Xenarthra 26 (2025): e2605
DOI: https://doi.org/10.2305/LOKD3922
ISSN for *Xenarthra*: 3006-6077
ISSN for *Edentata*: 1852-9208
https://www.xenarthrans.org

IUCN/SSC Anteater, Sloth & Armadillo Specialist Group

SHORT COMMUNICATION

Bilateral pre-axial polydactyly in a wild juvenile Hoffmann's two-toed sloth (*Choloepus hoffmanni*)

Sara Goñi Martinez[A,1], Ambre Thiriet[A], Sofia Astorga Alvarado[A] & Marta Venegas[A]

[A] Rescate Wildlife Rescue Center, Fundación Restauración de la Naturaleza, Alajuela 1327–4050, Costa Rica

[1] Corresponding author. E-mail: saragonimnez@gmail.com

Abstract Polydactyly is a relatively common congenital condition in humans, also described in some other species of animals, where more digits than usual are present in the hands or feet. The literature about congenital anomalies in sloths is sparse. In this short communication we present a case of bilateral pre-axial polydactyly in a juvenile Hoffmann's two-toed sloth (*Choloepus hoffmanni*), identified upon arrival to a rehabilitation center. The external and radiographical appearance are described, as well as the clinical relevance of the case.

Keywords: anatomy, evolution, genetics, polydactyly, sloth

Polidactilia pre-axial bilateral en un perezoso de dos dedos de Hoffmann juvenil (*Choloepus hoffmanni*)

Resumen La polidactilia es una condición congénita relativamente común en humanos, también descrita en otras especies animales, en la cual un individuo presenta más dígitos de lo normal en las manos o los pies. Sin embargo, la literatura científica sobre este tipo de anomalías en perezosos es limitada. En esta nota se presenta un ejemplo de un individuo juvenil de perezoso de dos dedos (*Choloepus hoffmanni*) con polidactilia pre-axial bilateral, diagnosticada al ser recibido en un centro de rehabilitación. Se describe la apariencia externa, así como la anatomía radiográfica, y se discute la relevancia clínica del caso.

Palabras clave: anatomía, evolución, genética, perezoso, polidactilia

Attributing sloths their common names, sloth digits have been reason for fascination and research in comparative anatomy and zoology. Two-toed sloths (those of the genus *Choloepus*) have reduced functional digits, with remaining digits II and III in the hand and II to IV in the foot (Mendel, 1981a).

Despite being listed as Least Concern in the last IUCN assessment, Hoffmann's two-toed sloth (*Choloepus hoffmanni*) populations are decreasing due to deforestation, hunting, and illegal trade (Plese *et al.*, 2022).

Polydactyly is a congenital malformation of limbs characterized by the occurrence of supernumerary digits or digital parts on the hands and/or feet. It is considered to be one of the most common hereditary defects in humans, and various classifications exist. First, it can be non-syndromic or associated with other malformations as part of a syndrome. Secondly, the clinical presentation leads to the identification of different phenotypes of polydactyly. Depending on the extra digit localization, the polydactyly will be referred to as preaxial (regarding the radial/tibial side of the limb), axial/central (regarding the median digits), or postaxial (regarding the ulnar/peroneal side of the limb). (Umair *et al.*, 2018; Kyriazis *et al.*, 2023). Polydactyly is a well-documented malformation in humans with various clinical presentations and surgical recommendations.

It has been described in numerous species of vertebrates (see www.omia.org), from mammals to birds (Dogliero *et al.*, 2018; Huang *et al.*, 2025) and

