SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article:

Appendix S1 Methods and results for the 1 km and 5 km grains of analysis.

Appendix S2 Discussion of existing studies about ants in extremely hot and arid places.

Figure S1 Distribution of survey locations in the ant assemblage database for the 1 km and 5 km grains of analysis.

Figure S2 Species density of ants predicted at the 1 km and 5 km grains using the best-performing model.

Figure S3 Plots of predicted versus observed species density for each of the 10 km grain models. Lines have a slope of one, indicating a perfect correspondence. MAT = mean annual temperature, Precip = precipitation in the wettest quarter of the year, Realm = biogeographic realm.

Figure S4 Distribution of climates that have not been adequately sampled for ants, shown under contemporary climate and the expansion of the non-sampled and no-analogue climates projected for 2050 for two climate models (GISS-AOM and BCCR-BCM2) using greenhouse gas emissions scenario A2a.

Table S1 Models of global species density of ants at 1 km and 5 km grains.

Table S2 Pearson correlations between predictions of species density at different grains.

Table S3 Attributes of sampled hot and arid sites. A subset of these sites that have precise geographic coordinates appears in Figure 6.

Appendix S1

Effects of spatial grain size

To explore the possible effects of spatial grain size (i.e. the size of grid cells for the analysis) on our ability to model environment-diversity relationships, we analysed the data at three different grains (grid cells of 1, 5, and 10 km on a side). Methods for calculating species density at the 1 km and 5 km grains were identical to those described in the main text for the 10 km grain, but adjusted for the smaller grid cell size. The final database had 204, 305, and 358 records suitable for analyses at 1 km, 5 km, and 10 km grains respectively (locations shown in Figures 1 and S1). Fewer records were suitable for finer grained analyses, primarily because the geographic coordinates for many studies had insufficient precision.

The model selection results were similar for all three grains of analysis. Model rankings were identical, with models retaining their broad pattern of improvement as variables were added (Tables 1 and S1). There was a general decline in R^2 from finer to coarser grains (Tables 1 and S1). We suspect this was due to the wider geographic and climate coverage included at coarser grains, and so there was more variability in the data for the model to explain. Another possibility is the increasing difference between the scale of actual field collections and the grain of the analysis. These explanations are speculative though.

Predictions of species density globally for different grains were similar (Figures 5 and S2) with Pearson correlations between the predictions of species density at different grains all above 0.71 (Table S2). The most noticeable differences are between the 1 km grain predictions and those of coarser grains, where the 1 km model predicted Africa to have generally higher species density and the Neotropics lower species density. However, it is at the 1 km grain that there are the fewest suitable records upon which to base a model, with substantially fewer records available for Asia, Africa, and South America compared to the 5 km and 10 km grains (Figures 1 and S1). Consequently, more of the world is also excluded from modelling at the 1 km grain because the smaller dataset samples less of the world's climates (e.g. much of Asia, Australia, the Middle East, and Africa were excluded).

From our analyses, we could not confidently discern effects due specifically to the grain of analysis. We found most studies to be suitable for use at a 10 km grain. Some studies did not include precise enough locality data to use them at a 5 km grain, but most did. For the 1 km grain, 43% of the records were unsuitable for our analyses, including most of the studies in Africa, Asia, and South America.

Appendix S2

Ants in hot and arid places

While across much of the range of conditions experienced by ants the patterns of diversity seem relatively simple, this is far from the case in hot and arid sites. Even a statement as simple as "drier conditions decrease diversity when precipitation is low" is difficult to make without qualifiers. For example, the exceptionally high ant diversity of arid Australia is maintained to at least 200 mm/year of rainfall (Greenslade, 1978; Hoffmann & James *in press*), with communities dominated numerically and ecologically by species of *Iridomyrmex*, and species of *Melophorus*, *Monomorium*, *Camponotus* and *Rhytidoponera* are highly abundant (Andersen, 2003). In contrast, the Tabernas desert and Cabo de Gata area of southeastern Spain are similarly dry with

