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Forum

Ant Profiler – a database of ecological characteristics of ants (Hymenoptera: Formicidae)

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Abstract: We developed a database of 24 major ecological characteristics of ants – "Ant Profiler" – which includes information on species morphology, colony dynamics, behaviour, habitat, nesting sites, diet, species interactions and distribution. Our database is a publically available research tool to study the ecology of ants and relies on the contribution of the myrmecologist community to provide information on ants. The specificity of our database, compared to other existing ant databases, is that it presents ecological information in a structured and standardized way instead of a descriptive text. The interface of our webpage makes information searchable and allows users to retrieve a list of species corresponding to any particular trait or combination of traits. The database allows downloading data that can be used by any statistic software for further analysis.

Introduction

Over the last decades, there has been an increasing awareness of the importance of ants for the understanding of ecology and ecosystem functioning. Ants do not only represent an important part of animal biomass (WILSON & HÖLLDOBLER 2005) they also play important roles in numerous ecosystem functions – from seed dispersal to nutrient cycling in the soil (FOLGARAIT 1998, LACH & HOOPER-BUI 2010). The high diversity of ants in terms of number of species, ecological roles, reproductive systems, social organizations and life styles makes ants an ideal model system. Understanding the role of ants in ecosystems and factors that influence ant diversity and abundance is crucial for a wide range of scientists, especially ecologists and conservation biologists.

First, it would be interesting to simply have an estimation of the proportion of known species that present certain traits such as polygyny, or the proportion of species that are parasitic, slave-making or nest raiding. Such information, although basic and crucial, is currently lacking, despite many specialists being knowledgeable about many traits for subsets of species.

Second, many outstanding questions in ecology and evolution concern the analysis of global patterns and correlations of species' traits. For example, recent studies have attempted to find correlates of geographic distributions of ants (GERAGHTY & al. 2007), to relate the species' ecology to phylogeny (JANDA & al. 2004, MACHAC & al. 2011), to investigate traits of invasive species (MCGLYNN 1999, LESTER 2005, WITTENBORN & JESCHKE 2011), or to test correlates of stress-tolerance (DIAMOND & al. 2011). However, these correlative studies have generally used a small subset of species (e.g., North American ants). A global database of ecological characteristics would allow further and more robust investigation of these questions and it would allow asking many more. For example, it would be interesting to search for traits associated with polygyny or different modes of colony foundation (NAKAMARU & al. 2007). It would be possible to investigate factors related to different colony sizes (HOLBROOK & al. 2011), reproductive strategies (BOOMSMA & al. 2009), different foraging behaviours (MOREHEAD & FEENER 1998, BESTELMEYER 2000), body sizes (KASPARI 2005), morphological castes and polydomy (DEBOUT & al. 2005) at a global scale.

Studying ecological traits of ants will lead to advances in understanding ecology in general. But it becomes especially important to know more about global patterns and correlations of ant characteristics in the light of on-going global changes. Notably climate change and biological invasions are both predicted to have enormous consequences for biodiversity (BELLARD & al. 2012, SIMBERLOFF & al. 2013). But species' vulnerability to these drivers of species' extinctions depends in part on the species' ecological traits (FODEN & al. 2008). Yet, in order to make predictions and quantitative assessments, global patterns need to be investigated (ANGERT 2011). With a large-scale database of ecological characteristics of ants, it becomes possible to test for global patterns.

A similar database on ecological and morphological traits of plants, LEDA (KLEYER & al. 2008), has been cited in 70+ publications on diverse subject areas, aiming to understand life-history strategies and ecological mechanisms, using plants as a model system. For example, this database has been used to investigate the role of life-history traits in ecosystem functioning (THOMPSON & al. 2005), species survival (SOONS & OZINGA 2005) and plant distributions in fragmented landscapes (ENDELS & al. 2007).

Currently, several excellent ant databases exist, including Antweb (FISHER 2012), Antbase (AGOSTI & JOHNSON 2005), Ants of Africa (TAYLOR 2010), Japanese ant image database (JAPANESE ANT DATABASE GROUP 2003), NZ landcare (LANDCARE RESEARCH 2012), Ants of North America (MACKAY & MACKAY 2003), Fourmis de France (WAGENKNECHT & al. 2012) and Encyclopedia of Life's (EOL) section on ants (WILSON 2003, KAUTZ & MOREAU 2011, ENCYCLOPEDIA OF LIFE 2012). Generally, the main focus of these databases is on species morphology and distribution. Additional information on the species ecology, e.g., habitat, nesting requirements or species interactions, is usually presented in form of a brief description. This ecological description of a species' ecology does not, however, follow a general structure, as it is classically the case for the descriptions of taxonomic characteristics in the databases mentioned above. Although, much information exists on the ecology of ants, it is dispersed in books, publications, and much exists in the form of personal knowledge of myrmecologists, unpublished datasets and the databases mentioned above. The lack of a standardized database of ant ecology makes it impossible to access and analyze this existing information in a quantitative way. Therefore, we decided to set up a global database of ecological characteristics of ants with the aim to offer this possibility to the scientific community. "Ant Profiler" (http://www.antprofiler.org), is the only database providing a structured and standardized ecological "profile" for each species, which can be directly used in global as well as comparative studies. The aim of the database is to become a public research tool that relies on the contribution of myrmecologists.

