

Courtship entanglements: a first report of mating behavior and sexual dichromatism in the Southeast Asian keel-bellied whipsnake, *Dryophiops rubescens* (Gray, 1835)

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Abstract. We describe the first observations of courtship behavior and sexual dichromatism in the keel-bellied whipsnake, *Dryophiops rubescens*, from an encounter near Sandakan, eastern Sabah, Borneo, Malaysia. During this behavior, two males and a female were longitudinally intertwined, with the males jockeying for position along the body of the female. This "mating braid" lasted for well over 1 h, with the entwined snakes moving a distance of over 10 m together. While polygynous mating is known from other snake species, direct observations of mating behaviors in Southeast Asian colubrids are extremely rare. These observations also revealed the presence of sexual dichromatism in *D. rubescens*, with darker head coloration present in the males.

Keywords. *Dryophiops rubescens*, Colubridae polygyny, courtship, mating braid, sexual dichromatism, Borneo, Sabah, Malaysia.

Introduction

The keel-bellied whipsnake, *Dryophiops rubescens* (Colubridae) is a medium-sized (1.0–1.2 m total length) diurnal, rear-fanged treesnake distributed in a wide geographic arc from the western Philippines (Palawan, Calamian Islands) through Borneo, Java, and Sumatra, into Peninsular Malaysia (inclusive of Penang and the Seribu Archipelago), southern Thailand (including Phuket Island), and Cambodia (Taylor, 1965; Frith, 1977; Manthey and Grossmann, 1997; Das, 2007, 2010; Grismer, 2011). It is encountered infrequently on Borneo (e.g., Stuebing, 1991, 1994; van Rooijen and van Rooijen, 2007) and its natural history remains poorly known (e.g., David and Vogel, 1996). The species has been recorded in low elevation wet tropical forest, secondary growth, and gardens, although its preferred habitat is most likely to be primary rainforest, where it preys upon lizards (Cox, 1991; David and Vogel 1996; Manthey and Grossmann 1997), particularly species of the genera *Draco* (Boulenger, 1912; Taylor, 1965; Stuebing and Inger, 1999) and *Hemidactylus*

(Brongersma 1947; Taylor 1965), and frogs (Manthey and Grossmann, 1997). Beyond basic information about the morphology of this species, which excludes any mention of sexual dichromatism, the only data on its reproductive habits available in the literature are a report of oviparity with the presence of two extremely elongated eggs in one specimen (Manthey and Grossmann, 1997), which is repeated frequently in field guides (e.g., Cox et al., 1998; Das, 2007, 2010). *Dryophiops rubescens* is not alone in this paucity of information on courtship and mating behaviors. Whereas the diversity of colubroid snakes in Borneo alone (Brunei, the Malaysian states of Sabah and Sarawak, and Indonesia's Kalimantan province) exceeds 125 (Barbour, 1912; de Haas, 1950; Stuebing and Inger, 1999; Uetz, 2012), we were unable to locate a single report in the primary literature on their reproductive behavior in nature. We here report the first observations of courtship behavior in *D. rubescens* in nature and the presence of sexual dichromatism.

Materials and Methods

On 29 July 2007 at ca. 1545 hrs, three intertwined individuals of *D. rubescens* were observed at Sepilok Jungle Resort on the outskirts of Sandakan, Sabah, Malaysia (5.8659°S, 117.9517°E), and their movements were documented photographically. Observations began when the snakes were initially seen and ended 55 min later when the snakes moved out of observable range into the undergrowth. Measurements on photographs were taken using PixelStick software (version 2.3; plumamazing.com) in units of head lengths of the largest snake, beginning at the tip of the snout of each snake.

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Results and discussion

The three snakes were first noticed while they were moving along the thin branches of bushes near a restaurant area at Sepilok Jungle Resort. The encounter was judged to be unusual because the individuals did not move around singly but as a unit, with the largest specimen (individual A) leading two smaller snakes (individuals B and C) by ca. 5.4 and 7.0 head lengths, respectively (Fig. 1A). Over a period of 35 min after the initial encounter, the three snakes made their way through the foliage together and onto a wooden walkway, with their positions shifting slightly as time progressed (Figs. 1B–D). In particular, there appeared to be some form of competition by the smaller snakes for a position closer to the head of the larger snake, and their positions changed (Fig. 1B–D) from 8.7 to 5.7 to 11.0 head lengths distant from the head of A for the darkest-headed snake (individual B), and 9.4, 7.7, and 4.5 head lengths distant for individual C. Whereas during the initial observations (Fig. 1A–C), B was closer to the head of A by a margin of 1.6, 0.7, and 2.0 head lengths, respectively, towards the end of the observations the positions of B and C became reversed, and B was tailing C by 5.5 head lengths. At the end of the observations, the snakes disappeared out of sight into the decaying leaves beneath the walkway, still moving together after a total distance traveled of well over 10 m.

