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Life history and reproductive ecology of sistrurus miliarius barbouri : the dusky pygmy rattlesnake in Long Pine Key, Everglades National Park

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ABSTRACT

The life history and reproductive ecology of the pygmy rattlesnake, Sistrurus miliarius barbouri was studied from January, 1984 to June, 1987 at Long Pine Key, Everglades National Park. This sample exhibits no sexual dimorphism except for relative tail lengths; mean adult size was about 47 cms. Females do however comprise the majority of the snakes over 50 cms. S.m.barbouri show no habitat preference between the four habitat types. They are active year round yet are clearly second half of the year snakes. The species activity peak is in October which marks the end of the wet season and the climax in water table level. In addition, gravid females are active in February and March. YOYs and juveniles also show a small peak of activity in May, the onset of the wet season. In the fall ovary length and egg size is small whereas the testis size is large suggesting mating in the fall. Eggs are yolked and enlarged in February and March but are still in the ovaries. Birth of the young occurs in July. Sperm retention is suggested. Mean hatchling size is larger than that cited by Klauber (1956). Growth rate in the first year of life is estimated to be approximately 82% Age at sexual maturity is estimated to be 3 years.

Florida International University

Life History and Reproductive Ecology of *Sistrurus miliarius barbouri*, the dusky pygmy rattlesnake, in Long Pine Key, Everglades National Park

By

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INTRODUCTION

Our knowledge of rattlesnake populations and ecology in general is limited. To discuss the ecology and populations of snakes, it is desirable to examine the habitats in which they are found, and the conditions that govern their lives and limit their spread. Klauber (1956) noted that rattlesnakes generally live in dry areas. One exception to that generalization is *Sistrurus miliarius barbouri*. *S.m.barbouri* ranges from southern South Carolina and southern Georgia, south throughout Florida and west across southern Alabama to southeastern Mississippi.

Studies on the rattlesnake genus *Sistrurus* seem to have been obscured in the light of the much larger genus *Crotalus*. This small and little known genus is made up of small to medium sized rattlesnakes ranging from southeastern Arizona to west New York and southern Ontario including the lower Mississippi Valley and Gulf Coast; they are also found in a small area at the southern tip of the Mexican Plateau. The two genera of rattlesnake differ primarily in head plate pattern and in hemipenal characteristics. *Sistrurus* is characterized by the top of head covered by nine plates and a gradual transition of spines and fringes on the hemipenes, whereas *Crotalus* has small scales on the top of the head and an abrupt transition between spines and fringes on the hemipenes.

Most of the studies on snake ecology are from the temperate zone or the tropics. Little is known about the ecology of snakes even all herps in a subtropical climate such as South Florida. The seasonal importance of rain is present in determining factors affecting the snake's life history. The subtropical temperatures and mild winters allow the snake to be active year round as opposed to hibernating like they do at higher latitudes. The main objectives of this study are to examine certain aspects of the life history and ecology of <u>S.m.barbouri</u> in Long Pine Key, Everglades National Park:

1. to describe the species morphology with emphasis on body size and sexual dimorphism,
2. to characterize the habitat utilization pattern for the species,
3. to detail the seasonal activity pattern and the factors that affect this pattern for the species in general and its component sex and age classes,
4. to describe the reproductive ecology of the species with emphasis on the link between activity and reproduction,
5. to estimate certain population parameters, such as growth and age at sexual maturity.

STUDY AREA

Long Pine Key is an 8000 ha portion of the Everglades National Park. This area is part of the original Atlantic Rock Ridge; most of which no longer exists due to the expansion of cities north of Long Pine Key. This rock land has a rough and irregular surface that is difficult to walk on. It is perforated with many solution holes and is crossed by several sloughs that before the drainage period carried an excess of water from the Everglades swamps to the coast.

The Everglades became a National Park in 1940. However before that time the area was not free from human disturbances such as logging of the pinelands, farming, and development of roads and canals. An area south of Long Pine Key was farmed until 1975 when the park service purchased the area. Since the disturbance, these prefarmed areas have established an exotic flora, the Brazilian Pepper. This area is locally known as hole-in-the-donut.

