

Exotic fishes phylogenetically close but functionally distant to native ones are more likely to establish

Supplementary information

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Table S1. Parameter estimates for the Bayesian hierarchical model to explain fish establishment success using multiple standardized explanatory variables (subtracting the mean and dividing by the standard deviation). Bold values are significantly different from zero (based on 95% credible intervals).

Predictors	Mean	SD	0.025 quant	0.15 quant	0.5 quant	0.85 quant	0.975 quant
Introduction-native MPD	-0.41	0.11	-0.64	-0.53	-0.41	-0.29	-0.19
Introduction-native MFD	0.33	0.17	0.00	0.16	0.33	0.51	0.67
Species richness	0.10	0.12	-0.13	-0.02	0.10	0.22	0.33
Native MPD	-0.03	0.11	-0.25	-0.14	-0.03	0.08	0.18
Native MFD	-0.08	0.14	-0.36	-0.23	-0.08	0.07	0.20
Area	-0.30	0.18	-0.70	-0.49	-0.28	-0.11	0.01
Elevation	0.01	0.11	-0.21	-0.10	0.01	0.13	0.24
Latitude	0.19	0.11	-0.02	0.08	0.19	0.31	0.41

Table S2. Parameter estimates for averaging generalized linear mixed model to explain fish establishment success using standardized explanatory variables (subtracting the mean and dividing by the standard deviation). Bold values denote the significant effects ($P < 0.05$). The model average is conducted by selecting and averaging the best fitted mixed models ($\Delta AIC < 2$).

	Estimate	SE	Adjusted SE	z value	Pr ($> z $)
Introduction-native MPD	-0.43	0.11	0.11	3.86	0.00
Introduction-native MFD	0.32	0.15	0.15	2.07	0.04
Species richness	0.01	0.05	0.05	0.26	0.79
Native MPD	-0.01	0.04	0.04	0.22	0.83
Native MFD	-0.05	0.10	0.10	0.48	0.63
Area	-0.24	0.18	0.18	1.36	0.17
Latitude	0.12	0.12	0.12	1.03	0.30

Table S3. The comparison of Candidate structural equation modelings (SEMs)

Model	Explanation	<i>Fisher's C</i>	<i>P</i>	K	AIC	Δ AIC	AIC weight
SEM1	Initial model	119.38	0.00	45	209.38	110.77	0.00
SEM2	Initial model plus effects of elevation on both similarity	27.04	0.00	47	121.04	22.43	0.00
SEM3	Initial model plus effects of elevation and latitude on both similarity	0.61	0.96	49	98.61	0.00	0.54
SEM4	Initial model plus effects of elevation and latitude on both similarity, and effect of area on phylogenetic similarity	0.13	0.94	50	100.13	1.52	0.25
SEM5	Initial model plus effects of elevation and latitude on both similarity, and effect of area on functional similarity	0.48	0.79	50	100.48	1.87	0.21

Table S4. Parameter estimates and standardized coefficients for the best-supported SEM

