ECOLOGICAL ASPECTS OF SHEDDING IN FREE-RANGING HOGNOSE SNAKES (*HETERODON PLATIRHINOS*)

Michael V. Plummer

Department of Biology, Box 12251,
Harding University, Searcy, Arkansas 72149, USA
Email: plummer@harding.edu

Much of our knowledge of the shedding ecology of snakes is based on studies of captive rather than free-living animals (e.g., Banks 1985; Maderson 1985). Whether information from captive snakes reflects what shedding snakes actually do and how they behave in nature requires radiotelemetric studies of free-ranging animals that can be visually checked often enough to yield information on their shedding status (Peterson et al. 1993). For example, Platt (1969) found that although *Heterodon nasicus* often shed more frequently in captivity, mark-recapture evidence suggested that under natural conditions, adults did not shed more than twice in an activity season.

From April 1992–March 1995, as part of a comparative radiotelemetric study of habitat and movement ecology of resident and translocated snakes, I made 1351 daily observations on eight adult hognose snakes (*Heterodon platirhinos*) which were resident on an approximate 200 ha study area in central Arkansas. The study area was an open upland oak-hickory forest containing abundant edge habitat and numerous grassy clearings of both natural and man-made origin. After being implanted with either non-temperature sensitive (AVM SM-1) or temperature-sensitive radiotransmitters (Telonics CHP-2P) according to procedures outlined by Reinert (1992), snakes were released into the field, located daily, and visually checked every 3–4 days during the activity season (15 April–15 October). Shedding was detected by the presence of opaque eyes or a shed skin.

The eight snakes were inactive (i.e., did not move between successive location days) on 43% (*SD* = 12%) of 1351 total locations during the activity season. Inactivity was positively associated with shedding on 24% (*SD* = 11%) of total locations and thus constituted over half (56%) of inactivity occurrences. Various aspects of shedding were determined by an extended longitudinal analysis of three *Heterodon* (female no. 1 and males nos. 6 and 8), each of which was monitored in its normal habitat and home range for periods of 546, 702, and 491 consecutive days, respectively, and included two activity seasons. Each of these three snakes shed 3–5 times per year, averaging one shed each 37.0 (*SD* = 6.5) days, and was inactive for 12.5 (*SD* = 2.7) days preceeding each shed (Table 1). The number of sheds and number of inactive days preceeding sheds were similar for a given snake over two years as were the dates of shedding within and among snakes (Table 1). The inactive days preceeding shedding were spent under grass or mixtures of grass and herbs or leaves in open or edge habitats (Fig. 1). For each snake, the physical locations of shedding sites were distributed throughout the snake's large home range

Figure 1. A melanistic adult female *Heterodon platirhinos* in the opaque period of ecdysis. To take this photograph, it was necessary to partially dislodge and expose this snake from its typical shedding posture and refugium (i.e., tightly coiled in the base of a clump of grass).

(~50 ha; Plummer and Mills, unpubl.) and no site was used more than one time. In paired samples t-tests on individual inactive snakes, mean body temperatures when shedding differed from those when not shedding in one of three snakes (Table 2). Body temperatures of both shedding and non-shedding snakes closely tracked ambient air temperatures (Fig. 2).

The length of the shedding cycle in free-ranging *H. platirhinos* (37 d) is similar to that in many captive colubrid snakes (e.g., Banks 1985) and to that reported for captive *H. platirhinos* held at constant 25°C (38 d; Smith 1976). Because shedding snakes often are highly secretive and immobile, studies that estimate shedding rates from data collected on the trapping or hand-capturing of only active snakes are likely to underestimate frequency of shedding as apparently did Platt (1969) for *H. nasicus*.

It has been reported that both natural injuries (Appleby 1980; Neill 1949) and surgery (Kauffeld 1969) increase rate of shedding in snakes. It was necessary to surgically replace transmitter batteries during the activity season on five total occasions among *Heterodon* nos. 1, 6, and 8. To test whether surgery affected shedding rates, I compared the intervals between successive sheds that included battery replacement surgery to those intervals between sheds that did not include such surgery. For snake no.1, three surgeries were necessary. Mean time interval including surgery ($\bar{x}$ = 33.3 ± 8.09 [*SE*] d) was similar to time interval without surgery ($\bar{x}$ = 35.4 ± 4.09 d; t = 0.26, P > 0.80, df = 6). For snakes 6 and 8, one replacement surgery each was necessary; the respective times including surgery (36 and 37 d) did not differ from times without surgery ($\bar{x}$ = 43.7 ± 9.82 and 33.3 ± 4.02 d) (no. 6, t = 0.45, P > 0.50, df = 2; no. 8, t = -0.38, P > 0.50, df = 5). In the lizard *Gekko*, surgery increases shedding rate only if it occurs soon after the previous shed (Maderson 1985).

