Growth and demography of the Fan-throated Lizard *Sitana ponticeriana* (Sauria: Agamidae) from a tropical environment in India

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ABSTRACT - This growth and demographic study of the Fan-throated Lizard *Sitana ponticeriana* was conducted from 2001-2003 in a tropical environment at Balukhand-Konark Wildlife Sanctuary, Orissa, India. A total of 216 hours (9 hrs/day) of observation were made and 2612 (mean 217.66 ± 88.95) lizards were studied. The size structure between the demographic size classes such as juveniles, subadults and adults changed between the wet (rainy and winter) and dry (summer) seasons. Lizards exhibited a maximum 58-60 mm of SVL. Regression relationships were expressed as linear regression equations and revealed that males were slightly larger than females. Hatchlings were observed in the field between early July and mid-November. For three demographic size classes growth rates varied with season i.e., faster in wet season than dry season. There was no significant sexual dimorphism in growth rate. Lizards reached sexual maturity within a year. On average, the subadult and adult sex-ratio was close to 1:1; however, the data for each group indicated that there was greater abundance of males in the population during the dry than the wet season. Our results indicate that, like other lizard species, growth and demographic characteristics of *S. ponticeriana* populations fluctuate with the proximate seasons of a tropical environment in natural habitats.

THE biological specializations of reptiles are associated with body size and morphometric parameters that are a part of life history and demography of an organism. The information on size i.e., snout-vent length, tail length and total length of most agamid lizards is described by Smith (1935), Singh & Thapliyal (1962), Sharma (1982), Goel & Reddy (1983), Tiwari & Aurofilo (1990) and Pradhan (2000). Bhupati & Kannan (1997) reported some information on size, specifically snout-vent length and tail length of several agamid species. For agamids, the size/morphology of the lizard does not depend upon the sex, rather it depends on the age of the animal and the amount of food intake (Mahendra, 1935). There is also an evolutionary association between morphology and habitat use by lizards. For Phrynosomatid lizards, that are similar to Agamids in autecology, male and female lizards of 30 species have been shown to exhibit these associations (Herrel et al., 2001).

Early theoretical work by Cole (1954) and Lewontin (1965) established that the pattern of life history determines the dynamics of biological populations and that life history variables differ with respect to their influences on population dynamics. Subsequent theoretical and empirical works have extended this idea (Caswell & Hastings, 1980; Stearns, 1992; Dobson & Oli, 2001). Furthermore, theoretical studies dealing with the relative importance of life history variables to population growth rate have focused on the sensitivity of the finite rate of population growth to changes in various life history variables. Lemos-Espinal et al. (2003) demonstrated in seasonal tropics, that lizards experience seasonal variation in their proximate environment and seasonality can affect many aspects of a lizard's life history and demography. Population regulation underlies many ecological and evolutionary processes and thus serves as a central, unifying concept in ecology (Murdoch, 1994; Turchin, 1995, 1999; Sinclair, 1996). Dobson & Oli (2001) demonstrated that an understanding of demography is essential for discerning the factors or processes that underlie biological populations. This is because life history variables differ substantially in density-dependent responses (Sinclair, 1989, 1996; Leips et al., 2000; Coulson et al., 2001) and because populations are potentially influenced by dynamic behaviour (Cole, 1954; Saether & Bakke, 2000) and often influenced by demographic origin of density dependence (Neubert & Caswell, 2000).

There is substantial literature demonstrating that ingestion levels, below what is required to sustain maximum growth rate, appear to increase the probability of survival under laboratory conditions (Metcalfe & Monaghan, 2001). Such mechanisms could also be important factors in directing the evolution of life histories in natural populations, which has, until recently, been overlooked by evolutionary ecologists (Metcalfe & Monaghan, 2001). In some lizard populations diet breadth and composition, and abundance of prey items, in lizard stomachs are also affected by seasonality (Vitt, 1991; Christian et al., 1996; Griffiths & Christian, 1996; Pal et al., 2007). In addition, recent research demonstrated that growth rate can be increased or reduced by an individual organism depending on these seaonal environmental triggers. In the majority of lizards, the number of males is more than females in natural populations. Published work by Singh & Thapliyal (1962), Subba Rao (1974) and Koul & Duda (1977) reported variable sex ratio for several species of lizards; *Agama tuberculata*, *Lygosoma himalayanum*, *Calotes nemoricala* and *Calotes versicolor*. Pradhan's (2000) observations indicated that more males than females appear to be common in lizards present in different geographical areas of Orissa, India.