Description of the database

For each species, a "profile" is created that contains the available information on 24 basic ecological characteristics (Appendix 1, as digital supplementary material to this article, at the journal's web page). The information is presented like an ID-card, in form of a list of all categories and the value corresponding to each of these categories (Fig. 1). We included information on: (I) species occurrence (ecozones, distribution by country, habitat types, nesting types, association with disturbance, invasiveness status); (II) species morphology (min. and max body size, worker polymorphism, sterile / egg-laying workers, presence of a sting); (III) colony dynamics (polygyny, colony structure, colony density, colony size); (IV) behaviour (diet, aggressiveness, foraging behaviour, activity range); and (V) species interactions (symbioses, parasitism, nest-raids, slave-making species). According to the type of data, the values of the characteristics can be binary, quantitative, mutually exclusive or multiple-choice (e.g., "habitat", as a species can be present in different habitat types).

At the end of the species' profile, references can be associated with each contribution. Published work from journals or books can be linked to one or several of the characteristics, so that the information in the database can be retraced to its original source. However, in order to avoid losing existing but unpublished information, it is also possible that myrmecologists indicate that the information is a "personal observation" and thereby they become the reference for the value they contributed.

Searching for information

The main specificity of our database is that it allows one to search for species with certain ecological characteristics (Fig. 2). We developed a search interface, which enables the user to search for all species corresponding to a certain trait (e.g., predatory species) or combination of traits (e.g., predatory species living in rainforests). To make searches easier, users can select the value of the trait that they are interested in and select a search link; in that way the user can select not only species corresponding exactly to a certain characteristic, but also species that have, for example, colony sizes that are "equal to" or "greater than" a certain numerical value. It is also possible to search for characteristics within a genus or a geographic area.

Furthermore, it is possible to search for traits of any given species by consulting its profile. This can be especially interesting for local investigations that aim to know all the traits of all species found in a specific site. Similarly, it is possible to search for traits within a given genus by accessing each of the species profiles that are all provided by one single request.

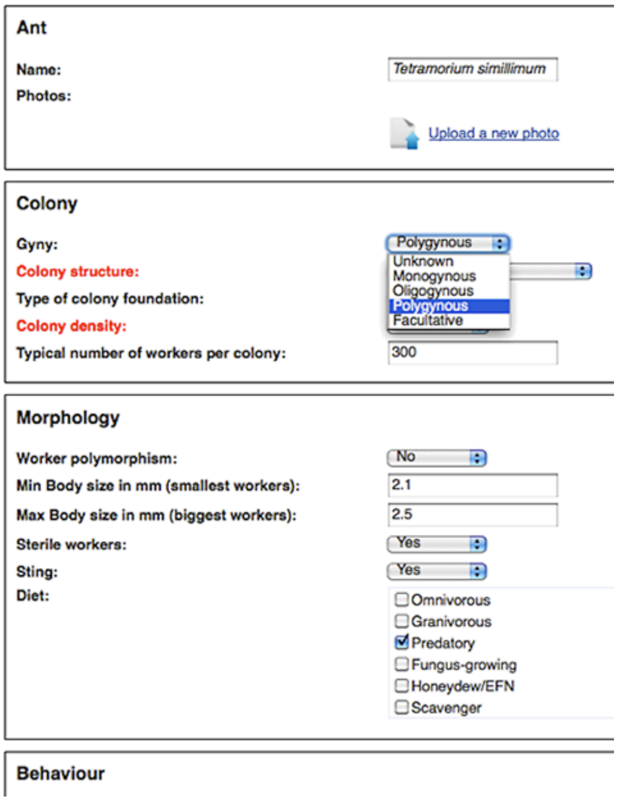

Fig. 1: Example of the first part of a species' profile.

In addition, the asset of this database structure is that it allows statistical analyses, such as correlations between any pair of traits or even more complete, multivariate analyses. The whole dataset can be downloaded as an excel file and data can be directly analyzed, opening the possibility to answer an endless number of questions (e.g., Fig. 3). As a first step, the access to the information, in form of a spread-sheet, will be restricted to significant contributors of the database.

Data contribution

Ant Profiler is an online database, which relies on the contribution of myrmecologists, who have to register in order to add information to the database. An author can either "create" a new species-profile, which does not already exist in the database, or contribute lacking information for an existing species. Each piece of information is linked to the name of the contributing author so that all contributions can be retraced to their author. The "history" of each profile is also displayed, enabling the user to consult the date at which new information has entered the database as well as the author and date of subsequent modifications. At present, approximately 30 authors are registered and more than 2000 profiles of ant species have been entered. This already represents 13.5% of described ant species in the Bolton catalogue (BOLTON & al. 2007). The number of species created can be visualized on the main page of the database.

