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SUPPLEMENTARY INFORMATION

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The impact of endothermy on the climatic niche evolution and the distribution of vertebrate diversity

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Supplementary methods and results

Simulations of the ancestral states and quality of the estimates

We simulated a set of true ancestral states and we then tested whether our method could recover accurately these states only with partial information (present day data and few/no fossils). These tests are described in details in the supplementary material of Silvestro *et al.* 2017 [52] (the following text has been modified from [52]): For each simulation, we generated a complete phylogenetic tree (extinct and extant taxa) under a constant rate of birth-death with 100 extant tips (using the *sim.bd.taxa* function with parameters: speciation rate (λ) = 0.4, and extinction rate (μ) = 0.2, in the R package TreePar[53]). The number of fossils simulated on the tree was defined by a Poisson distribution with expected number of occurrences set to 1, 5, and 20. Additional simulations were also run without any fossils for comparison. The simulation under the model presented here correspond to a constant rate of evolution σ^2 drawn from a gamma distribution $\Gamma(2, 5)$, and no phenotypic trend ($\mu 0 = 0$). We simulated 100 data sets under each scenario (i.e. number of fossils = 0, 1, 5, and 20). We analyzed each simulated dataset to estimate the rate parameters of the Brownian Motion model (σ^2) and the ancestral states. Each dataset was run for 500,000 MCMC generations, sampling every 500 steps. We summarized the results in two ways. First, we numerically quantified the overall accuracy of the σ^2 estimate across all simulations using the mean absolute percentage error (MAPE):

$$MAPE_j(\sigma^2) = \frac{1}{N}\sum_{i=1}^{N}\left(\frac{|\hat{\sigma_i^2} - \sigma_i^2|}{\sigma_i^2}\right)$$

where *j* is the simulation number, $\hat{\sigma_i^2}$ is the estimated rate at branch *i,* and σ_i^2 is the true rate at branch *i*, and *N* is the number of branches in the tree. Secondly, we calculated the coefficient of

determination (R^2) between the true and the estimated ancestral states. These analyses showed that our method is not biased (Supplementary Figure 8) and yields accurate estimations of ancestral states (Supplementary Figure 9). Additional test on the performance of the method are described in Silvestro *et al.* [52]. The code used to run these simulations is available at: https://github.com/dsilvestro/fossilBM.

Robustness of the results

To verify that our results were not affected by methodological biases, we ran a series of robustness tests.

1. *Niche evolution estimates might be artificially high in mammals and birds because there is more fossil data in these groups, or if the fossil record is biased (e.g if tropical occurrences were less likely to be recorded in the fossil record).* We ran all of the analyses again without the fossils and found that niche evolution remained faster in endotherms (Supplementary Figure 2). This latter result ensure that the main results of our study will hold even if fossil occurrences might not reflect the true ancestral latitude of the clades, and if fossils are misplaced on the tree (e.g. including changes in taxonomy between the fossil record and the phylogeny).
2. *Niche evolution estimates might be artificially high in mammals and birds because these two groups have larger phylogenies.* We ran all of the analyses again using pruned trees for each group and found that niche evolution remained faster in endotherms (Supplementary Figure 2).

3. *Niche evolution estimates might be artificially low in amphibians and squamates because they are older groups.* We tested for a relationship between the estimates of niche evolution rates in the 20 main orders (in birds and mammals) or families (in amphibians and squamates) and their age and did not observe a significant relationship (Supplementary Figure 6), which suggests that our results are not biased in this respect.
4. *Niche evolution estimates might be artificially high in mammals and birds because of our evolution model.* We tested whether similar niche evolution estimates could be obtained when applying Brownian motion (BM) and Ornstein-Uhlenbeck (OU) models (using the *fitContinuous* R function in the *geiger* package). We obtained mean temperatures for each species for which we had occurrence data points (GBIF), spatial distribution data (IUCN) and mean annual temperature climatic layer data (BIO1, WorldClim), and we estimated the rate of temperature evolution along the phylogenies for the four groups. These results, which do not include fossil information, confirmed our previous results in which endotherms were shown to have a faster niche evolution rate (Supplementary Table 1).
5. *Niche evolution estimates might be artificially high in birds because of migratory behavior.* It is difficult to describe with confidence the distribution of migratory species, as their occupancy area change across seasons. For birds, we estimated the niche evolution rate based on the mean annual temperatures of both the breeding and wintering ranges (the global distribution of each species without accounting for seasonal changes). This simplification might affect our niche evolution reconstruction and we might have underestimated the mean temperatures of migratory species; thus, we may have artificially inflated the rate of niche evolution in birds. To test for this potential bias, we re-estimated the rate of niche evolution using a BM model (using the *fitContinuous* R function in the

geiger package) that did not include fossil data but did include a phylogeny that only contained sedentary species as well as the mean temperatures obtained for each species. We also obtained migratory bird status data using the BirdLife International and NatureServe databases (http://www.birdlife.org/). Following the method described in Somveille *et al.*[54], we considered a species to be migratory if it has at least one non-breeding season polygon or one breeding season polygon (see Rolland *et al.*[55] for more details). We found migratory data for 6,142 of the species in our dataset, and we removed 1,387 migratory species, thus retaining a total of 4,755 sedentary species. We obtained comparable BM estimates between the sedentary birds (e.g., BM σ^2= 9.05) and all birds (e.g., BM σ^2=14.84, Supplementary Table 1), suggesting that potential bias caused by using mean annual temperatures does not affect our results and indicating that niche evolution remains higher in birds than in the three other groups (Mammals BM σ^2=2.92, Amphibians BM σ^2=1.01 and Squamates BM σ^2=0.65, Table S1).

6. *GBIF occurrence data points might be unevenly distributed inside the IUCN polygons and lead to biased values of altitude, latitude and temperature.* If the occurrence points inside the polygons were geographically (or environmentally) clustered, we would expect to see a mismatch between data extracted from polygons alone and data extracted from occurrences points inside the polygons. We thus extracted the latitude, altitude and temperature values for each species from polygons alone and we then tested if there was a considerable difference with the same data obtained from occurrences inside the polygons. We found no systematic bias in the values extracted with both approaches and an extremely high association between these variables (for latitude: $R^2_{birds} = 0.88$, $R^2_{mammals} = 0.97$, $R^2_{amphibians} = 0.99$, $R^2_{squamata} = 0.99$; for altitude: $R^2_{birds} = 0.78$, $R^2_{mammals} = 0.8$, $R^2_{amphibians} = 0.86$,

$R^2_{squamata}$ = 0.83; and for temperature: R^2_{birds} = 0.82 , $R^2_{mammals}$ = 0.91, $R^2_{amphibians}$ = 0.91, $R^2_{squamata}$ = 0.91; $P<10^{-16}$ for all groups). These results suggest that occurrences data are not strongly biased and represent accurately the variation of ecological conditions contained inside polygons.

7. *The temperature curve used in our study might be biased in the Neogene due to the presence of ice volumes*. Our paleo-temperature curve is based on the deep-sea benthic foraminiferal oxygen-isotope $\delta^{18}O$ (Zachos *et al*. [19]). These estimates conflate temperature and ice volume, which may be problematic when comparing greenhouse Eocene and icehouse Neogene. We now run the analyses with two other Cenozoic curves from Cramer *et al*. 2011 [56] (based on formulas 7a and 7b in the supplementary information of the study) that are based on the ratio Mg/Ca for the Cenozoic. In order to cover the 270 Myr of our study, we did not change the temperature curve before 62.4 Myr, and the Cramer *et al*. 2011 [56] curves were used after 62.4 Myr (we ran two independent analyses for the two curves). We found no effect of these new curves on our results with faster rate of niche evolution in birds and mammals compared to squamates and amphibians (birds= 0.86 or 0.64°C/Myr, respectively for the formulas 7a or 7b of Cramer *et al.* 2011 [56], mammals= 0.70 or 0.52°C/Myr, amphibians= 0.37 or 0.31 °C/Myr, squamates= 0.40 or 0.33°C/Myr.

8. *We also tested whether branches leading to nodes or tips informed by fossil or present-day data were giving the same results as the whole phylogeny*. This test permitted to test the robustness of our phylogenetic approach. We found the same results with only branches related to nodes informed by fossil or tips informed by field data, with higher rate of niche evolution for endotherms than ectotherms (mean rate of niche evolution birds=

2.09°C/Myr, mammals= 2.37°C/Myr, amphibians= 0.56°C/Myr, squamates= 0.61°C/Myr).

