

Maturity and Other Reproductive Traits of the Kanahebi Lizard *Takydromus tachydromoides* (Sauria, Lacertidae) in Mito

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SUMMARY : Reproduction in females of the kanahebi lizard, *Takydromus tachydromoides*, was studied in Mito, Ibaraki Prefecture. Yearling females larger than 40mm SVL and not reproductive early in the reproductive season (April-May) might be judged to be mature because their largest unyolked follicles were the same size as those of reproductive females (1.3mm or larger). Most yearlings bred once or twice late in the reproductive season (June-July), and they had a mean clutch size of 3.0. Older females reproduced from April through July, and they had a mean clutch size of 4.2 for the first clutch and of 4.0 for the second and third. In this population the mean dry weight of oviducal eggs was 84mg, and the mean ratio of clutch weight to body weight was 0.729.

INTRODUCTION

Comparative studies on reproductive traits of lizards give clues for solving the problem of the evolution of their life histories. At first interspecific comparisons were made (Tinkle 1967, 1969; Tinkle et al. 1970), but later, precise comparisons among populations within a species or among congeners were given increasing importance (Ballinger 1979; Ferguson et al. 1980; Parker and Pianka 1975; Tinkle and Ballinger 1972; Tinkle et al. 1970; Tinkle and Hadley 1975; Vitt and Congdon 1978).

The female reproductive cycle and reproductive potential of the kanahebi lizard, *Takydromus tachydromoides* at Hanno, Saitama Prefecture, were reported by Telford (1969). However, some parameters of its reproduction have not yet been defined. For the purpose of defining the parameters useful for intraspecific comparison of reproductive traits of *T. tachydromoides*, I made an investigation on several of its reproductive traits, especially on size at maturity and ratio of clutch mass to maternal body.

MATERIALS AND METHODS

Collecting of female *T. tachydromoides* was carried out from March to October,

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1973 on a hillside in the northern part of Mito City, Ibaraki Prefecture, near the study site of Takenaka (1980). The lizards were dissected within a day or two after capture. The ovaries were removed and placed on the stage of a profile projector (OLYMPUS UP-350). Outlines of ovarian follicles magnified fifty times on the screen were traced on paper. Later, the area (S) of each follicle profile was calculated with a planimeter. Then the diameter (D) of each follicle was calculated by using the formula $D=2(S/3.14)^{0.5}$. Clutch size was estimated from the number of oviducal eggs and/or corpora lutea, or from the number of yolked follicles larger than 2.0 mm in diameter. By counting corpora albicantia, the number of breeding seasons the lizard had gone through could be estimated (Telford 1969). When a female had oviducal eggs, these eggs and the maternal body including head, limbs and a portion of the tail up to the fifth scale segment, and excluding the rest of the tail, the liver, fat bodies and stomach, were dried and weighed.

RESULTS

During this study 69 females were captured. In April, 6 females which measured 53–64 mm in snout–vent length (henceforth SVL) and had corpora albicantia were considered 2 or more years old (henceforth older adults), and 5 females measured 30–43 mm SVL and had no corpus albicantium were considered yearlings (hatched in the previous year). In like manner, 5 females with 52–57 mm SVL in May and 3 with 55–57 mm SVL in June were older adults, and 12 with 33–47 mm SVL in May and 13 with 39–53 mm SVL in June were yearlings. For the samples from July through

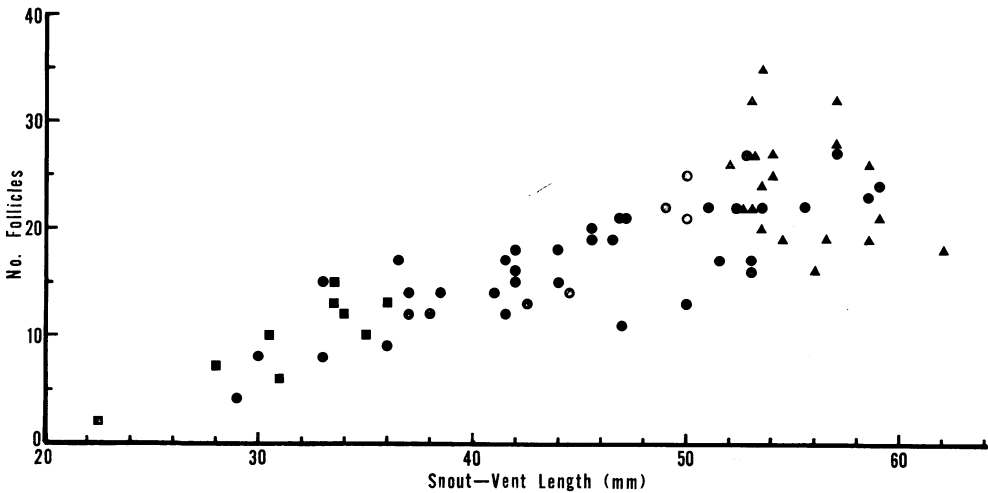


Fig. 1. Relationship of number of follicles to female SVL of *Takydromus tachydromoides*. Triangles=older females; circles=yearlings; squares=juveniles.