We present the results of a two-year study of growth and demographic variation in the Fan-throated Lizard *Sitana ponticeriana*, a species of agamid lizard that lives in sandy soils in Balukhand–Konark Wildlife Sanctuary, Orissa, India. Here we investigated whether growth was slower in the dry than in the wet season, and how population structure, such as size and sex ratio, changes with season in natural habitats.

METHODS AND MATERIALS

Censuses for *Sitana ponticeriana* were conducted on the Balukhand-Konark Wildlife Sanctuary (19º48' to 19º54'N, 85º52' to 86º 14'E), which is located in the District of Puri, Orissa, India. This Sanctuary is 71.7 km^2 and established on a sandy tract along the coast between Puri and Konark, bordered by vegetation. The boundaries of the Sanctuary include the Bay of Bengal on the east and villages on the west, north and south. There were scattered Tamarind (*Tamarindus indica*), Karanja (*Pongamia glabra*), Polanga (*Calophyllum inophyllum*), Neem (*Azadirachta indica*), *Eucalyptus* spp. and *Acacia* spp. trees on both sides of the sandy tract along the coast. The principal ground cover consisted of thickets of *Anacardium* spp. and *Casuarinas* spp. Understorey shrubs included *Pandanus* spp., Adhatoda (*Adhatoda vasica*) and various horticultural plantings, which provided refuges for lizards. Over the two years of our study period in this Sanctuary, we observed *S. ponticeriana* to be by far the most abundant lizard species, followed by in order of decreasing abundance *Calotes versicolor*, *Eutropis bibroni*, *E. macularia* and *Lygosoma punctata*. The mean maximum air temperature was 40ºC during summer (April-July) and mean minimum winter (November-January) temperature was 10ºC.

Sitana ponticeriana is found on sandy soft-soil throughout Puri but population densities are higher in coastal than in forested areas. It is the only member of the *Agama* that is abundant in the casuarinas plantation area, near the sea, especially in the Balukhand-Konark Wildlife Sanctuary (Pal et al., 2009b). The lizard's body is brown on the dorsum with a series of dark brown, black-margined, rhomboidal patches and vertebral spots on the back

(Shanbhag et al., 2003). They were observed to shelter at night in holes or cracks in the ground, or in bushes, and emerged out in the morning when direct sun rays fell upon the respective sites after sunrise (Pal et al., 2009b). There was daily variation in the timing of emergence and after the accomplishment of daily routine activities, lizards returned to their known shelters during evening hours when direct sunlight lessened on the activity sites (Pal et al., 2009b). The lizard eats primarily arthropods but occasionally consumes plants and small gastropods (Pal et al. 2007). In natural populations, the species becomes sexually mature within a year and minimal longevity in nature is around six years (Pal et al., 2009a). The biochemical aspects of the lizard species indicates higher amount of proteins and cholesterol in the blood serum of females than in males, and other biochemical blood parameters vary markedly from each other (Pal et al., 2008).

Surveys were conducted in various habitat patches in and around the wildlife sanctuary between 07:00 to 16:00 from October 2001 to September 2003. We carefully searched all habitat types in the sanctuary to eliminate potential bias of searching for lizards only where they were likely to be very common in their natural habitat. Focal observations were photographed from a distance of 3-5 m. Lizards were caught by hand or net, placed in a plastic jar, and snout-vent length (SVL) and tail length (TL) measured with digital calipers (Pal et al., 2009b). Time of capture and microhabitat use was recorded when lizards were first sighted/captured and the location of capture marked on a map of the study site. Lizard sex and age were classified using previously determined characteristics (Pal et al., 2007, 2008, 2009a). Lizards that were captured as hatchlings could be accurately aged based on their body size. All individuals were returned to their original place of capture within two hours. Care was taken to avoid sampling the same individual twice by visiting locations once per sample visit.

Growth rate was determined by calculating the change in SVL in each month over two years of our study period. We used a two-way ANCOVA to analyze growth rate with sex, season, and year as factors and mean SVL as a covariate. For the study of population age structure in natural habitat over two years and between seasons, we divided the population into three demographic size classes based on SVL; juveniles, subadults and adults. Size class juveniles included all individuals having SVL of < 25 mm, size class subadults had SVLs between 25 and 35 mm (likely individuals that were less than one year old but not reproductively mature), and size class adults included any individuals above 35 mm, and were most likely reproductively mature (Pal et al., 2009a). Gravid female lizards were also grouped with the adult size class. We analyzed population structure by using the proportion of individuals in each size class found in the monthly samples and treated these samples as statistically independent. To analyze the sex ratio in the population structure in natural habitat, we compared the mean of the proportions of males and females in the population for each sample to a 1:1 sex ratio using a T-test. Means are expressed ± 1 SD throughout.

