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Study of Some Reproductive Traits in *Mabuya multifasciata* (Sauria: Scincidae) Regarding Sexual Dimorphism during 2013-2015

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The *Mabuya* skink is a widely distributed species in India as well as in North East India and China (Zhaao and Adler, 1995; Ngnyen et al., 2009). In fact the species *Mabuya multifasciata* is commonly found in the open region of villages, secondary forests of different humid regions and in the region with variable temperatures (Ngnyen *et al.* 2009; Li *et al.* 2010). Many reptiles lay eggs while *Mabuya* gives birth to live young. This is a unique feature in case of lizards and skink as for example *Mabuya multifasciata*. We studied the size of the eggs and the nutrients and its effect on the reproductive cycle. The male reproductive cycle was also studied.

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Keywords: Mabuya multifasciata; fat body cycle; reproductive cycle.

1. INTRODUCTION

Determination of reproductive cycle of a species is an important indicator of reproductive biology. Many skinks of tropical and temperate regions show spring and summer reproductive activity. Most of the viviparous species display a fall reproductive cycle (Guillette and Sullivan, 1985). Abdominal fat bodies exhibit a seasonal cycle in many temperate and tropical reptiles, and these cycles are indicative of the pattern of reproductive effort of a species (Derickson, 1976).

The present study is dealt with the study of ovulation of tiny eggs (2-3mm) and its effect on nutrients for embryonic development by placental means. The female and male reproductive anatomy and seasonal changes was studied. Gonadal cycle as for example oogenesis in lizard *Mabuya multifasciata* initiated during the late March- May.

2. MATERIALS AND METHODS

Sample collection and paraffin embedding: Adult male and female *Mabuya multifascita* were collected from the sample sites of Darrang District. A total of 60 specimens of *Mabuya multifasciata* were collected during January 2013- December 2014 with the help of collecting net. After collecting the specimen body measurements of all the individual specimens were recorded i.e. SVL (Snout vent length), total body length (TBL), tail length (TL) as well as other characteristics like body coloration.

The animals were killed and dissected to open the abdominal cavity. The animals were divided into three groups. One in the period of January-April, second group is from May-August and the third group is from September-December. All the external morphology and gross anatomical features were studied, photographs were taken using Canon digital camera. The reproductive organs like ovary, oviduct from gravid and non gravid females as well as extra embryonic membrane together with ovary, fat bodies, stomach, embryo were removed carefully along with the required structures of male animals and placed them in 10% formalin. One or two ova per female were removed and kept on paper for drying and weighing. Mass of fat body was recorded for approximating lipid cycling (Dessauer 1955; Gorman and Licht 1974). Samples were thoroughly washed in a phosphate buffered saline and rapidly immersed either 10% paraformaldehyde for at least three days or in Bouin's fixative for 30 minutes. The samples were dehydrated in an ascending graded ethanol series (70, 90,95 and 100 %) for 30 minutes each and then cleared in 3 changes of xylene for 24 hours. The cleared specimens were then embedded in melted paraffin wax.

Histological staining: The paraffin embedded specimens were sectioned at five µm thickness using microtome. Sections were deparaffinised and stained with hematoxylin and eosin for studying general morphology.

3. RESULTS

The studied skink emerged from hibernation in April. Courtship and mating behaviour was observed during May to July .Aggressive behaviour among males were observed during this period. Females with observable oviducal eggs were observed during July to August. The first live bearing female in captivity was observed during May. The skink went to hibernation from late October onwards.

Female reproduction, placentation, fat body cycling: Ovulation occurred during August to October. Ova were very minute (1-1.5 mm) in diameter and containing very little amount of yolk (x' dry mass= 3.5 mg). The dry mass of egg remains constant throughout the late of February but development started. The rapid growth phase began at February to May with the increase in embryonic dry mass occurring over the next three months. In early May, development was going towards completion, increased fetal size in gestation. In Fig. 1, the great increase in the size of embryos is shown by the data of wet mass of embryos throughout the development period. Parturition took place from late May through mid July. The females of all the mature size collected during May through November (except for those October females containing near-term embryos) had tiny oviductal ova. Thus it was seen that almost all the females reproduced nearly synchronously. But at any given time consideration variation in the development of their embryos were occurred. The incubation period was observed 72- 102 days.

