


A global database of ant species abundances

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Abstract. What forces structure ecological assemblages? A key limitation to general insights about assemblage structure is the availability of data that are collected at a small spatial grain (local assemblages) and a large spatial extent (global coverage). Here, we present published and unpublished data from 51,388 ant abundance and occurrence records of more than 2,693 species and 7,953 morphospecies from local assemblages collected at 4,212 locations around the world. Ants were selected because they are diverse and abundant globally, comprise a large fraction of animal biomass in most terrestrial communities, and are key contributors to a range of ecosystem functions. Data were collected between 1949 and 2014, and include, for each geo-referenced sampling site, both the identity of the ants collected and details of sampling design, habitat type, and degree of disturbance. The aim of compiling this data set was to provide comprehensive species abundance data in order to test relationships between assemblage structure and environmental and biogeographic factors. Data were collected using a variety of standardized methods, such as pitfall and Winkler traps, and will be valuable for studies investigating large-scale forces structuring local assemblages. Understanding such relationships is particularly critical under current rates of global change. We encourage authors holding additional data on systematically collected ant assemblages, especially those in dry and cold, and remote areas, to contact us and contribute their data to this growing data set.

Key words: abundance; ants; database; disturbance; Formicidae; geo-referenced; habitat; local assemblage; occurrence; pitfall trap; Winkler trap.

The complete data sets corresponding to abstracts published in the Data Papers section of the journal are published electronically as Supporting Information in the online version of this article at <http://onlinelibrary.wiley.com/doi/10.1002/ecy.1682/supinfo>

Introduction

General aims of database

Questions concerning communities, or sets of co-occurring species, are among the most challenging in ecology (Sutherland et al. 2013). Ecologists have focussed largely on the role of local-scale biotic and abiotic processes in determining the diversity and composition of communities. More recent macroecological work has highlighted that factors operating at larger scales, such as biogeography (e.g., Violle et al. 2014) and evolutionary history (e.g., Ricklefs 2008) also play a role (Sutherland 2013). In addition, chance is important (e.g., Hubbell 2001). Recognition of increasing anthropogenic pressures on assemblages at multiple scales has also focussed research on understanding multi-scalar effects of factors such as anthropogenic disturbance, climate change and species invasions (e.g., Mishra et al. 2004, Woodward et al. 2010, Pacciardi et al. 2011). Important insights into the relative importance of different forces in determining assemblage structure and composition at local scales can be obtained by examining how their influence changes across broader scales. For example, Gibb et al. (2015) showed that climate regulates the impact of disturbance on species richness and evenness. However, very few publicly available datasets exist that allow researchers to test the effects of broad-scale drivers on local assemblages. Although plot-based data on plant assemblages are relatively common (Weiser et al. 2007, Swenson et al. 2012), they often cover only limited geographic or climatic scales (e.g., Andersen-Teixeira et al. 2015). Analogous data are usually missing for animals, particularly invertebrates. Terrestrial animal assemblage datasets often contain only presence-absence information collected at a coarse spatial grain, precluding meaningful analysis of species co-occurrence (e.g., PanTHERIA, Jones et al. 2009) or cover only limited geographic extent (e.g., Atlas of Living Australia, www.ala.org.au, Carabids.org, Homburg et al. 2014). Other databases (e.g., PREDICTS, Hudson et al. 2014) focus primarily on human impacts on biodiversity and are not yet publicly available.

Why ants?

Ants (Hymenoptera: Formicidae) were selected as the target taxon because: (1) ants comprise a large fraction of animal biomass in most terrestrial communities (King et al. 2013); (2) ants perform a range of important ecosystem functions (Folgarait 1998, Del Toro et al. 2012); (3) ant sampling uses standard methods of sampling (i.e., pitfall traps and Winkler samplers), making inter-site comparisons possible (Agosti et al. 2000); (4) ant workers are abundant, so they are likely to be trapped if present; (5) ants are diverse, but more manageable than some insect groups; (6) data on ant morphology is obtainable from museums and other collections worldwide; (7) ants are well described relative to other easily trapped groups and are well documented online through a unique digital resource of images (antweb.org), catalogue and taxonomic literature (antbase.org, antcat.org, plazi.org); and (8) a robust molecular phylogeny of ants to the genus level exists (Ward et al. 2010, 2015, 2016a, 2016b, Moreau and Bell 2013, Brady et al. 2014).

