Biodiversity Committee

Committee members: E. Abreu, J. Alston, T. Androski, M. Becker, C. Burgin, C. Calderón-Acevedo, J. Colella, E. Craig, T. Demos, J. Esselstyn, P.-H. Fabre, A. Feijó, A. Ferguson, J. Frey, M. Hawkins, D. Huckaby, B. Kohli, S. Liphardt, S. Maher, V. Mathis, M. McDonough, S. Mech, A. Mychajliw, J. Nations, R. Norris, G. Oliver, C. Parker, B. Patterson, N. Pradhan, D. Reeder, I. Rochon, M. E. Rodríguez-Posada, L. Ruedas, B. Tanis, N. Upham (Chair), J. Widness

Cross-committee links: Conservation (Ferguson,Upham), Human Diversity (Alston), Informatics (Maher, Kohli, Tanis), Nomenclature (Burgin, McDonough, Norris, Pradhan, Reeder, Ruedas), Mammal Images Library (Huckaby, Tanis), Public Education (Mech), Publications (Ruedas), Sys Collections (Upham)

Mission:

The Biodiversity Committee compiles and maintains the Mammal Diversity Database (MDD), an updatable online database of mammal taxonomic and biodiversity information hosted by ASM at http://mammaldiversity.org/. This database aims to provide the latest information on species-level and higher taxonomic changes, thereby promoting more rigorous study of mammalian biodiversity worldwide. The initial objective has been to aggregate, curate, and compile new citations on species descriptions and taxonomic revisions into regular releases that are downloadable in comma-delimited format. Downstream goals include expanded hosting of ecological, trait, and taxonomic data. Overall, this initiative aims to promote the ASM's role as a leader in high quality research on mammalian biology.

Information items:

I. Activities of the ASM Biodiversity Committee from April2020–May 2021 included:
   a. On 27 April 2020, we formed a Slack group that has become instrumental to the functioning of our taxonomic curation efforts. Moving everything online in response to the pandemic helped our group focus on core tasks.
      i. Our core team of now includes 7 assistants plus Chair Upham (Table 1; https://www.mammaldiversity.org/about.html).

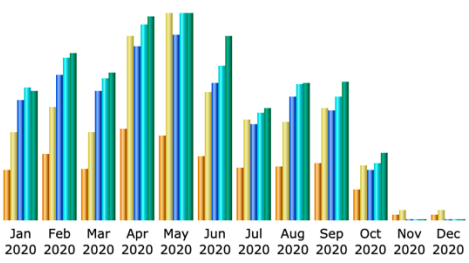
Table 1. Mammal Diversity Database curation team as of May 2021. Note that Rochon and Huckaby are non-student volunteers helping with direct data curation.

Connor Burgin	Jane Widness	Madeleine Becker	Camilla Parker	Schuyler Liphardt	Ingrid Rochon	David Huckaby
Student Taxonomic Curator	Student Research Assistant	Student Research Assistant	Student Research Assistant	Student Web Developer	Type Specimen Curator	Chair, Mammal Images Library Committee

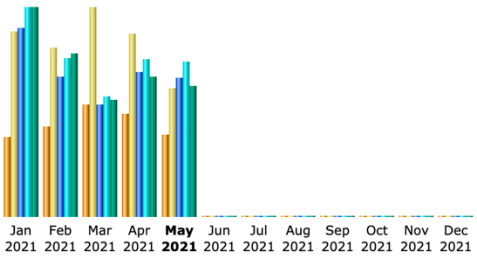
Connor Burgin	Jane Widness	Madeleine Becker	Camilla Parker	Schuyler Liphardt	Ingrid Rochon	David Huckaby
University of New Mexico	Yale University	George Mason University	Central New Mexico Community College	University of New Mexico	Smithsonian Mammals	California State University, Long Beach

b. On 16 October 2020, we launched a new version of the Mammal Diversity Database (MDD) that was simplified for easy editing via a Github backend (https://github.com/mammaldiversity/mammaldiversity.github.io). This followed from last year's goal to transition to a sustainable 'Open Science' model of operation for the MDD. Based on the professional advice of Jorrit Poelen, web programmer for the Global Biotic Interactions database (GloBI), and efforts of Student Web Programmer Schuyler Liphardt, we built a new bare-bones website to host the MDD taxonomy. This new website has the critical benefit of being ***updatable directly by students and volunteers of the ASM Biodiversity Committee***. Switching to this framework frees us of the previous obstacles of closed-door encryption posed by the PHP backend (as here https://github.com/tigerhawkvok/asm-mammal-database).
    i. Each update of the MDD taxonomy is now published as a citable version via a corresponding Zenodo repository (https://doi.org/10.5281/zenodo.4139722), e.g.: Mammal Diversity Database. (2021). Mammal Diversity Database (Version 1.4) [Data set]. Zenodo. http://doi.org/10.5281/zenodo.4139818