Response	Predictor	Estimate	SE	DF	<i>P</i> Value	Std. Coef
Introduction outcome	Introduction-native MPD	-3.270	0.955	965.000	0.001	-0.172
Introduction outcome	Introduction-native MFD	0.543	0.237	965.000	0.022	0.165
Introduction outcome	Species richness	0.026	0.035	965.000	0.458	0.038
Introduction outcome	Native MPD	-0.211	0.988	965.000	0.831	-0.010
Introduction outcome	Native MFD	-0.139	0.164	965.000	0.396	-0.051
Introduction outcome	Area	0.000	0.000	965.000	0.045	-0.134
Introduction outcome	Elevation	0.000	0.001	965.000	0.937	0.004
Introduction outcome	Latitude	0.051	0.034	965.000	0.132	0.073
Introduction-native MPD	Native MPD	0.371	0.031	856.602	0.000	0.332
Introduction-native MPD	Species richness	0.005	0.001	700.967	0.000	0.145
Introduction-native MPD	Native MFD	0.027	0.004	778.814	0.000	0.188
Introduction-native MPD	Elevation	0.000	0.000	726.806	0.000	-0.179
Introduction-native MPD	Latitude	-0.006	0.001	573.448	0.000	-0.154
Introduction-native MFD	Native MFD	0.428	0.016	763.396	0.000	0.518
Introduction-native MFD	Species richness	0.011	0.004	667.422	0.007	0.054
Introduction-native MFD	Native MPD	0.093	0.122	846.275	0.449	0.014
Introduction-native MFD	Elevation	0.000	0.000	722.272	0.282	-0.024
Introduction-native MFD	Latitude	0.003	0.005	535.617	0.495	0.015
Native MPD	Elevation	0.000	0.000	706.876	0.023	-0.105
Native MPD	Latitude	-0.005	0.002	715.127	0.001	-0.160
Native MPD	Area	0.000	0.000	658.347	0.028	-0.080
Native MFD	Elevation	-0.001	0.000	698.525	0.000	-0.186
Native MFD	Latitude	-0.080	0.012	709.917	0.000	-0.312
Native MFD	Area	0.000	0.000	665.043	0.192	-0.046
Species richness	Elevation	-0.002	0.000	965.000	0.000	-0.387
Species richness	Latitude	-0.031	0.006	965.000	0.000	-0.177
Species richness	Area	0.000	0.000	965.000	0.000	0.129
~~Introduction-native MPD	~~ Introduction-native MFD	0.285	NA	965.000	0.000	0.285
~~Native MPD	~~Species richness	-0.191	NA	965.000	0.000	-0.191
~~native MFD	~~Species richness	-0.053	NA	965.000	0.050	-0.053
~~Native MPD	~~native MFD	0.446	NA	965.000	0.000	0.446