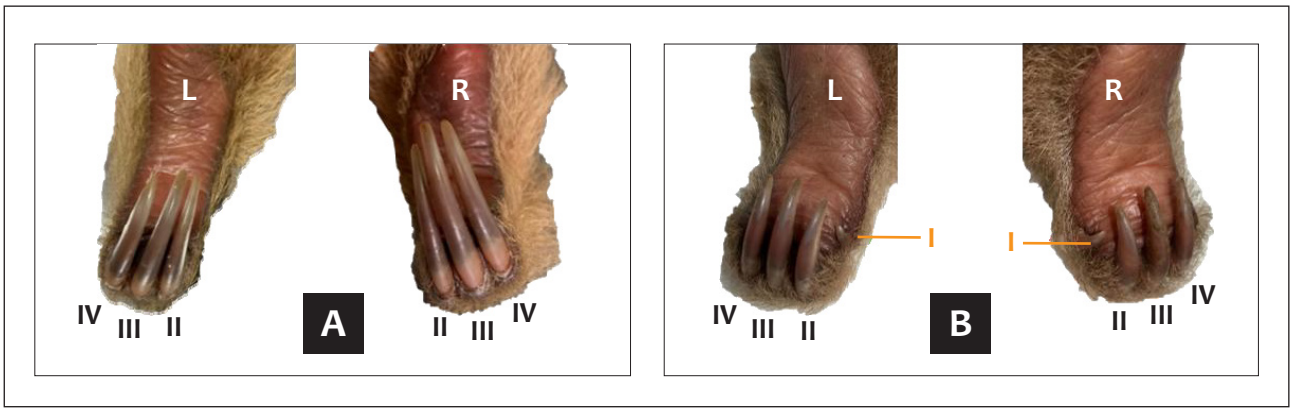

Figure 1. Photographs of the **A** = normal external appearance of a juvenile two-toed sloth's feet and **B** = external appearance of preaxial polydactyly in a juvenile *Choloepus hoffmanni*, Rescate Wildlife Rescue Center, Costa Rica. The supernumerary digits (**I**) are marked in orange. **R** = right foot; **L** = left foot.

amphibians (Meteyer, 2000). It is mostly described in domestic animals (Hamelin *et al.*, 2020; Hao *et al.*, 2024; Wehrenpfennig & Schmierer, 2024) but a few cases in wildlife have been reported (Fowler & Miller, 2008; da Silva *et al.*, 2016; Warburton *et al.*, 2021). Here we describe a case of polydactyly in a juvenile *Choloepus hoffmanni* upon arrival at a rehabilitation center. External and radiographic appearance are described, as well as a discussion about the possible origin and clinical significance. This case report aims to further our understanding of congenital disorders in sloths and their impact on their health and conservation.

Physical examination findings and external appearance

A juvenile male Hoffmann's two-toed sloth (*Choloepus hoffmanni*) was found and admitted to Rescate Wildlife Rescue Center in Costa Rica on 19 April 2025. The individual was rescued in Tárcoles, Puntarenas by local authorities after someone attempted to sell him, claiming he had been found alone, apparently without his mother nearby. Upon admission, his weight was 852 g. During physical examination, an additional digit with a well-developed claw was observed in the medial aspect of each of the feet, giving the diagnosis of preaxial polydactyly (**Fig. 1**). Palpation of the extra digits did not elicit pain and the external appearance was smaller but otherwise that of a normal digit. Function of the feet was unaffected by the polydactyly; the individual demonstrated good gripping strength with the digits and was able to move around the enclosure without difficulties.

Radiographic appearance

In addition to the physical examination, palmo-dorsal views of the hindlimbs were taken with a digital radiographic machine. They confirmed true polydactyly with development of the proximal, intermediate, and distal phalanges in both extra digits (**Fig. 2**). Otherwise the radiographic anatomy appeared normal when compared with the published literature (Mendel, 1981a).

Discussion

Although reports of polydactyly in other species exist, this condition had never been described, to the extent of our knowledge, in sloths. In domestic animals, polydactyly has been linked to genetic variations in different breeds of dogs and cows, as well as being considered an inherited trait in cattle, dogs, cats, and horses (Craig *et al.*, 2016). In humans, polydactyly is the most common hereditary limb anomaly, with multiple genes involved (Umair *et al.*, 2018).

