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SHORT COMMUNICATION

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Supernumerary rattle growth in a Mexican lance-headed rattlesnake *Crotalus polystictus*

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Cases of teratological conditions and other developmental abnormalities are important to document in reptiles and amphibians because they can bring to light new emergent pathogens, diseases or conditions that can have ecological and conservation implications (Barr et al., 2020; Kaiser, 1997; Schmidt, 1997; Bishop et al., 1991; 1998; Bell et al., 2006) or highlight understudied physiological, developmental or healing processes that are in need of more focused research (Barr et al., 2019; Alibardi & Meyer-Rochow, 2021). In rattlesnakes (*Crotalus* and *Sistrurus*), a well-studied group of New World pit vipers (Crotalinae), a wide variety of developmental aberrations have been recorded (for example Klauber, 1956; Pendlebury, 1976; Wallach, 2007; Sant'Anna et al., 2013; Murphy, 2018), but with regard to the specialised crotaline rattle, abnormalities have been rare; they include a case of accelerated growth in the structure which resulted in the accumulation of an abnormal number of rattle segments over a brief period (Walker et al., 2008), and the loss of the rattle style and matrix (Rice et al., 2016). Here, we report on an unusual aberration in an adult Mexican lance-headed rattlesnake *Crotalus polystictus* that resulted in the growth of secondary rattle tissue.

As part of an Association of Zoos and Aquariums-managed Species Survival Plan (SSP) for the species, *C. polystictus* has been maintained by Audubon Zoo since 2002. In August 2019, a 13-year-old captive-bred male (AZA regional studbook #192) that had been maintained at Audubon Zoo since 2009, underwent a veterinary physical examination due to concerns over an uncharacteristic decrease in its body mass (30.6 %) over the previous winter cooling period, and apparent difficulties with regaining its lost weight despite feeding regularly. The examination was performed by staff veterinarians while the animal was conscious and restrained in a tube, and its demeanor was bright, alert, and responsive. Full body orthogonal radiographs and coelomic ultrasonography showed no abnormalities. Blood was collected from the caudal coccygeal vein and submitted for a complete blood count, biochemistry panel, and protein electrophoresis; no parameters were significantly abnormal. Upon close visual inspection, a small (ca. 1 mm), firm, subcutaneous swelling was noticed on the right lateral aspect of the tail at the base of the rattle, which, based on its size and general appearance, was presumed to be a caseous abscess. The mass was aspirated using a 22-gauge hypodermic needle, and a small amount of yellowish liquid was collected and submitted for cytological examination. No microbial organisms were observed; occasional white blood cells were noted. The mass was left untreated to be closely monitored for changes in size and potential impacts on the animal's activity and behaviour.

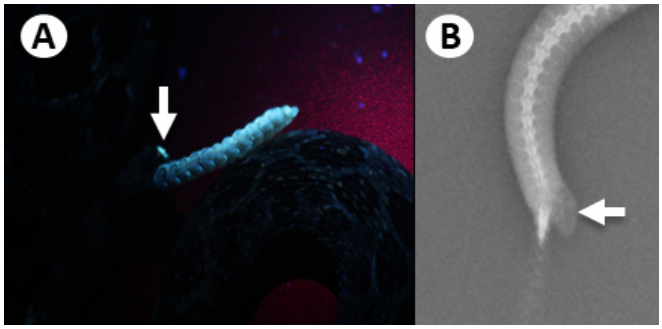

Figure 1. *Crotalus polystictus* rattle and secondary rattle - **A.** tissue growth (white arrow) fluorescing under 365 nm UV light, and **B.** Dorsoventral radiograph showing the soft tissue opacity (white arrow) of the secondary rattle tissue growth

A follow-up examination in September 2020 revealed that the mass had increased in size to ca. 2 mm in diameter and had begun to protrude from the skin. With the specimen restrained in a tube, the exposed emergent tissue was closely examined and revealed by palpation not to be an abscess, but rather the same keratinised tissue as the rattle. This was later reaffirmed during a study on pit viper biofluorescence (Paul & Mendyk, 2021) in which the emergent tissue fluoresced the same colour and intensity as the primary rattle when illuminated with a 365 nm ultraviolet LED torch in a darkened room (Fig. 1A). Since the snake had begun to regain its body weight, was eating well and was otherwise behaving normally, it was decided not to intervene surgically and to continue monitoring the mass.

In December 2021, the specimen was re-examined, measured (69.2 cm, SVL 74.9 cm, TL 212 g), and radiographed again. Dorsoventral radiographs showed a soft tissue opacity growth lateral to the rattle on the right side (Fig. 1B), and there was no evidence of infection or other disease process to the underlying bone. The continued outward growth of the mass appeared to be displacing the primary rattle, causing it

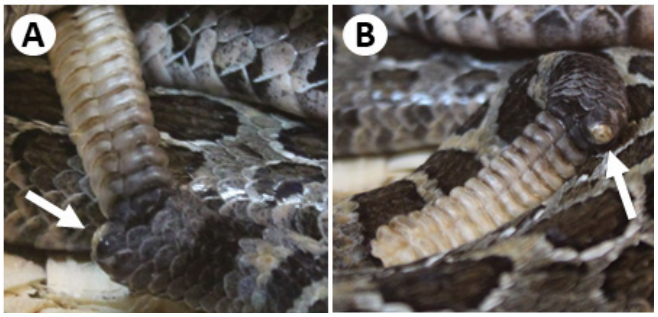

Figure 2. *Crotalus polystictus* rattle and secondary rattle tissue growth - **A.** Displacement of the primary rattle by the secondary rattle tissue growth (white arrow), and **B.** Detail of supernumerary rattle growth (white arrow)

to angle upwards at an inclination of ca. 50 degrees (Fig. 2A), with the externalised portion then protruding ca. 3 mm (Fig. 2B) and the entire mass measuring ca. 4 mm in diameter. Just a few months later in April 2022, it was noticed that the mass had been ejected from the body, possibly during ecdysis, and could not be located, leaving an empty walled-off cavity that eventually closed up on its own after a few weeks. No immediate signs of regrowth have since been observed. Notably, defensive usage of the rattle was not observed during the development and subsequent loss of the supernumerary growth; this has continued long after recovery and no further usage of the rattle has been observed to date.

This account appears to represent the first documented case of supernumerary rattle growth in a rattlesnake. Considering that no similar cases have been reported in the literature for either *Crotalus* or *Sistrurus* when probably tens of thousands of specimens have been collected as museum vouchers, studied in the field, and maintained in captivity over the last two centuries (e.g. Klauber, 1956; Murphy & Armstrong, 1978; Murphy, 2017), the condition is presumed to be extremely rare. Since biopsy of the affected tissues at the base of the rattle for histological analysis was not considered essential for the health and welfare of the individual, and because the ejected mass could not be located for further analysis, the etiology of the condition remains unclear.

In lizards, the growth of bifid and supernumerary tails is typically the result of failures in tail regeneration related to trauma or disturbance to the spinal cord (Bellairs & Bryant, 1985; Alibardi, 2010), but in rattlesnakes, the rattle is produced through an entirely different mechanism that is independent of the spinal cord (Meik & Schuett, 2016). Moreover, since there was no evidence of prior trauma to the tail of the *C. polystictus*, an injury-related etiology seems unlikely. The possibility of a teratoma or other neoplastic disorder could not be ruled out.

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