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First reported case of diphallia in *Corynorhinus townsendii*

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ABSTRACT.—We describe the first reported case of diphallia in a bat, *Corynorhinus townsendii*, captured during fall swarming at a hibernaculum in northern Utah, USA. Upon examination, we determined that one phallus was functional, as evidenced by production of urine, while the secondary phallus appeared to be overgrown with skin. A review of the medical literature relevant to diphallia suggests that this is a case of pseudodiphallia with a bifid shaft. We hypothesize that this morphological deformity likely has a low impact on the survival of this individual but may act as a physical barrier to copulation. To our knowledge, this is the first reported case of diphallia in bats.

RESUMEN.—Describimos el primer caso reportado de difalia en *Corynorhinus townsendii* capturado durante el enjambre de otoño en un hibernáculo en el norte de Utah, USA. Tras el examen, determinamos que un falo era funcional, como lo demuestra la producción de orina, mientras que el falo secundario parecía estar cubierto de piel. Una revisión de la literatura médica relevante para la difalia sugiere que este es un caso de pseudodifalia con un eje bifido. Nuestra hipótesis es que esta deformidad morfológica probablemente tenga un bajo impacto en la supervivencia de este individuo, pero puede actuar como una barrera física para la cópula. Por lo que sabemos, este es el primer caso reportado de difalia en murciélagos.

Cases of extra appendages or organs are relatively common but typically occur as a product of inbreeding in domesticated animals, livestock, and humans (Lange and Müller 2017). In natural systems, cases of extra body parts are rarer, given that additional limbs or organs are often deleterious and are thus removed from the population because individuals with these conditions rarely survive to adulthood. Despite their rarity, there are reported cases of extra body parts in invertebrates and vertebrates (e.g., Orós et al. 1997, Meteyer 2000, Velo-Anton et al. 2007, Sönmez et al. 2017). The causative agent of these conditions varies. In some typical cases, the extra appendages are caused by a genetic mechanism such as overexpression of genes, gene duplications, or specific mutations (Goodman 2002). In other cases, extra appendages result from somatic cell division errors during development. Such errors may arise from errant cell divisions or from environmental factors impacting epigenetic

processes throughout development, including malnutrition, toxins that impact cellular processes or endocrine function, and mechanical disruptions (Sower et al. 2000). Ecological interactions, such as damage caused by trauma due to failed predation attempts or territorial defense, parasites, and disease can also cause growth of extra appendages (Johnson and Chase 2004, Lannoo 2008).

While there are many documented cases of additional limbs (Lange and Müller 2017), cases of abnormal sexual development in the wild, such as animals with extra genitals, have not been described in the literature. Genital deformities are likely to have a large negative impact on fitness, effectively removing an individual from the breeding population because incompatible morphologies will act as a physical barrier to mating. Penile duplication, or diphallia, is an extremely rare congenital developmental anomaly that is well documented in the medical literature. In humans, such cases are usually accompanied

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Fig. 1. A diphallid male *Corynorhinus townsendii* captured outside Logan, Utah, USA, in October 2017. The phallus on the right side of the bat appears to be a functional unit, while the phallus on the left side of the bat appears to be an accessory organ. This bat was in good health and was released after collection of standard biometric measurements for bats.

by numerous complications associated with urogenital defects, often rendering the genitals nonfunctional to the point of requiring surgical correction. In a natural system, where surgical correction is not an option, most of these deformities will result in mortality, and thus cases of diphallia in the wild will be exceedingly rare.