RESULTS

A total of 2612 (217.66 ± 88.95) specimens of *S. ponticeriana* was sampled in 216 hours (9 hrs/day) during two study years. Maximum samples of juvenile, subadult and adult lizards in 2001-2002 and 2002-2003 were, 441 (36.75 ± 36.95), 390 (32.5 ± 32.21) and 405 (33.75 ± 36.65), and 422 (35.16 ± 3621), 477 (39.75 ± 15.09) and 477 (39.75 ± 14.48) respectively. Estimates of densities were made for the three different seasons for both study years. As shown in Fig. 1, the juvenile populations were dominant during the rainy season, declined in early winter and were totally absent in late summer months. Similarly, the subadult populations were smaller in rainy season, appeared to reach maximum densities in winter, over that of juveniles and adults, and were totally absent in late summer. Adult populations were present during all three seasons in the study area and maximum densities were observed in summer. As the peak breeding season was May through July, all the gravid females were sampled during these months (unpublished data). In each study year, population peaks were observed from July to November, followed by a steady decline in late winter. Minimum densities of lizards were observed in summer (Fig. 1). The variation in population size in the sanctuary over

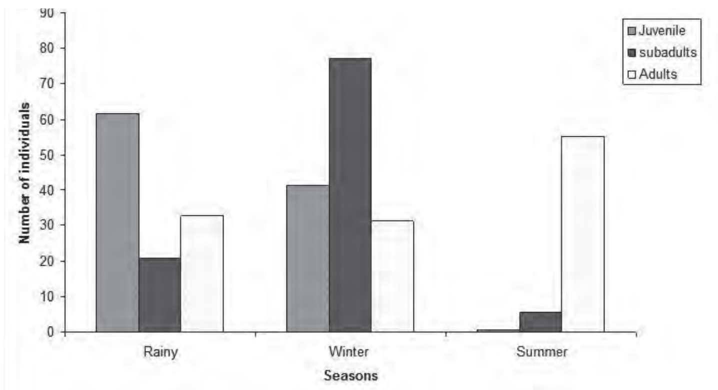

Figure 1. Mean ± 1SD distribution of three demographic size classes (juveniles, subadults and adults) of *Sitana ponticeriana* in three seasons from October 2001 to September 2003 at Balukhand–Konark Wildlife Sanctuary.

Year/Month	Sex	SVL Range (mm)	TL Range (mm)	TOL (mm) Range	Mean TOL (mm)	SD
October	J	22-27	46-60	68-93	77.5	+ 0.692
	M	28-49	70-91	107-140	123.5	+ 3.229
	F	28-45	55-63	90-108	93.5	+ 0.929
November	J	18-27	38-56	56-85	70.5	+ 1.024
	M	28-38	57-80	85-118	101.5	+ 1.016
	F	28-47	48-73	76-120	96.0	+ 2.521
December	J	17-27	26-60	43-87	65.0	+ 0.963
	M	28-53	58-91	86-144	113.0	+ 1.863
	F	28-47	40-90	68-139	103.5	+ 1.936
2002						
January	J	20-27	40-51	60-78	69.0	+ 0.976
	M	30-49	57-91	87-140	113.5	+ 1.383
	F	28-33	43-74	71-107	89.0	+ 0.806
February	J	27-28	56-57	83-85	84.0	+ 0.057
	M	28-45	60-97	88-142	115.0	+ 1.524
	F	28-37	66-74	94-111	102.5	+ 0.610
March	J	---------	---------	82	82.0	+ 00
	M	30-48	66-96	96-144	120.0	+ 2.370
	F	33.41	60-83	93-124	108.5	+ 0.912
April	J	---------	---------	---------	---------	+ 00
	M	43-51	102-108	145-159	152.0	+ 0.453
	F	34-43	80-97	114-140	127.0	+ 0.820
May	J	---------	---------	---------	---------	+ 00
	M	39.53	82.115	121-168	144.5	+ 1.065
	F	39.48	59.96	98-144	121.0	+ 0.523
June	J	---------	---------	---------	---------	+ 00
	M	38-54	84-104	122-158	140.0	+ 1.101
	F	43-47	58-94	128-141	134.5	+ 0.427
July	J	18-23	33-44	51-67	59.0	+ 0.614
	M	44-53	85-110	129-163	149.0	+ 1.002
	F	47-54	67-92	114-146	130.0	+ 1.042
August	J	15-27	32-56	47-83	65.0	+ 1.136
	M	28-49	64-109	92-158	125.0	+ 3.466
	F	28-48	52-90	80-128	104.0	+ 0.801
September	J	16-27	29-52	45-79	62.0	+ 0.723
	M	49-55	102-108	151-163	157.0	+ 1.131
	F	45-49	79-93	124-142	133.0	+ 2.683

