Biodiversity Committee

Committee Members: E. Abreu, J. Alston, C. Burgin, C. Calderón-Acevedo, J. Colella, E. Craig, T. Demos, J. Esselstyn, P.-H. Fabre, A. Feijó, A. Ferguson, M. Hawkins, D. Huckaby, B. Kohli, S. Maher, V. Mathis, M. McDonough, S. Mech, A. Mychajliw, J. Nations, R. Norris, O. Ornelas, B. Patterson, N. Pradhan, D. Reeder, L. Ruedas, B. Tanis, N. Upham (Chair).

Cross-committee links: Informatics (Maher, Tanis), Nomenclature (Norris, Reeder, McDonough, Pradhan), Mammal Images Library (Huckaby, Tanis), Public Education (Mech).

Mission:

The Biodiversity Committee stewards the Mammal Diversity Database (MDD), an ASM-based, readily updatable, and online database of mammal taxonomic and biodiversity information hosted at http://mammaldiversity.org/ [beta version; official launch in July 2017]. This database aims to serve the global mammalogy community by providing the latest information on species-level and higher taxonomic changes, thereby promoting more rigorous study of mammalian biodiversity worldwide. The initial objective for this online database is to aggregate, curate, and compile new citations on species descriptions and taxonomic revisions into regular releases in comma-delimited format. Downstream goals include expanded hosting of ecological, trait, and taxonomic data, and an online forum for discussing mammalian taxonomy and systematics. By serving as both a platform and forum, this initiative aims to stimulate interest in mammals and promote the ASM's role as a leader in high quality research on mammalian biology.

Information Items:

(**1**) Activities of the ASM Biodiversity Committee from June 2018 – April 2019 included:

    (**a**) We met in person at the ASM annual meeting in Manhattan, Kansas to discuss the future goals of this committee, what to prioritize first, and how best to reach those goals.

    (**b**) Organizing for Biodiversity Committee-affiliated programing at the 2019 ASM meeting:

      i. *Mammal diversity from GenBank to the RedList: Challenges and rewards of integrating museum specimens in global databases of genetics, taxonomy, and spatial biodiversity.* N. Upham and L. Ruedas, organizers.

      Our final line-up of symposium presentations consists of:
- Jane Widness, Research Assistant on the Mammal Diversity Database & iNaturalist, Department of Anthropology, Yale University.
- John Sullivan and Conrad Schoch, GenBank Taxonomy, NIH/NLM/NCBI.
- Mariel Campbell, Incoming Chair of the Arctos Working Group, Museum of Southwestern Biology, University of New Mexico.
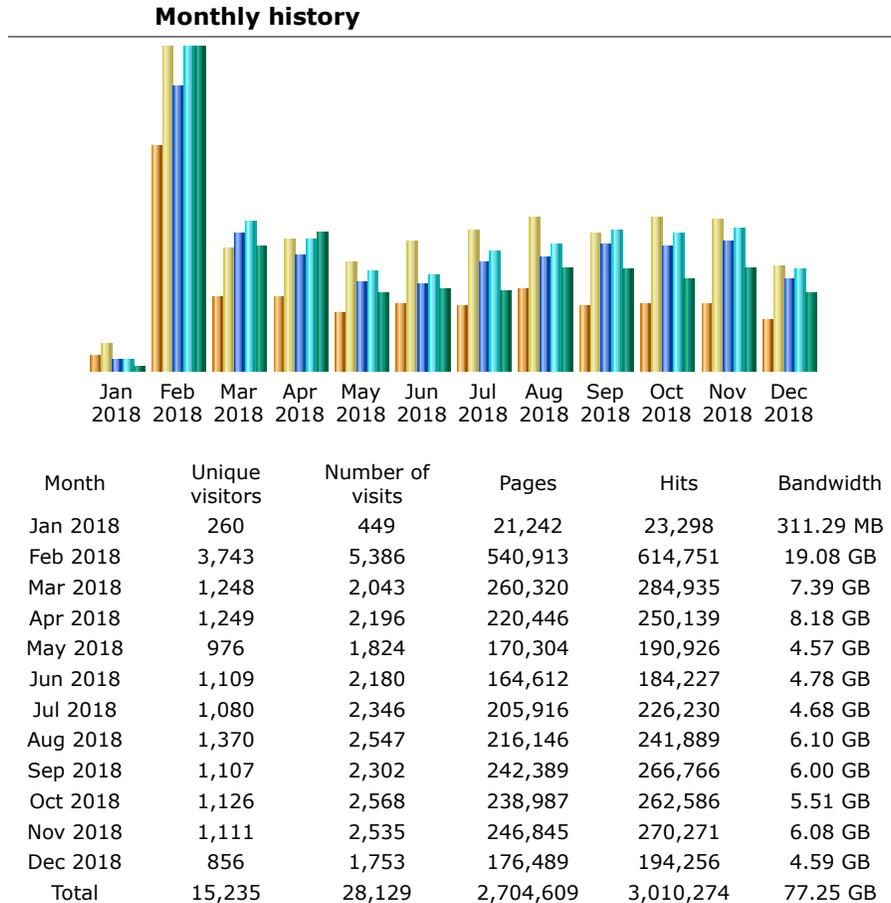- Thomas E. Lacher, Jr., IUCN Small Mammal SG Co-Chair, Texas A&M Univ.

