Supplemental Materials

Identifying studies.—We identified studies that would have estimates of **G** and ***β***, or **P** – matrix based approximations of **G**, by screening past meta-analyses of selection and performing literature searches. As a starting point, we screened all of the studies included in the Kingsolver et al. (2001), Geber & Griffen (2003), and Hereford et al. (2004) meta-analyses of natural selection. From these meta-analyses, we identified studies that had measured selection on multiple traits and had reported one of the following: (1) a **G** matrix, (2) a **P**-matrix, or (3) standardized estimates of ***β*** and **s** that allowed us to calculate a correlation matrix between traits (see below).

We added studies not included in these meta-analyses to our sample with literature searches. First, we identified articles citing the Kingsolver et al. (2001) meta-analysis, and selected articles that had the necessary data (we used the Kingsolver et al. (2001) meta-analysis instead of Geber & Griffen (2003) and Hereford et al. (2004), as it was published first and hence most likely to garner citations in papers on natural selection). Second, we scanned the table of contents and abstracts of papers published in *Evolution, Ecology, American Naturalist, Journal of Evolutionary Biology*, and *Evolutionary Ecology Research* from 1998 to 2005 to identify promising studies; we supplemented these scans by using keyword searches in JSTOR as described by Geber & Griffen (2003). Finally, we added studies to our sample based on our own work, our familiarity with particular empirical papers that measured selection, and investigators that frequently measure selection on multiple traits. Where estimates of ***β*** based on breeding values or family means (*e.g.*, Rausher 1992) were available, we used those data.

While our sample is clearly not exhaustive, it is unbiased with respect to the question of whether correlations between traits function as evolutionary constraints: all papers that had the necessary data were included, and the decision to include or exclude individual studies was made before we extracted the necessary data to calculate *R*.

Estimating P from $\boldsymbol{\beta}$ and **s. --** Many studies report neither a **P** nor **G** matrix, but instead report both selection gradients and selection differentials. For cases in which investigators measured selection on 2 or 3 traits, and used standardized selection gradients and differentials (*i.e.*, traits standardized to variance = 1), it is possible to use the relationship $\boldsymbol{\beta} = \mathbf{P}^{-1}\mathbf{s}$ to estimate the correlations among traits. Using standardized estimates of $\boldsymbol{\beta}$ and **s** means that the diagonal elements of **P** are all 1, and when only 2 or 3 traits are measured, the number of unknowns (the off-diagonals of **P,** or the correlations among traits) is less than or equal to the number of known parameter estimates (elements of $\boldsymbol{\beta}$ and **s).**

For the three trait case, $s_1 = \beta_1 + \beta_2\text{corr}(1,2) + \beta_3\text{corr}(1,3)$; $s_2 = \beta_2 + \beta_1\text{corr}(1,2) + \beta_3\text{corr}(1,3)$; and $s_3 = \beta_3 + \beta_2\text{corr}(2,3) + \beta_3\text{corr}(1,3)$. Solving these equations for the correlations yields:

$$\text{Corr}(1,2) = \frac{-\beta_1^2 + \beta_2^2 - \beta_3^2 - \beta_1 s_1 - \beta_2 s_2 + \beta_3 s_3}{2\,\beta_1\,\beta_2} \quad (1a)$$

$$\text{Corr}(1,3) = \frac{-\beta_1^2 + \beta_2^2 + \beta_1 s_1 - \beta_2 s_2 + \beta_3(-\beta_3 + s_3)}{2\,\beta_1\,\beta_3} \quad (1b)$$

$$\text{Corr}(2,3) = \frac{\beta_1^2 - \beta_2^2 - \beta_1 s_1 + \beta_2 s_2 + \beta_3(-\beta_3 + s_3)}{2\,\beta_2\,\beta_3} \quad (1c).$$

For the two trait case, there are two solutions, which in theory should give the same answer in the absence of rounding error. In practice, we used the average of these two estimates

$$\text{Corr}(1,2) = \frac{-\beta_1 + s_1}{\beta_2} \quad (2a)$$

$$\text{Corr}(2,1) = \frac{-\beta_2 + s_2}{\beta_1} \quad (2a).$$

Studies included in the database. The following table includes information about the studies included in the database and how we estimated **P**.