Table 1. Percent of female *Mabuya multifasciata* in distinct reproductive states during different months

		Percent Occurence			
Months	**N**	**NVF**	**EVF**	**OE**	**PP**
April	10	100	0	0	0
May	13	90	6	0	0
June	25	55	45	0	0
July	20	12	32	27	33
August	15	0	9	32	63
September	16	0	0	0	100
October	10	0	0	0	100

N = Sample size; NVF = Non vitellogenic follicle, EVF = Enlarged vitellogenic follicle; OE = Oviducal egg; PP = Post parturient

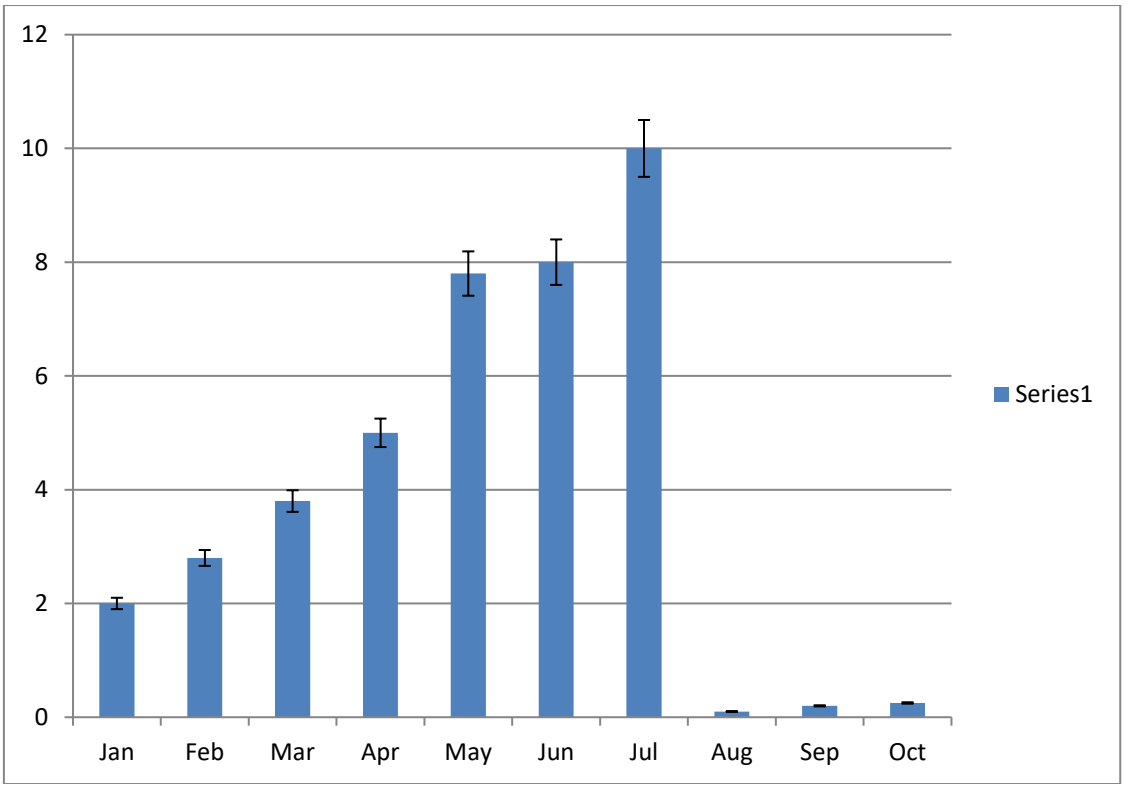

Fig. 1. Wet mass of preserved ova (oviductal) or embryos of *Mabuya multifasciata*. S.D. appeares over each figure

Reproductive cycle: Both diameter of epididymis and testicular volume increased with body size (testis: ln Y = -10.615, + 2.215 in SVL, N = 105, F = 70.709, P < 0.001; epididymis: ln Y: = - 6.150 + 1.502 In SVL, N= 105, F= 70.026, P < 0.001). The result varied significantly in both SVL adjusted testicular volume and diameter of the epididymis. (Testis: 12.867, df = 7, 94, P < 0.001; epididymis: F = 15.626, DF = 7, 94, P < 0.001).

The smallest size of female with near term embryo was 80- 85 (± 5) mm in SVL collected during late May-June. The average size of reproductive adult in SVL was 100± 5.284 mm.

Brood size 3-7 (S.D= ± 2, N= 33). It was correlated with SVL of female. Brood size is positively correlated with SVL size of female (r=0.98, F 1,31, p≤ 0.001).