- Rob Guralnick, Curator of Biodiversity Inform., Florida Museum of Nat Hist.
- Richard Pyle, ZooBank Steering Committee, Bishop Museum.

ii. *Hackathon for the Mammal Diversity Database*. N. Upham, J. Colella, and C. Burgin, organizers.

<u>Our (still tentative) line-up of workshop facilitators consists of:</u>
- Nathan Upham, Jocie Colella, Connor Burgin, Philip Kahn, Jane Widness
- We are still working on arranging Philip's travel from CA.
- We have 6 participants registered from 3 countries.

(c) The 2018 *J. Mamm* article about the Mammal Diversity Database ("How many species of mammals are there?") has now been viewed >13,000 times and cited 39 times.

(d) Since launching in February 2018, the http://mammaldiversity.org website hosting the Mammal Diversity Database has been accessed by an impressive **15,235 unique visitors**, including an addition of ~1,000 users per month through December 2018 (see Fig. 1). The ~3,000,000 page views are likely exaggerated by bots, but the rate of 1.84 visits per visitor (28,129 total visits) indicates that most users returned for second helpings.

Monthly history

Month	Unique visitors	Number of visits	Pages	Hits	Bandwidth
Jan 2018	260	449	21,242	23,298	311.29 MB
Feb 2018	3,743	5,386	540,913	614,751	19.08 GB
Mar 2018	1,248	2,043	260,320	284,935	7.39 GB
Apr 2018	1,249	2,196	220,446	250,139	8.18 GB
May 2018	976	1,824	170,304	190,926	4.57 GB
Jun 2018	1,109	2,180	164,612	184,227	4.78 GB
Jul 2018	1,080	2,346	205,916	226,230	4.68 GB
Aug 2018	1,370	2,547	216,146	241,889	6.10 GB
Sep 2018	1,107	2,302	242,389	266,766	6.00 GB
Oct 2018	1,126	2,568	238,987	262,586	5.51 GB
Nov 2018	1,111	2,535	246,845	270,271	6.08 GB
Dec 2018	856	1,753	176,489	194,256	4.59 GB
Total	15,235	28,129	2,704,609	3,010,274	77.25 GB

Figure 1. Summary of usage statistics on mammaldiversity.org for 2018.
The Mammal Diversity Database was launched in February 2018 with a large spike in usage associated with news articles and social media postings.

(2) Content updates for v2.0 of the MDD taxonomy: We have been working toward releasing a second full version (2.0) of the MDD taxonomy to update the content released in February 2018.

