



GBOL III: DARK TAXA

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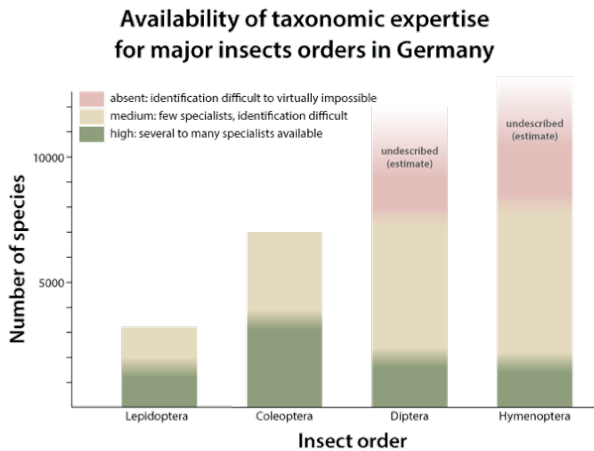
Researchers launch new BIOSCAN project that aims to illuminate thousands of new insect species on Germany's doorstep

Currently, around 1.4 million species of animals are known. For tropical regions, many species are still unknown, with estimates of global biodiversity ranging from five to 30 or even 100 million species. More recent studies suggest that there are about 10 million species on our planet. In contrast to the tropics, the Central European fauna is considered to be very well studied. However, specialists have mostly concentrated on less diverse and easy-to-study organisms, neglecting the species-rich, often taxonomically difficult groups, like many Diptera and Hymenoptera. This led to a mismatch between high species numbers and a small number of researchers, often referred to as

the 'taxonomic impediment'. This is most prominent for the megadiverse faunas of tropical regions. Less known is that this also applies, to some extent, for countries with a long history of taxonomic research like Germany, covering 200 or more years. For example, for the compilation of the German checklist of Hymenoptera, 32 specialists were available for 247 species of digger wasps (Crabronidae), while for parasitoid wasps of the family Ichneumonidae one specialist had to deal with 3,332 species.

In Germany, about 48,000 species of animals have been documented, including about 33,300 species of insects. In

little-studied groups such as insects and arachnids, preliminary results of earlier DNA barcoding initiatives indicate the presence of thousands of species that are still awaiting discovery. Among the groups with a particularly large suspected number of unknown species are the Diptera (flies) and the Hymenoptera (in particular, the parasitoid wasps). With almost 10,000 known species each, these two insect orders account for two-thirds of the German insect fauna, underlining their importance.



“DARK TAXA” ARE, AS A RULE, SMALL-SIZED AND RICH IN SPECIES, AND HAVE THEREFORE BEEN LARGELY IGNORED BY TAXONOMISTS. THIS IS REFLECTED BY THE NUMBER OF UNDESCRIBED SPECIES IN THESE TAXA, COMBINED WITH A LOW CHANCE TO GET SPECIMENS IDENTIFIED BY SPECIALISTS.

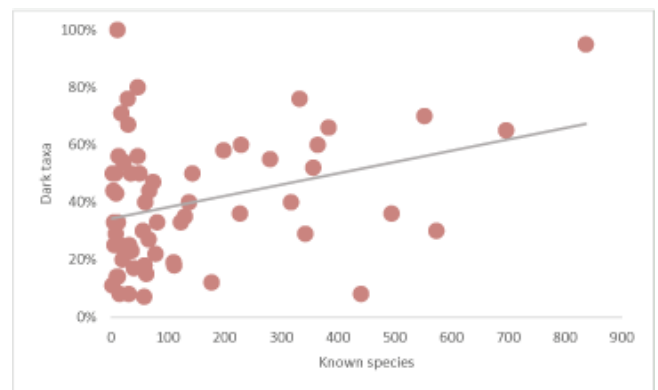
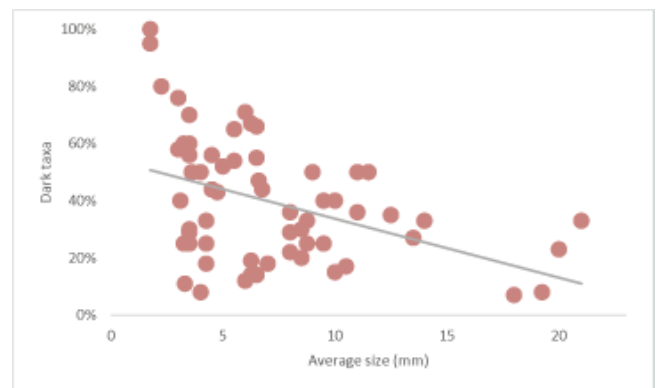
The insight that there are not only a few but many unknown species in Germany is a result of the earlier [German Barcode of Life](#) projects GBOL I and II, both supported by the [Federal Ministry of Education and Research](#) (Bundesministerium für Bildung und Forschung, BMBF) and the Bavarian Ministry of Science (project [Barcoding Fauna Bavarica](#)). The projects aimed at making all German species reliably, quickly and inexpensively identifiable by DNA barcodes. Since the first project was launched about ten years ago, more than 25,000 animal species have been barcoded, in collaboration with national and international partners. Among them are mostly well-known groups such as butterflies, moths, beetles, grasshoppers, spiders, bees and wasps.

