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EDITORIAL

Morphology and Evolution of the Xenarthra: an Introduction

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This special issue of the *Journal of Mammalian Evolution* comprises a collection of articles presented at the symposium "Morphology and Evolution of the Xenarthra" organized and chaired by MSB and JAN. The symposium took place during the *11th International Congress of Vertebrate Morphology* (ICVM-11), Washington, D.C., USA, from June 29 to July 3, 2016.

The aim of the symposium was to bring together morphologists from around the world that work on extant and extinct xenarthrans, one of the most fascinating and enigmatic mammalian clades. Given the lack of an international conference that specializes on the group, there is a tradition of holding symposia that focus on the Xenarthra (X-symposia from here on) during the ICVM meetings. The past X-symposia took place in Jena (2001, ICVM-6), Paris (2007, ICVM-8), and Punta del Este (2010; ICVM-9).

The last X-symposium during 2016 (ICVM-11) represented an excellent opportunity to give continuity to these meetings and to present the latest research results to the international colleagues in the field. We had 22 contributions, 14 oral presentations (including one keynote lecture by Gerry De Iuliis) and eight posters, of altogether 41 authors from Argentina, Uruguay, USA, Canada, Spain, France, and Germany (Fig. 1). The topics of the presentations were diverse, counting bone histology, geometric morphometrics, functional morphology, comparative biomechanics, paleontology, and phylogeny. With a common interest in the overall evolution of the Xenarthra, the talks were loosely structured in three blocks focusing on 1) the systematics of extinct Xenarthra, 2) the functional morphology of extinct Xenarthra, and 3) the morphology of extant Xenarthra. The subjects of the posters generally followed this structure, too. We are very grateful to Lawrence M. Witmer (Ohio University), chair of the ICVM Scientific Program Committee, for his support during the organization of the symposium, and to all participants for their great contributions and attending the meeting.

This special issue features ten papers that reflect the current state of the art in the research of the Xenarthra. Several contributions are reviewing the available literature, and thus help to identify new (or understudied) research avenues, whereas the other papers contribute valuable new data.

Current Knowledge and Future Directions – Review Articles in this Special Issue

In the paper "Recent progress and future prospects in fossil xenarthran studies, with emphasis on current methodology in sloth taxonomy, "Gerry De Iuliis reviews the progress of the field with a particular focus on the last 20 years (De Iuliis 2017, this issue). While the author acknowledges several aspects of improvement, it is also lamented that some areas need an increased effort by the community. These include improved

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Fig. 1 Contributors of the X-Group at the ICVM-11 (2016). From left to right, back row: John Nyakatura, Néstor Toledo, Jens Thielebein, Santiago Patiño, Robert McAfee, Lionel Hautier, Mariana Di Giacomo, Guillaume Billet, Sergio Vizcaíno, Tim Gaudin, and Jillian Oliver. First row: Eli Amson, Daniela Kalthoff, Richard Fariña, Soledad D'Esteban Trivigno, Susana Bargo, Sebastián Tambusso, Mariela Castro. Kneeling: Greg McDonald, Gerry De Iuliis, and Rachel Olson

description and illustration of several regions of the body that are sorely needed for alpha taxonomy. In a second pure review paper with the title "The postcranial musculoskeletal system of xenarthrans: insights from over two centuries of research and future directions," Eli Amson and John Nyakatura focus on the functional morphology of the postcranium in the Xenarthra (Amson and Nyakatura 2017, this issue). They review two centuries of research and identify several areas lacking research and promising new research frontiers, including but not limited to bone inner structure. For example, the authors also predict an upswing in the use of computer modelling techniques to further explore the morphology of extant and extinct xenarthrans. In yet another contribution that has the character of a review, "An overview of the presence of osteoderms in sloths: implications for osteoderms as a plesiomorphic character of the Xenarthra," Greg McDonald studies the presence of osteoderms in fossil sloths and specifically makes the case for the osteoderms of fossil sloths to be independently acquired in one or two subclades of the currently recognized sloths (McDonald 2017, this issue).

Sergio Vizcaíno and colleagues review the "Advantages and limitations in the use of extant xenarthrans (Mammalia) as morphological models for paleobiological reconstruction," but also contribute new analyses (Vizcaíno et al. 2017, this issue). The authors highlight the extreme morphological differences between the extant forms and many of the (enormous) fossil specimens. The authors warn that these fossil specimens lack modern analogues within the Xenarthra. A new database of linear dimensions of the appendicular skeleton of extant and extinct specimens was built and explored using a principal components analysis. All in all, the team shows that the common approach of actualism and modern analogues needs to be complemented with other approaches to address the form-function relationships of xenarthran morphologies. Similarly mixing a thorough review of available literature with new original results, Lionel Hautier and his co-authors focus on the development of the Xenarthra in their contribution entitled "An overview of xenarthran developmental studies with a focus on the development of the xenarthrous vertebrae" (Hautier et al. 2017, this issue). The authors elaborate on the developmental sequence of the iconic xenarthrous articulations and discuss its functional and historical implications. The paper ends with the identification of future directions of evolutionary developmental research on xenarthrans.