Citation	Organism	Number of Traits & Environments	Type & Source of Data	Comments
Barbraud (2000)	Snow petrels (*Pagodrama nivea*)	3	P matrix. Correlation matrix from Table 2, Heritabilities from Table 3, β from Table 5.	Males and females measured separately, we used "reproductive success" as the fitness measure.
Bertin & Cezilly (2003)	Isopods (*Asellus aquaticus*)	2 traits, 5 sites.	Estimated P matrix from β (Table 3) and s (Table 5); γ from Table 4.	Fitness measure was pairing success.
Bjorklund & Senar (2001)	Serins (*Serinus serinus*)	6 traits	P matrix for males and females separately (Table 2), and s for males and females (Table 3).	Reported Gammas from various partial models not including all traits; we did not use reported Gammas.
Callahan & Pigliucci	Thale cress (*Arabidopsis*	3 traits, 2 sites, 2 years	Estimated G matrix from	We used field study data

(2002)	*thaliana*)		family means estimates of β and s (Table 5). For phenotypic-only analysis (LCD): estimated P from β and s (Table 5).	only and omitted the lab study; Data from year 1 was excluded because the estimated genetic correlation matrix had values outside ±1. For phenotypic-only analysis, we used all years.
Candolin (2004)	Water boatmen (*Sigara falleni*)	3 traits, males and females separately.	Estimated P matrix from β and s (Table 1)	Made total fitness measure as the sum of Female Choice and Male-Male competition β; Used the average of correlation matrices inferred from β and s.

Candolin & Voigt (2003)	Threespine stickleback (*Gasterosteus aculeatus*)	3 traits	Estimated P matrix from β (Table 3) and s (Table 2).	We used data on hatching success as the fitness measure.
Carlson et al. (2004)	Brown trout (*Salmo trutta*)	2 traits, but at several life stages.	Estimated P matrix from β and S (Table 3)	Used total fitness as the fitness measure.
Caruso (2004)	Great blue lobelia (*Lobelia siphilitica*)	7 traits; 2 sites, 2 years.	G matrix and heritabilities (Table 2) and β (Table 3, table 4)	G matrix estimated from greenhouse grown plants.
Charmantier et al. (2004)	Blue tits (*Parus caeruleus*)	2 traits, 3 sites.	G matrix and heritabilities (Table 1); β and γ (Table 3).	G-matrix and breeding values Beta were estimated from 'animal model'. We omitted site 3, as the change in the fitness of the mean phenotype was negative, which can occur when γ

				is strong relative to β.
Coltman et al. (2005)	Big horn sheep (*Ovis canadensis*)	6 traits	G matrix (Table 4), heritabilities (Table 1), β (Table 6).	Traits reported in G and β are not completely overlapping due to high colinearity, so we used a subset of the data for which all values are reported.
Conner (1988)	Fungus beetles (*Bolitotherus cornutus*)	3 traits	P (Table 2) and β (Table 3).	We used total fitness as the fitness measure.
Donohue (2002)	Thale cress (*Arabidopsis thaliana*)	4 traits, 2 environments	P matrix (Table 3); β (Table 2); Some γ in footnotes to Table 2.	
Einum & Fleming (2000)	Salmon (*Salmo salar*)	2 traits	P matrix; Correlation between traits reported in text on p. 635, left	We used mortality as the fitness measure, and the "overall" category that

			column; β (Table 4).	includes all time periods.
Etterson (2004)	Partridge pea (*Chamaecrista fasciculata*)	3 traits ; 3 populations in each of 3 sites.	β (Table 3), γ (Table 3).	We only used data from each population in its own site. We calculated the G matrix from data reported in Etterson & Shaw (2001); heritabilities are also from Etterson and Shaw (2001). We omitted the KS population because the calculated genetic correlation matrix had values outside ±1. We were unable to use P matrix data from β and s