Table 1. Body size data of *Sitana ponticeriana* collected from October 2001-September 2003 at Balukhand–Konark Wildlife Sanctuary. Continued overleaf.

Year/Month	Sex	SVL Range (mm)	TL Range (mm)	TOL (mm) Range	Mean TOL (mm)	SD
October	J	16-27	35-58	47-84	78.7	+ 0.472
	M	28-57	57-100	85-157	127.5	+ 3.631
	F	28-50	45-98	73-148	97.5	+ 0.899
November	J	21-27	38-59	61-85	73.8	+ 0.993
	M	28-42	59-88	86-130	105.4	+ 1.115
	F	28-47	59-80	87-127	98.0	+ 1.981
December	J	19-26	38-54	54-79	63.2	+ 1.103
	M	28-50	55-105	83-155	119.5	+ 1.906
	F	28-50	58-89	86-139	101.5	+ 2.021
2002						
January	J	23-27	41-58	57-85	69.0	+ 0.827
	M	28-45	48-95	76-142	113.5	+ 1.203
	F	28-35	49-72	78-109	89.0	+ 1.085
February	J	25-27	34-48	59-75	68.0	+ 0.121
	M	28-45	52-98	80-142	124.5	+ 1.394
	F	28-40	47-76	76-112	1042.0	+ 0.568
March	J	26-26	55-55	81-81	81.0	+ 00
	M	35-46	66-101	101-147	123.5	+ 2.571
	F	30-45	45-79	75-118	106.0	+ 1.210
April	J	0-0	0-0	0-0	00	+ 00
	M	40-51	85-106	127-157	145.5	+ 0.547
	F	38-43	76-83	116-128	123.5	+ 0.769
May	J	0-0	0-0	0-0	0	+ 00
	M	40-51	85-107	127-157	146.5	+ 1.214
	F	37-53	77-95	114-148	137.5	+ 0.653
June	J	0-0	0-0	0-0	0	+ 00
	M	43-56	90-119	133-175	157.0	+ 1.313
	F	50-53	90-95	140-150	144.5	+ 0.562
July	J	15-20	22-33	41-52	44.5	+ 0.784
	M	50-51	109-115	159-166	162.5	+ 1.322
	F	46-58	83-103	131-161	149.0	+ 0.978
August	J	16-27	25-60	42-81	68.0	+ 1.526
	M	28-60	54-102	82-175	132.5	+ 2.986
	F	28-55	56-89	84-140	118.5	+ 1.037
September	J	17-27	30-59	47-88	67.0	+ 0.893
	M	28-55	59-112	87-167	143.5	+ 1.287
	F	28-51	59-99	87-150	136.0	+ 2.385

the two years presented a similar pattern. As shown in Fig. 1, a large portion of individuals disappeared from the population before the first reproductive season, beginning in March.

The snout-vent length (SVL), tail length (TL) and total length (TOL) distribution frequencies in both sexes are presented in Fig. 2. As shown in Table 1, the cumulative data on size range of three demographic size classes were represented for the two study years. Male lizards ranged from 15-60 mm with a mean of 33.42 ± 10.31 mm and coefficient variation (CV) was 106.29. Similarly, the tail length ranged from 22-119 mm with a mean of 68.73 ± 22.53 mm and the CV was 508.01. The total length ranged from 41-175 mm with a mean ranged 102.07 ± 32.61 mm and CV was 1063.45. The SVL of females ranged from 15-58 mm with a mean of 30.45 ± 9.56 mm and CV was 91.41. The TL ranged from 25-103 mm with a mean of 60.53 ± 18.45 mm and CV was 340.56. The total length ranged from 38-161mm with a mean ranged 90.98 ± 27.55 mm and CV was 759.49. The regression curve of SVL, TL and TOL of both the sexes are shown in Fig. 3. This indicates that the males were slightly larger than females.