Supplementary references

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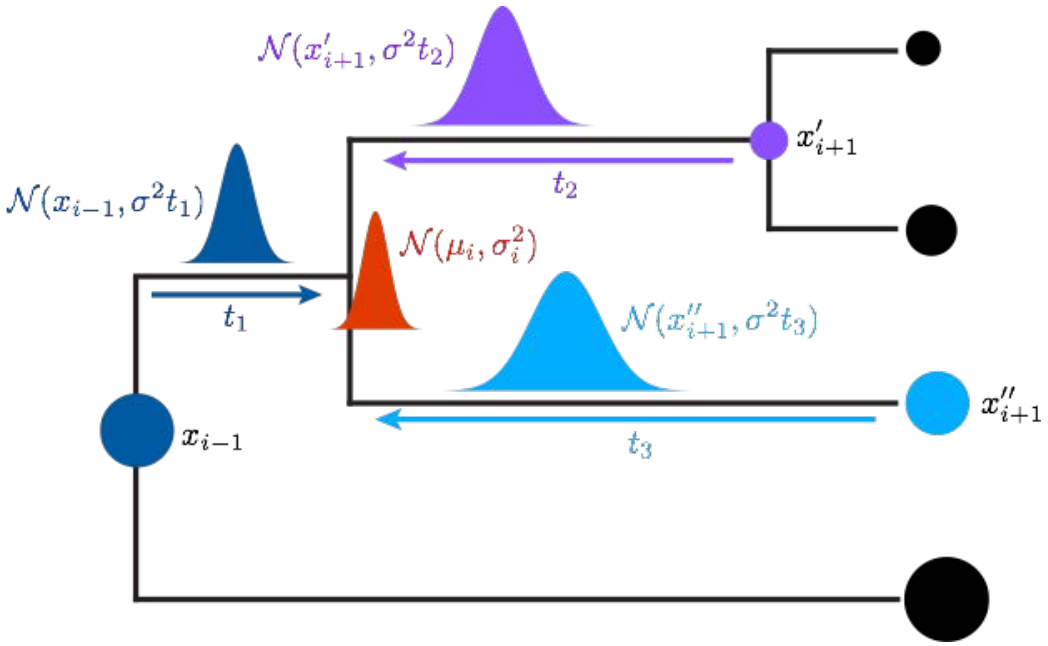
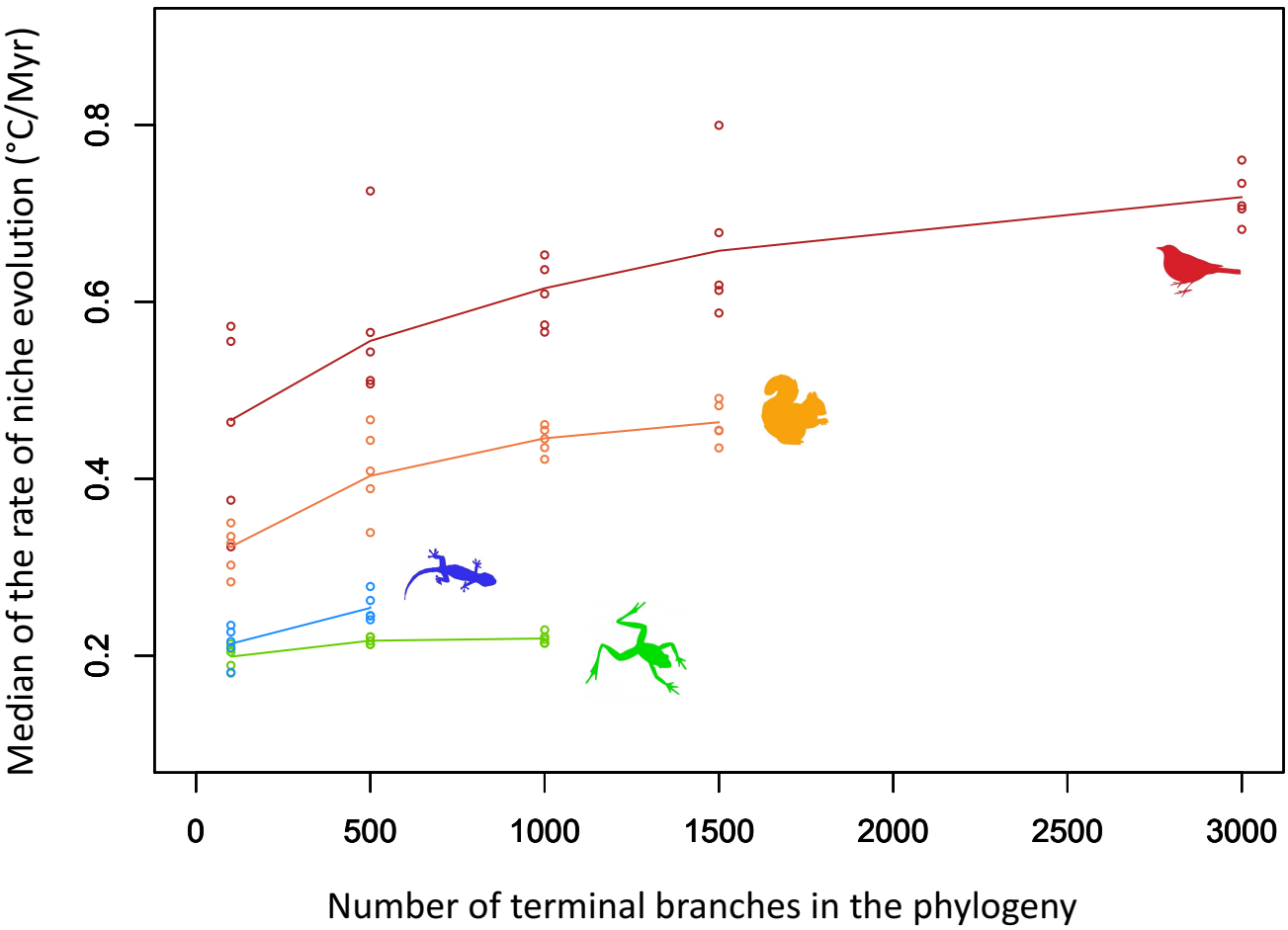
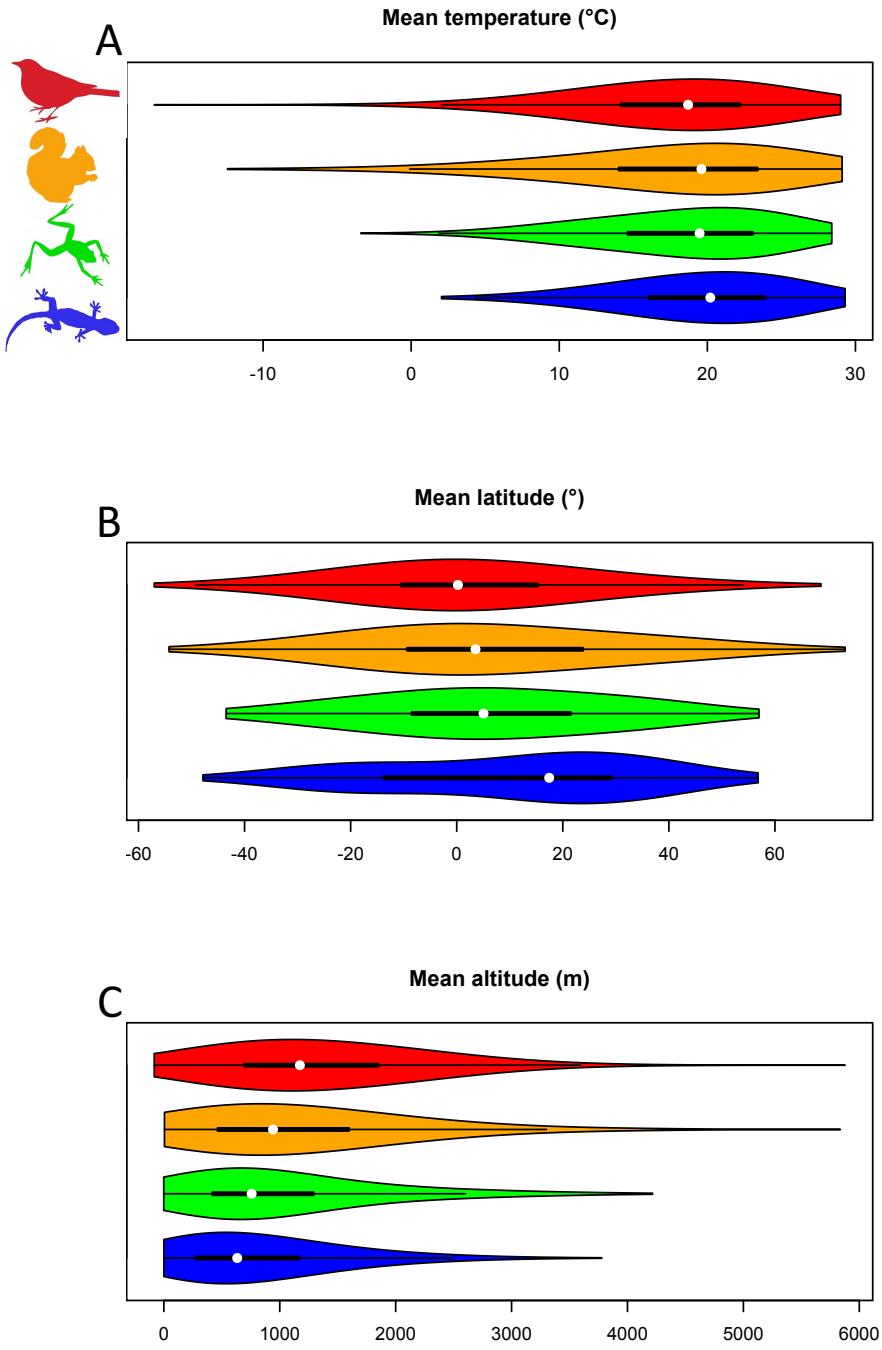


