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DIET AND REPRODUCTIVE BIOLOGY OF THE ROTTNEST ISLAND BOBTAIL, *TILIQUA RUGOSA KONOWI* (LACERTILIA, SCINCIDAE)

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ABSTRACT

Diet and reproduction in *Tiliqua rugosa konowi* were examined by dissection of museum specimens. *Tiliqua r. konowi* attains a smaller size than other races of *T. rugosa*. Adult males and females were similar in size. Reproduction was seasonal, both testis length and ovarian follicle diameter peaking in early Spring (September). One or two young were born in late summer (February). The diet included large quantities of both plant and animal material, as in other subspecies, and contained a high proportion of *Acanthocarpus preissii* seeds and piedish beetles (Tenebrionidae) in spring and summer.

INTRODUCTION

The occurrence of *Tiliqua rugosa* on Rottnest Island, 18km off the south-west coast of Western Australia, was first noted by Werner (1910) and Glauert (1929), although it was Mertens (1958) who described this insular population as a subspecies, *T. r. konowi*, on the basis of its smaller size and darker coloration than adjacent mainland populations. Although the subspecific status of this population has been accepted without question by several authors (Worrell, 1963; Storr, Smith and Johnstone, 1981; Cogger, 1983), nothing has been published on its natural history apart from observations on drinking following rain (Sadleir, 1958). Two named subspecies of *T. rugosa* occur on the mainland, *T. r. rugosa* west of Balladonia and Zanthus, Western Australia, and *T. r. asper* east of Caiguna and Rawlinna, Western Australia, with a third unnamed subspecies north of the Murchison River, Western Australia (Mertens, 1958; pers. obs.).

As part of a taxonomic revision of the genus, I examined all of the specimens of *T. r. konowi* (n = 63) in the collection of the Western Australian Museum (WAM), and took the opportunity to gather data on body size, reproduction and diet from this material.

MATERIALS AND METHODS

Snout-vent length was measured on all material. Specimens were sexed by gross examination of gonads through a single ventral midline incision over the abdomen. Diameter of largest ovarian follicle and testis length were measured, and a subjective estimate of testis condition made: 1. flattened, elongate and narrow; 2. laterally expanded but flaccid; 3. turgid. Minimum size at maturity was based on the smallest specimens with ovarian follicles $\geq$5mm or turgid testes $\geq$12.5mm long and opaque vasa deferentia, and all specimens greater than this size assumed to be mature. The stomach and colon were opened and any digesta removed for examination and sorting under a dissecting microscope.

RESULTS

The smaller size described for this subspecies by Mertens (1958) is a valid diagnostic character (adult SVL 201-260mm, $\bar{x}$ = 231.5, SD = 14.56, n = 55 *vs* 209-300mm, $\bar{x}$ = 252.4, SD = 19.32, n = 96 for *T. r. rugosa*; Mann-Whitney U test, z = 6.02, P<0.001). Mature males were similar in size to mature females (SVL ♂♂ 205-251 mm, $\bar{x}$ = 233.3, SD = 12.99, n = 23 *vs* ♀♀ 201-260mm, $\bar{x}$ = 230.2, SD = 15.72, n = 32; Mann-Whitney U test, z = 0.81, P>0.05). Gravid females (SVL 213-250mm, $\bar{x}$ = 232.8, SD = 11.14, n = 12) were not different in size to other females.

Tiliqua rugosa konowi, like other *Tiliqua* (Cogger, 1983; Shine, 1985), is viviparous, with litter sizes (based on enlarged yolking ovarian follicles $\geq$12mm, unshelled oviducal eggs or embryos) of 1-2 ($\bar{x}$ = 1.3, SD = 0.49, n = 12). There was no significant correlation between maternal SVL and litter size (r = 0.27, n = 12), nor was there a significant difference in SVL between females with one *vs* two young (Mann-Whitney U test, z = 0.81, P>0.05). Gravid females females had litters of one.

Female reproductive activity was strongly seasonal. Enlarged yolking ovarian follicles were present in females collected on 7 September (n = 2) and 1 November (n = 1), oviducal eggs were present on 22 January (n = 3), while well developed embryos were present in February (n = 2). Other females collected between January and early September (n = 16) had ovarian follicles ≤9mm in diameter, with the larger follicles occurring in the later months (Fig. 1).

