafinch	Caprimulgimorphae	1,115,139
1,154,298	Caprimulgimorphae	Passeriformes	1,008,146
1,031,957	Passeriformes	Galliformes	1,006,619
1,022,817	Galliformes	Neoaves	983,549
1,011,461	Neoaves	ibis+egret+pelican	827,106
960,696	Phoenicopterimorphae	Phoenicopterimorphae	808,468
887,143	owl+Accipitriformae	parrots	780,546
879,770	ibis+egret+pelican	penguins	600,099
812,535	parrots	oscines	597,331
770,336	Accipitriformae	Accipitriformae	592,447
633,400	penguins	fulmar+penguins	476,563
604,510	oscines	fulmar+penguins+Pelecaniformes	354,782
406,094	fulmar+penguins	Aequornithia	352,973
381,028	fulmar+penguins+Pelecaniformes	eagles	318,368
350,432	Telluraves	Telluraves	304,676
313,691	Aequornithia	Otidimorphae+Caprimulgimorphae	undef
310,792	eagles	waterbirds+Telluraves	undef
undef	Cursorimorphae+waterbirds	owl+Coraciimorphae	undef
undef	egret+pelican	egret+pelican	undef

red highlighted values - within UQ of size partition
green highlighted values - within 3rd quartile of size partition
blue highlighted text - branches not present in other tree
undef - cannot be calculated due to zero CBL

Table S10. Estimated *N_e* of nucleotide and indel gene trees using MP-EST* tree.

clade	MRCA	1938 loci					2515 loci		
		nucleotides	unweighted indels	weighted indels	nts+unwt indels	nts+wt indels	nucleotides	unwt indels	nts+unwt indels
Neoaves	69.0	304,414	540,806	639,388	309,810	316,282	404,989	655,077	413,363
Columbea	68.0	1,637,861	1,606,884	1,870,892	1,214,492	1,183,648	1,513,846	1,644,456	1,261,689
Passerea	68.0	1,396,665	2,514,668	2,446,239	1,408,931	1,291,268	1,639,269	3,278,070	1,709,764
Passerea minus Otidimorphae	67.1	1,787,064	3,159,555	3,922,098	1,459,457	1,688,865	1,864,034	3,227,462	1,466,233
Galloanseres	67.1	421,623	674,840	841,763	420,189	451,125	519,035	845,476	519,738
Otidimorphae (cuckoo+turaco+bustard)	66.2	982,273	2,293,435	2,265,959	1,107,612	1,062,655	1,148,160	2,631,364	1,225,214
hoatzin+Cursorimorphae+waterbirds+Telluraves	65.8	37,991,088	undef	undef	undef	undef	undef	undef	undef
Columbimorphae	65.4	8,407,116	30,671,161	8,358,593	7,217,440	9,353,390	7,683,900	16,160,645	9,870,241
hoatzin+Cursorimorphae+waterbirds	65.1	1,848,209	1,873,093	1,604,765	1,624,631	2,304,076	1,936,467	1,862,903	1,811,433
Cursorimorphae+waterbirds	64.3	undef	undef	undef	undef	undef	undef	undef	undef
Telluraves	63.6	145,557	238,700	254,642	148,500	151,740	171,375	279,198	174,819
Caprimulgimorphae	63.6	299,220	687,987	756,698	307,561	323,796	343,015	760,762	359,422
waterbirds	63.5	962,018	2,255,617	1,739,870	928,668	1,017,121	1,081,167	2,122,586	1,044,105
turaco+bustard	63.5	282,914,480	10,018,014	22,169,592	62,487,576	undef	162,191,909	14,787,632	38,374,951
owl+Accipitrimorphae	62.6	1,104,335	780,123	890,438	785,403	830,766	1,206,274	803,409	862,918
Coraciimorphae+Australaves	62.4	1,221,822	1,691,600	1,790,131	1,036,018	1,110,123	1,298,083	1,628,958	1,047,116
Cursorimorphae	62.2	2,718,950	3,068,898	3,945,274	3,632,370	3,242,110	3,410,815	4,121,263	4,843,546
Aequornithia	62.0	199,226	265,061	266,008	200,742	205,625	216,886	287,625	216,694
mesite+sandgrouse	61.8	530,140	1,192,736	1,268,817	526,832	544,635	587,489	1,296,209	577,974
Australaves	61.4	256,992	820,417	776,880	316,200	300,920	304,125	956,910	365,819
Coraciimorphae	60.7	1,556,615	8,927,821	8,643,779	1,900,395	1,663,897	1,798,540	19,248,013	2,249,619
fulmar+penguins+Pelecaniformes	60.4	127,154	271,730	272,116	131,342	131,300	149,205	304,620	153,392
Accipitrimorphae	60.1	310,884	620,471	645,713	307,346	310,355	366,799	681,153	356,570
Phaethontimorphae	59.6	508,954	1,188,146	1,249,436	532,562	557,203	586,219	1,339,811	601,241
falcon+Passerimorphae	59.5	388,239	987,819	1,226,180	375,517	412,345	452,451	1,176,458	448,442
Coraciimorphae minus mousebird	59.3	262,299	997,238	880,255	290,301	310,684	303,832	1,074,481	340,620
fulmar+penguins	59.2	202,855	315,222	291,207	192,152	182,992	224,470	368,085	216,321
Pelecaniformes	58.3	145,427	757,457	760,480	153,600	161,904	177,890	839,157	189,331
ibis+egret+pelican	56.8	176,274	489,654	516,729	175,830	181,128	207,779	571,963	215,380
trogon+hornbill+bee-eater+woodpecker	56.1	1,177,988	3,994,296	3,783,402	1,165,227	1,281,119	1,431,494	4,021,967	1,363,826
egret+pelican	54.9	679,384	4,441,474	5,664,033	739,667	830,741	763,207	7,892,830	854,615
Passerimorphae	54.6	1,302,891	2,963,212	3,246,684	1,038,207	1,169,328	1,450,494	2,989,916	1,178,947
Phoenicopterimorphae	53.9	220,723	544,082	591,227	214,906	225,256	280,539	628,457	270,388
hornbill+bee-eater+woodpecker	53.0	391,507	2,020,082	1,813,248	392,345	447,136	468,556	2,179,183	478,422
bee-eater+woodpecker	43.2	2,145,995	7,873,819	12,532,267	2,136,188	2,170,510	2,634,003	8,275,670	2,613,442
swift+hummingbird ("Apodiformes")	43.1	451,771	1,196,040	1,335,266	449,370	517,292	607,557	1,414,773	598,967
Passeriformes	38.4	234,006	404,529	438,348	231,949	236,035	264,302	505,318	266,588
Eupasseriformes	31.9	277,820	669,562	746,818	259,401	286,720	332,667	758,708	322,506
Galliformes	28.7	1,040,482	1,028,953	1,034,323	1,029,190	1,029,190	1,253,472	1,233,493	1,244,437
parrots	28.1	248,580	362,600	368,616	274,355	274,370	312,264	464,901	307,618
oscines	20.5	175,728	235,290	277,070	176,170	164,582	190,245	290,717	190,500
penguins	19.6	184,339	313,853	324,048	184,295	203,206	227,725	423,117	233,367
finch+zebrafinch	10.0	214,833	405,145	486,477	180,572	200,774	267,818	485,464	252,454
eagles	7.4	231,815	274,219	274,589	227,848	227,848	223,389	385,147	219,702