166

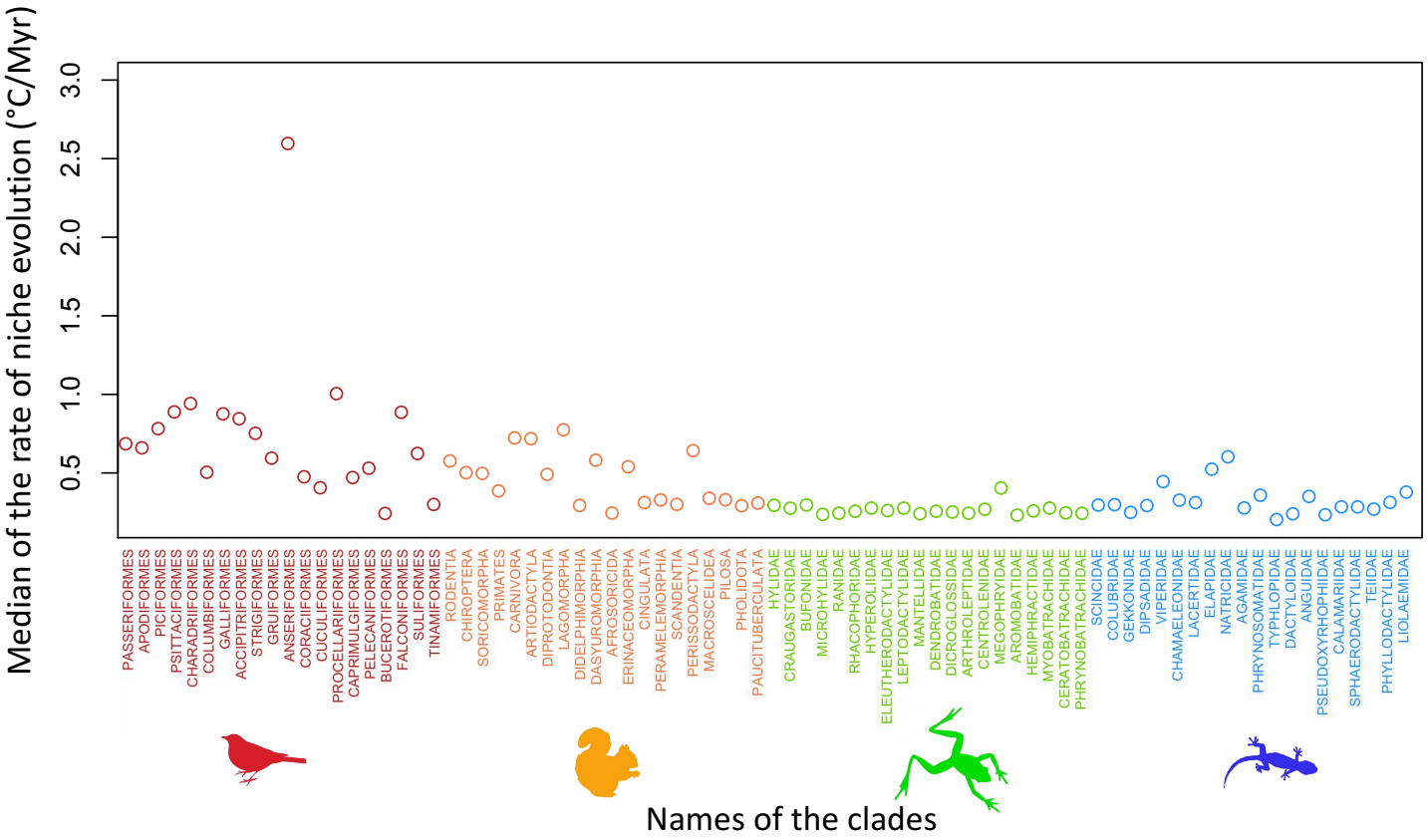
167 **Supplementary Figure 1. Bayesian inference of ancestral states using a fossil-calibrated**
168 **Brownian motion model of evolution.** The example shows an ultrametric tree with trait values
169 indicated by the size of the circles at the tips and at the internal nodes. The ancestral state of any
170 given internal node *i* is sampled directly from its joint posterior distribution through Gibbs
171 sampling. The joint posterior distribution of node *i* is a normal distribution obtained by combining
172 four normal distributions: three from the expectation of the Brownian motion with rate parameter
173 σ^2 (ancestral node in dark blue and the two descendant values in purple and light blue) and one for
174 the prior assigned to the node (in red). The prior is either informative, i.e. when defined based on
175 fossil data, or non-informative with an arbitrary large variance if fossils are not available (see
176 "Fossils" and "Ancestral reconstruction of latitude and altitude" sections for more details).