History of the database

The database was originally assembled by Dunn et al. (2007), who focused on total species richness and abundance of georeferenced ant assemblages. Several papers using that dataset and investigating species richness and abundance responses to climate have been published (Dunn et al. 2009, Weiser et al. 2010, Jenkins et al. 2011). More recently, the database was significantly expanded to include more studies and data on the abundance of individual species within each assemblage. This has allowed collaborators to explore questions related to the composition of species within local assemblages, for example by investigating the

influence of the interactive effects of climate and disturbance on species richness and evenness (Gibb et al. 2015). Other research currently in progress using these data includes an examination of global drivers of the dominance-impoverishment rule (Arnan et al. in prep.), impacts of invasive species on assemblage structure and composition, and whether climate differentially affects ants belonging to different trophic groups (Sagata 2016).

Suggested links

The species assemblage database provides opportunities to link data with pre-existing online databases containing information on taxonomy (e.g., AntWeb, <http://www.antweb.org>; Antbase, <http://antbase.org>; Antcat, <http://antcat.org>), biogeography (e.g., GABI, <http://benoitguernard.wordpress.com/gabi-articles/>, <http://antmaps.org>, Janicki et al. 2016) and species traits (e.g., AntProfiler, <http://www.antprofiler.org>, Antkey, <http://antkey.org>). The authors are also in the process of developing a traits database that directly complements this database (<http://www.globalants.org>, Parr et al. in press). Further, data on ant assemblages can be combined with databases that cover other taxa (e.g., PREDICTS, <http://www.predicts.org.uk>, Hudson et al. 2014, TERN, <http://www.tern.org.au/Creating-a-global-vegetation-database-bgp3564.html>) to ask questions on the drivers of assemblage composition and structure at broader taxonomic scales.

Questions

The database will allow researchers to ask questions about the drivers of co-existence and diversity of ants at local scales and to separate the effects of different drivers of global change on species assemblages. Some questions worthy of investigation include:

- What are the key environmental drivers of assemblage structure and composition?
- Does the effect of global change drivers (climate, disturbance and invasive species) on species depend on trophic position, taxonomy or another trait?
- How do patterns of ant diversity and distribution compare with other better-studied taxa, such as plants and terrestrial vertebrates?
- What are the global-scale drivers of beta diversity for ants?
- What are the multi-scalar effects of spatial and temporal environmental heterogeneity on ant diversity?

Getting started

The database is presented as three separate csv files. These are the “Source”, “Localities” and “Observations” files, the contents of which are detailed in the Metadata section of this paper. Broadly, the **Source** file contains information about where the data came from, including the details of publications from which it was drawn or whether it is unpublished data, the **Localities** file includes a range of information about the studies, such as georeferencing, site descriptions, including disturbance status, details on trapping methods and simple measures of total abundance and total species richness for each locality, and the **Observations** file includes lists of species or morphospecies collected in each study and a measure of their abundance.

Files can be linked using the shared terms: Source and Localities files are linked by the “Source_ID” term, while Locality and Observation files are linked using the “Locality_ID” or “Source_ID” term, depending on the resolution required. All Observations data sets can be linked to Locations data by the “Source_ID” term, and most can be linked with the “Locality_ID” term. There are a few datasets for which ant assemblage details were not provided at the local scale and therefore cannot be linked with the “Locality_ID” term. Using the “Source_ID” link gives the assemblage for an entire study (several localities combined),

while using the “Locality_ID” link gives the assemblage for individual localities, so is preferable for most questions. Not all sites given in the Locality file link to Observations data: for these sites, the data were extracted from papers that reported only total species richness and abundance (but not species composition). Limitations of the data are detailed in the “Data limitations” section of this paper.

Metadata

Class I. Data set descriptors

A. Data set identity

Title: A global database of ant species abundances.

B. Data set and metadata identification codes

Suggested data set identity codes: global_ants_sources.csv, global_ants_localities.csv, global_ants_observations.csv.

C. Data set description

Investigators: same names and addresses as above.

Abstract: same as above.

D. Key words

Abundance, ants, database, disturbance, Formicidae, geo-referenced, habitat, local assemblage, occurrence, pitfall trap, Winkler trap

Class II. Research origin descriptors

A. Overall project description

Identity: local assemblage composition of ants

Originators: same names and addresses as above. Data were extracted from the literature or provided by co-authors; this project was part of an Australian Research Council grant (DP120100781) to HG, CLP, NJS and RRD.

Period of Study: 1949-2014

Objective: the aim of the study was to compile data detailing the abundance of ant species in local assemblages, i.e., co-occurring species. This data is ideal as a basis for studies investigating global drivers of the local–scale determinants of community structure.