Despite their popularity, these groups represent only a fraction of the total inventory of German insects. In Germany there are 170 butterfly species, 81 dragonfly and damselfly species, 87 species of grasshoppers, katydids and crickets, and 580 species of ground beetles, all of which are well-studied. Taken together, these 918 species stand for only a small fraction (2.8%) of the German insect fauna. They are morphologically well identifiable, have manageable species numbers, can easily be monitored during

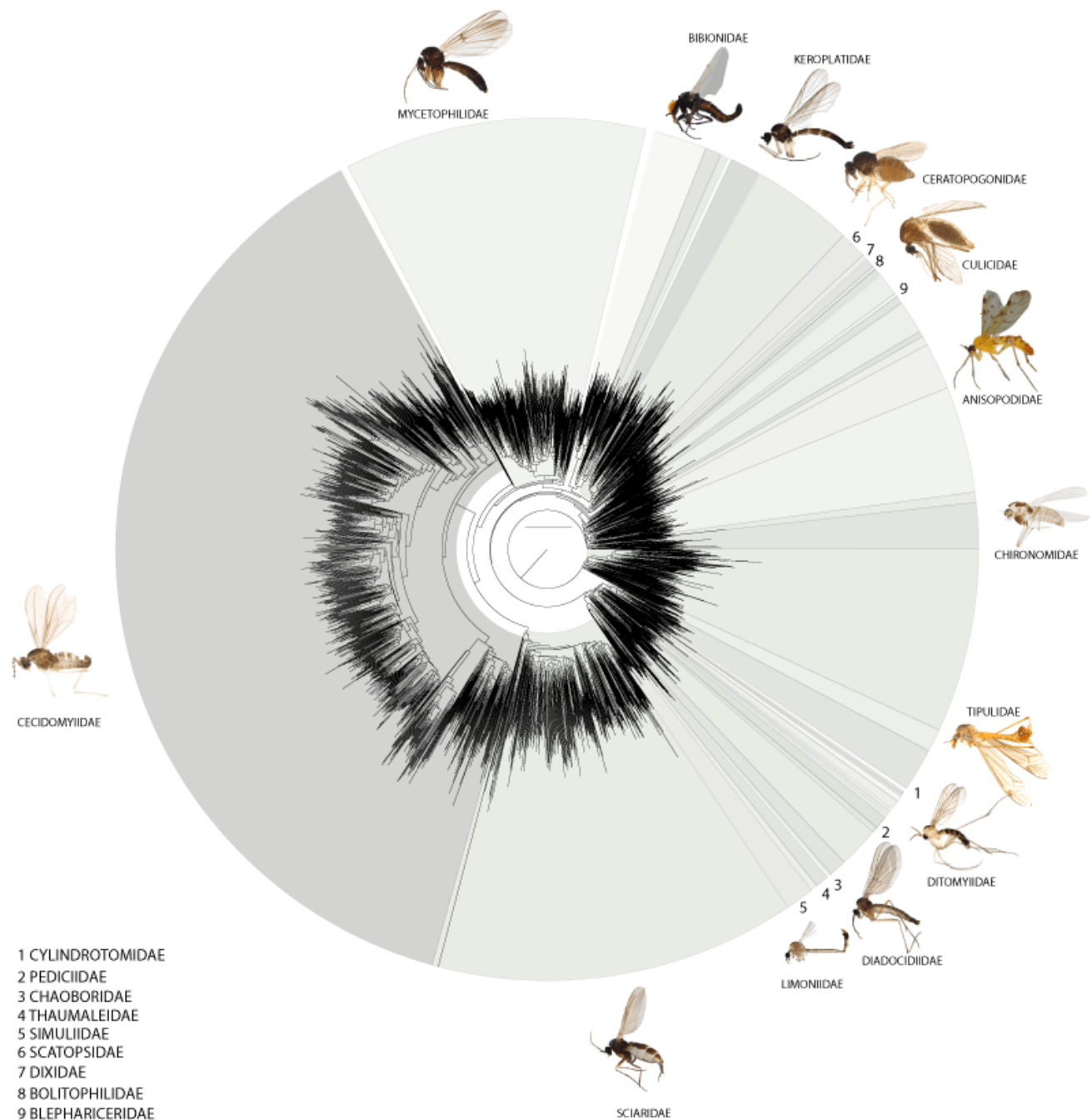
daytime and are therefore regarded as relevant in nature conservation and often used for monitoring species diversity. Conversely, however, this means that the vast majority of the native species diversity has been largely ignored in nature conservation and in general and applied research.

