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Reproductive Ecology of Japanese Lacertid Lizards

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Abstract: Clutch size and other reproductive aspects of the Japanese lacertids, *Takydromus amurensis* and *Apeltonotus dorsalis*, were investigated. They were compared with those of the other Japanese oviparous lacertids, *T. tachydromoides* and *T. smaragdinus*. The clutch size and the clutch mass per mother mass correlated positively with the latitude, and the egg mass per mother mass negatively correlated with it. *T. amurensis* and *T. tachydromoides* were northern large-clutch layers, and *T. smaragdinus* and *A. dorsalis* were southern small-clutch layers.

Key Words: *Takydromus*; *Apeltonotus*; Japan; Lacertid lizards; Reproduction;

The reproductive ecology of a few species of Japanese lizards has been intensively investigated. However, that of many other species has been studied only little. The islands of Japan have a wide expansion north to south, and the latitudinal difference in climate should have affected reproductive characteristics of Japanese lizards. Comparisons of these reproductive characteristics between taxonomic groups, congeners or different populations of the same species in the Japanese lizards would give a clue to how each taxon makes reproductive adjustment to different seasonal environments and their constraints.

In this study, the reproduction of the two lacertid lizards, *Takydromus amurensis* and *Apeltonotus dorsalis*, which have not been investigated in Japan, is reported. Their data were compared with those of other Japanese oviparous lacertids, *Takydromus tachydromoides* and *T. smaragdinus*, and the relationship between their reproductive characteristics and geographical distributions is discussed.

The genus *Takydromus* is widely distributed from cold-temperate regions to the tropics in eastern Asia (Amur region to Indonesia). This latitudinal range is one of the largest among lizard genera. Thus, a comparative study of reproductive traits of lizards of the genus *Takydromus* and the allied genera, *Apeltonotus* and *Platyplacopus*, would offer an excellent example of reproductive adaptation. I hope this study will inspire studies on reproduction of other Asian lacertids.

MATERIALS AND METHODS

Specimens of *Takydromus amurensis* and *Apeltonotus dorsalis* were

Table 1. Sampling data of *T. amurensis* and *A. dorsalis*.

Species	Locality	Sampling period	N of captures	
			Females	Males
Takydromus amurensis	Northern part of Tsushima Island (lat. 34°37' N)	12–14 Jun 1977	3	1
		23–25 May 1979	1	1
		21–23 May 1980	2	2
Apeltonotus dorsalis	Iriomote Island (lat. 26°17' N)	22–25 Aug 1976	7	11
		28–31 Oct 1977	10	17
		30 Jun–3 Jul 1979	5	4

Table 2. Source of data of *T. tachydromoides* and *T. smaragdinus*.

Species	Locality	Source
Takydromus tachydromoides	Sapporo, Kaminokuni, Kanita, Tazawako, Kahoku, Mito, Tokyo, Sarushima Is., Kannami, Mori, Gamagouri, Kyoto, Mukaishima, Fukuoka, Miyazaki, Hayato, Yaku Is. (lat. 42°57'–30°23'N)	Takenaka (1981)
Takydromus smaragdinus	Southern part of Okinawa Island (lat. 26°10'N)	Takenaka (1981)

Table 3. Clutch data of *Takydromus amurensis* and *Apeltonotus dorsalis*.

Specimen No.	SVL of mother (mm)	Clutch size	Clutch mass (dry wt in mg)	Mean egg mass (dry wt in mg)	Clutch mass /Body mass
Takydromus tachydromoides					
001	78	6	594	99	0.51
002	74	6	694	116	0.73
Apeltonotus dorsalis					
062	68	1	130	130	0.14
063	64	1	153	153	0.19
064	65	2	302	151	0.34
068	63	2	305	153	–
080	67	1	152	152	0.18

collected from Tsushima Island and Iriomote Island, respectively. Collecting data of the two species and source of data of *Takydromus tachydromoides* and *T. smaragdinus* are shown in Tables 1 and 2.

Specimens were measured, weighed, killed in ethanol solution, fixed in FAA and preserved in ethanol solution. Then, they were dissected, and their

Table 4. Mean value of several reproductive aspects of the Japanese lacertids. Clutch size of *T. tachydromoides* and *T. smaragdinus* is of older females (2 or more years old); for *T. tachydromoides*, the extremes of 17 local populations are represented.

