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Ecology of Australian Elapid Snakes of The Genera *Furina* and *Glyphodon*

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ABSTRACT—The closely-related snake genera *Furina* and *Glyphodon* contain small to medium sized nocturnal species. Dissection of 472 specimens provided data on food habits, body sizes, clutch sizes, growth rates and seasonal schedules of reproduction. All 70 prey items recorded were scincid lizards; *Furina* species take small diurnal skinks (especially *Lampropholis*) whereas *Glyphodon* take larger skinks (especially *Sphenomorphus*). Females attain larger body sizes than males in *Furina* species. Clutch sizes average 3 to 4 in *Furina*, 6 to 10 in *Glyphodon*. Female reproductive cycles are strongly seasonal in temperate-zone *Furina diadema*, but aseasonal in tropical *Furina*. Both sexes of *F. diadema* attain sexual maturity in the year following their birth.

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INTRODUCTION

The red-naped snake, *Furina diadema*, is a small nocturnal elapid morphologically similar to the North American colubrid ringneck snakes (*Diadophis*). *Furina diadema* is the smallest member of a complex of related species. The snakes within this complex have been variously referred to the genera *Aspidomorphus, Brachysoma, Furina, Lunelaps* and *Glyphodon*; regardless of nomenclature, there seems little doubt that all of these species are closely related (Cogger, 1979). The present study describes general ecology (reproduction, food habits, growth rates) of these snakes, and summarizes available published data on the group.

MATERIALS AND METHODS

Cogger (1979) lists diagnostic characters for the *Furina–Glyphodon* complex. Within this complex I recognize the following five species:

(i) *Furina diadema*. The red-naped snake is common in New South Wales and Queensland, and is diagnosed by its small body size and the presence of a sharply defined color patch behind the head (see Fig. 1).

(ii) "Northern *Furina*." This species is larger than the preceding form, with a more diffuse light "collar" behind the head. In some areas (e.g. Mount Molloy, Qld.), it is sympatric with *F. diadema* (J. Covacevich, pers. comm.). Most specimens I examined came from north Queensland and the Northern Territory.

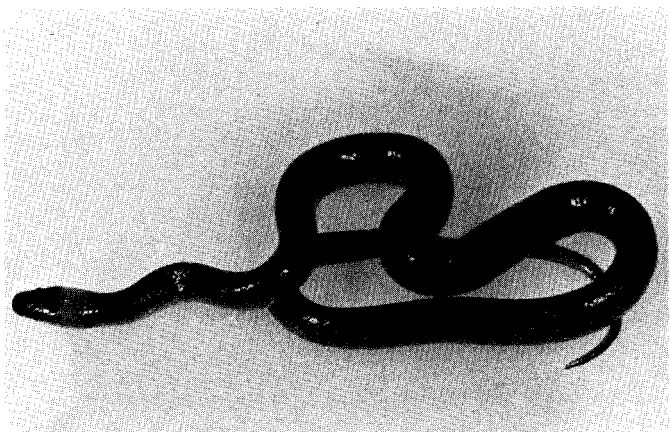

FIGURE 1. Red-naped snake, *Furina diadema*. Photograph by H. Cogger.

(iii) *Glyphodon barnardi.* A rare species of eastern Queensland.
(iv) *Glyphodon dunmalli.* An extremely rare species from south-eastern Queensland.
(v) *Glyphodon tristis.* A larger form from northern Queensland.

In summary, this paper follows Cogger's (1979) taxonomy and nomenclature except that I recognize an additional species, the "northern *Furina*." This species *may* prove to be conspecific with either *F. diadema* or *G. barnardi*; until the problem has been resolved it seems best to treat the "northern *Furina*" as a separate species.

Data were obtained from examination of 472 snakes in the collections of the Australian Museum and the Queensland Museum. Each specimen was measured and snout-vent length (SVL) recorded. Then a midventral incision was made to enable examination of gonads and stomach contents. Procedures have been described previously (e.g. Shine, 1980a, b).

RESULTS

(i) *Body sizes.* The three *Glyphodon* species attain much larger body sizes than do the *Furina* (Table 1). No marked geographic variation in size is evident within the wide-ranging *F. diadema* (compare N.S.W. and Qld. specimens in Table 1). Females are much smaller than males in *Furina* species; sample sizes of *Glyphodon* species are too small to be useful in this respect.