Long Pine Key is made up of four main habitat types. There are about 4650 ha of open canopy pinelands (Snyder, 1986). Besides the slash pine (locally known as Dade County Pine) which occupies practically all of the higher rock land, most of the plants of Dade County can be found in the pinelands. Dotting the pinelands are closed canopy tree islands termed tropical hardwood hammocks. They occur at a higher elevation usually one to one and a half feet above the surrounding pineland and three to four feet above the prairies. The hammocks range in size from a quarter of an acre to one hundred acres. The more characteristic trees in the hammocks are primarily tropical hardwood species. A series of seasonally flooded prairies lace the pinelands. They sharply contrast the vegetation of the pinelands and hammocks. The prairies support saw grass, willow heads, pond apple heads and other grasses. The last habitat type is termed hole-in-the-donut and is described above.

METHODS AND MATERIALS

Collection of snakes:

Two methods of collection were used in the study: trapping and road cruising. The traps consist of cylindrical funnel traps made of one-eighth inch hardware cloth about one meter in length and thirty centimeters in diameter. These funnel traps were placed at the ends of shade cloth which was thirty meters long, and one meter high. Twelve centimeter flaps were sewn on the bottom which were then covered with soil, rocks and leaf litter so that the snakes couldn't crawl under the fence. The two drift fences intersected perpendicularly to form an array similar to an "x".

The traps were placed in each of the four habitat types: three traps in prairies, three in pinelands, four in hardwood hammocks and 2 in hole-in-the-donut. The traps were checked regularly during the three and a half year study. They were checked about two to three times a week.

Besides the traps, the snakes were caught while running a transect of approximately six miles of improved road. This road, called "research road," was regurlarly cruised at varying hours throughout the study period to improve the chance of catching snakes. In the cooler months collection efforts are concentrated in the middle of the day, meanwhile, in the warmer months efforts shift to either early morning or late afternoon.

Marking and measurements:

All live S.m.barbouri collected have been marked using the method of Brown and Parker (1976). Each snake was sexed, weighed and snout-vent length and tail length was taken. Sex was determined by probing the cloacal opening for the presence of hemipenes or by manually forcing the hemipenes to evert. The sex for the young of the year was not determined due to the inaccuracy of this method in such small, immature snakes. The presence of enlarged eggs or developing young were evaluated by palpation. The snakes were then released at the collection site.

The road-killed snakes were all collected unless they were too destroyed. These snakes were also weighed and their snout-vent and tail length was measured. They were preserved in either 70% Ethanol or Formalin. The gonads' length and width were measured in mm using a TESA caliper accurate to .02 mm. The eggs were counted and their lengths were measured.

All summary statistics, graphs and word processing were produced by computer programs called STATS II and Symphony.

RESULTS AND DISCUSSION

Trapping Results

The trapping results include all *Sistrurus miliarius barbouri* captured in Long Pine Key, Everglades National Park from January 1984 through June 1987. During the three and a half year study, 212 snakes were collected either in the traps or on the road. Sixty-five dead specimens were collected on the road; only one dead snake was found in a trap. As mentioned in the Materials and Methods, these snakes were dissected for further information on reproductive effort. Because pygmy rattlesnakes are venomous a few snakes were not collected by research assistants: 10 of the 148 live snakes were neither measured nor sexed. Still these 10 snakes are important data in regards to the species annual activity patterns. The other 138 live snakes were marked, sexed, measured, weighed and released at the site of capture. As of June, 1987 no recaptures have been recorded. Due to *S.m.barbouri*'s small scales, it is possible that a marked snake might have been overlooked. However, it is probable that the population of pygmy rattlesnakes in the Everglades is so large that the chance of recapture is extremely low. Dalrymple (1986) suggests the lack of recaptures is not due to a lapse in the collection effort but is indeed a testimony to the difficulty in obtaining information on snake populations when they are not concentrated around a physical resource as is the case in the Long Pine Key.

Date of capture, snout-vent length, tail length, weight, habitat and sex are listed for the 212 snakes in Table 1. Five habitat types are specified, that is; road, low-land prairies, higher elevated pinelands, tropical hardwood hammocks and the disturbed habitats or hole-in-the-donut. Also six classifications for sex are designated in the table, more specifically, adult male and female, gravid female, juvenile male and female, and young of the year (YOY). The growth and sexual maturity section details the rationale for designating certain size snakes as an adult, juvenile or young of the year. The table is sorted by month and by snout-vent length. It may be referred to verify any summary statistics used thoughout the manuscript.

