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Correspondence

What do water snakes eat? First report of predation by a Neotropical Hydropsini snake on giant earthworms (Glossoscolecidae)

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Earthworms are an abundant, high protein-containing food resource for many vertebrates, including snakes. Several fossorial or semi-fossorial (e.g., *Atractus, Carphophis, Diadophis, Geophis, Ninia, Storeria, Virginia*) and semi-aquatic snakes (e.g., *Gomesophis, Sordellina, Thamnophis*) belonging to the families Dipsadidae and Natricidae (taxonomy following Zaher et al. 2009 and Grazziotin et al. 2012) have been reported to feed on earthworms (Gregory 1978, Marques et al. 2004, Pisani 2009). Highly specialized aquatic dipsadids such as those belonging to the tribe Hydropsini, as well as homalopsids and certain aquatic natricids (e.g., *Nerodia*), feed mainly on aquatic vertebrates (frogs, salamanders, fishes; Scartozzoni 2009, Colston et al. 2010). Here we report on incidents of predation on giant earthworms by individuals of the brown-banded water snake, *Helicops angulatus* (Linnaeus, 1758), a member of the tribe Hydropsini (Dipsadidae: Xenodontinae).

Helicops angulatus occurs throughout the Amazon Forest domain and its transitional areas with neighbouring biomes (see Roberto et al. 2009). Individuals of this snake dwell in forests and disturbed areas, often being found in shallow ponds and riparian habitats, in both small and large bodies of water (Martins & Oliveira 1999). They are usually active at night and feed mostly on fish, including elongate symbranchiforms (Cunha & Nascimento 1993, Martins & Oliveira 1999 and references therein, Ford & Ford 2002, Scartozzoni 2009). Frogs, including their tadpoles, and aquatic lizards were also reported as prey of *H. angulatus* (Dixon & Soini 1977, Martins & Oliveira 1999, Silva et al. 2003).

Data herein reported were obtained when searching for amphibians and reptiles in riparian habitats along forest streams and around lakes in the municipality of Lucas do Rio Verde, state of Mato Grosso, Brazil. Vouchers (collecting permit IBAMA/SISBIO #13429-1) are deposited at the Coleção Zoológica de Vertebrados, Universidade Federal de Mato Grosso (UFMT), Cuiabá, Mato Grosso, Brazil, and Coleção de Invertebrados Paulo Young, Universidade Federal da Paraíba (CLI-UFPB), João Pessoa, Paraíba, Brazil.

On 13 May 2004, at 18:00 h, in a small groundwater upwelling site in the gallery forest of the right bank of Córrego Lucas (13°04' S, 55°55' W; a small tributary of the Rio Verde, belonging to the Tapajós-Amazonas River Basin), a female of *H. angulatus* (UFMT 1201: 390.0 mm snout–vent length; 172.0 mm tail length; 14.1 mm head width; 70.6 g body mass after fixation) was observed preying upon a giant earthworm, later identified as *Rhinodrillus* sp. (Annelida: Oligochaeta: Glossoscolecidae). The earthworm (largest diameter after fixation 11.3 mm) had been seized in its posterior portion by the snake, which succeeded in pulling it out of the muddy soil after a few minutes.

Soon after having swallowed its prey, the snake was collected. Upon collection, it immediately disgorged the earthworm, which presented some punctiform wounds and a partial rupture of the body. The earthworm was preserved in 10% formalin. We also stored (ethanol 70%) faeces dropped by the snake about three hours after capture. Subsequent microscopic examination revealed it contained many chetae, indicating a successful previous predation of

at least one other individual of giant earthworm. Based on the mass of a conspecific, similar-sized, and intact specimen of Glossoscolecidae obtained in the same area and occasion (CLI-UFPB 065), the estimated prey/predator weight ratio was 0.23. On another occasion, remnants of a glossoscolecid specimen were regurgitated by a male of *H. angulatus* (UFMT 6908: 328.0 mm snout–vent length; 214.0 mm tail length; 11.9 mm head width; 26.0 g live body mass) collected on 30 July 2008, approximately at 19:00 h, at a groundwater upwelling site in the bank of a marginal lake of Rio Verde (13°10' S, 55°90' W).

