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Supplementary Information for

Species interactions limit the occurrence of urban-adapted birds in cities

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This PDF file includes:

- Supplementary text
- Figs. S1 to S14
- Tables S1 to S6
- References for SI reference citations
- Additional Acknowledgments
- List of the cities included in this study
- List of the bird species examined in this study
- Literature reviewed for behavioral dominance relationships
- References used for assessing breeding range overlap of cities

Other supplementary materials for this manuscript include the following:

Dataset and R code are available at the Dryad Digital Repository:
https://doi.org/10.5061/dryad.t85bf04

www.pnas.org/cgi/doi/10.1073/pnas.1809317115

Supplementary Text

Supplementary Methods and Results.

Selection of Species. In twelve cases, the youngest, phylogenetically-independent species comparisons involved more than two species. For example, *Melospiza melodia* is dominant to both *M. georgiana* and *M. lincolnii* (sister species) that are equally divergent from *M. melodia*. We have no data on dominance relationships between *M. georgiana* and *M. lincolnii*, so we included the three species (*M. melodia* dominant, *M. geogiana* and *M. lincolnii* subordinate) as one phylogenetically-independent comparison. For this reason, the 142 phylogenetically-independent comparisons in our study incorporate 296 species in total (rather than 284 species expected if each comparison represented only two species).

In two cases, multiple species pairs were not phylogenetically independent, and one species was both dominant and subordinate to two different species at equal genetic distances. In these two cases (*Falco*, *Sterna*), we included only the species pair with the most data (i.e., data from the most cities across both species in the species pair). We took this approach rather than including all of the data because one species could not be coded as both dominant and subordinate at the same time.

Phylogeny. We imported our maximum clade credibility tree into R using the R package *ape* (1), and exported the tree in Newick format for editing. Once exported, we made 3 edits. (i) We updated the names of species to match those of the International Ornithologists' Union (2) that we use in our dataset, necessary to match the data with branches in the phylogeny. (ii) One of the branch lengths in the phylogeny was negative and thus nonsensical (*Acrocephalus – Sylvia*/*Turdoides*). We changed this value to positive and adjusted the branch lengths immediately downstream so that all branches remained ultrametric. (iii) One of our focal species, *Corvus cornix*, was missing from ref. 3 because the taxonomy used in that source considered it to form one species with *C. corone*. Thus, we added *Corvus cornix* as the sister lineage to *C. corone* in our phylogeny (following ref. 4), and specified a branch length of 0.003 to reflect a divergence time on the order of a few thousand years (4). After these modifications, we imported the new phylogeny using *ape* (1) for use in our statistical analyses.

Spatial Autocorrelation. We tested for the effects of spatial autocorrelation in our analyses by calculating Moran's I values and their significance for [(rescaled breeding occurrence values - MCMCglmm model predicted values)/(standard deviation of rescaled breeding occurrence values)] using the R package *ncf* (5). We also plotted spatial autocorrelation by geographic distance between cities (correlograms) using the *spline.correlog* function in *ncf* (5) (Fig. S11). Moran's I values were significant, but very small and negative overall: main model (predictors = dominance * sympatry * urban-breeding propensity), correlation = -0.0012, P = 0.003; continent model (predictors = dominance * sympatry * urban-breeding propensity * continent), correlation = -0.0010, P = 0.002; economic development model (predictors = dominance * sympatry * urban-breeding propensity * economic development), correlation = -0.00087, P = 0.005. Correlograms, however, revealed significant, positive spatial autocorrelation at short distances between cities (clustering) (Fig. S11), particularly in the main model, and thus we ran additional models that incorporated spatial autocorrelation to test our hypotheses. We knew of no straightforward way to incorporate spatial autocorrelation into Bayesian generalized linear mixed models [MCMCglmms (6)], so we used generalized least squares (gls) models in the R package *nlme* (7) instead. We initially chose MCMCglmm models because alternatives (linear mixed-effects [lme] and gls models) did not fit our data well. Nonetheless, lme and gls models provided similar results to MCMCglmm models that did fit well, suggesting that any lack of fit did not overly influence the main results of lme/gls models.

We first compared the performance of gls models with the same predictor variables, but with different forms of spatial autocorrelation (Exponential, Gaussian, Spherical, Linear, Ratio), and compared these again to a linear mixed-effects model that did not incorporate spatial autocorrelation but included species pair as a random effect. All models used restricted maximum likelihood; we assessed model performance using Akaike Information Criterion (AIC) estimates. Models that incorporated exponential spatial autocorrelation performed best (lowest AIC; same result for our main model and models with continent and economic development), so we incorporated the exponential form into our subsequent gls tests.

We next re-ran our analyses using gls models incorporating exponential spatial autocorrelation. We first compared models with different combinations of variance heterogeneity with the goal of finding the best fit possible for each model (following ref. 8). We ran all combinations of variance heterogeneity (fixed effects were the same for all models) using restricted maximum likelihood and AIC values to identify the best-performing model for each analysis. We then tested the importance of the focal interaction term by comparing AIC values for models using maximum likelihood and differing only in the inclusion of the interaction term (our main effect). R code for these analyses are available from the Dryad Digital Repository: https://doi.org/10.5061/dryad.t85bf04.

Our analysis incorporating spatial autocorrelation revealed similar results (Table S5). The interaction between dominance, sympatry, and urban-breeding propensity improved the gls model controlling for spatial autocorrelation (ΔAIC = -12.5), with breeding occurrence varying as a function of behavioral dominance, sympatry, and urban-breeding propensity (3-way interaction, $P = 0.0001$). The interaction between our main effects and continent no longer improved model fit once spatial autocorrelation was included (ΔAIC = +0.4), as we expected given that continental effects reflected spatial clustering. In contrast, our main effects again varied as a function of economic development: dominant species had higher occurrence values in cities compared with closely-related subordinate species, but only when the species pair was sympatric, adapted to urban environments, and occurred in countries with developed economies ($P < 0.0001$) or countries in economic transition ($P = 0.029$). Among the alternative hypotheses to explain continental variation, only economic development improved model fit overall, and in an interaction with our main effect. All other predictor variables did not improve model fit (positive ΔAICs for all) when included in an interaction with our main effect in models incorporating spatial autocorrelation (Table S5). These results suggest that economic development was the only predictor to explain variation in our main effects beyond spatial clustering.

Dominance Data. Our dataset comprised 142 species pairs for which dominance relationships have been described in the literature. These included cases where we could reanalyze raw competitive interaction data (binomial tests of wins; $N = 76$ species pairs), cases where dominance was tested using statistical tests on the results of experiments (e.g., song playback experiments; $N = 4$ species pairs), and cases where the dominance relationship was described in the literature but the interaction data were not accessible for reanalysis ($N = 62$ species pairs). We had greater confidence in dominance relationships among species pairs for which we could statistically test for dominance asymmetries (i.e., where raw data were accessible, or where statistical tests of behaviors had already been performed). Thus, we retested our main findings using the subset of species pairs for which we had the highest confidence in dominance relationships ($N = 80$ species pairs), predicting that our main results should persist in this subset of our data.

Re-running our main analyses with this subset ($N = 80$ species pairs) yielded similar results. In allopatry, breeding occurrence values of dominant and subordinate congeners again did not differ as a function of their propensity to breed in cities [MCMCglmms; differences in linear slopes (subordinate relative to dominant) in allopatry, estimate = -0.096, 95% CI: -0.19, +0.0028, $P_{MCMC} = 0.054$]; in sympatry, however, urban-adapted dominant species were more widespread than subordinate congeners [differences in linear slopes (subordinate relative to dominant) in sympatry, estimate = -0.59, 95% CI: -0.69, -0.49, $P_{MCMC} < 0.0001$; Fig. S12]. This general pattern again depended on the level of a country's economic development (Fig. S13). In developed countries, breeding occurrence values of dominant and subordinate congeners did not differ as a function of urban adaptation in allopatry [difference in slopes (subordinate relative to dominant) in allopatry, linear component estimate = -3.63, 95% CI: -7.87, +0.50, $P_{MCMC} = 0.09$; polynomial component estimate = -2.36, 95% CI: -6.41, +1.73, $P_{MCMC} = 0.26$], while urban-adapted dominant species were more widespread than subordinate congeners in sympatry [difference in slopes (subordinate relative to dominant), linear component estimate = -18.39, 95% CI: -22.00, -14.76, $P_{MCMC} < 0.0001$; quadratic component estimate = -1.78, 95% CI: -5.35, +1.75, $P_{MCMC} = 0.32$; Fig. S13]. Countries in transition between developing and developed economies also showed no difference in occurrence between dominant and subordinate congeners as a function of their propensity to breed in urban habitats in allopatry [difference in slope (subordinate relative to dominant) in allopatry, linear component estimate = -3.69, 95% CI: -18.00, +10.48, $P_{MCMC} = 0.61$; quadratic component estimate = +4.65, 95% CI: -6.66, +15.57, $P_{MCMC} = 0.41$], while urban-adapted dominant species were more widespread than subordinate congeners in sympatry [difference in slopes (subordinate relative to dominant) in sympatry, linear component estimate = -13.79, 95% CI: -20.56, -7.08, $P_{MCMC} < 0.0001$; quadratic component estimate = +8.87, 95% CI: +2.10, +15.49, $P_{MCMC} = 0.009$; Fig. S13]. Analysis of data from developing countries showed no difference in occurrence between dominant and subordinate species as a function of urban adaptation in allopatry [difference in slopes (subordinate relative to dominant) in allopatry, linear component estimate = -0.83, 95% CI: -5.00, +3.28, $P_{MCMC} = 0.69$; quadratic component estimate = +3.66, 95% CI: -0.41, +7.66, $P_{MCMC} = 0.07$]; urban-adapted dominant species, however, were marginally more widespread than subordinate species in sympatry, although they showed no clear decline with increasing propensity to breed in cities [difference in slopes (subordinate relative to dominant) in sympatry, linear component estimate = -7.73, 95% CI: -14.08, -1.24, P_{MCMC} = 0.018; quadratic component estimate = +6.96, 95% CI: +0.74, +13.22, P_{MCMC} = 0.029; Fig. S13].

Cultural Bias. Different cultural backgrounds of our survey respondents could have influenced how they perceived and responded to our survey questions. Such cultural bias could have influenced our results, particularly the variation that we found among different levels of economic development. Accounting for potential cultural bias is difficult because some observers did not share the cultural background of the countries to which they responded. For example, professional bird guides raised or living in Western countries (e.g., USA, UK, Sweden) provided data on the breeding birds of some cities in developing countries (e.g., in South America, Asia, and Africa).

We expected cultural bias to have a more pronounced effect on subtler distinctions between occurrence that are more open to different interpretations (e.g., local versus widespread breeders), rather than simpler, unequivocal distinctions of presence versus absence. Thus, we reanalyzed variation in our main results with a country's economic development using a simplified dataset that included only presence or absence of species as breeders in cities. The results of this test were similar to the results of the main analysis (Fig. S14). In developed countries, breeding presence/absence of dominant and subordinate congeners again did not differ as a function of urban adaptation in allopatry [difference in slopes (subordinate relative to dominant) in allopatry, estimate = +0.23, 95% CI: -0.84, +1.31, P_{MCMC} = 0.67], but urban-adapted dominant species were more likely to be present than subordinate congeners in sympatry [difference in slopes (subordinate relative to dominant) in sympatry, estimate = -2.77, 95% CI: -3.62, -1.95,

$P_{MCMC} < 0.0001$; Fig. S14]. Developing countries showed no difference in presence/absence between dominant and subordinate species as a function of urban adaptation in allopatry [difference in slopes (subordinate relative to dominant) in allopatry, estimate = +0.39, 95% CI: -0.40, +1.23, $P_{MCMC} = 0.33$] or sympatry [difference in slopes (subordinate relative to dominant) in sympatry, estimate = -0.44, 95% CI: -1.44, +0.54, $P_{MCMC} = 0.37$; Fig. S14]. Countries in transition between developing and developed economies showed no difference in presence/absence between dominant and subordinate congeners as a function of their propensity to breed in urban habitats in allopatry [difference in slope (subordinate relative to dominant) in allopatry, estimate = -0.49, 95% CI: -2.35, +1.35, $P_{MCMC} = 0.61$], but showed patterns intermediate between developing and developed countries in sympatry [difference in slopes (subordinate relative to dominant) in sympatry, estimate = -1.32, 95% CI: -2.60, -0.056, $P_{MCMC} = 0.035$; Fig. S14].

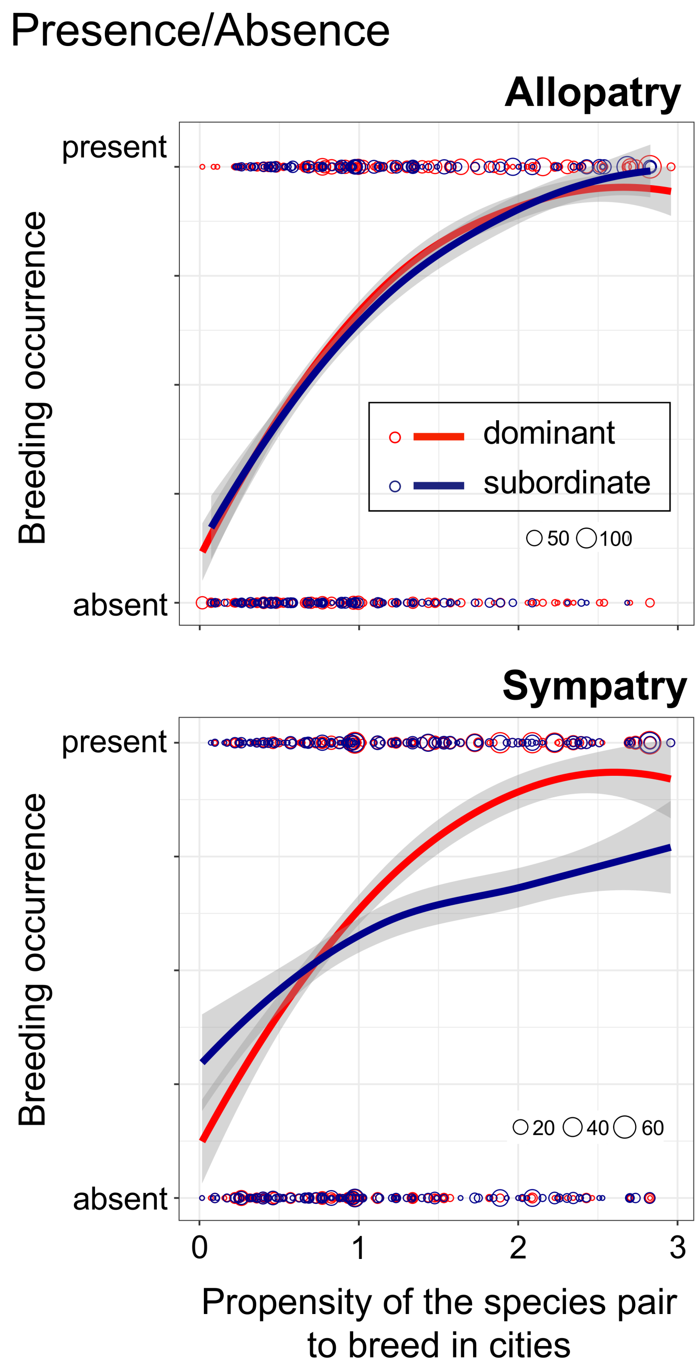

Fig. S1. Presence versus absence of birds breeding in urban habitats as a function of dominance status, range overlap, and propensity for species pairs to breed in cities. Breeding occurrence values greater than zero were categorized as “present” and zero values as “absent.” Upper panel shows data for allopatry (i.e., cities where focal dominant and subordinate congeners did not overlap their breeding ranges); bottom panel shows data for sympatry (i.e, cities where focal dominant and subordinate congeners overlapped breeding ranges). The effect of dominance depended on both sympatry and the propensity for species pairs to breed in cities

(Categorical [bivariate] MCMCglmm, $P_{MCMC} < 0.0001$). In allopatry, dominant and subordinate congeners did not consistently differ in their breeding occurrence values in urban habitat (Categorical MCMCglmm, difference in slopes, $P_{MCMC} = 0.22$). In sympatry, dominant species were more widespread than their subordinate congeners when species pairs had a high propensity to breed in cities (Categorical MCMCglmm, difference in slopes, $P_{MCMC} < 0.0001$). Lines (red = dominant species; blue = subordinate species) are loess splines (span = 1.5) with 95% confidence limits shown in gray. Point size reflects the number of overlapping points (see legend at bottom right of graphs).