Abstract: same as above.

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B. Specific subproject description

Site description: this data set comprises georeferenced local assemblage data on ant abundances from publications (i.e., 291 peer-reviewed manuscripts, 4 books, 16 theses and 11 reports or technical papers) and co-authors’ unpublished data (47 studies).

Experimental/Sampling design: all data were obtained from the literature (articles, books, theses, reports) and ecologists/myrmecologists. Sampling methods differed among studies and the details for each study are included in the `global_ants_localities.csv` file. Examples of methods used are aerial nets, artificial nests, baits, Berlese, emergence, excavation, fogging/ insecticide spraying, foliage beating, hand collecting, interception, light traps, malaise, mini Winkler, pan traps, pitfall traps, soil sample, sticky traps, subterranean, sweeping, tray sifting, vacuum, window and Winkler. Pitfall trapping was the most common method used (3142 out of 4212 localities) but was often combined with other trapping methods.

Research methods: Dunn et al. (2007) compiled a global database of ant biodiversity studies, including details of species richness and abundance for local ant assemblages.

The original database has not been made publicly available. This database extends Dunn et al. (2007) by including additional studies and by adding an ‘observations’ (global_ants_observations.csv) page, which details the abundance of individual species whereas the original database provided only abundance and species richness for the entire assemblage. The original database commenced with compilation of data from North American ant assemblages, followed by a larger-scale collaboration initiated at the International Union for the Study of Social Insects meeting in Washington D.C. in 2006. Collaborators compiled data from their own work and other studies. Further, we searched the Web of Science, Google Scholar and Formis (an ant literature database covering the 1800s through to 2003) using key words including FORMICIDAE + PITFALL, FORMICIDAE + LITTER, FORMICIDAE + TRANSECT and FORMICIDAE + DIVERSITY. Although we focussed on searches including the terms ‘pitfall’ (pitfall trapping) and ‘Winkler’ (Winkler litter sampling), we also included studies that used other methods, e.g., baiting and hand collection. We did not include studies that were limited to specific trophic groups, i.e., only studies sampling whole assemblages within a habitat were considered. For a limited set of datasets, repeated sampling at different times was provided as separate datasets for the same localities.

Class III. Data set status and accessibility

A. Status

Latest updates: the formal literature search for trait information ended in December 2010. Since that date, data has been collected through contributions from collaborators on an ongoing basis.

Latest archive date: current.

Metadata status: current.

Data Verification: data were double-checked for accuracy.

B. Accessibility

Storage location and medium: the original data files are held by the authors. This data set, published in Ecology, is the first public release of this data.

Contact person: queries about the entire data set or individual specific studies can be initially directed to Heloise Gibb, email: h.gibb@latrobe.edu.au or directly to the authors of individual studies (co-authors of this dataset).

Copyright and proprietary restrictions: none. When using the dataset, please cite this article to recognize the effort involved in gathering and collating the data and the willingness of the authors to make it publicly available.

Costs: none.

Class IV. Data structural descriptors

A. (1) Source file

Identity: global_ants_sources.csv

Size: 369 lines of source data, excluding header row.

Format and storage mode: comma-delimited, no compression.

Header information: column headers contain character formatted labels for source data. Each column has a unique column header e.g. Source ID, Author, Contributor, Source Type, Year of Publication and Source citation.

Alphanumeric attributes: mixed.

Special characters/fields: none.

(2) Localities data set file

Identity: global_ants_localities.csv

Size: 4455 lines of data, excluding header row. Overall, this data set contains 4212 georeferenced locations where abundance or occurrence and species richness of ant assemblages were recorded. Not all locality data has associated observed data as data that was extracted from manuscripts sometimes contained only abundance and species richness for the entire assemblage and no data on the abundance/ occurrence of individual species. Additional lines of data for the same locality appear if different trapping methods or data from different sampling times were kept separate.

Format and storage mode: comma-delimited, no compression.

Header information: column headers contain character formatted labels for locality data. See 'locality table' below for details.

Alphanumeric attributes: mixed.

Special characters/fields: none.

(3) Observations data set file

Identity: global_ants_observations.csv

Size: 51,388 lines of data, excluding header row. Overall, this data set contains 51,388 individual observations of abundance or occurrence for 2693 species and 7953 morphospecies.

Format and storage mode: comma-delimited, no compression.

Header information: column headers contain character formatted labels for observation data. See 'observations table' below for details.

Alphanumeric attributes: mixed.

Special characters/fields: none.