Although this is the first record of earthworms as prey of Hydropsini snakes, it is possible that consumption of these and of other soft-bodied, readily digested prey (such as tadpoles) by aquatic snakes may be more common than can be inferred from published data. A more careful examination of gut contents in future studies on this or other water snakes could reveal the presence of earthworm chetae.

Predation on earthworms has been reported for several Neotropical snakes. Representatives of the Natricidae (*Thamnophis*, *Storeria*, *Virginia*) and ten genera of Dipsadidae belonging to at least two different subfamilies (Dipsadinae and Xenodontinae) are earthworm-eaters. Semi-fossorial snakes of the closely related genera *Adelphicos*, *Atractus*, *Chapinophis*, *Chersodromus*, *Geophis*, *Ninia*, and *Omoadiphas* primarily predate upon earthworms (Cadle & Greene 1993, Cisneros-Heredia 2005). Once considered a 'lumbricophagous subclade' of the Xenodontinae (Cisneros-Heredia 2005), these species are presently allocated to the Dipsadinae (except *Omoadiphas*, considered as 'incertae sedis' by Zaher et al. 2009). Among the Neotropical subfamily Xenodontinae, occasional consumption of earthworms was reported for the semi-aquatic *Erythrolamprus breviceps* (Beebe 1946, Martins & Oliveira 1999), presently allocated to the tribe Xenodontini (Grazziotin et al. 2012). Two other semi-aquatic xenodontines, *Gomesophis brasiliensis* (tribe Tachymenini) and *Sordellina punctata* ('incertae sedis' tribe; see Grazziotin et al. 2012), are specialized earthworm-eaters, with the latter occasionally including giant earthworms in its diet (Marques 1996, Oliveira et al. 2003, Pereira et al. 2007).

As a tentative conclusion, three groups of snakes that habitually or occasionally feed on earthworms can be recognized among Neotropical snakes: the semi-fossorial dipsadines and the semi-aquatic or aquatic xenodontines (including a representative of the tribe Hydropsini, as reported herein), besides natricides. Available phylogenetic hypotheses (e.g., Vidal et al. 2010, Grazziotin et al. 2012) suggest that the consumption of earthworms among Colubroidea snakes has multiple independent origins and is usually associated with aquatic habitat exploitation. On the other hand, the ability to overwhelm elongate prey (including both vertebrates – symbranchiform fish, caecilians, amphisbaenians, and snakes – and earthworms) seems to consistently represent a primitive trait among snakes (Greene 1983), and might represent strong evidence of niche conservatism (Wiens et al. 2010) amongst evolutionary lineages of Colubroidea.

Giant earthworms in the family Glossoscolecidae appear to be an abundant and reliable food resource at the many groundwater upwelling sites found along riparian systems belonging to the Rio Verde sub-basin. We hypothesize that *H. angulatus* might find an advantage from alternatively exploiting this dietary resource, particularly in view of the anthropogenic changes presently being effected in most parts of this watershed.

Due to an intense and ever-expanding occupation for agriculture, the municipality of Lucas do Rio Verde now harbours less than 28% of its original land cover (Jesus et al. 2009). Along the whole extension of Córrego Lucas, and in many sections along the Rio Verde as well, all natural vegetation except the gallery forest was cleared out for the establishment of soybean or corn plantations. As a consequence, erosive and depositional processes are intense along most local river courses. Together with the intensive use of pesticides (Moreira et al. 2012), these changes possibly result in a shortage of the fish (Bruton 1985) that usually comprise the main food of *H. angulatus* in other parts of its range (mainly characiforms and perciforms, according to Scartozzoni 2009; see also Cunha & Nascimento 1993, Ford & Ford 2002).