c. From Jan – Dec 2020, the http://mammaldiversity.org website hosting the Mammal Diversity Database was accessed by 21,300 unique visitors, including ~2,000 users per month (see Fig. 1). However, note that "usage" drops off dramatically starting in October 2020 when the new website was launched – we strongly suspect this is because ***many of the previous "users" were in fact automated bots***. The new Github-based site is less susceptible to this type of web-crawling traffic. Thus, we posit that the true number of unique visitors is more likely in the range of ~200 per month (Fig. 1). Extrapolating, we estimate annual usage of the ASM MDD of ~2,500 unique researchers worldwide.



Month	Unique visitors	Number of visits	Pages	Hits	Bandwidth
Jan 2020	1,748	3,062	297,518	328,279	6.15 GB
Feb 2020	2,319	3,947	361,431	402,929	7.98 GB
Mar 2020	1,804	3,090	320,220	350,888	7.04 GB
Apr 2020	3,188	6,430	430,929	485,452	9.71 GB
May 2020	2,951	7,228	458,252	512,300	9.86 GB
Jun 2020	2,217	4,483	341,056	383,129	8.79 GB
Jul 2020	1,812	3,503	238,109	265,329	5.34 GB
Aug 2020	1,853	3,424	305,519	336,717	6.54 GB
Sep 2020	1,995	3,900	271,520	305,249	6.61 GB
Oct 2020	1,051	1,924	124,843	141,251	3.18 GB
Nov 2020	183	345	517	550	17.01 MB
Dec 2020	179	361	453	462	11.09 MB
Total	21,300	41,697	3,150,367	3,512,535	71.22 GB



Month	Unique visitors	Number of visits	Pages	Hits	Bandwidth
Jan 2021	191	444	1,212	1,341	33.31 MB
Feb 2021	214	403	900	1,014	25.98 MB
Mar 2021	269	500	716	768	18.63 MB
Apr 2021	246	437	927	1,008	22.32 MB
May 2021	196	308	892	991	20.78 MB
Jun 2021	0	0	0	0	0
Jul 2021	0	0	0	0	0
Aug 2021	0	0	0	0	0
Sep 2021	0	0	0	0	0
Oct 2021	0	0	0	0	0
Nov 2021	0	0	0	0	0
Dec 2021	0	0	0	0	0
Total	1,116	2,092	4,647	5,122	121.02 MB

Figure 1. Summary ofusage statistics on mammaldiversity.org for 2020-2021. The Mammal Diversity Database transitioned to a new Github-based interface in October 2020, which likely explains the apparent drop off in user activity – previous estimates were artifactual, likely driven by automated "bots" or webcrawlers. Note different scale on the left and ride side figures.

d. Geographic usage of the MDD is global (Fig. 2)

Locales (Top 25) - Full list

Locales		Pages	Hits	Bandwidth
United States	us	1,208,120	1,362,103	25.29 GB
Brazil	br	285,989	308,263	5.98 GB
Mexico	mx	204,465	225,419	4.01 GB
Germany	de	154,611	166,136	2.80 GB
Canada	ca	116,795	129,974	2.69 GB
Colombia	co	107,952	118,879	2.02 GB
Great Britain	gb	95,181	108,378	3.03 GB
France	fr	70,617	77,152	1.62 GB
Argentina	ar	48,880	56,247	1.22 GB
Australia	au	47,359	53,531	1.20 GB

Figure 2. Top 10 countries using mammaldiversity.org annually in 2020. Note that these data include the inflated bot hits mentioned above; once complete, our 2021 data will be more accurate in this regard.

e. The 2018 *Journal of Mammalogy* article about v1.0 of the Mammal Diversity Database taxonomy ("How many species of mammals are there?") has now been viewed >54,000 times and cited 379 times. This summary remains one of the most visible recent products of the ASM, suggesting that it filled an open niche of taxonomic synthesis that our committee should continue developing.

