Phyllomedusa 24(2):333–337, 2025

ISSN 1519-1397 (print) / ISSN 2316-9079 (online)
doi: http://dx.doi.org/10.11606/issn.2316-9079.v24i2p333-337

Short Communication

First record of dicephalism in *Epicrates cenchria* (Serpentes: Boidae) from Brazil

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Keywords: Bicephalic snake, Congenital anomalies, Herpetology, Teratology, Vertebrate zoology.

Palavras-chave: Anomalias congênitas, Herpetologia, Serpente bicefálica, Teratologia, Zoologia de vertebrados.

Although the factors responsible for malformations in wild animals are still poorly understood, the embryonic development of most animals comprises critical periods during which the embryo is more sensitive to harmful influences. Each organ or system has its own critical period, which varies among species. Significant interference from exogenous forces during these stages can compromise proper embryonic formation, resulting in relevant morphological alterations (Haschek *et al.* 2010).

Dicephalism, also referred to as axial bifurcation or bicephaly, is the most frequently reported malformation in snakes, characterized by total or partial duplication of the head. It is a rare condition (Wallach 2007), with an estimated occurrence of 1:100,000 (Belluomini 1959), although more recent studies indicate a higher prevalence, around 73:100,000 (Sant'Anna *et al.* 2013). The condition has been described in several snake families, including viperids (Belluomini *et al.* 1977, Andrade and Abe 1992, Sant'Anna *et al.* 2013, Esqueda *et al.* 2016), colubrids (Prado 1943, Albuquerque *et al.* 2013) and boids (Cunha 1968, Albuquerque *et al.* 2010).

This study reports the first case of dicephalism in *Epicrates cenchria* (Linnaeus, 1758) (Serpentes: Boidae) born under human care, with a description of its external morphological characteristics, internal anatomy, birth history, and biological implications. Dicephalism in the genus *Epicrates* is not unprecedented, as Wallach (2018) documented previous occurrences.

Epicrates cenchria, commonly known as the rainbow boa, red boa, or salamanta, belongs to the family Boidae, is viviparous, and produces litters of 8 to 15 offspring per gestation. It is a non-venomous snake that subdues its prey by constriction. Its diet is broad, including mammals,

Received 28 August 2025
Accepted 02 October 2025
Distributed December 2025

birds, bird eggs, and lizards. It exhibits both diurnal and nocturnal activity. Adult individuals can reach approximately 1.5 m in length (Vanzolini *et al.* 1980). The species is endemic to the Neotropical region, occurring in forest formations of the Amazon Basin in Colombia, Ecuador, Peru, Bolivia, Venezuela, Guyana, Suriname, French Guiana, and Brazil. A disjunct population occurs in the Atlantic Forest of Brazil, from the state of Alagoas to Rio de Janeiro (Passos and Fernandes 2008).

The animal was born in 2023 from the mating of two individuals of the same species that had been kept at the Bauru Municipal Zoo (São Paulo state, Brazil) since 2019. The litter consisted of nine offspring, with only one exhibiting malformation. The parents originated from the illegal wildlife trade and, therefore, had no known genetic history. They were housed in a terrarium with controlled temperature and humidity. After birth, the offspring were transferred to individual terrariums.

Regarding external morphology, the dicephalic specimen exhibited bifurcation of the axial column in the cervical region, with two necks and two independent skulls arranged laterally. The left head was slightly larger and more aligned with the body axis. Coloration was similar to the characteristic pattern of the species.

During the observation period, the left head was consistently dominant over the right. Both heads ingested water and food (neonatal mice), but only the left performed constriction, while the right had greater difficulty swallowing. We observed feeding competition, which required intervention with physical barriers. The dominant head typically controlled locomotion; however, the right head occasionally assumed control when the left remained inactive. During ecdysis, we recorded skin retention at the bifurcation site, which required manual removal of the retained skin.

The specimen survived for eight months. After death, we radiographed and dissected the animal. At necropsy, it had a body mass of 35 g and a total length of 51 cm. The bifurcation began 5.5 cm from the cephalic extremity.

Radiographs and dissections revealed duplication of the tracheae, functional and independent hearts, livers, gallbladders, spleens, pancreases, and stomachs. The systems merged at the initial portion of the small intestine (Figure 1). The individual also had two lungs of similar extension and two kidneys.