gray area – corresponds to Paleocene epoch

MRCA – most recent common ancestor

undef – cannot be calculated due to zero coalescent branch length (CBL)

red highlighted values – greater than or equal to upper quartile

green highlighted values – greater than or equal to median

Table S11. Estimated N_e of nucleotide and indel gene trees using TENT .

clade	MRCA	1938 loci					2515 loci		
		nucleotides	unweighted indels	weighted indels	nts+unwt indels	nts+wt indels	nucleotides	unwt indels	nts+unwt indels
Neoaves	69.2	296,013	525,882	621,743	301,260	307,554	393,813	637,000	401,956
Columbea	68.1	1,815,263	1,780,931	2,073,534	1,346,038	1,311,852	1,677,816	1,822,572	1,398,347
Passerea	67.9	1,166,465	2,561,357	2,590,579	1,134,147	1,089,530	1,327,302	3,016,739	1,284,649
Otidimorphae+Caprimulgimorphae	66.7	18,852,583	undef	undef	undef	undef	32,946,625	undef	168,011,840
hoatzin+Cursorimorphae+waterbirds+Telluraves	66.7	3,444,021	3,201,447	3,589,267	3,799,865	3,692,247	3,714,985	3,184,485	3,817,322
hoatzin+Cursorimorphae	65.9	2,591,809	2,892,964	2,758,447	2,108,211	1,915,033	3,444,419	4,585,077	2,510,946
Galloanseres	65.8	445,771	713,492	889,975	444,256	476,963	548,763	893,902	549,507
Columbimorphae	65.6	8,064,419	29,420,923	8,017,875	6,923,238	8,972,121	7,370,683	15,501,894	9,467,904
waterbirds+Telluraves	65.4	undef	undef	undef	undef	213,469,454	undef	undef	undef
Otidimorphae	64.9	1,085,083	2,047,205	2,047,384	1,162,446	1,122,482	1,188,228	2,240,114	1,259,728
Cursorimorphae	64.6	4,870,494	2,715,247	3,176,406	5,449,356	5,652,564	3,925,155	3,146,607	5,158,027
waterbirds	64.5	1,151,567	1,956,246	1,551,453	1,064,996	1,118,090	1,110,715	1,821,415	1,040,825
Telluraves	63.5	131,868	208,613	221,207	133,778	136,642	153,305	240,427	154,597
Caprimulgimorphae	62.9	356,894	803,623	871,458	359,488	377,131	408,097	882,560	421,964
Aequornithia	62.8	224,174	298,253	299,320	225,881	231,374	244,045	323,685	243,830
Afroaves	62.8	1,819,700	3,069,773	3,866,709	2,622,765	3,816,989	2,159,926	3,569,873	3,787,687
turaco+bustard	62.3	276,007,143	9,773,424	21,628,323	60,961,947	undef	158,232,005	14,426,593	37,438,029
Australaves	62.1	291,601	915,997	866,877	353,416	334,692	343,580	1,054,696	404,544
owl+Coraciimorphae	61.6	2,321,224	undef	undef	3,042,704	2,284,499	2,532,396	undef	3,879,204
mesite+sandgrouse	61.6	572,202	1,287,371	1,369,489	568,632	587,848	634,102	1,399,054	623,832
fulmar+penguins+Pelecaniformes	61.4	118,395	253,012	253,372	122,295	122,255	138,928	283,637	142,826
Accipitrimorphae	60.3	278,737	451,841	479,549	264,457	269,341	320,913	479,954	300,447
Phaethontimorphae	60.0	603,090	1,407,906	1,480,533	631,065	660,264	694,647	1,587,624	712,447
falcon+Passerimorphae	60.0	425,513	1,082,657	1,343,903	411,569	451,933	495,890	1,289,408	491,497
fulmar+penguins	60.0	238,056	369,922	341,740	225,496	214,746	263,423	431,958	253,859
Coraciimorphae	59.9	1,593,695	5,801,745	4,730,466	1,460,375	1,604,906	1,719,263	7,754,349	1,611,521
Pelecaniformes	58.9	172,923	900,671	904,266	182,642	192,515	211,525	997,818	225,128
Coraciimorphae minus mousebird	58.6	248,369	944,277	833,507	274,884	294,184	287,696	1,017,418	322,531
ibis+egret+pelican	57.6	165,722	460,343	485,797	165,304	170,285	195,341	537,725	202,487
Phoenicopterimorphae	56.3	185,748	457,870	497,544	180,853	189,563	236,086	528,875	227,543
egret+pelican	55.2	804,572	5,259,887	6,707,722	875,962	983,818	903,840	9,347,211	1,012,092
trogon+hornbill+bee-eater+woodpecker	55.1	1,250,914	4,241,571	4,017,621	1,237,362	1,360,429	1,520,113	4,270,955	1,448,256
Passerimorphae	54.5	1,414,928	3,218,022	3,525,870	1,127,484	1,269,880	1,575,224	3,247,022	1,280,326
hornbill+bee-eater+woodpecker	52.0	380,872	1,965,207	1,763,992	381,687	434,990	455,828	2,119,987	465,426
swift+hummingbird ("Apodiformes")	43.7	429,921	1,138,193	1,270,686	427,636	492,273	578,173	1,346,348	569,998
bee-eater+woodpecker	42.3	2,080,700	7,634,244	12,150,950	2,071,190	2,104,468	2,553,858	8,023,868	2,533,923
Passeriformes	38.5	228,607	395,195	428,234	226,597	230,589	258,204	493,658	260,437
Eupasseriformes	31.8	279,512	673,640	751,367	260,981	288,466	334,694	763,329	324,470
parrots	28.9	238,794	348,325	354,104	263,554	263,568	299,971	446,599	295,507
Galliformes	27.9	1,024,004	1,012,658	1,017,943	1,012,892	1,012,892	1,233,621	1,213,958	1,224,730
penguins	23.0	174,647	297,352	307,011	174,606	192,522	215,753	400,872	221,098
oscines	20.5	173,641	232,496	273,780	174,078	162,628	187,985	287,264	188,238
finch+zebrafinch	9.9	217,116	409,451	491,648	182,492	202,908	270,665	490,625	255,138
eagles	6.0	237,466	280,903	281,282	233,401	233,401	228,834	394,535	225,057