Source table

Column header	Variable definition	Unit	Data storage
Source ID	Unique identification name used to link the associated locality, observed and traits data with the source	N/A	Character
Authors	Author/s of the article or researchers responsible for the collection of the data (for unpublished data)	N/A	Character
Institution of primary author	The institution (university, museum, government department) associated with the primary author of the source	N/A	Character
Contributor	Person/ people who submitted the data for entry into the Global Ants Database	N/A	Character
Source Type	Location of original data e.g. Published manuscript, Unpublished data, Book chapter, Master's thesis, PhD thesis, Report	N/A	Character
Year of Publication	The year the data was published ("no year" for unpublished data)	N/A	Character
Source Citation	Complete citation of data source e.g. APA format for published manuscripts, books, reports and theses, and author and date of data collection for unpublished data	N/A	Character

Locality table

Column header	Variable definition	Unit	Data storage
Source ID	Link to source data	N/A	Character
Locality ID	Unique identification name used to link the locality data with a specific location and to a source	N/A	Character
Contributor	Person/ people who submitted the locality data for entry into the Global Ants Database	N/A	Character
Continent	Continent where the data was collected e.g. Oceania	N/A	Character
Political Region 1	Country where the data was collected e.g. Australia	N/A	Character
Political Region 2	State/region where the data was collected e.g. Victoria	N/A	Character
Political Region 3	Name of local area where the data was collected e.g. Wilson's Promontory National Park	N/A	Character
Locality Name	Locality name assigned by researcher/ as described in publication, e.g. Wilson's Promontory Closed Forest J	N/A	Character
Locality Description	Description of the location e.g. Grazed pasture, Savanna, Secondary forest	N/A	Character
Elevation	Elevation	metres	Numerical
Latitude	Coordinates	decimal degrees	Numerical
Longitude	Coordinates	decimal degrees	Numerical
Location Source	Source of locality position information (elevation, latitude, longitude)	N/A	Character
Accuracy of coordinates	Accuracy of the provided coordinates in metres	metres	Numerical
Total Ant Abundance	Total ant abundance per locality	N/A	Numerical
Total Ant Species Richness	Total ant species richness per locality	N/A	Numerical
Total Native Species Richness	Total native ant species richness per locality	N/A	Numerical

Column header	Variable definition	Unit	Data storage
Total Non Native Species Richness	Total non native ant species richness per locality	N/A	Numerical
Number Of Sampling Events	The number of separate data collection events e.g. 2, if sampled over two separate seasons	N/A	Numerical
Start Date (dd)	Day of the month when data collection began (dd)	N/A	Numerical
Start Date (mm)	Month when data collection began (mm)	N/A	Numerical
Start Date (yyyy)	Year when data collection began (yyyy)	N/A	Numerical
End Date (dd)	Day of the month when data collection ended (dd)	N/A	Numerical
End Date (mm)	Month when data collection ended (mm)	N/A	Numerical
End Date (yyyy)	Year when data collection ended (yyyy)	N/A	Numerical
Total Number Of Transects	Total number of transects or plots per locality	N/A	Numerical
Length	Length of transects/plots	metres	Numerical
Width	Width of transects/plots	metres	Numerical
Plot Transect Separation	The distance between plots or transects	metres	Numerical
Method	Method used to collect ant specimens e.g. Pitfall, Baits, Winkler, Hand collecting, Vacuum, Arboreal baits	N/A	Character
Method Description	Written description of the method/procedure used to collect ant specimens	N/A	Character
Pitfall Number	Number of pitfall traps (total for location per sampling event)	N/A	Numerical
Pitfall Surface Area	Surface area of a single pitfall trap open face	centimetres ²	Numerical
Pitfall Spacing	Distance between pitfalls	metres	Numerical
Pitfall Duration	Total duration pitfall traps were exposed i.e. combined total of all sampling events	hours	Numerical
Baits Number	Number of baits (total for location per sampling event)	N/A	Numerical
Bait Stations Number	Number of bait stations (total for location per sampling event)	N/A	Numerical