New Insights into Extinct and Extant Xenarthra – Original Articles in this Special Issue

The other half of the contributions to this special issue all provide new original data and focus on diverse aspects of the morphology and evolution of the Xenarthra. Néstor Toledo and co-workers in their paper "The concept of pedolateral pes revisited: the giant sloths *Megatherium* and *Eremotherium* (Xenarthra, Folivora, Megatheriinae) as a case study" focus on a specific peculiarity of fossil sloths, the habitually inverted pes already described in very early accounts of fossil sloth morphology (Toledo et al. 2017, this issue). Reanalyzing two of the truly gigantic forms, the team surprisingly found little evidence that suggests a strongly inverted pes. These results call for a thorough reappraisal of the available fossil material and could also benefit from relatively recent approaches like computer modelling. In a completely different approach, but also with a focus on fossil xenarthrans, Luciano Varela and colleagues study the paleo-biogeographical distribution of 15 extinct xenarthran taxa using species distribution models in their paper "Potential distribution of fossil xenarthrans in South America during the late Pleistocene: co-occurrence and provincialism" (Varela et al. 2017, this issue). Their new data provide a differentiated basis for inferences in terms of suitable and preferential areas of the species in light of climatic changes and accompanying changes of sea level. In the final contribution with a primary focus on fossil

xenarthrans, Daniela Kalthoff and Jeremy Green study the "Feeding ecology in Oligocene mylodontoid sloths (Mammalia, Xenarthra) as revealed by orthodentine microwear analysis" (Kalthoff and Green 2017, this issue). The microwear analyses on the recovered molariforms of two of the earliest sloths carried out by these authors support the reconstruction of Deseadan environments as open habitats and indicate that the studied species likely were bulk feeders at ground level.

This special issue is rounded out by two contributions on extant xenarthrans. Both focus on the postcranial musculature. These soft tissues usually are not preserved in fossils and therefore insights into the muscle anatomy of extant sloths may provide novel insight not only for a better understanding of the modern forms, but also for some of the extinct species (but see the paper by Vizcaíno et al. 2017, this issue). Tim Gaudin and John Nyakatura take measurements of the epaxial musculature in a species of armadillo (*Dasypus*) and a sloth (*Choloepus*) and compare these data to the Virginia opossum which is often considered a "generalized mammal." In their paper entitled "Epaxial musculature in armadillos, sloths, and opossums: functional significance and implications for the evolution of back muscles in the Xenarthra," the authors suggest that the specific muscular arrangement and relative sizes of the epaxial muscles in the armadillo present an adaptation to effective digging (Gaudin and Nyakatura 2017, this issue). Furthermore, the epaxial muscle anatomy of the sloths is surprisingly similar to that of the armadillos and was probably inherited from digging ancestors. Last but not least, Rachel Olson and co-workers thoroughly study the "Architectural properties of sloth forelimb muscles (Pilosa: Bradypodidae)" (Olson et al. 2017, this issue). Surprisingly, the authors find that several properties of the forelimb muscles in these slow moving animals reflect a mechanical design indicative of fast rotational velocity instead of large joint torques. Nevertheless, many flexors are characterized by large moment arms that appear to compensate for overall reduced skeletal muscle mass.

We are sure that this special issue will represent a valuable contribution and valuable source of information for experienced xenarthrologists and those on their way to becoming one. Functioning as guest editors, we (MSB and JAN) would like to thank all contributors for their sustained efforts during the peer review phase of the articles published here. It was worth it! We would also like to express our appreciation and gratitude to John R. Wible, the editor-in-chief of the *Journal of Mammalian Evolution*, for his constant support and for giving this collection of themed papers a home.

References

Amson E, Nyakatura JA (2017) The postcranial musculoskeletal system of xenarthrans: insights from over two centuries of research and future directions. J Mammal Evol

De Iuliis G (2017) Recent progress and future prospects in fossil xenarthran studies, with emphasis on current methodology in sloth taxonomy. J Mammal Evol

Gaudin TJ, Nyakatura JA (2017) Epaxial musculature in armadillos, sloths, and opossums: functional significance and implications for the evolution of back muscles in the Xenarthra. J Mammal Evol

Hautier L, Oliver JD, Pierce SE (2017) An overview of xenarthran developmental studies with a focus on the development of the xenarthrous vertebrae. J Mammal Evol

Kalthoff D, Green J (2017) Feeding ecology in Oligocene mylodontoid sloths (Mammalia, Xenarthra) as revealed by orthodentine microwear analysis. J Mammal Evol

McDonald G (2017) An overview of the presence of osteoderms in sloths: implications for osteoderms as a plesiomorphic character of the Xenarthra. J Mammal Evol

Olson RA, Glenn ZD, Cliffe RN, Butcher MT (2017) Architectural properties of sloth forelimb muscles (Pilosa: Bradypodidae). J Mammal Evol

Toledo N, De Iuliis G, Vizcaíno SF, Bargo MS (2017) The concept of pedolateral pes revisited: the giant sloths *Megatherium* and *Eremotherium* (Xenarthra, Folivora, Megatheriinae) as a case study. J Mammal Evol

Varela L, Tambusso PS, Patiño SJ, Di Giacomo M, Fariña RA (2017) Potential distribution of fossil xenarthrans in South America during the late Pleistocene: co-occurrence and provincialism. J Mammal Evol

Vizcaíno SF, Toledo N, Bargo MS (2017) Advantages and limitations in the use of extant xenarthrans (Mammalia) as morphological models for paleobiological reconstruction. J Mammal Evol