In natural habitat, hatchlings were observed between early July and mid November in both study years. There was sufficient data from lizards caught in the study area after hatching during the two years (July, August, September, October and November) to allocate some comparison of hatchling size. The smallest hatchlings were 15 mm SVL and mean size was 17.34 ± 0.67 mm (N = 102) (Table 1). Data on body size of hatchlings

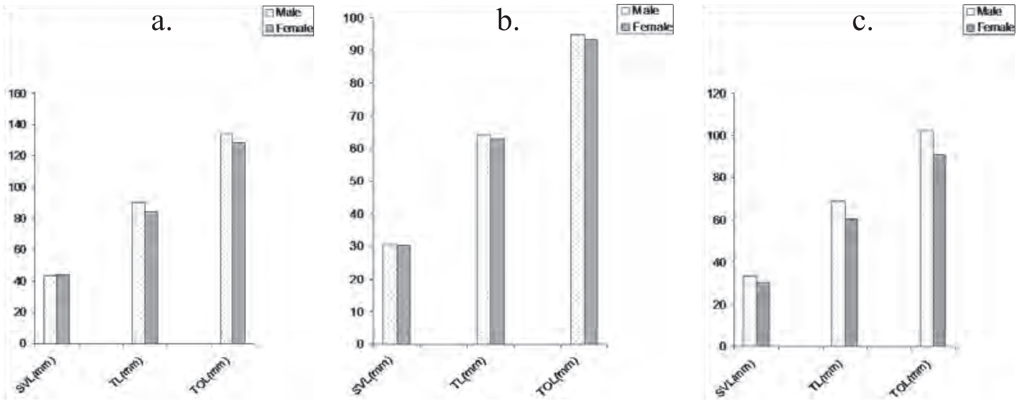

Figure 2. Histogram illustrating mean size distribution of snout-vent length (SVL), tail length (TL) and total length (TOL) of subadult males and females (a), adult males and females (b) and total males and females (c) of Sitana ponticeriana from October 2001 to September 2003 at Balukhand–Konark Wildlife Sanctuary.

was combined to test for differences in hatchling size among months. Hatchling SVL did not vary significantly among months (F = 0.562, P< 0.0001). Of the 102 hatchlings, 57 % (N = 58) were < 20 mm SVL, and had presumably hatched within a few days prior to capture in the study area, and 43 % (44) were 20-25 mm SVL, and presumably represented the early hatchlings. In the fall following hatching by early August, September and October they had reached an average of 23.68