Morphology

Sistrurus miliarius is one of the smallest of all twenty-nine species of rattlesnakes. Of the three subspecies, *S.m.barbouri* is the largest with a standard adult length of 535 mm (Wright and Wright, 1979). The average adult snout-vent length and weight in the sample are 47.19 $\pm$ 5.22 cms and 78.03 $\pm$ 31.04 g, respectively. No sexual dimorphisms are found in snout-vent length, tail length and weight at a 95% confidence interval (Table 2). However, there was a sexual difference in relative tail length (TL/SVL): males have a larger relative tail length by confidence intervals ($p<.05$). Seigel (1986) also found no sexual differences in body size for *Sistrurus catenatus* in

Missouri except in relative tail length. Male rattlesnakes are generally larger than the females. In fact Klauber went so far to say that fully adult males exceed the females in length by about fifteen percent in all species except the sidewinder and that any report otherwise probably resulted from inadequate number of specimens.

Figure 1 shows the size frequency of 202 S.m.barbouri in Long Pine Key. A sample ranging from 16.3 to 61 cms snout-vent length is found. Over 40% of the snakes were under 30 cms, about 20% were between 30 and 40 cms, and another 40% were over 40 cms. The largest individual was a male which is consistent with the majority of rattlesnake's accounts in which a male is the largest specimen measured (Klauber 1956). As mentioned previously, no sexual dimorphism exist in body size, however, the percentage of females that attained a snout-vent length of over 50 cms was almost double that of males (Figure 2). There may be advantages for smaller males such as greater agility for movement as well as a lower energy requirement. Conversely Gibbons (1972) found that of the 20 heaviest and longest canebrake rattlesnakes, males were more numerous. He suggested larger size could be advantageous for predator discouragement or for aggresive male interactions. Male pygmy rattlesnakes are known to have a combat ritual (Carpenter 1979 and Lindsey 1979) yet no reference is made to a larger size being advantageous . There may also be reproductive advantages for females attaining a larger body size as suggested by Fitch (1970) and Diller (1984), that is, the larger females are more fecund.

Habitat

Pygmy rattlesnakes were found in all habitats of Long Pine Key. The majority of snakes were captured on the paved roads; only 31 snakes were caught in the traps (Table 3). For the trapped snakes, the lowland prairies and higher elevated pinelands are the preferred habitats with over 70% of snakes found there as opposed to the hammocks and disturbed habitats. However there is no significant difference among habitat propensities by contingency tables ($p>.05$). When the data is analyzed in relation to the time of year, no conclusions can be reached for three of the four habitats due to small sample size. However enough snakes were trapped in the prairies for observations to be made. Twelve of the thirteen snakes were caught from August to December. Only one snake was trapped in May. The prairies during the latter part of the year are extremely wet. The abundance of prey items (rodents, lizards and frogs) would encourage the snake to frequent the prairies. Furthermore, this abundance of S.m.barbouri in the prairies during the second part of the year is a reflection of the species' activity climax. Conversley to S.m.barbouri Reinert (1982) found a definate shift in habitat use for a population of Sistrurus catenatus in Pennsylvania. In the spring and fall the snakes frequented low, poorly drained habitats near the hibernaculum and in the summer the snakes prefered habitats with sparse vegetation and dry soil. Seigel (1986) also found a habitat shift in his study of S.catenatus: snakes are found in cordgrass prairies in spring and autumn and in drier, upland areas in the summer. To reiterate, Sistrurus miliarius barbouri in Long Pine Key is a habitat generalist: data show no preference for habitat. The Everglades is such a patchy environment that the pygmy rattlesnake chooses a non-specialized strategy for survival.

A definate sexual difference is found in both the traps and roads. Males are more prevelent in both the traps and roads: 70.0% in the traps and 33.7% on the road as opposed to females only 22.6% and 18.8%, respectively. Males are three times more commonly trapped than females suggesting that males move more frequently.