II. Plans for a summary article of the forthcoming v2.0 MDD taxonomy:

a. In a series of versions since MDD v1.0, our group has been focusing on unifying the cumulative taxonomy from the Handbook of the Mammals of the World series (Volumes 1-9) and Checklist of the Mammals of the World (2020) with our independent understanding from MDD literature surveys. Our MDD taxonomy particularly diverges from the ~300 additional species of ungulates recognized by Groves & Grubb (2011), a departure which we have justified on the new "About" page: https://www.mammaldiversity.org/about.html. The changes in taxonomy across these versions are summarized in Table 2, and the versions are listed here:

Version 1.4 10.5281/zenodo.4679816 Apr 11, 2021
Version 1.31 10.5281/zenodo.4429371 Jan 8, 2021
Version 1.3 10.5281/zenodo.4397179 Dec 28, 2020
Version 1.2 10.5281/zenodo.4139818 Sep 24, 2020
Version 1.1 10.5281/zenodo.4139788 Mar 29, 2019

b. Those taxonomic updates are now joined by parallel efforts to assign and curate ***country-level geographic ranges*** to each species in the MDD taxonomy. That effort, led by Connor Burgin and David Huckaby, has involved updating the listings from Checklist of the Mammals of the World using additional literature and IUCN records to match the taxonomic concepts in the MDD. This information is now present in pipe-separated format in the 'countryDistribution' field of the CSV download.

i. Using this information, we are now writing an article investigating "How many species of mammals are there in each country?" relative to this updated information. Our plan is to submit this article to the *Journal of Mammalogy* at the end of summer 2021.

Table 2. Taxonomies compared among previous compendia: Mammal Species of the World (MSW), International Union for the Conservation of Nature (IUCN), and the Mammal Diversity Database (MDD).

Taxa	MSW3 2005	IUCN 2008	MDD v1.0 2018	MDD v1.1 2019	MDD v1.2 2020	MDD v1.3 2020	MDD v1.4 2021	MDD v2 (in progress)
Species								
Total	5,416	5,513	6,495	6,526	6,485	6,513	6,533	6,543
Extinct	1	79	96	100	103	103	103	103
Living	5,415	5,436	6,399	6,426	6,382	6,410	6,430	6,440
Domestic	0	0	16	17	19	19	19	19
Flagged	0	0	212	212	29	29	29	29
Wild & valid	5,415	5,436	6,171	6,197	6,334	6,362	6,382	6,392
Genera	1,230	1,226	1,314	1,322	1,331	1,330	1,332	1,332
Families	153	149	167	167	167	167	167	167

Orders	29	24	27	27	27	27	27	27

III. Continued goals for work Mammal Diversity Database (2021 and beyond):

a. **Synonyms.** Our work in this area has been strong, led by Madeleine Becker, Connor Burgin, and Jane Widness. Due to their efforts in the last year, we now have a vetted synonym list containing 27,373 equivalencies to accepted MDD species names. This information is not yet published, but will be included in the v2.0 MDD release.

b. **Type specimens.** Thanks to the expert volunteer efforts of Ingrid Rochon, we now have all of the species-level holotypes from the Smithsonian Mammal Collections allied to our MDD taxonomy, plus additional holotype listings for other collections – this totals 2,154 species with specimens listed for the 'holotypeVoucher' field – remarkable progress from where we were a year ago (247 species).

c. **Type localities.** We now have type locality information for ***all species in the MDD accepted list***, but are now working to gather latitude and longitude information in decimal degrees for the type localities of these taxa. We currently have geocoordinates of type specimens for 1,055 species.

d. Improved organization of volunteers. In 2019, we assembled an initial list of per-clade ASM members and non-member specialists to help vet and provide editorial curation as the MDD taxonomy continues to evolve. See Table 2 in our 2019 Annual Report for that list of people spread across 25 taxon-specific subcommittees. However, despite on progress on other fronts, we still lack the organizational infrastructure needed to properly use the efforts of those volunteers. Thus, we have yet to formally reach out to them as a group. Nevertheless, we still maintain the goals of these subcommittees and plan to incorporate them as part of an in-progress NSF proposal to fund the MDD for 2022-2025.

IV. Plans for non-ASM funding support:

a. One of the main recommendations derived from our 2019 ASM Workshop on "Hacking the MDD" was the need to pursue a "burst" of outside funding from NSF or similar agencies to push the volume, diversity, and quality of content of the MDD to a higher level. The ASM could then continue to support MDD with low-level sustainable funding. As a result, Chair Upham has been in regular conversations with Dee Ann Reeder of *Mammal Species of the World* (MSW) and Nancy Simmons of *Batnames.org* with respect to applying for major grant funds. These discussions have been productive, and joined with taxonomic name-to-concept alignment ideas that Upham and his ASU colleagues (Nico Franz, Beckett Sterner) have been independently developing. A grant proposal is now in progress that if successful would unify the MDD with Batnames.org and MSW (volume 3 was the last edition of MSW, but the delayed volume 4 will now likely be joined with our group ASM-based effort). Thus, our plan is to present mammals as a test case for the potential benefits of enhanced taxonomic concept mapping, while also centralizing an updated global taxonomy for use in biodiversity portals like GBIF, CoL+, and iNaturalist.