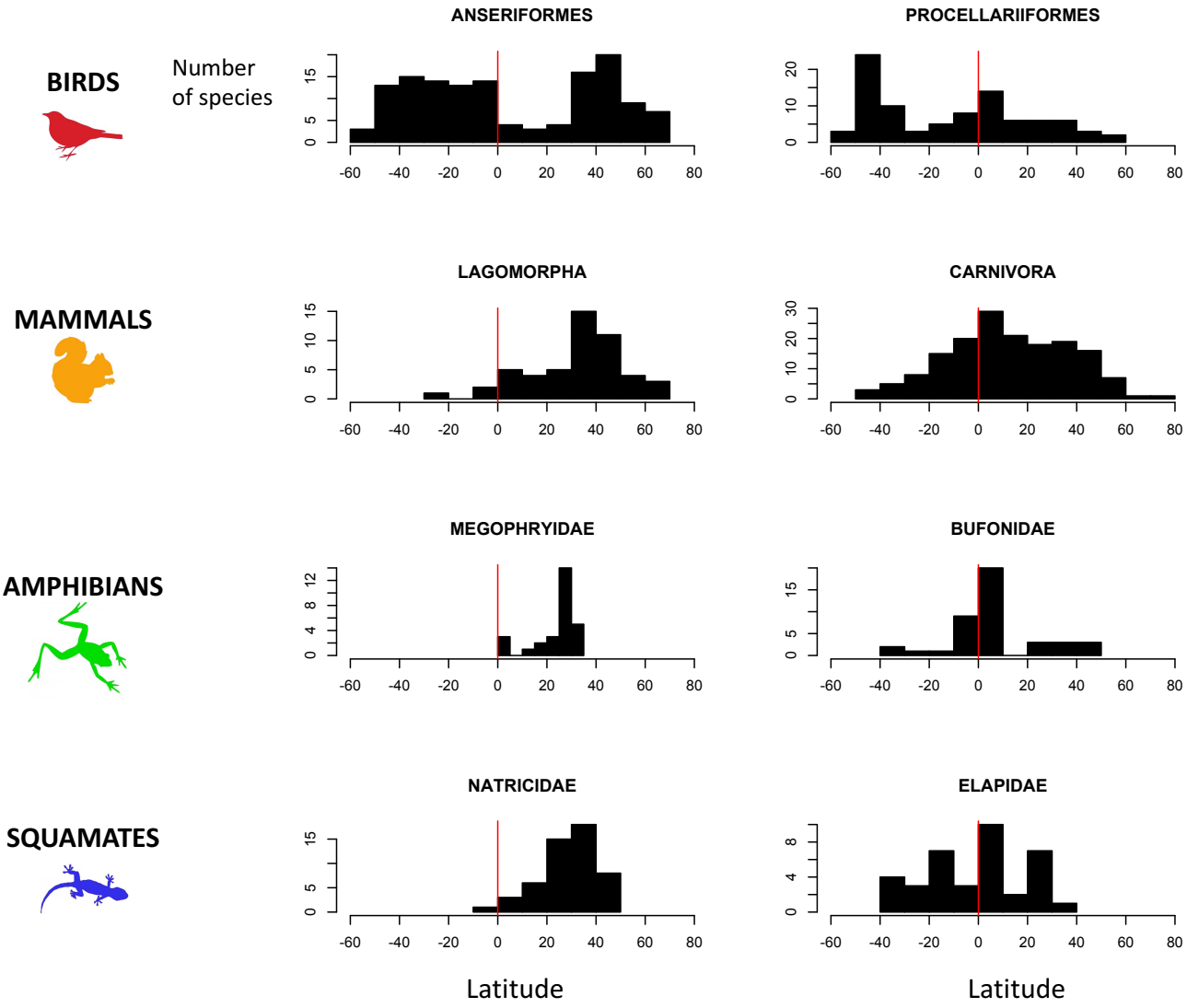
Supplementary Figure 2. Robustness analysis. Niche evolution remains faster in endotherms even when trees are pruned and fossil data are removed. The niche evolution of each group was estimated based on four reconstructions: minimum and maximum latitude and minimum and maximum altitude. These four analyses were run on trees of five different sizes for birds (3000, 1500, 1000, 500 and 100 tips), four different sizes for mammals (1500, 1000, 500 and 100 tips), three different sizes for amphibians (1000, 500 and 100 tips), and two different sizes for squamates (500 and 100 tips). Each reconstruction was replicated five times for each tree size, for a total of 5 x 4 x 14=280 reconstructions. We designed a pruning algorithm to remove randomly monophyletic clades from the original tree (code available at https://github.com/jonathanrolland/niche_evolution). This methodology allowed us to retain the phylogenetic signal inside each group and was more conservative than randomly pruning individual tips (rates of niche evolution were substantially higher when the tips were randomly removed). In addition, to account for the potential effect of fossils in our results, we did not consider fossil information in these robustness analyses.



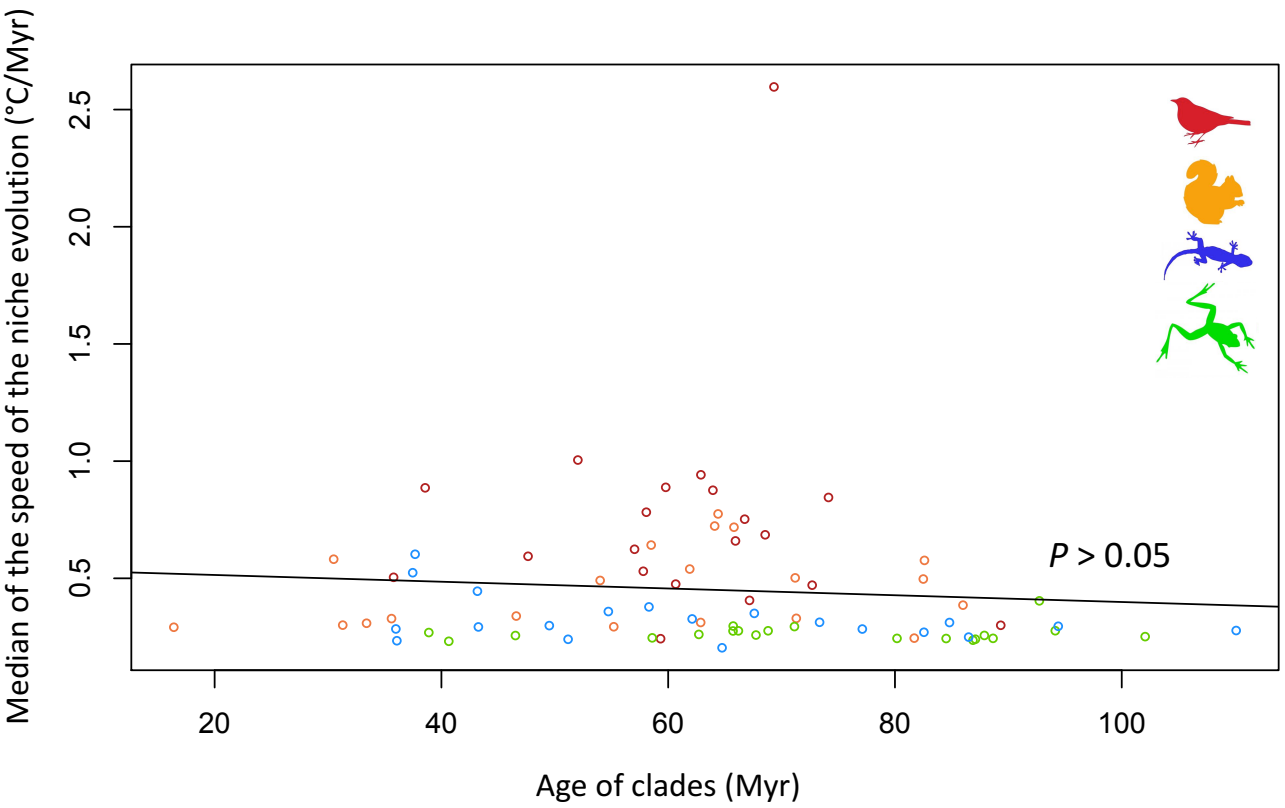
Supplementary Figure 3. Avian (red) and mammalian (orange) species cover a wider range of mean temperature, mean latitude and mean altitude than amphibian (green) and squamate (blue) species. Violin plots were calculated using all of the species in each group.



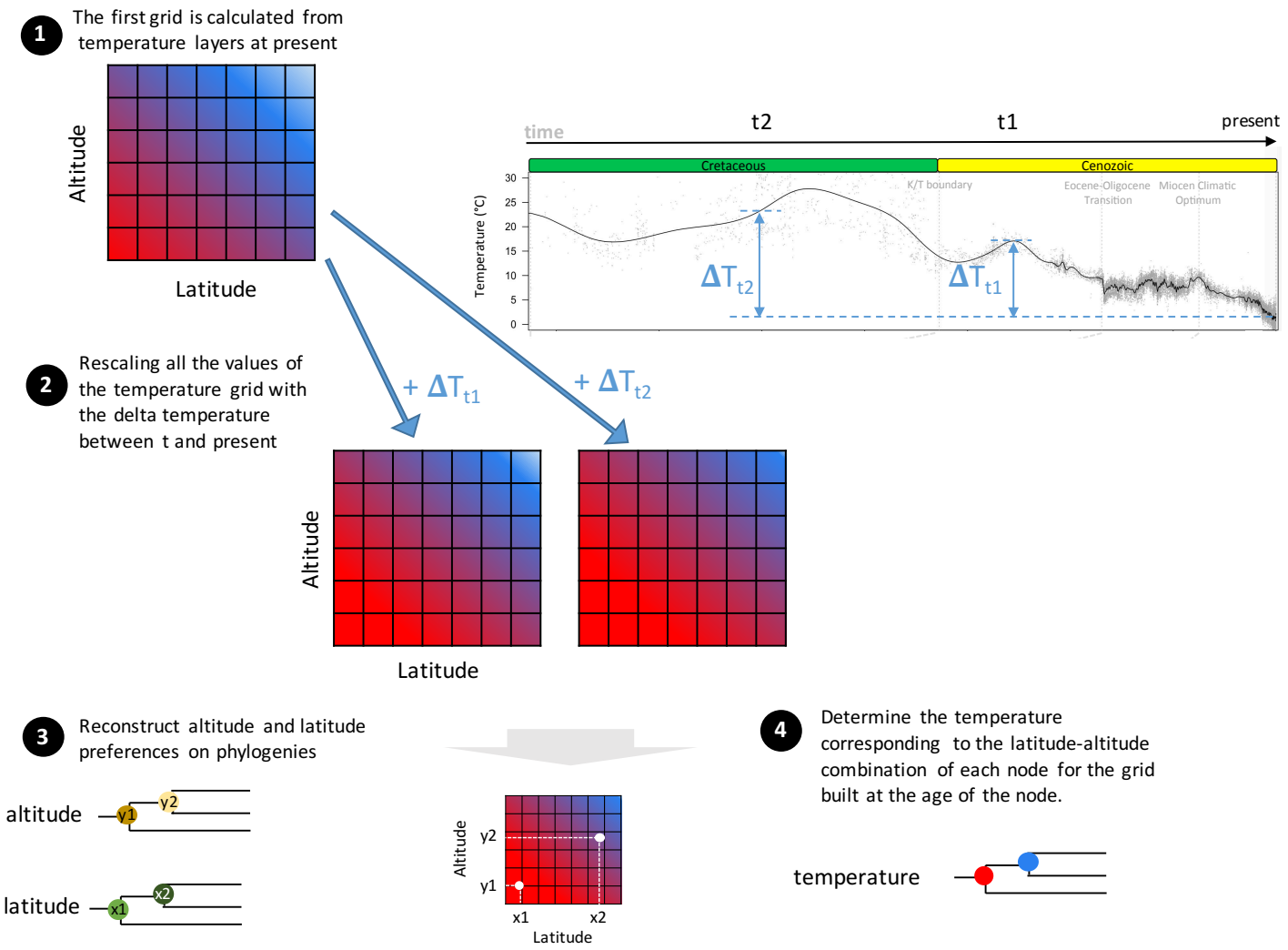
198 **Supplementary Figure 4. Median rate of niche evolution for the 20 richest orders of birds**
199 **(red) and mammals (orange) and the 20 richest families of amphibians (green) and**
200 **squamates (blue).**