gray area – corresponds to Paleocene epoch

MRCA – most recent common ancestor

undef – cannot be calculated due to zero coalescent branch length (CBL)

red highlighted values – greater than or equal to upper quartile

green highlighted values – greater than or equal to median

Table S12. Estimated N_e Median and Upper Quartiles on TENT.

	indels				
	≥100 bp	≥50 bp	≥10 bp	≥2 bp	all
Median	555,971	695,437	1,675,629	1,965,111	1,874,342
Upper Quartile	967,672	1,428,132	2,914,212	3,208,141	3,405,207

	gene trees				
	1938 loci			2515 loci	
	nts	unwt indels	wt25 indels	nts+unwt indels	nts+wt25 indels
Median	429,921	1,012,658	1,017,943	419,603	464,448
Upper Quartile	1,504,312	2,804,106	2,967,427	1,237,362	1,311,852
Upper Quartile	1,504,312	2,804,106	2,967,427	1,237,362	1,311,852

Table S13. Rank Ordered N_e Estimates Nucleotides 1938 Loci.

MP-EST*	MP-EST*	TENT	TENT
282,914,480	turaco+bustard	turaco+bustard	276,007,143
37,991,088	hoatzin+Cursorimorphae+waterbirds+Telluraves	Otidimorphae+Caprimulgimorphae	18,852,583
8,407,116	Columbimorphae	Columbimorphae	8,064,419
2,718,950	Cursorimorphae	Cursorimorphae	4,870,494
2,145,995	bee-eater+woodpecker	hoatzin+Cursorimorphae+waterbirds+Telluraves	3,444,021
1,848,209	hoatzin+Cursorimorphae+waterbirds	hoatzin+Cursorimorphae	2,591,809
1,787,064	Passerea minus Otidimorphae	owl+Coraciimorphae	2,321,224
1,637,861	Columbea	bee-eater+woodpecker	2,080,700
1,556,615	Coraciimorphae	Afroaves	1,819,700
1,396,665	Passerea	Columbea	1,815,263
1,302,891	Passerimorphae	Coraciimorphae	1,593,695
1,221,822	Coraciimorphae+Australaves	Passerimorphae	1,414,928
1,177,988	trogon+hornbill+bee-eater+woodpecker	trogon+hornbill+bee-eater+woodpecker	1,250,914
1,104,335	owl+Accipitrimorphae	Passerea	1,166,465
1,040,482	Galliformes	waterbirds	1,151,567
982,273	Otidimorphae	Otidimorphae	1,085,083
962,018	waterbirds	Galliformes	1,024,004
679,384	egret+pelican	egret+pelican	804,572
530,140	mesite+sandgrouse	Phaethontimorphae	603,090
508,954	Phaethontimorphae	mesite+sandgrouse	572,202
451,771	swift+hummingbird ("Apodiformes")	Galloanseres	445,771
421,623	Galloanseres	swift+hummingbird ("Apodiformes")	429,921
391,507	hornbill+bee-eater+woodpecker	falcon+Passerimorphae	425,513
388,239	falcon+Passerimorphae	hornbill+bee-eater+woodpecker	380,872
310,884	Accipitrimorphae	Caprimulgimorphae	356,894
304,414	Neoaves	Neoaves	296,013
299,220	Caprimulgimorphae	Australaves	291,601
277,820	Eupasseriformes	Eupasseriformes	279,512
262,299	Coraciimorphae minus mousebird	Accipitrimorphae	278,737
256,992	Australaves	Coraciimorphae minus mousebird	248,369
248,580	parrots	parrots	238,794
234,006	Passeriformes	fulmar+penguins	238,056
231,815	eagles	eagles	237,466
220,723	Phoenicopterimorphae	Passeriformes	228,607
214,833	finch+zebrafinch	Aequornithia	224,174
202,855	fulmar+penguins	finch+zebrafinch	217,116
199,226	Aequornithia	Phoenicopterimorphae	185,748
184,339	penguins	penguins	174,647
176,274	ibis+egret+pelican	oscines	173,641
175,728	oscines	Pelecaniformes	172,923
145,557	Telluraves	ibis+egret+pelican	165,722
145,427	Pelecaniformes	Telluraves	131,868
127,154	fulmar+penguins+Pelecaniformes	fulmar+penguins+Pelecaniformes	118,395
undef	Cursorimorphae+waterbirds	waterbirds+Telluraves	undef

red highlighted values - within UQ of size partition
green highlighted values - within 3rd quartile of size partition
blue highlighted text - branches not present in other tree
undef - cannot be calculated due to zero CBL

Table S14. Rank Ordered *Ne* Estimates unwt Indels 1938 Loci.

