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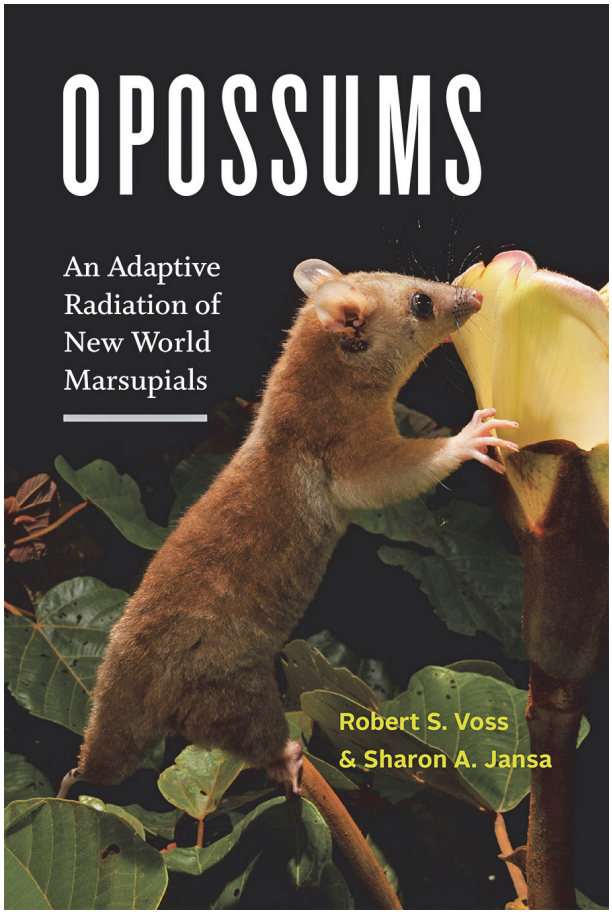
Opossums: An Adaptive Radiation of New World Marsupials

Review by Robin M.D. Beck

Voss, Robert S. & Jansa, Sharon A. Johns Hopkins University Press. 313 pages. $59.95 (hardcover).

With their unspecialised dentitions, largely insectivorous diets, and generalised postcranial skeletons, opossums (family Didelphidae) are often considered good living analogues of early therian mammals. This family of predominantly Neotropical mammals is also of interest as an example of a relatively species rich (>140 species described to date) mammalian clade that has radiated comparatively recently, and as a marsupial clade that has diversified widely despite the presence of numerous placental competitors. It is therefore perhaps surprising that the group has not been the subject of a dedicated volume until now. With their new book, Rob Voss (Curator of Mammalogy at the American Museum of Natural History) and Sharon Jansa (Professor at the University of Minnesota) have done an admirable job in filling this gap. These authors have published extensively on didelphid systematics (e.g. Voss and Jansa, 2009), but the current volume is far more ambitious and wide-ranging, attempting nothing less than a comprehensive summary of what is currently known about didelphid anatomy, physiology, behaviour, and ecology within an explicitly evolutionary context. The authors have succeeded admirably in this aim: the book is an outstanding example of how the scientific literature can be distilled into a coherent, detailed, and thought-provoking account of a mammalian clade.



The book is the ideal size to fit into a backpack, and, at 240 pages (excluding appendices and references), the content is relatively easily

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digested. Nevertheless, a huge amount of information is synthesised here. The first section comprises three chapters on the position of Didelphidae within the larger clades Marsupialia and Metatheria, the evolutionary history of mammals in South America, and the impact of the Great American Biotic Interchange. These chapters are necessarily highly condensed accounts of a vast and complex literature—readers with a deeper interest in the overall history of South American mammal evolution during the Cenozoic should check out Croft (2016), which covers these issues in much greater detail—but they are up-to-date and accurate, and provide a useful broader context to the chapters that follow. The next chapter summarises what is known (and, equally importantly, what remains unknown) regarding the taxonomy and natural history of members of each of the currently recognised didelphid genera. As well as general information concerning such key aspects as overall appearance, distribution, and diet, it includes numerous fascinating observations, such as the construction of leaf nests by *Hyladelphys* (with the leaves "cemented together…by a mysterious white substance of unknown origin"), and the acrobatic copulation of *Tlacuatzin*, which takes place "with both partners suspended upside down by their tails". The chapter ends with a key inference that is of broad relevance to mammal systematics, namely that, in didelphids at least, "ecological-niche occupancy often corresponds to generic membership".