This applies in particular to the Diptera (flies). The observation that estimates of the number of species of native Diptera have been far too low was not only a result of the DNA barcoding projects at the [ZSM](#), but became clear in a recent study by Paul Hebert and his team². In this large-scale study, DNA barcodes of about one million insects were analysed. Based on this study, Canada’s gall midges alone are estimated to include about 16,000 species, suggesting the existence of at least two million species on earth. That would be more species of gall midges worldwide than all previously described animal species combined.

The little-known or unknown species, referred to as ‘dark taxa’, are the subject of another BMBF-funded DNA barcoding project that is being carried out at the ZSM in collaboration with other German natural history museums and institutions. The project focuses on Diptera and Hymenoptera (in particular, parasitoid wasps), each with a large proportion of ‘dark taxa’.



RELATIONSHIP BETWEEN BODY SIZE (TOP) AND SPECIES RICHNESS (BOTTOM) IN GERMAN DIPTERA¹



A CIRCULAR NEIGHBOUR-JOINING TREE FOR THE TWO SUBORDERS OF FLIES, NEMATOCERA AND BRACHYCERA¹. EACH LINE IN THE TREE CORRESPONDS TO A DISTINCT BARCODE INDEX NUMBER (BIN). WHEREAS FOR TWO OF THE “BIG FOUR” INSECT ORDERS, THE LEPIDOPTERA AND COLEOPTERA, THE NUMBER OF GERMAN SPECIES ARE VERY PRECISELY KNOWN, THE NUMBERS FOR THE DIPTERA AND HYMENOPTERA MUST RELY ON ROUGH ESTIMATES.

The new project, funded by a grant of 5.3 million Euro, starts July 1st 2020, with 12 PhD students at three major natural history institutions in Bonn ([Zoological Research Museum Alexander Koenig](#)), Munich ([SNSB – Zoologische Staatssammlung München](#)) and Stuttgart ([State Museum of Natural History Stuttgart](#)), to address a range of questions related to the taxonomy of German ‘dark taxa’, targeting selected groups of Diptera and parasitoid Hymenoptera.

Among the major aims of GBOL III is assessing of the performance of DNA barcoding for species identification of ‘dark taxa’, and assessing the species detection ability of DNA barcodes in mass samples that are obtained from metabarcoding studies. Other aims of the project include the development of a platform for managing OTU-based taxonomic data, developing a pipeline for reliable and fast barcoding of small and poor-quality samples, and training of the next generation of taxonomists.

GBOL III is designed to make an important contribution to the global BIOSCAN initiative of the Centre for Biodiversity Genomics. It helps to lay the foundations for a global biomonitoring system to record the biodiversity of our planet on a large geographical scale in times of rising temperatures, increasing weather extremes and receding ice, and to track its changes as a result of global environmental changes.

References:

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2. Hebert PDN, Ratnasingham S, Zakharov EV, Telfer AC, Levesque-Beaudin V, Milton MA, Pedersen S, Jannetta P, deWaard JR (2016) Counting animal species with DNA barcodes: Canadian insects. *Philosophical Transactions of the Royal Society B: Biological Sciences* 371: 20150333. doi.org/10.1098/rstb.2015.0333



SMALL PARASITOID WASPS OF THE FAMILIES EULOPHIDAE (TOP) AND MYMARIDAE (BOTTOM), BOTH GROUP WITH POSSIBLY HUNDREDS OF NEW SPECIES IN GERMANY THAT STILL AWAIT DISCOVERY.

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