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”

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Abstract

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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.
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).

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**BIBLIOGRAPHY**