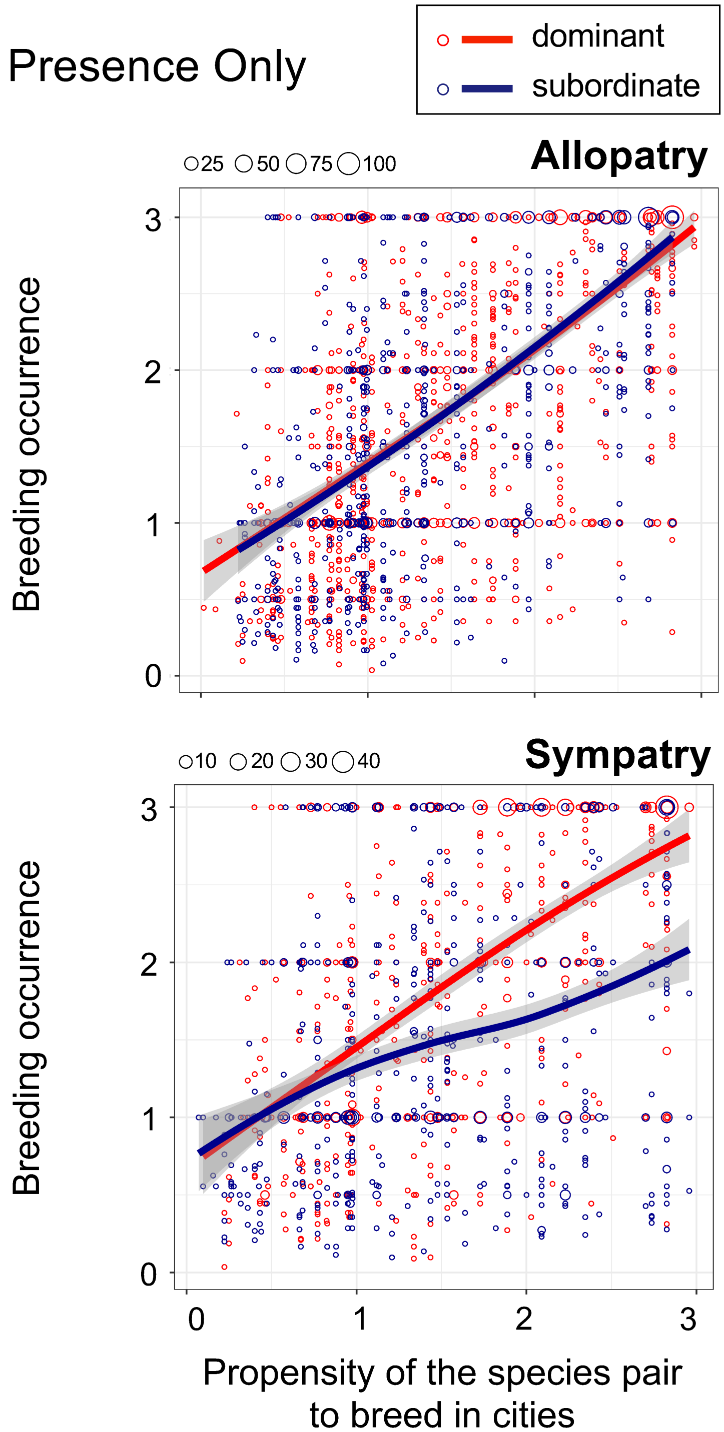

Fig. S2. Presence (only) of birds breeding in urban habitats as a function of dominance status, range overlap, and propensity for species pairs to breed in cities. Plots reflect breeding occurrence values restricted to cases were the species was present breeding in urban habitats (i.e, all zeros removed). Thus, for sympatric species, we included occurrence data for species that were present, even if their congener was absent (i.e., had a value of zero for occurrence, and thus was dropped). Upper panel shows data for allopatry (i.e., cities where focal dominant and subordinate congeners did not overlap their breeding ranges); bottom panel shows data for sympatry (i.e, cities where focal dominant and subordinate congeners overlapped breeding ranges). The effect of dominance depended on both sympatry and the propensity for species pairs to breed in cities (MCMCglmm, $P_{MCMC} < 0.0001$). In allopatry, dominant and subordinate congeners did not consistently differ in their breeding occurrence values in urban habitat (MCMCglmm, difference in slopes, $P_{MCMC} = 0.14$). In sympatry, dominant species were more widespread than their subordinate congeners when species pairs had a high propensity to breed in cities (MCMCglmm, difference in slopes, $P_{MCMC} < 0.0001$). Lines (red = dominant species; blue = subordinate species) are loess splines (span = 1.5) with 95% confidence limits shown in gray. Point size reflects the number of overlapping points (see legend at top left of graphs).

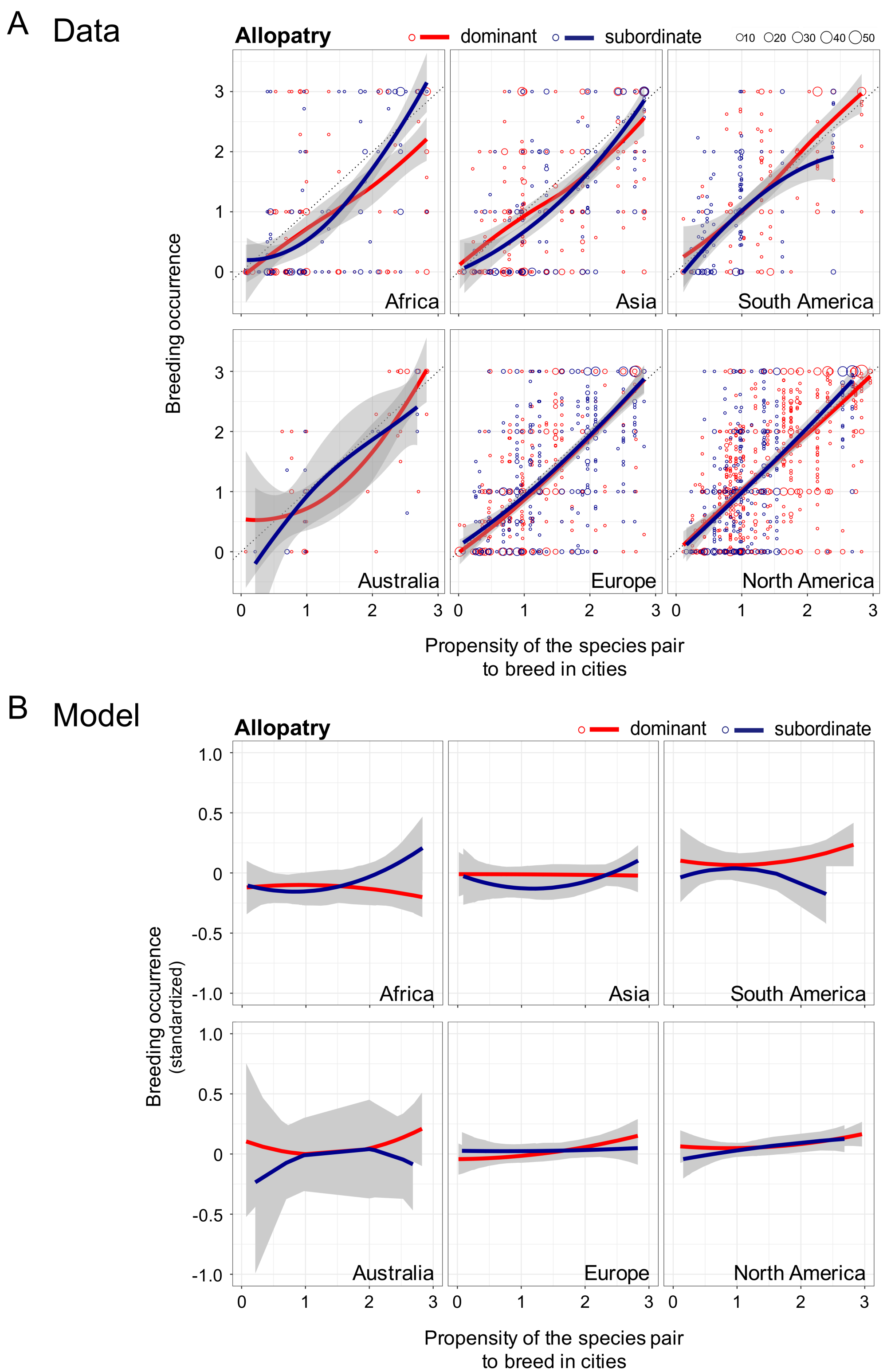

Fig. S3. Geographic variation in the urban-breeding occurrence of dominant and subordinate bird species in allopatry. Panels show only cases where dominant and subordinate species did not overlap their breeding ranges (allopatry). See Table S2 for statistical results. See caption of Fig. 2 in the main text for definitions of axes. Solid lines (red = dominant species; blue = subordinate species) are (*A*) loess splines (span = 1.5) with 95% confidence limits shown in gray, and (*B*) model predicted values with 95% confidence limits shown in gray from a MCMCglmm analysis. Slopes in (*B*) are flattened relative to slopes in (*A*) because statistical models in (*B*) incorporated standardized breeding occurrence values (y-axes) = [breeding occurrence value - mean(breeding occurrence for the species pair)] / [2 * standard deviation(breeding occurrence for the species pair)]. Point size in (*A*) reflects the number of overlapping points (see legend at top right of graph). Sample sizes (allopatry only): Africa, N = 328 points; Asia, N = 562; Australia, N = 62, Europe, N = 929; North America, N = 1,231; South America, N = 323. In our analysis, we included cities in New Zealand with Australia, and Central America and the Caribbean with North America.

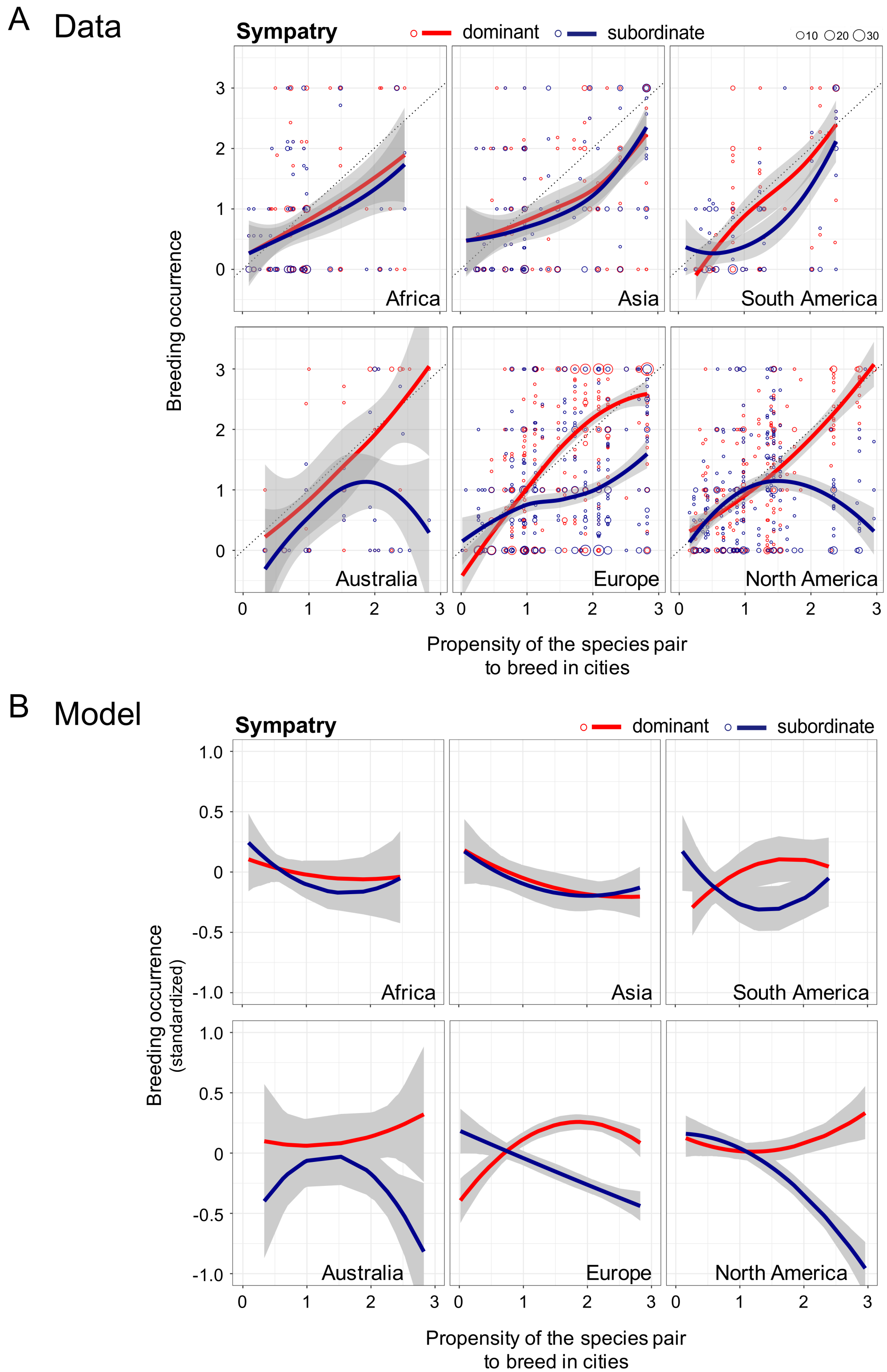

Fig. S4. Geographic variation in the urban-breeding occurrence of dominant and subordinate bird species in sympatry. Panels show only cases where dominant and subordinate species overlapped their breeding ranges (sympatry). See Table S2 for statistical results. See caption of Fig. 2 in the main text for definitions of axes. Solid lines (red = dominant species; blue = subordinate species) are (*A*) loess splines (span = 1.5) with 95% confidence limits shown in gray, and (*B*) model predicted values with 95% confidence limits shown in gray from a MCMCglmm analysis. Slopes in (*B*) are flattened relative to slopes in (*A*) because statistical models in (*B*) incorporated standardized breeding occurrence values (y-axes) = [breeding occurrence value - mean(breeding occurrence for the species pair)] / [2 * standard deviation(breeding occurrence for the species pair)]. Point size in (*A*) reflects the number of overlapping points (see legend at top right of graph). Sample sizes (sympatry only): Africa, N = 218 points; Asia, N = 276; Australia, N = 74, Europe, N = 874; North America, N = 577; South America, N = 174. In our analysis, we included cities in New Zealand with Australia, and Central America and the Caribbean with North America.