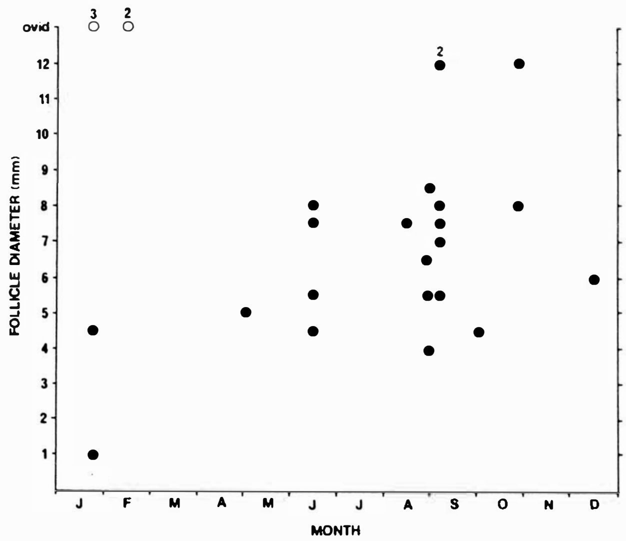

Fig. 1 Seasonal variation in diameter of largest ovarian follicle (dots) and presence of oviducal eggs (open circles) in *Tiliqua rugosa konowi*.

Male reproductive activity paralleled the female cycle. Males with laterally expanded turgid to flaccid testes were collected between 26 March and 23 November, testicular length increasing throughout this period, whereas most males collected in January had thin, narrow testes (Fig. 2).

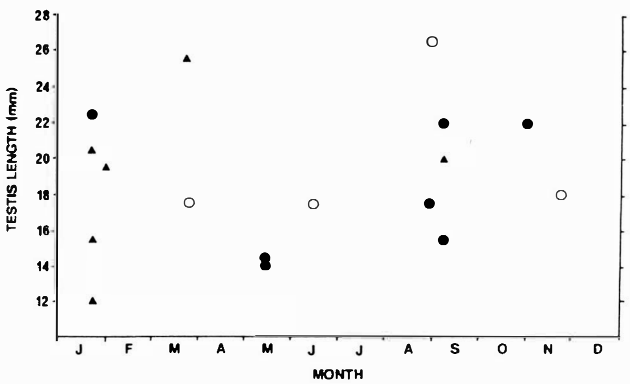

Fig. 2 Seasonal variation in testis length and condition in *Tiliqua rugosa konowi*. Condition categories used are flattened, elongate and narrow (triangles), laterally expanded but flaccid (open circles) and turgid (dots).

No food items were found in stomachs examined. However, the dilated colon usually contained large amounts of digesta. Of 49 colons with identifiable food items, 47 (96%) contained some plant material, this being by far the major component in 35 (71%). Seeds from the perennial herb *Acanthocarpus preissii* (Dasypogonaceae) were a major contributor to colon contents, occurring in 27 (55%) specimens. The presence of these seeds was seasonal, restricted primarily to the period October to March, when they were present in 15 of 20 (75%) colons. All 11 specimens collected 22 January 1958 contained *A. preissii* seeds, the number in the colon (not including rectum) varying from 9 to over 200. Other species of seed were also frequently present (11 of 49 cases; 22%). Non-seed plant material was mostly herbage, from both monocots and dicots, although small amounts of moss were present in four cases, and single small mushrooms in two cases. Herbage appeared to be poorly digested, with most leaf material entire and even whole new growth tips present.

The majority of identifiable animal material in colons consisted of piedish beetles (Tenebrionidae) of two species (60 small (length approximately 1cm) in 17 colons, 16 large (length approximately 1.5cm) in 9 colons) and snails. The presence of piedish beetles was strongly associated with *Acanthocarpus preissii* seeds, with only one colon having piedish beetles but no seeds. Snails and shell grit were present in 29 colons. In at least 10 of these, whole snails were present, while in the remaining cases, the grit may have been ingested as grit.

Other identifiable animal material included beetles of other species (17 specimens in 9 colons, including *Promecoderus* sp. (Carabidae), *Onthophagus duboulayi* (Scarabaeidae) and unidentified Melolonthinae (Scarabaeidae)), millipedes (Diplopoda) (4 in 4 colons), insect larvae, at least some lepidopterous (19 in 6 colons), roaches (6 in 6 colons), small amounts of arthropod fragments, including some crustacean and arachnid material (6 colons), and apparent carrion (3 mammalian caudal vertebrae in 2 colons, and a small tuft of hair with about 80 dipterous pupae in another). Some seasonal variation in the animal component of the diet was apparent, with insect larvae (mostly hairy caterpillars) only present in late autumn and winter, and piedish beetles only in summer.

Nematodes of several species were present in 35 of 49 colons (71%).

DISCUSSION

Timing of reproduction in *T. r. konowi* is similar to that in mainland *T. rugosa* populations (Bamford, 1980; Bourne, Stewart and Watson, 1986; Bourne, Taylor and Watson, 1986), and agrees with the common pattern of mid or late spring mating and summer or early autumn birth in viviparous squamates in temperate Australia (Shine, 1985). Litter size is similar to that of *T. r. rugosa* on the adjacent mainland (1-2, $\bar{x}$ = 1.35, n = 20, Bamford, 1980; 1-2, $\bar{x}$ = 1.56, n = 18, pers. obs.), although litter size in both subspecies is lower than in *T. r. asper* (1-3, $\bar{x}$ = 2.2, n = 9, Bull, 1987; $\bar{x}$ = 2.8, n = 6, Bourne, Stewart and Watson, 1986).