(ii) *Food habits.* Seventy prey items were recorded from guts (Table 2). All items were scincid lizards, but a variety of species were found. Most prey items of *Glyphodon* were skinks of the genus *Sphenomorphus* (5 of 6 records), whereas *Furina* species more commonly prey on smaller diurnal skinks, especially of the genus *Lampropholis* (43 of 64 records). Feeding occurs year-round in *Furina diadema,* most commonly in the warmer months (Fig. 2).

(iii) *Reproduction.* Mode of reproduction could be established only for *Furina diadema.* Gravid females from both N.S.W. and Qld. contained oviducal eggs with thick shells, indicating oviparity. I presume that *Glyphodon* species are oviparous also, but proof is lacking.

Analysis of ovarian follicle sizes (Fig. 3) reveals a clear annual cycle in *Furina diadema.* Follicles are small for most of the year, vitellogenesis commences in early spring (Aug.–Sept.), and ovulation occurs in late spring or summer (Oct.–Feb.). The prolonged period over which preovulatory specimens may be found in Qld. *F. diadema* (Fig. 3 (b)) suggests that females in this warm-climate population may produce more than one clutch of eggs each year.

TABLE 1. Sample sizes, body sizes and sexual size dimorphism in adults of *Furina* and *Glyphodon.*

	Furina			*Glyphodon*		
	diadema N.S.W.	*diadema* Qld.	"northern *Furina*"	*barnardi*	*dunmalli*	*tristis*
Total sample size (N)	180	141	102	9	3	37
Adult males						
N	64	32	35	2	0	23
$\bar{x}$ SVL (cm)	24.7	23.9	29.1	28.8	—	60.9
S.E.	0.3	0.2	0.6	—	—	1.8
range	20.2–29.0	21.7–27.7	23.6–37.8	28.5–29.1	—	44.7–77.8
Adult females						
N	45	40	41	7	2	5
$\bar{x}$ SVL (cm)	28.1	26.0	36.5	44.0	52.9	58.4
S.E.	0.5	0.4	1.3	2.0	—	4.1
range	22.7–33.8	22.2–34.3	21.4–58.1	37.2–54.8	49.5–56.2	45.1–67.6
Ratio $\bar{x}$ $\frac{\delta}{\varphi}$ SVL	.88	.92	.80	.65	—	1.04

TABLE 2. Prey items from stomachs of *Furina* and *Glyphodon*.

Prey species	*Furina*			*Glyphodon*		
	diadema N.S.W.	*diadema* Qld.	"northern *Furina*"	*barnardi*	*dunmalli*	*tristis*
Carlia spp.			2			
Cryptoblepharus spp.			1			
Ctenotus spp.			4			
C. robustus		2				
Egernia striolata					1	
Lampropholis spp.	17	5	3			
L. delicata		13				
L. guichenoti	1	4				
Leiolopisma spp.	3					
Menetia spp.	1					
Sphenomorphus spp.				1		2
S. pardalis						1
S. tenuis						1
Unknown skinks	1	3	4			
Total	23	27	14	1	1	4

No such obvious seasonal pattern can be detected in the tropical "northern *Furina*" (Fig. 3 (c)). Large ovarian follicles are present during most of the year. Insufficient data are available to describe seasonal reproductive cycles in *Glyphodon*. A large female *G. tristis* had developing follicles (diameter 12 mm) in mid-August.

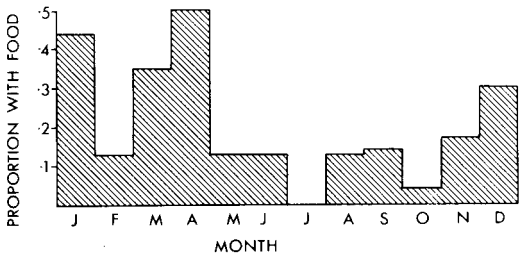

FIGURE 2. Seasonal variation in proportion of *Furina diadema* containing food items in the stomach.