Among the classification systems for duplications in reptiles, the one proposed by Nakamura (1938) stands out and is widely adopted in the specialized literature. According to this classification, the specimen is categorized as a teratodymus derodymus, characterized by bifurcation of the vertebral column in the cervical region, resulting in the presence of two heads. The organ duplication observed in this case is consistent with other reports in snakes of the family Boidae (Albuquerque *et al.* 2010).

According to Nakamura (1938), in snakes, duplication of the axial skeleton is restricted to the anterior portion of the body. In the most common cases of teratodymus derodymus, the bifurcation occurs in the cervical region, forming two distinct heads, as observed in the present study.

In addition to Nakamura's (1938) system, Smith and Pérez-Higareda (1991) proposed a classification comprising seven categories of axial bifurcations. Within this system, the present case is classified as proarchodichotomous, characterized by individuals with two heads, two elongated necks, and a single body.

Cases of dicephalism in snakes reported in the literature show considerable variability in the degree of duplication of internal structures. Nakamura (1938) described four teratodymus derodymus with a single functional heart but varying degrees of duplication of digestive system organs. Albuquerque *et al.* (2013) reported a dicephalic specimen of *Philodryas patagoniensis* (Girard, 1858) with duplication restricted to the esophagus and trachea, while the other organs remained identical in number and position. In a study with *Eunectes notaeus* Cope, 1862, Albuquerque *et al.* (2010) observed

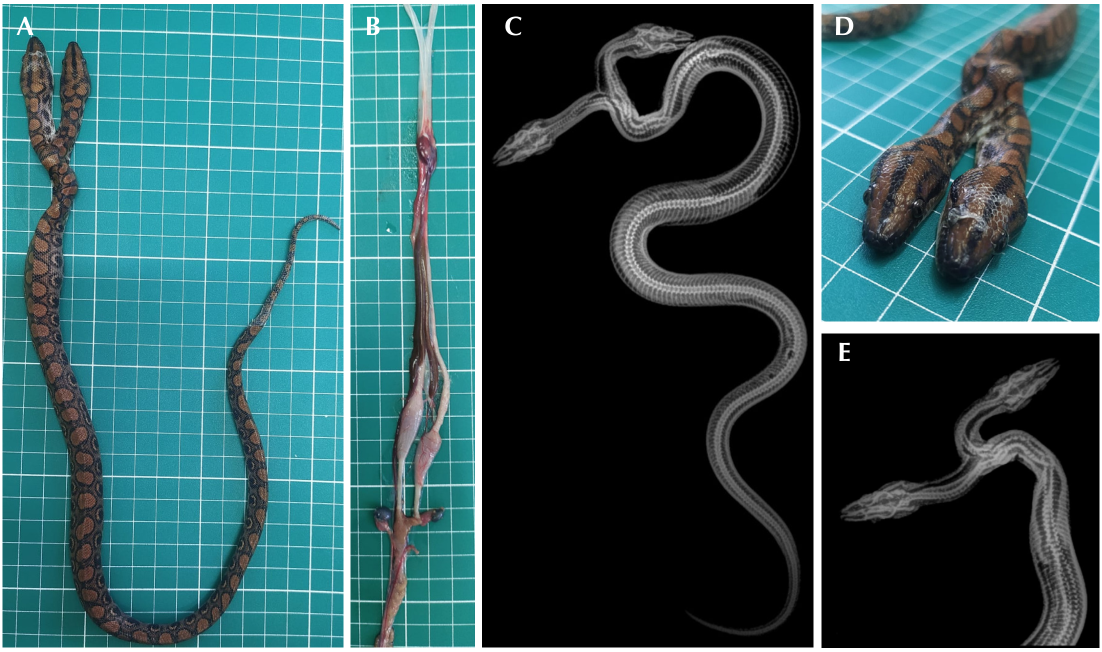

Figure 1. Morphological and anatomical aspects of a dicephalic *Epicrates cenchria.* (**A**) Dorsal view of the entire body of the specimen, showing cephalic duplication. (**B**) Dissection and arrangement of the organs, showing duplication of internal structures. (**C**) Dorsoventral radiograph showing bifurcation of the vertebral column in the cervical region. (**D**) Frontal view detail of the two heads. (**E**) Dorsoventral radiograph of the cephalic region, highlighting the separation of the skulls and cervical vertebrae.

duplication of the heart, lung, liver, and stomach. Cunha (1968) described a case of *Boa constrictor* Linnaeus, 1758 in which the individual on the right side had all vital organs complete, while the one on the left was anatomically and physiologically incomplete, and was dependent on the other to survive. These reports, together with the present case, highlight significant morphological heterogeneity among dicephalic individuals, with no clearly defined pattern of internal duplication.