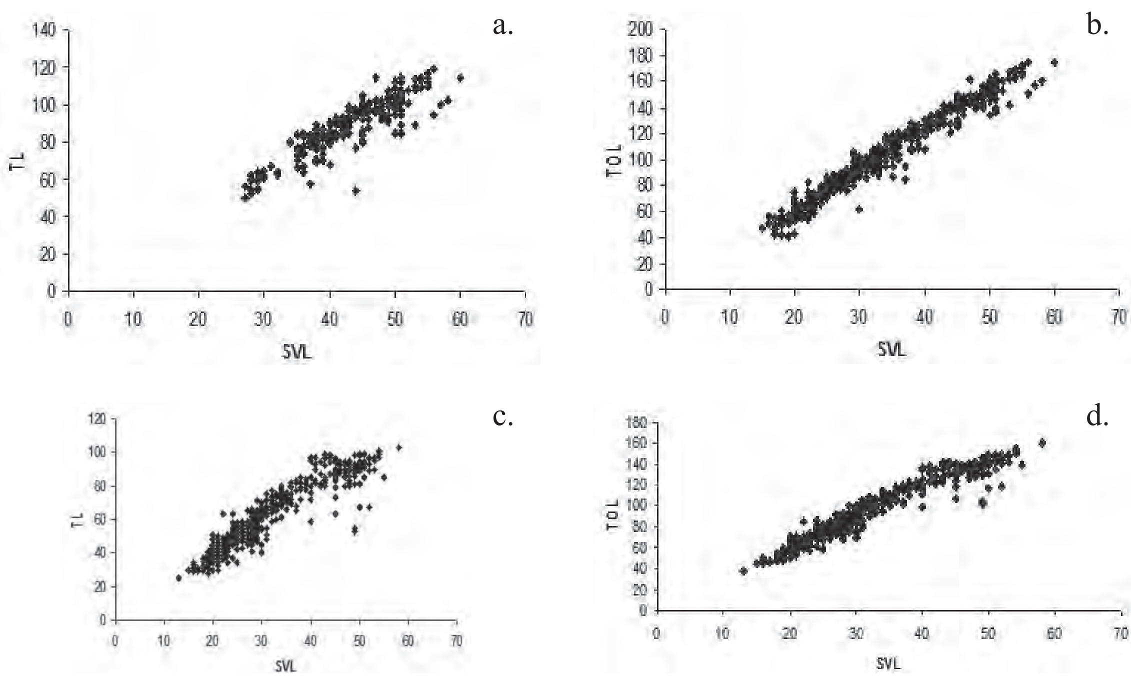

Figure 3. Regression curves of (a) tail length (TL) against snout-vent length (SVL) of total male, (b) total length (TOL) against snout-vent length (SVL) of total male (c) tail length (TL) against snout-vent length (SVL) of total female and (d) total length (TOL) against snout-vent length (SVL) of total female *Sitana ponticeriana* from October 2001 to September 2003 at Balukhand–Konark Wildlife Sanctuary.

± 0.83 mm SVL, indicating the growth rate was 0.147 mm SVL per day and an average rate of 0.106 mm/d. Within three seasons (i.e. rainy, winter and summer), juvenile, subadult and adult growth rates were calculated based on their SVL captured in the last week of each month. Two-way ANOVA was used to test for differences in average growth rates between the different seasons ($F = 7.94$, $P < 0.001$) as well as between subadult male and female ($F = 0.14$, $P > 0.5$). The only pair wise contrast was between rainy (0.232 mm/day), winter (0.197 mm/day) and summer (0.012 mm/day). During the rainy and winter seasons of both years, subadult males showed an average growth of 0.032 mm/day-0.029 mm/day, and subadult females 0.028 mm/day-0.025 mm/day respectively. Interestingly, growth rates of subadult lizards that were captured in early summer averaged 0.008 mm/d for males and 0.009 mm/d for females, indicating minimal growth rates during this sampling period. There was no significant difference between the growth rates of males and females of subadult and adults within the rainy, winter and summer sampling intervals (Kruskal-Wallis Test; all $P > 0.05$). Similarly, the growth rates of both mature adult males and females did not significantly change in wet and dry seasons over the two years (Kruskal-Wallis Tests; all $P < 0.05$).

Table 1 shows the size reached by yearling animals in the summer (March, April, May and June) of their first growing season at age 9 to 12 months. The maximum size reached by yearling females at the end of the reproductive season in their first growing season was 37 mm SVL and since the vast majority of females reproduce until they are at least 35-58 mm SVL our data suggests that yearling females have the possibility to reach sexual maturity. During summer months (April-Junne), and sometimes in the rainy season (July-October), sexually mature females had enlarged oviducts or large yellow-orange ovarian follicles. These females contained ova in early stages of vitellogenesis and the smallest female containing oviducal eggs was 37 mm SVL. The smallest sexually mature male and female were 35 and 38 mm SVL (Pal et al., 2009a). Thus, it it likely that animals mature within a year of birth.

For the analysis of age structure in natural population, the lizards were divided into demographic size groups (i.e. juveniles, subadults and adults) among animals handled in three different seasons (Fig. 1) in both study years. Snout-vent length was adjusted to rainy and winter periods using the average growth rates calculated for juveniles and subadult lizards. In both study years, monthly fluctuation in size structure was varied (Table 1). For the adult lizards, it was not possible to derive accurate data on age from their sizes recorded in natural habitats. Therefore, age structure of the adult lizards was derived from skeletochronology (Pal et al., 2009a) of aged individuals. As shown in Fig. 4, sex ratio (male: female) of *S. ponticeriana* was determined for the two study years. All the specimens sampled were grouped into three demographic size classes (juveniles, subadults, and adults). The minimum and maximum number of males was sampled during April ($N = 9$) and during September ($N = 46$) respectively. The minimum and the maximum number females sampled were 6 during April and 63 during September respectively. The minimum and maximum sex ratio (0.615:1 and 2.647:1) was obtained during April 2001 and August 2003 respectively. Sex ratio of *S. ponticeriana* was, in different months, represented by more females than males (Fig. 4). However, the cumulative sex ratio of all the adult males ($N = 591$) and adult females ($N = 604$) obtained over a period of 24 months was 0.978:1. Hence, the high sex ratio 2.647:1 obtained during August 2003 is attributed to sampling error. Among the few dissected juveniles (used for skeletochronology [Pal et al., 2009a]) the sex ratio was not significantly different from 1:1.