Fecundity is low in *Furina*; an average clutch contains three or four eggs (Table 3). Fecundity in *F. diadema* is proportional to maternal body size (Table 3); $p < .05$ in both N.S.W. and Qld. populations. Fecundity is higher in *Glyphodon* (6–10 eggs) than in *Furina* (Table 3).

(iv) *Growth.* Seasonal distributions of body lengths reveal the growth pattern of N.S.W. *Furina diadema* (Fig. 4). Hatching occurs in late summer (Jan.–Feb.) at a SVL of approximately 12 cm. Growth is rapid, with most snakes attaining nearly 20 cm SVL at the end of their calendar year of birth. Hence, sexual maturity in both sexes is attained prior to the following spring (Fig. 4). I infer that female *F. diadema* first ovulate at an age of approximately 21 months.

The body size of the smallest individual measured, gives an estimate of the size at hatching. This estimate is 11.8 cm. SVL for N.S.W. *F. diadema,* 10.7 cm. for Qld. *F. diadema* and 12.1 cm. for "northern *Furina.*"

DISCUSSION

Published data on *Furina-Glyphodon* ecology are sparse, but generally are consistent with the results of the present study. Most authors have agreed that lizards are the major prey type (Ormsby, 1949; Worrell, 1963; Kinghorn, 1964; Gow, 1976; McPhee, 1979; Cogger, 1979). Several authors have erroneously attributed insectivory to *Furina* (Mitchell, 1961; Worrell, 1963; Gow, 1976; Cogger, 1979).

I cannot dispute Gow's (1976) comment that *Glyphodon* species eat geckoes as well as skinks; sample sizes in the present study are too low. However, it seems clear that *Furina*, at least,