Activity

S.m.barbouri are found year round. However, the species increases in activity during the second half of the year (Figure 3). October is the peak month with over 24% of all animals collected. The number of pygmy rattlesnakes begins to increase in July, peaks in October, then declines sharply after the month of December. There are two small rises in activity centering around the months of March and May, followed by a decrease in June. This species activity pattern appears to be unique when compared to other rattlesnakes. Klauber (1956) notes that all rattlesnakes have a major peak in activity in the spring. He continues to say that only some species show a minor peak in the fall possibly caused by recruitment of young or foraging to accumulate fat reserves for hibernation. Klauber (1956) is making generalizations about rattlesnakes from observations of some western species and one study on massasaugas in Pennsylvania. Seigel (1986) found that _S.catenatus_ in Missouri were most active during April and May and sligthly less active in October. Seigel said that the decline of snakes during the period of July-September could reflect a slowing of activity, but is more likely the result of differences in habitat use, the lush vegetation during the summer and high air temperatures that impeded collecting efforts. Seigel neglects to examine other possible factors in the fluctuation of snakes numbers besides sampling bias. Moore (1978) noted two different activity patterns in _C.mitchelli_ and _C.cerastes_ in a field enclosure study in California. Both species were not active from December through March. _C.mitchelli_ was shown to have a gradual, single peak in hours of activity starting in April and peaking in September. For _C.cerastes_, maximum activity occurred in May and October, months in which competition from _C.mitchelli_ is at a minimum.

The pygmy rattlesnake is also unique in its activity pattern when compared to other species of snakes in the Everglades. Dalrymple (1986) notes that the general pattern for annual activity for most species in the region is one similar to temperate zones, with two peaks of activity, one in the early summer and the other in the late summer or early fall. Moreover, when Dalrymple evaluated <u>Sistrurus</u> via a cluster analysis in regards to to annual pattern of occurence, it showed no significant correlations with any other species.

In analysis of monthly flucuations of snake numbers, several parameters must be examined, most importantly, climate. Oliver (1947) outlined other various factors influencing the activity pattern of snakes: 1)aggregation of some species in the vicinity of hibernation dens (there is no period of hibernation in the Everglades), 2) mating activity, 3) basking during periods of near-minimal air temperatures, 4) variations in the amount of protective cover provided by vegetaion, 5) change from diurnal to crepuscular or nocturnal habits with an increase in diurnal temperatures, 6) seasonal variations in human activity, 7) oviposition, 8) appearance of the young of the year.

Most of the information addressing annual activity in snakes, in particular rattlesnakes, is from temperate zone animals. In these higher latitudes, where there are extreme fluctuations in temperature, snake activity is strongly influenced by monthly temperature. In contrast, there is only a slight variation in mean monthly temperature in the tropics, indicating that temperature is not the basic cause for the fluctuations. Rainfall appears to be the most important physical factor affecting variations in annual activity patterns. Rainfall problably affects the snake's activity indirectly by several means: 1) abundance of their prey, 2) amount of dry land, or 3) amount of protective cover furnished by vegetation (Oliver 1947). Few studies have been done in a subtropical climate such as southern Florida. As in the tropics, the change in monthly temperature in the sub-tropics is not great enough to alone explain the shifts in snake activty. Dalrymple (1986, Fig.3) noted that the total abundance of the snake community in Long Pine Key correlates signicantly to rainfall. However, he stresses the importance of narrowing the scope of community wide correlations since there are so many variables in an ecological study.

When compared to rainfall, the pygmy rattlesnake's activity pattern was shown not to correlate significantly ($p > .05$) (Figure 4). In fact, during the wettest months of the year (May, June, July), the numbers of Sistrurus are relatively low which give further credence to other factors aside from rain such as reproductive cycles as reasons for increased activity. The major peak in activity appears to echo the second peak of rainfall during late summer at the end of the wet season. As mentioned before, rainfall appears to have an indirect affect on activity. In Long Pine Key, the accumulation of water in the water table at the end of the wet season may be one reason for the increase in actitity. The peak of activity in March does not correlate at all with rainfall, whereas the peak in May correlates with the start of the wet season.

Sexual differences in annual activity are indeed apparent in the sample of pygmy rattlesnakes as shown in Figure 5. Adult males are most common in October (36.4%).