MP-EST*	MP-EST*	TENT	TENT
30,671,161	Columbimorphae	Columbimorphae	29,420,923
10,018,014	turaco+bustard	turaco+bustard	9,773,424
8,927,821	Coraciimorphae	bee-eater+woodpecker	7,634,244
7,873,819	bee-eater+woodpecker	Coraciimorphae	5,801,745
4,441,474	egret+pelican	egret+pelican	5,259,887
3,994,296	trogon+hornbill+bee-eater+woodpecker	trogon+hornbill+bee-eater+woodpecker	4,241,571
3,159,555	Passerea minus Otidimorphae	Passerimorphae	3,218,022
3,068,898	Cursorimorphae	hoatzin+Cursorimorphae+waterbirds+Telluraves	3,201,447
2,963,212	Passerimorphae	Afroaves	3,069,773
2,514,668	Passerea	hoatzin+Cursorimorphae	2,892,964
2,293,435	Otidimorphae	Cursorimorphae	2,715,247
2,255,617	waterbirds	Passerea	2,561,357
2,020,082	hornbill+bee-eater+woodpecker	Otidimorphae	2,047,205
1,873,093	hoatzin+Cursorimorphae+waterbirds	hornbill+bee-eater+woodpecker	1,965,207
1,691,600	Coraciimorphae+Australaves	waterbirds	1,956,246
1,606,884	Columbea	Columbea	1,780,931
1,196,040	swift+hummingbird ("Apodiformes")	Phaethontimorphae	1,407,906
1,192,736	mesite+sandgrouse	mesite+sandgrouse	1,287,371
1,188,146	Phaethontimorphae	swift+hummingbird ("Apodiformes")	1,138,193
1,028,953	Galliformes	falcon+Passerimorphae	1,082,657
997,238	Coraciimorphae minus mousebird	Galliformes	1,012,658
987,819	falcon+Passerimorphae	Coraciimorphae minus mousebird	944,277
820,417	Australaves	Australaves	915,997
780,123	owl+Accipitrimorphae	Pelecaniformes	900,671
757,457	Pelecaniformes	Caprimulgimorphae	803,623
687,987	Caprimulgimorphae	Galloanseres	713,492
674,840	Galloanseres	Eupasseriformes	673,640
669,562	Eupasseriformes	Neoaves	525,882
620,471	Accipitrimorphae	ibis+egret+pelican	460,343
544,082	Phoenicopterimorphae	Phoenicopterimorphae	457,870
540,806	Neoaves	Accipitrimorphae	451,841
489,654	ibis+egret+pelican	finch+zebrafinch	409,451
405,145	finch+zebrafinch	Passeriformes	395,195
404,529	Passeriformes	fulmar+penguins	369,922
362,600	parrots	parrots	348,325
315,222	fulmar+penguins	Aequornithia	298,253
313,853	penguins	penguins	297,352
274,219	eagles	eagles	280,903
271,730	fulmar+penguins+Pelecaniformes	fulmar+penguins+Pelecaniformes	253,012
265,061	Aequornithia	oscines	232,496
238,700	Telluraves	Telluraves	208,613
235,290	oscines	Otidimorphae+Caprimulgimorphae	
	hoatzin+Cursorimorphae+waterbirds+Telluraves	waterbirds+Telluraves	
	Cursorimorphae+waterbirds	owl+Coraciimorphae	

red highlighted values - within UQ of size partition
green highlighted values - within 3rd quartile of size partition
blue highlighted text - branches not present in other tree
undef - cannot be calculated due to zero CBL

Table S15. Rank Ordered N_e Estimates wt25 Indels 1938 Loci.

MP-EST*	MP-EST*	TENT	TENT
22,169,592	turaco+bustard	turaco+bustard	21,628,323
12,532,267	bee-eater+woodpecker	bee-eater+woodpecker	12,150,950
8,643,779	Coraciimorphae	Columbimorphae	8,017,875
8,358,593	Columbimorphae	egret+pelican	6,707,722
5,664,033	egret+pelican	Coraciimorphae	4,730,466
3,945,274	Cursorimorphae	trogon+hornbill+bee-eater+woodpecker	4,017,621
3,922,098	Passerea minus Otidimorphae	Afroaves	3,866,709
3,783,402	trogon+hornbill+bee-eater+woodpecker	hoatzin+Cursorimorphae+waterbirds+Telluraves	3,589,267
3,246,684	Passerimorphae	Passerimorphae	3,525,870
2,446,239	Passerea	Cursorimorphae	3,176,406
2,265,959	Otidimorphae	hoatzin+Cursorimorphae	2,758,447
1,870,892	Columbea	Passerea	2,590,579
1,813,248	hornbill+bee-eater+woodpecker	Columbea	2,073,534
1,790,131	Coraciimorphae+Australaves	Otidimorphae	2,047,384
1,739,870	waterbirds	hornbill+bee-eater+woodpecker	1,763,992
1,604,765	hoatzin+Cursorimorphae+waterbirds	waterbirds	1,551,453
1,335,266	swift+hummingbird ("Apodiformes")	Phaethontimorphae	1,480,533
1,268,817	mesite+sandgrouse	mesite+sandgrouse	1,369,489
1,249,436	Phaethontimorphae	falcon+Passerimorphae	1,343,903
1,226,180	falcon+Passerimorphae	swift+hummingbird ("Apodiformes")	1,270,686
1,034,323	Galliformes	Galliformes	1,017,943
890,438	owl+Accipitrimorphae	Pelecaniformes	904,266
880,255	Coraciimorphae minus mousebird	Galloanseres	889,975
841,763	Galloanseres	Caprimulgimorphae	871,458
776,880	Australaves	Australaves	866,877
760,480	Pelecaniformes	Coraciimorphae minus mousebird	833,507
756,698	Caprimulgimorphae	Eupasseriformes	751,367
746,818	Eupasseriformes	Neoaves	621,743
645,713	Accipitrimorphae	Phoenicopterimorphae	497,544
639,388	Neoaves	finch+zebrafinch	491,648
591,227	Phoenicopterimorphae	ibis+egret+pelican	485,797
516,729	ibis+egret+pelican	Accipitrimorphae	479,549
486,477	finch+zebrafinch	Passeriformes	428,234
438,348	Passeriformes	parrots	354,104
368,616	parrots	fulmar+penguins	341,740
324,048	penguins	penguins	307,011
291,207	fulmar+penguins	Aequornithia	299,320
277,070	oscines	eagles	281,282
274,589	eagles	oscines	273,780
272,116	fulmar+penguins+Pelecaniformes	fulmar+penguins+Pelecaniformes	253,372
266,008	Aequornithia	Telluraves	221,207
254,642	Telluraves	Otidimorphae+Caprimulgimorphae	
undef	hoatzin+Cursorimorphae+waterbirds+Telluraves	waterbirds+Telluraves	
	Cursorimorphae+waterbirds	owl+Coraciimorphae	

red highlighted values - within UQ of size partition
green highlighted values - within 3rd quartile of size partition
blue highlighted text - branches not present in other tree
undef - cannot be calculated due to zero CBL

Table S16. Rank Ordered *Ne* Estimates nts+unwt Indels 1938 Loci.