Conclusion

Ant Profiler is a database of ant species that includes 24 basic ecological characteristics and that allows to search any species corresponding to a certain characteristic or combination of characteristics. The database includes quantifiable

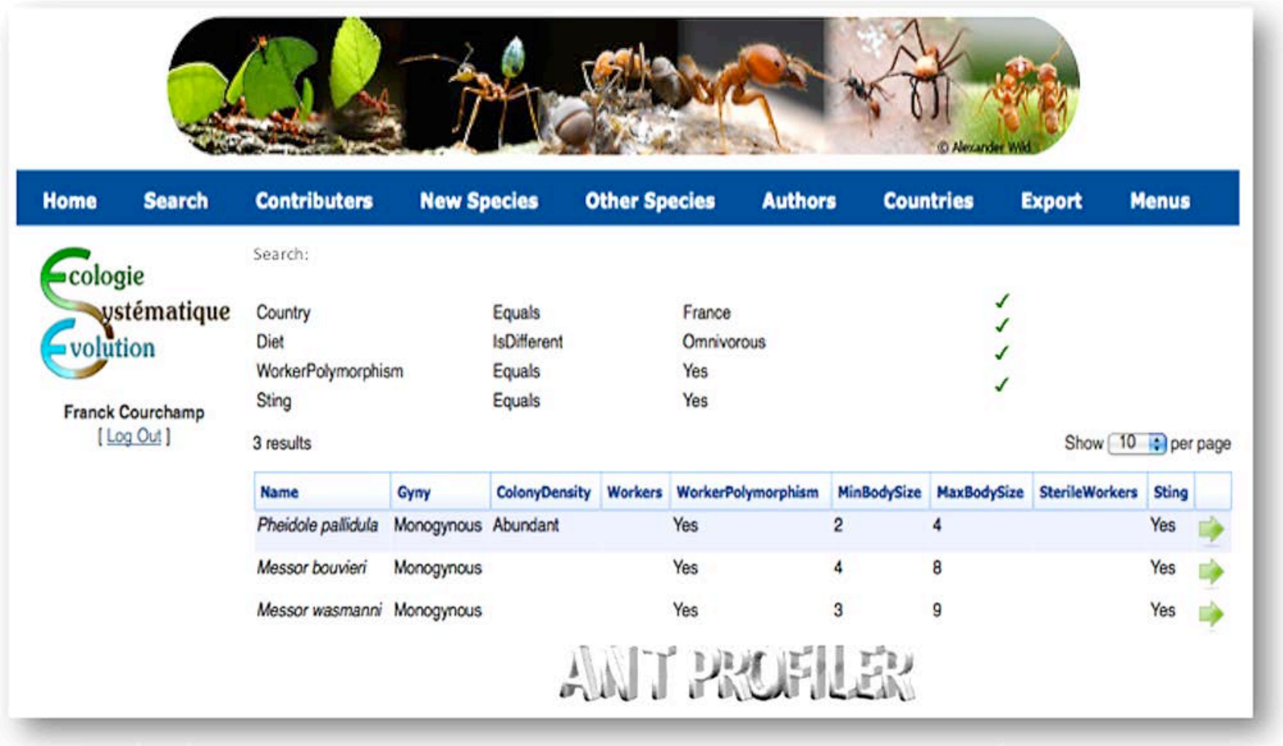

Fig. 2: Search interface allowing the user to search for all species in the database presenting any particular trait or combination of traits. It is possible to access any of the profiles of these species.

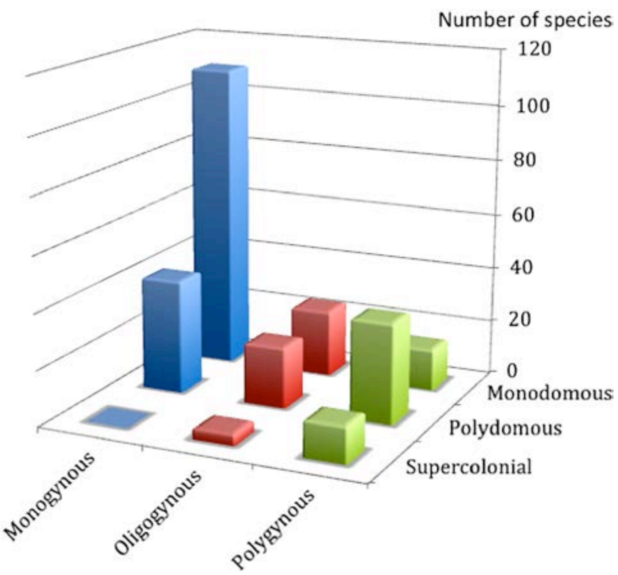

Fig. 3: Relationship between nest structure and the number of queens as an illustration of a possible question that could be investigated with the Ant Profiler dataset.

information on ants that can also be analysed statistically. At this stage it is crucial that a collective effort from the myrmecologist community is made to contribute data – or datasets – in order to fill up the database. This quantitative approach has the potential to lead to the discovery of new patterns and to new understanding of the ecology of ants, and beyond of other organisms. If all specialists were each to create a few profiles, the resulting richness of the collective knowledge would far surpass the sum of its components, allowing virtually boundless possibilities of questions, searches and analyses, for an incomparably improved knowledge of ant ecology.

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