

Body size, food habits, reproduction and growth in a population of black whip snakes (*Demansia vestigiata*) (Serpentes : Elapidae) in tropical Australia

S. Fearn^A and D. F. Trembath^{B,C}

^ADepartment of Primary Industries and Water, Level 1, 167 Westbury Road, Prospect, Tas. 7250, Australia.

^BMuseum and Art Gallery Northern Territory, GPO Box 4646, Darwin, NT 0801, Australia.

^CCorresponding author. Email: dane.trembath@nt.gov.au

Abstract. Two species of large black whip snakes (*Demansia vestigiata* and *D. papuensis*) are morphologically and ecologically similar and have broadly overlapping distributions. A long history of taxonomic difficulties has meant that most previous taxonomic and ecological studies comprise composite samples of both taxa. Here, we provide ecological data (body sizes, food habits, reproduction and inferred growth rates) collected from captured and road-killed specimens from a tropical population of *D. vestigiata* at Townsville, north-eastern Queensland, Australia. Males attain larger body sizes and have longer tails than females. All food items were ectotherms (lizards and frogs). Female reproductive cycles were strongly seasonal. Clutch size is significantly positively related to maternal body size. Egg dimensions, clutch mass and neonatal size are reported. Inferred growth rates indicate that sexual maturation is attained at ~21 months for females.

Introduction

Until recently, the biology of tropical Australian snakes has received little attention compared with that of temperate zone taxa. However, apart from extensive field-based studies in the Northern Territory of an acrochordid (*Acrochordus arafurae*) (Shine 1986; Houston and Shine 1994), a python (*Liasis fuscus*) (Madsen and Shine 1996, 2002; Madsen *et al.* 2006) and a colubrid (*Tropidonophis mairii*) (Brown and Shine 2002, 2004, 2005), there have only been limited field studies of snakes in north-east Queensland and these have typically focussed on the pythons *Morelia kinghorni* (Fearn *et al.* 2005), *M. viridis* (Wilson *et al.* 2006a, 2006b; Wilson 2007; Wilson and Heinsohn 2007) and recently the colubrid *Boiga irregularis* (Trembath and Fearn 2008). Tropical Elapidae have failed to receive similar attention, with only one taxon (*Acanthophis*) being the subject of detailed field studies in the Northern Territory (Webb *et al.* 2002). Consequently, most datasets that incorporate tropical snake taxa (and elapids in particular) are based on the dissection of museum specimens (Shine 1991), compelling investigators to combine information from widely different locations and different years (Seigel and Ford 1987; Greer 1997). The reproductive ecology of tropical Australian snakes, in particular, is poorly understood but data suggest that some taxa display continuous aseasonal reproduction (Shine 1980; Brown and Shine 2006). Here we provide ecological data on a single population of a tropical elapid (*Demansia vestigiata*), which appears to display seasonal reproduction.

Whip snakes of the genus *Demansia* are common and widespread in the wet–dry tropics of northern Australia (Wilson

and Swan 2008). As a group, they are similar in morphology (slender body, long tail, large eyes), behaviour (rapid movement, diurnality, terrestriality) and ecology (predominately saurophagous, oviparity), and adapted for chasing and capturing fast-moving, diurnal, surface-active scincid lizards (Shine 1980). Australian *Demansia* also show a remarkable degree of morphological convergence, with distantly related colubrid ‘whip snakes’ in America, Asia, Europe and Africa (Shine 1980).

The ‘black’ whip snakes, *D. vestigiata* and *D. papuensis*, both of which attain body lengths of more than 1 m are broadly sympatric throughout the Australian tropics (Shea 1998). The taxonomic history of the black whip snakes is extensive and confusing, and it has been difficult to differentiate the two taxa. However, recent taxonomic work indicates that these species can be distinguished by scalation, size and, to a lesser extent, colour (Shea 1998). *D. vestigiata* is smaller with fewer ventral and subcaudal scales, and is more broadly distributed than *D. papuensis*.

