

Appendix from H. Qiao et al., “Impacts of Niche Breadth and Dispersal Ability on Macroevolutionary Patterns” (Am. Nat., vol. 188, no. 2, p. 149)

Supplementary Information

Supplemental table S1 presents raw speciation and extinction counts for the 7,758 completed simulations. Biome abbreviations are as follows: DX = desert and xeric scrublands; Med = Mediterranean forests, woodlands, and scrub; MonGrass = montane grasslands and shrublands; PA6 = boreal forest and taiga; TempCon = temperate coniferous forest; TempFor = temperate broadleaf and mixed forests; TempGrass = temperate grasslands, savannas, and shrublands; TrpDrFr = tropical and subtropical dry broadleaf forest; TrpWtFr = tropical/subtropical moist broadleaf forest; and Tundra = tundra. See table S1.

Table A1: Number of completed simulations for each macroecological combination and climate-change scenario

	Fast climate Δ			Moderate climate Δ			Slow climate Δ		
	Narrow NB	Intermediate NB	Broad NB	Narrow NB	Intermediate NB	Broad NB	Narrow NB	Intermediate NB	Broad NB
Poor	499	500	500	500	500	500	500	500	500
Good	420	191	251	460	297	235	500	456	449

Note: NB = niche breadth.

Table A2: Number of unfinished simulations by biome

Biome	Count
Desert and xeric shrublands	112
Mediterranean forests	74
Montane grasslands	154
Boreal forest and taiga	155
Temperate conifer forests	139
Temperate broadleaf forests	115
Temperate grasslands	173
Tropical dry broadleaf forests	140
Tropical wet broadleaf forests	66
Tundra	114

Note: No systematic bias exists with respect to the biome and the simulations that failed.

Table A3: Results from multivariate generalized linear models assessing associations of climate scenario, niche breadth, and dispersal ability with counts of speciation and extinction events

Factor	df	Speciations		Extinctions	
		Wald statistic	P	Wald statistic	P
Intercept	1	51,638.9	<.001	343.483	<.001
DA	1	6,130.84	<.001	613.118	<.001
NB	2	38,502.6	<.001	329.473	<.001
Climate scenario	2	8,886.54	<.001	626.864	<.001
DA × NB	2	3,079.37	<.001	1,632.845	<.001
DA × climate	2	2,393.71	<.001	1,988.616	<.001
NB × climate	4	10,932.1	<.001	527.861	<.001
DA × NB × climate	4	4,687.81	<.001	...	...

Note: DA = dispersal ability; NB = niche breadth. One of the interaction terms could not be tested for lack of sufficient numbers of extinction events.

Table A4: Results from multivariate generalized linear models assessing the contribution of niche breadth (NB) and dispersal ability (DA) on counts of speciation and extinction events under each of the three climate-change scenarios (fast, moderate, and slow)

Factor	df	Speciations		Extinctions	
		Wald statistic	<i>P</i>	Wald statistic	<i>P</i>
Slow climate Δ :					
Intercept	1	395,682.6	<.001	21.2053	<.001
DA	1	15,971.1	<.001	308.1152	<.001
NB	2	10,711.4	<.001	151.8457	<.001
DA $\times$ NB	2	81.9	<.001	401.1905	<.001
Moderate climate Δ :					
Intercept	1	369,527.2	<.001	360.5076	<.001
DA	1	22,390.6	<.001	19.0452	<.001
NB	2	27,115.7	<.001	245.4834	<.001
DA $\times$ NB	2	748.6	<.001	46.8187	<.001
Fast climate Δ :					
Intercept	1	5,491.58	<.001	311.594	<.001
DA	1	1,947.47	<.001	6,047.065	<.001
NB	2	21,985.29	<.001	284.687	<.001
DA $\times$ NB	2	4,819.4	<.001	...	...

Note: One of the interaction terms could not be tested for lack of sufficient numbers of extinction events.

Table A5: Average extinction rate for each macroecological combination, including only those simulations with extinction >0

Dispersal	Slow climate Δ			Moderate climate Δ			Fast climate Δ
	Narrow NB	Intermediate NB	Broad NB	Narrow NB	Intermediate NB	Broad NB	Narrow NB
Poor	8.27	4.09	4.51	5.30	7.00	3.11	2.43
Good	4.08	2.98	3.26	7.58	5.21	2.50	3.30

Note: Calculations were not possible for intermediate and broad niche breadths (NB) under the fast climate-change scenario, given that extinction did not occur in these simulations.