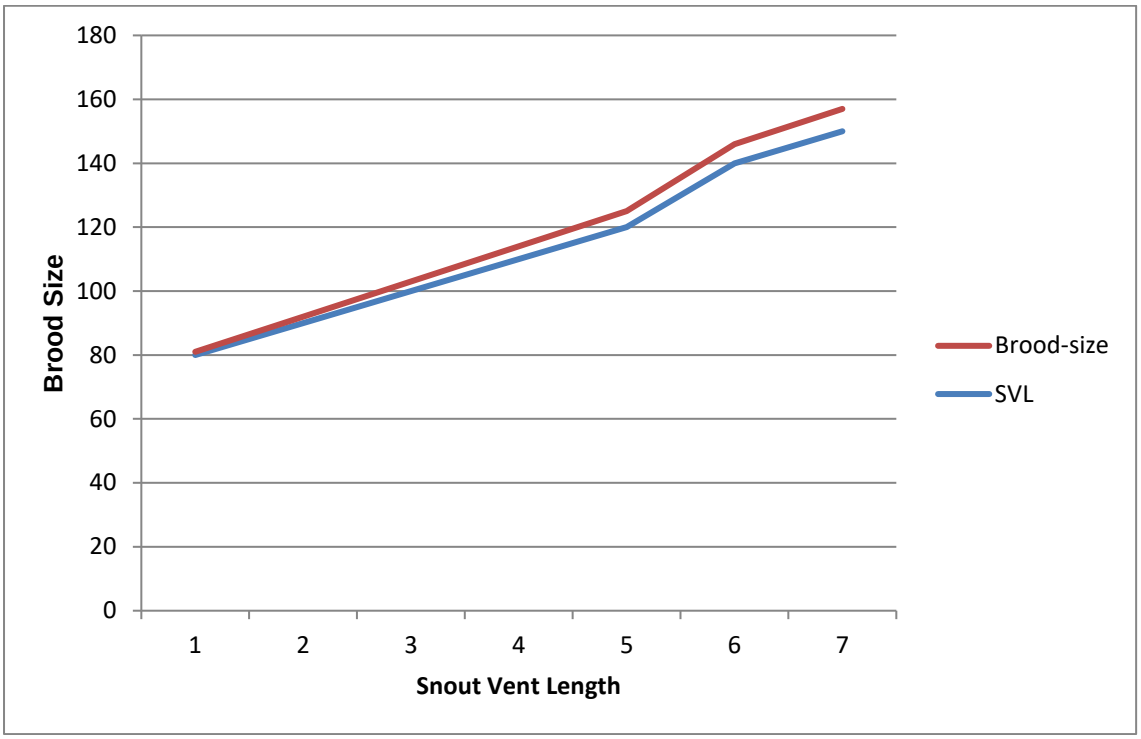

Fig 2. Relationship of brood size to female snout-vent-length in *Mabuya multifasciata* collected during February to May