    (a) This work has progressed satisfactorily with key input from student researchers Widness, Burgin, and Colella. Table 1 summarizes how this updated taxonomy compares to previous taxonomies of Mammalia.

Table 1. Taxonomies compared from the Mammal Diversity Database (MDD) and previous compendium of Mammal Species of the World (MSW) and IUCN.

Taxa	MSW3 2005	IUCN 2008	MDD v1 2018	MDD v2 (unpublished)
Species				
Total	5,416	5,513	6,495	6,526
Extinct	1	77	96	100
Living	5,415	5,436	6,399	6,426

Living				
wild	5,415	5,436	6,382	6,409
Genera	1,230	1,226	1,314	1,322
Families	153	149	167	167
Orders	29	24	27	27

So 27 new recognized species and 8 genera of extant mammals are included in this list. More substantially, we have focused on two content extensions:

i. **Synonyms.** We have merged the extensive list of synonyms from MSW3 to the MDD v2 list and are working to resolve discordances. Our initial matching yielded synonym data for 3,113 species (1 or more junior synonym equivalency with authority & year). We also have one or more listed subspecific epithet for 1,299 species. Merging and reconciling the MSW3 data, along with data from other biodiversity aggregators (e.g., ITIS, Wikipedia) is a priority for our group.

ii. **Type specimens.** We recognize a key priority of reconciling these recent taxonomic changes in mammals with the *museum location of type specimens* that pertain to these recognized mammalian species. This task is not trivial, however. To date, we have manually added holotype museum numbers to 247 species. We additionally began parsing VertNet data and found 2,313 extant holotypes and 6,257 extant any types (including para- and topo-types) in VertNet collections.

iii. **Authority full citation & year.** This content priority has become clear and will be especially useful for mammalogists without strong library resources. Our goal here is to provide links to digitized open-source materials when available.

(b) Unfortunately, our updated database is *not yet online* due to technical issues with adding content to the web database. This boils down to our current inability to access & update the GitHub back-end of our web database due to mismatches with our permissions files and the encryption of the database (public and private keys). Our web developer has been over-loaded with work from his other job and so as yet unable to resolve this issue for us. We are now considering alternative solutions, and will hopefully have an answer for this by the June 2019 ASM annual meetings.

(1) Summarized progress on stated committee goals for 2019-2020 (formulated in April 2018):

(a) Improved organization of volunteers. We have now 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.

Table 2. Proposed division of clades to form advisory subcommittees. See the Appendix I listing of higher taxa for details of how divisions were formed. The asterisk (*) denotes existing members of the Biodiversity Committee who are aware of their nomination.

	Clade	Species	Putative members
1	Ameridelphia	123	Rob Voss, Sergio Solari, Leonora Costa, Sharon Jansa
2	Australidelphia + Monotremata	264	Kris Helgen, Jack Ashby, Pat Woolley
3	Afrotheria	90	Galen Rathbun, Link Olson, Gary Bronner
4	Xenarthra	36	Anderson Feijó*, Frederic Delsuc, Flavia Miranda, Manuel Ruiz-García
5	ARTIODACTYLA: Ruminantia, Suina, Tylopoda	453	Eliécer Gutiérrez, Jesse Alston*, G.M. Gasparini, Spartaco Gippoletti,
6	ARTIODACTYLA: Whippomorpha	99	Jim Dines, John Ososky, Randall Reeves
7	CARNIVORA: Caniformia	175	Jocie Colella*, Adam Ferguson*, Brian Tanis*
8	CARNIVORA: Feliformia	130	Andrew Kitchener, Nobby Yamaguchi
9	CHIROPTERA: Yinpterochiroptera	410	Nancy Simmons, Alexandre Hassanin, Norberto Giannini
10	CHIROPTERA: Yango: Emballonuroidea	70	Burton Lim, Peter Vallo
11	CHIROPTERA: Yango: Noctilionoidea	244	Paúl Velazco, Valeria Tavares, Camilo Calderón*
12	CHIROPTERA: Yango: Vespertilionoidea	671	Ara Monadjem, Terry Demos*, Jesse Alston*, Ricardo Moratelli, Manuel Ruedi
13	EULIPOTYPHLA: hedgehogs + moles	78	Verity Mathis*, Nobby Yamaguchi, Werner Haberl
14	EULIPOTYPHLA: shrews	452	Jake Esselstyn*, Connor Burgin*, Alexis Mychajliw*, Rainer Hutterer, Neal Woodman
15	PERISSODACTYLA + PHOLIDOTA	30	Philippe Gaubert, Patricia Moehlman
16	PRIMATES: Catarrhini	189	Jane Widness*, Tom Butynski, Lu Yao
17	PRIMATES: Platyrrhini	172	Jean Boubli, Jessica Lynch Alfaro, Guilherme Garbino
18	PRIMATES: Strepsirrhini	147	Ann Yoder, David Weisrock, Rodin Rasoloarison
19	PRIMATES (tarsiers) + DERMOPTERA + SCANDENTIA	38	Eric Sargis, Link Olson, *Melissa Hawkins