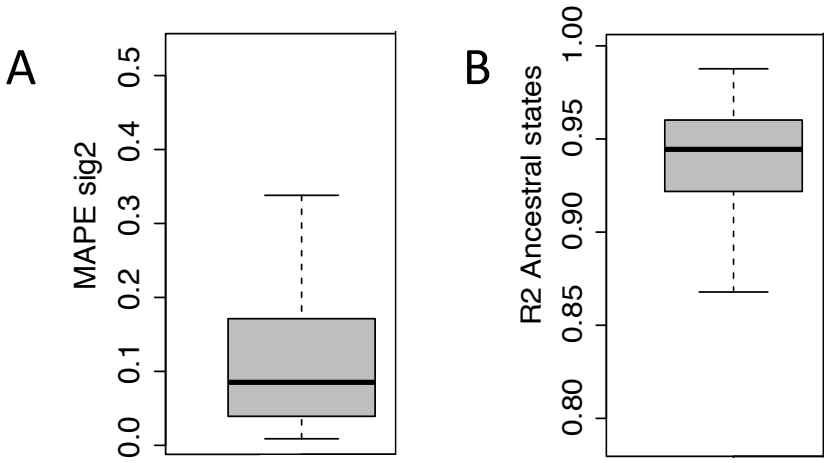
Supplementary Figure 5. Latitudinal diversity gradients of the groups that showed rapid niche evolution. The vertical red line corresponds to the equator.



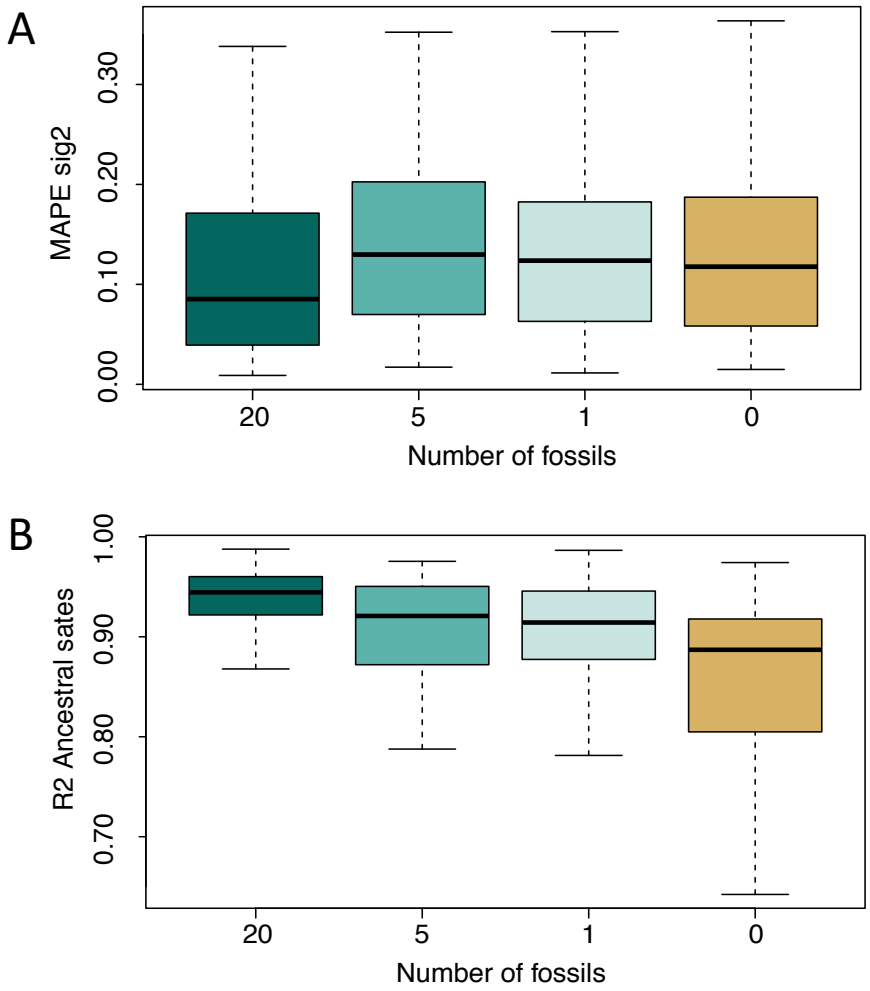
Supplementary Figure 6. Robustness analysis. Niche evolution rates are not associated with the age of the clades (orders and families). The rate of niche evolution was estimated for the 20 richest orders of birds (red) and mammals (orange) and the 20 richest families of amphibians (green) and squamates (blue). The black line represents the regression of the linear model between the rate of niche evolution and the age of the groups ($P > 0.05$).