				because it resulted in matrices with negative determinants.
Fornoni et al. (2004)	Jimson weed (*Datura stramonium*)	2 traits ; 2 sites.	Estimated G-matrix from β (Table 2) and s (Table 1).	Traits were estimated for each paternal half sib family and used in a genotypic selection analysis.
Johnston (1991)	Great blue lobelia (*Lobelia siphilitica*)	6 traits, 1 environment.	P matrices (Tables 2-4), *β* (Table 5 and *γ* (Table 5).	Only diagonal *γ* are reported.
Johnston (1991)	Cardinal flower (*Lobelia cardinalis*)	6 traits, 2 environments.	P matrices (Tables 2-4), *β* (Table 5 and *γ* (Table 5).	Only diagonal *γ* are reported.
Jones et al. (2004)	Rough skinned newt (*Taricha granulosa*)	3 traits, 4 experimental treatments	Estimated P matrix from *β* and s (Table 3).	Total reproductive success was the fitness

				measure we used.
Kelly (1992)	Partridge pea (*Chamaecrista fasciculata*)	3 traits, multiple sites, 2 years.	P matrix (Table 2), β (Table 3), γ (Table 4 for 1998, site 1).	Seed production was the fitness measure we used.
Kruuk et al. (2002)	Red deer (*Cervus elaphus*)	2 traits	G matrix (genetic correlation reported in text, page 1690, right column); β (Table 4)	
Labeyrie et al. (2003)	Leaf beetles (*Oreina glorisoa*)	3 traits	Estimated P matrix from β and s (Table 1).	We used field data only, and only consider selection on males through pairing success.
Labeyrie et al. (2003)	Leaf beetles (*Oreina cacaliae*)	3 traits	Estimated P matrix from β and s (Table 1).	We used field data only, and only consider selection on males through pairing success.

LeBas et al. (2004)	Dance fly (*Rhamphomyia sulcata*)	3 traits	Estimated P matrix from β and s (Table 2).	We did not use reported γ estimates, as these were estimated from a series of pairwise models that did not include all terms (to avoid multi-collinearity).
Mezquida & Benkman (2005)	Aleppo pine (*Pinus halepensis*)	3 traits.	P matrix (Table 3) and β (Table 4).	The authors report selection analyses for a subset of traits (dropping out highly correlated traits). We use P for the traits for which they reported an estimate of β.
Moeller & Geber (2005)	Gunsight larkia (*Clarkia*	3 traits, 9 populations	Estimated P matrix from	Excluded population 6

	xantiana)		s (Table 2) and β (Table 3); γ (Table 3).	because estimated correlation matrix had values outside ±1.
Moore (1990)	Pond dragonfly (*Libellula luctuosa*)	4 traits	P matrix (Table 2), β (Table 4), and γ (Table 5).	We used total sexual selection as the fitness measure.
Nunez-Farfan & Dirzo (1994)	Jimsonweed (*Datura stramonium*)	3 traits	G matrix (Table 1), β (Table 3a), and γ (3a). Heritabilities, Table 4. For phenotypic-only analysis (LCD): P (Table 1), β (Table 2a).	Negative heritabilities set to zero. β estimated from a breeding values analysis.
O'Connell & Johnston (1998)	Pink ladyslipper (*Cypripedium acaule*)	3 traits, 2 environments.	P matrix (Table 2), β and γ (Table 5).	Used total fitness.
O'Neil (1997)	Purple loosestrife (*Lythrum salicaria*)	4 traits	P matrix (Table 1), β and γ (Table 2).	Only diagonal γ estimates are reported;