20	LAGOMORPHA	98	Luis Ruedas*, Connor Burgin*, Andrey Lissovsky
21	RODENTIA: Guinea-pig related	310	Nate Upham*, Pierre-Henri Fabre*, Thales Freitas, Agustina Ojeda, Guillermo D'Elía, Louise Emmons
22	RODENTIA: Squirrel-related	330	Edson Abreu*, Melissa Hawkins*, Boris Krystufek
23	RODENTIA: Mouse-related: anomalures, jerboas, geomyoids, etc	291	Ryan Norris*, Jane Widness*, Nelish Pradhan*, Molly McDonough*
24	RODENTIA: Mouse-related: CRICETIDAE	789	Bruce Patterson*, Brooks Kohli*, Ryan Norris*, Alexandre Percequillo, Pablo Teta, Cibele Bonvincino
25	RODENTIA: Mouse-related: MURIDAE	837	DeeAnn Reeder*, Pierre-Henri Fabre*, Terry Demos*, Larry Heaney, Molly McDonough*, Jon Nations*
	TOTAL	**6526**	

The critical goal of establishing taxonomic subcommittees is to provide consensus oversight on the accepted taxonomic changes for a particular clade. Each of these 25 subcommittees will be *group* efforts such that no single individual has full authority over the advising decisions for a particular taxon. In keeping with the objectivity goals of the Mammal Diversity Database, only published taxonomic opinions are allowed to be considered. The taxonomic subcommittees will contain multiple voices spanning diverse perspectives toward the goal of judging which published works will be accepted into the MDD active listing.

Thus, these subcommittees will be primarily *objective*, but also have limited *one-directional* subjective control over the accepted species in their group. While species additions must be derived from the peer-reviewed literature (including compendia), species can be excluded or 'flagged' for additional study under the judgement of supporting evidence by group members. The exact details of these taxonomic subcommittee procedures will be the primary topic for discussion during the Biodiversity Committee's in-person meeting in June at ASM.

Initial plans this "bottom up" volunteer effort of taxonomic subcommittees include:
- Distributing per clade spreadsheets of the taxa pertaining to each group;
- Setting a 6-month schedule for returning an updated listing of publications & revisions per clade;
- Incorporating these per-clade updates into a full MDD version release on a 10-month basis (e.g., July to April would be useful given the June ASM meetings); and,
- Giving *citation credit* to these taxonomic subcommittees, with author order determined by the individual subcommittees.

It is additionally worth noting that many of the proposed subcommittee members are *not current members of the ASM*, but rather are parts of mammalogy networks overseas. Thus, these non-

ASM members will not be direct members of the Biodiversity Committee, but rather will be volunteering under the supervision of Biodiversity Committee members. We view this aspect as a strength of our proposal that extends our network of expertise beyond the regular membership of ASM, and will perhaps help to recruit new members to ASM.

Critically, we emphasize that "top down" data integration is still needed to make use of these "bottom up" volunteers, which is why we propose 2020 funding for student assistants (see below).