Previous ecological studies of Australian *Demansia* (Shine 1980) comprised a composite dataset of both *D. vestigiata* and *D. papuensis* (referred to as *D. atra*), reflecting taxonomic uncertainties at that time (Shea 1998). While the ecology of both taxa is probably similar, *D. papuensis* grows to a larger size (1600 mm snout–vent length (SVL)), and therefore may take a wider range of prey, and has different patterns of reproduction and growth than *D. vestigiata* (Shea 1998; R. Shine, pers. comm.).

Here we provide the first ecological data (body size, diet, reproduction, inferred growth rates) for a population of tropical *D. vestigiata*.

Methods

Between February 1997 and October 2006, data were collected for *D. vestigiata* whenever the opportunity arose during fieldwork. Most snakes were collected from Townsville (19°00'S, 146°46'E), in the strongly seasonal wet–dry tropics of north-eastern Australia. Vegetation is predominantly open savanna woodland with a grassy understorey. Soils are infertile, diurnal temperatures are always high (25.0–31.4°C mean daily maximum: Ridpath 1985) and daylength varies little. Rainfall is markedly seasonal and its monthly distribution pattern within the wet season (October–March) varies between years (Ridpath 1985). Data were also collected for specimens from Magnetic Island (19°10'S, 146°50'E), lying 4.5 km off the coast from Townsville and similar with respect to vegetation and climate.

All specimens were identified as *D. vestigiata* using counts of the ventral and subcaudal scales (after Shea 1998). All snakes were weighed, and measurements taken of SVL and tail length. Road-killed specimens were dissected to determine diet as well as the reproductive condition of females. Live snakes were palpated for prey, faecal material and ova if female. The sex of male snakes was determined by the manual eversion of the hemipenes. Prey in stomachs and faecal material were identified as closely as possible to species and, if intact, weighed and measured. Egg dimensions and clutch mass were recorded for two clutches of eggs. One of these clutches was successfully incubated and the dimensions of the neonates were recorded.

All variables were log-transformed to improve normality and homogeneity of variance (Fowler *et al.* 1998). All snakes with incomplete tails were excluded from tail-length analysis. Means and range were described for SVL, body mass and tail length. Relative tail length, calculated as tail length divided by SVL, was compared using non-parametric *t*-test. Inferred growth rates were obtained by plotting the month of capture against SVL with a regression performed on individuals <470 mm SVL, classed as juveniles. Shine (1978) suggested that this method is accurate for juvenile, fast-growing specimens. Statistical analysis of data used SigmaStat (Version 3.1, Systat Software, San Jose, CA) and SPSS (Version 11, SPSS Inc., Chicago, IL).

Results

In total, 77 *D. vestigiata* were examined during this study (Table 1). Most specimens ($n=56$) were encountered opportunistically while involved in other studies of the region's herpetofauna, along with a smaller sample from Magnetic Island ($n=11$), and a nuisance snake callout service conducted by the Queensland Parks and Wildlife Service ($n=10$).

Demansia vestigiata were mostly encountered during the day (49 of 59 records, 83%), but specimens were also found to display nocturnal activity (10 of 59 records, 17%).

Body size

Measures of SVL, tail length and body mass were recorded for 42 male and 35 female *D. vestigiata* (Table 1). Males were found to be significantly larger than females, for SVL (Mann–Whitney U Test: $Z=-2.77$, $P=0.006$) and body mass (Mann–Whitney U Test: $Z=-3.56$, $P<0.00$). Males had longer tails than females (Table 1). Tail lengths were 45–350 mm in males and 46–300 mm in females (Table 1). Relative tail lengths also differed significantly between the sexes (Mann–Whitney U Test: $Z=-2.60$, $P=0.009$). Male and female *D. vestigiata* were found to differ significantly in body mass relative to SVL (Fig. 1) (ANCOVA with site as factor, $\ln(\text{SVL})$ as covariate, $\ln(\text{mass})$ as dependent variable: interaction, $F_{2,76}=190.37$, $P<0.001$; intercepts, $F_{1,79}=1690.82$, $P<0.00$).