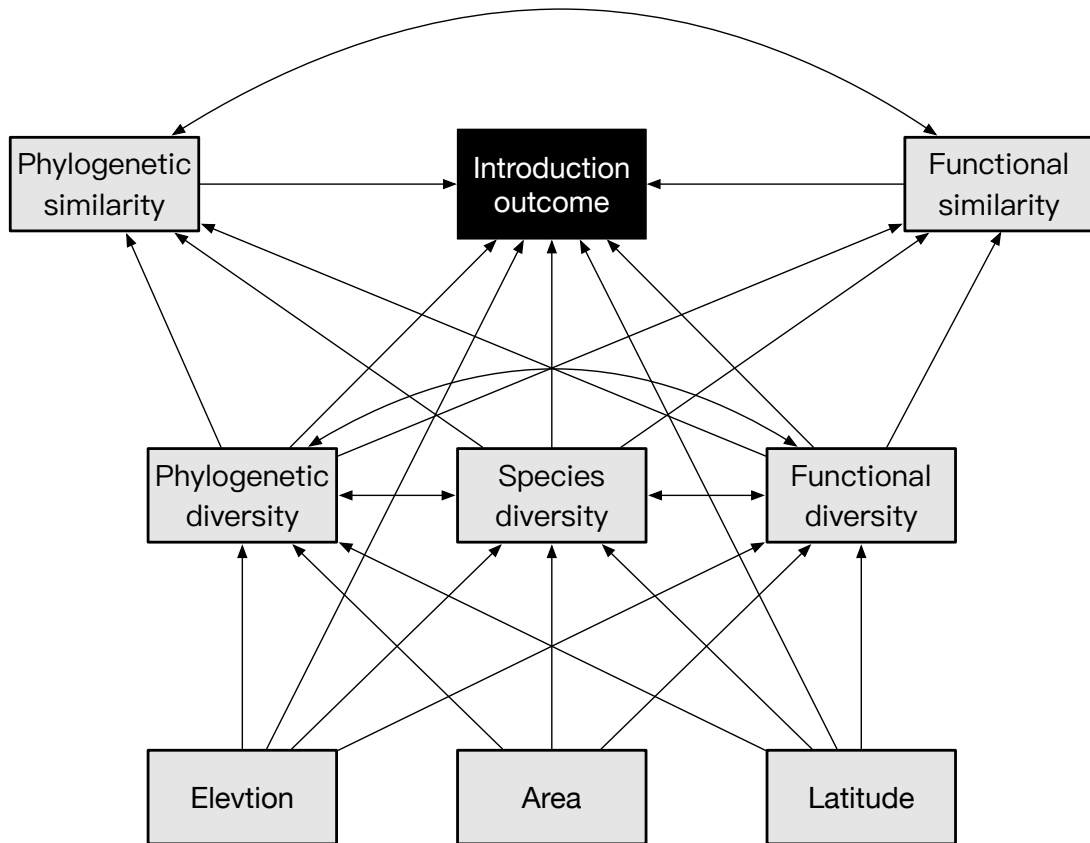


Figure S1. The initial model for structural equation modeling (SEM) exploring the effects of similarity, diversity, and geographical factors on the establishment of exotic fish species.

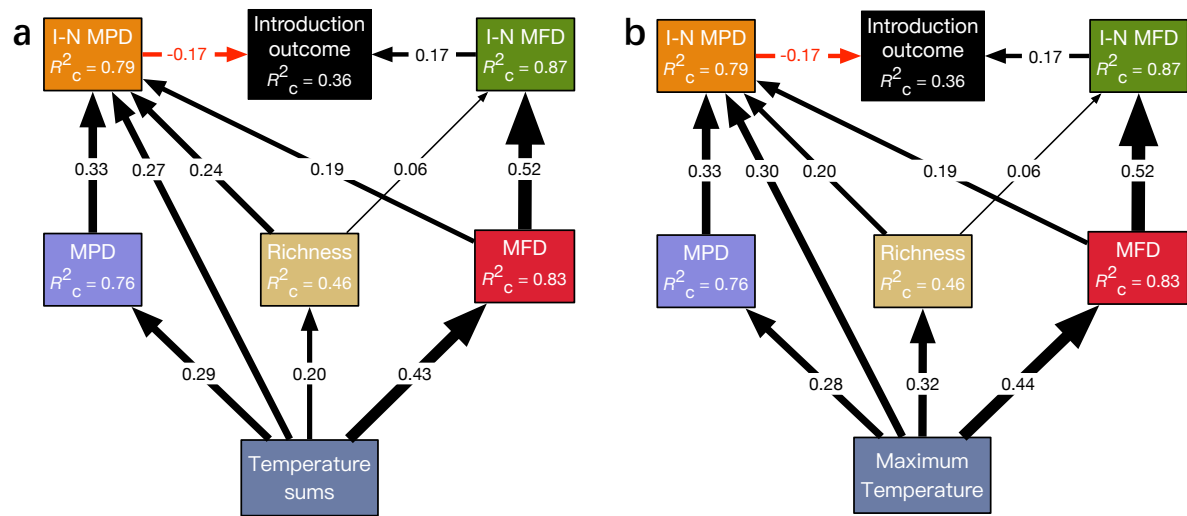


Figure S2. Structural equation modeling (SEM) exploring the effects of similarity, diversity on the establishment of exotic fish species considering the accumulated water temperature (a) and maximum water temperature (b). Both SEMs fit the data well (a: Fisher's $C = 0.083$, d.f. = 2, $P = 0.959$; $K = 38$, $n = 965$; b: Fisher's $C = 0.408$, d.f. = 2, $P = 0.816$; $K = 38$, $n = 965$). For clarity, only the significant paths ($P < 0.05$) are shown in the figures. Boxes represent measured variables and arrows represent relationships among variables. Black arrows denote positive relationships and red arrows negative ones. Standardized path coefficients are given for each significant path, the width of which is scaled by the magnitude of the standardized path coefficient. Conditional R_c^2 (based on both fixed and random effects) for each endogenous variable are reported in the corresponding boxes.