Table 1. Examples of size arrangement of follicles in individual females.

SVL of female (mm)	53		53		44		42		37	
Age of female	2		2		1		1		1	
Date of capture	13 May		13 May		10 June		13 May		13 May	
Size of yolked follicles (mm) (right, left)	4.5	4.6	3.8	3.7	3.4	3.3				
	4.4	4.5		3.6						
Size of UYFs (mm) (right, left)	1.5	1.4	1.4	1.5	1.5	1.4	1.5	1.4	1.2	1.2
	1.4	1.3	1.4	1.4	1.4	1.3	1.3	1.2	1.2	1.1
	1.2	1.2	1.2	1.3	1.2	1.1	1.0	1.0	.9	.9
	1.2	1.2	1.1	1.1	1.0	1.0	.9	.8	.9	.8
	1.1	1.1	1.0	1.1	.7	.8	.6	.6	.5	.4
	1.0	.9	.8	1.0	.5	.7	.6	.5	.5	.3
	.9	.9	.7	.8	.4	.5	.3	.3		
	.9	.8	.6	.7	.3	.3	.2	.2		
	.7	.7	.6	.5		.2				
	.7	.5	.3	.5						
	.4	.3	.3	.2						
	.4	.3	.2							
	.3	.2	.1							
	.1	.1								

October, 7 females with 9 or more corpora lutea and albicantia were arbitrarily classified as older adults, and 7 with from 2 to 8 corpora as yearlings. Nine juveniles hatched in the year (1973) were captured from August through October.

Older adults had 16 to 35 follicles, yearlings 4 to 27, and juveniles 2 to 15. The number of follicles was positively correlated with female size for yearlings ($r=0.81$) and for juveniles ($r=0.85$), whereas for older adults such a correlation was not found ($r=-0.34$, $P>0.05$) (Fig. 1). Follicles could be arranged in order of increasing size, and the arrangement of the right ovary was similar to that of the left ovary as shown in Table 1. Transparent and unyolked follicles (henceforth UYFs) gradually increased in size through the arrangement, but yolked follicles jumped in size and could be clearly distinguished from UYFs. All of the follicles smaller than 1.4 mm were transparent (unyolked) and all of the follicles larger than 1.7 mm were opaque or translucent (yolked). The maximum size of the UYFs of each reproductive female with yolked follicles or oviducal eggs was 1.3 mm or larger. It is conceivable that yolked follicles developed from UYFs somewhat larger than 1.3 mm.

Seasonal changes in the maximum size of UYFs in each female are shown in Figure 2. During the reproductive season (April–July) all the older females which were reproductive had UYFs larger than 1.2 mm. Yearlings smaller than 40 mm

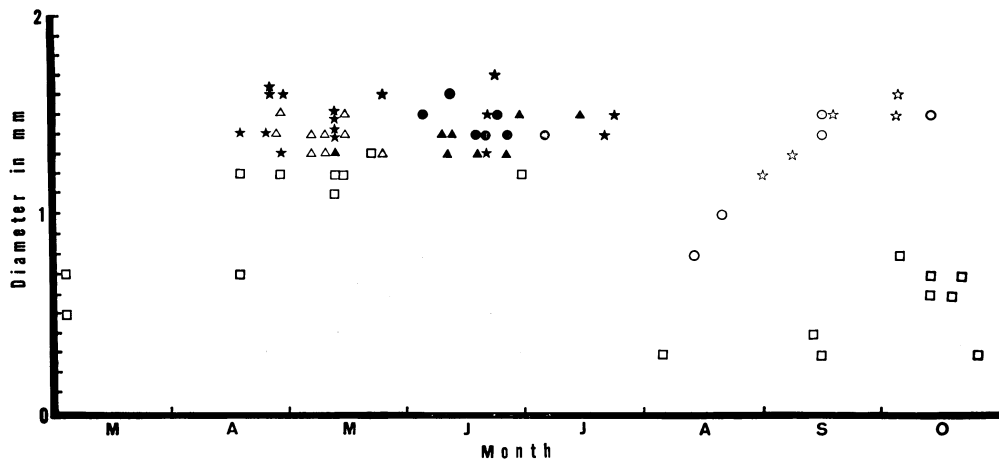


Fig. 2. Maximum size of unyolked follicles (UYFs) in females of *Takydromus tachydromoides*. Stars=older females ; circles=yearlings larger than 49mm SVL ; triangles=yearlings, 40-49mm SVL ; squares=females smaller than 40mm SVL. Closed symbols=reproductive ; open symbols=nonreproductive.