We would also like to call attention to a conservation issue involving giant earthworms of the family Glossoscolecidae, endemic to the Neotropics. Largely employed as live bait for fishing, they are subjected to heavy and uncontrolled exploitation pressure in many parts of Brazil. Together with limited distribution ranges (see Lavelle & Lapied 2003), habitat specificity, and the present rates of habitat loss, the unsustainable exploitation of some species from Central Brazil (e.g., *Rhinodrilus alatus*) once resulted in their inclusion in official lists of threatened species (Machado et al. 2008). Effective conservation measures and sustainable use policies for giant earthworms would demand better information on their taxonomy and distribution (Christoffersen 2007), as well as information on their natural history, including natural predators.

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References

Beebe, W. (1946): Field notes on the snakes of Kartabo, British Guiana, and Caripito, Venezuela. – Zoologica, **31**: 11–52.

Bruton, M. N. (1985): The effects of suspensoids on fish. – Hydrobiologia, **125**: 221–241.

Cadle, J. E. & H. W. Greene (1993): Phylogenetic patterns, biogeography, and the ecological structure of Neotropical snake assemblages. – pp. 281–293 in: Ricklefs, R. E & D. Schluter (eds.): Species diversity in ecological communities: historical and geographical perspectives. – University of Chicago Press, Chicago.

Christoffersen, M. L. (2007): Biodiversity and distribution of the *Glossoscolex* genus-group (Annelida, Clitellata, Lumbricina, Glossoscolecidae) in South America. – Neotropical Biology and Conservation, **2**: 155–160.

Cisneros-Heredia, D. F. (2005): Report of molluscivory in *Atractus carrioni* Parker, 1930. – Herpetozoa, **18**: 185–186.

Colston, T. J., G. C. Costa & L. J. Vitt (2010): Snake diets and the deep history hypothesis. – Biological Journal of the Linnean Society, **101**: 476–486.

Cunha, O. R. & F. P. Nascimento (1993): Ofídios da Amazônia. As cobras da região leste do Pará. – Boletim do Museu Paraense Emílio Goeldi, série Zoologia, **9**: 1–191.

Dixon, J. R. & P. Soini (1977): The reptiles of the Upper Amazon Basin, Iquitos region, Peru. II. Crocodilians, turtles and snakes. – Contributions in Biology and Geology, **12**: 1–91.

Ford, N. B. & D. F. Ford (2002): Notes on the ecology of the South American water snake *Helicops angulatus* (Squamata: Colubridae) in Nariva Swamp, Trinidad. – Caribbean Journal of Science, **38**: 129–132.

Grazziotin, F. G., H. Zaher, R. W. Murphy, G. Scrocchi, M. A. Benavides, Y. P. Zhang & S. L. Bonatto (2012): Molecular phylogeny of the New World Dipsadidae (Serpentes: Colubroidea): a reappraisal. – Cladistics, **28**: 437–459.

Greene, H. W. (1983): Dietary correlates of the origin and radiation of snakes. – American Zoologist, **23**: 431–441.

Gregory, P. T. (1978): Feeding habits and diet overlap of three species of garter snakes (*Thamnophis*) on Vancouver Island. – Canadian Journal of Zoology, **56**: 1967–1974.

Jesus, S. C., G. B. S. Silva, V. A. Martins & A. K. Miura (2009): Análise da expansão de área agrícola do município de Lucas do Rio Verde – GO entre os anos de 1986 e 2007. – pp. 1385–1392 in: Anonymous (ed.): Anais XIV Simpósio Brasileiro de Sensoriamento Remoto. – INPE, Natal.

Lavelle, P. & E. Lapied (2003): Endangered earthworms of Amazônia: an homage to Gilberto Righi. – Pedobiologia **47**: 419–427.