In horses, polydactyly is sub-divided into teratogenic (originating from altered basipodal elements in the embryo), atavistic (a reappearance of a digit that was present in the ancestral horse), and heritable (usually bilateral and with the extra digit in the medial aspect) (Farrow, 2006). Two-toed sloths (*Choloepus* sp.) have reduced functional digits with remaining II and III in the hand and II to IV in the foot (Mendel, 1981a; Casali *et al.*, 2022). These digits are made of syndactylous phalanges to the level of the distal inter-phalangeal joints (Mendel, 1981a, b; Casali *et al.*, 2022). In the foot, digits I and V are reduced to metatarsals, still allowing insertions of muscles such as the peroneus tertius and a portion of the extensor hallucis longus (Mendel, 1981a).

To this day, the origin and apparition of syndactyly in sloths remains unknown. Some hypotheses advanced for marsupials stand that it might be an adaptation to arboreal locomotion (Mendel, 1981b; Weisbecker & Nilsson, 2008; Nyakatura, 2012; Casali *et al.*, 2022). *Choloepus hoffmanni* is a member of the Megalonychidae, a group of primarily extinct ground-sloths (Nyakatura, 2012). Ground-sloths have been depicted as having five digits in the pes in the

rock art of Serranía de la Lindosa, Colombia (Iriarte *et al.*, 2022).

While the bilateral and symmetric features of this case could classify it as a heritable polydactyly, the radiographic appearance, coupled with the evolutionary origin of the species, suggests an atavistic origin, with the polydactyl digits originating from the metatarsals. However, genetic analysis would be required to further clarify the origin of the polydactyly in this case.

The clinical relevance of polydactyly varies depending on its association with other congenital abnormalities. Polydactyly has been associated with other congenital anomalies in 14.6% of human cases (Castilla *et al.*, 1998). Evidence of polydactyly as part of inherited syndromes with other dysostosis and anomalies such as cleft palate and scoliosis has been described in small animal medicine by several authors (Villagómez & Alonso, 1998; Lockwood *et al.*, 2009; Wehrenpfennig & Schmierer, 2024). In wildlife, Warburton *et al.* (2021) describe a case of extreme polydactyly in a healthy adult kangaroo. However, da Silva *et al.* (2016) report two cases of polydactyly in howler monkeys with affectation of mobility.

In the case presented, no anomalies were observed in the physical exam of the juvenile sloth, and the polydactyly did not seem to affect the locomotion of the individual. Therefore, surgical correction, the proposed treatment in most cases (Carstanjen *et al.*, 2007), was not considered, as this finding appears to have no clinical relevance.

To our knowledge, this is the first report of polydactyly in sloths. In Rescate Wildlife Rescue Center, 145 Hoffmann's two-toed sloths were admitted between the years 2018 and 2025, with this case being the only one where polydactyly was observed. The overall incidence of polydactyly in *C. hoffmanni* remains unknown.

Birth defects have been reported in orphaned baby sloths at some Costa Rican centers (The Sloth Conservation Foundation, 2025), including albinism and jaw malformations.

Determining the cause of birth defects such as polydactyly is challenging. Genetic bottlenecks