Diet

Of the 77 captured *D. vestigiata*, 17 (22%) contained recently ingested prey items in the stomach or readily identifiable remains (skink scales) in faeces. Fifteen of these snakes contained a single prey item and two individuals contained two and four prey items. The diet consisted entirely of ectotherms (scincid lizards 71.5%, and frogs 28.5%) (Table 2). The dates of capture indicate that feeding continues year round in this region.

Reproduction

Of 30 adult females examined, eight (26.6%) were reproductively active. Reproductive specimens were encountered only in the late dry season or early wet season (August–November), with one record from April (Fig. 2). Well developed ova were palpated in living snakes in late August and mid-November. Two road-killed specimens revealed ovarian follicles larger than 5 mm (early September) and large oviducal eggs (late October). Clutch size ranged from 5 to 10 and was correlated with maternal body length ($r^2=0.63$, $n=8$, $P=0.01$) (Fig. 3). One female laid five eggs (mid-November) while in a collecting bag several hours after capture.

Two clutches of full-term eggs were examined. Five eggs removed from a road-killed female (SVL 480 mm, weight 28 g) ranged in length from 30 to 36 mm and their diameter at midpoint was 9–10 mm. Clutch mass was 10 g, representing 35.7% of maternal mass. Five eggs laid by a newly captured female (SVL 590 mm, weight 36 g) ranged in length from 28 to 35 mm and in diameter from 13 to 14 mm. In this case, clutch mass was 16 g, 44.4% of maternal mass. This clutch was laid in early November

Table 1. Sample sizes, body sizes, and mass of *Demansia vestigiata* from the Townsville area, Queensland
SVL, snout–vent length; TL, total length

Sex		SVL (mm)	TL (mm)	Mass (g)	TL/SVL
Male	Mean (s.e.)	748.04 ± 37.62	205.77 ± 11.83	111.15 ± 11.78	0.27 ± 0.007
	Range	193–1090, $n=44$	45–350, $n=44$	2–310, $n=43$	0.11–0.44, $n=44$
Female	Mean (s.e.)	624.91 ± 37.35	169.83 ± 11.00	68.24 ± 7.32	0.27 ± 0.010
	Range	190–1035, $n=37$	46–300, $n=36$	2–200, $n=37$	0.23–0.62, $n=36$

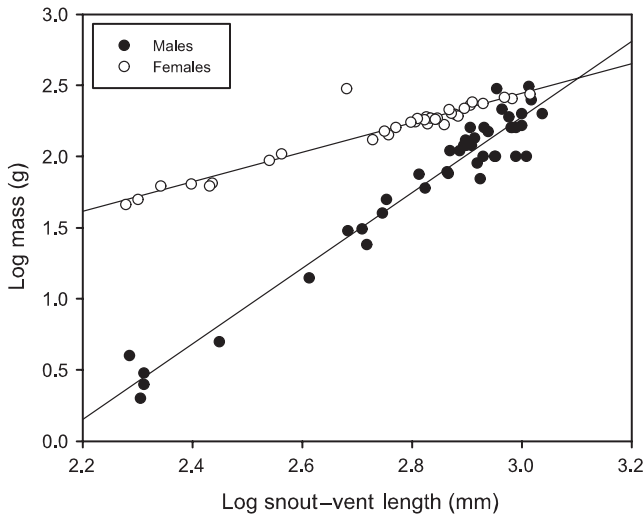


Fig. 1. Log(body mass) relative to log(SVL) of male and female *Demansia vestigiata* from the Townsville area, Queensland.

Table 2. Prey records for *Demansia vestigiata* from the Townsville area

Species	No. of records
Amphibia	
Hylidae	1
Unidentified frogs	5
Reptilia	
Scincidae	6
<i>Carlia schmeltzii</i>	4
<i>C. pectoralis</i>	3
<i>C. jarnoldae</i>	1
<i>Lampropholis delicata</i>	1
Total	21

and four of the eggs were successfully incubated in a container of damp vermiculite at ambient room temperature (22–33°C). Two neonates emerged on the 79th day of incubation, the third and fourth neonates emerged over the following two days. Two female neonates measured 191 and 202 mm SVL and both weighed 2 g. Two males had a SVL of 205 mm and weighed 2.5 g and 3 g.