Urban breeding birds - Toronto

Urban breeding birds of Toronto, Ontario, Canada

Please indicate which bird species (listed below) **breed every year in urban habitats** within the city limits of **Toronto**. Note that we are only interested in **breeding**; please do not select "yes" if the species only winters, migrates through, or visits, but does not breed, in your city.

Please note that **not all** urban breeding species are listed (only the focal species that we are studying), and many of the species listed may not breed in urban habitats.

"Urban habitats" include urban parks and ponds, and industrial, commercial, residential, and suburban areas, in addition to the downtown core, but **do not** include natural areas within the city (for example, wildlife preserves, conservation areas, or isolated patches of natural habitat).

If species have undergone a major decline recently (for example, Asian vultures, some aerial insectivores), please record the historical breeding status in your city.

All responses are anonymous; however, your are welcome to leave your name in the "Comments" section at the end. Responses are limited to one response per city per device. For more information on this study and links to surveys for other cities, please click here.

[Taxonomy and order follow the International Ornithological Congress, World Bird List (version 6.2) http://dx.doi.org/10.14344/IOC.ML.6.2]

1. Mute Swan, *Cygnus olor*

- ◯ **yes** - this species is a **widespread** breeder in urban habitats across the city
- ◯ **yes** - this species is a **local** breeder in urban habitats in the city, found in only a few locations
- ◯ **yes** - this species is **somewhere in between** a local and widespread breeder in urban habitats in the city
- ◯ **no** - this species does not breed in urban habitats in the city
- ◯ **not sure**

2. Trumpeter Swan, *Cygnus buccinator*

- ◯ **yes** - this species is a **widespread** breeder in urban habitats across the city
- ◯ **yes** - this species is a **local** breeder in urban habitats in the city, found in only a few locations
- ◯ **yes** - this species is **somewhere in between** a local and widespread breeder in urban habitats in the city
- ◯ **no** - this species does not breed in urban habitats in the city
- ◯ **not sure**

68. Northern Cardinal, *Cardinalis cardinalis*

- **yes** - this species is a **widespread** breeder in urban habitats across the city
- **yes** - this species is a **local** breeder in urban habitats in the city, found in only a few locations
- **yes** - this species is **somewhere in between** a local and widespread breeder in urban habitats in the city
- **no** - this species does not breed in urban habitats in the city
- **not sure**

69. Please rate your knowledge of the breeding birds of Toronto from 1 (you know the city's birds a little bit) to 5 (you know the city's birds very well).

1. I know the city's birds a little bit.	2.	3. I know the city's birds moderately well.	4.	5. I know the city's birds very well.
○	○	○	○	○

70. Please include any additional comments here (optional).

If you would like to hear about the results of this study, please leave your contact information. Note that the study may take a year or two to complete. Thank you!!

Fig. S5. An example of one of our surveys (Toronto, Canada). For brevity, we show only the first and last pages. The intervening pages included other bird species whose breeding ranges overlap Toronto.

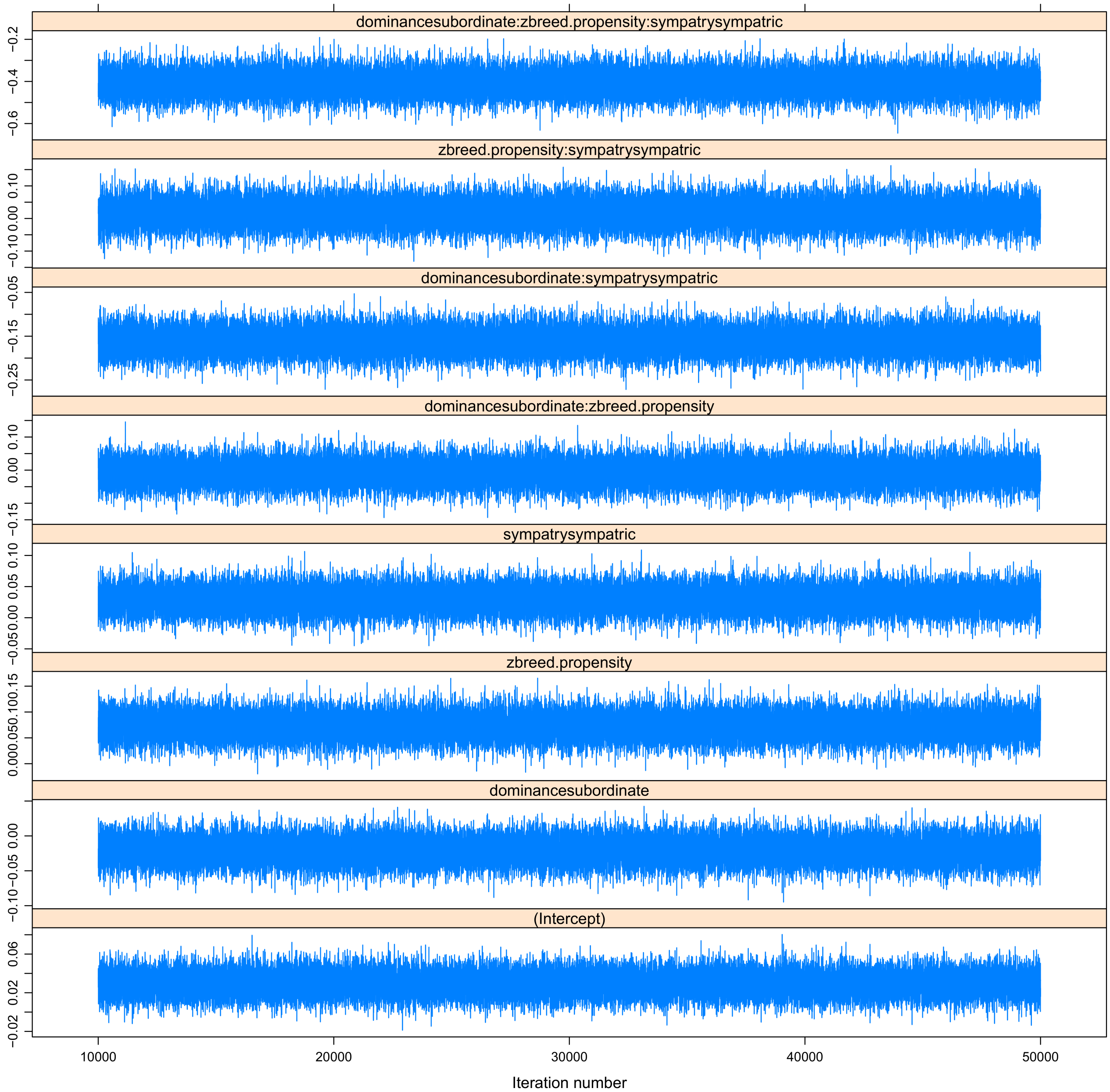

Fig. S6. Trace plots for fixed factors in our main MCMCglmm analysis. See Table S6 for additional diagnostics.

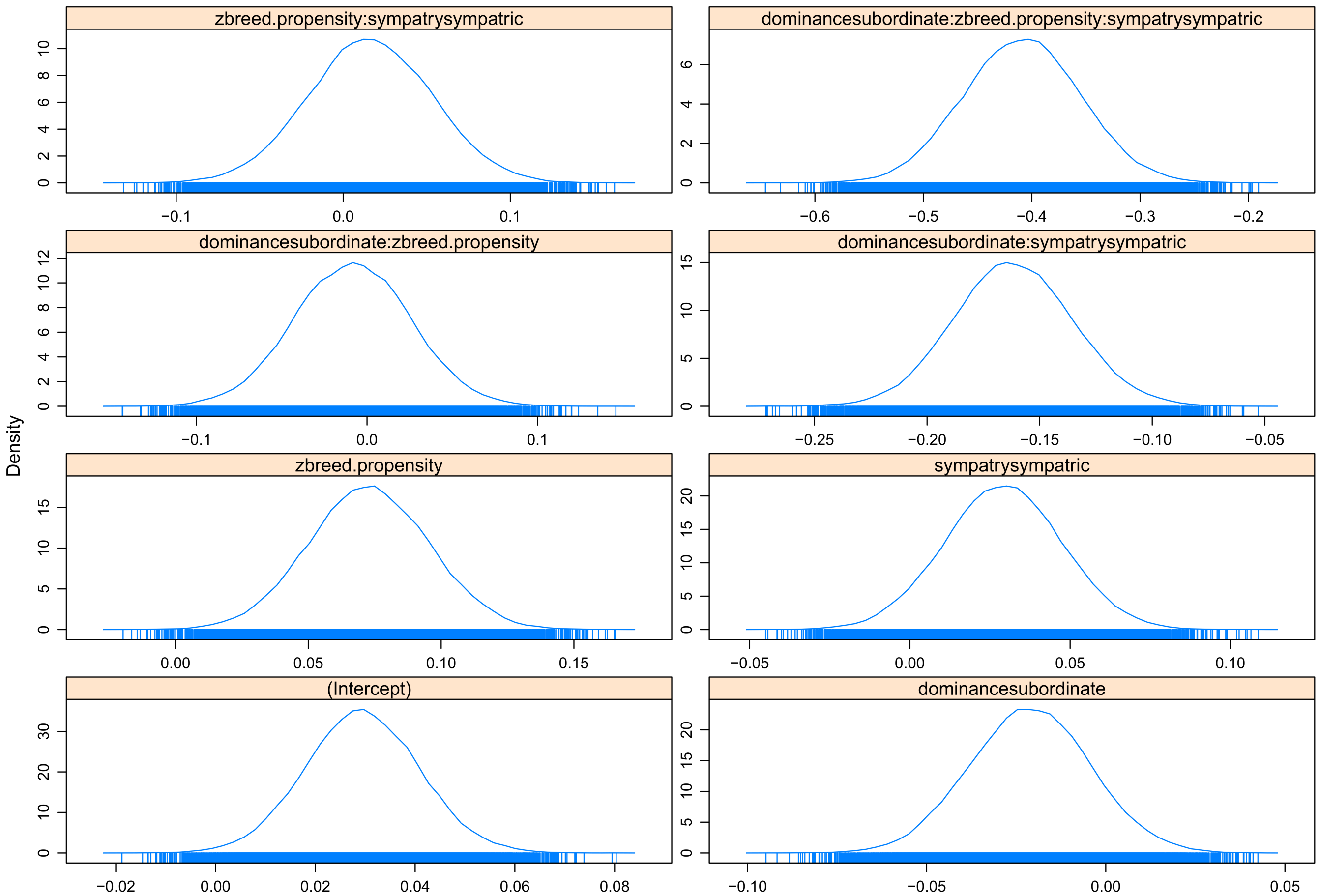

Fig. S7. Density plots for fixed factors in our main MCMCglmm analysis. See Table S6 for additional diagnostics.

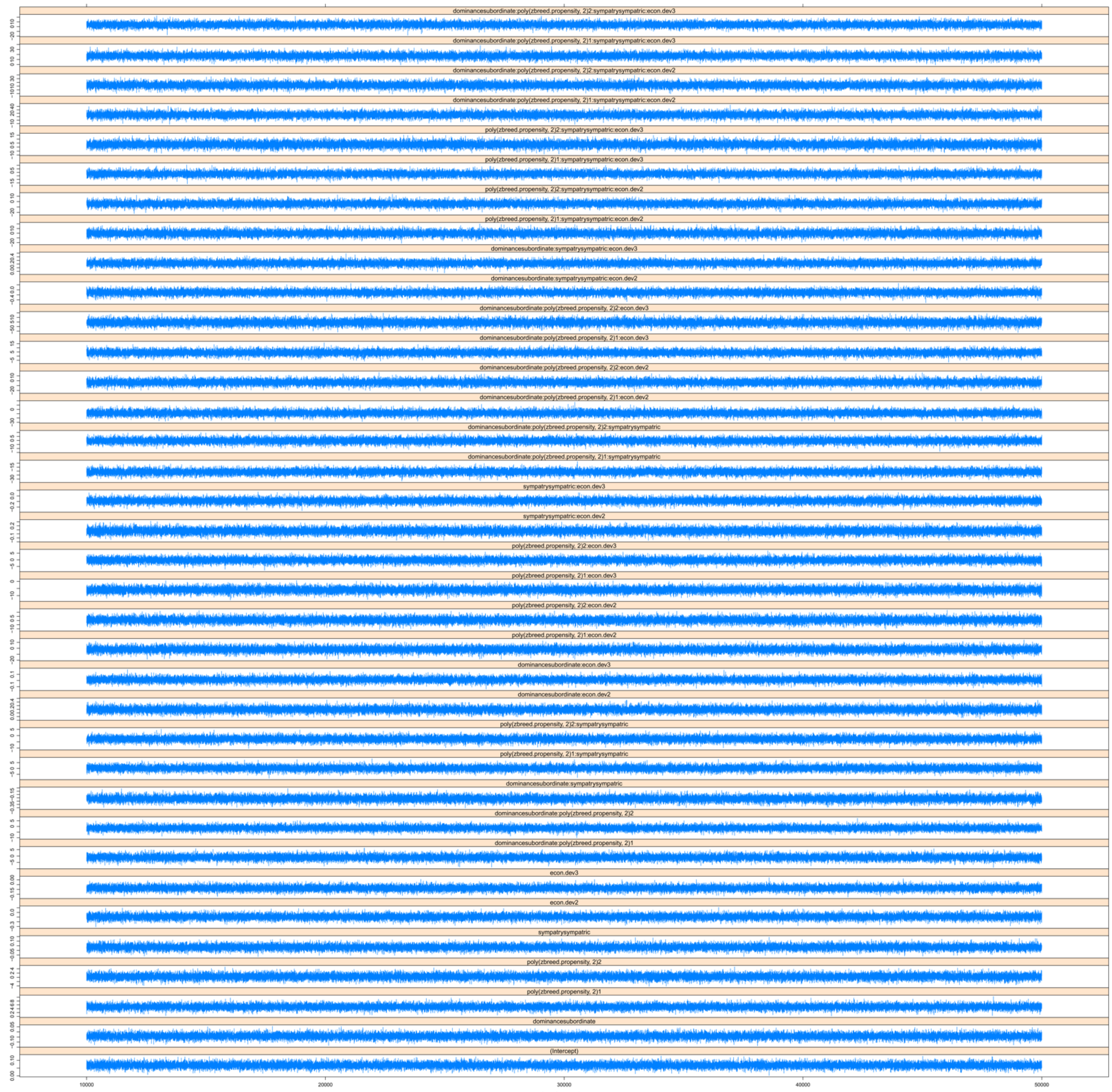

Fig. S8. Trace plots for fixed factors in our MCMCglmm analysis with economic development. See Table S6 for additional diagnostics.

