Dataset

3D models related to the publication: "The functional significance of aberrant cervical counts in sloths: insights from automated exhaustive analysis of cervical range of motion"

Luisa J.F. Merten[1,2*], Armita R. Manafzadeh[3,4,5,6], Eva C. Herbst[7,8], Eli Amson[9], P. Sebastián Tambusso[10], Patrick Arnold[11+], John A. Nyakatura[1+]

[+] *contributed equally to this study*
[1] *Comparative Zoology, Institute of Biology, Humboldt University of Berlin, Philippstr. 12/13, 10115 Berlin, Germany*
[2] *Museum für Naturkunde, Leibniz Institute for Evolution and Biodiversity Science, Invalidenstraße 43, 10115 Berlin, Germany*
[3] *Yale Institute for Biospheric Studies, Yale University, New Haven, CT 06520, USA*
[4] *Department of Earth & Planetary Sciences, Yale University, New Haven, CT 06520, USA*
[5] *Yale Peabody Museum of Natural History, New Haven, CT 06520, USA*
[6] *Department of Mechanical Engineering and Materials Science, Yale University, New Haven, CT 06520, USA*
[7] *Palaeontological Institute and Museum, University of Zurich, Karl-Schmid-Strasse 4, 8006 Zurich, Switzerland*
[8] *Department of Health Sciences and Technology, ETH, University of Zurich, Hönggerbergring 64, 8093 Zürich, Switzerland*
[9] *Staatliches Museum für Naturkunde Stuttgart, Rosenstein 1, 70191 Stuttgart, Germany*
[10] *Departamento de Paleontología, Facultad de Ciencias, Universidad de la República, Iguá 4225, 11400, Montevideo, Uruguay*
[11] *Institute for Biochemistry and Biology, University of Potsdam, Karl-Liebknecht-Strasse 24-25, 14476 Potsdam, Germany*
***Corresponding author**: isa.merten@web.de

Abstract
The present 3D Dataset contains the 3D models analyzed in Merten, L.J.F, Manafzadeh, A.R., Herbst, E.C., Amson, E., Tambusso, P.S., Arnold, P., Nyakatura, J.A., 2023. The functional significance of aberrant cervical counts in sloths: insights from automated exhaustive analysis of cervical range of motion. Proceedings of the Royal Society B. doi: 10.1098/rspb.2023.1592

Keywords: articular surfaces, cervical vertebrae, vertebral biomechanics, zygapophyses

Submitted:2023-09-25, published online:2023-11-04. https://doi.org/10.18563/journal.m3.215

INTRODUCTION

The suspensory extant "tree sloths" are the only mammals, besides manatees, that deviate from the otherwise stable cervical count (CC) of seven vertebrae. Interestingly, the two living genera do so in opposite directions, which is seemingly reflected in their neck mobility: *Bradypus* has an increased number of cervicals (eight to ten) and a very high torsional ability of the neck while individuals of *Choloepus* show a decreased CC (seven to five cervicals) and are not known for similar neck movements (Buckland 1834) (see figure 1). In the associated paper by Merten et al. (2023), we studied whether the CC or rather the morphology of the vertebrae is the driving factor behind an increase or decrease of overall neck mobility by assessing 3D intervertebral range of motion (ROM) based on exhaustive automated detection of bone collisions and joint disarticulation while accounting for interacting rotations of roll, yaw, and pitch. This was tested in a comparative evolutionary framework that included the two extant sloth genera, an extinct "ground sloth", representatives of the closely-related anteaters, as well as the red panda, which has a generalized neck anatomy (see table 1, figure 1). The assessment revealed that CC played only a secondary role in defining ROM. Instead, ROM and especially summed torsion (roll) was primarily determined by vertebral anatomy, specifically the shape of the vertebral bodies and the size and orientation of the zygapophyseal facets, suggesting limited adaptive significance of the CC aberration in sloths. The study demonstrated the suitability of the automated approach for the comparative assessment of osteological ROM in vertebral series. All analyzed 3D models besides *Cyclopes* of the related paper are published here, as well as the atlas and available thoracic vertebrae associated to the analyzed cervical series (if scanned together with the cervical vertebrae). *Cyclopes* from the ZSM is subject to strict data sharing regulations, which is why the associated scan can only be shared upon request by the curator (PD Dr. habil. Anneke H. van Heteren, vanheteren@snsb.de).