Species No.	Clutch size	Egg mass (mg)	Clutch mass (dry wt in mg)	Egg mass /Body Mass	Clutch mass /Body mass
T. amurensis	5.0	107	642	0.10	0.62
T. tachydromoides	2.9–5.1	82–135	282–635	0.11–0.20	0.42–0.64
T. smaragdinus	2.0	91	190	0.20	0.39
A. dorsalis	1.4	149	208	0.17	0.21

ovaries were observed. Presence of corpora albicantia and corpora lutea and their numbers were recorded. Yolked follicles and transparent follicles all were measured with a micrometer. Females with corpora albicantia were presumed to have laid eggs in the past, and those with yolked follicles or corpora lutea were regarded as gravid females. Oviductal eggs were dried in an oven and weighed. Maternal body mass (dry weight) of *T. amurensis* and *A. dorsalis*, was estimated with an equation obtained from the relationship between wet weight and dry weight of body of the two species, *T. tachydromoides* and *T. smaragdinus*.

Some gravid females of the four species were kept in captivity for a while. Eggs laid by them were weighed and incubated in wet sand at room temperature. Mothers were also weighed. Hatchlings were measured and weighed.

RESULTS AND DISCUSSION

Six females of *Takydromus amurensis* were collected in 3 trips in May and June (Table 1). Five *T. amurensis* specimens were gravid, and their SVLs were 64–78 mm. Another female, which was 43 mm SVL, was immature judging from her ovaries with only small transparent follicles. Two adults captured in May had 5 and 21 corpora albicantia, and 3 adults in June had 5, 7 and 53. SVLs of males captured on the same trips were 39, 44, 53 and 64 mm. It seems that medium-sized females larger than 43 mm and smaller than 64 mm were not captured by reason of their inconspicuous underground life. It is more probable that females with 5–7 corpora albicantia reproduced their first clutch in their 2nd spring–summer period when they were medium-sized.

Twenty-one females of *Apeltonotus dorsalis* were captured (Table 1). July and August samples contained gravid adults and non-reproductive young. Gravid adults were 63–68 mm SVL, and non-reproductive females were 39–54 mm SVL. Four of the five gravid adults had corpora albicantia. All specimens of the October sample were not reproductive, and only the largest female (66 mm SVL) had corpora albicantia. The other females were 38–60 mm SVL. It is probable that non-reproductive females in August and females having no corpora albicantia in October were individuals hatched in that year, but confirmation by mark-recapture method is needed.

Mean clutch size based on the number of corpora lutea or yolked follicles

Table 5. Clutch size of *Takydromus* lizards in the literature; numbers in parentheses are the number of records or sampling size.

Species	Locality	Clutch size	Source
T. amurensis	Maritime, USSR	7 (1)	Terent'ev et al. (1949)
	Liaoning, China	6 (2)	Ji et al. (1987)
T. tachydromoides	Kyoto, Japan	mean = 3.6, range 1–8 (275)	Ishihara (1964)
	Saitama, Japan	mean = 3.4, range 1–7 (332)	Telford (1969)
T. wolteri	Liaoning, China	mean = 5.45, range 4–9	Ji et al. (1987)
T. septentrionalis	Fukien, China	mean = 3.2, range 1–6 (23)	Pope (1929)
	Hanchow, China	2–6	Wang (1966)
	Soochow, China	mean = 3.5 (23)	Liu (1939)
T. hsuehshanensis	Mt. Hsiao-hsueh	2 (2)	Lin et al. (1981)
T. formosanus	Taipei, Taiwan	2–3	Liang et al. (1975)
T. stejnegeri	Taichung, Taiwan	mean = 2.2, range 1–4	Cheng (1987)
T. sexlineatus meridionalis	Hainan, China	5 (1)	Schmidt (1927)
	Futsing, China	1 (1), 2 (2)	Pope (1929)
T. sexlineatus	Malaysia	2 (5), 3 (1)	Kopstein (1938)
	Thailand	2–4	Taylor (1963)

was 5.1 ± 0.8 (1SD) for *T. amurensis* and 1.4 ± 0.5 for *A. dorsalis*. Two specimens of *T. amurensis* and 5 of *A, dorsalis* had oviductal eggs. Clutch data on them are shown in Table 3. *T. amurensis* had relatively larger clutch size, larger clutch mass, and smaller egg mass than *A. dorsalis*.