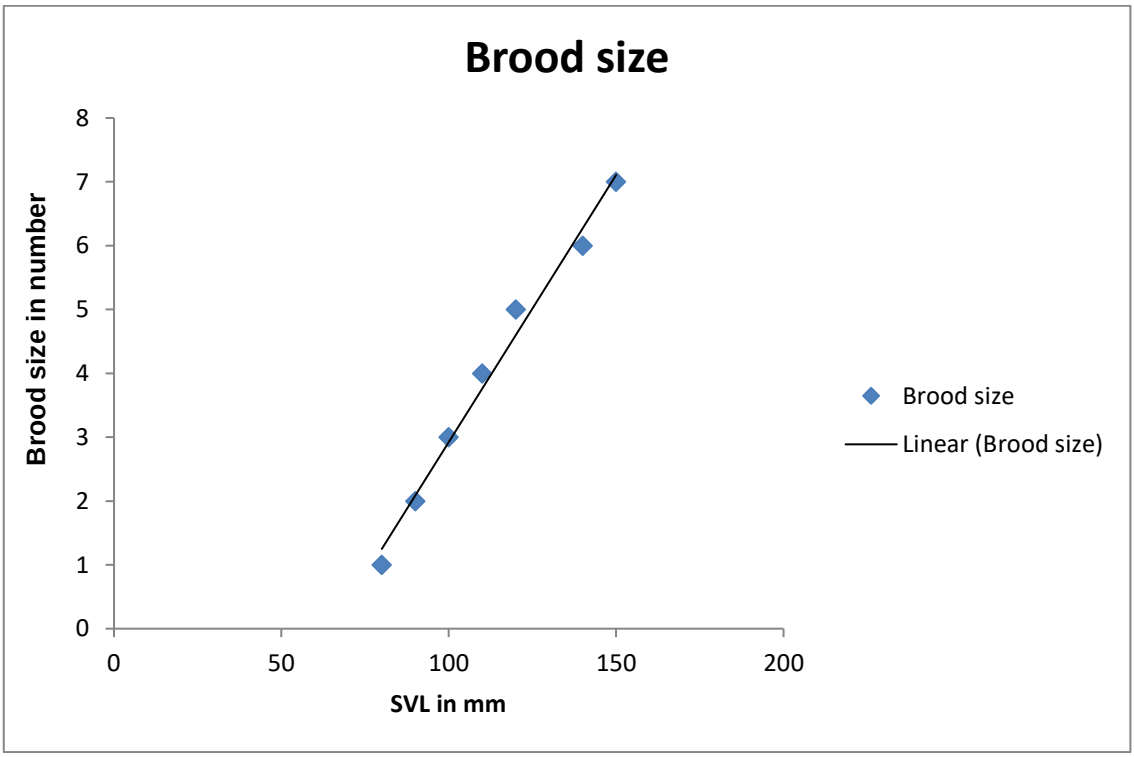

Fig. 3. Correlation of brood size and female SVL (in mm) (Pearson correlation) collected during February to May of *Mabuya multifasciata*. (N=105)

Seasonal cycle of fat bodies:

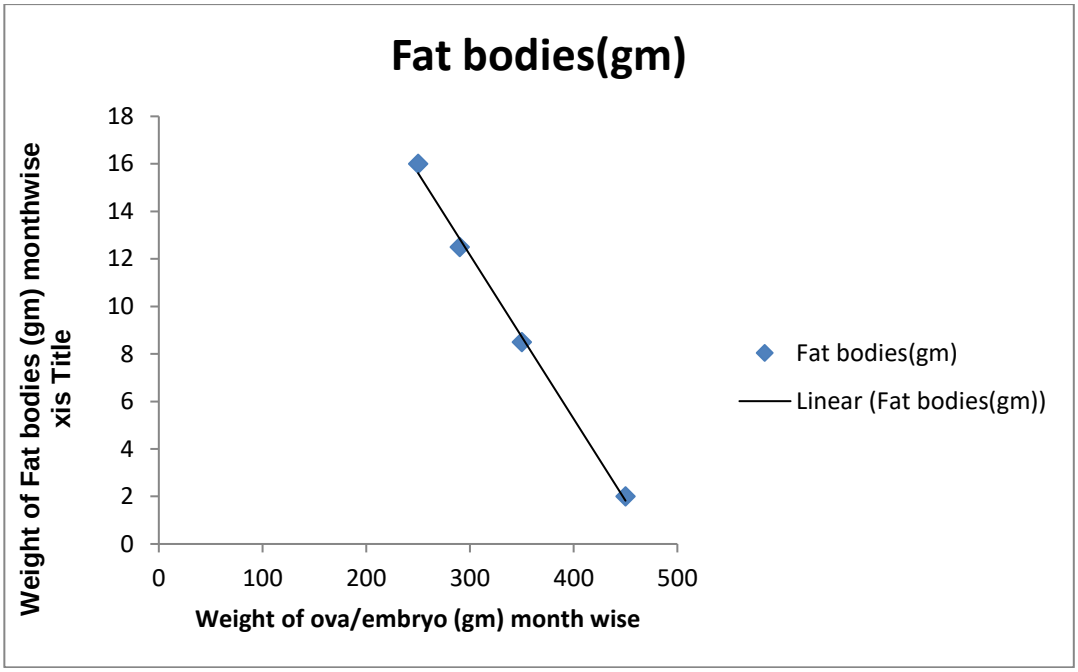

Fig. 4. Seasonal cycle of fat bodies adjusted for variation in wet weight of ova/embryo during the month of February-May of *Mabuya multifasciata*

Table 2. Month wise fat bodies and weight of ova/embryo in females of *M. multifasciata*, N=105

Month	Wet weight of ova/ embryo (gm)	Wet weight of fat bodies (gm)
Feb	250± 10	16±5
Mar	290± 10	12.5±5
Apr	250± 10	8.5±5
May	450± 10	2± 0.5

The fat body masses decreased rapidly in the female during the time of rapid embryonic growth. And again increased in size following the parturition. Both the embryonic growth and decreasing of fat bodies were negatively correlated ($F_{1, 31}=0.998$, $p \leq 0.0001$).

4. DISSCUSSION

Studies of sexual size dimorphism (SSD) common (Garcia et al. 2008). Lizards have served as important models for the evolution of sexual dimorphism (Valentin et al, 1993; Trivers 1976). It provides an ideal field to integrate broad phylogenetic patterns and genetics of sexual differentiation (Cox et al. 2009; Cox et al 2007; Cox 2005; Hews and Quinn 2003).