METHODS

The cervical series ranging from the atlas to the last cervical vertebrae (C1 to C6/7/8) was computed tomography and structured light scanned in different facilities for all specimens (see table 1). Virtual surface models of all vertebrae were then reconstructed in Amira (Version 6.0.0., Thermo Fisher Scientific, Germany) and exported as 3D objects. Meshes were cleaned to ensure manifoldness and mesh count was reduced within the software Geomagic Studio (Version 2013.0.2., 3D Systems GmbH, Germany). The 3D surface models are provided in .obj format, and can therefore be opened by an extensive list of free and open-source software.

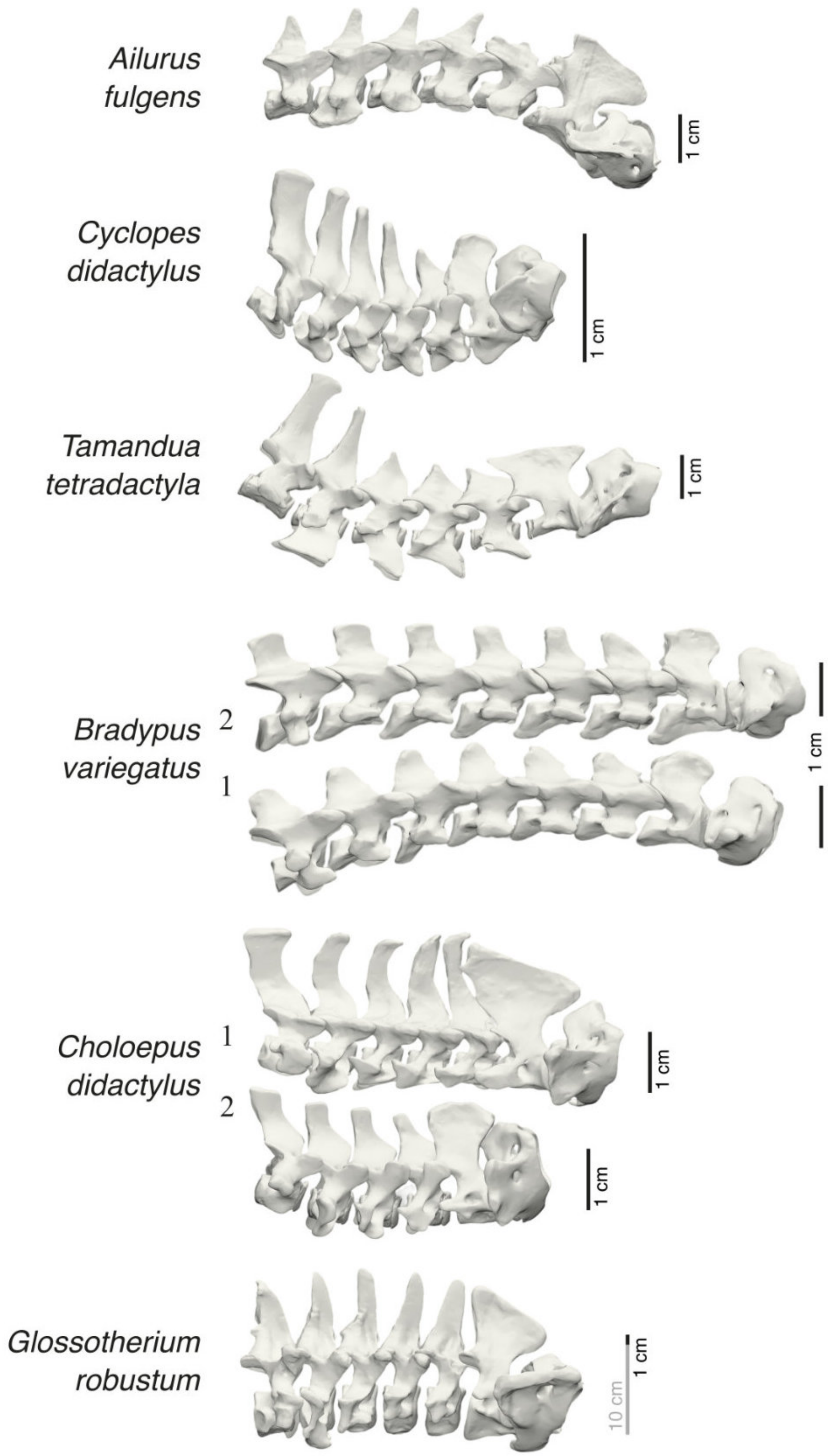

Figure 1. Articulated cervical series of all specimens of the related publication (Merten et al. 2023). All cervical series are shown in right lateral view from caudal (left) to cranial (right) and are arranged in ONP (further explanation see related publication). Black scale bars measure 1cm, grey scale bar measures 10cm.

 ISSN: 2274-0422

Inv nr.	Taxon	Description	Collection
PMJ_Mam_6639	*Ailurus fulgens*	C1-7	PMJ*
ZMB_Mam_91345	*Bradypus variegatus*	C1-8,T1	MNB*
ZMB_Mam_35824	*Bradypus variegatus*	C1-8,T1-2	MNB**
ZMB_Mam_38388	*Choloepus didactylus*	C1-7	MNB**
ZMB_Mam_102634	*Choloepus didactylus*	C1-6,T1	MNB**
ZSM_1925/... (sic)	*Cyclopes didactylus*	C1-7,T1	ZSM**
ZMB_Mam_91288	*Tamandua tetradactyla*	C1-7,T1	MNB**
MNHN_n/n	*Glossotherium robustum*	C1-7,T1	MNHN***