230 mm and 150 mm/year of rainfall respectively, but tend to be species poor with from 4 to 11 species per plot (X. Cerdá & R. Boulay, unpublished data) and a total regional richness of just 25 species (Tinaut *et al*., 2009), far fewer than similarly dry parts of Australia. The most abundant species in these Spanish sites are *Lepisiota* (formerly *Acantholepis*) *frauenfeldi*, *Monomorium subopacum*, *Tapinoma nigerrimum* and the thermophilous *Cataglyphis iberica*. Even the somewhat wetter Mediterranean habitats (forests, grasslands, shrublands) of the region tend to be relatively poor with between 11 and 15 species (Retana & Cerdá, 2000).

The ant fauna is also relatively depauperate in arid parts of Africa, as in Spain, although the composition of the fauna is different. In the pre-Saharan steppes (120 mm/year) and Saharan desert (32 – 150 mm/year), the thermophilic genus *Cataglyphis* is common, just as in Spain, but there is a greater diversity of the granivorous *Messor* (Marsh, 1986) and *Lepisiota frauenfeldi* and *Camponotus thoracicus* are locally abundant (Bernard, 1958; Délye, 1968; Heatwole & Muir, 1991). Elsewhere in Africa, species richness tends to decline as rainfall decreases and is generally low in arid climates. In the dune fields and gravel plains of Namibia (~100 mm/year of rainfall), only 36 species were found in an area of approximately 60 km^2 (Marsh, 1986). In Northern Sinai in Egypt (<100 mm/year), local richness ranges from zero to 11 species with a total of 27 species for all of Egypt (El-Moursy *et al*., 2001). Comparatively higher richness has been recorded on the Arabian Peninsula, although this may be due to higher rainfall and greater vegetation cover in some areas (Collingwood, 1985; Collingwood & Agosti, 1996). Other surveys in southern Africa find from 9 species in semi-arid areas (300-350 mm/year) to a mean of 5.5 species in drier areas (<150 mm/year) (Koch & Vohland, 2004). The subfamily Myrmicinae tends to dominate, particularly granivorous species of *Tetramorium* and *Monomorium*. Highly thermophilic *Ocymyrmex* species are also a conspicuous addition.

The lower richness in African and European arid areas compared with Australia is possibly due to two factors. First, the average rainfall is simply much lower in parts of Africa than in the Australian arid zone, with large areas receiving 100 mm/year of rainfall or less. Australia has no such areas of extreme aridity (<100 mm/year). Second, in the most arid parts of Africa the vegetation cover, which provides a more varied microclimate, a range of nesting sites, as well as an important source of carbohydrates, is also lower than in Australia.

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Table S1 General linear models of global species density of ants at 1 km and 5 km grains. The percent change for Δ AICc represents the percent decline in the AICc value relative to that of the intercept only model. MAT = mean annual temperature, Precip = precipitation in the wettest quarter of the year, Realm = biogeographic realm.

1 km

Model	**$R^{2\ a}$**	**AICc**	**Δ AICc (-%)**	**Δ Log likelihood**	**DF**
MAT + Precip + Realm + Precip*Realm	0.83	2425	-5448 (69.2%)	2737	12
MAT + Precip + Realm	0.78	2612	-5261 (66.8%)	2638	7
MAT + Precip	0.42	3867	-4006 (50.9%)	2005	2
MAT	0.43	3907	-3966 (50.4%)	1984	1
Intercept only	-	7873	-	-	0

5 km

Model	**$R^{2\ a}$**	**AICc**	**Δ AICc (-%)**	**Δ Log likelihood**	**DF**
MAT + Precip + Realm + Precip*Realm	0.74	3973	-7839 (66.4%)	3932	12
MAT + Precip + Realm	0.45	5588	-6224 (52.7%)	3119	7
MAT + Precip	0.31	7223	-4589 (38.9%)	2297	2
MAT	0.31	7310	-4502 (38.1%)	2252	1
Intercept only	-	11812	-	-	0

Table S2 Pearson correlations between predictions of species density at different grains.