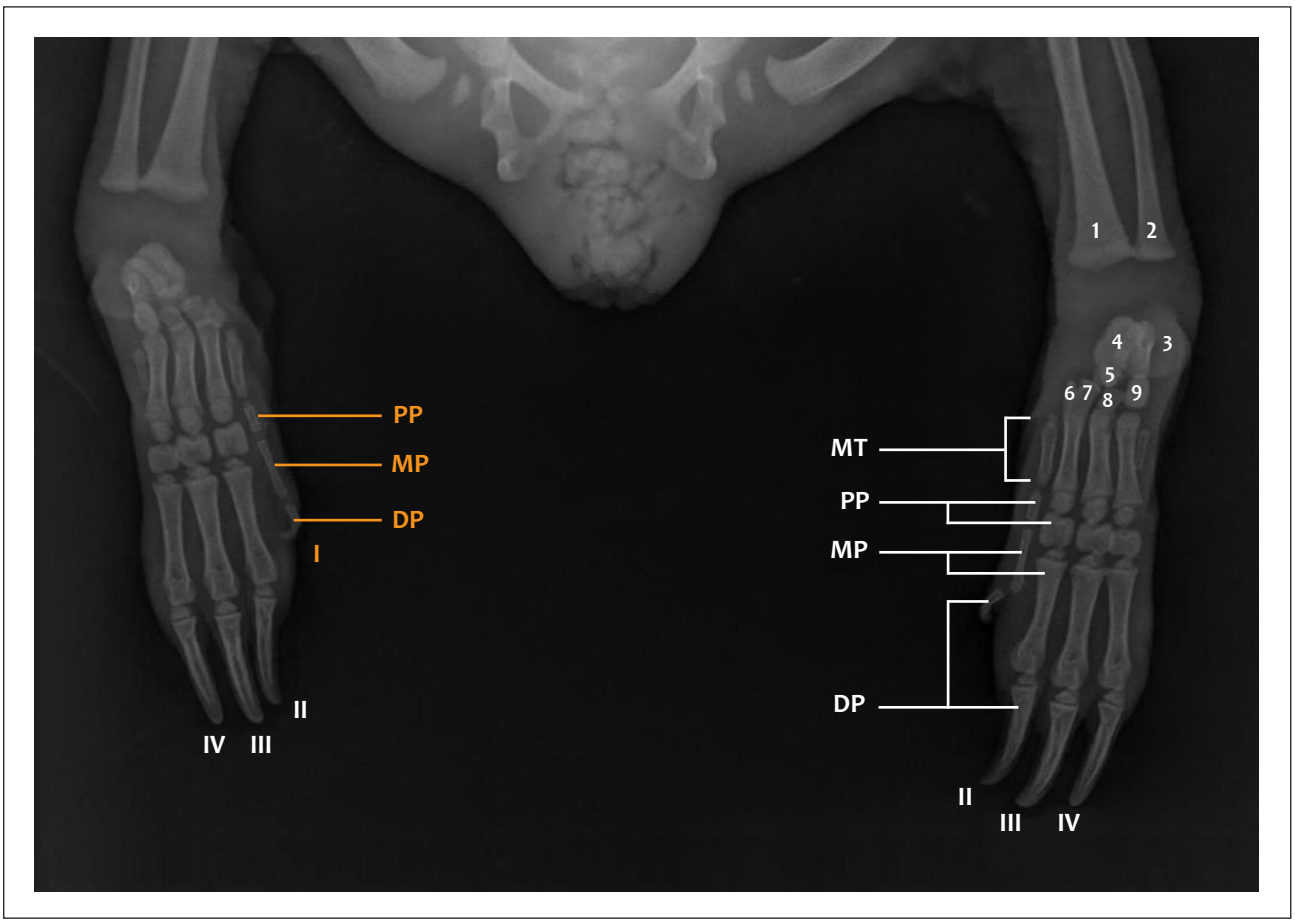

Figure 2. Radiograph (44 kV, 5 mAs) of right and left hindlimbs of a juvenile *Choloepus hoffmanni* with pre-axial polydactyly in a palmo-dorsal view, Rescate Wildlife Rescue Center, Costa Rica. Red annotations represent the additional bones conforming the polydactyly. **I** = supernumerary digit; **II–IV** = digits; **1** = tibia; **2** = fibula; **3** = calcaneus; **4** = talus; **5** = navicular, **6, 7, 8** = medial, intermediate, and lateral cuneiforms; **9** = cuboid; **MT** = metatarsal bones; **PP** = proximal phalanges; **MP** = intermediate phalanges; **DP** = distal phalanges.

can result from habitat loss, and may lead to health problems in the remaining populations (O'Brien *et al.*, 1983; Pinto *et al.*, 2024), while widespread use of pesticides has been shown to alter growth and reproduction in a variety of organisms (Carsten *et al.*, 2023; Wan *et al.*, 2025). Although here we present an isolated case, the potential increase in abnormalities observed in rescued juvenile sloths may serve as a warning to increase surveillance, as further research is required to understand the extent of this problem and the potential implications for the conservation of the species at a population level.