MP-EST*	MP-EST*	TENT	TENT
62,487,576	turaco+bustard	turaco+bustard	60,961,947
7,217,440	Columbimorphae	Columbimorphae	6,923,238
3,632,370	Cursorimorphae	Cursorimorphae	5,449,356
2,136,188	bee-eater+woodpecker	hoatzin+Cursorimorphae+waterbirds+Telluraves	3,799,865
1,900,395	Coraciimorphae	owl+Coraciimorphae	3,042,704
1,624,631	hoatzin+Cursorimorphae+waterbirds	Afroaves	2,622,765
1,459,457	Passerea minus Otidimorphae	hoatzin+Cursorimorphae	2,108,211
1,408,931	Passerea	bee-eater+woodpecker	2,071,190
1,214,492	Columbea	Coraciimorphae	1,460,375
1,165,227	trogon+hornbill+bee-eater+woodpecker	Columbea	1,346,038
1,107,612	Otidimorphae	trogon+hornbill+bee-eater+woodpecker	1,237,362
1,038,207	Passerimorphae	Otidimorphae	1,162,446
1,036,018	Coraciimorphae+Australaves	Passerea	1,134,147
1,029,190	Galliformes	Passerimorphae	1,127,484
928,668	waterbirds	waterbirds	1,064,996
785,403	owl+Accipitriformae	Galliformes	1,012,892
739,667	egret+pelican	egret+pelican	875,962
532,562	Phaethontimorphae	Phaethontimorphae	631,065
526,832	mesite+sandgrouse	mesite+sandgrouse	568,632
449,370	swift+hummingbird ("Apodiformes")	Galloanseres	444,256
420,189	Galloanseres	swift+hummingbird ("Apodiformes")	427,636
392,345	hornbill+bee-eater+woodpecker	falcon+Passerimorphae	411,569
375,517	falcon+Passerimorphae	hornbill+bee-eater+woodpecker	381,687
316,200	Australaves	Caprimulgimorphae	359,488
309,810	Neoaves	Australaves	353,416
307,561	Caprimulgimorphae	Neoaves	301,260
307,346	Accipitriformae	Coraciimorphae minus mousebird	274,884
290,301	Coraciimorphae minus mousebird	Accipitriformae	264,457
274,355	parrots	parrots	263,554
259,401	Eupasseriformes	Eupasseriformes	260,981
231,949	Passeriformes	eagles	233,401
227,848	eagles	Passeriformes	226,597
214,906	Phoenicopterimorphae	Aequornithia	225,881
200,742	Aequornithia	fulmar+penguins	225,496
192,152	fulmar+penguins	Pelecyaniformes	182,642
184,295	penguins	finch+zebrafinch	182,492
180,572	finch+zebrafinch	Phoenicopterimorphae	180,853
176,170	oscines	penguins	174,606
175,830	ibis+egret+pelican	oscines	174,078
153,600	Pelecaniformes	ibis+egret+pelican	165,304
148,500	Telluraves	Telluraves	133,778
131,342	fulmar+penguins+Pelecaniformes	fulmar+penguins+Pelecaniformes	122,295
undef	hoatzin+Cursorimorphae+waterbirds+Telluraves	Otidimorphae+Caprimulgimorphae	undef
undef	Cursorimorphae+waterbirds	waterbirds+Telluraves	undef

red highlighted values - within UQ of size partition

green highlighted values - within 3rd quartile of size partition

blue highlighted text - branches not present in other tree

undef - cannot be calculated due to zero CBL

Table S18. Rank Ordered N_e Estimates Nucleotides 2515 Loci.

MP-EST*	MP-EST*	TENT
162,191,909	turaco+bustard	turaco+bustard
7,683,900	Columbimorphae	Otidimorphae+Caprimulgimorphae
3,410,815	Cursorimorphae	Columbimorphae
2,634,003	bee-eater+woodpecker	Cursorimorphae
1,936,467	hoatzin+Cursorimorphae+waterbirds	hoatzin+Cursorimorphae+waterbirds+Telluraves
1,864,034	Passerea minus Otidimorphae	hoatzin+Cursorimorphae
1,798,540	Coraciimorphae	bee-eater+woodpecker
1,639,269	Passerea	owl+Coraciimorphae
1,513,846	Columbea	Afroaves
1,450,494	Passerimorphae	Coraciimorphae
1,431,494	trogon+hornbill+bee-eater+woodpecker	Columbea
1,298,083	Coraciimorphae+Australaves	Passerimorphae
1,253,472	Galliformes	trogon+hornbill+bee-eater+woodpecker
1,206,274	owl+Accipitrimorphae	Passerea
1,148,160	Otidimorphae	Galliformes
1,081,167	waterbirds	Otidimorphae
763,207	egret+pelican	waterbirds
607,557	swift+hummingbird ("Apodiformes")	egret+pelican
587,489	mesite+sandgrouse	Phaethontimorphae
586,219	Phaethontimorphae	mesite+sandgrouse
519,035	Galloanseres	swift+hummingbird ("Apodiformes")
468,556	hornbill+bee-eater+woodpecker	Galloanseres
452,451	falcon+Passerimorphae	falcon+Passerimorphae
404,989	Neoaves	hornbill+bee-eater+woodpecker
366,799	Accipitrimorphae	Caprimulgimorphae
343,015	Caprimulgimorphae	Neoaves
332,667	Eupasseriformes	Australaves
312,264	parrots	Eupasseriformes
304,125	Australaves	Accipitrimorphae
303,832	Coraciimorphae minus mousebird	parrots
280,539	Phoenicopterimorphae	Coraciimorphae minus mousebird
267,818	finch+zebrafinch	finch+zebrafinch
264,302	Passeriformes	fulmar+penguins
227,725	penguins	Passeriformes
224,470	fulmar+penguins	Aequornithia
223,389	eagles	Phoenicopterimorphae
216,886	Aequornithia	eagles
207,779	ibis+egret+pelican	penguins
190,245	oscines	Pelecaniformes
177,890	Pelecaniformes	ibis+egret+pelican
171,375	Telluraves	oscines
149,205	fulmar+penguins+Pelecaniformes	Telluraves
	hoatzin+Cursorimorphae+waterbirds+Telluraves	fulmar+penguins+Pelecaniformes
	Cursorimorphae+waterbirds	waterbirds+Telluraves

red highlighted values - within UQ of size partition
green highlighted values - within 3rd quartile of size partition
blue highlighted text - branches not present in other tree
undef - cannot be calculated due to zero CBL

Table S19. Rank Ordered *Ne* Estimates unwt Indels 2515 Loci.