Predictions were restricted to those areas that were predictable at all grains.

Comparison	Correlation
1 km x 5 km	0.713
1 km x 10 km	0.730
5 km x 10 km	0.928

Table S3 Attributes of sites indicated in Figure 6. "Arid" indicates that the locality had an aridity index value <500. "Hot" indicates that the locality had a mean annual temperature >27°C, but was not arid. While the most arid sites sampled tend to have very few species, the hottest non-arid sites were consistently diverse, even though these sites included conditions close to the highest temperatures experience on terrestrial Earth. Sampling types used in the study are coded as: P = pitfalls; B = baits; L = litter; S = soil; H = hand collecting.

	Species density	**Country**	**Continent**	**Aridity index / Mean temp.**	**Number of samples**	**Sampling types**	**Reference**
				Arid sites (< 500)			
Arid	1	Tunisia	Africa	496	Unclear	H	Heatwole 1996
Arid	6-15	Namibia	Africa	109-376	30	P	Marsh 1986
Arid	1-8	Algeria	Africa	111-251	Unclear	H	Delye 1960
Arid	2-7	Algeria	Africa	32-545	Unclear	H	Delye 1964
Arid	4	Algeria	Africa	96	Unclear	H	Delye 1969
Arid	5-14	Libya	Africa	49	Unclear	H	Bernard 1948
Arid	10	Mongolia	Asia	478	75	BH	Pfeiffer *et al*. 2003
Arid	5	Israel	Asia	267	48	PH	Segev 2010
Arid	8	U.A. Emirates	Asia	<500	26	B	Heatwole 1991
Arid	2	Peru	S. America	129	26	B	Heatwole 1996
Arid	0	Chile	S. America	N/A	Unclear	H	Hunt & Snelling 1975
Arid	2	Chile	S. America	409	80	B	Medel & Vásquez 1994
Arid	3	Chile	S. America	248	80	B	Medel & Vásquez 1994
Arid	4	Chile	S. America	450	80	B	Medel & Vásquez 1994
				Hot sites (> 27°C)			

Hot	74	Australia	Australia	27.4	1924	PB	Andersen & Patel 1994
Hot	47	Australia	Australia	27.4	60	PL	Andersen & Reichel 1994
Hot	43	Australia	Australia	27.8	45	P	Andersen & Sparling 1997
Hot	81	Australia	Australia	27.9	118	P	Andersen 1991
Hot	145	Australia	Australia	27.9	1280	PB	Andersen 1992
Hot	145	Australia	Australia	27.1	448	P	Andersen *et al*. 2004
Hot	74	Australia	Australia	27.2	640	PL	Andersen *et al*. 2006
Hot	19-41	Australia	Australia	27.3-28.1	45	PBLH	Andersen & Majer 1991
Hot	16	Australia	Australia	27.4	60	B	Clay & Andersen 1996
Hot	14 - 38	Australia	Australia	27.7	20	PB	Greenslade 1985
Hot	70	Australia	Australia	27.3	300	P	Hoffmann 2000
Hot	91	Australia	Australia	27.3	480	P	Hoffmann 2003
Hot	140	Australia	Australia	27.3	240	PLSH	Hoffmann *et al*. 1999
Hot	28-51	Australia	Australia	27.4	30-90	PH	Reichel & Andersen 1996
Hot	143	Brazil	S. America	27.1	360	L	Vasconcelos *et al*. 2000
Hot	32	Venezuela	S. America	27.4	1	L	Ward 2000

Figure S1 Distribution of survey locations in the ant assemblage database for the 1 km and 5 km grains of analysis. Those suitable for analyses at a particular grain are marked with black circles while those excluded as unsuitable are marked with open circles. Maps use an equal area projection.