Column header	Variable definition	Unit	Data storage
Baits Spacing	Distance between baits/bait stations	metres	Numerical
Baits Duration	Total duration baits/bait stations were exposed i.e. combined total of all sampling events	hours	Numerical
Winkler Number	Number of Winkler traps (total for location per sampling event)	N/A	Numerical
Winkler Spacing	Distance between Winkler traps	metres	Numerical
Berlese Number	Number of Berlese traps (total for location per sampling event)	N/A	Numerical
Berlese Spacing	Distance between Berlese traps	metres	Numerical
Total Litter Sample Volume	Volume of individual litter samples	litres	Numerical
Total Litter Sample Area	Area of individual litter samples	metres	Numerical
Habitat Type	Habitat type e.g. closed canopy forest	N/A	Character
Disturbance	Category of habitat disturbance e.g. Transformed, Disturbed, Undisturbed	N/A	Character
Disturbance Type 1	Description of type of habitat disturbance e.g. Agriculture, Cropping, Fire, Mining	N/A	Character
Disturbance Type 2	Description of second type of habitat disturbance e.g. Agriculture, Cropping, Fire, Mining	N/A	Character
Habitat Description	Written description of the habitat where data was collected	N/A	Character
Notes	Additional relevant information that is not appropriate for the determined column headers	N/A	Character

Observed table

Column header	Variable definition	Unit	Storage type
Observed ID	Unique identifier for each species observed at each Locality ID	N/A	Character
Source ID	Links the Locality data with the Source data	N/A	Character
Locality ID	Links the observed data to the Locality data	N/A	Character
Contributor	Name of the person/ people who submitted the observed data to the Global Ants Database	N/A	Character
Genus	Genus name	N/A	Character
Species	Species name	N/A	Character
Morphospecies	Morphospecies name as designated by contributor	N/A	Character
Measurement Type	Type of abundance measure e.g. Abundance, Occurrence, Other	N/A	Character
Abundance	The number of individuals of each species per locality	N/A	Numerical
Occurrence	The number of traps in which a species occurred at each locality	N/A	Numerical
Other	Data not in the form of abundance or occurrence e.g. frequency	N/A	Numerical
Notes	Additional relevant information that does not fit into a determined column header	N/A	Character

B. Data limitations

Studies were conducted over varying timeframes, at varying scales and with a range of sampling methods and efforts, all of which differ in the completeness in which they sample assemblages. These elements of the dataset are documented so it is possible to use measures of scale and trapping effort as covariates in analyses. In some cases different trapping methods were pooled, but we have made an effort to keep different trapping methods separate as often as possible. Similarly, different sampling events at the same locality were sometimes kept separate.

There are limitations associated with sampling workers of colonial insects. As noted previously (Gotelli et al. 2011), estimating ant abundance from the number of workers collected in traps can be problematic. Ants vary in colony size, foraging and recruitment behaviour and these (along with other factors) will influence the number of individuals found in a pitfall trap or Winkler sample. While the ideal ecological estimate of abundance would include the number of nests or colonies per unit area or sampling effort, the number of workers collected still holds value as a measure of relative abundance or indication of species-specific activity during the period of sampling. For guidelines on how to analyse abundance or occurrence data based on worker capture, see Gotelli et al. (2011).

Methods of recording abundances include mainly the total count of individuals (abundance) and the count of traps in which a species occurs (occurrence), but some studies also report abundances using less common metrics, including: mean abundance, proportion of occurrence, presence/ absence, adjusted abundance, frequency of occurrence, number of nests (nest excavation studies), and categorised occurrence, e.g., present in 5 or fewer traps, present in more than 5 traps. Spatial coverage is somewhat unbalanced, with very few studies from Asia and north Africa. Additionally, ants are poorly described in some parts of the world and in those areas, morphospecies, rather than species, are commonly used in community analyses. Limitations associated with the use of morphospecies should be considered when using the dataset. These sources of variation may limit the analyses that the data can be used for.

Class V. Data set references

These are provided in the `global_ants_sources.csv` file, either as publications or as authors and institutions for unpublished data.

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Funders for collection of individual data sets are listed in Class II A above.

Literature cited

Agosti, D., J. Majer, E. Alonso, and T. Schultz, (eds.) 2000. *Ants: Standard methods for measuring and monitoring biodiversity*. Biological Diversity Handbook Series. Smithsonian Institution Press. Washington D.C.

Anderson-Teixeira, K. J., S. J. Davies, A. C. Bennett, E. B. Gonzalez-Akre, H. C. Muller-Landau, S. Joseph Wright, K. Abu Salim, A. M. Almeyda Zambrano, A. Alonso, J. L. Baltzer, Y. Basset, N. A. Bourg, E. N. Broadbent, W. Y. Brockelman, S. Bunyavejchewin, D. F. R. P. Burslem, N. Butt, M. Cao, D. Cardenas, G. B. Chuyong, K. Clay, S. Cordell, H. S. Dattaraja, X. Deng, M. Detto, X. Du, A. Duque, D. L.