			Heritabilities (Table 3).	heritabilities estimated from mid-parent values.
Podolsky (2001)	Sand dollar (*Dendraster excentricus*)	2 traits, 5 replicates	P matrix (Table 2), β and γ (Table 3).	Lab study of fertilization. It appears that γ is mislabeled as eta.
Price (1984b)	Darwin's medium ground finch (*Geospiza fortis*)	3 traits	P matrix (Table 6), β (Table 5).	Measured selection on males, fitness estimated as mating success. We used selection on the single cohort males. The P matrix in table 6 is also a mix of product-moment and spearman rank correlations; we used product moment

				correlations only.
Price (1984a)	Darwin's medium ground finch (*Geospiza fortis*)	4 traits	P matrix (Table 1) and β (Table 5).	Various fitness measures reported; we used selection estimated with mortality as the fitness measure, for males and females separately.
Raberg & Stjernman (2003)	Blue tits (*Parus caeruleus)*	2 sets of 2 traits.	Estimated P matrix from β and s (Table 2) and again for (Table 4).	The authors estimate selection on 2 primary antibody responsiveness traits and 2 secondary antibody responsiveness traits, in separate models. Diagonal γ are reported in Tables 2 and 4, respectively.

Reale et al. (2003)	Red squirrels (*Tamiasciurus hudsonicus*)	2 traits	G matrix (Table 1), s, β, γ (Table 2). For phenotypic-only analysis (LCD): P estimated from β and s (Table 2).	
Rausher & Simms (1989)	Tall morning glory (*Ipomoea purpurea*)	5 traits	G matrix (Table 1), β and γ (Table 3). For phenotypic-only analysis (LCD): P matrix (Table 1) and β (Table 2).	Estimated breeding values as twice the deviation of paternal half-sib family means from the population mean; Used breeding value estimates in regressions to estimate selection.
Roy et al. (1999)	Charlock mustard (*Sinapis arvensis*)	2 traits, 6 environments	Estimated P matrix from β (Table 4) and s (Table	

			5); γ (Table 4).	
Sheldon et al. (2003)	Collared flycatcher (*Ficedula albicollis*)	9 traits	G matrix (Table 1), β (Table 2); γ (Table 2). For phenotypic-only analysis (LCD): P (Table 1), β (Table 2).	γ are for the diagonals only.
Stinchcombe & Rausher (2001)	Ivyleaf morning glory (*Ipomoea hederacea*)	2 traits	G matrix (correlation reported in text on 382, figure caption), β (Table 3).	G and β are estimates based on inbred-line means.
Stinchcombe & Schmitt (2006)	Jewelweed (*Impatiens capensis*)	4 traits, 2 environments	G matrix (Table 3), β (Table 4).	G matrix estimated by REML; β estimated using inbred line means.
Tiffin & Rausher (1999)	Tall morning glory (*Ipomoea purpurea*)	4 traits	G matrix (Table 5), β (Table 6), γ (Table 6).	G matrix, β, γ, are based on analysis of paternal-half sib family means.

Totland (2001)	Tall buttercup (*Ranunculus acris*)	8 traits, 4 environments	P matrix (Table 3), β (Table 4), γ (Table 4).	γ are diagonals only.
van Kleunen & Ritland (2004)	Yellow monkey flower (*Mimulus guttatus*)	8 traits	G matrix (Table 4, below diagonal), β (Table 3), heritabilities (Table 2).	We used the G-matrix estimated via the Lynch (1999) method, as the authors focus on that estimate in the Discussion. For heritabilities, we use the Riska (1989) estimator with negative values set to zero. Measured selection using female fitness (seed production) and male fitness (siring success)

Verhoeven et al. (2004)	Wild barley (*Hordeum spontaneum*)	6 traits, 2 environments.	G-matrix (Table 6), β (Table 7).	G matrix and β are based accession means.
Weinig (2000)	Velvetleaf (*Abutilon theophrasti*)	3 traits, 3 environments	P matrix (Table 5), β (Table 6), γ (Table 6).	Only significant γ are reported.
Zuk (1988)	Field crickets (*Gryllus pennsylvanicus*)	3 traits.	P matrix (Table 3), β (Table 4).	

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