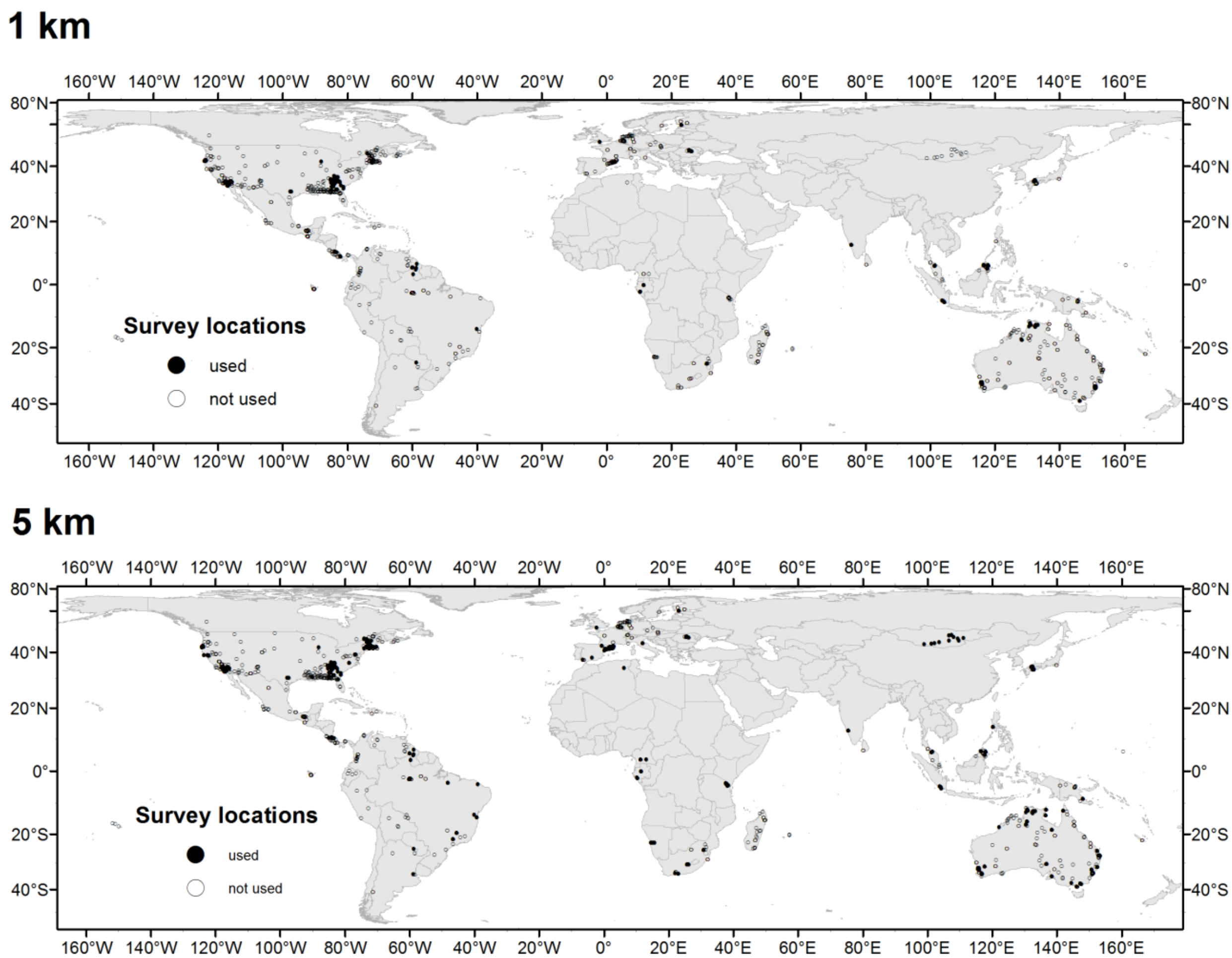

Figure S2 Species density of ants predicted at the 1 km and 5 km grains using the best-performing model, which includes: mean annual temperature, precipitation in the wettest quarter of the year, biogeographic realm, and the interaction between precipitation and realm (see Table S1). Dark grey areas are non-sampled climates as described in figure 4. Maps use an equal area projection.