- Erikson, C. E. N. Ewango, G. A. Fischer, C. Fletcher, R. B. Foster, C. P. Giardina, G. S. Gilbert, N. Gunatilleke, S. Gunatilleke, Z. Hao, W. W. Hargrove, T. B. Hart, B. C. H. Hau, F. He, F. M. Hoffman, R. W. Howe, S. P. Hubbell, F. M. Inman-Narahari, P. A. Jansen, M. Jiang, D. J. Johnson, M. Kanzaki, A. R. Kassim, D. Kenfack, S. Kibet, M. F. Kinnaird, L. Korte, K. Kral, J. Kumar, A. J. Larson, Y. Li, X. Li, S. Liu, S. K. Y. Lum, J. A. Lutz, K. Ma, D. M. Maddalena, J.-R. Makana, Y. Malhi, T. Marthews, R. Mat Serudin, S. M. McMahon, W. J. McShea, H. R. Memiaghe, X. Mi, T. Mizuno, M. Morecroft, J. A. Myers, V. Novotny, A. A. de Oliveira, P. S. Ong, D. A. Orwig, R. Ostertag, J. den Ouden, G. G. Parker, R. P. Phillips, L. Sack, M. N. Sainge, W. Sang, K. Sri-ngernyuang, R. Sukumar, I. F. Sun, W. Sungpalee, H. S. Suresh, S. Tan, S. C. Thomas, D. W. Thomas, J. Thompson, B. L. Turner, M. Uriarte, R. Valencia, M. I. Vallejo, A. Vicentini, T. Vrška, X. Wang, X. Wang, G. Weiblen, A. Wolf, H. Xu, S. Yap, and J. Zimmerman. 2015. CTFS-ForestGEO: a worldwide network monitoring forests in an era of global change. *Global Change Biology* 21:528-549.
- Brady, S. G., B. L. Fisher, T. R. Schultz, P. S. Ward 2014. The rise of army ants and their relatives: diversification of specialized predatory doryline ants. *BMC Evolutionary Biology* 14:93.
- Del Toro, I.; R. R. Ribbons, S. L. Peleni 2012. The little things that run the world revisited: a review of ant-mediated ecosystem services and disservices (Hymenoptera: Formicidae). *Myrmecological News* 17:133-146.
- Dunn, R. R., D. Agosti, A. N. Andersen, X. Arnan, C. A. Bruhl, C. X., A. M. Ellison, B. L. Fisher, M. C. Fitzpatrick, H. Gibb, N. J. Gotelli, A. D. Gove, B. Guenard, M. Janda, M. Kaspari, E. J. Laurent, J.-P. Lessard, J. T. Longino, J. D. Majer, S. B. Menke, T. P. McGlynn, C. L. Parr, S. M. Philpott, M. Pfeiffer, J. Retana, A. V. Suarez, H. L. Vasconcelos, M. D. Weiser, and N. J. Sanders. 2009. Climatic drivers of hemispheric asymmetry in global patterns of ant species richness. *Ecology Letters* 12:324-333.
- Dunn, R. R., N. J. Sanders, M. C. Fitzpatrick, E. Laurent, J. P. Lessard, D. Agosti, A. N. Andersen, C. Bruhl, X. Cerda, A. M. Ellison, B. Fisher, H. Gibb, N. Gotelli, A. D. Gove, B. Guenard, M. Janda, M. Kaspari, J. T. Longino, J. D. Majer, T. P. McGlynn, S. Menke, C. L. Parr, S. M. Philpott, M. Pfeiffer, J. Retana, A. V. Suarez, and H. L. Vasconcelos. 2007. Global ant (Hymenoptera: Formicidae) biodiversity and biogeography - a new database and its possibilities. *Myrmecological News* 10:77-83.
- Folgarait, P. J. 1998. Ant biodiversity and its relationship to ecosystem functioning: a review. *Biodiversity and Conservation* 7:1221-1244.
- Gotelli, N.J., A.M. Ellison, R.R. Dunn and N.J. Sanders. 2011. Counting ants (Hymenoptera: Formicidae): biodiversity sampling and statistical analysis for myrmecologists. *Myrmecological News* 15:13-19.
- Gibb, H., N. J. Sanders, R. R. Dunn, S. Watson, M. Photakis, S. Abril, A. N. Andersen, E. Angulo, I. Armbrrecht, X. Arnan, F. B. Baccaro, T. R. Bishop, R. Boulay, C. Castracani, I. Del Toro, T. Delsinne, T. M. Fayle, M. Diaz, D. A. Donoso, M. L. Enri, D. A. Grasso, S. Groc, B. Heterick, B. D. Hoffmann, L. Lach, J. Lattke, M. Leponce, J.-P. J. J.-P. Lessard, D. Mezger, A. Mori, T. C. Munyai, O. Paknia, J. Pearce-Duvet, M. Pfeiffer, S. M. Philpott, J. L. P. De Souza, M. Tista, H. L. Vasconcelos, M. Vonshak, C. L. Parr, C. Valle, I. Del Toro, T. Delsinne, M. Diaz, D. A. Donoso, M. L. Enriquez, T. M. Fayle, D. H. Feener, M. C. Fitzpatrick, C. Gomez, D. A. Grasso, S. Groc, B. Heterick, B. D. Hoffmann, L. Lach, J. Lattke, M. Leponce, J.-P. Lessard, J. Longino, A. Lucky, J. Majer, S. B. Menke, D. Mezger, A. Mori, T. C. Munyai, O.

