Alpha-taxonomy in world mammals

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BSc Hons Biological Sciences, Species & speciation module deliverable

For A/Prof A.M. Muasya

Herein I discuss the progress of mammalian alpha-taxonomy from 1975 to 2005. First, I focus on the methods employed to diagnose and delimit these mammal species and how these have changes over the the past 30 to 40 years. Second, I discuss the new species and groups discovered in this period. Third, I will attempt to draw conclusions, if possible, about the speciation mechanisms at work in mammal populations based on the evidence use to delimit those mammal species. I will frame these discussions in the context of the species concepts (or lack thereof) typically used in mammalogy and mammalian taxonomy.

Mammal Species of the World, 3rd Edition (MSW3) (Wilson & Reeder 2005) is a reputable database of mammalian taxa (species, sub-specific, and super-specific) and information concerning their treatments (e.g. scientific name, authors' name and year described, original publication citation, distribution, etc. (Wilson & Reeder 2005)) from 1702 to 2005 AD. This data product is a boon to the discussions here. Using the `.csv` file from the MSW3 webpage (https://www.departments.bucknell.edu/biology/resources/msw3/), I explored this dataset in `R` (R Core Team 2017), primarily using the `tidyverse` suite of packages for data exploration and visualisation (Wickham 2017). Not only does MSW3 enable exploration of mammal taxonomic discovery through time, it also facilitated easier literature searches, providing common journals in which mammal descriptions are published.

There is a subset of mammal order that are most taxonomically "active" (Figure 1), such that there are only eight orders in which ≥ 10 new species were described in the period 1975—2005. This is worth bearing in mind when discussing mammalian taxonomy; there is a taxonomic bias to, either, the rate of discovery in certain taxa, or the species richness of certain taxa. Either way, species concepts have bearing on these numbers, discussed below.

Mammalogical species concepts

The species concept or criteria a taxonomist follows can affect the number of species delimited. Supposing there is reality to species, and that two lineages being different species is grounded in reality, species concepts enable us to estimate when this occurs. Following the reasoning of De Queiroz (2011), different

species concepts each deal with different lines of empirical evidence. These each describe different aspects of the speciation process, such that in each the criteria for delimiting two different species is based on some property of each lineage that would differ between them if they were separate species (De Queiroz 2011). Consequently, different species concepts all encapsulate *some* aspect of dissimilarity between two lineages as a consequence of speciation. De Queiroz (2011) argues that should any one criterion be met, it is parsimonious to assume speciation has begun, and that the bifurcation of the lineages be appropriately regarded with a species delineation. This aside, consistency in species concepts in taxonomic research is still desirable (if perhaps unattainable). The case with mammal taxonomists is summarised well:

> *Mammalogists, for the most part, have avoided debate on species concepts, but most investigators follow a particular species definition*

Baker & Bradley (2006) make this somewhat alarming statement about the *modus operandi* of mammal taxonomists. It appears that mammal taxonomy, like many fields of biology, has agreed-upon nomenclatural standards, but has little consensus on which species concepts to use when delineating species. This precludes ready comparison of, say, mice species vs bovid species, as there is no guarantee that "species" represent similarly biologically important units.

For the most part, mammologists historically followed (if only loosely) the Biological Speciec Concept (BSC). The Phylogenetic Species Concept (PSC) contrasts with the BSC in focussing on an explicitly evolutionary, lineage based criterion . The PSC thus now dominates in mammalogy, as the most common species concept used or referred to. The transition from majority usage of the BSC to PSC in mammal taxonomy is entirely not so simple, however. There is little explicit consideration of species concepts by the majority of mammal taxonomists.

Baker & Bradley (2006) themseleves put forward the Genetic Species Concept (GSC), wherein a species represents:

> *[...] a group of genetically compatible interbreeding natural populations that is genetically isolated from other such groups.*

This does not necessarily imply reproductive isolation. E.g. Thomomys pocket gophers; But there is debate… "[…] 100% diagnosable: they have fixed heritable differences between them […]"; "[…] offer a repeatable, falsifiable definition of species […]"; Groves 2012. American Journal of Primatology. 74(8):687–691.

Lines of evidence

Lines of evidence in mammal species delimitation; 1) Morphology (pre-1985) (But still influential! e.g. in allopatry); Phenetics still common, or 1st port-of-call e.g. Lew et al. 2006. J. Mammal. 87(2):224–237;

2-4) Karyotype studies, Allozymes, DNA sequencing; costly in the early days, but soon very doable!! very objective!; can highlight cryptic species; taxonomic infaltion?; see cases below

Mammal discoveries, 1975—2005

- Cape
  - Myosorex longicaudatus
    * Meester & Dippenaar 1978. Annals of the Transvaal Museum. 31(4):30–42
    * Knysna
    * Morphology & geography
- Africa
  - Primates, Rodents, Soricom.
- Global?
  -
- e.g. cytochrome-b (mtDNA)
  - Carvalho et al. 2009. Phylogeny of Thylamys (Didelphimorphia, Didelphidae) species, with special reference to Thylamys karimii

The increase in the number of named species [means] that we have increased our perception and understanding of the diversity of the primates.—Rylands et al. 2012. International Zoo Yearbook. 46(1):11–24