SVL only had follicles smaller than 1.3 mm, except for one having 1.3 mm follicles. All the yearlings smaller than 40 mm SVL were not reproductive. Most of the yearlings larger than 40 mm SVL also were not reproductive in April and May, but all the yearlings larger than 41 mm SVL were reproductive in June and July. During the reproductive season all the yearlings larger than 40 mm SVL had UYFs 1.3 mm or larger even early in the reproductive season (Fig. 2). Just after the reproductive season (August) the size of the largest UYFs declined (Fig. 2). By late September the largest UYFs had returned to the size of those in the reproductive season (Fig. 2). Juveniles had only UYFs smaller than 0.9 mm (Fig. 2).

Sixteen older females and 12 yearling females had yolked follicles larger than 2.0 mm, and 5 older females and 8 yearlings had oviducal eggs and/or corpora lutea. Older females had a mean clutch size ($\bar{x} \pm 1$ SD) of 4.2 ± 1.0 (range 3-7, $n=14$) for the first clutch and of 4.0 ± 0.5 (range 3-5, $n=8$) for the second and third. A third clutch was observed in one of the older females and its ovaries contained a set of large corpora lutea, another set of small corpora lutea, and yolked follicles. Yearling females had a mean clutch size of 3.0 ± 0.6 (range 2-4, $n=13$) for the first and 3.0 (range 3, $n=6$) for the second clutch. One of the yearling females had only a pair of corpora lutea of the first clutch just after the reproductive season. An older female, 2 years old, caught in early spring had only 2 small corpora lutea. From these 2 examples it seems that poorly grown yearling females oviposited once at Mito. No third clutch was observed in yearlings.

Older females captured during the reproductive season had 4-52 corpora albi-

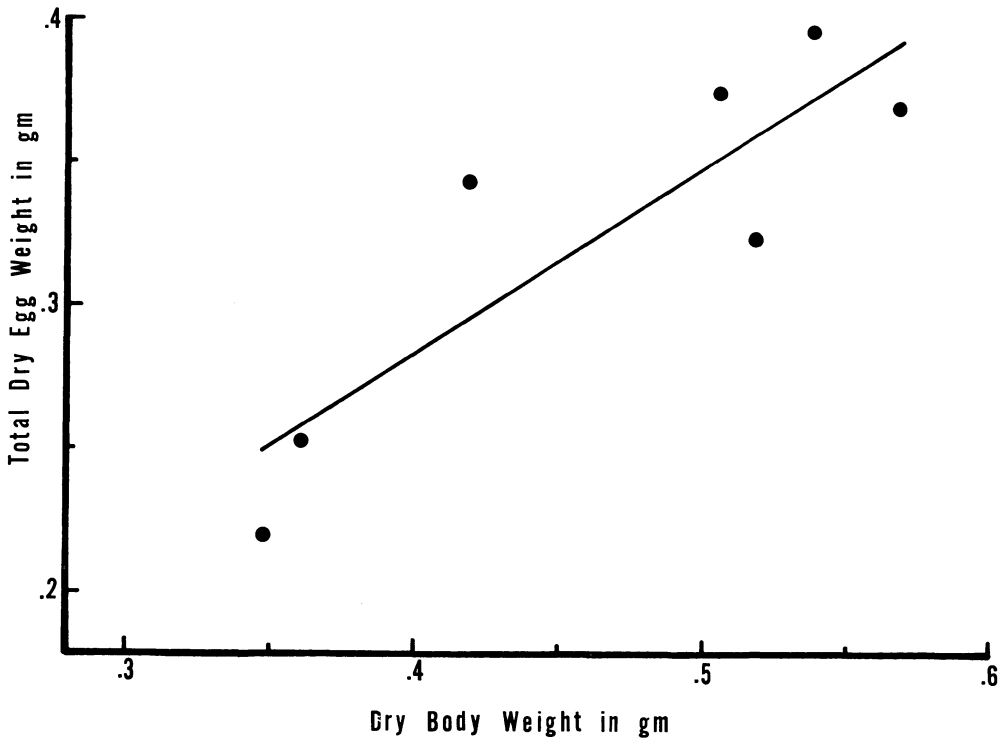


Fig. 3. Relationship of clutch weight to body weight in *Takydromus tachydromoides* ($r=0.87$; $Y=0.65X+0.02$).

cantia. Since older females could not always be aged precise population structure could not be known. During the reproductive season 33 yearling and 15 older females were captured, and the proportion of older females to the total sample was 31.3%.