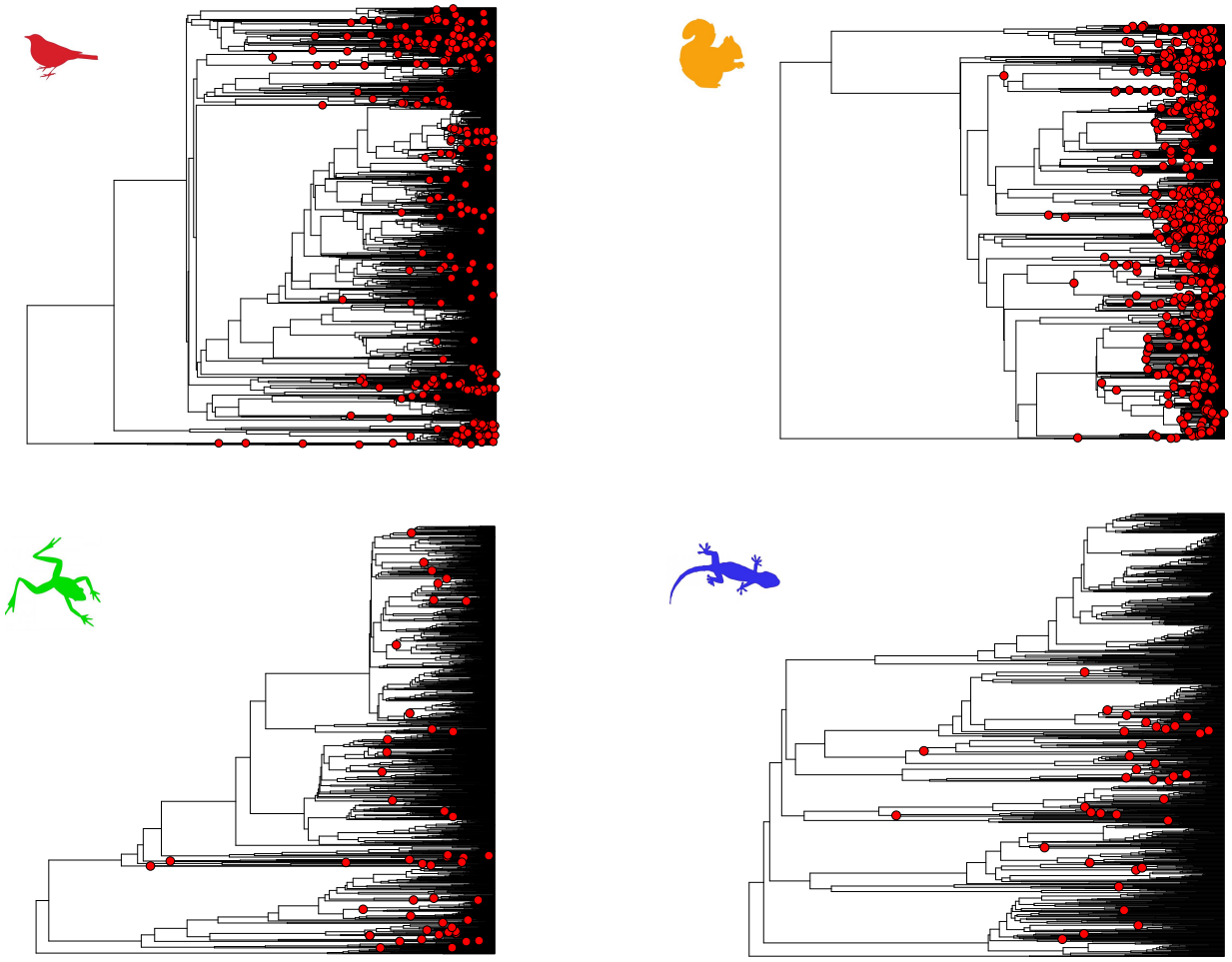
Supplementary Figure 7. Description of the procedure to obtain temperature for each node of the phylogeny from both the reconstructions of latitude and altitude and the climatic grid through time.



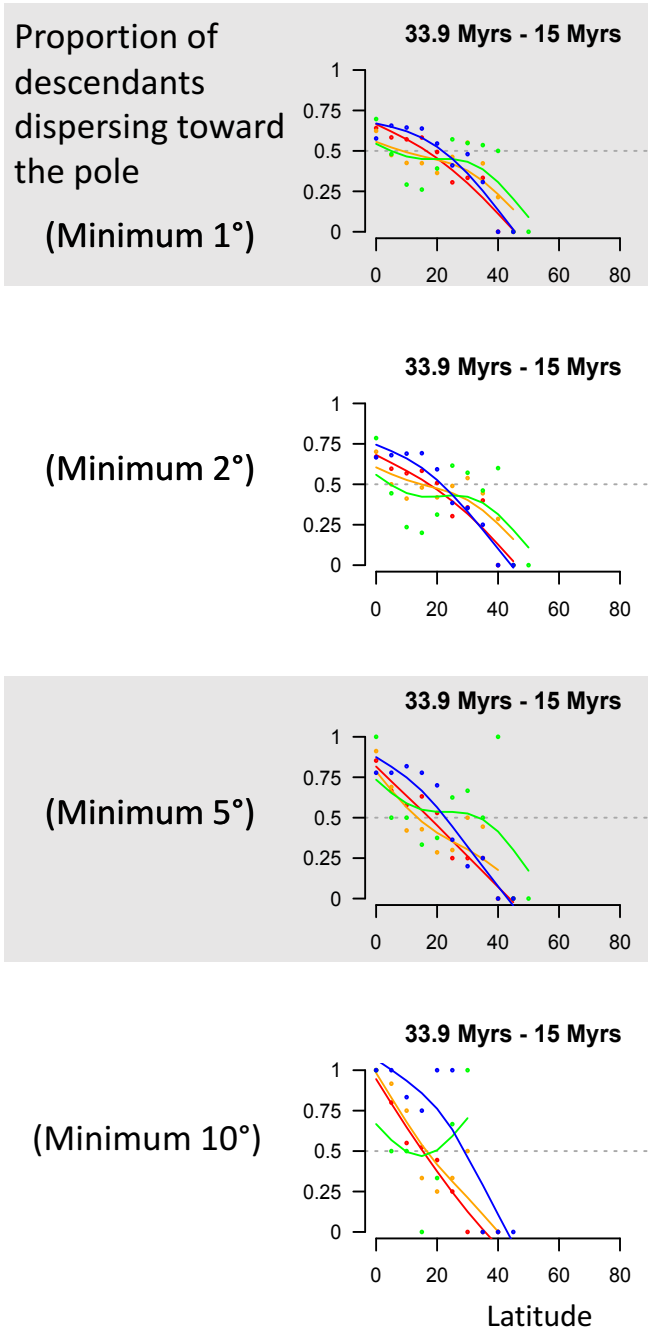
Supplementary Figure 8. Accuracy of parameter estimation summarized across 100 simulations. Mean absolute percentage errors (MAPE) are reported for the rate parameters (σ^2, panel A), and the coefficient of determination is used for ancestral states (R^2, panel B, modified from Figure S2 of Silvestro *et al.* 2017 [52]).



Supplementary Figure 9. Accuracy of parameter estimation summarized across 100 simulations with decreasing number of fossils: 20, 5, 1, and 0. Mean absolute percentage errors (MAPE) are reported for the rate parameters (σ^2, panel A), and the coefficient of determination R^2 is used for ancestral states (R^2, panel B). (modified from Figure S3 of Silvestro *et al.* 2017 [52]).



Supplementary Figure 10. Distribution of the nodes calibrated using fossil information (red points) on the phylogenies of the four studied groups. 2663 fossil occurrences were used to calibrate 239 of the 6141 nodes present in the birds phylogeny, 21767 fossil occurrences were used to calibrate 473 or the 2921 nodes of the mammals phylogeny, 908 occurrences were used to calibrate 48 of the 1413 nodes in amphibian phylogeny and 476 occurrences permitted to calibrate 37 of the 986 nodes in squamates phylogeny, the rest of the nodes in the phylogenies had flat priors. We also provided in Table S2-S4 the number of fossils that permitted to calibrate each node.



Supplementary Figure 11. Robustness analysis. The pattern of the dispersal of the species distributed at high latitudes towards the equator (presented in the figure 3D) is robust when we considered only the lineages that disperse more than 1°, 2°, 5° or 10° latitude.

Supplementary Table 1. Robustness analysis. Niche evolution rates remain higher in birds and mammals when estimated based on Brownian motion (BM) and Ornstein-Uhlenbeck (OU) models and when the present time mean annual temperatures are used for each species (BIO1 from WorldClim). This analysis was performed using the *fitContinuous* function in the *geiger* R package. z0 corresponds to the ancestral value of temperature at the root of the tree according to the BM process, and α measures the strength of attraction of the OU process toward the point of attraction θ. Compared with previous analyses, ancestral temperatures were not estimated using latitudinal and altitudinal reconstructions. This analysis did not include fossil data.

	Brownian motion			Ornstein–Uhlenbeck			
	AIC	σ2	z0	AIC	σ2	α	θ
Birds	47361.6	14.84	19.47	39728.1	206.81	2.72	19.20
Mammals	**19018.6**	**2.92**	**18.87**	**18439.5**	**4.56**	**0.047**	**19.08**
Amphibians	9047.5	1.01	16.39	8601.2	1.61	0.024	17.69
Squamates	**5760.5**	**0.65**	**21.25**	**5600.5**	**1.08**	**0.022**	**20.97**

Supplementary Table 2. Number of fossil occurrences used to inform the most recent common node of each genus in the birds phylogeny.