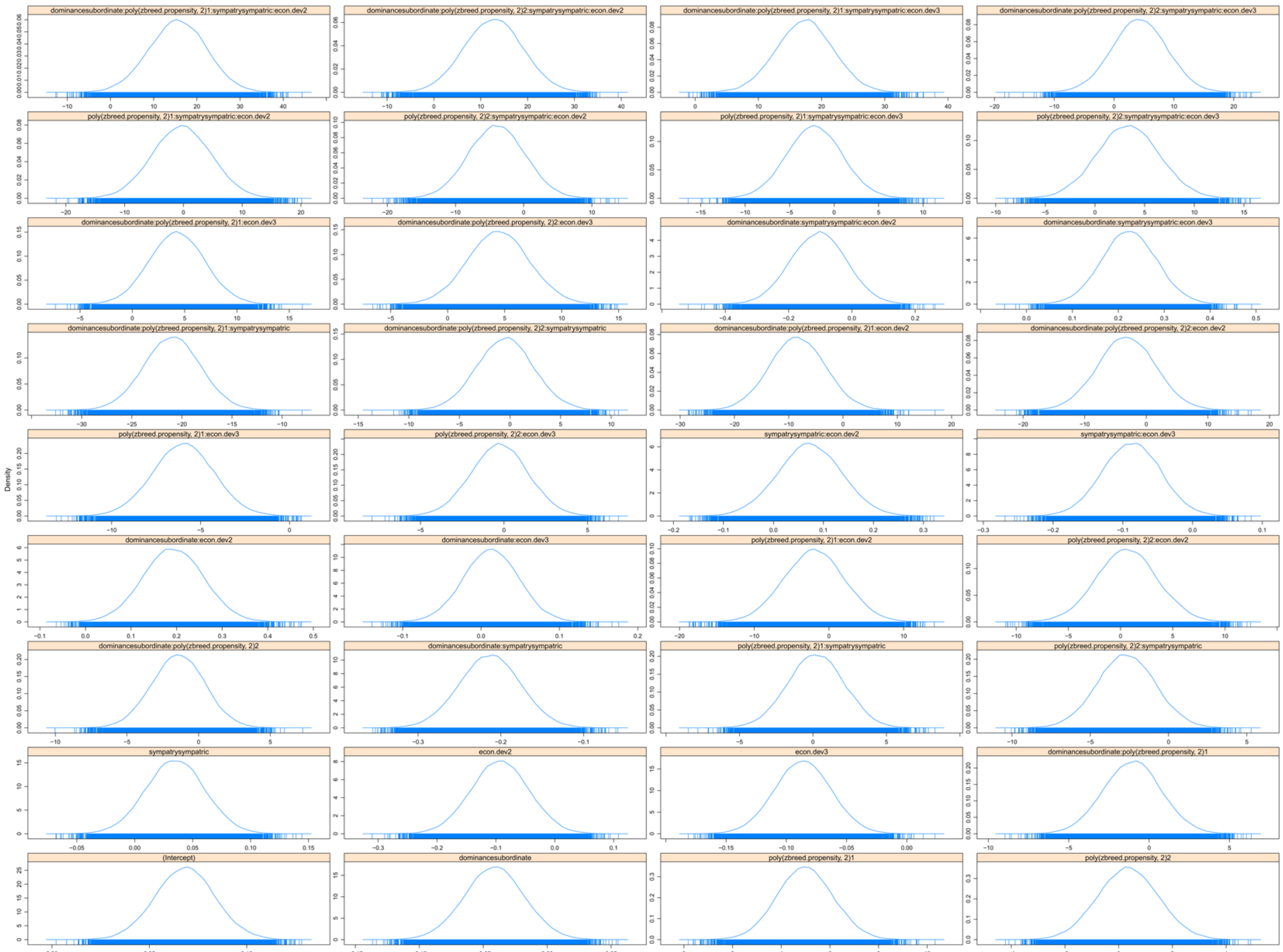

Fig. S9. Density plots for fixed factors in our MCMCglmm analysis with economic development. See Table S6 for additional diagnostics.

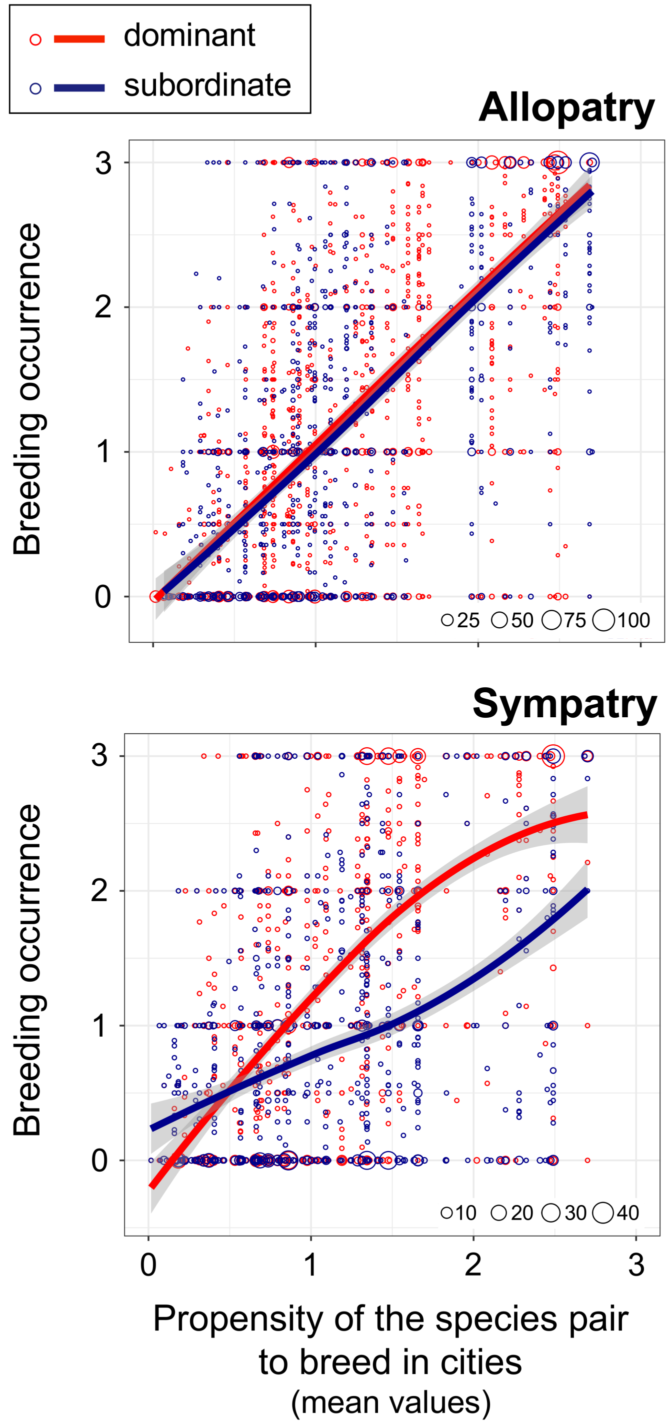

Fig. S10. Test of hypotheses for how competitive dominance influences breeding occurrence of birds in cities as a function of the propensity for species pairs to breed in cities, with propensity calculated using mean rather than maximum occurrence values. The effect of dominance depended on both sympatry and the propensity for species pairs to breed in cities (MCMCglmm, $P_{MCMC} < 0.0001$). In allopatry, breeding occurrence values of dominant and subordinate congeners did not differ (MCMCglmm, difference in slopes, $P_{MCMC} = 0.90$). In sympatry, dominant species were more widespread than subordinate congeners when species pairs had a high propensity to breed in cities (MCMCglmm, difference in slopes, $P_{MCMC} < 0.0001$). Each point in the figures represents the breeding occurrence of one species in one city (allopatry, $N = 3{,}425$; sympatry, $N = 2{,}193$); point size reflects the number of overlapping points (see legend at bottom right of graphs). Solid lines (red = dominants; blue = subordinates) are loess splines (span = 1.5) with 95% confidence limits shown in gray. Breeding occurrence values are means for each species in each city (averaged across observers, weighted by observer ability), and range from 0 (absent from urban habitats) to 3 (widespread breeder in urban habitats). The propensity to breed in cities was calculated for each paired dominant and subordinate species (one value for each pair) as the mean (rather than maximum, which was used in the main analyses) breeding occurrence value within a species pair for each city, averaged across all focal cities that overlapped their breeding ranges.

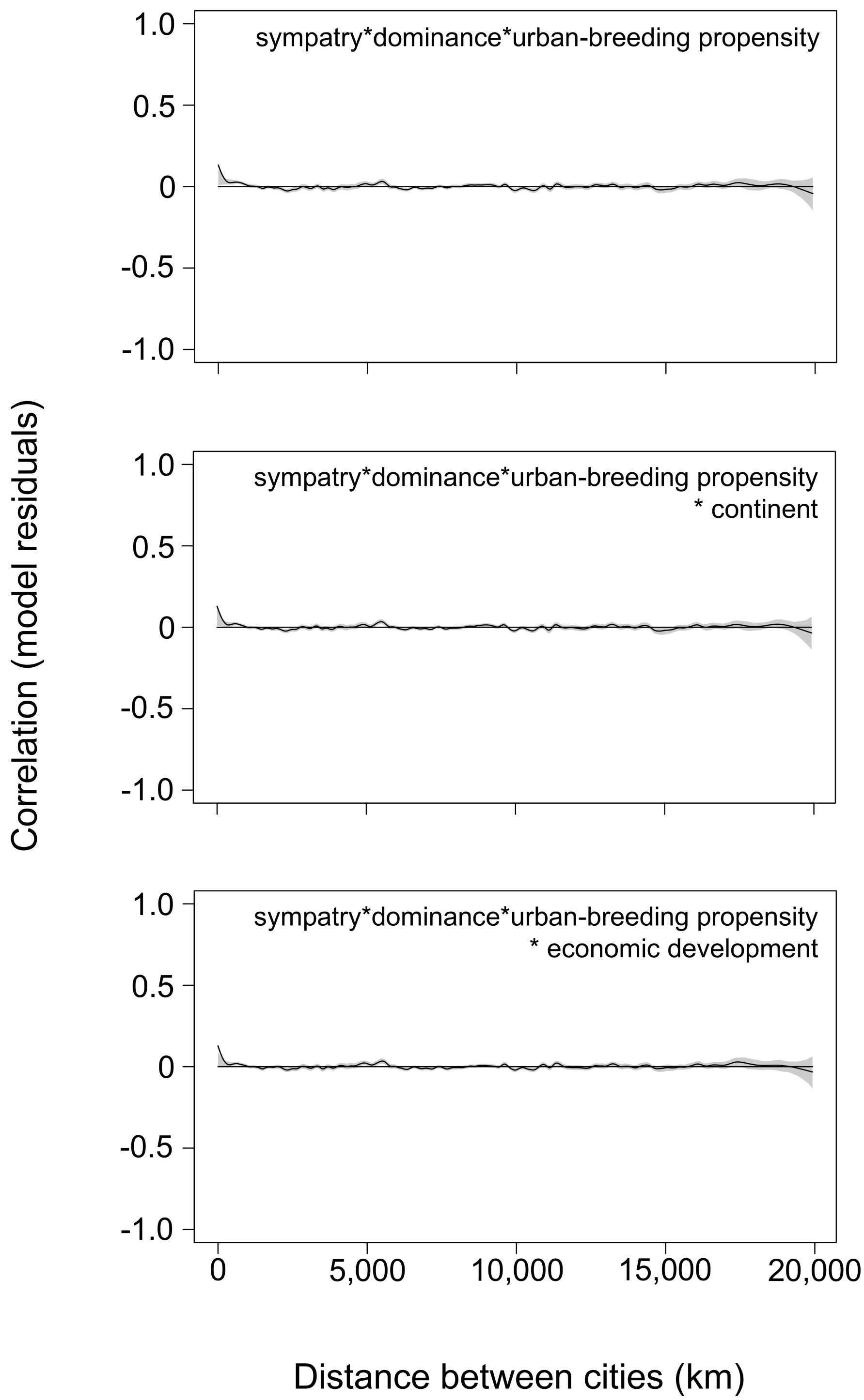

Fig. S11. Spatial autocorrelation in residuals from our main analyses. Plots illustrate spatial variation in correlations (95% bootstrap confidence limits in gray) of residuals [(rescaled breeding occurrence values - model predicted values) / (standard deviation of rescaled breeding occurrence values)] for our main model with the three-way interaction of dominance, sympatry, and urban-breeding propensity (top), and the four-way interactions between these terms and continent (middle) or economic development (bottom).

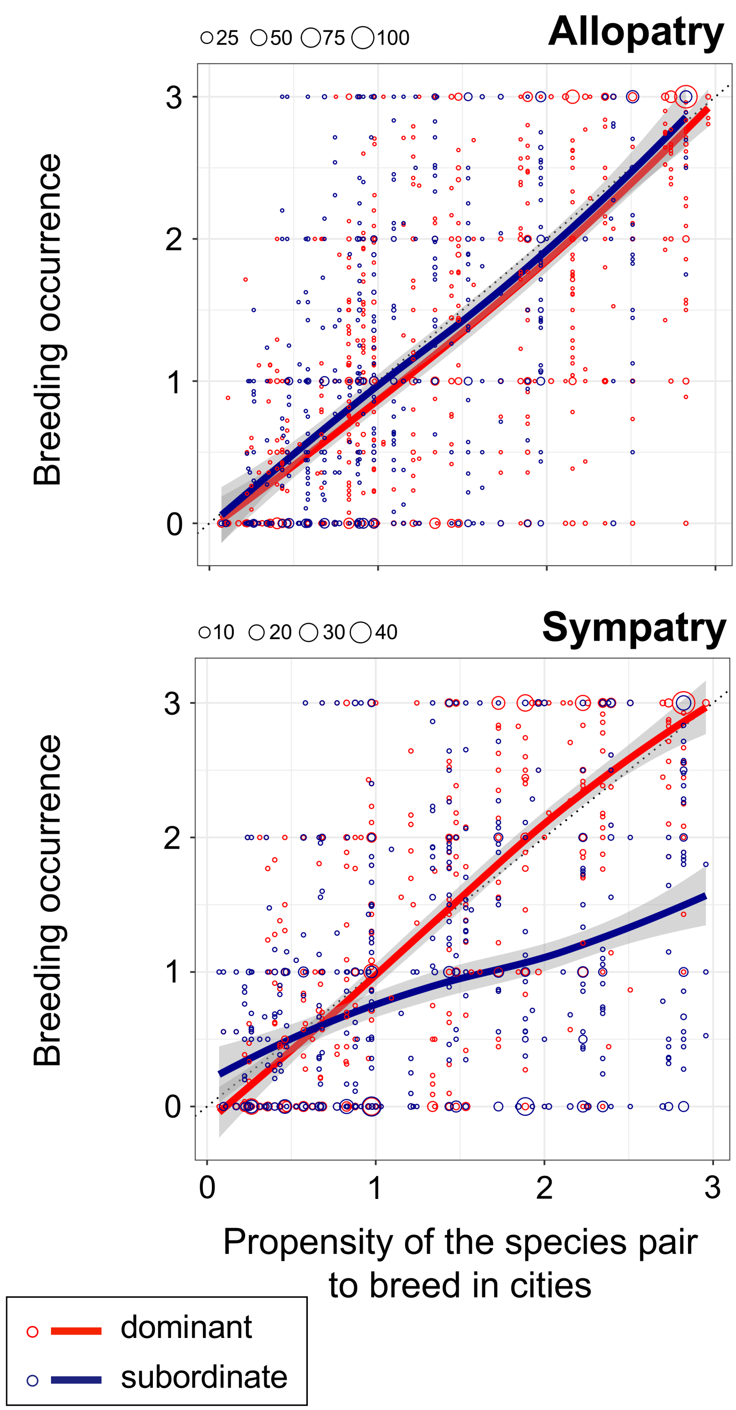

Fig. S12. Variation in the urban-breeding occurrence of dominant and subordinate bird species as a function of their propensity to breed in cities, restricted to the subset of species pairs for which quantitative data used to determine behavioral dominance were accessible (N = 80 species pairs). In allopatry, breeding occurrence values of dominant and subordinate congeners did not differ (MCMCglmm, difference in slopes, $P_{MCMC} = 0.053$). In sympatry, dominant species were more widespread than subordinate congeners when species pairs had a high propensity to breed in cities (MCMCglmm, difference in slopes, $P_{MCMC} < 0.0001$). Each point in the figures represents the breeding occurrence of one species in one city (allopatry, *N* = 1,767; sympatry, *N* = 1,342); point size reflects the number of overlapping points (see legend at top left of graphs). Solid lines (red = dominant species; blue = subordinate species) are loess splines (span = 1.5) with 95% confidence limits shown in gray. Breeding occurrence values are means for each species in each city (averaged across observers, weighted by observer ability), and range from 0 (absent from urban habitats) to 3 (widespread breeder in urban habitats). Propensity to breed in cities was calculated for each paired dominant and subordinate species as the maximum breeding occurrence within a species pair for each city, averaged across all focal cities that overlapped their breeding ranges (one value per species pair; same value for sympatry and allopatry). See *Supplementary Methods and Results* for statistical results.