Acknowledgements

The authors would like to acknowledge the work of the keepers at Rescate Wildlife Rescue Center that provide care to this and many other sloths in rehabilitation.

References

Carstanjen, B., M. Abitbol & C. Desbois. 2007. Bilateral polydactyly in a foal. Journal of Veterinary Science 8: 201–203. https://doi.org/10.4142/jvs.2007.8.2.201

Carsten, A.B., *et al.* 2023. Pesticide use in banana plantations in Costa Rica—A review of environmental and human exposure, effects and potential risks. Environment International 174: 107877. https://doi.org/10.1016/j.envint.2023.107877

Casali, D.M., A. Boscaini, T.J. Gaudin & F.A. Perini. 2022. Reassessing the phylogeny and divergence times of sloths (Mammalia: Pilosa: Folivora), exploring alternative morphological partitioning and dating models. Zoological Journal of the Linnean Society 196: 1505–1551. https://doi.org/10.1093/zoolinnean/zlac041

Castilla, E.E., R. Lugarinho, M. da Graça Dutra & L.J. Salgado. 1998. Associated anomalies in individuals with polydactyly. American Journal of Medical Genetics 80: 459–465. https://doi.org/10.1002/(SICI)1096-8628(19990827)85:5<455::AID-AJMG5>3.0.CO;2-Z

da Silva, M.A., *et al.* 2016. Two cases of polydactyly in wild brown howler monkeys (*Alouatta guariba clamitans*). Journal of Medical Primatology 45: 47–51. https://doi.org/10.1111/jmp.12205

Dogliero, A., G. Quaranta & M.M. von Degerfeld. 2018. Bilateral pentadactyly in an immature alpine swift (*Tachymarptis melba*). Journal of Avian Medicine and Surgery 32: 342–344. https://doi.org/10.1647/2017-279

Farrow, C.S. 2006. Skeletal maturity, immaturity, and dysmaturity. Pp. 1–22 in: Veterinary diagnostic imaging: the horse (C.S. Farrow, ed.). Mosby Elsevier, St. Louis, Missouri. https://doi.org/10.1016/B0-32-301206-X/50003-2

Fowler, M.E. & R.E. Miller. 2008. Congenital and hereditary conditions of camelids. Pp. 391–406 in: Fowler's zoo and wild animal medicine: current therapy. Volume 6. Saunders Elsevier, St. Louis, Missouri. https://doi.org/10.1016/B978-141604047-7.50051-8

Hamelin, A., *et al.* 2020. Genetic heterogeneity of polydactyly in Maine Coon cats. Journal of Feline Medicine and Surgery 22(12): 1103–1113. https://doi.org/10.1177/1098612X20905061

Hao, Y., Y. Song, F. Chen & J. Tang. 2024. Whole genome resequencing reveals candidate genes for postaxial polydactyly in large white pigs. Animal Genetics 55: 277–281. https://doi.org/10.1111/age.13399

Huang, Z., X. Miao, D. Li, J. Liu, H. Chen & Y. Su. 2025. Integrated genomic and transcriptomic analysis of polydactyly in chickens. Frontiers in Veterinary Science 21: 1592068. https://doi.org/10.3389/fvets.2025.1592068

Iriarte, J., *et al.* 2022. Ice Age megafauna rock art in the Colombian Amazon? Philosophical Transactions of the Royal Society 377: 20200496. https://doi.org/10.1098/rstb.2020.0496

Kyriazis, Z., P. Kollia, I. Grivea, N. Stefanou, S. Sotiriou & Z.H. Dailiana. 2023. Polydactyly: clinical and molecular manifestations. World Journal of Orthopedics 14: 13–22. https://doi.org/10.5312/wjo.v14.i1.13

