sDiv working group meeting report "sBombus"

Focal areas of discussion + main results/conclusions + open questions

Discussions at our second meeting built off previous discussions. We focused primarily on developing a global *Bombus* monitoring network and the development of a concept paper describing e.g., the need for such a program, how it would be implemented, what the goals would be, how data from the program would be used, and how it would be funded in the long term. We also discussed how computer vision would play a central role through deployment of automated monitoring systems and through integrating mobile apps, such as BeeMachine, into community science efforts. To be effective, computer vision algorithms need to be more accurate and include a more comprehensive list of bumble bee species. The challenge here is in gathering training data from biologically diverse areas like China that are not well represented in online datasets or in easily accessible specimen collections. We discussed how to form collaborations with researchers and institutions for this purpose. South American bumble bees are not as diverse as in China, but present other challenges related to the difficulty of separating all-black species and understanding the impacts of invasive bumble bees on native species. We began development of a paper describing the bumble bees of South America that will serve as a resource for S. American *Bombus* studies. Finally, we discussed ways to improve computer vision models with existing data. For example, including ancillary information on location, date, and habitat can reduce the rate of misclassifications, especially for species with few training images. We conducted preliminary analyses and are in the process of writing the paper.

Content of presentations

We had presentations in-person presentations from Andres Acosta, Vera Lucia Imperatriz-Fonseca Patricia Nunes Silva, Madeleine Ostwald, and James Crall. Michael Orr gave a remote presentation.

Drs. Acosta, Nunes Silva, and Imperatriz-Fonseca gave presentations on a wide range of topics related to *Bombus* in and around Brazil. One concern in this region is on the potential movement of Bombus terrestris from Argentina into southern Brazil. This is an invasive species causing declines of native species and is being monitored carefully for movement into Brazil.

Dr. Ostwald presented on her work with the Big Bee project, an ambitious imaging initiative for bees in collections. She described some of the research that can arise from imaging beyond species ID.

Dr. Crall spoke about his work with automated monitoring platforms, including some of the camera systems he has developed to monitor bees visiting flowers in different environments.

Dr. Orr presented on his research on bumble bees in China, specifically on data availability in different regions and the potential for developing collaborations with researchers in that region where data is currently limited.Brian Spiesman, Christina Grozinger, and Victoria Campopiano Robinson also spoke at the weekly iDiv symposium. We presented on our sBombus project and talked more specifically about some of the research our labs are involved in that contributes directly to our sBombus program.

General research ideas, questions & directions discussed (incl. potential data to be used etc.)

Our main research idea was to develop an assessment for the need and requirements for a feasible and impactful global monitoring plan for bumble bees. This was a continuation from our first meeting. However, we made substantial progress in both solidifying ideas and in writing a manuscript. We assimilated data on existing community science programs, research initiatives, and AI-based tools that can be used as part of such a plan.

One of our primary ideas is to find ways to improve the classification models using existing data. That is, how can additional types of data and newer modeling approaches improve *Bombus* classification? This could include incorporating other types of data into the classification process, such as location, data, or other information about the sighting like habitat, etc. We previously conducted analyses using location and date. However, during the second meeting we included additional information on climate and habitat to improve the species distribution models. This resulted in additional improvement for the species classification models.

Another research idea is to characterize the state of existing global *Bombus* image data. This would utilize existing data housed in online repositories, such as GBIF, and locating additional data sources from citizen science groups. This would be important for quantifying the limitations of data availability imposed on our ability to generate accurate and comprehensive classification models. For example, what are the geographic biases in data availability what species are over- and underrepresented, and why. How will the current state of *Bombus* taxonomy and geopolitical issues hamper developing high-quality databases?

Lastly, we continued our discussions from the first in-person meeting on best practices for AI model development for *Bombus* (or other insects) identification. For example, what are effective data pipelines, how should images be collected, how many do we need, how do we make datasets available?

General structure of the week (break out groups, presentations, sessions with remote participants etc.)

Our days generally started off with a brief presentation from one or two of our meeting participants. We followed presentations with discussions of topics on our meeting agenda. Afternoons were spent mainly writing manuscripts or discussions in small groups on focal topics. On Wednesday, we presented some of our ideas at the iDiv symposium.

Next steps & upcoming deliverables

The next steps are to meet online with the full group for a summary of our progress and to discuss papers in progress based on our work in Leipzig in June. We have three papers in progress: a concept paper on developing a global *Bombus* monitoring network, another on incorporating location, date, and climate information into the classification model process, and a third describing the *Bombus* of South America. The concept paper will be submitted in January 2026 and the other two will be submitted for publication soon thereafter.

General working atmosphere and feedback on sDiv support (What kind of support? How helpful was it?)

We received excellent support from the sDiv staff. They worked with us to handle individual travel issues when necessary and were always very accommodating. Our meeting room was more than adequate for our discussions. It provided a well-lit, comfortable, and nice environment to have our meetings. The lunches were always nice, and it was great to have drinks available throughout the day. It was a very pleasant working atmosphere because of the excellent facilities and presence of many other friendly researchers, students, and staff. Our hotel was very nice as well. The breakfast was excellent, and it was very nice to be able to eat as a group on two of the nights as part of the project. We ate together most nights anyway.