Other progress on committee goals for 2019-2020:

(i) Use of the data curation backend by student researchers and volunteers.
- We have a back-end URL for point-and-click curation of the MDD content (login credentials available on request: https://mammaldiversity.org/admin-login.php). However, we have so far used this sparingly since these are time-consuming *manual* edits & there is somewhat limited capacity. For example, adding and deleting species or higher taxon categories does not work as currently intended.

(ii) Harmonization of the MDD taxonomy with Mammal Images Library content.
- Discussions with David Huckaby (Chair of the MIL Committee) have continued, particularly in the form of his help with curating the species list. However, no additional steps were taken this year regarding a formal union of the MDD taxonomy with the taxonomy underlying the MIL.
  - o Huckaby has helped us flag a series of inconsistencies with the database, which we've organized into 67 separate issues (see Google Sheet here).
  - o We've also identified many recent taxonomic changes, including those in the Handbook of the Mammals of the World, that have yet to be integrate to our list.
  - o Once these harmonizations & updates can be made successfully, then we can again discuss how to profitably unify the efforts for the MIL and MDD.

(iii) Editorial oversight by a small group of taxonomic experts.
- The above Table 2 and point (i) details our efforts related to this goal.

(iv) Other content-based priorities:
- These goals still remain for longer-term implementation:
  - o Hyperlinks to new species citations (e.g., in *J. Mammalogy, Mammal. Biol., Zootaxa*)
  - o Expansion of per-species content to include detailed natural history, ecological, and geographic information (e.g., collaboration with Arkive, Animal Diversity Web).
  - o Downstream: per-species info on phylogenetic position (VertLife tree of mammals), geo-distributions by region (continent, country, state in USA), and NCBI/IUCN links.

RECAP OF BUDGETS 2017, 2018, and 2019 (partial)

(1) Website construction and maintenance:
- Initial construction of database and website
  - o 2017 budgeted (300 hrs @ $30/hr) ………..……………………… $9,000.00
  - o 2017 actual: Philip Kahn …………................................………… $7,602.50

2017 unspent ……………... $1,397.50

- Re-vamp of website based on Committee feedback
  - 2018 budgeted (275 hrs @ $30/hr) ……...…………………… $8,250.00
  - 2018 actual: Philip Kahn …………...............................………… $645.00
    2018 unspent …...………... $7,605.00

- Website stability, updates to content and interface, small feature modifications
  - 2019 budgeted (~40 hrs @ $30/hr) …………………………..… $1,200.00
  - 2019 actual: …………………………………………………….. $0.00
    2019 to date remaining $1,200.00

(2) Hiring of graduate student research assistant(s):
- Initial formation of the mammalian species-level list
  - 2017 budgeted (~10 hrs/week @ $20/hr, 50 weeks) ……...……… $10,000.00
  - 2017 actual (Apr-Dec): Jocie Colella and Connor Burgin ……….. $3,698.75
    2017 unspent …….. $6,301.25

- Continued efforts in curating the taxonomy database
  - 2018 budgeted (~10 hrs/w @ $15/hr grad, $10/hr UG, 36 weeks) … $9,000.00
  - 2018 actual: Jocie Colella …………………………………... $30.00
    Connor Burgin …………………………………. $175.00
    Jane Widness ………………………………… $802.50
    Subtotal …… $1,007.50
    2018 unspent ….....… $8,825.00

- We discontinue the employment of MDD student researchers in 2019-2020 in favor of ramping up volunteer and community-based efforts to curating this taxonomy database for new species descriptions, taxonomic revisions, and possible content expansion.
  - **2019 unbudgeted …………………………………………………… $0.00**

(3) Website hosting fees:
- Website hosting (note that $0 were spent here because we ended up using the existing ASM web server; Linux, with Apache, PhP, and MySQL)
  - 2017 budgeted …………………….……….............................. $6,000.00
  - 2017 actual ...………………………………………….……… $0.00
    2017 unspent …...…… $6,000.00