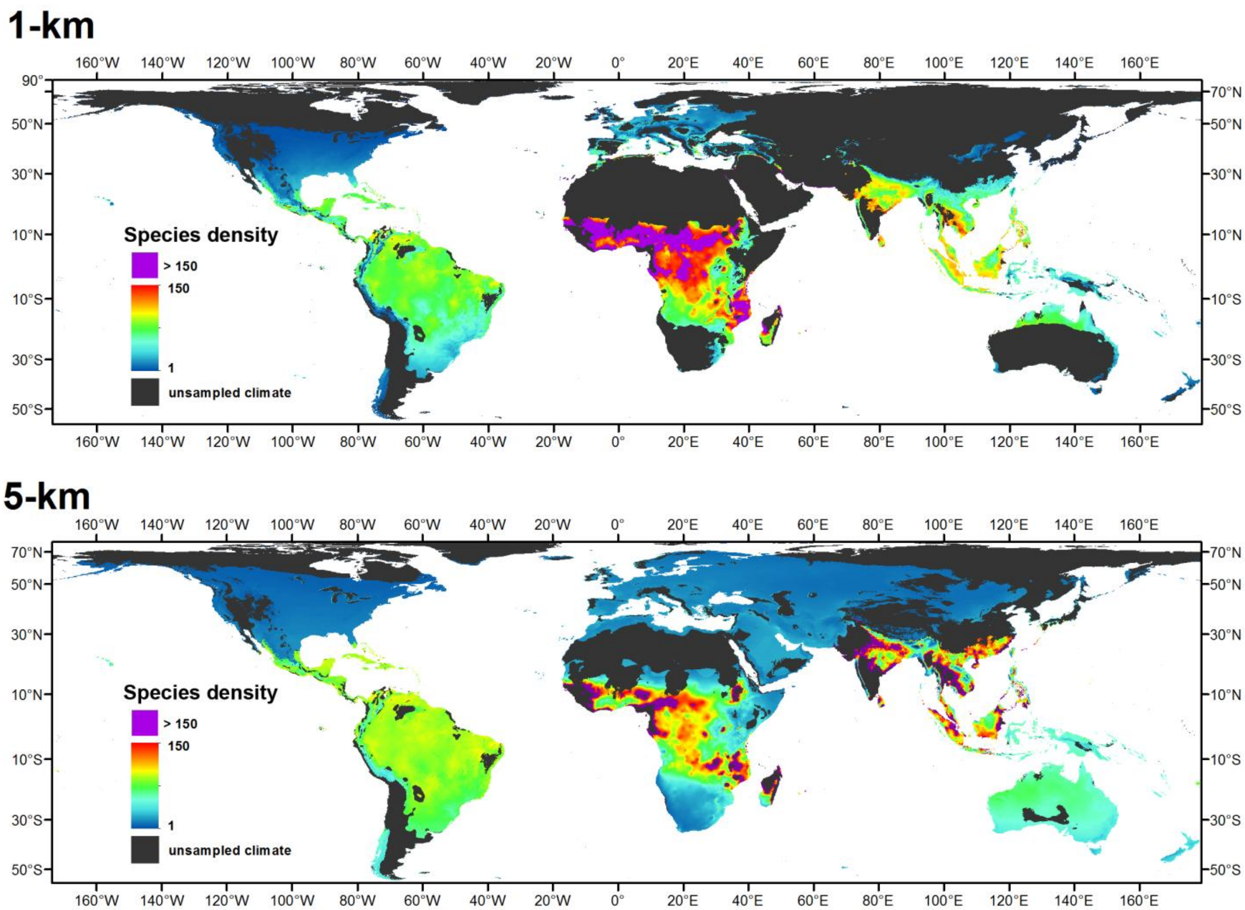

Figure S3 Plots of predicted versus observed species density for each of the 10 km grain models.