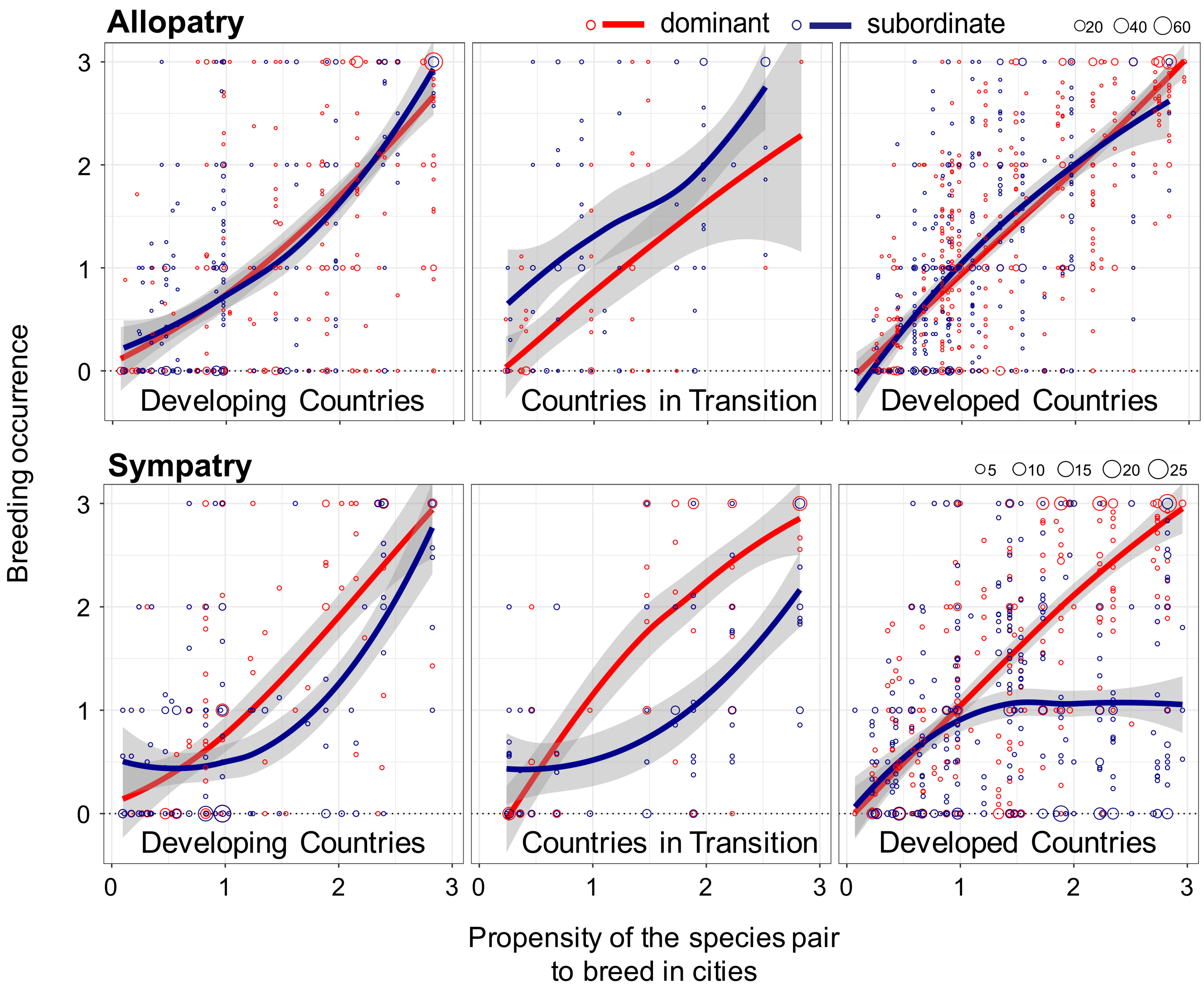

Fig. S13. Variation in the urban-breeding occurrence of dominant and subordinate bird species across levels of economic development, restricted to the subset of species pairs for which quantitative data on behavioral dominance were accessible (*N* = 80 species pairs). Economic development categorization follows country-level designations of the United Nations from 2014. Solid lines (red = dominant species; blue = subordinate species) are loess splines (span = 1.5) with 95% confidence limits shown in gray. Point size reflects the number of overlapping points (see legend at top right of graphs). See caption of Fig. 2 in the main text for definitions of axes. In allopatry, linear slopes for dominant and subordinate species did not differ in developed, in-transition, or developing countries (MCMCglmm, difference in linear slopes, $P_{MCMC} > 0.05$). In sympatry, linear slopes for dominant and subordinate species differed in developed ($P_{MCMC} < 0.0001$) and in-transition countries ($P_{MCMC} < 0.0001$), but less so in developing countries ($P_{MCMC} = 0.02$). Sample sizes, allopatry: developed $N = 974$, in transition $N = 160$, developing $N = 633$; sympatry: developed $N = 821$, in transition $N = 182$, developing $N = 339$. See *Supplementary Methods and Results* for statistical results.

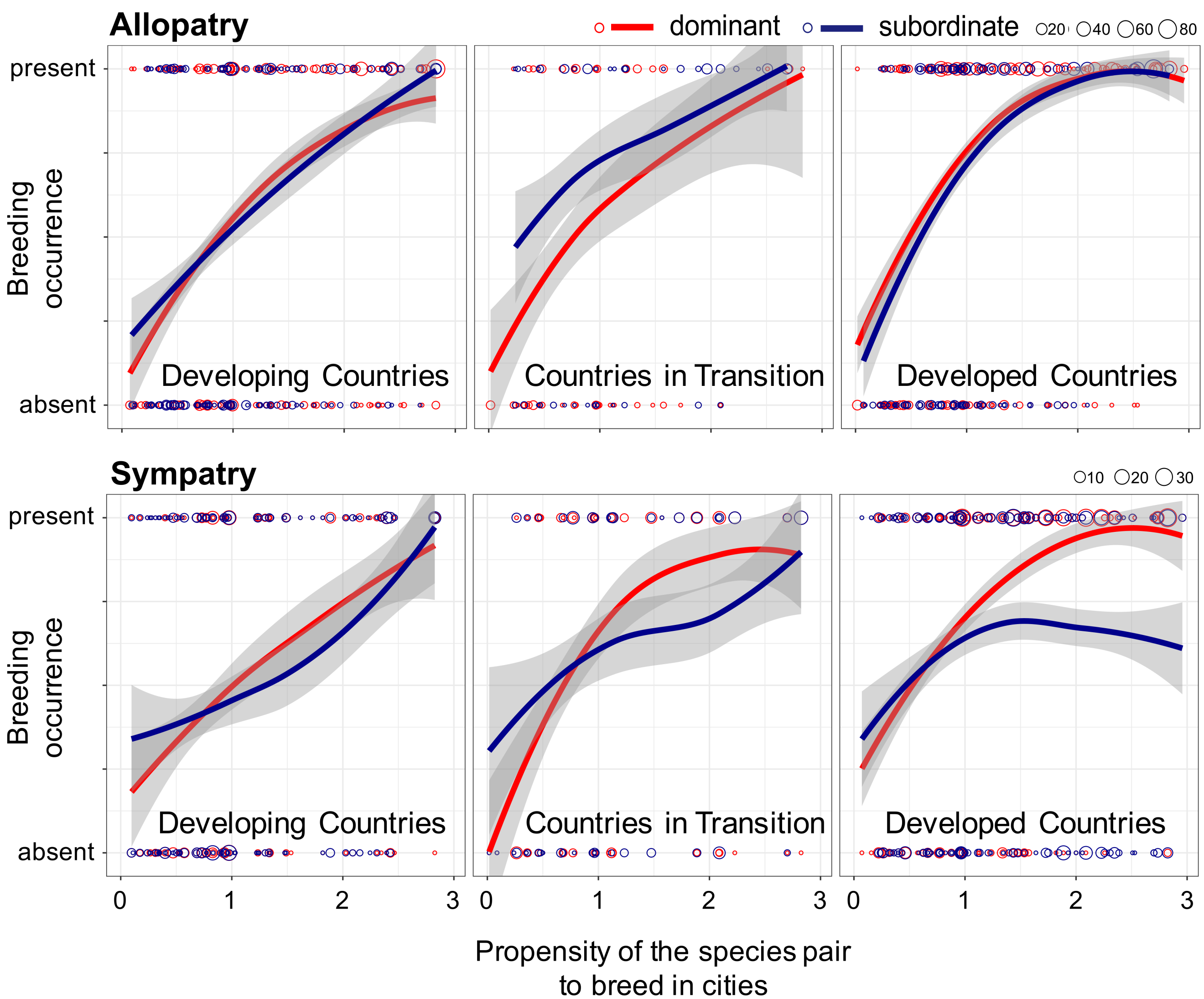

Fig. S14. Variation in the presence versus absence of urban-breeding dominant and subordinate bird species across levels of economic development. Economic development categorization follows country-level designations of the United Nations from 2014. Solid lines (red = dominant species; blue = subordinate species) are loess splines (span = 1.5) with 95% confidence limits shown in gray. Point size reflects the number of overlapping points (see legend at top right of graphs). See caption of Fig. 2 in the main text for definitions of axes. In allopatry, linear slopes for dominant and subordinate species did not differ in developed, in-transition, or developing countries (Categorical MCMCglmm, difference in linear slopes, $P_{MCMC} > 0.10$). In sympatry, linear slopes for dominant and subordinate species differed in developed ($P_{MCMC} < 0.0001$) and in-transition countries ($P_{MCMC} = 0.035$), but not developing countries ($P_{MCMC} = 0.37$). Sample sizes, allopatry: developed $N = 1{,}803$, in transition $N = 303$, developing $N = 1{,}329$; sympatry: developed $N = 1{,}184$, in transition $N = 370$, developing $N = 639$. See *Supplementary Methods and Results* for statistical results.

Table S1. Results and model performance before and after accounting for phylogeny in our analyses[1]. We accounted for phylogeny in two ways: (*A*) incorporating the phylogeny of our focal species into the analysis as a random factor, and (*B*) including taxonomic order as a fixed factor in a saturated model with dominance, urban-breeding propensity, and sympatry as other predictors.

(*A*) Phylogeny as a Random Factor	**Saturated model**	**3-way interaction[2] removed**	**3-way interaction[2] contribution**
	DIC[3]	**DIC[3]**	**Δ DIC[4]**
Main effect[5] (phylogeny not included as a random factor)	7,823.1	7,878.0	**-54.90**
Main effect[5] (phylogeny included as a random factor)	7,817.6	7,871.8	**-54.24**

(*B*) Taxonomic Order as a Fixed Factor	**Saturated model (with taxonomic order)**	**4-way interaction[6] removed**	**4-way interaction[6] contribution**
	DIC[3]	**DIC[3]**	**Δ DIC[4]**
Taxonomic order (all orders included)	7,802.4	7,795.2	+7.24
Taxonomic order (orders with <3 species pairs removed)	7,207.0	7,200.2	+6.73

[1] response variable = breeding occurrence value for each species in each city = average across observers, weighted by the observer's self-reported ability (*N* = 5,618); random factor = phylogenetically-independent species pair

[2] 3-way interaction term = dominance : urban-breeding propensity : sympatry

[3] DIC = Deviance Information Criterion; lower values denote better model performance

[4] negative values denote an improvement on the model

[5] main effect: the effect of dominance depended on urban-breeding propensity and sympatry (3-way interaction term)

[6] 4-way interaction term = dominance : urban-breeding propensity : sympatry : taxonomic order

Table S2. Results and model performance after accounting for geographic variation across continents[1]. We accounted for geographic variation by including continent as a fixed factor in a saturated model with dominance, urban-breeding propensity, and sympatry as other predictors. (*A*) Model performance when continent was included as an interaction term with our main effects (saturated model), and when the 4-way interaction term was removed. (*B*) Estimates (slopes for subordinate species relative to dominants) and P_{MCMC} values for tests of the difference in slopes between dominant and subordinate species in allopatry (Fig. S3) and sympatry (Fig. S4) for each continent.

(*A*) Continent as a Fixed Factor[2]	**Saturated model (with continent)**	**4-way interaction[3] removed**	**4-way interaction[3] contribution**
	DIC[4]	**DIC[4]**	**Δ DIC[5]**
Continent	7,755.5	7,775.5	**-20.02**

(*B*) Model Results with Continent Included (Saturated Model)	**Linear component**			**Quadratic component**		
	Estimate[6]	**95% confidence intervals**	P_{MCMC}	**Estimate[6]**	**95% confidence intervals**	P_{MCMC}
Allopatry						
Africa	9.72	+1.96, +17.43	0.013	5.05	-3.39, +13.62	0.25
Asia	3.95	-2.15, +9.93	0.20	3.69	-2.30, +9.64	0.23
Australia	-1.16	-19.67, +18.60	0.90	-9.29	-34.02, +15.75	0.47
Europe	-3.83	-8.79, +1.12	0.13	-0.70	-5.40, +4.05	0.77
North America	1.61	-3.09, +6.26	0.49	-1.59	-6.35, +3.32	0.52
South America	-10.58	-21.94, +0.81	0.07	-6.51	-15.86, +3.04	0.18

Sympatry						
Africa	0.18	-17.81, +18.39	0.98	5.26	-7.82, +17.78	0.42
Asia	2.22	-5.65, +10.27	0.58	1.67	-6.44, +9.74	0.69
Australia	-13.33	-31.95, +5.90	0.17	-18.96	-41.55, +2.91	0.096
Europe	-20.28	-25.16, -15.25	< 0.0001	8.20	+3.35, +12.91	0.0009
North America	-27.50	-33.91, -20.74	< 0.0001	-9.90	-15.73, -4.03	0.0011
South America	-0.96	-14.63, +12.86	0.89	19.34	+3.50, +34.36	0.015

[1] response variable = breeding occurrence value for each species in each city = average across observers, weighted by the observer's self-reported ability (N = 5,618); random factor = phylogenetically-independent species pair

[2] main effect: the effect of dominance depended on urban-breeding propensity and sympatry (3-way interaction term)

[3] 4-way interaction term = dominance : urban-breeding propensity : sympatry : continent

[4] DIC = Deviance Information Criterion; lower values denote better model performance

[5] negative values denote an improvement on the model

[6] estimate describes the slope of the subordinate relative to the dominant, where x=urban-breeding propensity and y=breeding occurrence

Table S3. Comparisons of model performance for candidate factors to explain geographic variation in our main result[1]. Each candidate factor was included as a predictor variable in saturated models with dominance, urban-breeding propensity, and sympatry. The influence of candidate factors on our main result was assessed by comparing saturated models with the candidate factor to the saturated model with continent identity, as well as by dropping the 4-way interaction and comparing the saturated model with the model with the 4-way interaction removed. We used the Deviance Information Criterion values (DIC) to assess model performance for all comparisons. We also assessed the influence of candidate factors in models by dropping them completely from the model, and comparing DIC between the saturated model and the model with the candidate factor removed.