Here, we report an observation of diphallia in a bat. Townsend's big-eared bat, *Corynorhinus townsendii*, is a vespertilionid bat that ranges across much of the United States (Kunz and Martin 1982). *C. townsendii* is a cave-obligate species that forms maternity colonies in caves and abandoned mines during the summer and large clusters of hibernating individuals in the same or nearby locations during the winter. Individuals of this species, like many vespertilionids, show high fidelity to their natal roost, often returning to the same

sites annually to hibernate, raise pups, and mate (Humphrey and Kunz 1976). While trapping at a hibernaculum outside Logan, Utah, USA (41.7370° N, 111.8338° W), during the evening of 11 October 2017, we captured a diphallid *C. townsendii* (Fig. 1). This animal was not collected as a museum specimen but was photographed and examined. While further study would be possible with a museum specimen, this project was not permitted on a state or federal level to collect specimens of healthy, uninjured animals. In addition, recent advances in digital photography and new regulations on animal handling and specimen collection have made voucher photographs more common (e.g., Marshall and Evenhuis 2015). We collected standard measurements from this bat (i.e., body mass and forearm length) and assessed age and reproductive condition. This adult male was of normal size (43.1 ± 0.1 mm forearm length) and mass (8.6 ± 0.1 g) for pre-hibernating *C. townsendii* males captured at this site and others during a regional study of hibernating bats (mean forearm length 43.1 mm [SD 1.3], mean mass 8.8 g [SD 0.8]; N.W. Fuller, unpublished data). Examination of the testes showed that this individual had normal morphology and was undergoing spermatogenesis, storing sperm for fall swarm copulations. The phallus on the left side of the bat appeared to be an accessory appendage based on its size—about three-quarters the size of the phallus on the right (Fig. 2). The secondary phallus appeared to be overgrown with skin; however, close examination to determine whether this skin was foreskin sheath or an overgrown cap of tissue was not possible. Based on the excretion of urine from a single phallus, we believe that only the right penis was functional, at least in terms of waste elimination. This morphology falls within the category of pseudo-diphallia and is likely a case of a bifid shaft with a rudimentary secondary phallus (Johnson et al. 1974). Copulatory capabilities of either phallus are not known. Given the apparent functionality of the right phallus, we expect that it is capable of copulation, while the left organ is not. It is possible that the additional phallus may impact the fitness of this individual by providing a physical barrier to normal copulatory mechanics. While the phallus on the left appears nonfunctional and smaller, it is likely large enough to provide a barrier to mating.



Fig. 2. An enlarged image of the pubic region of a diphallid male *Corynorhinus townsendii*. Visual examination suggests that the accessory phallus is overgrown with skin and, if a urethra is present, it is a blind duct. Note the production of urine from the right phallus, indicating functionality at least for elimination of waste.

Reports of developmental morphological defects are limited in bats: to date, there exist reports of wing and foot defects, such as polydactyly (Koford and Krutzsch 1948, Constantine 1958, Jennings 1958, Kunz and Chase 1983, Caire 1988, Pekins 2009, Gonçalves et al. 2012), and conjoined twins (Peterson and Fenton 1969, Urban et al. 2015, Nogueira et al. 2017). To our knowledge, this is the first reported case of a diphallid bat. Collectively, the authors have handled many thousands of individual bats from 5 continents, including nearly 500 *C. townsendii*, and have never noted a diphallid bat. In addition, from conversations with experienced mammalogists and veterinary pathologists, we suspect that this may be among the first reported cases of diphallia in wild mammals.

A search of the literature suggests that diphallia is a rare case of malformity in mammals. The most extensive records of diphallia have been recorded in the medical literature, the first case noted from examination of a human cadaver in 1609 (Wecker 1609). Since then, approximately 100 cases have been reported in the medical literature, with no

cases being identical, and these cases are usually associated with other conditions, including an additional bladder or extra intestines (Gyftopoulos et al. 2002). Some cases of diphallia have been noted in livestock (Bosu and Barker 1971, Abu-Seida and Torad 2014) and other domesticated animals (Laube et al. 2017), but we were unable to find records of free-ranging mammals with a similar condition. This case appears to be that of an unusual member of the species *C. townsendii* that underwent abnormal sexual development and grew an additional physically distinct penis. Although deformities like those described in this paper are quite rare and could be difficult to observe in small mammals, we encourage other researchers to closely examine the genitals of captured animals to establish the frequency of such deformities in natural systems.

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