Functional dominance of one head, as observed in this study, was also described by Cunha (1968) and Wallach (2007). According to these authors, dominance influences both locomotion and feeding behavior. In the case reported here, the left head showed greater activity, performing constriction and guiding body movements, which possibly contributed to the animal's physiological maintenance during its survival.

Dicephalism in snakes is predominantly observed in neonates or very young individuals (Nakamura 1938, Cunha 1968, Albuquerque *et al.* 2010) which are commonly short-lived (Cunha 1968, Wallach 2018). This condition can impair essential functions, such as predation and predator avoidance, leading to premature death by starvation or predation in natural environments. Under human care, however, survival can be prolonged due to assisted management, although most affected individuals still haave a short life expectancy (Wallach 2018).

According to Wallach (2007), dicephalic individuals with heads of similar size and development tend to survive longer. This condition is presumed to be associated with the proper formation of muscular, visceral, and neurological connections between the duplicated regions and the rest of the body. In the case described, the dominance of one head, combined with the absence of severe motor dysfunctions, may have favored the specimen's relatively prolonged survival.

Several etiological factors have been proposed for the occurrence of dicephalism in snakes: (1) incomplete division of a single embryo; (2) partial fusion of two embryos; (3) exposure to extreme temperatures during incubation or gestation; (4) regeneration following embryonic injury; (5) anoxia during embryonic development; (6) toxic effects of metabolic secretions associated with prolonged retention in the oviduct; (7) inbreeding in populations with reduced genetic diversity; (8) interspecific hybridization; (9) environmental pollution; (10) exposure to toxic substances in captivity; and (11) ionizing radiation (Wallach 2007).

Although it was not possible to determine the exact cause of the malformation in this case, several hypotheses can be considered. According to Wallach (2007), significant thermal changes during gestation are among the factors most frequently associated with dicephalism. The breeders involved were kept under controlled environmental conditions, making this hypothesis less likely—although not entirely dismissible. Developmental disturbances during embryogenesis are also potential causes of this anomaly. Nevertheless, the absence of specific data on the gestation of the individual prevents a conclusive assessment.

Both parents originated from the illegal wildlife trade, having been rescued and later kept at the Bauru Municipal Zoo. Given the lack of prior genetic information, it was not possible to determine the degree of relatedness between the progenitors. It is noteworthy, however, that clandestine breeding facilities often neglect proper genetic management practices, thereby promoting inbreeding to maximize offspring production for illegal trade.

Inbreeding has been identified as a factor associated with increased incidence of congenital anomalies, including dicephalism, in snakes bred in captivity. The rise in reports of axial bifurcation in these animals over the past decade may be primarily related to genetic depression resulting from inbreeding between individuals bred in captivity as a consequence of repeated crosses between siblings or between parents and offspring (Wallach 2018). This association is supported by studies such as that of Federsoni Júnior (1979), which identified a high occurrence of teratogenesis and mortality in inbred litters of *Bothrops atrox* (Linnaeus, 1758).

Studies have shown that organochlorine environmental contaminants, such as polychlorinated biphenyls, have bioaccumulative potential and can cross the placental barrier in viviparous snakes (Fontenot *et al.* 2000). Thus, the possibility cannot be excluded that the parents were exposed to chemical toxins, pollutants, or ionizing radiation prior to rescue, which could have contributed to the occurrence of the malformation observed in the offspring.

Although it was not possible to precisely determine the etiology of the malformation observed in the specimen of *E. cenchria* described in this study, it is plausible that its origin is related to the interaction of multiple factors, both genetic and environmental. Documenting rare cases such as this is relevant for advancing knowledge of morphological anomalies in wild animals, especially in species with scarce available literature.

In addition to contributing relevant anatomical and behavioral data, reports such as this can support future comparative studies, assist in identifying possible etiological patterns, and foster investigations into the effects of inbreeding, captive conditions, and environmental contaminants on the embryonic development of reptiles. The continued reporting and detailed analysis of similar cases are essential for a more profound understanding of the occurrence of congenital malformations in snakes and other vertebrates.

Acknowledgments.—The authors thank the Bauru Municipal Zoo for providing the specimen and for the institutional support for development of this research.

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Editor: Jaime Bertoluci