Candidate Factor[2]	**Saturated model (with factor)**	**4-way interaction removed**	**4-way interaction contribution**	**Candidate factor contribution[3]**
	DIC[4]	**DIC[4]**	**Δ DIC[5]**	**Δ DIC[5]**
Continent	**7,755.5**	**7,775.5**	**-20.0**	**-67.5**
Continent (with full phylogeny added as a random effect)	7,748.5	7,768.4	-19.9	-74.5
Economic development (country)	**7,731.2**	**7,743.1**	**-11.9**	**-91.8**
Continent peripheral to where dominance data collected?	7,767.1	7,765.7	+1.5	-55.9
Average annual temperature (degrees C) (city)	7,770.5	7,775.0	-4.5	-52.5
Absolute latitude (decimal degrees) (city)	7,772.8	7,775.2	-2.4	-50.2
Number of species (city)	7,788.2	7,792.4	-4.2	-34.8
Taxonomic order	7,802.1	7,795.2	+6.9	-20.9
Net primary productivity (g/m^2/year) (city)	7,810.4	7,811.3	-0.9	-12.6
Number of sympatric, urban-adapted species (city)	7,814.0	7,812.3	+1.7	-9.0
Number of observers (city)	7,814.1	7,812.8	+1.3	-8.9
Continent peripheral to species range centroid?	7,826.4	7,825.3	+1.0	+3.4
Human population size (city)	7,827.3	7,828.3	-1.1	+4.2
Average ability of observers (city)	7,829.9	7,830.6	-0.7	+6.9

[1] response variable = breeding occurrence value for each species in each city = average across observers, weighted by the observer's self-reported ability (*N* = 5,618); random factor = phylogenetically-independent species pair

[2] see Methods for definitions and sources of data for candidate factors

[3] DIC for the models with only dominance, propensity to breed in urban habitats, and sympatry was 7,823

[4] DIC = Deviance Information Criterion; lower values denote better model performance

[5] negative values denote an improvement to the model

Table S4. Results and model performance after accounting for a country's level of economic development[1]. Economic development categorization follows country-level designations of the United Nations from 2014. We included economic development as a fixed factor in a saturated model with dominance, urban-breeding propensity, and sympatry as other predictors. Table provides estimates and P_{MCMC} values for tests of the difference in slopes between dominant and subordinate species in allopatry and sympatry (Fig. 3).

Economic Development[2]	Linear component			Quadratic component		
	Estimate[3]	95% confidence intervals	P_{MCMC}	Estimate[3]	95% confidence intervals	P_{MCMC}
Allopatry						
Developed	-1.04	-4.62, +2.45	0.56	-1.43	-5.06, +2.19	0.44
In transition	-9.42	-18.89, -0.002	0.051	-4.58	-13.17, +4.00	0.30
Developing	3.23	-0.64, +7.12	0.10	3.05	-0.90, +6.93	0.13
Sympatry						
Developed	-22.01	-26.19, -17.61	< 0.0001	-1.88	-5.99, +2.26	0.37
In transition	-14.78	-22.00, -7.63	< 0.0001	7.63	+0.53, +14.48	0.034
Developing	-0.40	-6.18, +5.47	0.89	6.79	+0.79, +12.75	0.026

[1] response variable = breeding occurrence value for each species in each city = average across observers, weighted by the observer's self-reported ability (N = 5,618); random factor = phylogenetically-independent species pair

[2] economically developed countries, countries in transition between developing and developed economies, and economically developing countries

[3] estimate describes the slope of the subordinate relative to the dominant, where x=urban-breeding propensity and y=breeding occurrence

Table S5. Comparisons of model performance for our main model (*A*), and for candidate factors to explain geographic variation in our main result (*B*), using a generalized least squares approach that incorporates spatial autocorrelation[1]. (*A*) We tested if the effects of dominance on breeding occurrence varied as a function of urban-breeding propensity and sympatry by dropping the 3-way interaction from the model and comparing model performance using Akaike Information Criterion values (AIC). (*B*) Each candidate factor was included as a predictor variable in saturated models with dominance, urban-breeding propensity, and sympatry. The influence of candidate factors on our main result was assessed by dropping the 4-way interaction and comparing AIC values between the saturated model and the model with the 4-way interaction removed. We also assessed the influence of candidate factors by dropping them completely from the model, and comparing AIC values between the saturated model and the model with the candidate factor removed. The model with economic development (bold) was the only factor that improved model fit in an interaction with the main effects.

(*A*) Main Analysis	**Saturated model**	**3-way interaction removed**	**3-way interaction contribution**
	AIC[2]	**AIC[2]**	**Δ AIC[3]**
Model (dominance * sympatry * urban-breeding propensity)	7,061.3	7,073.8	-12.5

(*B*) Test of Candidate Factors[4]	**Saturated model (with factor)**	**4-way interaction removed**	**4-way interaction contribution**	**Candadate factor contribution[5]**
	AIC[2]	**AIC[2]**	**Δ AIC[3]**	**Δ AIC[3]**
Generalised least squares analysis				
Continent	**7,102.0**	**7,101.6**	**+0.4**	**+40.7**
Economic development (country)	**7,009.5**	**7,012.4**	**-2.9**	**-51.8**
Continent peripheral to where dominance data collected?	7,064.7	7,051.5	+13.2	+3.4
Average annual temperature (degrees C) (city)	7,055.0	7,042.7	+12.3	-6.3

Absolute latitude (decimal degrees) (city)	7,053.5	7,050.9	+2.6	-7.8
Number of species (city)	7,053.7	7,044.2	+9.5	-7.6
Taxonomic order[6]	na	na	na	na
Net primary productivity (g/m/year) (city)	7,068.1	7,057.9	+10.2	+6.8
Number of sympatric, urban-adapted species (city)	7,070.4	7,057.6	+12.8	+9.1
Number of observers (city)	6,935.4	6,928.6	+6.8	-125.9
Continent peripheral to species range centroid?	7,084.8	7,072.0	+12.8	+23.5
Human population size (city)	7,066.9	7,055.2	+11.7	+5.6
Average ability of observers (city)	7,068.3	7,059.0	+9.3	+7.0

[1] response variable = breeding occurrence value for each species in each city = average across observers, weighted by the observer's self-reported ability (*N* = 5,618)

[2] AIC = Akaike Information Criterion; lower values denote better model performance

[3] negative values denote an improvement to the model

[4] see Methods for definitions and sources of data for candidate factors

[5] AIC for the models with only dominance, propensity to breed in urban habitats, and sympatry was 7,061

[6] models with taxonomic order resulted in singularities and could not be run

Table S6. Diagnostic values for assessing model fit for our main MCMCglmm analyses. Values for (*A*) our main model with fixed factors dominance*sympatry*urban-breeding propensity, and (*B*) our model with economic development (i.e., dominance*sympatry*urban-breeding propensity*economic development).

Factor	Upper confidence interval for Gelman and Rubin's Convergence Diagnostic	Effective sample size	Geweke's Convergence Diagnostic
(*A*) Main analysis			
Intercept (dominant, allopatric)	1	36,782	1.03
Dominance (subordinate)	1	40,000	0.22
Sympatry (sympatric)	1	38,824	-0.42
Urban-breeding propensity	1	40,000	0.81
Dominance : sympatry	1	40,000	-1.01
Dominance : urban-breeding propensity	1	40,000	0.65
Sympatry : urban-breeding propensity	1	40,000	-1.12
Dominance: sympatry : urban-breeding propensity	1	40,624	0.04
Multivariate potential scale reduction factor	1	na	na
Species pair (random)	na	1,818	na
Units (random)	na	40,000	na
(*B*) Economic development analysis[1]			
Intercept (dominant, allopatric, developed)	1	40,000	0.87
Dominance (subordinate)	1	40,000	0.08
Sympatry (sympatric)	1	40,000	-0.73
Economic development (in transition)	1	40,000	-1.30
Economic development (developing)	1	40,000	-0.58

Urban-breeding propensity (linear)	1	38,890	0.09
Urban-breeding propensity (quadratic)	1	40,000	-0.27
Dominance : sympatry	1	40,000	0.45
Dominance : economic development (in transition)	1	40,000	0.13
Dominance : economic development (developing)	1	40,000	0.33
Dominance : urban-breeding propensity (linear)	1	40,000	-0.57
Dominance : urban-breeding propensity (quadratic)	1	40,000	-0.60
Sympatry : economic development (in transition)	1	40,000	0.48
Sympatry : economic development (developing)	1	40,000	0.42
Sympatry : urban-breeding propensity (linear)	1	40,000	1.35
Sympatry : urban-breeding propensity (quadratic)	1	40,000	0.19
Economic development (in transition) : urban-breeding propensity (linear)	1	39,427	1.77
Economic development (in transition) : urban-breeding propensity (quadratic)	1	40,903	2.79
Economic development (developing) : urban-breeding propensity (linear)	1	40,000	-1.65
Economic development (developing) : urban-breeding propensity (quadratic)	1	39,344	1.17
Dominance : sympatry : urban-breeding propensity (linear)	1	40,000	0.33
Dominance : sympatry : urban-breeding propensity (quadratic)	1	42,209	1.57
Dominance : economic development (in transition) : urban-breeding propensity (linear)	1	38,879	-0.53
Dominance : economic development (in transition) : urban-breeding propensity (quadratic)	1	40,631	-2.54
Dominance : economic development (developing) : urban-breeding propensity (linear)	1	40,000	2.09
Dominance : economic development (developing) : urban-breeding propensity (quadratic)	1	40,000	-0.46
Dominance : sympatry : economic development (in transition)	1	40,000	0.56

Dominance : sympatry : economic development (developing)	1	40,000	-0.46
Sympatry : economic development (in transition) : urban-breeding propensity (linear)	1	40,000	-1.05
Sympatry : economic development (in transition) : urban-breeding propensity (quadratic)	1	40,000	-2.35
Sympatry : economic development (developing) : urban-breeding propensity (linear)	1	40,000	0.48
Sympatry : economic development (developing) : urban-breeding propensity (quadratic)	1	41,348	-0.29
Dominance : sympatry : economic development (in transition) : urban-breeding propensity (linear)	1	38,048	-0.32
Dominance : sympatry : economic development (in transition) : urban-breeding propensity (quadratic)	1	41,190	1.67
Dominance : sympatry : economic development (developing) : urban-breeding propensity (linear)	1	40,000	-1.68
Dominance : sympatry : economic development (developing) : urban-breeding propensity (quadratic)	1	40,000	-0.75
Multivariate potential scale reduction factor	1	na	na
Species pair (random)	na	1,705	na
Units (random)	na	39,331	na

[1] includes orthogonal polynomial for urban-breeding propensity

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List of the cities for which we obtained breeding bird occurrence data used in this study (*N* = 260 cities).

Continent[1]	Country	City	Latitude (degrees)	Longitude (degrees)	Human Population[2]	Number of completed surveys
Africa	Algeria	Algiers	36.75	3.06	1,569,897	1
Africa	Angola	Luanda	-8.84	13.29	2,776,168	1
Africa	Benin	Cotonou	6.37	2.39	780,000	1
Africa	Cameroon	Yaoundé	3.85	11.50	1,817,524	2
Africa	Côte d'Ivoire	Abidjan	5.36	-4.01	1,929,079	1
Africa	Democratic Republic of the Congo	Kinshasa	-4.39	15.97	7,785,965	1
Africa	Egypt	Cairo	30.04	31.24	7,771,617	1
Africa	Ethiopia	Addis Ababa	8.98	38.76	2,757,729	1
Africa	Ghana	Accra	5.60	-0.19	1,594,419	1
Africa	Ghana	Kumasi	6.67	-1.62	1,730,249	1
Africa	Guinea	Conakry	9.64	-13.58	1,091,500	1
Africa	Kenya	Nairobi	-1.29	36.82	3,133,518	2
Africa	Liberia	Monrovia	6.29	-10.76	970,824	1
Africa	Libya	Tripoli	32.89	13.19	1,150,989	2
Africa	Madagascar	Antananarivo	-18.88	47.51	1,300,000	2
Africa	Malawi	Lilongwe	-13.96	33.77	1,087,917	2
Africa	Mali	Bamako	12.64	-8.00	1,810,366	1
Africa	Morocco	Casablanca	33.57	-7.59	3,144,909	1
Africa	Morocco	Fes	34.02	-5.01	964,891	1
Africa	Morocco	Marrakesh	31.63	-7.98	839,296	2
Africa	Niger	Niamey	13.51	2.13	774,235	1
Africa	Nigeria	Ibadan	7.38	3.95	1,835,300	1
Africa	Senegal	Dakar	14.76	-17.37	1,056,009	1

Africa	Sierra Leone	Freetown	8.47	-13.23	802,639	1
Africa	Somalia	Mogadishu	2.05	45.32	2,587,183	1
Africa	South Africa	Cape Town	-33.92	18.42	987,007	3
Africa	South Africa	Port Elizabeth	-33.71	25.52	775,255	1
Africa	South Africa	Soweto / Johannesberg	-26.25	27.85	904,165	1
Africa	Sudan	Khartoum	15.50	32.56	1,974,647	2
Africa	Tanzania	Dar es Salaam	-6.79	39.21	1,360,850	1
Africa	Uganda	Kampala	0.35	32.58	1,516,210	1
Africa	Zambia	Lusaka	-15.39	28.32	1,747,152	1
Africa	Zimbabwe	Harare	-17.83	31.03	1,485,231	1
Asia	Afghanistan	Kabul	34.56	69.21	3,043,532	2
Asia	Armenia	Yerevan	40.18	44.50	1,060,138	2
Asia	Azerbaijan	Baku	40.41	49.87	2,166,355	3
Asia	Bangladesh	Chittagong	22.35	91.81	2,023,489	2
Asia	Bangladesh	Dhaka	23.81	90.41	5,333,571	2
Asia	Bangladesh	Khulna	22.85	89.54	770,498	2
Asia	Cambodia	Phnom Penh	11.54	104.89	1,573,544	3
Asia	China	Beijing	39.90	116.41	11,509,595	3
Asia	China	Chengdu	30.57	104.07	4,333,541	1
Asia	China	Shanghai	31.23	121.47	14,348,535	2
Asia	China	Shijiazhuang	38.04	114.51	1,969,975	2
Asia	China	Ürümqi	43.83	87.62	1,753,298	1
Asia	China	Yantai	37.46	121.45	1,724,404	1
Asia	China, Hong Kong SAR	Hong Kong	22.40	114.11	7,241,700	1
Asia	Georgia	Tbilisi	41.72	44.83	1,172,700	1
Asia	India	Bangalore	12.97	77.59	5,701,446	2
Asia	India	Chennai (Madras)	13.08	80.27	6,560,242	3
Asia	India	Delhi	28.61	77.21	12,877,470	1
Asia	India	Durg-Bhilai Nagar	21.19	81.35	927,864	1