- Paknia, J. Pearce-Duvel, M. Pfeiffer, S. M. Philpott, J. L. P. de Souza, M. Tista, H. L. Vasconcelos, M. Vonshak, C. L. Parr. 2015. Climate mediates the effects of disturbance on ant assemblage structure. *Proceedings of the Royal Society of London B: Biological Sciences* 282:20150418.
- Homburg, K., N. Homburg, F. Schäfer, A. Schuldt, and T. Assmann. 2014. Carabids.org—a dynamic online database of ground beetle species traits (Coleoptera, Carabidae). *Insect Conservation and Diversity* 7:195-205.
- Hubbell, S. P. 2001. *The Unified Neutral Theory of Biodiversity and Biogeography*. Princeton University Press, NJ, USA.
- Hudson, L. N., T. Newbold, S. Contu, S. L. Hill, I. Lysenko, A. D. Palma, H. R. Phillips, R. A. Senior, D. J. Bennett, and H. Booth. 2014. The PREDICTS database: a global database of how local terrestrial biodiversity responds to human impacts. *Ecology and Evolution* 4:4701-4735.
- Janicki, J. H., N. Narula, M. Ziegler, B. Guénard and E. P. Economo. 2016. Visualizing and interacting with large-volume biodiversity data using client-server web mapping applications: The design and implementation of antmaps.org. *Ecological Informatics* 32:185-193.
- Jenkins, C. N., N. J. Sanders, A. N. Andersen, X. Arnan, C. A. Bruhl, X. Cerda, A. M. Ellison, B. L. Fisher, M. C. Fitzpatrick, N. J. Gotelli, A. D. Gove, B. Guenard, J. E. Lattke, J. P. Lessard, T. P. McGlynn, S. B. Menke, C. L. Parr, S. M. Philpott, H. L. Vasconcelos, M. D. Weiser, and R. R. Dunn. 2011. Global diversity in light of climate change: the case of ants. *Diversity and Distributions* 17:652-662.
- Jones, K. E., J. Bielby, M. Cardillo, S. A. Fritz, J. O'Dell, C. D. L. Orme, K. Safi, W. Sechrest, E. H. Boakes, and C. Carbone. 2009. PanTHERIA: a species-level database of life history, ecology, and geography of extant and recently extinct mammals: *Ecological Archives* E090-184. *Ecology* 90:2648-2648.
- King, J. R., R. J. Warren and M. A. Bradford. 2013. Social insects dominate eastern US temperate hardwood forest macroinvertebrate communities in warmer regions. *PLoS One*. 8: e75843.
- Mishra, B. P., O. P. Tripathi, R. S. Tripathi, and H. N. Pandey. 2004. Effects of anthropogenic disturbance on plant diversity and community structure of a sacred grove in Meghalaya, northeast India. *Biodiversity and Conservation* 13:421–436.
- Moreau, C. S. and C. D. Bell. 2013. Testing the museum versus cradle tropical biological diversity hypothesis: phylogeny, diversification, and ancestral biogeographic range evolution of the ants. *Evolution* 67:2240-2257.
- Pacciardi, L., A. M. De Biasi and L. Piazzzi. 2011. Effects of *Caulerpa racemose* invasion on soft-bottom assemblages in the Western Mediterranean Sea. *Biological Invasions* 13:2677–2690.
- Parr, C. L., R. R. Dunn, N. J. Sanders, M. D. Weiser, M. Photakis, M. C. Fitzpatrick, X. Arnan, F. Baccaro, T. R. Bishop, C. R. F. Brandão, L. Chick, D. A. Donoso, T. M. Fayle, C. Gómez, B. Grossman, T. C. Muniyai, R. Pacheco, J. Retana, K. Sagata, R. R. Silva, M. Tista, H. L. Vasconcelos, M. Yates, and H. Gibb. in review. GLobal Ants trait Database (GLAD): a new database on the geography of ant traits (Hymenoptera: Formicidae). in press. *Insect Diversity and Conservation*.