MP-EST*	MP-EST*	TENT
19,248,013	Coraciimorphae	15,501,894
16,160,645	Columbimorphae	14,426,593
14,787,632	turaco+bustard	9,347,211
8,275,670	bee-eater+woodpecker	8,023,868
7,892,830	egret+pelican	7,754,349
4,121,263	Cursorimorphae	4,585,077
4,021,967	trogon+hornbill+bee-eater+woodpecker	4,270,955
3,278,070	Passerea	3,569,873
3,227,462	Passerea minus Otidimorphae	3,247,022
2,989,916	Passerimorphae	3,184,485
2,631,364	Otidimorphae	3,146,607
2,179,183	hornbill+bee-eater+woodpecker	3,016,739
2,122,586	waterbirds	2,240,114
1,862,903	hoatzin+Cursorimorphae+waterbirds	2,119,987
1,644,456	Columbea	1,822,572
1,628,958	Coraciimorphae+Australaves	1,821,415
1,414,773	swift+hummingbird ("Apodiformes")	1,587,624
1,339,811	Phaethontimorphae	1,399,054
1,296,209	mesite+sandgrouse	1,346,348
1,233,493	Galliformes	1,289,408
1,176,458	falcon+Passerimorphae	1,213,958
1,074,481	Coraciimorphae minus mousebird	1,054,696
956,910	Australaves	1,017,418
845,476	Galloanseres	997,818
839,157	Pelecaniformes	893,902
803,409	owl+Accipitriformae	882,560
760,762	Caprimulgimorphae	763,329
758,708	Eupasseriformes	637,000
681,153	Accipitriformae	537,725
655,077	Neoaves	528,875
628,457	Phoenicopterimorphae	493,658
571,963	ibis+egret+pelican	490,625
505,318	Passeriformes	479,954
485,464	finch+zebrafinch	446,599
464,901	parrots	431,958
423,117	penguins	400,872
385,147	eagles	394,535
368,085	fulmar+penguins	323,685
304,620	fulmar+penguins+Pelecaniformes	287,264
290,717	oscines	283,637
287,662	Aequornithia	240,427
279,198	Telluraves	
	hoatzin+Cursorimorphae+waterbirds+Telluraves	
	Cursorimorphae+waterbirds	
	Columbimorphae	
	turaco+bustard	
	egret+pelican	
	bee-eater+woodpecker	
	Coraciimorphae	
	hoatzin+Cursorimorphae	
	trogon+hornbill+bee-eater+woodpecker	
	Afroaves	
	Passerimorphae	
	hoatzin+Cursorimorphae+waterbirds+Telluraves	
	Cursorimorphae	
	Passerea	
	Otidimorphae	
	hornbill+bee-eater+woodpecker	
	waterbirds	
	Phaethontimorphae	
	mesite+sandgrouse	
	swift+hummingbird ("Apodiformes")	
	falcon+Passerimorphae	
	Galliformes	
	Australaves	
	Coraciimorphae minus mousebird	
	Pelecaniformes	
	Galloanseres	
	Caprimulgimorphae	
	Eupasseriformes	
	Neoaves	
	ibis+egret+pelican	
	Phoenicopterimorphae	
	Passeriformes	
	finch+zebrafinch	
	Accipitriformae	
	parrots	
	fulmar+penguins	
	penguins	
	eagles	
	Aequornithia	
	oscines	
	fulmar+penguins+Pelecaniformes	
	Telluraves	
	Otidimorphae+Caprimulgimorphae	
	waterbirds+Telluraves	
	owl+Coraciimorphae	

red highlighted values - within UQ of size partition
green highlighted values - within 3rd quartile of size partition
blue highlighted text - branches not present in other tree
undef - cannot be calculated due to zero CBL

Table S20. Rank Ordered *N_e* Estimates nts+unwt Indels 2515 Loci.

MP-EST*	MP-EST*	TENT	TENT
38,374,951	turaco+bustard	Otidimorphae+Caprimulgimorphae	168,011,840
9,870,241	Columbimorphae	turaco+bustard	37,438,029
4,843,546	Cursorimorphae	Columbimorphae	9,467,904
2,613,442	bee-eater+woodpecker	Cursorimorphae	5,158,027
2,249,619	Coraciimorphae	owl+Coraciimorphae	3,879,204
1,811,433	hoatzin+Cursorimorphae+waterbirds	hoatzin+Cursorimorphae+waterbirds+Telluraves	3,817,322
1,709,764	Passerea	Afroaves	3,787,687
1,466,233	Passerea minus Otidimorphae	bee-eater+woodpecker	2,533,923
1,363,826	trogon+hornbill+bee-eater+woodpecker	hoatzin+Cursorimorphae	2,510,946
1,261,689	Columbea	Coraciimorphae	1,611,521
1,244,437	Galliformes	trogon+hornbill+bee-eater+woodpecker	1,448,256
1,225,214	Otidimorphae	Columbea	1,398,347
1,178,947	Passerimorphae	Passerea	1,284,649
1,047,116	Coraciimorphae+Australaves	Passerimorphae	1,280,326
1,044,105	waterbirds	Otidimorphae	1,259,728
862,918	owl+Accipitrimorphae	Galliformes	1,224,730
854,615	egret+pelican	waterbirds	1,040,825
601,241	Phaethontimorphae	egret+pelican	1,012,092
598,967	swift+hummingbird ("Apodiformes")	Phaethontimorphae	712,447
577,974	mesite+sandgrouse	mesite+sandgrouse	623,832
519,738	Galloanseres	swift+hummingbird ("Apodiformes")	569,998
478,422	hornbill+bee-eater+woodpecker	Galloanseres	549,507
448,442	falcon+Passerimorphae	falcon+Passerimorphae	491,497
413,363	Neoaves	hornbill+bee-eater+woodpecker	465,426
365,819	Australaves	Caprimulgimorphae	421,964
359,422	Caprimulgimorphae	Australaves	404,544
356,570	Accipitrimorphae	Neoaves	401,956
340,620	Coraciimorphae minus mousebird	Eupasseriformes	324,470
322,506	Eupasseriformes	Coraciimorphae minus mousebird	322,531
307,618	parrots	Accipitrimorphae	300,447
270,388	Phoenicopterimorphae	parrots	295,507
266,588	Passeriformes	Passeriformes	260,437
252,454	finch+zebrafinch	finch+zebrafinch	255,138
233,367	penguins	fulmar+penguins	253,859
219,702	eagles	Aequornithia	243,830
216,694	Aequornithia	Phoenicopterimorphae	227,543
216,321	fulmar+penguins	Pelecaniformes	225,128
215,380	ibis+egret+pelican	eagles	225,057
190,500	oscines	penguins	221,098
189,331	Pelecaniformes	ibis+egret+pelican	202,487
174,819	Telluraves	oscines	188,238
153,392	fulmar+penguins+Pelecaniformes	Telluraves	154,597
undef	hoatzin+Cursorimorphae+waterbirds+Telluraves	fulmar+penguins+Pelecaniformes	142,826
undef	Cursorimorphae+waterbirds	waterbirds+Telluraves	undef