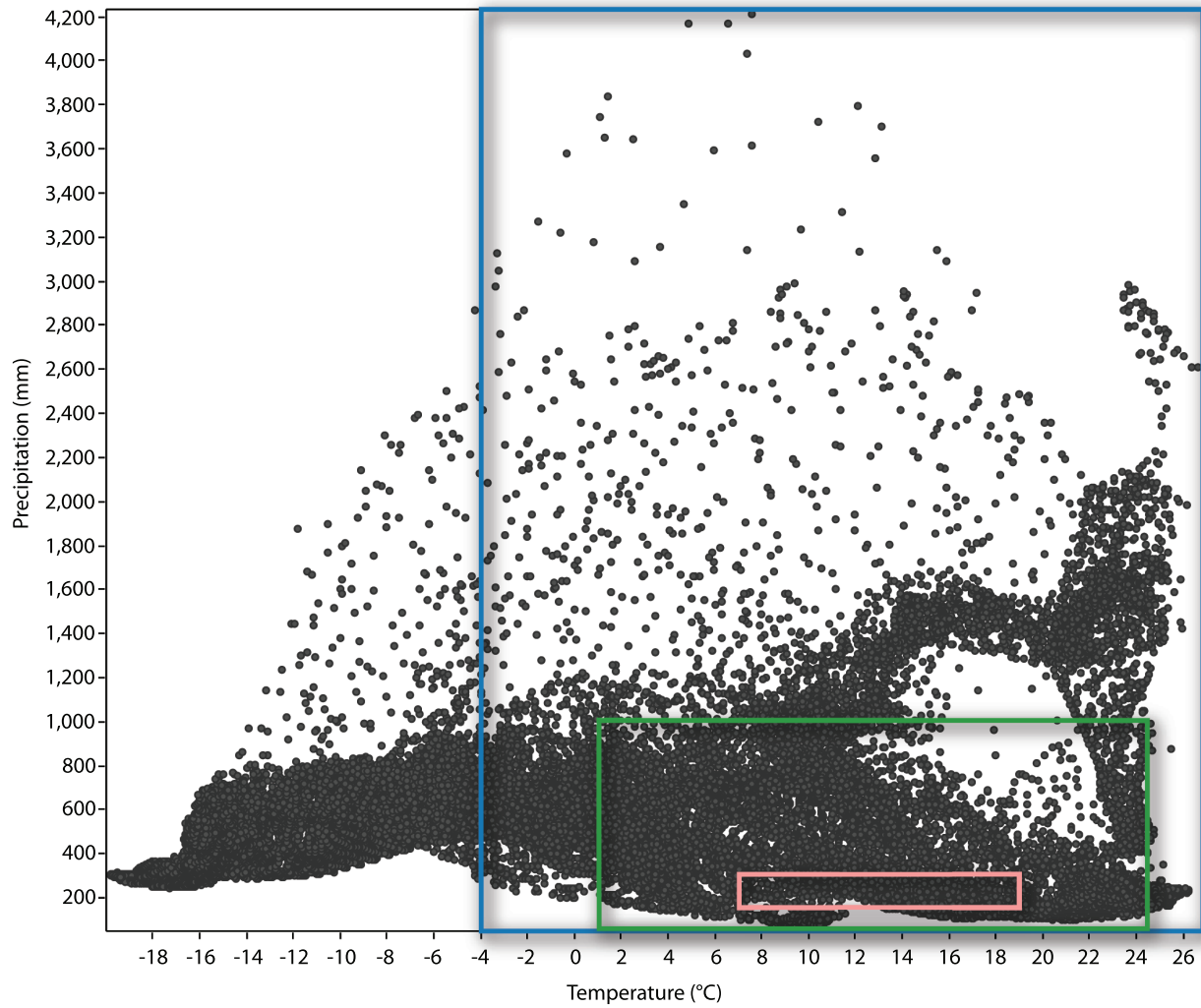


Figure A1: Niche-breadth dimensions (three boxes) for an exemplar species seeded within the desert and xeric shrublands biome of Eurasia. The backdrop represents mid-Holocene (warm) annual mean temperature and precipitation conditions of Eurasia. Broad niche breadth is represented by the blue rectangle, intermediate by the green rectangle, and narrow by the pink rectangle. Note that for the broadest niche in this example, dimensions extend beyond the existing environmental conditions of Eurasia during the mid-Holocene, such that the fundamental niche is not fully observable under current climatic conditions.