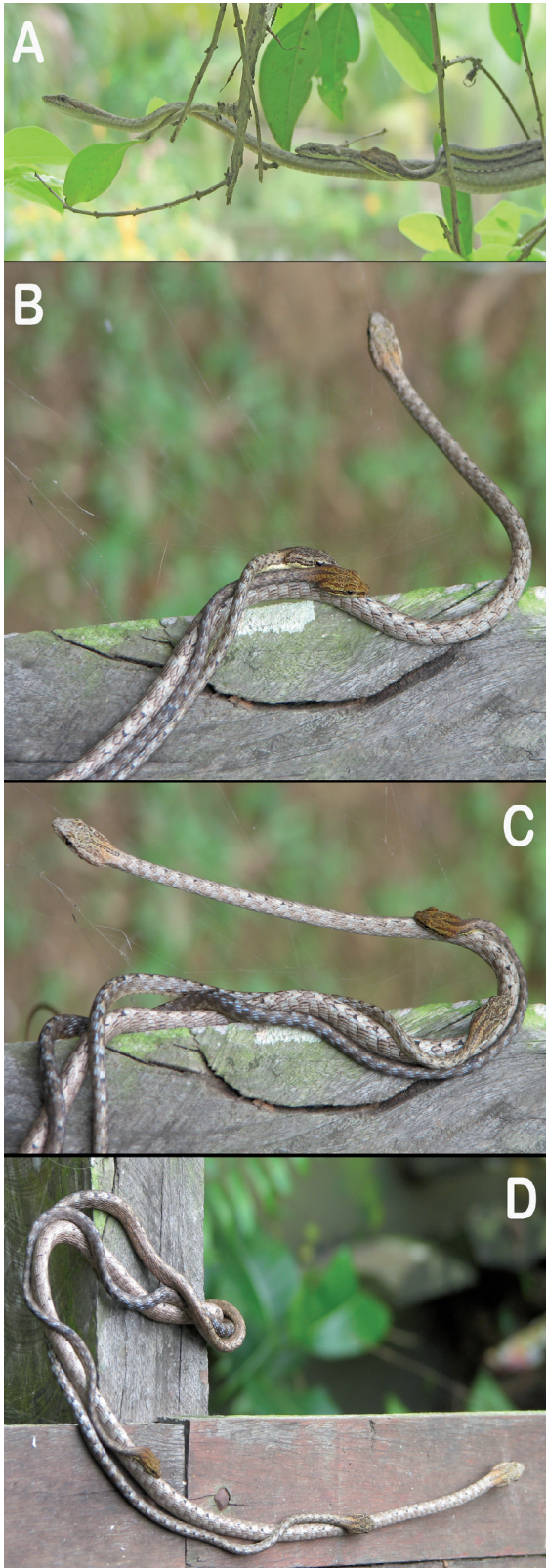
During the study of the images chronicling the movement of the snakes, evidence of differences in head coloration was noted. Whereas the leading, largest individual had a grey-brown head of a relatively light hue, both of the smaller individuals had head colors of a deeper brown tone (Fig. 1B–C). Furthermore, the darker markings on the heads of these three individuals were quite pale in the largest specimen, whereas they were considerably more prominent in the two smaller ones.

The only type of activity that can reasonably explain the observed behavior is courtship, presumably soon followed by mating. We believe the photographic sequence shows the reproductively receptive female A, whose pheromonal trail attracted two males, the smaller individuals B and C. These males approached A and made contact. While it is not possible to determine whether the two males met up with the female simultaneously or whether they arrived consecutively, both became entwined and tried to further their chances of mating by using the female's body as the substrate. This activity has been referred to as "chase-mount behavior" (Greene and Mason, 2000) in a study of captive brown tree snakes, *Boiga irregularis* (Bechstein, 1902). The

restrictive surface and movement of the female, as well as the pursuit of the males, caused the observed changes in position of the males as they attempted to jockey into a successful mating position. Despite the competitive activities while positioned in this mating tangle, the slender bodies of these snakes permitted their combined movement unimpeded, through the branches of several bushes, across a wooden walkway, and into the leaf litter beneath the walkway.