Growth rates

Body sizes of juvenile *D. vestigiata* increased throughout the year (Fig. 4). Using regression analysis, we predicted that juvenile *D. vestigiata* will attain ~400 mm SVL after one year. If growth continues at this rate, we predict that females will mate for the first time at ~21 months of age, and produce their first clutch of eggs ~3 months after mating.

Discussion

Within the Townsville area we found *D. vestigiata* to be relatively easy to sample via the methods we used. Additionally, we were able to record valuable trophic and reproductive data that has been difficult to study in a population of *Boiga irregularis* from the same area (Trembath and Fearn 2008).

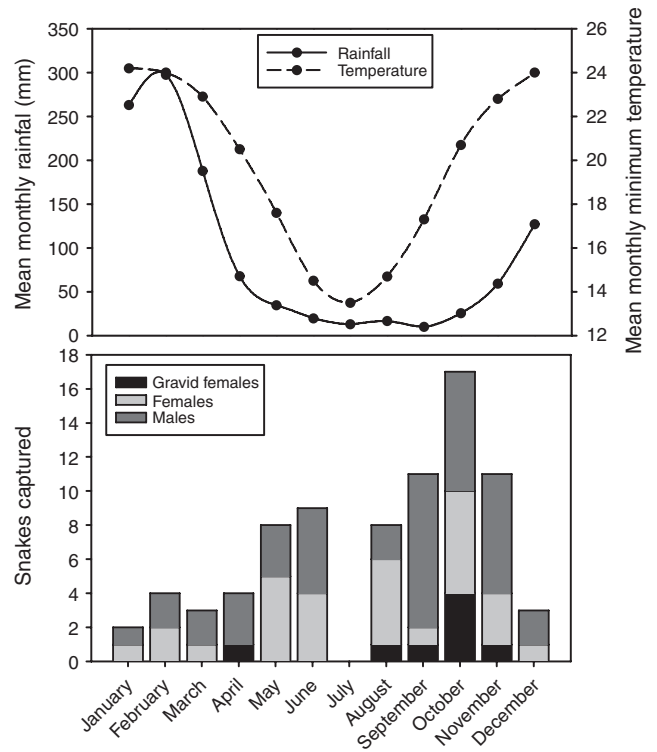


Fig. 2. Climatic data and activity patterns of *Demansia vestigiata* from the Townsville area, Queensland, based on specimens sampled. Climatic data were downloaded from Anon. (2006).

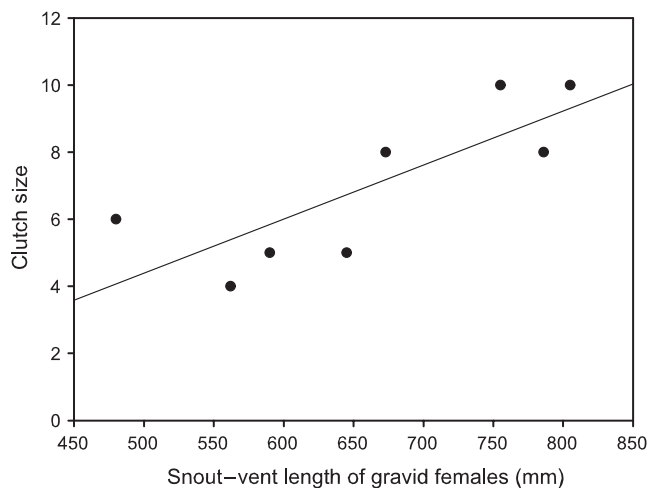


Fig. 3. Clutch sizes in relation to SVL of female *Demansia vestigiata* from the Townsville area, Queensland.