Machado, A. B. M., A. D. Brescovit, O. H. Mielke, M. Casagrande, F. A. Silveira, F. P. Ohlweiler, D. Zeppelini, M. de Maria & A. H. Wieloch (2008): Panorama geral dos invertebrados terrestres ameaçados de extinção. – pp. 303–323 in: Machado, A. B. M., G. M. Drummond & A. P. Paglia (eds.): Biodiversidade 19. Livro vermelho da fauna brasileira ameaçada de extinção. – MMA/Fundação Biodiversitas, Brasília.

Marques, O. A. V. (1996): *Sordellina punctata* (NCN). Diet. Natural History Notes. – Herpetological Review, **27**: 147.

Marques, O. A. V., A. Eterovic & I. Sazima (2004): Snakes of the Brazilian Atlantic Forest: an illustrated field guide for the Serra do Mar range. – Holos Editora, Ribeirão Preto, 205 pp.

Martins, M. & M. E. Oliveira (1999): Natural history of snakes in forests of the Manaus region, Central Amazonia, Brazil. – Herpetological Natural History, **6**: 78–150.

Moreira, J. C., F. Peres, A. C. Simões, W. A. Pignati, E. de C. Dores, S. N. Vieira, C. Strüssmann & T. Mott (2012): Groundwater and rainwater contamination by pesticides in an agricultural Region of Mato Grosso State in Central Brazil. – Ciência & Saúde Coletiva, **17**: 1557–1568.

Oliveira, J. L., M. Borges & O. A. V. Marques (2003): *Gomesophis brasiliensis* (NCN). Reproduction and diet. – Herpetological Review, **34**: 251–252.

Pereira, D. N., F. Stender-Oliveira, M. G. Rodrigues & R. S. Bérnils (2007): Distribution and habitat use of *Sordellina punctata* (Serpentes, Colubridae), with a new record from State of São Paulo, Brazil. – Herpetological Bulletin, **100**: 18–22.

Pisani, G. (2009): *Virginia valeriae* and *Storeria dekayi* in a Northeast Kansas grassland community: ecology and conservation implications. – Journal of Kansas Herpetology, **32**: 20–36.

Roberto, I. J., S. C. Ribeiro, M. M. S. Delfino & W. O. Almeida (2009): Reptilia, Colubridae, *Helicops angulatus*: distribution extension and rediscovery in the state of Ceará. – Checklist, **5**: 118–121.

Scartozzoni, R. R. (2009): Estratégias reprodutivas e ecologia alimentar de serpentes aquáticas da tribo Hydropsini (Dipsadidae, Xenodontinae). – Unpublished doctoral thesis. Programa de Pós-Graduação Interunidades em Biotecnologia, USP/IPT/Instituto Butantan, São Paulo, Brasil, 160 pp.

Silva Jr., N. J., I. F. Souza, W. V. Silva, R. S. M. Ribeiro, C. Costa, N. C. Valle & H. L. R. Silva (2003): *Helicops angulatus* (Water-snake). Diet. – Herpetological Review, **34**: 68.

Vidal, N., M. Dewynter & D. J. Gower (2010): Dissecting the major American snake radiation: a molecular phylogeny of the Dipsadidae Bonaparte (Serpentes, Caenophidia). – Comptes Rendus Biologies, **333**: 48–55.

Wiens, J. J., D. D. Ackerly, A. P. Allen, B. L. Anacker, L. B. Buckley, H. V. Cornell, E. I. Damschen, J. Davies, J.-A. Grytnes, S. P. Harrison, B. A. Hawkins, R. D. Holt, C. M. McCain & P. R. Stephens (2010): Niche conservatism as an emerging principle in Ecology and Conservation Biology. – Ecology Letters, **13**: 1310–1324.

Zaher, H., F. G. Grazziotin, J. E. Cadle, R. W. Murphy, J. C. Moura-Leite & S. L. Bonatto (2009): Molecular phylogeny of advanced snakes (Serpentes, Caenophidia) with an emphasis on South American xenodontines: a revised classification and descriptions of new taxa. – Papéis Avulsos de Zoologia, **49**: 115–153.