Captive snakes often demonstrate a strong thermophilic response immediately prior to shedding. Although this behavior is predicted to occur in free-ranging snakes (Peterson et al. 1993), it could be statistically demonstrated in only one of three *H. platirhinos*. A thermophilic response may result in snakes selecting, in comparison to habitats

Table 1. Dates of shedding, time ($\bar{x}$ ± 1 *SD*) between sheds, and time ($\bar{x}$ ± 1 *SD*) spent inactive preceeding shedding in two consecutive years for three *Heterodon platirhinos*. The unusually long mean time between sheds for no. 6 in 1993 was affected by a 68 d aestivation period from 7 July–12 September in which shedding did not occur. The two dates with question marks indicate probable sheds based on behavior (long period of inactivity followed by a burst of activity), but not confirmed visually by the presence of eye opaqueness or a skin slough.

Snake no.	Year	No. days obs.	Dates of shedding for shed no.						No. days between sheds	No. days inactive preceeding shedding
			1	2	3	4	5	6		
1	1992	265	-	5/16	7/05	7/28	8/29	9/27	33 ± 11.5	12 ± 1.3
	1993	281	-	5/05	6/20	7/12	8/18	9/27	36 ± 10.3	12 ± 5.4
6	1993	254	-	5/24	6/30	-	-	9/12	50 ± 18.4	17 ± 5.5
	1994	365	-	5/16	6/18	7/26	-	9/10?	34 ± 3.5	11 ± 4.6
8	1993	253	-	5/26	6/18	7/25	-	9/10	36 ± 12.1	14 ± 6.9
	1994	238	4/18	5/28	6/24	7/31?	8/25	-	33 ± 7.9	9 ± 1.8

Table 2. Percent of daily locations in grassy microhabitats and body temperatures ($\bar{x} \pm 1$ SE, n) of inactive shedding and inactive non-shedding *Heterodon platirhinos* during the activity season (15 April–15 October). Results of paired-samples t-tests on body temperatures are shown. In these tests, body temperatures from shedding periods were paired with those from temporally adjacent non-shedding periods for each individual snake.

Snake no.	Grassy loc. (%)		Body temperature (°C)		t	f	P
	shed	non-shed	shed	non-shed			
1	81.6	72.5	28.3 ± 0.46 (76)	26.4 ± 0.45 (131)	-2.62	75	0.01
6	96.8	82.7	28.8 ± 0.33 (57)	28.6 ± 0.35 (127)	0.29	56	0.77
8	86.2	79.2	24.1 ± 0.82 (26)	23.5 ± 0.42 (72)	-0.50	25	0.62

used between shedding periods, more thermally favorable open habitats when shedding (Peterson et al. 1993; Reinert 1993). However, many snakes also seek cover when shedding and this behavior may mask a thermophilic response if the cover is located in the same habitat where the snake is inactive when not shedding. For example, prior to shedding, *H. platirhinos* seek cover in the same micro- and macrohabitats used when they are inactive and not shedding (i.e., coiled under grass clumps in open or edge habitats; Platt 1969;

Plummer and Mills, unpubl.), although they do so at a higher frequency (Table 2; 88.2% vs. 78.1%; paired $t = 4.78$, $P < 0.05$, $df = 2$). Thus, due to the common microhabitats used, differences in body temperature between quiescent shedding and non-shedding *H. platirhinos* would not, a priori, necessarily be expected to differ. Active *H. platirhinos*, however, maintain higher body temperatures than inactive snakes, regardless of shedding status (Plummer, unpubl.).
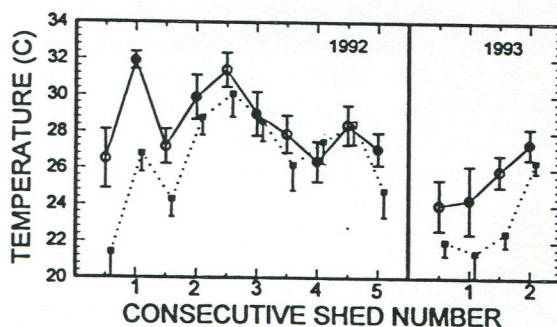
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Figure 2. Mean body temperatures of *Heterodon platirhinos* no. 1 during successive non-shedding and shedding periods over two years. Open circles represent body temperatures of inactive snakes in non-shedding periods and closed circles represent body temperatures of inactive snakes in shedding periods. Open squares represent air temperatures measured at the time of snake location for non-shedding periods and closed squares represent air temperatures measured at the time of snake location for shedding periods. Statistics in both plots are $\bar{x} \pm 1$ SE.

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