Although *T. rugosa* has been widely reported to be omnivorous (e.g., Worrell, 1963; Cogger, 1967, 1983; Bustard, 1970; Swanson, 1976; McPhee, 1979) there are few specific data on the diet of any population. Bamford (1980) examined the diet of two mainland populations of *T. rugosa*, representing both *T. r. rugosa* (Spectacle Swamp, W. A.) and *T. r. asper* (Eyre, W. A.). His results were broadly comparable with the present

	T. r. rugosa	*T. r. asper*	*T. r. konowi*
Weevils	17	35	<1
other Coleoptera	4	12	70
Hymenoptera	6	1	2
Ornithoptera	4	5	—
Blattodea/ Hemiptera	<1	4	5
Insect larvae	68	43	15
Diplopoda	1	—	3
Arachnida	—	—	2
Crustacea	—	—	2
Unidentified arthropods	—	—	2

TABLE 1: Numerical analysis of arthropod prey items in three subspecies of *T. rugosa*. Values are percentage of total number of arthropod prey items. Data for *T. r. rugosa* and *T. r. asper* from Bamford (1980), from gut contents and scat analysis respectively; data for *T. r. konowi* from present study.

study, although statistical comparisons are impossible due to the different methods of dietary analysis employed. As in the present study, plant material was the major component of the diet (in terms of wet weight), although seeds were only a minor dietary component in *T. r. rugosa*. The majority of animal material consisted of insects and snails, with insect larvae being most common in winter. However, the major insect prey in the two mainland populations were weevils (Table 1) compared with piedish beetles in *T. r. konowi*. It is not known whether this merely reflects prey availability. Anecdotal records of food items in mainland *T. rugosa* populations are also largely in agreement with these findings (Table 2), although suggesting a greater degree of herbivory.

The small adult size of *T. r. konowi* compared to mainland populations would appear to be of very recent origin, as Rottnest I was last isolated from the mainland only 7000 years ago by sea level changes (Abbott, 1978), and populations on the adjacent mainland coast and nearby Garden I (Robinson, Maryan and Browne-Cooper, 1987; WAM R89982, SVL = 263mm; WAM R89996, SVL = 280mm) do not appear to differ significantly from other populations of *T. r. rugosa* in adult size or morphology. Recent studies (Schwaner, 1985; Shine, 1987) have hypothesised that large and small adult body size in tiger snakes (*Notechis*) on other continental shelf islands of southern Australia relative to mainland populations is due to limitations in prey availability. However, given the wide dietary range and trend to herbivory in *T. rugosa*, and the relatively diverse vegetation and physiography of Rottnest I (Storr, 1962; Storr, Green and Churchill, 1959), this hypothesis does not appear to apply to *T. r. konowi*.

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Anon (1892)	*Styphelia* berries, fungus
Chapman and Dell (1980)	seeds, dragonfly, grasshopper (Acrididae), beetle (Carabidae: *Calosoma schayeri*), bugs
Cole (1930)	*Lycium ferocissimum* berries
Dell and Chapman (1979)	weevils, Acrididae, plant remains, old rabbit bones
Frauca (1966)	dandelions, other plant material
French (1901)	*Wahlenbergia gracilis* flowers
Frith (1962)	Mallee Fowl (*Leipoa ocellata*) egg
Keighery (1984)	*Astroloma macrocalyx* fruits
Longley (1944)	mushrooms
Loveridge (1934)	large weevil
Mattingley (1909)	*Arctotheca calendula* flowers
Meredith and Cann (1952)	succulent plants, yellow flowers (*Dodonaea*, *Arctotheca calendula*, dandelions)
Peters (1973)	yellow flowers
Satrawaha and Bull (1981)	snails (*Helicella virgata*), carrion, *Lycium ferocissimum* flowers and berries, beetles
Serventy (1970)	dried boletus-type fungus, dessicated carrion, *Arctotheca calendula* flowers
Shugg (1983)	*Patersonia* flowers
Simpson (1973)	small yellow flowers, *Pogona barbata* and rabbit carrion
Sullivan (1927)	roach, *Eucalyptus* leaves, flower buds
Tubb (1938)	*Myoporum insulare* and *Gasoul crystallinum* seeds
Turner and Doery (1981)	orchid flowers
Waite (1925)	*Leptomeria* berries, toadstools

TABLE 2: Literature records of specific food items for *T. rugosa*.

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