red highlighted values - within UQ of size partition

green highlighted values - within 3rd quartile of size partition

blue highlighted text - branches not present in other tree

undef - cannot be calculated due to zero CBL

Table S21. Sensitivity Analysis of Generation Length on MP-EST* Tree.

	≥100 bp		≥50 bp		≥10 bp		≥2 bp		all	
	median	UQuart	median	UQuart	median	UQuart	median	UQuart	median	UQuart
Galloanseres	12.4	6.6	14.8	6.7	9	3.9	9.1	3.7	9.1	4.5
Galliformes	6.7	3.6	7.6	3.4	3.9	1.7	3.8	1.6	3.7	1.8
Neoaves	5.9	3.2	6.8	3.1	4.7	2.1	4.8	2	4.7	2.3
Columbea	11	5.9	8.1	3.7	24.2	10.6	33.4	13.8	22.1	11
Phoenicopterimorphae	4.9	2.6	6.6	3	5.8	2.5	5.6	2.3	5	2.5
Columbimorphae	41.2	22.1	167.5	75.9	122.8	53.5	87.6	36.1	121	60.1
mesite+sandgrouse	6.9	3.7	8.1	3.7	6.6	2.9	6.9	2.9	6.1	3
Passerea	8.2	4.4	59.8	27.1	18.7	8.1	15.2	6.2	16.5	8.2
Otidimorphae	9.4	5.1	15.3	6.9	23.6	10.3	27.7	11.4	25.3	12.6
turaco+bustard	undef	undef	undef	undef	50.2	21.9	40.3	16.6	49.7	24.7
Passerea minus Otidimorphae	32.8	17.6	23.8	10.8	19.2	8.4	21.8	9	16.7	8.3
Caprimulgimorphae	5	2.7	7	3.2	5.9	2.6	5.8	2.4	5.2	2.6
swift+hummingbird ("Apodiformes")	8.2	4.4	10.5	4.8	8.3	3.6	9.1	3.8	8.5	4.2
hoatzin+Cursorimorphae+waterbirds+Telluraves	undef	undef	undef	undef	272.8	118.9	76.5	31.5	130.2	64.7
hoatzin+Cursorimorphae+ waterbirds	16.5	8.9	8.6	3.9	8.6	3.8	8.2	3.4	9.3	4.6
Cursorimorphae+ waterbirds	undef	undef	undef	undef	undef	undef	undef	undef	undef	undef
Cursorimorphae	20.5	11	79.6	36.1	67.2	29.3	99.1	40.8	103.7	51.5
waterbirds	110.9	59.5	20.7	9.4	9.1	4	12.7	5.2	12	5.9
Phaethontimorphae	6.8	3.6	8	3.6	8.9	3.9	8.7	3.6	7.6	3.8
Aequornithia	2.9	1.6	3.5	1.6	2.3	1	2	0.8	1.8	0.9
fulmar+penguins+Pelecaniformes	2	1	2.9	1.3	2.9	1.3	2.7	1.1	2.3	1.1
fulmar+penguins	2.1	1.1	3.5	1.6	2.9	1.2	2.8	1.1	2.6	1.3
penguins	8.2	4.4	10.6	4.8	7.1	3.1	5.9	2.4	5.5	2.7
Pelecaniformes	3	1.6	5.8	2.6	10.9	4.7	10.2	4.2	9.1	4.5
ibis+egret+pelican	5.5	3	9	4.1	5.7	2.5	5.8	2.4	5.2	2.6
egret+pelican	28.3	15.2	36.3	16.4	undef	undef	undef	undef	undef	undef
Telluraves	2.6	1.4	3.3	1.5	2.2	1	2	0.8	1.7	0.8
owl+Accipitrimorphae	8.6	4.6	19	8.6	6.9	3	5.2	2.2	4.3	2.2
Accipitrimorphae	3.1	1.7	4.1	1.8	4.1	1.8	4.4	1.8	3.9	2
eagles	8.5	4.6	8.6	3.9	4.2	1.8	3.2	1.3	3	1.5
Coraciimorphae+Australaves	31.6	17	22.7	10.3	17.3	7.5	9.4	3.9	9.9	4.9
Coraciimorphae	17.5	9.4	28.8	13.1	36.2	15.8	39.6	16.3	36.9	18.4
Coraciimorphae minus mousebird	3.1	1.7	5.7	2.6	10.3	4.5	11.4	4.7	9.3	4.6
trogon+hornbill+bee-eater+woodpecker	11	5.9	20.5	9.3	20.5	8.9	22.9	9.4	22.6	11.2
hornbill+bee-eater+woodpecker	4.5	2.4	5.8	2.6	10.6	4.6	14.8	6.1	14.6	7.3
bee-eater+woodpecker	32.1	17.2	36.9	16.7	33.9	14.8	42.5	17.5	41.1	20.4
Australaves	30.3	16.3	14.2	6.4	8.9	3.9	11.4	4.7	9.1	4.5
falcon+Passerimorphae	4	2.2	7.9	3.6	8.7	3.8	8.1	3.4	7.6	3.8
Passerimorphae	25.5	13.7	20	9.1	20.3	8.8	20.8	8.5	20.1	10
parrots	4.8	2.6	5.9	2.7	3.6	1.6	3.6	1.5	3.5	1.7
Passeriformes	3.6	1.9	4.5	2	3.5	1.5	3.6	1.5	3.4	1.7
Eupasseriformes	7.5	4	9.8	4.4	7.3	3.2	7.5	3.1	7.1	3.5
oscines	3.4	1.8	3.8	1.7	2.1	0.9	1.9	0.8	1.9	0.9
finch+zebrafinch	6.5	3.5	7	3.2	3.3	1.4	3	1.2	2.9	1.4

red highlighted values - greater than 30 (years)

undef - cannot be calculated due to zero CBL

Table S22. Sensitivity Analysis of Generation Length on TENT.