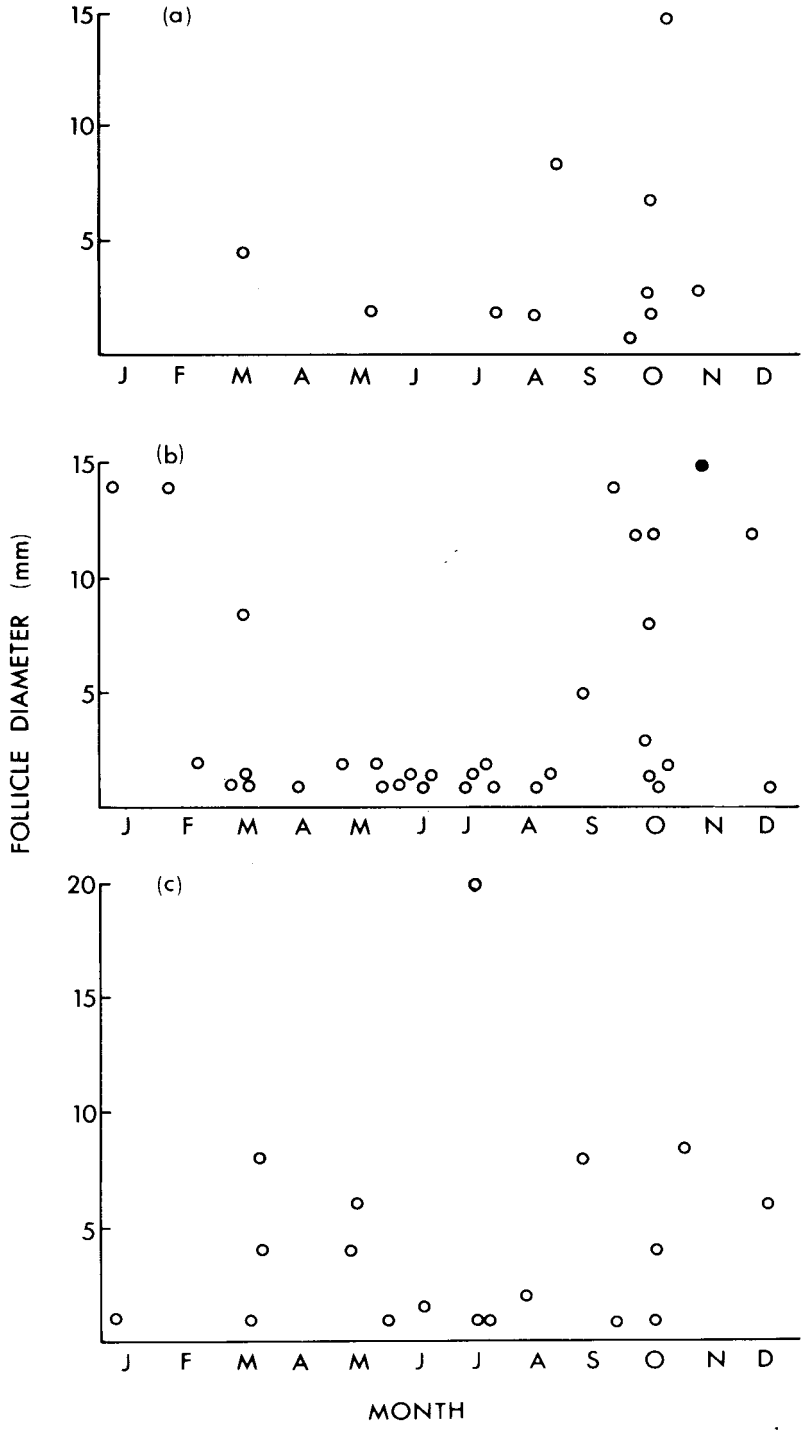

FIGURE 3. Seasonal variation in diameter of the largest ovarian follicle in adult females of *Furina* species (a) *F. diadema* from N.S.W.; (b) *F. diadema* from southeastern Qld.; (c) "northern *Furina*" from Northern Territory and northern Qld. Circles show ovarian follicles, dots show oviducal eggs.

TABLE 3. Fecundity of *Furina* and *Glyphodon*. Table gives values to solve the regression equation $y = ax + b$, where y is clutch size and x is snout-vent length (cm). N is sample size. All regressions significant at $p < .05$.

Species	N	a	b	Mean clutch size and range	r^2
Furina diadema N.S.W.	10	.24	−3.95	3.0 (2–5)	.39
Furina diadema Qld.	9	.19	−1.85	3.2 (1–5)	.42
"Northern *Furina*"	4	—	—	4.3 (3–6)	—
Glyphodon barnardi	3	—	—	8.3 (7–10)	—
G. tristis	1	—	—	6	—

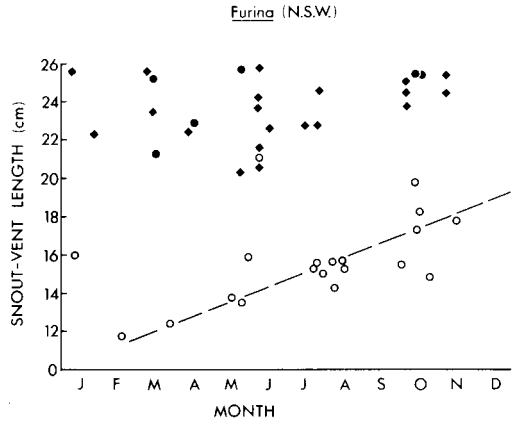

FIGURE 4. Seasonal distribution of body sizes in N.S.W. *Furina diadema*, with inferred growth rate. Circles show juvenile snakes, diamonds show mature males, dots show mature females. Inferred growth rate is shown by the dotted line.

specializes entirely on skinks (N = 64 prey items recorded). The apparent specialization of *Glyphodon* on *Sphenomorphus* deserves further study.

Clutch sizes previously reported for *Furina diadema* generally are overestimates (8 to 10 eggs: Gunther 1863; Gow, 1976; McPhee, 1979; *versus* 1 to 5 eggs recorded in present study). Overestimation of fecundity is a consistent feature of anecdotal reports on snake reproduction (Fitch, 1970).

The seasonal reproductive cycle in southern populations of *Furina diadema* (N.S.W. and southeastern Qld.) is similar to that of other elapid snakes in the same region (e.g. Shine 1977, 1980a, b, c, 1981). The apparently aseasonal reproduction in the tropical "northern *Furina*" is consistent with comments by Cogger (1967), and data on *Demansia* species (Shine, 1980c). Indeed, there are strong parallels between *Furina* and *Demansia*; in both cases, reproductive cycles of southern species are highly seasonal whereas those of tropical species are not.

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