Courtship behaviors among snakes involving a single female and several males are well known through the communal mating reported for some species. The best-known examples of this are probably the so-called mating balls (e.g., garter snakes: Mason and Crews, 1985; anacondas: Rivas and Burghardt, 2001). This type of mating behavior has been classified as "scramble polygyny" (Shine *et al.*, 2003). Gregory (1975) even reported a brief occurrence of such behavior when a single putative female *Thamnophis sirtalis parietalis* (Say, 1823) led a large group of suitors into the branches of a bush, duplicating the arboreality we report here, though not the finesse of the interaction. A report of mating in the Central American colubrid *Scaphiodontophis annulatus* (Duméril *et al.*, 1854) featured interactions between the same number of individuals as we observed (two males and a female), but after much grabbing, holding, and biting only one of the males eventually succeeded in entangling itself with the female, with the other male left out of the more intimate encounter (Sasa and Curtis, 2006).

We believe that the behavior we observed constitutes the first report of what may best be referred to as a "mating braid," in which three or more snakes form a longitudinal entanglement, reminiscent of the human hairstyle of that name. In very slender, long-tailed species, such as *D. rubescens*, this configuration presents a clear physical advantage over mating balls in a habitat composed of branches surrounded by foliage. The physical advantages include (1) the ability to continue movement through the habitat even as courtship proceeds, making the snakes less vulnerable to external influences than if they stayed put; and (2) the better weight distribution along the length of the body of the participating individuals, allowing courtship to take place along almost any diameter and arrangement of branches. We expect that the morphology of whip- and vinesnakes, especially those of extremely thin body diameter (e.g., *Ahaetulla*, *Oxybelis*) not only dictates the extremely elongate shape of their eggs, but also places constraints on their courtship behavior to force



the formation of mating braids as the most effective way for males to compete for a female. Whereas the mating entanglement of two individuals (i.e., a single male and a single female) has been documented in Asia for *Ptyas mucosa* (Linnaeus, 1758) (Millett, 1909; Beadon, 1910; Wall, 1921) as well for some European taxa (see Davis, 1936), and a report exists of two *Boiga cyanea* (Duméril et al., 1854) males intertwining during combat in captivity (O'Shea, 1994), we have been unable to locate additional reports. We therefore eagerly anticipate observations on other very elongated groups (e.g., *Ahaetulla*, *Boiga*, *Dendrelaphis*, *Dryocalamus*, *Lepturophis*) to permit testing of our assertions.

Sexual dichromatism is generally considered one of the big differences between lizards and snakes, with color differences among snakes a relative rarity (Reed and Tucker, 2011). Even though sexual dichromatism among some viperid snakes appears to have antipredatory significance (e.g., the “flicker-fusion hypothesis”: Shine and Madsen, 1994; Lindell and Forsman, 1996), differentiated hues of head coloration, as in the case of *D. rubescens*, would not be a significant deterrent for a visual predator.

Acknowledgments. We thank Jason Lim for being at the right place at the right time and for the use of his photographs, Harry Greene for his encouraging comments on the manuscript, Gernot Vogel for a thorough review, and Aaron Bauer for checking a key reference.

Figure 1. Observations on the courtship behavior of *Dryophiops rubescens* at the Sepilok Jungle Resort in Sandakan, Sabah, Malaysia. (A) During the initial encounter, the largest specimen was observed moving through the bushes with two smaller individuals intertwined. Time: 1549 hrs. (B) Closer observation became possible when the three individuals descended from the vegetation and moved along a wooden walkway. Time: 1639 hrs. (C) Throughout the observations, the positions of the smaller individuals with respect to the larger animal and each other changed. Time: 1640 hrs. (D) The two smaller individuals have switched places along the body of the larger one. Shortly after this photograph was taken, the snakes moved out of visual range. Time: 1642 hrs. Panels B–D also illustrate the difference in coloration between the smaller individuals and the larger one: the former have darker heads and blue interscalar spaces in the first third of the body. Photos by Jason Lim.