	≥100 bp		≥50 bp		≥10 bp		≥2 bp		all	
	median	UQuart	median	UQuart	median	UQuart	median	UQuart	median	UQuart
Galloanseres	15.2	8.7	13.8	6.7	8	4.6	8.3	5.1	9.1	5
Galliformes	7.6	4.4	6.6	3.2	3.2	1.8	3.2	2	3.4	1.9
Neoaves	6.8	3.9	5.9	2.9	3.9	2.2	4.1	2.5	4.3	2.4
Columbea	14.3	8.2	8	3.9	22.6	13	32.4	19.9	23.3	12.8
Phoenicopterimorphae	4.7	2.7	4.8	2.4	4.1	2.3	4	2.5	3.9	2.1
Columbimorphae	46.4	26.6	143.3	69.8	99.2	57.1	73.6	45.1	110.3	60.7
mesite+sandgrouse	8.7	5	7.8	3.8	6	3.4	6.5	4	6.2	3.4
Passerea	10.1	5.8	34.1	16.6	14.6	8.4	15.3	9.4	16.8	9.3
Otidimorphae+Caprimulgimorphae	undef	undef	undef	undef	undef	undef	undef	undef	undef	undef
Otidimorphae	9.4	5.4	11.6	5.6	10.6	6.1	12.9	7.9	11.8	6.5
turaco+bustard	undef	undef	undef	undef	40.3	23.2	33.6	20.6	45	24.8
Caprimulgimorphae	5.4	3.1	6	2.9	4.8	2.8	4.7	2.9	4.6	2.5
swift+hummingbird ("Apodiformes")	8.9	5.1	8.7	4.3	6.5	3.7	7.4	4.6	7.5	4.1
hoatzin+Cursorimorphae+waterbirds+Telluraves	undef	undef	107.4	52.3	14.9	8.6	13.4	8.2	13	7.2
hoatzin+Cursorimorphae	undef	undef	16.9	8.3	33.4	19.2	15.9	9.7	22	12.1
Cursorimorphae	15.1	8.7	75.4	36.7	14.9	8.5	44.1	27	34.2	18.8
waterbirds+Telluraves	undef	undef	undef	undef	undef	undef	undef	undef	undef	undef
waterbirds	undef	undef	27.9	13.6	9.5	5.5	11.6	7.1	12.9	7.1
Phaethontimorphae	9.1	5.3	8.2	4	8.6	5	8.7	5.3	8.3	4.6
Aequornithia	3.8	2.2	3.5	1.7	2.1	1.2	1.9	1.2	1.9	1
fulmar+penguins+Pelecaniformes	2.1	1.2	2.4	1.2	2.2	1.3	2.2	1.3	2	1.1
fulmar+penguins	2.8	1.6	3.6	1.7	2.8	1.6	2.8	1.7	2.8	1.6
penguins	8.9	5.1	8.7	4.3	5.5	3.2	4.7	2.9	4.8	2.6
Pelecaniformes	4.1	2.4	6	2.9	10.6	6.1	10.4	6.4	10.1	5.5
ibis+egret+pelican	5.9	3.4	7.4	3.6	4.4	2.5	4.7	2.9	4.6	2.5
egret+pelican	38.5	22.1	37.4	18.2	undef	undef	undef	undef	undef	undef
Telluraves	2.7	1.6	2.5	1.2	1.6	0.9	1.5	0.9	1.4	0.8
Afroaves	8.9	5.1	21.5	10.5	23.9	13.8	undef	undef	61.1	33.6
owl+Coraciimorphae	undef	undef	undef	undef	undef	undef	undef	undef	undef	undef
Coraciimorphae	15.9	9.1	12.5	6.1	15.5	8.9	13.7	8.4	14.7	8.1
Coraciimorphae minus mousebird	3.5	2	4.9	2.4	8.4	4.8	9.6	5.9	8.5	4.7
trogon+hornbill+bee-eater+woodpecker	14	8	19.8	9.6	18.6	10.7	21.6	13.2	23.1	12.7
hornbill+bee-eater+woodpecker	5.1	3	5.1	2.5	8.7	5	12.8	7.8	13.7	7.5
bee-eater+woodpecker	36.8	21.1	32.1	15.6	27.9	16	36.3	22.3	38.1	21
Accipitrimorphae	3.4	2	3.9	1.9	3	1.7	3	1.8	2.9	1.6
eagles	10.2	5.9	7.8	3.8	3.6	2.1	2.8	1.7	2.9	1.6
Australaves	23.3	13.4	12.5	6.1	9	5.2	10.7	6.6	9.8	5.4
falcon+Passerimorphae	5.3	3	7.9	3.9	8.2	4.7	8	4.9	8.1	4.4
Passerimorphae	32.9	18.9	19.7	9.6	18.8	10.8	20	12.3	21	11.6
parrots	5.4	3.1	5	2.5	2.9	1.7	3	1.9	3.2	1.8
Passeriformes	4.2	2.4	3.9	1.9	2.9	1.7	3.1	1.9	3.2	1.8
Eupasseriformes	8.9	5.1	8.8	4.3	6.2	3.6	6.6	4	6.7	3.7
oscines	3.9	2.2	3.3	1.6	1.7	1	1.6	1	1.7	1
finch+zebrafinch	7.6	4.4	6.2	3	2.8	1.6	2.7	1.6	2.8	1.5

red highlighted values - greater than 30 (years)

undef - cannot be calculated due to zero CBL