The mean values of each reproductive aspect of 4 Japanese lacertids are shown in Table 4. *T. tachydromoides* and *T. amurensis* were larger clutch layers, and *T. smaragdinus* and *A. dorsalis* were smaller clutch layers. Reports on the other *Takydromus* species' clutch size also show that there are larger clutch layers and smaller clutch layers, and northern species tend to be larger clutch layers (Table 5).

The egg mass of *A. dorsalis* was greater than that of the others. Clutch mass per body mass in northern species, *T. amurensis* and *T. tachydromoides*, was greater than in southern species, *T. smaragdinus* and *A. dorsalis* (Table 4). Southern species had rather greater egg mass per body mass than northern species (Table 4). However, the southern population of *T. tachydromoidis* on Yaku Island had relatively smaller mean clutch size, 2.9, and higher mean of egg mass per mother mass, 0.20 (Takenaka, 1981). For 20 population of 4 species, 17 *T. tachydromoides* populations and 3 of the other species, the clutch size positively correlated with the latitude ($r = 0.78$), the clutch mass per mother mass also positively correlated with it ($r = 0.67$), and the egg mass per mother mass negatively correlated with it ($r = -0.62$). There was no correlation between the egg mass and latitude ($r = -0.04$).

Data on eggs laid by females of 4 species and their hatchlings are shown in Table 6. For *T. tachydromoides*, gravid females from several localities were

Table 6. Data on egg laying and hatchlings of the Japanese lacertids.

Species (Locality)	Time of laying	N of mothers	Mean of sample: Mohter mass (g)	Clutch size	Egg mass (g)	Mass (g)	SVL (mm)	Tail (mm)
T. tachydromoides								
(Kaminokuni)	Jul 1979	5	3.9	4.0	0.35	0.39	27.8	52.5
(Ibid)	Jul 1980	10	4.1	3.4	0.36	0.42	26.8	50.6
(Tsukuba)	Jun 1982	3	3.3	4.7	0.22	0.26	24.7	–
(Tokyo)	Jul 1979	5	2.5	3.2	0.22	0.24	23.9	42.4
(Sarushima Is.)	Jul 1977	2	1.8	3.0	0.22	0.24	23.5	–
(Fukuoka)	May 1980	2	3.2	4.0	–	0.26	24.8	46.5
(Yaku Is.)	Jun 1979	3	–	2.0	–	0.29	24.2	43.0
T. amurensis								
(Tsushima Is.)	Jun 1977	1	4.2	4.0	0.31	0.33	25.5	50.5
(Ibid)	Jun 1979	1	4.8	4.0	0.27	0.31	23.0	40.0
T. smaragdinus								
(Okinawa Is.)	Jul 1979	1	2.3	2.0	0.31	0.24	24.0	59.0
(Ibid)	Apr 1987	6	1.8	1.7	0.21	0.21	25.9	58.3
A. dorsalis								
(Iriomote Is.)	Jul 1979	2	3.4	2.0	0.29	0.32	26.5	54.8

obtained. The local differences in egg and hatchling mass were in accordance with those obtained from the clutch data from preserved specimens (Takenaka, 1981). That is, females captured at a locality where large oviductal egg mass was recorded laid large eggs, from which large juveniles hatched.

Hatchlings were somewhat heavier than live eggs shortly after being laid. The average of the hatchling mass per egg mass was 1.16 (n = 26). This was the case with the examples of *T. amurensis* and *A. dorsalis*, but was not with the examples of *T. samaragdinus* (Table 6). However, the sample size is too little to say the species characteristics.

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Errata

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Table 3, in the table, line 3, replace the name "*Takydromus tachydromoides*" with "*Takydromus amurensis*".

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Table 4, in the table, the third column, replace the title "Egg mass (mg)" with "Egg mass (dry wt in mg)".

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Table 6, in the table, the 4th column, replace the word "Mohter" with "Mother", the 7th column, the title "Mass (g)" with "Hatchling mass (g)", the 8th column, the title "SVL (mm)" with "Hatchling SVL (mm)", and the 9th column, the title "Tail (mm)" with "Hatchling tail length (mm)"