V. COVID-19 involvement of the Biodiversity Committee:

a. Beginning inApril 2020, Chair Upham began representing the MDD in the CETAF-DiSSCo Taskforce formed in response to the global COVID-19 epidemic. To date, ~60 scientists from Europe, the United States, and Brazil have been involved in this taskforce aiming to centralize the most relevant and up-to-date museum-based biodiversity information for the biomedical research community. Using the MDD taxonomy, that group produced an improved mammal host-virus dataset (https://zenodo.org/record/4068958#.YLAb6utlCF0) and corresponding perspective piece set to be published in *The Lancet Planetary Health* (https://ecoevorxiv.org/txekq).

RECAP OF BUDGET 2020

1. Website construction and maintenance:

- Website stability, updates to content and interface, feature modifications
  - 2020 approved (~60 hrs @ $20/hr) ……..…. $1,200.00
  - Spent during 2020 (Liphardt) ……... $1,120.00

2. Hiring of student research assistant(s):

- Four student assistants employed at ~5/hrs per week to facilitate integration of updated taxonomic data in this ASM initiative
  - 2020 approved (~5hrs/w @ $15/hr, 4 graduate students, 18 weeks) ….. $5,400.00
  - Spent during 2020 (Burgin, Widness, Parker, and Becker) ……..……..…… $4,130.50

TOTAL BUDGET APPROVED (2020) …….. $6,600.00
Spent during 2020…… $5,250.50

TO DATE BUDGET 2021

1. Website construction and maintenance:

- Website stability, updates to content and interface, feature modifications
  - 2021approved (~60 hrs @ $20/hr) ……..…. $1,200.00
  - Spent to date (Liphardt) ……. ……$0.00

2. Hiring of student research assistant(s):

- Four student assistants employed at ~5/hrs per week to facilitate integration of updated taxonomic data in this ASM initiative.
  - 2021approved (~5hrs/w @ $15/hr, 4 graduate students, 18 weeks) ….. $5,400.00
  - Spent to date (Burgin, Widness, Parker, and Becker) ……..……..……. $270.00

TOTAL BUDGET APPROVED (2021) …….. $6,600.00
Spent to date (May 2021) ….……..…… $270.00

Action Items:

PROPOSED BUDGET 2022

1. ***Website construction and maintenance***:

- Website stability, updates to content and interface, feature modifications
  - 2022 proposed (~60 hrs @ $20/hr) ……...… $1,200.00

2. ***Hiring of student research assistant(s)***:

- We plan to continue needing 2-4 student assistants employed at ~5/hrs per week. These student assistants will facilitate integration of updated taxonomic data in this ASM initiative. Specifically, student assistants will perform functions of:
  - (i) "bottom-up" data gathering from recent and historical publications relevant to mammal taxonomic changes;
  - (iii) "top-down" data gathering efforts in terms of parsing, matching, and curating global mammal databases (e.g., VertNet) relative to the data already in the MDD.

⇨ Therefore, we request funds for continued efforts in curating the taxonomy database:
  - 2022 proposed (~5hrs/w @ $15/hr, 2-4 students, 18-36 weeks) …….. $5,400.00

TOTAL BUDGET REQUESTED (2022) …….. $6,600.00

SUMMARY

Overall, we highlight that 2021-2022 will be another year of change for the Mammal Diversity Database. As the Covid-19 pandemic has demonstrated, there is an overarching need for updated taxonomies about the mammalian hosts of zoonotic viruses such as SARS-CoV-2, Ebola, and many others. The ASM Biodiversity Committee is well positioned to contribute to the robustness of this information, and should continue to do so as an authoritative leader on mammalian biology. Mammals are now in closer parity to other tetrapod groups where taxonomic databases have existed for over a decade (e.g., http://amphibiaweb.org, http://reptile-database.org/), but there is still a long way to go to realize the type of interconnected data needed to address mammal biodiversity issues in society. Keeping track of "How many species of mammals are there?", "in which countries?", and "according to who?" are questions that are only growing in importance in our changing world.

Respectfully submitted,
Nathan S. Upham, Chair
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