Birds

Genus	Nb. of fossils used to inform the node
Aythya	38
Anas	165
Crinifer	1
Nycticorax	8
Pandion	10
Haliaeetus	14
Meleagris	45
Spheniscus	18
Phalacrocorax	80
Fulmarus	11
Sula	34
Buteo	70
Gavia	40
Morus	29
Puffinus	69
Diomedea	9
Uria	21
Cepphus	6
Oceanodroma	2
Dromaius	10
Calonectris	6
Ortalis	4
Tympanuchus	10
Strix	17
Geranoaetus	5
Ardea	31
Burhinus	5
Mycteria	10
Grus	33
Aramus	5
Balearica	2
Anhinga	16
Egretta	14
Ardeola	1
Jacana	4
Phoenicopterus	10
Fulica	27
Bartramia	5
Falco	62
Aquila	23
Ptychoramphus	9
Mergus	29
Ceryle	1
Podilymbus	31
Corvus	82
Agelaius	15
Rallus	38
Aix	8
Bucephala	13
Limnodromus	6
Colinus	24
Butorides	6
Ciconia	19
Gallinula	13
Spizaetus	4
Gymnogyps	18
Gallinago	7
Botaurus	8
Laterallus	5
Nyctanassa	6
Tringa	13
Dendrocygna	8
Scolopax	14
Ixobrychus	3
Eudocimus	12
Branta	34
Oxyura	3
Plegadis	4
Otus	21
Bonasa	12
Perisoreus	3
Melospiza	6
Circus	5
Molothrus	6
Cardinalis	4
Zonotrichia	12
Accipiter	25
Melanerpes	15
Passerina	1
Junco	8
Zenaida	21
Colaptes	27
Passerculus	4
Tyto	33
Passerella	2
Picoides	6
Aphelocoma	4
Podiceps	28
Vermivora	2
Coragyps	16
Columba	24
Bubo	33
Sturnella	11
Coccyzus	4
Glaucidium	4
Euphagus	6
Asio	20
Dryocopus	4
Tachybaptus	2
Hylocichla	2
Ammodramus	3
Buteogallus	3
Cyanocitta	12
Porzana	21
Turdus	46
Dumetella	2
Chondestes	2
Toxostoma	4
Catharus	3
Spizella	6
Calidris	13
Cathartes	16
Aegolius	8
Quiscalus	9
Pica	10
Recurvirostra	5
Somateria	8
Pelecanus	9
Charadrius	12
Cistothorus	3
Caracara	17
Pipilo	4
Icterus	2
Anser	24
Xanthocephalus	3
Tachycineta	4
Lophodytes	7
Numenius	13
Cygnus	17
Melanitta	12
Stercorarius	6
Larus	36
Aechmophorus	5
Megaceryle	3
Dendrocopos	4
Limosa	7
Struthio	72
Francolinus	28
Numida	14
Streptopelia	4
Aegypius	2
Milvus	3
Tadorna	9
Caprimulgus	2
Oceanites	4
Colius	4
Pachyptila	8
Scopus	1
Leptoptilos	8
Turnix	6
Passer	1
Ploceus	2
Coturnix	13
Ephippiorhynchus	2
Hirundo	8
Carduelis	6
Gypaetus	1
Athene	11
Parus	3
Jabiru	4
Alauda	7
Eremophila	8
Sturnus	11
Otis	4
Surnia	5
Apus	3
Gallus	9
Pyrrhocorax	11
Casuarius	1
Cerorhinca	6
Synthliboramphus	12
Alca	25
Aethia	4
Haematopus	7
Pluvialis	7
Bulweria	1
Fratercula	15
Procellaria	2
Sterna	3
Pterodroma	9
Chloephaga	3
Rhea	10
Nothura	2
Pygoscelis	4
Vultur	2
Sarcoramphus	2
Eudromia	2
Columbina	4
Milvago	4
Arenaria	4
Crypturellus	1
Syrigma	1
Thinocorus	3
Theristicus	1
Alle	18
Dendragapus	5
Cyrtonyx	3
Callipepla	1
Pavo	1
Sayornis	4
Petrochelidon	2
Contopus	2
Sitta	5
Phaethon	1
Carpodacus	3
Chaetura	2
Pinicola	2
Piranga	2
Gallirallus	3
Chenonetta	2
Pelecanoides	5
Cyanoramphus	2
Eudyptes	5
Coenocorypha	2
Apteryx	2
Megadyptes	3
Hemiphaga	2
Anthornis	1
Thalassarche	2
Petroica	1
Hymenolaimus	1
Coracopsis	1
Leptopterus	1
Foudia	1
Upupa	1
Terpsiphone	1
Mirafra	1
Zosterops	1
Oreortyx	3
Loxia	3
Bombycilla	1
Menura	1
Brachyramphus	2
Rissa	3
Aegotheles	1
Collocalia	1
Cinclosoma	2
Ptilonorhynchus	1
Cacatua	2
Anthochaera	2
Phaps	2
Dasyornis	2
Glossopsitta	1
Platycercus	1
Phalaropus	2
Neochen	1
Pagophila	1

Supplementary Table 3. Number of fossil occurrences used to inform the most recent common node of each genus in the mammals phylogeny.