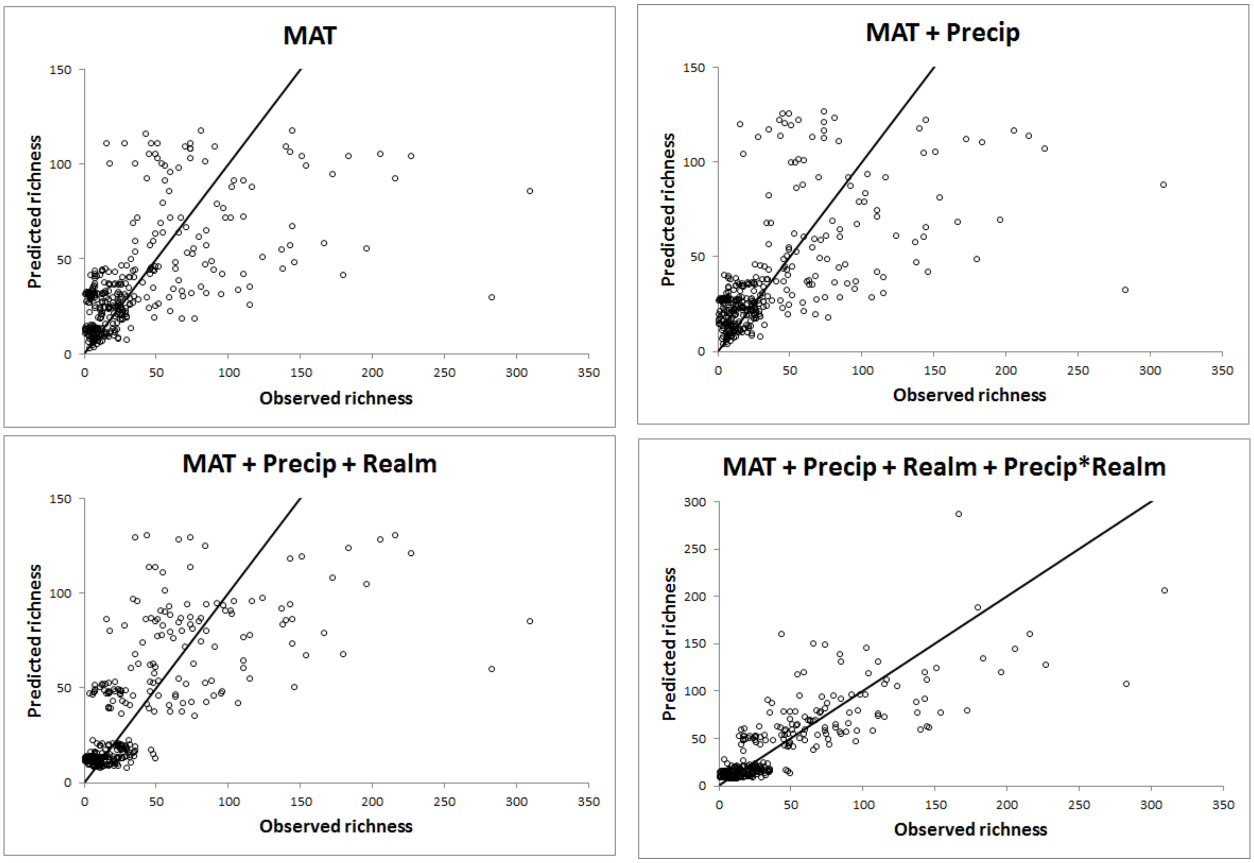

Figure S4 Distribution of climates that have not been adequately sampled for ants, shown under contemporary climate (dark grey, 34% of land area) and the expansion of these non-sampled climates, plus the emergence of no-analogue climates, projected for 2050 (red) for two additional climate models (GISS-AOM and BCCR-BCM2) using climate emissions scenario A2a. Together these areas are indicative of our ignorance of the potential future world. Maps use an equal area projection.