Table 1. Collection number, scanning information, and number of vertebrae (C, cervical vertebra; T, thoracic vertebra) of the specimens. MNB: Museum für Naturkunde Berlin, Germany. ZSM: Zoologische Staatssammlung München, Germany. Museo Nacional de Historia Natural, Montevideo, Uruguay. *Specimens scanned with a Tomoscope Synergy Twin (ElysiaRaytest GmbH, Straubenhaerdt, Germany); ** Specimens scanned with a phoenix|X-ray Nanotom M (Zoologische Staatssammlung München, Germany); *** Specimen scanned at the DAVID SLS-2 Structured Light Scanner (David Vision Systems, Germany). The 3D model of the neck of ZSM_1925/... (sic) (*Cyclopes didactylus*) is available upon request (contact: PD Dr. habil. Anneke H. van Heteren, vanheteren@snsb.de).

ACKNOWLEDGEMENTS

Part of the data acquisition (EA) was funded by the Alexander von Humboldt Foundation. ARM was funded by a Gaylord Donnelley Postdoctoral Environmental Fellowship from the Yale Institute for Biospheric Studies. All other aspects of this study were conducted using budgetary funds. We thank David Baier for development of the XROMM_MayaTools and Stephen Gatesy for his previous contributions to the development of the MEL code for Maya-based automated ROM analysis.

BIBLIOGRAPHY

Buckland W. 1834. IV. On the adaption of the sloths to their peculiar mode of life. Transactions of the Linnean Society of London 17, 17–27. https://doi.org/10.1111/j.1095-8339.1834.tb00015.x

Merten, L.J.F, Manafzadeh, A.R., Herbst, E.C., Amson, E., Tambusso, P.S., Arnold, P., Nyakatura, J.A., 2023. The functional significance of aberrant cervical counts in sloths: insights from automated exhaustive analysis of cervical range of motion. Proceedings of the Royal Society B. https://doi.org/10.1098/rspb.2023.1592

 ISSN: 2274-0422