Whip snakes in the genus *Demansia* have been described as typically diurnal (Shine 1980); however, tropical populations may also be active at night, particularly larger species such as *D. vestigiata* that include adult frogs in their diet. *D. vestigiata* was found to have a nocturnal component to its ecology and, of these, one heavily gravid female was discovered at 2020 h outstretched and dorsolaterally flattened on a sealed road

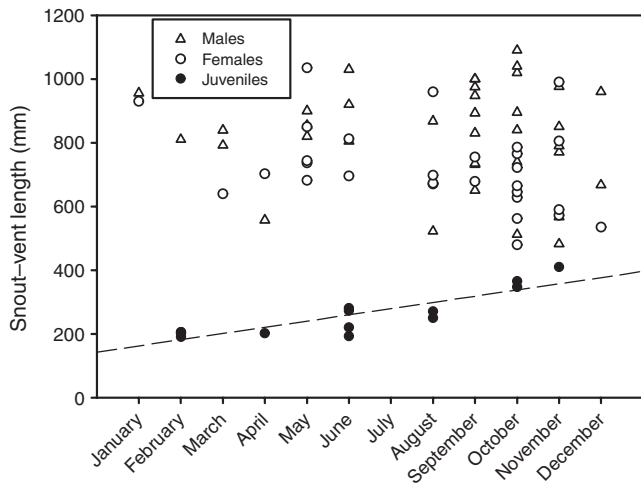


Fig. 4. Seasonal distribution and inferred juvenile growth rate of *Demansia vestigiata* from the Townsville area, Queensland.

apparently thermoregulating. Nocturnal activity is common among tropical snakes (Greer 1997; Trembath 2004) where consistent high ambient and substrate temperatures allow snakes to be active while avoiding extreme diurnal temperatures.

Adult mean and maximum body size and size at maturity determined in this study are consistent with the findings of Shea (1998), the only other known study of *D. vestigiata* that does not include congeners. Intraspecific male combat has been documented for *D. vestigiata* (Covacevich *et al.* 1994), possibly favouring selection for larger male body size in this taxon (Shine 1978, 1994). Male combat in our sample of *D. vestigiata* is strongly supported, with males having significantly greater body mass than females, possibly due to greater muscle mass. Male-biased sexual dimorphism amongst Australian elapid snakes appears to be strongly associated with male–male combat (Shine 1994).

Sexual dimorphism in tail length relative to SVL is evident in some Australian elapid snakes but not others and appears to be less evident in larger-bodied taxa (body length >1200 mm). No particular pattern in relative tail length holds true, even in species that commonly display intraspecific male combat, and its ecological significance is unknown (Greer 1997). For taxa with clear dimorphism in tail length, such as our sample of *D. vestigiata*, longer tail lengths in males may be due to sexual selection for male mating success (Shine *et al.* 1999).

Although in our study only 17 snakes had identifiable gut contents, prey types were consistent with those reported for other Australian *Demansia* (Shine 1980). In our study, diurnal surface-active scincid lizards comprised much of the diet. Shine (1980) observed that *D. atra* (= *vestigiata/papuensis*) differed from other *Demansia* by including a relatively high proportion of frogs in its diet. Our sample also suggests that *D. vestigiata* will take frogs opportunistically. We suggest that predominantly nocturnal prey (frogs) are discovered in their diurnal retreats by foraging snakes as well as falling prey to nocturnally active *D. vestigiata*, which is supported by the findings of Trembath and Rowley (2005), who observed a diurnally foraging

D. vestigiata detect, probe below ground level and consume a burrowing frog, *Limnodynastes ornatus*.

Clutch size and egg dimensions in our sample were consistent with those reported for *Demansia* in general (Shine 1980) and *D. vestigiata* in particular (Shea 1998). Increasing fecundity with maternal body size is common in reptiles (Seigel and Ford 1987) and typical of Australian elapids (extensive data summarised in Shine 1991; Greer 1997).

The seasonal timing of reproduction is of particular interest in *D. vestigiata*. Other composite data for *D. vestigiata* and *D. papuensis* have shown female reproduction to be aseasonal (Shine 1980). However, our Townsville data suggest that female reproduction primarily takes place in the transition from dry to wet seasons (August–November). There may be several reasons for this apparent discrepancy. First, the breeding season of the composite sample was determined by dissecting specimens (Shine 1980). Using this method, enlarged but relatively small ovarian follicles are readily detected; however, we were able to dissect only 20% of adult females. Second, it is not possible to detect relatively small ovarian follicles through the palpation of live snakes, thus females in our sample may have been reproductively active at other times of the year, yet their status was not detected. However, the presence of enlarged ovarian follicles may not indicate that reproduction will occur in the same season. Follicular developmental rate is poorly understood for tropical elapids and it cannot be determined with certainty whether a female with enlarged ovarian follicles will definitely reproduce, or whether one with small follicles definitely will not (Seigel and Ford 1987).