Mabuya multifasciata shows sexual size dimorphism. Here the female is larger than the male.Sexual size dimorphism is highly variable in lizards. Female sometimes having larger by upto 20% in some polychrotids (*Ploychrus*), skinks (*Mabuya)* and Pygopodis *(Aprasia).* Within most families variation in the direction and magnitude of SSD is typical within some genera (*Mabuya, Anolis, Lacerta, Sceloporus*) and in some geographically wide spread species (Cox et al. 2007; Cox et al. 2003; Fitch 1981, 1978). This is opposed to the previous report as adult males are larger in SVL than females (Yu DU, Yanyn SUN, Chixian LIN and Xiang JI; 2012).

The difference between the sexes have some selective advantages of body size and sexual dimorphism may be expressed other than body size (Trivers 1972). The important attribute to consider the interpretation of reproductive data is sexual dimorphism in reptiles. Selection pressure favours large body size or size of structures (ornamentation, heads etc) where the species involved in competition with males. In case of females larger body size is associated with clutch or brood size (Fitch 1978, 1981;

Trivers 1972, 1976; Vitt 1983), Fig. 2 and Fig. 3 and Table 2.

Comparative studies indicate that favourable condition towards SSD in lizards broadly reflects a balance between fecundity selection favouring large females with respect to body size.

(Olsson et al. 2010). In *Mabuya multifasciata*, the larger body size indicates capability of larger brood size. Associated with viviparity (Shine 2007). In Malaysia,the Scincid lizard *Mabuya multifasiata* having the brood size 3.8± 0.84 having the range of 3-5, n=5 (Ngo Dac Chung, 2015). The suit of reproductive characteristics of *Mabuya multifasciata,* the combination of viviparity,ovulation of tiny ova, nearly year long gestation period,rapid growth in females while carrying embryos,increase in wet mass upto 60000% of embryos from ovulation to parturition placed them in a different reproductive strategy than recognized by Tinkle et al. 1965. Females produce as 3-7 offspring per litter as opposed to the previous reported upto nine offsprings per litter (Yu DU, Yanyn SUN, Chixian LIN and Xiang JI; 2012). Most females gave birth between May to July (Table 1); earlier reported May –June (Ji et al., 2006) and March- August (LIN et al; 2012). Females In the present study having relatively larger value of SVL female producing heavier clutches. Earlier studies in some lizards like oriental Leaf-Toad Gecko *Hemidactylus bowringii* (Xu and Ji, 2007) where a negative correlation between cluctch mass and female size better explains female smaller SSD in the two oviparopus species, the energy allocation was preferable for production of offspring rather than growth of the offspring.

The present study found that parturition occurred during May-July. However previous study reported that no *Mabuya mabouya* were gravid from November to May in Peru. Its suggested that the reproductive characterisitics was very different in Peru (Dixon and Soini, 1975).

The recorded data shows that broods were produced in the onset of wet season or at the end of dry season. It effects on its food too. The relatively high resources were needed for the rapidly growing embryos (Janzen and Schoener, 1968). It was followed by the depletion of fat mass in the abdominal cavities of the female during the period of rapid growth of the embryo (Fig. 4 and Table 2). Abdominal fat bodies lying adjacent to the ovaries along with subcutaneous fat pads were also present as it is present in several species of squamates (Fox 1977, Licht 1984, Sarkar & Shivanadappa 1989). In this study female ovulated follicles of minimum 1.5 mm in diameter which develop into offspring measuring 240-250 mm SVL, Fig. 1 and Table 2. Earlier it was reported that female ovulate follicle of 2mm in diameter which developed into offspring having SVL 29-30mm (Somma and Brooks,1976). In time of parturition the most important fact is resources availability. In lizards fat bodies were recoded to serve as nutrient reserve during winter (Bhagyashri A Shanbhag, 2002). Earlier studies show that an inverse relationship were present between fat bodies and gonadal cycle of many species including Indian lizards *M. carinata* (Sarkar & Shivanandappa, 1989; Sharma & Shanbhag 1992). It was shown that a significant decrease in the fat body mass occurs during the breeding period. The fat bodies may play a crucial supportive role in reproduction mainly during the period of resource scaricity.

The data also confirms that maternal size has a significant role in reproduction in *Mabuya multifasciata*, with larger SVL female produced larger and more offsprings. So litter mass is most tightly related with female body mass.

5. CONCLUSION

In the conclusion we can say that *Mabuya multifasciata* is a sexually dimorphic species in body size and shape. The main values are greater mean SVL in female than the male, the greater head size in the female and also the wide abdominal size of the female.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

1. But for statistical analysis, we used statistical software as for example SPSS.
2. For the reference section we used Mendeley software.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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