Genus	Nb. of fossils used to inform the node
Ellobius	18
Viverra	24
Giraffa	252
Lutra	42
Tapirus	246
Potamochoerus	60
Moschus	9
Muntiacus	34
Crocidura	145
Blarinella	10
Anourosorex	8
Myotis	231
Eptesicus	73
Pipistrellus	31
Plecotus	34
Callosciurus	5
Tamiops	3
Dremomys	6
Hylopetes	12
Mus	61
Hystrix	203
Macaca	70
Martes	66
Felis	174
Sus	182
Rhinoceros	85
Gazella	424
Antilope	86
Equus	1578
Hippopotamus	452
Cervus	399
Capreolus	80
Erinaceus	73
Hyaena	85
Canis	713
Vulpes	234
Ursus	346
Panthera	329
Microtus	816
Capra	41
Bos	158
Procavia	83
Hipposideros	31
Rhinolophus	81
Tadarida	29
Dasypus	83
Tamias	63
Didelphis	44
Sylvilagus	275
Blarina	82
Scalopus	55
Sorex	516
Marmota	104
Castor	172
Oryzomys	40
Peromyscus	309
Sigmodon	201
Neotoma	318
Neofiber	37
Ondatra	162
Synaptomys	73
Zapus	39
Urocyon	53
Tremarctos	26
Procyon	92
Mustela	231
Spilogale	63
Mephitis	48
Conepatus	19
Lontra	32
Lynx	161
Odocoileus	237
Puma	51
Hydropotes	5
Elephas	85
Crocuta	142
Paguma	4
Herpestes	62
Arctonyx	9
Cuon	16
Rattus	34
Eothenomys	2
Pongo	16
Trachypithecus	7
Macropus	94
Dasyurus	10
Boselaphus	1
Bison	263
Rangifer	76
Redunca	116
Atlantoxerus	26
Sciurus	104
Ochotona	117
Sicista	43
Apodemus	313
Micromys	37
Chironectes	3
Aotus	3
Presbytis	1
Manis	10
Thylamys	7
Noctilio	5
Thyroptera	3
Leopardus	15
Lutreolina	6
Lepus	301
Bassariscus	45
Perognathus	136
Spermophilus	388
Catagonus	15
Thomomys	207
Onychomys	61
Antrozous	22
Geomys	171
Ammospermophilus	20
Lasiurus	28
Parascalops	19
Baiomys	25
Nasua	7
Taxidea	62
Cynomys	85
Scapanus	49
Cryptotis	41
Neurotrichus	3
Tayassu	31
Cerdocyon	6
Notiosorex	23
Reithrodontomys	85
Cratogeomys	22
Eumops	11
Histiotus	1
Dipodomys	135
Erethizon	66
Chrysocyon	5
Antilocapra	29
Orthogeomys	7
Phenacomys	61
Lasionycteris	3
Microdipodops	3
Oreamnos	9
Myodes	124
Chaetodipus	22
Ovis	90
Enhydra	22
Lemmus	41
Lemmiscus	28
Brachylagus	8
Ochrotomys	7
Glaucomys	26
Podomys	11
Tamiasciurus	33
Alces	50
Condylura	12
Napaeozapus	9
Vespertilio	10
Gulo	22
Myrmecophaga	5
Dicrostonyx	27
Ovibos	37
Desmodus	16
Pan	2
Hydrochoerus	19
Mormoops	5
Antidorcas	146
Litocranius	3
Aepyceros	146
Damaliscus	131
Connochaetes	158
Hippotragus	76
Oryx	41
Kobus	321
Madoqua	27
Otocyon	12
Mellivora	44
Papio	83
Pedetes	11
Thryonomys	43
Caracal	41
Ichneumia	8
Cephalophus	59
Phacochoerus	90
Lycaon	17
Theropithecus	179
Mungos	9
Loxodonta	137
Ceratotherium	205
Diceros	96
Tragelaphus	391
Tatera	46
Cercocebus	11
Syncerus	111
Genetta	33
Rhynchocyon	8
Civettictis	4
Raphicerus	110
Cercopithecus	25
Colobus	11
Aethomys	41
Aonyx	26
Arvicanthis	22
Thallomys	27
Chlorocebus	12
Scotophilus	4
Nycteris	4
Jaculus	5
Mastomys	21
Xerus	16
Taphozous	6
Helogale	10
Gerbillus	30
Pelomys	9
Acomys	10
Heterocephalus	14
Paraxerus	11
Lemniscomys	14
Myosorex	12
Suncus	23
Eidolon	2
Galago	12
Heterohyrax	8
Heteromys	3
Eira	4
Galictis	3
Molossops	2
Molossus	3
Artibeus	5
Carollia	1
Glossophaga	2
Micronycteris	4
Phyllostomus	3
Sturnira	2
Trachops	2
Rhogeessa	2
Alouatta	5
Cuniculus	8
Rhynchonycteris	1
Tonatia	2
Cebus	4
Zygodontomys	4
Coendou	8
Dasyprocta	6
Marmosa	14
Tamandua	4
Choloepus	3
Myoprocta	2
Potos	3
Caluromys	4
Monodelphis	2
Metachirus	4
Ateles	3
Chiropotes	1
Pithecia	1
Mesomys	2
Proechimys	8
Philander	4
Bradypus	3
Priodontes	2
Neacomys	1
Rhipidomys	2
Mazama	22
Petauroides	2
Melomys	2
Antechinus	10
Planigale	1
Sminthopsis	8
Lagorchestes	2
Thylogale	4
Petaurus	4
Cercartetus	1
Aepyprymnus	6
Bettongia	5
Wallabia	3
Isoodon	3
Perameles	8
Pseudocheirus	5
Trichosurus	12
Hydromys	2
Uromys	1
Pteronura	3
Bassaricyon	2
Callicebus	1
Lagothrix	1
Saguinus	3
Saimiri	1
Dactylomys	1
Oecomys	2
Oligoryzomys	4
Nectomys	2
Marmosops	1
Callithrix	1
Dinomys	1
Alcelaphus	126
Acinonyx	28
Cabassous	1
Microsciurus	1
Dasymys	16
Lophuromys	2
Praomys	24
Cricetomys	4
Graphiurus	12
Sylvisorex	3
Hylochoerus	6
Ictonyx	7
Proteles	9
Cryptomys	22
Cynictis	18
Elephantulus	32
Amblysomus	6
Steatomys	20
Dendromus	21
Saccostomus	32
Otomys	34
Rhabdomys	8
Atilax	14
Bathyergus	18
Suricata	7
Georychus	3
Parotomys	2
Chrysochloris	8
Tachyoryctes	15
Poecilogale	1
Mystromys	21
Malacothrix	7
Sylvicapra	6
Dendrohyrax	5
Oryctolagus	58
Nesokia	7
Thamnomys	3
Miniopterus	21
Grammomys	1
Atelerix	3
Zelotomys	8
Zenkerella	2
Rousettus	8
Neotragus	2
Crossarchus	2
Scutisorex	2
Heliosciurus	1
Bdeogale	1
Funisciurus	2
Protoxerus	2
Nyctereutes	41
Anomalurus	1
Macroscelides	3
Meriones	22
Glis	73
Cricetus	94
Calomyscus	3
Eliomys	106
Phascogale	2
Sarcophilus	7
Phascolarctos	6
Vombatus	6
Lasiorhinus	2
Potorous	4
Nyctophilus	1
Mastacomys	2
Hypsiprymnodon	1
Strigocuscus	3
Muscardinus	61
Desmana	61
Episoriculus	42
Meles	52
Talpa	210
Lagurus	36
Urotrichus	10
Spalax	32
Soriculus	7
Galemys	14
Neomys	20
Dryomys	8
Cricetulus	27
Arvicola	92
Hemitragus	23
Mesocricetus	5
Chionomys	2
Vormela	3
Axis	8
Myospalax	12
Rupicapra	4
Hemiechinus	1
Barbastella	4
Nyctalus	3
Rhizomys	10
Allactaga	8
Dorcopsis	3
Viverricula	1
Atherurus	3
Asellia	1
Tarsius	3
Megaderma	8
Ctenomys	27
Scaptonyx	5
Alticola	1
Eolagurus	4
Cavia	9
Hylomys	5
Ratufa	4
Tupaia	3
Nycticebus	1
Belomys	2
Niviventer	7
Leopoldamys	3
Petromus	1
Gerbillurus	1
Lagostomus	28
Myocastor	15
Chaetophractus	16
Zaedyus	12
Microcavia	10
Lestodelphys	7
Akodon	7
Oxymycterus	3
Reithrodon	13
Phyllotis	7
Galea	8
Holochilus	11
Ozotoceros	6
Calomys	10
Lophostoma	1
Leptonycteris	2
Chimarrogale	2
Murina	4
Petaurista	3
Chiropodomys	1
Burramys	2
Pseudochirops	2
Macroderma	2
Dendrolagus	2
Euphractus	7
Andinomys	2
Euryzygomatomys	1
Hippocamelus	4
Graomys	1
Balantiopteryx	1
Liomys	3
Dolichotis	5
Blastocerus	2
Lyncodon	1
Pteronotus	3
Chrotopterus	1
Lonchophylla	1
Necromys	3
Lagidium	4
Colomys	1
Kerodon	1
Vicugna	1
Aplodontia	5
Pappogeomys	2
Solenodon	1
Macrotus	3
Brachyphylla	3
Nycticeius	2
Geogale	2
Microgale	6
Tenrec	2
Pteropus	1
Microcebus	2
Cheirogaleus	2
Lemur	2
Propithecus	2
Avahi	1
Fossa	1
Cryptoprocta	1
Nesomys	1
Echinops	1
Triaenops	1
Mormopterus	1
Eliurus	2
Paradoxurus	1
Uropsilus	1
Tylonycteris	1
Trichys	1
Elaphodus	1
Budorcas	1
Phyllops	1
Gracilinanus	2
Scapteromys	2
Clyomys	1
Thrichomys	1
Prionailurus	1
Lutrogale	1
Babyrousa	2
Natalus	1
Mogera	3
Pteromys	1
Hylobates	1
Pseudois	1
Peroryctes	2
Dasyuroides	1
Eligmodontia	2
Abrothrix	1
Neotomys	1
Capromys	3
Auliscomys	1
Pecari	2

Supplementary Table 4. Number of fossil occurrences used to inform the most recent common node of each genus in the amphibians and squamates phylogenies.

Squamata

Genus	Nb. of fossils used to inform the node
Ophisaurus	107
Uromastyx	4
Sceloporus	42
Anolis	25
Gerrhonotus	12
Rhineura	11
Leiocephalus	7
Eumeces	38
Holbrookia	10
Phrynosoma	25
Heloderma	4
Crotaphytus	13
Gambelia	1
Uta	1
Anniella	2
Varanus	35
Egernia	2
Blanus	13
Chalcides	8
Trogonophis	1
Lacerta	82
Tarentola	3
Agama	3
Tropidophorus	2
Chamaeleo	8
Eremias	2
Amphisbaena	2
Urosaurus	2
Elgaria	1
Paroedura	1
Zonosaurus	1
Furcifer	1
Callisaurus	1
Ameiva	3
Sauromalus	1
Aristelliger	1
Sphaerodactylus	1

Amphibians

Genus	Nb. of fossils used to inform the node
Salamandra	20
Pelodytes	6
Plethodon	7
Rana	212
Pseudotriton	1
Bufo	195
Ambystoma	96
Hyla	64
Barbourula	1
Tylototriton	2
Necturus	2
Cryptobranchus	8
Amphiuma	9
Siren	30
Scaphiopus	28
Rhinophrynus	2
Taricha	3
Spea	32
Andrias	13
Acris	10
Pseudacris	21
Pseudobranchus	5
Notophthalmus	12
Gyrinophilus	3
Gastrophryne	6
Discoglossus	12
Xenopus	6
Litoria	3
Limnodynastes	3
Pelobates	30
Triturus	22
Alytes	2
Bombina	5
Eupsophus	1
Lechriodus	1
Ceratophrys	2
Leptodactylus	3
Leiopelma	3
Eleutherodactylus	7
Desmognathus	7
Eurycea	1
Chioglossa	1
Laliostoma	1
Ptychadena	1
Scaphiophryne	1
Rhacophorus	1
Dicamptodon	1
Lissotriton	5
Mertensiella	1