Our combined data indicate that, at least in the Townsville area, females appear to restrict reproduction to the late dry season. Hatchling wild-caught *D. vestigiata* in our sample (8 specimens) were all captured during July–August. Timing of female reproduction, hatching of eggs maintained at ambient temperatures in February and inferred growth rates (Fig. 4) indicate that these individuals probably emerged from eggs laid throughout November. In addition, female reproductive data for 13 other snake taxa (six Elapidae, four Colubridae and three Pythonidae), including *D. psammophis*, from the Townsville region, indicate that reproduction takes place during the mid to late dry season (S. Fearn and D. Trembath, unpubl. data). The only exception to this pattern in our sample of *D. vestigiata* was a gravid female sampled in April. Given that all the other records in our sample place timing of female parturition in the late dry season, the April record may be an example of double clutching (where a female produces two clutches per season) rather than evidence of aseasonality. Double clutching has been reported for other tropical snake genera and it is thought to occur due to higher food intake in favourable conditions (Shine and Covacevich 1983).

The unpredictability of rainfall, both in timing and amount in the wet–dry tropics (even in the wet season), creates an environment which is analogous to the temperate zone winter, in that food availability is low (Ridpath 1985). Thus, female *D. vestigiata* may time neonate hatching to coincide with the relatively high moisture and prey abundance (juvenile lizards and metamorphosing frogs) of the mid to late wet season, similar to the synchronised reproductive cycles of temperate-zone taxa where ovulation occurs in spring (Shine 1977a,

1977b). Large varanid and agamid lizards in Australia's strongly seasonal wet-dry tropics largely cease movements, feeding and growth during the dry season due to low availability of food and moisture (Christian *et al.* 1995; Griffiths and Christian 1996). These constraints may also be severe on hatchling snakes with low body mass and hence greater susceptibility to desiccation. Additionally, the requirements to actively seek out and pursue juvenile skinks and frogs are most readily available during the wet season. Aseasonal reproduction for tropical Queensland snakes in general may become more common in the very high tropics (Cape York), or in areas with more consistent rainfall (Queensland's Wet Tropics); however, all studies to date (see Introduction) from the Australian tropics (with the exception of the colubrid *Tropidonophis mairii*) indicate that seasonality may be the norm for most taxa.

Inferred growth rates for north-eastern Queensland *D. vestigiata* from our study are similar to inferred growth rates for *D. psammophis* from across Queensland (Shine 1980). The rapid growth of *D. psammophis* is likely to be a function of both a favourable climate (year-round feeding) and slender body shape (Shine 1980). Slender body form means that small increases in biomass (or energy content) cause large increases in body length. Rate of growth and size at sexual maturity for *D. vestigiata* is similar to other small to medium Australian elapids. Smaller species mature in the second season after their own hatching/birth, and larger species mature in the third or fourth season (reviewed by Greer 1997).

Demansia vestigiata in our study area were common and easily collected, providing the first detailed regional data collected on this species. This species, as well as many other *Demansia* species, have extensive distributions that incorporate a range of climatic zones and habitat types. Further studies in the southern and extreme northern portions of the range of these snakes will be important in determining how much influence timing and amount of rainfall may have on timing and frequency of reproduction, on growth rates, as well as the relative importance of amphibians in the diet.

Acknowledgements

This work was conducted under permit numbers F1/000330/00/SAA, WITK02196804, #WISP02196704, and #WISP01039503 from the Queensland Environment Protection Agency, and James Cook University Ethics Approval Number A594-00. Thanks to C. Camacho, T. Dell, A. Fagerlid, D. Freier, G. Gilroy, R. Lloyd, D. Poppi, J. Rowley, J. Sambono, J. Schaffer, S. Sullivan, E. Undheim and D. Watt for providing or reporting snake specimens. Thanks also to Dr Lin Schwarzkopf and Dr Jason Elliott for contributions to an earlier draft of this work. Thanks to the Bureau of Meteorology for permission to download climatic data.