- cytochrome-b in rodents
  - Re: GSC sensu Baker & Bradley 2006 (J. of Mammal. 87(4):643–662), Bradley & Baker 2001 (J. of Mammal. 82(4):960–973)
- multi-locus work in Afro-tropical shrews
  - cytochrome-b, among others,
  - Jacquet et al. 2012. Zool. J. Linn. Soc. 166(3):672–687

Modes of mammalian speciation

…

Concluding remarks

- Molecular species delimitation is relevant to PSC/ESC/BSC
- Ecologically relevant speciation processes (e.g. bats) are case-by-case

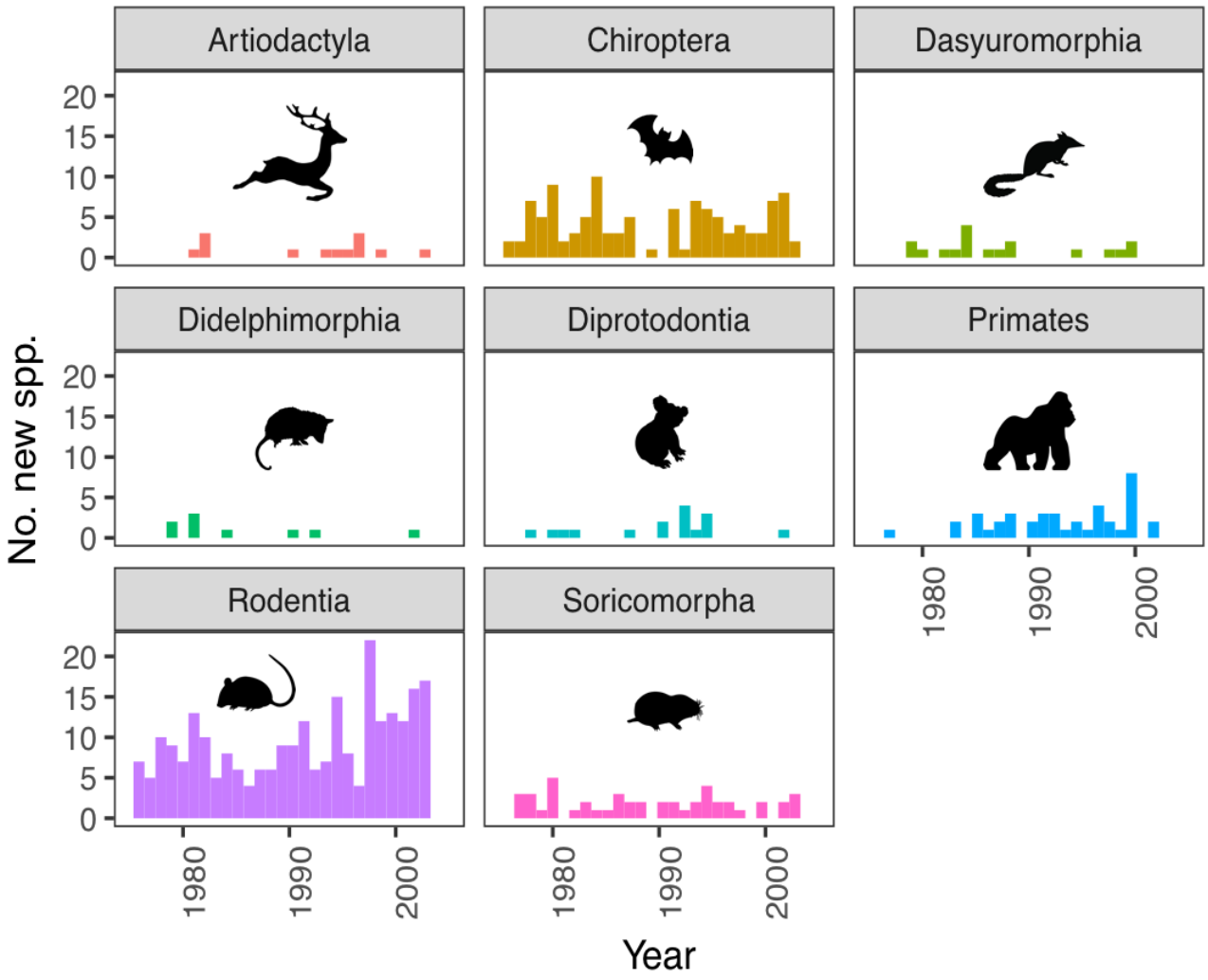

Figure 1: Bar-plots of the number of new species (*sensu stricto*, excluding sub-specific additions) described each year in the eight most taxonomically active orders of mammal over the period 1975—2005. Data are from MSW3 (see text) (Wilson & Reeder 2005). Taxonomically "active" here implies that $\geq$ 10 new species were described for an order over the 1975—2005 period. These eight orders are those that meet this criterion.

- Little generality to be drawn about speciation from the alpha-taxonomic methods
- Genetic sequencing & PSC (or at least ESC)
- Good taxonomic inflation!
- Genomics is up-and-coming! e.g. Murphy et al. 2004

References

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