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Short Communication

Effect of sudden loss of vision on foraging behavior in captive born Tiger Snakes, *Notechis scutatus* (Serpentes: Elapidae)

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In animals, survival often is compromised when vision is partially or totally lost as a result of injury or disease (Martin 1981, Brown *et al.* 1984, Gauthier 1991). However, under particular circumstances, sudden loss of vision may have little impact on viability, as has been shown in wild populations of the Australian Tiger Snake, *Notechis scutatus* (Peters 1861, Bonnet *et al.* 1999, Aubret *et al.* 2005, Aubret and Thomas 2009). Carnac Island in Western Australia hosts a large population of Tiger Snakes in which many adult individuals have sustained severe head injuries (Figure 1) inflicted by nesting Silver Gulls, *Larus novaehollandiae,* which defend their progeny by attacking the heads of snakes (Mona Lisa Production 2004). Of the estimated 400 adult snakes, 7.5% are totally blind and 6.6% blind in one eye (Bonnet *et al.* 1999). Nevertheless, many injured snakes survive. Their body condition is no different than that of snakes with no visual impairment, suggesting that they feed normally. Injured animals are also involved in reproductive events (Bonnet *et al.* 1999).

In laboratory studies, blindfolded adult Tiger Snakes had great difficulty in capturing mobile prey (Aubret *et al.* 2005). On the other hand, field data revealed that blind snakes feed on seagull chicks almost exclusively, whereas full-sighted animals also took fast moving prey (lizards and mice). Thus, on islands, the ability of large adult Tiger Snakes to survive without vision may be attributed to the availability of abundant, helpless prey (seagull chicks) in insular ecosystems with few or no adult snake predators (Aubret *et al.* 2005). To investigate this fascinating natural phenomenon, I explored the potential occurrence of sensory compensation (Haverly and Kardong 1996, Cohen *et al.* 1997,

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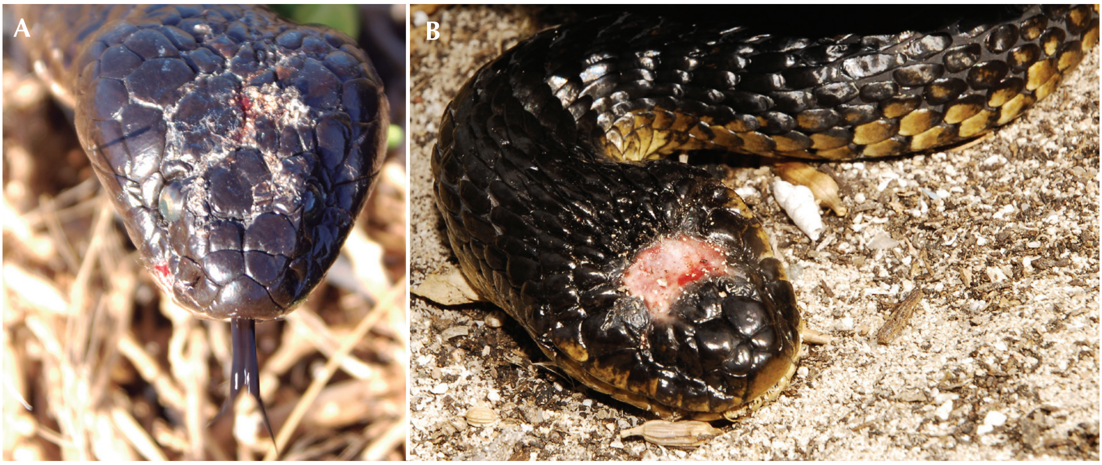

Figure 1. Head injuries sustained from Silver Gulls defending their chicks (**A**, Christmas Island, Tasmania) may eventually lead to total blindness (**B**, Carnac Island, Western Australia). Photographs: F. Aubret (A) and X. Bonnet (B).

Lessard *et al.* 1998) in blinded snakes. The potential confounding effects of experimenting with field-experienced adult snakes was removed by measuring the impact of sudden blindness on foraging behavior in laboratory-born young Tiger Snakes. Thirteen juvenile Tiger Snakes (three females from Carnac Island [32°07' S, 115°39' E] and four males and six females from Herdsman Lake [31°55' S, 115°48' E]) were born in captivity in April 2003 to three Carnac Island females and eight Herdsman Lake females. At the start of the experiment, snakes were 262.46 ± 12.47 days old, weighed 13.34 ± 4.93 g, and measured 27.54 ± 4.11 cm in snout-vent length. Snakes were maintained in a controlled-temperature room (27°C by day and 20°C by night) and housed individually in transparent plastic boxes (20 × 15 × 5 cm) with a water dish, shelter, and paper towel as substrate. Water was available at all times and food offered once a week (dead mice).

For each individual, control tests as well as "blinded" tests were repeated three times each during consecutive weeks and mean scores were calculated for each individual. After all three control tests were performed on an individual, a rectangular piece of black tape was applied across its head, covering both eyes and was left in place until all three "blinded" tests were done. Assumptions for normality of the data and equality of variances were tested using Lilliefors and Levene's tests and *t*-tests for dependent samples performed on the data.

Dead young mice were purchased from the University of Western Australia animal care unit. They were slowly introduced in front of the snake's snout, using long tweezers (30 cm) so as to not disturb the snakes. Snakes were offered similarsized mice for control and blinded tests (respectively 3.10 ± 0.48 *versus* 3.04 ± 0.68; $t_{12} = 0.27$; $p = 0.79$). Time started with the first tongue flick. Each trial lasted a maximum of 30 s during which the total number of tongue flicks was recorded. If the prey was bitten, the trial ended.

Results showed that once blinded (Table 1), snakes were less successful at biting the prey and required more time and more tongue flicks to bite the prey. The frequency of tongue flicking (mean number of tongue-flicks per second) was decreased by blindness.

Table 1. The effect of blindness in feeding neonates was analyzed using *t*-test for dependent samples. Means ± SD are given.

Traits	Control	"Blind"	df; t	*p*
Strike time (s)	4.05 ± 2.43	17.07 ± 10.28	12; –4.68	0.0006
Number of tongue flicks	4.97 ± 2.66	17.21 ± 9.28	12; –4.82	0.0005
Frequency of tongue flicks (N per s)	1.27 ± 0.25	1.09 ± 0.24	12; –2.31	0.039
Number of mice bitten (N out of 3)	3.00	1.92 ± 1.32	12; –2.94	0.012

Both visual and chemical/olfaction senses play major roles in feeding behavior of snakes (Herzog and Burghardt 1974, Drummond 1985, Teather 1991, Cooper *et al.* 2000). In young Tiger Snakes, the biting delay increased significantly after loss of vision, more tongue flicks were emitted before biting, and the frequency of tongue flicks decreased. That is, there was no immediate compensation of sight loss by an increase of tongue flicks (although this may occur over time in the case of permanent blindness). Overall, sight and olfaction triggered more successful and faster bites than olfaction alone. These results are consistent with observations on adult Tiger Snakes (Aubret *et al.* 2005) and further support the hypothesis that a large supply of sessile prey, such as abundant Silver Gull chicks, may allow the counter-intuitive survival of blinded adult snakes in the wild.

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