References

- Anon. (2006). Bureau of Meteorology. Available at: www.bom.gov.au [accessed July 2006].
- Brown, G. P., and Shine, R. (2002). Reproductive ecology of a tropical natricine snake, *Tropidonophis mairii* (Colubridae). *Journal of Zoology* **258**, 63–72. doi: 10.1017/S0952836902001218
- Brown, G. P., and Shine, R. (2004). Maternal nest-site choice and offspring fitness in a tropical snake (*Tropidonophis mairii*, Colubridae). *Ecology* **85**, 1627–1634. doi: 10.1890/03-0107
- Brown, G. P., and Shine, R. (2005). Links between female phenotype, life-history and reproductive success in free-ranging snakes (*Tropidonophis mairii*, Colubridae). *Ecology* **86**, 2763–2770. doi: 10.1890/04-1805
- Brown, G. P., and Shine, R. (2006). Why do most tropical animals reproduce seasonally? Testing alternative hypotheses on the snake *Tropidonophis mairii* (Colubridae). *Ecology* **87**, 133–143. doi: 10.1890/04-1882
- Christian, K. A., Corbett, L. K., Green, B., and Weavers, B. W. (1995). Seasonal activity and energetics of two species of varanid lizards in tropical Australia. *Oecologia* **103**, 349–357. doi: 10.1007/BF00328624
- Covacevich, J. A., Roberts, L., and Mckinna, I. (1994). Male combat in the black whip snake *Demansia vestigiata*. *Memoirs of the Queensland Museum* **37**(1), 52.
- Fearn, S., Schwarzkopf, L., and Shine, R. (2005). Giant snakes in tropical forests: a field study of the Australian scrub python, *Morelia kinghorni*. *Wildlife Research* **32**, 193–201. doi: 10.1071/WR04084
- Fowler, J., Cohen, J., and Jarvis, P. (1998). 'Practical Statistics for Field Biologists.' 2nd edn. (John Wiley and Sons Publishing: New York.)
- Greer, A. E. (1997). 'The Biology and Evolution of Australian Snakes.' (Surrey Beatty: Sydney.)
- Griffiths, A. D., and Christian, K. A. (1996). Diet and habitat use of frillneck lizards in a seasonal tropical environment. *Oecologia* **106**, 39–48.
- Houston, D., and Shine, R. (1994). Population demography of Arafura filesnakes (Serpentes: Acrochordidae) in tropical Australia. *Journal of Herpetology* **28**, 273–280. doi: 10.2307/1564525
- Madsen, T., and Shine, R. (1996). Seasonal migration of predators and prey – a study of pythons and rats in tropical Australia. *Ecology* **77**, 149–156. doi: 10.2307/2265663
- Madsen, T., and Shine, R. (2002). Short and chubby or long and slim? Food intake, growth and body condition in freeranging pythons. *Austral Ecology* **27**, 672–680. doi: 10.1046/j.1442-9993.2002.01228.x
- Madsen, T., Ujvari, B., Shine, R., and Olsson, M. (2006). Rain, rats and pythons: climate driven population dynamics of predators and prey in tropical Australia. *Austral Ecology* **31**, 30–37. doi: 10.1111/j.1442-9993.2006.01540.x
- Ridpath, M. G. (1985). Ecology in the wet-dry tropics: how different? *Proceedings of the Ecological Society of Australia*. **13**, 3–20.
- Seigel, R. A., and Ford, N. B. (1987). Reproductive ecology. In 'Snakes: Ecology and Evolutionary Biology'. (Eds R. A. Seigel, J. T. Collins and S. S. Novak.) pp. 210–252. (MacMillan Publishing: New York.)
- Shea, G. M. (1998). Geographic variation in scalation and size of the black whip snakes (Squamata: Elapidae: *Demansia vestigiata* complex): evidence for two broadly sympatric species. *The Beagle. Records of the Museums and Art Galleries of the Northern Territory* **14**, 41–61.
- Shine, R. (1977a). Reproduction in Australian elapid snakes. 1. Testicular cycles and mating seasons. *Australian Journal of Zoology* **25**, 647–653. doi: 10.1071/ZO9770647
- Shine, R. (1977b). Reproduction in Australian elapid snakes. 2. Female reproductive cycles. *Australian Journal of Zoology* **25**, 655–666. doi: 10.1071/ZO9770655
- Shine, R. (1978). Growth rates and sexual maturation in six species of Australian elapid snakes. *Herpetologica* **34**, 73–79.
- Shine, R. (1980). Ecology of eastern Australian whip snakes of the genus *Demansia*. *Journal of Herpetology* **14**, 381–389. doi: 10.2307/1563694
- Shine, R. (1986). Ecology of a low energy specialist: food habitats and reproductive biology of the Arafura filesnake. *Copeia* **1986**, 424–437. doi: 10.2307/1445000
- Shine, R. (1991). 'Australian Snakes: a Natural History.' (Reed Books: Sydney.)
- Shine, R. (1994). Sexual size dimorphism in snakes revisited. *Copeia* **1994**, 326–346. doi: 10.2307/1446982
- Shine, R., and Covacevich, J. (1983). Ecology of highly venomous snakes: the Australian genus *Oxyuranus* (Elapidae). *Journal of Herpetology* **17**, 60–69. doi: 10.2307/1563782