Lockwood, A., R. Montgomery & V. McEwen. 2009. Bilateral radial hemimelia, polydactyly and cardiomegaly in two cats. Veterinary and Comparative Orthopaedics and Traumatology 22: 511–513. https://doi.org/10.3415/VCOT-08-12-0124

Craig, L.E., K.E. Dittmer & K.G. Thompson. 2016. Bones and joints. Pp. 16–163 in: Jubb, Kennedy & Palmer's pathology of domestic animals. Volume 1, Sixth Edition (M.G. Maxie, ed.). Elsevier, St. Louis, Missouri. https://doi.org/10.1016/B978-0-7020-5317-7.00002-3

Mendel, F.C. 1981a. Foot of two-toed sloths: its anatomy and potential uses relative to size of support. Journal of Morphology 170: 357–372. https://doi.org/10.1002/jmor.1051700307

Mendel, F.C. 1981b. Use of hands and feet of two-toed sloths (*Choloepus hoffmanni*) during climbing and terrestrial locomotion. Journal of Mammalogy 62: 413–421. https://doi.org/10.2307/1380728

Meteyer, C.U. 2000. Field guide to malformations of frogs and toads with radiographic interpretations. Biological Science Report USGS/BRD/BSR-2000-005, Madison, Wisconsin.

Nyakatura, J.A. 2012. The convergent evolution of suspensory posture and locomotion in tree sloths. Journal of Mammalian Evolution 19: 225–234. https://doi.org/10.1007/s10914-011-9174-x

O'Brien, S.J., D.E. Wildt, D. Goldman, C.R. Merril & M. Bush. 1983. The cheetah is depauperate in genetic variation. Science 221: 459–462. https://doi.org/10.1126/science.221.4609.459

Pinto, A.V., B. Hansson, I. Patramanis, H.E. Morales & C. van Oosterhout. 2024. The impact of habitat loss and population fragmentation on genomic erosion. Conservation Genetics 25: 49–57. https://doi.org/10.1007/s10592-023-01548-9

Plese, T., *et al.* 2022. *Choloepus hoffmanni*. The IUCN Red List of Threatened Species 2022: e.T4778A210443596. https://doi.org/10.2305/IUCN.UK.2022-2.RLTS.T4778A210443596.en. Accessed on 02 December 2025.

Sponenberg, D.P.A.T. & Bowlin. 1985. Heritable syndrome of skeletal defects in a family of Australian shepherd dogs. The Journal of Heredity 76: 393–394.

The Sloth Conservation Foundation. 2025. Sloth deformities—A genetic study. https://slothconservation.org/sloth-deformities-genetic-study/. Accessed on 28 August 2025.

Umair, M., F. Ahmad, M. Bilal, W. Ahmad & M. Alfadhel. 2018. Clinical genetics of polydactyly: an updated review. Frontiers in Genetics 9: 447. https://doi.org/10.3389/fgene.2018.00447

Villagómez, D.A. & R.A. Alonso. 1998. A distinct Mendelian autosomal recessive syndrome involving the association of anotia, palate agenesis, bifid tongue, and polydactyly in the dog. Canadian Veterinary Journal 39: 642–643.

Wan, N.F., *et al.* 2025. Pesticides have negative effects on non-target organisms. Nature Communications 16: 1360. https://doi.org/10.1038/s41467-025-56732-x

Warburton, N.M., M.A. Cake & K.R. Kelman. 2021. Extreme bilateral polydactyly in a wild-caught western grey kangaroo. The Anatomical Record 7: 1361–1374. https://doi.org/10.1002/ar.24530

Wehrenpfennig, P. & P. Schmierer. 2024. Ectrodactyly with polydactyly in a dog—Case description and description of surgical therapy with resection and fusion podoplasty. Animals (Basel) 14:1647. https://doi.org/10.3390/ani14111647

Weisbecker, V. & M. Nilsson. 2008. Integration, heterochrony, and adaptation in pedal digits of syndactylous marsupials. BMC Evolutionary Biology 8: 160. https://doi.org/10.1186/1471-2148-8-160

Received: 30 August 2025; Accepted: 9 December 2025