References

- Beadon, C. (1910): A snake flirtation. *Journal of the Bombay Natural History Society* 20: 228.
- Barbour, T. (1912): A contribution to the zoögeography of the East Indian Islands. *Memoirs of the Museum of Comparative Zoology* 44: 1-203.
- Bongersma, L.D. (1947): Zoological notes from Port Dickson. 1. Amphibians and reptiles. *Zoologische Mededelingen* 27: 300-308.
- Boulenger, G.A. (1912): A Vertebrate Fauna of the Malay Peninsula from the Isthmus of Kra to Singapore, Including Adjacent Islands. *Reptilia and Batrachia*. London, United Kingdom, Taylor & Francis.
- Cox, M.J. (1991): *The Snakes of Thailand and Their Husbandry*. Malabar, Florida, USA, Krieger Publishing.
- Cox, M.J., van Dijk, P.P., Nabhitabhata, J., Thirakhupt, K. (1998): A Photographic Guide to Snakes and Other Reptiles of Peninsular Malaysia, Singapore, and Thailand. Sanibel Island, Florida, USA, Ralph Curtis Publishing.
- Das, I. (2007): *A Pocket Guide: Amphibians and Reptiles of Brunei*. Kota Kinabalu, Sabah, Malaysia, Natural History Publications (Borneo) Sdn. Bhd.
- Das, I. (2010): *Reptiles of South-East Asia*. London, United Kingdom, New Holland Publishers.
- David, P., Vogel, G. (1996): *The Snakes of Sumatra. An Annotated Checklist and Key with Natural History Notes*. Frankfurt am Main, Germany, Edition Chimaira.
- Davis, D.D. (1936): Courtship and mating behavior in snakes. *Field Museum of Natural History, Zoological Series* 22: 257-290.
- de Haas, C.J.P. (1950): Checklist of the snakes of the Indo-Australian Archipelago (Reptilia, Ophidia). *Treubia* 20: 511-625.
- Frith, C.B. (1977): A survey of the snakes of Phuket Island and the adjacent mainland areas of Peninsular Thailand. *Natural History Bulletin of the Siam Society* 26: 263-316.
- Greene, M.J., Mason, R.T. (2000): Courtship, mating, and male combat of the brown tree snake, *Boiga irregularis*. *Herpetologica* 56: 166-175.
- Gregory, P.T. (1975): Arboreal mating behavior in the red-sided garter snake. *Canadian Field-Naturalist* 89: 461-462.
- Grismer, L.L. (2011): *Amphibians and Reptiles of the Seribuat Archipelago (Peninsular Malaysia) – A Field Guide*. Frankfurt am Main, Germany, Chimaira.
- Lindell, L.E., Forsman, A. (1996): Sexual dichromatism in snakes: support for the flicker-fusion hypothesis. *Canadian Journal of Zoology* 74: 2254-2256.
- Manthey, U., Grossmann, W. (1997): *Amphibien und Reptilien Südostasiens*. Münster, Germany, Natur und Tier-Verlag.
- Mason, R.T., Crews, D. (1985): Female mimicry in garter snakes. *Nature* 316: 59-60.
- Millett, G.P. (1909): A snake flirtation. *Journal of the Bombay Natural History Society* 19: 758-759.
- O'Shea, M. (2003): Natural history notes. *Boiga cyanea* (green cat snake). Male rivalry. *Herpetological Review* 34: 147.
- Reed, R.N., Tucker, A.D. (2011): Determining age, sex, and reproductive condition. In: *Reptile Biodiversity: Standard Methods for Inventory and Monitoring*, p. 151-163. McDiarmid, R.W., Foster, M.S., Guyer, C., Gibbons, J.W., Chernoff, N., Eds., Berkeley, California, USA, University of California Press.
- Rivas, J., Burghardt, G.M. (2001): Understanding sexual size dimorphism in snakes: wearing the snake's shoes. *Animal Behaviour* 62: F1-F6.
- Sasa, M., Curtis, S. (2006): Field observations of mating behavior in the neck-banded snake *Scaphiodontophis annulatus* (Serpentes: Colubridae). *Revista de Biología Tropical* 54: 647-650.
- Schreiber, E. (1912): *Herpetologia Europaea*. Jena, Germany, Gustav Fischer Verlag.
- Shine, R., Madsen, T. (1994): Sexual dichromatism in snakes of the genus *Vipera*: a review and a new evolutionary hypothesis. *Journal of Herpetology* 28: 114-117.
- Shine, R., Langkilde, T., Mason, R.T. (2003): Confusion within 'mating balls' of garter snakes: does misdirected courtship impose selection on male tactics? *Animal Behaviour* 66: 1011-1017.
- Stuebing, R.B. (1991): A checklist of the snakes of Borneo. *The Raffles Bulletin of Zoology* 39: 323-362.
- Stuebing, R.B. (1994): A checklist of the snakes of Borneo. Addenda and corrigenda. *The Raffles Bulletin of Zoology* 42: 931-936.
- Stuebing, R.B., Inger, R.F. (1999): *A Field Guide to the Snakes of Borneo*. Kota Kinabalu, Sabah, Malaysia, Natural History Publications (Borneo) Sdn. Bhd.
- Taylor, E.H. (1965): *The serpents of Thailand and adjacent waters*. University of Kansas Science Bulletin 45: 609-1096.
- Uetz, P., Ed. (2012): *The Reptile Database*. Accessed at <http://www.reptile-database.org> on 24 May 2012.
- van Rooijen, J., van Rooijen, M. (2007): The land snakes of the Santubong Peninsula, Sarawak, Borneo: a preliminary list of species with natural history notes. *Russian Journal of Herpetology* 14: 27-38.
- Wall, F. (1921): *Ophidia taprobanica*, or the Snakes of Ceylon. Colombo, Sri Lanka, H.R. Cottle.