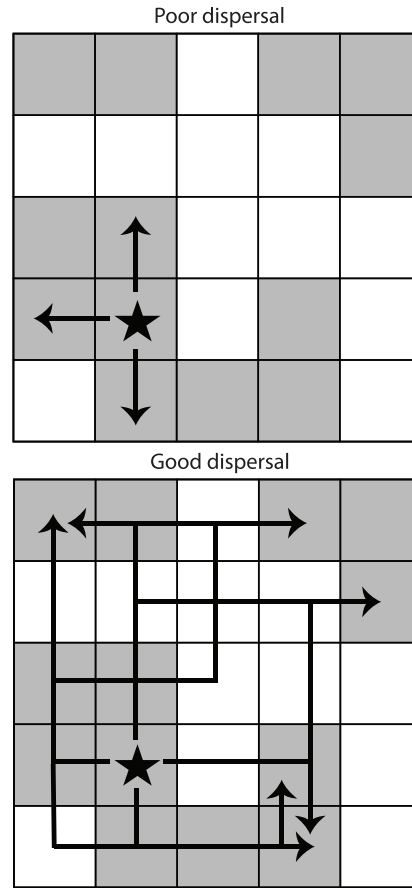
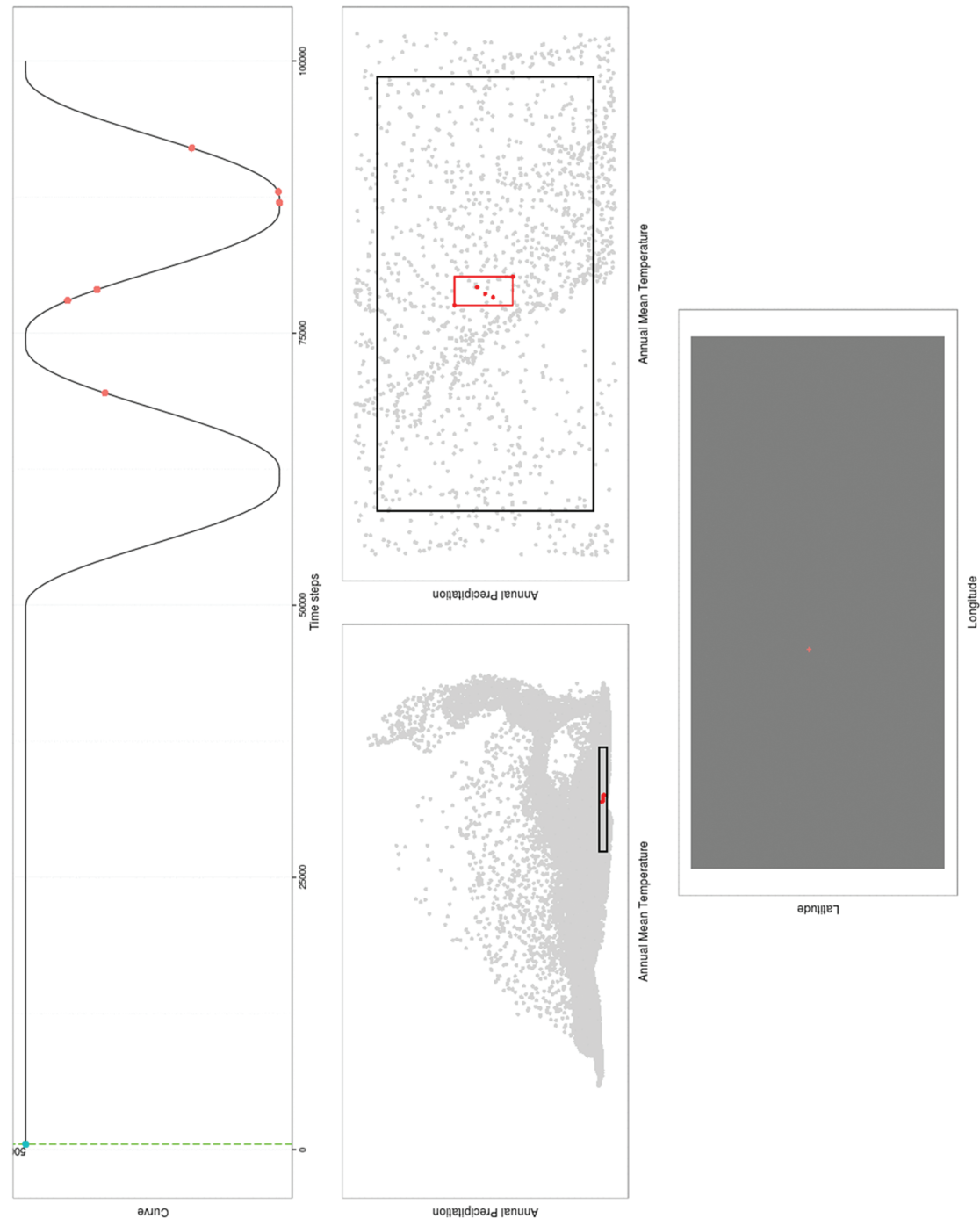


Figure A2: Representation of the two different dispersal scenarios explored in our simulations. Poor dispersers may search only one cell away from occupied cells per 500 time steps, whereas good dispersers may search five cells away from occupied cells per 500 time steps. Thus, poor dispersers encountered adjacent cells only, whereas good dispersers could jump over unsuitable patches to find more remote areas of suitability. Species search for suitable conditions simultaneously from all currently occupied cells. In this example, the initial occupied cell is indicated with a star, and white and gray squares represent unsuitable and suitable conditions, respectively.



Video A1: Still image from video of the simulation framework for an exemplar species with poor dispersal ability and a narrow niche breadth under the rapid climate-change scenario. The curve at the top defines the style and rate of environmental change. The green line associated with this curve indicates the current model time step, and every red point on the curve designates a speciation event. The middle left panel illustrates the fundamental niche (black rectangle) and the realized niche (color rectangle) of the species in environmental space; a detailed view of these dynamics is provided on the right. The bottom figure depicts the distribution of the simulated species in geographic space. If speciation occurs, daughter species are assigned separate panels.