Three chapters on didelphid phenotypes (grouped as "Anatomy", "Physiology", and "Behavior") follow; again, these are rich in detail. The anatomy chapter provides an excellent, well-illustrated overview of the didelphid skeleton and soft tissues (including an outline of dental function in the group that is likely to be of particular interest to palaeomammalogists), but also informed speculation on the adaptive significance of the unusual pelage and markings seen in some opossums (e.g., the unusual white underfur of *Didelphis*, the bright pink ventral fur of *Monodelphis emiliae*, and the dark circumocular masks of many species), and a fascinating account of the (presumably sensory) papillae on the hands of the semi-aquatic *Chironectes*, among other intriguing tidbits. The physiology chapter is similarly diverse, covering topics such as metabolic rate, life history, and sensory ecology, as well as a detailed look at toxin resistance among members of the group. The behavioural repertoire of living opossums is unremarkable by mammalian standards, with a few exceptions (e.g. the famous death-feigning behaviour of *Didelphis virginiana* and possibly other congeners), but again the authors have done an exceptional job of synthesising the available literature into a coherent summary.

The following section on natural history covers "Habitats", "Diets", "Parasites", "Predators", "Competitors and Mutualists", and "Population Biology" – once again, these are comprehensive and information dense, and deal with many concepts and principles that are of broad relevance to mammalogists, ecologists, and palaeoecologists. Of particular interest are the cogent summaries of the distinctive features of different habitats (e.g., lowland rainforest, where most opossums live today), and how these influence the faunas living within them. The observation that opossums occurring in sympatry appear to be stratified both vertically (with members of the same genus typically adapted to specific vertical microhabitats, e.g. *Caluromys* in the canopy and subcanopy vs. *Monodelphis* on the ground) and horizontally (with members of the same genus segregating according to specific vegetation type) is also a key inference, and one that may be apply to small mammals more widely. The chapter on diets takes an admirably sceptical view, noting that all methods for determining diet in mammals suffer from limitations of one kind of another; not mentioned, however, is the potential for environmental DNA-based methods for inferring diet. These chapters are brimming with fascinating insights and topics in need of further study, such as (to pick but a few) the potentially ancient co-evolutionary relationship between the didelphids and the medically important trypanosome parasite *Trypanosoma cruzi*, the possibility that the "tweezer-like" first upper incisor of didelphids might be an adaptation for removing ectoparasites, the observation that jaguars actively avoid predating on *Didelphis marsupialis*, and the possibility that the non-overlapping ranges of females seen in many didelphid species is to avoid female-mediated infanticide. The chapter on didelphid population biology provides an intriguing point of comparison to Australian marsupials: unlike the Australian family Dasyuridae, few didelphids are genuinely semelparous, but extremely high annual population turnover (>80%) has nevertheless been observed in several opossums, which therefore represent excellent examples of mammal species with "fast" mammalian life histories.

The final chapter synthesises the preceding chapters into a persuasive overall scenario for the diversification and adaptive radiation of modern

didelphids. The authors revisit the unusual period of zero diversification seen in a Lineage Through Time plot of didelphid diversification that they previously identified (Jansa et al., 2014), and consider it most likely that this reflects a mass extinction event ~11 Ma ago, caused by the arrival of novel predators (probably procyonid carnivorans) in South America. The treatment of the didelphid fossil record—which includes some highly distinctive forms, many of which appear to have been more carnivorous than living species (e.g., *Thylatheridium*, *Hyperdidelphys*, *Sparassocynus*)—is very brief, and it would have been good to have a more detailed treatment of this topic and a discussion of what additional information the fossil evidence might provide regarding the radiation of didelphids in time and space. But this is nitpicking: overall, this book is a remarkable achievement, combining broad scope with brevity, and written with rigour and refreshing honesty about what we do and do not know about this fascinating mammalian group. A book purely on opossums might sound rather niche, but it is crammed to the gills with information of relevance to mammalian systematists, palaeomammalogists, Neotropical ecologists, and evolutionary biologists with a general interest in the nature of adaptive radiations, and I wholeheartedly recommend it to all such researchers.

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