- Transitioning from MySQL-based database to a graph database structure
  - 2018 budgeted ($50/mo, 12 months) …………………..………….. $600.00
  - 2018 actual (was only $9/mo actually; discontinued after 1 month) $9.00
    2018 unspent ………..... $591.00

- Database hosting of unknown provenance
  - 2019 budgeted ($50/mo, 12 months) ………………….……….......... $600.00

o   2019 actual ……………………………………………………. $0.00
2019 to date remaining. $600.00

Action Items:

PROPOSED BUDGET 2020

(1) Website construction and maintenance:
- Website stability, updates to content and interface, feature modifications
    o   2020 proposed (~40 hrs @ $30/hr) …………………………….....… $1,200.00

(2) Hiring of graduate student research assistant(s):
- While we moved in 2019 to discontinue the employment of MDD student researchers, the first several months of 2019 have reinforced the key value of student assistants on this project. Volunteer efforts that were targeted to supersede paid student effort are forthcoming – however, it is clear that they will additionally be time-consuming to coordinate. Integrating the resulting data updates from volunteer advisory subcommittees is a non-trivial task that will require directed effort. Without student assistants, all the data coordination responsibilities in 2019 have fallen to Biodiversity Committee Chair Upham, and therefore slowed considerably.
- To solve this, we propose to add two student assistants employed at ~5/hrs per week. Doing so will facilitate integration of updated taxonomic data in this ASM initiative. Specifically, student assistants will perform functions of:
    o   (i) secondary processing of per-clade data sheets that are returned;
    o   (ii) emailing and coordination of per-clade volunteer tasks ("bottom-up" data);
    o   (iii) "top-down" data gathering efforts in terms of parsing, matching, and curating existing global mammal databases (e.g., MSW3, ITIS, Wikipedia) relative the data already included in the MDD.
- Therefore, we request funds for continued efforts in curating the taxonomy database:
    o   2020 proposed (~5 hrs/w @ $15/hr, 2 graduate students, 36 weeks) ….. $5,400.00

(3) Website hosting fees:
- It is now clear that database hosting costs can be covered on the same server as the ASM website; thus, we no longer a need for a separate budget item here.
    o   2020 unbudgeted ……………………………………………………. $0.00

TOTAL BUDGET REQUEST (2020) ……………………………….. $6,600.00

SUMMARY
As this project continues to evolve, it has been faced with different sets of challenges that have required adaptation of our goals, budgeting, and spending. Although $42,875 was budgeted by the committee in 2017 and 2018, we only spent $12,962.75 during that period for a variety of reasons, including:
(i)   Cost savings in 2017 enacted by hiring a freelance web developer who was willing to work for a non-profit rate of $30/hr;
(ii)   Difficulty in securing work time from that same web developer in 2018 after they were hired for a different, higher-paying job; and

(iii)   Recruiting fewer student assistants than our 2017-18 budget capacity would have allowed, due to the time constraints placed on Chair Upham by his day job (Postdoctoral Associate at Yale Univ).

Nevertheless, our committee has accomplished a remarkable amount in the ~2 years of our existence, most notably establishing a widely used web platform for the public dissemination of the latest taxonomic opinions regarding mammalian species diversity. This may reasonably be **one of the top 3 most visible activities of the American Society of Mammalogists**, along with the *Journal of Mammalogy* and the IACUC oversight recommendations. Mammals are now in closer parity to other tetrapod groups where online taxonomic databases have existed for over a decade (e.g., http://amphibiaweb.org, http://reptile-database.org). Keeping track of "How many species of mammals are there?" will only grow in importance in our changing world.

Therefore, we view it as appropriate for the ASM to continue to invest in this Mammal Diversity Database initiative, as well as any other initiative that aims to synthesize and publicly distribute biodiversity information regarding the organisms that unite our organization.

Respectfully submitted,
Nathan S. Upham, Chair
(nathan.upham@yale.edu)