Asia	India	Guwahati	26.14	91.74	818,809	1
Asia	India	Hyderabad	17.39	78.49	5,742,036	1
Asia	India	Jaipur	26.91	75.79	2,322,575	1
Asia	India	Kanpur	26.45	80.33	2,715,555	2
Asia	India	Kozhikode	11.26	75.78	880,247	1
Asia	India	Ludhiana	30.90	75.86	1,398,467	1
Asia	India	Madurai	9.93	78.12	1,203,095	1
Asia	India	Mumbai (Bombay)	19.08	72.88	16,434,386	5
Asia	India	Mysore	12.30	76.64	799,228	1
Asia	India	Nagpur	21.15	79.09	2,129,500	1
Asia	India	Pune	18.52	73.86	3,760,636	4
Asia	India	Salem	11.66	78.15	751,438	1
Asia	Indonesia	Bandung	-6.92	107.62	2,394,873	2
Asia	Indonesia	Jakarta	-6.17	106.82	9,607,787	1
Asia	Indonesia	Palembang	-2.98	104.78	1,455,284	1
Asia	Indonesia	Surabaya	-7.26	112.75	2,765,487	1
Asia	Iraq	Baghdad	33.31	44.36	3,841,268	2
Asia	Japan	Hiroshima	34.39	132.46	1,173,843	1
Asia	Japan	Nagoya	35.18	136.91	2,263,894	2
Asia	Japan	Osaka	34.69	135.50	2,665,314	1
Asia	Japan	Sapporo	43.06	141.35	1,913,545	1
Asia	Japan	Sendai	38.27	140.87	1,045,986	2
Asia	Jordan	Amman	31.96	35.95	1,055,262	3
Asia	Kazakhstan	Almaty	43.22	76.85	1,507,509	2
Asia	Kazakhstan	Astana	51.16	71.47	814,435	3
Asia	Malaysia	Kuala Lumpur	3.14	101.69	1,588,750	1
Asia	Mongolia	Ulaanbaatar	47.89	106.91	1,367,508	1
Asia	Myanmar	Yangon	16.87	96.20	5,209,541	1
Asia	Nepal	Kathmandu	27.72	85.32	1,003,285	2

Asia	Oman	Muscat	23.59	58.41	797,000	1
Asia	Pakistan	Karachi	24.86	67.01	9,339,023	1
Asia	Philippines	Cebu	10.32	123.89	866,171	3
Asia	Philippines	Quezon City / Manila	14.68	121.04	2,761,720	3
Asia	Qatar	Doha	25.29	51.53	796,947	1
Asia	Republic of Korea	Seoul	37.57	126.98	9,860,372	8
Asia	Russian Federation	Ekaterinburg	56.84	60.61	1,420,285	1
Asia	Saudi Arabia	Jiddah	21.29	39.24	2,801,481	1
Asia	Singapore	Singapore	1.35	103.82	5,469,724	5
Asia	Syria	Damascus	33.51	36.28	1,569,394	2
Asia	Syria	Homs	34.73	36.71	775,404	2
Asia	Taiwan	Kaohsiung City	22.63	120.30	1,519,711	1
Asia	Taiwan	Taichung	24.15	120.67	1,040,725	3
Asia	Taiwan	Taipei	25.03	121.57	7,871,900	2
Asia	Thailand	Bangkok	13.76	100.50	8,305,218	2
Asia	United Arab Emirates	Dubai	25.20	55.27	1,137,347	2
Asia	Vietnam	Ho Chi Minh City	10.82	106.63	3,467,331	1
Australia	Australia	Adelaide	-34.93	138.60	1,263,888	1
Australia	Australia	Brisbane	-27.47	153.02	2,143,121	2
Australia	Australia	Melbourne	-37.81	144.96	4,181,021	2
Australia	Australia	Perth	-31.95	115.86	1,901,582	3
Australia	Australia	Sydney	-33.87	151.21	4,373,433	1
Australia	New Zealand	Auckland	-36.85	174.76	1,526,900	1
Europe	Austria	Wien	48.21	16.37	1,766,746	3
Europe	Belarus	Minsk	53.90	27.56	1,911,433	1
Europe	Belgium	Bruxelles (Brussels)	50.85	4.35	1,561,395	2
Europe	Bulgaria	Sofia	42.70	23.32	1,210,820	2
Europe	Croatia	Zagreb	45.82	15.98	790,017	2
Europe	Czech Republic	Praha	50.08	14.44	1,244,762	3

Europe	Denmark	Copenhagen	55.68	12.57	1,153,615	2
Europe	France	Bordeaux	44.84	-0.58	843,425	1
Europe	France	Marseille	43.30	5.37	1,559,789	1
Europe	France	Paris	48.86	2.35	10,460,118	4
Europe	Germany	Berlin	52.52	13.41	3,421,829	3
Europe	Germany	Hamburg	53.55	9.99	1,746,342	1
Europe	Germany	München (Munich)	48.14	11.58	1,407,836	2
Europe	Greece	Athinai	37.98	23.73	789,166	3
Europe	Hungary	Budapest	47.50	19.04	2,548,428	4
Europe	Ireland	Dublin	53.35	-6.26	1,110,627	2
Europe	Italy	Milano	45.47	9.19	1,293,135	3
Europe	Italy	Napoli	40.85	14.27	974,082	2
Europe	Italy	Roma	41.90	12.50	2,751,082	4
Europe	Italy	Torino	45.07	7.69	887,114	5
Europe	Latvia	Riga	56.95	24.11	764,329	3
Europe	Netherlands	Amsterdam	52.37	4.90	1,068,724	1
Europe	Poland	Kraków	50.06	19.95	759,131	2
Europe	Poland	Łódź	51.76	19.46	756,666	1
Europe	Poland	Warszawa	52.23	21.01	1,711,324	2
Europe	Republic of Moldova	Chișinău (Kishinev)	47.01	28.86	785,917	1
Europe	Romania	Bucuresti	44.43	26.10	1,912,515	7
Europe	Russian Federation	Moskva	55.76	37.62	11,918,057	2
Europe	Russian Federation	St. Petersburg	59.93	30.34	4,990,602	1
Europe	Russian Federation	Volgograd	48.71	44.51	1,018,762	1
Europe	Russian Federation	Voronezh	51.68	39.21	997,447	1
Europe	Serbia	Beograd (Belgrade)	44.79	20.45	1,669,552	2
Europe	Spain	Barcelona	41.39	2.17	1,607,104	1
Europe	Spain	Madrid	40.42	-3.70	3,186,241	1
Europe	Spain	Murcia	37.99	-1.13	772,211	16

Europe	Spain	Sevilla	37.39	-5.98	984,092	1
Europe	Spain	Valencia	39.47	-0.38	789,364	3
Europe	Sweden	Göteborg (Gothenburg)	57.71	11.97	883,764	2
Europe	Sweden	Stockholm	59.33	18.07	789,024	1
Europe	Switzerland	Zürich	47.38	8.54	1,210,875	2
Europe	Turkey	Ankara	39.93	32.86	3,517,182	5
Europe	Turkey	Antalya	36.90	30.71	758,188	1
Europe	Turkey	Istanbul	41.01	28.98	11,174,257	3
Europe	Ukraine	Dnepropetrovsk	48.46	35.05	990,025	2
Europe	Ukraine	Kharkov	49.99	36.23	1,431,461	2
Europe	Ukraine	Kiev	50.45	30.52	2,803,716	3
Europe	Ukraine	Lvov	49.84	24.03	751,225	2
Europe	Ukraine	Odessa	46.48	30.72	997,189	1
Europe	United Kingdom	London	51.51	-0.13	8,278,251	3
Europe	United Kingdom	Manchester	53.48	-2.24	2,244,931	5
Europe	United Kingdom	Tyneside	54.99	-1.45	879,996	1
Europe	United Kingdom	West Midlands	52.48	-1.83	2,284,093	2
North America	Canada	Calgary	51.05	-114.07	1,406,721	3
North America	Canada	Edmonton	53.54	-113.49	1,328,290	5
North America	Canada	Montréal	45.50	-73.57	4,027,121	5
North America	Canada	Ottawa	45.42	-75.70	1,318,122	9
North America	Canada	Québec	46.81	-71.21	799,632	5
North America	Canada	Toronto	43.65	-79.38	6,055,724	38
North America	Canada	Vancouver	49.28	-123.12	2,470,289	11
North America	Canada	Winnipeg	49.90	-97.14	782,640	3
North America	Cuba	La Habana	23.11	-82.37	2,121,871	1
North America	Dominican Republic	Santo Domingo	18.49	-69.93	965,040	1
North America	Guatemala	Ciudad de Guatemala	14.63	-90.51	1,022,001	1
North America	Honduras	Tegucigalpa	14.07	-87.19	765,675	1

North America	Jamaica	Kingston	18.02	-76.81	937,700	1
North America	Mexico	Aguascalientes	21.89	-102.29	932,369	1
North America	Mexico	Chihuahua	28.63	-106.07	852,533	1
North America	Mexico	Ciudad de Mexico	19.43	-99.13	20,116,842	2
North America	Mexico	Ciudad Del Carmen	18.65	-91.81	17,963,196	1
North America	Mexico	Coatzacoalcos	18.13	-94.46	1,301,452	1
North America	Mexico	Guadalajara	20.66	-103.35	4,434,878	1
North America	Mexico	Irapuato	20.68	-101.35	3,764,371	1
North America	Mexico	Mérida	20.97	-89.59	973,046	1
North America	Mexico	Morelia	19.71	-101.20	807,902	2
North America	Mexico	San Luis Potosí - Soledad de Graciano Sanchez	22.16	-100.99	1,040,443	1
North America	Mexico	Santiago de Querétaro	20.59	-100.39	1,097,025	1
North America	Mexico	Torreón	25.54	-103.41	1,215,817	1
North America	Mexico	Veracruz	19.17	-96.13	801,295	1
North America	Mexico	Villahermosa	17.99	-92.95	755,425	1
North America	Nicaragua	Managua	12.12	-86.24	908,892	1
North America	United States of America	Atlanta (GA)	33.75	-84.39	3,499,840	3
North America	United States of America	Austin (TX)	30.27	-97.74	842,592	4
North America	United States of America	Boston (MA)	42.36	-71.06	4,032,484	2
North America	United States of America	Charlotte (NC)	35.23	-80.84	775,202	3
North America	United States of America	Chicago (IL)	41.88	-87.63	2,714,856	22
North America	United States of America	Cincinnati (OH)	39.10	-84.51	1,503,262	1
North America	United States of America	Cleveland (OH)	41.50	-81.69	1,786,647	3
North America	United States of America	Columbus (OH)	39.96	-83.00	809,798	1
North America	United States of America	Dallas (TX)	32.78	-96.80	1,241,162	6
North America	United States of America	Denver (CO)	39.74	-104.99	1,984,887	6
North America	United States of America	Detroit (MI)	42.33	-83.05	910,921	3
North America	United States of America	Hartford (CT)	41.76	-72.69	851,535	1

North America	United States of America	Houston (TX)	29.76	-95.37	2,160,821	1
North America	United States of America	Indianapolis (IN)	39.77	-86.16	834,852	2
North America	United States of America	Jacksonville (FL)	30.33	-81.66	836,507	1
North America	United States of America	Kansas City (MO)	39.10	-94.58	1,361,744	1
North America	United States of America	Las Vegas (NV)	36.17	-115.14	1,314,357	1
North America	United States of America	Los Angeles (CA)	34.05	-118.24	3,857,799	5
North America	United States of America	Louisville (KY)	38.25	-85.76	863,582	2
North America	United States of America	Memphis (TN)	35.15	-90.05	972,091	1
North America	United States of America	Miami (FL)	25.76	-80.19	4,919,036	2
North America	United States of America	Milwaukee (WI)	43.04	-87.91	1,308,913	2
North America	United States of America	Minneapolis (MN)	44.98	-93.27	2,388,593	5
North America	United States of America	New Orleans (LA)	29.95	-90.07	1,009,283	11
North America	United States of America	New York (NY)	40.71	-74.01	8,336,697	2
North America	United States of America	Orlando (FL)	28.54	-81.38	1,157,431	1
North America	United States of America	Philadelphia (PA)	39.95	-75.17	1,547,607	2
North America	United States of America	Phoenix (AZ)	33.45	-112.07	1,488,750	2
North America	United States of America	Pittsburgh (PA)	40.44	-80.00	1,753,136	2
North America	United States of America	Portland (OR)	45.52	-122.68	1,583,138	3
North America	United States of America	Richmond (VA)	37.54	-77.44	818,836	2
North America	United States of America	Sacramento (CA)	38.58	-121.49	1,393,498	7
North America	United States of America	Salt Lake City (UT)	40.76	-111.89	887,650	7
North America	United States of America	San Antonio (TX)	29.42	-98.49	1,382,951	3
North America	United States of America	San Jose (CA)	37.34	-121.89	982,765	1
North America	United States of America	Seattle (WA)	47.61	-122.33	2,712,205	22
North America	United States of America	St. Louis (MO)	38.63	-90.20	2,077,662	2
North America	United States of America	Tampa (FL)	27.95	-82.46	2,062,339	1
North America	United States of America	Virginia Beach (VA)	36.85	-75.98	1,394,439	1
North America	United States of America	Washington (DC)	38.91	-77.04	3,933,920	3
South America	Argentina	Buenos Aires	-34.60	-58.38	12,847,328	5

South America	Argentina	Córdoba	-31.42	-64.19	1,517,610	2
South America	Argentina	Mendoza	-32.89	-68.85	1,079,744	1
South America	Argentina	Tucumán - Tafí Viejo	-26.73	-65.27	867,724	1
South America	Bolivia	La Paz	-16.49	-68.12	789,585	2
South America	Bolivia	Santa Cruz	-17.81	-63.16	1,113,582	1
South America	Brazil	Belém	-1.46	-48.49	1,381,475	2
South America	Brazil	Belo Horizonte	-19.92	-43.94	2,375,151	5
South America	Brazil	Brasilia	-15.79	-47.88	2,481,272	2
South America	Brazil	Campo Grande	-20.47	-54.62	776,242	6
South America	Brazil	Curitiba	-25.42	-49.27	1,751,907	6
South America	Brazil	Goiânia	-16.69	-49.26	1,297,154	1
South America	Brazil	Maceió	-9.65	-35.71	932,078	2
South America	Brazil	Manaus	-3.12	-60.02	1,792,881	1
South America	Brazil	Recife	-8.05	-34.88	1,537,704	1
South America	Brazil	Rio de Janeiro	-22.91	-43.17	6,320,446	3
South America	Brazil	Salvador	-12.97	-38.50	2,674,923	3
South America	Brazil	São Luís	-2.54	-44.28	958,545	2
South America	Brazil	São Paulo	-23.55	-46.63	11,152,968	8
South America	Brazil	Teresina	-5.09	-42.80	767,559	1
South America	Chile	Santiago	-33.45	-70.67	5,150,010	3
South America	Colombia	Barranquilla	10.98	-74.82	1,112,889	1
South America	Colombia	Bogotá	4.71	-74.07	6,778,691	6
South America	Colombia	Cali	3.45	-76.54	2,075,380	6
South America	Colombia	Medellín	6.24	-75.58	2,219,861	3
South America	Ecuador	Guayaquil	-2.17	-79.92	2,291,158	1
South America	Ecuador	Quito	-0.18	-78.47	1,619,146	4
South America	Paraguay	Asunción	-25.26	-57.58	1,620,483	5
South America	Peru	Arequipa	-16.41	-71.54	784,651	1
South America	Peru	Lima	-12.05	-77.04	8,472,935	2