- Shine, R., Olsson, M. M., Moore, I. T., LeMaster, M. P., and Mason, R. T. (1999). Why do male snakes have longer tails than females? *Proceedings of the Royal Society of London* **266**, 2147–2151.
- Trembath, D. F. (2004). Possible nocturnal activity by the coastal taipan *Oxyuranus scutellatus* (Elapidae) at Hencamp Creek, north Queensland. *Herpetofauna* **34**, 84–85.
- Trembath, D. F., and Fearn, S. (2008). Body sizes, activity times, food habits and reproduction of the brown tree snake (*Boiga irregularis*) (Serpentes: Colubridae) from tropical north Queensland, Australia. *Australian Journal of Zoology* **56**, 173–178. doi: 10.1071/ZO08008
- Trembath, D. F., and Rowley, J. (2005). An observation of the foraging behaviour of the black whip snake *Demansia vestigiata* (Serpentes: Elapidae): a successful predation of a frog *Limnodynastes ornatus* (Anura: Myobatrachidae) buried underground. *Herpetofauna* **35**, 114–115.
- Webb, J. K., Christian, K. A., and Fisher, P. (2002). Fast growth and early maturation in a viviparous sit-and-wait predator, the northern death adder (*Acanthophis praelongus*), from tropical Australia. *Journal of Herpetology* **36**, 505–509.
- Wilson, D. (2007). Foraging ecology and diet of an ambush predator: the green python *Morelia viridis*. In 'Biology of the Boas and Pythons'. (Eds R. Henderson and R. Powell.) pp. 141–150. (Eagle Mountain Publishing: Eagle Mountain, UT.)
- Wilson, D., and Heinsohn, R. (2007). Geographic range, population structure and conservation status of the green python (*Morelia viridis*), a popular snake in the captive pet trade. *Australian Journal of Zoology* **55**, 147–154. doi: 10.1071/ZO06078
- Wilson, S., and Swan, G. (2008). 'A Complete Guide to Reptiles of Australia.' 2nd edn. (New Holland Publishers: Sydney.)
- Wilson, D., Heinsohn, R., and Legge, S. (2006a). Spatial ecology of dichromatic green pythons (*Morelia viridis*) in Australian tropical rainforests. *Austral Ecology* **31**, 577–587. doi: 10.1111/j.1442-9993.2006.01519.x
- Wilson, D., Heinsohn, R., and Wood, J. (2006b). Life history traits and colour change in the arboreal tropical python *Morelia viridis*. *Journal of Zoology* **270**, 399–407. doi: 10.1111/j.1469-7998.2006.00190.x

Handling Editor: Jane Melville

Manuscript received 30 September 2008, accepted 22 April 2009