DISCUSSION

Populations of *Sitana ponticeriana* from the Balukhand–Konark Wildlife Sanctuary showed variation in life history traits and demography. As discussed in our previous publications, seasonal tropical environments potentially present organisms with demographic traits that vary both within months and among seasons. In our present study, populations of Fan-throated Lizards exhibited variation in growth and demographic traits between different seasons of our two year study period.

An important aspect of this study is the

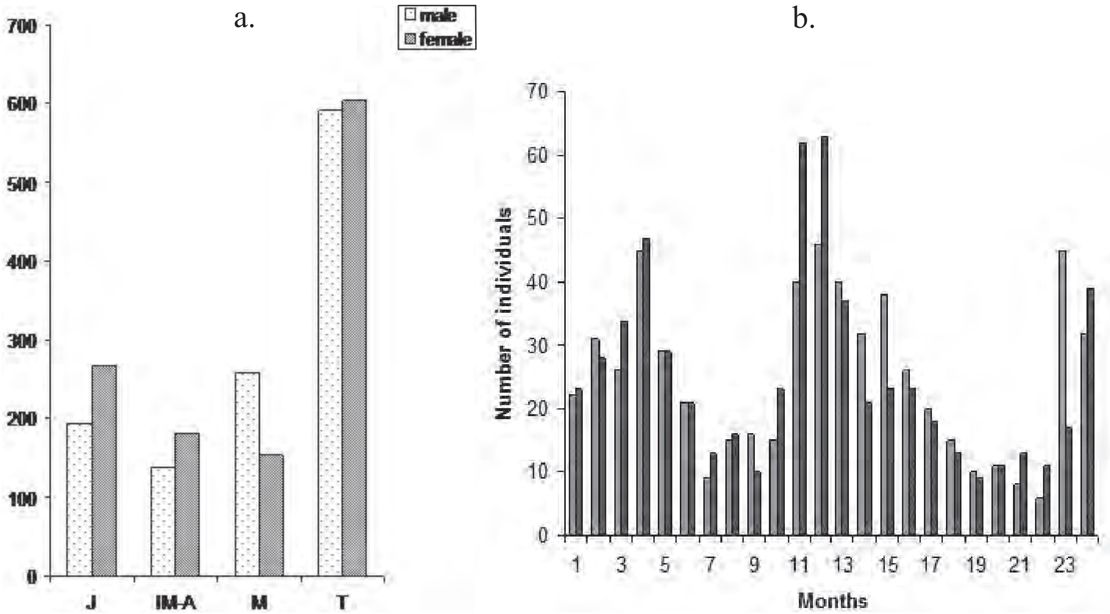

Figure 4. Histogram illustrating sex ratio of (a) demographic size classes i.e. juveniles (J), subadult (IM-A), mature adults (M) and total (T) and (b) in different months of *Sitana ponticeriana* from October 2001 to September 2003 at Balukhand–Konark Wildlife Sanctuary.

demonstration of high turnover of lizards during the wet season (wet and winter) and more or less stable population sizes over the complete two year period. The juvenile population dominated in abundance during the rainy season, whereas the subadults were dominant in abundance during the winter season. At the onset of summer neither juveniles nor subadult lizards appeared in their natural habitat, which reveals that the juveniles grow to be subadults during, and become, adult within one year. In comparison of the population density in three different seasons, the numbers of individuals were more in rainy and winter seasons than summer, possibly due to higher availability of food in their natural habitat (Pal et al., 2007). In India, there are several studies on size analysis of agamid lizards found in different geographical areas (Singh & Thapliyal, 1962; Tiwari & Aurofilio, 1990; Kastle et al., 1993; Bhupathy & Kannan, 1997). Regarding *S. ponticeriana*, Smith's (1935) report suggests larger physiology in Western India (Bombay) populations (SVL; 70-80 mm). On the other hand Bhupathy & Kannan (1997) reported only a maximum SVL of 46 mm. Similarly, Sharma's (1982) study of the species from Gujarat indicated SVL ranges of 21-51 mm. Pradhan (2000) reported maximum SVL of males which ranged from 30 to 53 mm and females that ranged from 37 to 58 mm in different geographical areas of Orissa, India. On the basis of our sample size, the SVL of mature male and female *S. ponticeriana* (including gravid females) was 60 and 58 mm respectively. This size range of *S. ponticeriana* is comparable to those reported by Sharma (1982), Bhupathy & Kannan (1997), and Pradhan (2000).