South America	Uruguay	Montevideo	-34.90	-56.16	1,379,560	3
South America	Venezuela	Barquisimeto	10.07	-69.35	1,000,632	1
South America	Venezuela	Caracas	10.48	-66.90	2,104,423	7
South America	Venezuela	Ciudad Guayana	8.37	-62.65	850,262	1
South America	Venezuela	Maracaibo	10.65	-71.71	1,339,019	2
South America	Venezuela	Valencia	10.16	-68.00	917,999	1

[1] "North America" includes Central America and the Caribbean; "Australia" includes New Zealand

[2] from United Nations (data.un.org/; accessed June 2016); for countries missing from the UN dataset, values are from http://www.geonames.org/, accessed July 2016

List of the bird species examined in this study.[1]

Phylogenetically-independent comparison	**Taxonomic order**	**Taxonomic family**	**Genus**	**Dominant species**	**Subordinate species**
1	Anseriformes	Anatidae	*Dendrocygna*	*autumnalis*	*bicolor*
2	Anseriformes	Anatidae	*Cygnus*	*cygnus*	*olor*
2[2]	Anseriformes	Anatidae	*Cygnus*	*buccinator*	*olor*
3	Anseriformes	Anatidae	*Anas*	*strepera*	*americana*
4	Anseriformes	Anatidae	*Anas*	*discors*	*cyanoptera*
5	Anseriformes	Anatidae	*Anas*	*acuta*	*carolinensis*
6	Anseriformes	Anatidae	*Aythya*	*americana*	*collaris*
7	Anseriformes	Anatidae	*Bucephala*	*islandica*	*clangula*
8	Galliformes	Phasianidae	*Tympanuchus*	*phasianellus*	*cupido*
9	Podicipediformes	Podicipedidae	*Podiceps*	*grisegena*	*auritus*
10	Pelecaniformes	Ardeidae	*Ardeola*	*idae*	*ralloides*
11	Pelecaniformes	Ardeidae	*Ardea*	*cinerea*	*alba*
11[2]	Pelecaniformes	Ardeidae	*Ardea*	*herodias*	*alba*
12	Pelecaniformes	Ardeidae	*Egretta*	*tricolor*	*caerulea*
13	Pelecaniformes	Ardeidae	*Egretta*	*garzetta*	*thula*
14	Suliformes	Phalacrocoracidae	*Phalacrocorax*	*lucidus*	*capensis*
15	Accipitriformes	Cathartidae	*Cathartes*	*aura*	*burrovianus*
15[2]	Accipitriformes	Cathartidae	*Cathartes*	*aura*	*melambrotus*
16	Accipitriformes	Accipitridae	*Gyps*	*rueppellii*	*africanus*
16[2]	Accipitriformes	Accipitridae	*Gyps*	*coprotheres*	*africanus*
17	Accipitriformes	Accipitridae	*Accipiter*	*gentilis*	*cooperii*
18	Accipitriformes	Accipitridae	*Circus*	*pygargus*	*aeruginosus*
19	Accipitriformes	Accipitridae	*Milvus*	*migrans*	*milvus*
20	Accipitriformes	Accipitridae	*Haliastur*	*indus*	*sphenurus*
21	Accipitriformes	Accipitridae	*Buteo*	*swainsoni*	*jamaicensis*

21[2]	Accipitriformes	Accipitridae	*Buteo*	*swainsoni*	*regalis*
22	Gruiformes	Rallidae	*Fulica*	*armillata*	*leucoptera*
23	Gruiformes	Gruidae	*Grus*	*antigone*	*rubicunda*
24	Charadriiformes	Charadriidae	*Vanellus*	*coronatus*	*lugubris*
25	Charadriiformes	Charadriidae	*Charadrius*	*vociferus*	*melodus*
26	Charadriiformes	Scolopacidae	*Numenius*	*arquata*	*phaeopus*
27	Charadriiformes	Laridae	*Chroicocephalus*	*ridibundus*	*genei*
28	Charadriiformes	Laridae	*Larus*	*marinus*	*smithsonianus*
29	Charadriiformes	Laridae	*Sterna*	*dougallii*	*paradisaea*
30	Columbiformes	Columbidae	*Columba*	*palumbus*	*oenas*
31	Columbiformes	Columbidae	*Streptopelia*	*decaocto*	*turtur*
32	Columbiformes	Columbidae	*Spilopelia*	*chinensis*	*senegalensis*
33	Cuculiformes	Cuculidae	*Crotophaga*	*ani*	*sulcirostris*
34	Strigiformes	Strigidae	*Bubo*	*lacteus*	*africanus*
35	Strigiformes	Strigidae	*Strix*	*varia*	*occidentalis*
36	Caprimulgiformes	Caprimulgidae	*Chordeiles*	*minor*	*acutipennis*
37	Apodiformes	Trochilidae	*Phaethornis*	*longirostris*	*striigularis*
38	Apodiformes	Trochilidae	*Colibri*	*coruscans*	*thalassinus*
39	Apodiformes	Trochilidae	*Amazilia*	*tzacatl*	*franciae*
40	Apodiformes	Trochilidae	*Amazilia*	*beryllina*	*violiceps*
41	Apodiformes	Trochilidae	*Lampornis*	*clemenciae*	*amethystinus*
42	Apodiformes	Trochilidae	*Calypte*	*anna*	*costae*
43	Apodiformes	Trochilidae	*Selasphorus*	*rufus*	*calliope*
44	Coraciiformes	Alcedinidae	*Halcyon*	*pileata*	*smyrnensis*
45	Coraciiformes	Alcedinidae	*Chloroceryle*	*inda*	*americana*
46	Coraciiformes	Meropidae	*Merops*	*apiaster*	*persicus*
47	Bucerotiformes	Bucerotidae	*Bycanistes*	*albotibialis*	*fistulator*
48	Piciformes	Ramphastidae	*Ramphastos*	*tucanus*	*vitellinus*
49	Piciformes	Megalaimidae	*Psilopogon*	*pyrolophus*	*oorti*
50	Piciformes	Lybiidae	*Pogoniulus*	*bilineatus*	*leucomystax*
51	Piciformes	Lybiidae	*Lybius*	*melanopterus*	*torquatus*

52	Piciformes	Lybiidae	*Trachyphonus*	*erythrocephalus*	*darnaudii*
53	Piciformes	Indicatoridae	*Indicator*	*variegatus*	*meliphilus*
54	Piciformes	Indicatoridae	*Indicator*	*indicator*	*minor*
55	Piciformes	Picidae	*Melanerpes*	*lewis*	*erythrocephalus*
56	Piciformes	Picidae	*Sphyrapicus*	*thyroideus*	*nuchalis*
57	Piciformes	Picidae	*Dendrocopos*	*major*	*leucotos*
58	Piciformes	Picidae	*Picoides*	*arcticus*	*dorsalis*
59	Piciformes	Picidae	*Picus*	*viridis*	*canus*
60	Falconiformes	Falconidae	*Falco*	*peregrinus*	*biarmicus*
61	Psittaciformes	Psittaculidae	*Platycercus*	*elegans*	*eximius*
62	Psittaciformes	Psittaculidae	*Trichoglossus*	*moluccanus*	*chlorolepidotus*
63	Passeriformes	Furnariidae	*Synallaxis*	*gujanensis*	*albigularis*
64	Passeriformes	Dendrocolaptidae	*Dendrocincla*	*merula*	*fuliginosa*
65	Passeriformes	Dendrocolaptidae	*Dendrocolaptes*	*picumnus*	*certhia*
66	Passeriformes	Dendrocolaptidae	*Xiphorhynchus*	*lachrymosus*	*susurrans*
67	Passeriformes	Thamnophilidae	*Thamnophilus*	*doliatus*	*aethiops*
68	Passeriformes	Tyrannidae	*Todirostrum*	*chrysocrotaphum*	*maculatum*
69	Passeriformes	Tyrannidae	*Contopus*	*pertinax*	*sordidulus*
70	Passeriformes	Tyrannidae	*Empidonax*	*traillii*	*alnorum*
71	Passeriformes	Tyrannidae	*Empidonax*	*wrightii*	*oberholseri*
72	Passeriformes	Tyrannidae	*Tyrannus*	*vociferans*	*verticalis*
73	Passeriformes	Climacteridae	*Climacteris*	*picumnus*	*erythrops*
74	Passeriformes	Meliphagidae	*Phylidonyris*	*novaehollandiae*	*niger*
75	Passeriformes	Meliphagidae	*Philemon*	*corniculatus*	*citreogularis*
76	Passeriformes	Meliphagidae	*Melithreptus*	*lunatus*	*brevirostris*
77	Passeriformes	Meliphagidae	*Anthochaera*	*carunculata*	*phrygia*
78	Passeriformes	Meliphagidae	*Manorina*	*melanocephala*	*flavigula*
79	Passeriformes	Pardalotidae	*Pardalotus*	*striatus*	*punctatus*
80	Passeriformes	Acanthizidae	*Sericornis*	*magnirostra*	*citreogularis*
81	Passeriformes	Malaconotidae	*Tchagra*	*senegalus*	*australis*
82	Passeriformes	Laniidae	*Lanius*	*minor*	*collurio*

83	Passeriformes	Vireonidae	*Vireo*	*olivaceus*	*gilvus*
83[2]	Passeriformes	Vireonidae	*Vireo*	*olivaceus*	*philadelphicus*
84	Passeriformes	Oriolidae	*Oriolus*	*auratus*	*oriolus*
85	Passeriformes	Corvidae	*Cyanocitta*	*stelleri*	*cristata*
86	Passeriformes	Corvidae	*Aphelocoma*	*wollweberi*	*woodhouseii*
87	Passeriformes	Corvidae	*Pyrrhocorax*	*pyrrhocorax*	*graculus*
88	Passeriformes	Corvidae	*Corvus*	*culminatus*	*splendens*
89	Passeriformes	Corvidae	*Corvus*	*corone*	*cornix*
90	Passeriformes	Corvidae	*Corvus*	*coronoides*	*mellori*
91	Passeriformes	Paridae	*Poecile*	*palustris*	*montanus*
92	Passeriformes	Paridae	*Poecile*	*atricapillus*	*gambeli*
93	Passeriformes	Pycnonotidae	*Pycnonotus*	*tricolor*	*nigricans*
94	Passeriformes	Hirundinidae	*Tachycineta*	*bicolor*	*thalassina*
95	Passeriformes	Phylloscopidae	*Phylloscopus*	*humei*	*trochiloides*
96	Passeriformes	Acrocephalidae	*Acrocephalus*	*schoenobaenus*	*paludicola*
97	Passeriformes	Acrocephalidae	*Acrocephalus*	*palustris*	*scirpaceus*
98	Passeriformes	Leiothrichidae	*Turdoides*	*hartlaubii*	*jardineii*
99	Passeriformes	Sylviidae	*Sylvia*	*atricapilla*	*borin*
100	Passeriformes	Sylviidae	*Sylvia*	*ruppeli*	*cantillans*
100[2]	Passeriformes	Sylviidae	*Sylvia*	*ruppeli*	*melanocephala*
101	Passeriformes	Regulidae	*Regulus*	*calendula*	*satrapa*
102	Passeriformes	Troglodytidae	*Troglodytes*	*aedon*	*solstitialis*
103	Passeriformes	Sittidae	*Sitta*	*castanea*	*frontalis*
104	Passeriformes	Certhiidae	*Certhia*	*familiaris*	*brachydactyla*
105	Passeriformes	Sturnidae	*Sturnus*	*unicolor*	*vulgaris*
106	Passeriformes	Buphagidae	*Buphagus*	*africanus*	*erythrorhynchus*
107	Passeriformes	Turdidae	*Sialia*	*currucoides*	*sialis*
108	Passeriformes	Turdidae	*Turdus*	*merula merula*	*iliacus*
109	Passeriformes	Muscicapidae	*Luscinia*	*luscinia*	*megarhynchos*
110	Passeriformes	Muscicapidae	*Ficedula*	*albicollis*	*hypoleuca*
111	Passeriformes	Muscicapidae	*Phoenicurus*	*ochruros*	*phoenicurus*

112	Passeriformes	Muscicapidae	*Saxicola*	*rubicola*	*rubetra*
113	Passeriformes	Muscicapidae	*Oenanthe*	*isabellina*	*oenanthe*
113[2]	Passeriformes	Muscicapidae	*Oenanthe*	*pileata*	*oenanthe*
114	Passeriformes	Muscicapidae	*Oenanthe*	*deserti*	*pleschanka*
115	Passeriformes	Muscicapidae	*Oenanthe*	*finschii*	*lugens*
115[2]	Passeriformes	Muscicapidae	*Oenanthe*	*finschii*	*chrysopygia*
116	Passeriformes	Nectariniidae	*Cinnyris*	*afer*	*chalybeus*
116[2]	Passeriformes	Nectariniidae	*Cinnyris*	*fuscus*	*chalybeus*
117	Passeriformes	Passeridae	*Passer*	*domesticus*	*montanus*
117[2]	Passeriformes	Passeridae	*Passer*	*hispaniolensis*	*montanus*
118	Passeriformes	Ploceidae	*Ploceus*	*xanthops*	*velatus*
119	Passeriformes	Ploceidae	*Euplectes*	*ardens*	*orix*
120	Passeriformes	Prunellidae	*Prunella*	*fulvescens*	*atrogularis*
121	Passeriformes	Motacillidae	*Motacilla*	*capensis*	*clara*
122	Passeriformes	Motacillidae	*Motacilla*	*grandis*	*alba*
123	Passeriformes	Motacillidae	*Anthus*	*spinoletta*	*pratensis*
124	Passeriformes	Fringillidae	*Fringilla*	*montifringilla*	*coelebs*
125	Passeriformes	Fringillidae	*Haemorhous*	*mexicanus*	*purpureus*
126	Passeriformes	Fringillidae	*Astragalinus*	*psaltria*	*lawrencei*
127	Passeriformes	Parulidae	*Leiothlypis*	*celata*	*virginiae*
128	Passeriformes	Parulidae	*Setophaga*	*tigrina*	*americana*
129	Passeriformes	Parulidae	*Setophaga*	*aestiva*	*magnolia*
130	Passeriformes	Parulidae	*Setophaga*	*pinus*	*dominica*
131	Passeriformes	Icteridae	*Sturnella*	*defilippii*	*superciliaris*
132	Passeriformes	Icteridae	*Icterus*	*parisorum*	*abeillei*
133	Passeriformes	Icteridae	*Agelaius*	*phoeniceus*	*tricolor*
134	Passeriformes	Emberizidae	*Zonotrichia*	*leucophrys*	*albicollis*
135	Passeriformes	Emberizidae	*Junco*	*phaeonotus*	*hyemalis*
136	Passeriformes	Emberizidae	*Melospiza*	*melodia*	*lincolnii*
136[2]	Passeriformes	Emberizidae	*Melospiza*	*melodia*	*georgiana*
137	Passeriformes	Emberizidae	*Ammodramus*	*maritimus*	*caudacutus*

138	Passeriformes	Thraupidae	*Ramphocelus*	*nigrogularis*	*carbo*
139	Passeriformes	Thraupidae	*Thraupis*	*sayaca*	*palmarum*
140	Passeriformes	Thraupidae	*Tangara*	*icterocephala*	*gyrola*
141	Passeriformes	Thraupidae	*Diglossa*	*lafresnayii*	*humeralis*
142	Passeriformes	Cardinalidae	*Cardinalis*	*cardinalis*	*sinuatus*

[1] references for dominance and phylogenetic relationships are included in the dataset, available at Dryad

[2] see Supplemental Methods for an explanation of cases where one phylogenetically-independent comparison consisted of more than two species

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