- Ricklefs, R. E. 2008. Disintegration of the ecological community. *American Naturalist* 172:741-750.
- Sagata, K. 2016. Climate effects on ant-Hemiptera interactions, ant richness and morphology. PhD thesis, La Trobe University, Melbourne, Australia.
- Sutherland, W. J., R. P. Freckleton, H. C. J. Godfray, S. R. Beissinger, T. Benton, D. D. Cameron, Y. Carmel, D. A. Coomes, T. Coulson, M. C. Emmerson, and R. S. Hails. 2013. Identification of 100 fundamental ecological questions. *Journal of Ecology* 101:58-67.
- Swenson, N. G., B. J. Enquist, J. Pither, A. J. Kerkhoff, B. Boyle, M. D. Weiser, J. J. Elser, W. F. Fagan, J. Forero-Montaña, N. Fyllas, N. J. B. Kraft, J. K. Lake, A. T. Moles, S. Patiño, O. L. Phillips, C. A. Price, P. B. Reich, C. A. Quesada, J. C. Stegen, R. Valencia, T. E. Lacher Jr, A. Monteagudo, M. P. Núñez-Vargas, R. Vasquez-Martínez, and K. M. Nolting. 2012. The biogeography and filtering of woody plant functional diversity in North and South America. *Global Ecology and Biogeography* 21: 798-808.
- Violle, C., P. B. Reich, S. W. Pacala, B. J. Enquist, and J. Kattge. 2014. The emergence and promise of functional biogeography. *Proceedings of the National Academy of Sciences of the United States of America* 111: 13690-13696.
- Ward, P. S., B. B. Blaimer and B. L. Fisher. 2016a. A revised phylogenetic classification of the ant subfamily Formicinae (Hymenoptera: Formicidae), with resurrection of the genera *Colobopsis* and *Dinomyrmex*. *Zootaxa* 4072:343-357.
- Ward, P. S., S. G. Brady, B.L. Fisher and T.R. Schultz. 2010. Phylogeny and biogeography of dolichoderine ants: effects of data partitioning and relict taxa on historical inference. *Systematic Biology* 59:342-362.
- Ward, P. S., S. G. Brady, B. L. Fisher and T. R. Schultz. 2015. The evolution of myrmicine ants: phylogeny and biogeography of a hyperdiverse ant clade (Hymenoptera: Formicidae). *Systematic Entomology* 40:61-81.
- Ward, P. S. and B. L. Fisher. 2016b. Tales of dracula ants: the evolutionary history of the ant subfamily Amblyoponinae (Hymenoptera: Formicidae). *Systematic Entomology* 41:683-693.
- Weiser, M. D., B. J. Enquist, B. Boyle, T. J. Killeen, P. M. Jørgensen, G. Fonseca, M. D. Jennings, A. J. Kerkhoff, T. E. Lacher Jr., A. Monteagudo, M. P. N. Vargas, O. L. Phillips, N. G. Swenson, and R. V. Martínez. 2007. Latitudinal patterns of range size and species richness of New World woody plants. *Global Ecology and Biogeography* 16: 679-688.
- Weiser, M. D., N. J. Sanders, D. Agosti, A. N. Andersen, A. M. Ellison, B. L. Fisher, H. Gibb, N. J. Gotelli, A. D. Gove, K. Gross, B. Guenard, M. Janda, M. Kaspari, J. P. Lessard, J. T. Longino, J. D. Majer, S. B. Menke, T. P. McGlynn, C. L. Parr, S. M. Philpott, J. Retana, A. V. Suarez, H. L. Vasconcelos, S. P. Yanoviak, and R. R. Dunn. 2010. Canopy and litter ant assemblages share similar climate-species density relationships. *Biology Letters* 6:769-772.
- Woodward, G., D. M. Perkins and L. E. Brown. 2010. Climate change and freshwater ecosystems: impacts across multiple levels of organization. *Philosophical Transactions of the Royal Society of London B: Biological Sciences* 365:2093-2106.