This study also examined the interactive effects of demography and weather on fitness components, and their effect on the growth rate of *Sitana ponticeriana*. Despite the large biological differences of the study species, the results revealed the same patterns as those reported for mammals and birds (Gaillard et al., 1989; Saether & Bakke, 2000), suggesting that these patterns may be general for most terrestrial vertebrates. The main finding is that growth rate of *S. ponticeriana* in its natural habitat is seasonally variable. Lizards grew faster during rainy and winter seasons than during the summer season in both study years. Interestingly, the arthropods in tropical habitats are often more abundant during the wet season (Vitt & Blackburn, 1991; Griffiths & Christian, 1996; Pal et al., 2007) and *S. ponticeriana* feeds primarily on insects (Pal et al. 2007). This factor may have been attributable to the variation.

Seasonal growth rates in lizards are not a new phenomenon and there are a few examples of other tropical lizard species that show seasonal variation in growth rates. Andrews & Wright (1994) reported that adding water to experimental plots increased the growth rates of *Anolis humilis* during the dry season; but that growth rate did not differ between the dry and wet seasons for control lizards. Similarly, *Chlamydosaurus kingii* from another seasonal tropical environment of Australia exhibits growth that is limited to the wet season (Griffiths & Christian, 1996). Vogel (1984) reported in a population of *Anolis lineatopus* that reduction in growth rates of juveniles during the dry season was attributed to lower arthropod abundances during the dry season. In addition, Rocha (1995) found a correlation between rainfall and growth in *Liolaemus lutzae* populations from the seasonal tropics of Brazil. In our study, male and female lizards grew at the same rate although males and females did differ in growth rate annually and seasonally. These results suggest that males and females of Fan-throated Lizards react to changes in their proximate environment in similar ways. In a population of *Tropidurusi tambere* from a Cerrado area of southeastern Brazil, Van Sluys (1998) demonstrated that male growth rates were affected by environmental conditions such as temperature and food availability, but that male growth rates were not. In the tropical sanctuary in this study, we noticed the growth pattern of both male and female *S. ponticeriana* to be comparable with other lizard species over the two years of our study period.

Age structure of the *S. ponticeriana* population also varied seasonally. During the recruitment period, from July to November, there was a predominance of juveniles that were not recorded from December onwards. These results reflect a similar pattern of seasonal reproduction in other lizard species (Wiederhecker et al., 2002). Early age of maturity was estimated at five months for *Tropidurus torquatus* (Squamata, Tropiduridae) (Pinto, 1999). The importance of juvenile recruitment for a population is basically due to the low permanence rates and the population's annual reproductive success (as shown in *Anolis limifrons* [Andrews, 1988]). The predominance of juveniles, at least in part of the year, is typical of species with short life cycles that result in a high annual turnover of individuals in a population (Barbault, 1976; Howland, 1992). Martori et al. (1998) reported, for *Liolaemus wiegmannii*, that size structure varied with season, which reflected recruitment and growth of the species. Similar seasonal fluctuations in population size structure were also observed in *L. lutzae* (Rocha, 1992) and *T. itambere* (Van Sluys, 2000). The main finding in the above studie was that variation in lizard survival was strongly affected by summer temperature and scarcity of food in their natural habitats. Many publications demonstrate that climatic variation often affects subsets of a population differently, and in such cases, its effect on population dynamics depends on the current demographic composition of the population (Leirs et al., 1997; Coulson et al., 2001). The results of our study suggest that survival of *S. ponticeriana* is more susceptible to harsh summer conditions than other fitness components.

For most lizards, the number of males is more than females in a natural population. Publications by Singh & Thapliyal (1962), Subba Rao (1974) and Koul & Duda (1977) reported variable sex ratio for several species of lizards viz. *Agama tuberculata*, *Lygosoma himalayanum*, *Calotes nemoricala* and *Calotes versicolor*. Pradhan's (2000) observations in different geographical areas of Orissa indicate that more males than females appears to be a common feature in lizards. Previous data regarding sex ratio of Fan-throated Lizards are rather sparse. This study reports the sex ratio of *S. ponticeriana* to have a slightly higher number of males to females and the mean density of those individuals to be lower than previously documented, suggesting that differences between the two sexes can result from higher competition among males in denser populations, which generates a female biased sex ratio. Another factor that may contribute to a proportional higher number of females in the population of *S. ponticeriana* was the greater size difference between established males and males at the onset of sexual maturity.

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