The mean dry weight of the oviducal eggs of each clutch ranged from 73 to 94 mg and the overall mean was 84 ± 7 mg ($n=7$). The total dry weight of the clutch was positively correlated with the dry weight of the maternal body excluding the tail ($r=0.88$, Fig. 3). The mean ratio of clutch weight to body weight (RCB) was 0.729 ± 0.075 (range 0.641–0.849, $n=7$). The RCB was not correlated to body weight ($r=-0.07$). The mean ratio of clutch weight to body plus intact tail weight was 0.537 ± 0.045 (range 0.476–0.572, $n=4$).

DISCUSSION

Generally the size at maturity of female lizards is determined by minimum size of gravid females (Ballinger 1974, 1979; Gorman and Licht 1974; Parker and Pianka

1975; Tinkle 1961, 1976; Vinegar 1975; and others) and the age of maturity is determined by the age at first breeding (Ballinger 1974; Tinkle and Ballinger 1972; Vinegar 1975; and others). The time when a female commences to produce the initial brood does not necessarily coincide with the time when it attains the minimum size of gravid females (Ballinger 1977; Tinkle and Ballinger 1972). Such a discordance was also shown to exist in *T. tachydromoides* by this study. Yearlings larger than the size of the smallest reproductive females (42 mm SVL) had not yet developed yolked follicles in April and May when older females were reproductive. They were, however, judged to be ready to reproduce because the largest UYFs were the same size (1.3 mm or larger) as those of reproductive females. It seems that these yearling females were forced to wait to reproduce, and they persisted in directing energy to body growth (Takenaka 1980). Thus the attainment to the minimum size of reproductive females and the beginning of the first reproduction are similar but are two different things, so that an additional criterion for maturity should be set for the prereproductive females. Maximum size of UYFs may be a suitable criterion for this. All the yearlings larger than 40 mm SVL had UYFs 1.3 mm or larger, so that yearlings which measured 41–47 mm SVL in April and May may be judged to be mature despite the fact that most of them were nonreproductive. This consideration is necessary when studying lizard populations in which mature size is attained earlier than the first reproductive season, for otherwise the size of maturity will be overestimated. However, this can not be adopted in the period just after the reproductive season, for the largest UYFs of adults were smaller than those of reproductive females. A similar decline of maximum UYF size is found in the reproductive cycle of *Uta stansburiana stejnegeri* (Tinkle 1961). This may relate to a refractory period in the reproductive cycle (Tinkle and Irwin 1965).

The number of follicles in juvenile and yearling *T. tachydromoides* increased as the size of the lizard increased. This relationship between SVL and the number of follicles is almost the same as that of the Hanno population (Telford 1969). However, the number of follicles is not a suitable criterion for maturity in prereproductive females, because the number of follicles of immature females overlapped that of the females larger than the minimum size of reproductive females (Fig. 1).

I define the RCB of *T. tachydromoides* as total clutch weight divided by maternal cleared body weight excluding the tail beyond the fifth scale segment. As a good portion of adult *T. tachydromoides* possess a broken and regenerated tail (Fukada and Ishihara 1967), maternal weight including the tail is often unsuitable to use as the denominator of the RCB.

Vitt and Congdon (1978) suggested clutch-to-body ratios as indices for the relationship between clutch volume and body cavity. They used the total clutch

and body volume as the denominator of the clutch-to-body ratio (relative clutch mass) for comparisons with data in the literature which were applied to estimation of reproductive effort. For comparisons of relationships between clutch volume and body cavity (not between clutch energy and total energy budget), the RCB is more suitable than "relative clutch mass", because the RCB directly increases with clutch volume.

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要 約

水戸地域のカナヘビの成熟及び生殖特性

竹中 踐

カナヘビ *Takydromus tachydromoides* の雌の生殖について、茨城県水戸市において調査した。前年産の雌の中で頭胴長41mm以上のものは生殖期前期（4—5月）には生殖活動に入っていなかったが、生殖中の年長雌と同じ大きさの最大未発達濾胞を、どの個体も持っていたので、成熟していると判定した。前年産雌は生殖期後期（6—7月）に1, 2腹産卵すると考えられた。その平均一腹卵数は3.0であった。年長雌は4月から7月まで生殖活動にあり、3腹までの証拠が得られた。その平均一腹卵数は第一腹については4.2, 第2, 第3腹についてはまとめて4.0であった。また、7個体の雌から輸卵管内卵が得られ、その平均卵乾重は84mgであった。尾部, 肝臓, 胃腸, 脂肪体を除いた母体乾重に対する一腹の合計卵乾重の平均比率は0.729であった。