Their numbers begin to rise in August, peak in October, then decline. Very few adult males, 16.4%, are found from January to July. On the other hand, adult females have two periods in which they are most common; one in September, October (37.5%) and one during the early part of the year specifically, February and March (25.0%). Adult females are inactive during the months of June and July. Further scrutiny of the data reveals that all the adult females found between February and May were in advanced vitellogenesis either by palpation in the field or by dissection in the lab. This compares to the sample of Thamnophis radix and T.sirtalis that Reichenbach and Dalrymple (1986) studied in which gravid females were more active than both males and non-gravid females during the summer months. They attributed this increase in activity of gravid females to their added energetic needs during vitellogenesis and gestation, then just prior to parturition, the gravid females become sedentary. S.m.barbouri follow this pattern of increased activity during preovulatory vitellogenesis by gravid females, then in May, June and July, there is a drop off in activity. More evidence for this sedentary behavior in gravid females is shown by Reinert and Kodrich (1982) who noted that in a comparison of gravid vs. nongravid Sistrurus catenatus, a significantly shorter length of mean activity range for gravid snakes was revealed. No gravid females, early or late, were caught in the traps suggesting that even though they may be active they are not moving long distances. Gravid females are probably using the paved road to raise their body temperatures. Moreover, Keenlyne (1972, 1973) found sexual differences in feeding habits two species of rattlesnakes, *Crotalus horridus* and *Sistrurus catenatus*. Food items were found at a significantly higher rate in non-gravid than gravid females. Gravid female eat very little, if any thing at all, during the latter stages of gestation. In the case of the massasaugas, Keenlyne noted that the occurence of food items in gravid females was highest in the spring before advanced egg development. Studies of feeding behavior can provide some information as to the energetic flow and indirectly the activity fluctuations due to reproduction. Immediately following the birth of the young snake in July, the females again increase in activity.

For *Sistrurus* there is a narrow period of recruitment of young starting in July and August as seen in Figure 6. Young of the year activity peaks in October as does that of the adult males and females. Similar to the adult males the YOYs are only active during the second half of the year with 77% collected from July through November. Also noted is a small peak of activity at the onset of the wet season in May with 9% of young of the year collected. When juveniles are analyzed in regard to monthly fluctuations in numbers, again a peak is seen in October (Figure 7). The peak is only slightly higher than the other months from July to November. Eighty percent of all juveniles were collected during those months. No second year snakes were caught from January through March. Eleven percent of juvenile snakes were

collected in May, which compares to the small increase in young of the year activity during that same month. Gibbons (1987) suggests that juvenile snakes are not involved in activities associated with reproduction.
Reproduction is integrally linked with adult activity patterns. Gibbons goes on to suggest that juveniles may therefore have different activity patterns as a result of different selective pressures such as diet and predation. The activity pattern for juvenile males is similar to the adult males in that both peak in October, however, there is a second peak of activity for the juveniles. The activity pattern for juvenile females is very different than that for adult females (Figures 8 & 9). Both adult and juvenile females have a peak in September, October, yet the juveniles lack a second peak in activity in March, April, May. Adult females must obtain an energetic advantage by increasing their activity during early vitellogenesis either through an intermittent active foraging and basking in these mostly cool, dry months.

All sex classes of pygmy rattlesnakes have their major peak in activity in October. As mentioned previously, this peak follows the second increase in rainfall; this physical parameter may be a selective pressure that causes this single activity increase. Still, an important question may be raised as to why pygmys aren't common during the first and larger peak in rainfall during May, June and July when prey is very abundant. Two possible answers are presented. First, rattlesnakes are sit and wait predators. Gibbons

(1987) explains that except for reproductive activity or movements to and from hibernacula, activity is dominated by foraging in most species of snakes. However, for a sit and wait predator the level of activity as measured in movements should be low. Pygmy rattlesnakes should not show an increase in activity due to foraging when prey is abundant. Yet, when prey is not available and energetic cost of reproduction necessitate, early gravid females do show an increase in activity perhaps for foraging. Another reason for having greater activity at the end of the wet season rather than at the beginning is the probable increased level of the water table. This possibility has not yet been thoroughly investigated. I am suggesting that the water table level and not rainfall dictates the fluctuations in activity.

Reproduction is another factor for increased activity during the fall. Activty in both adult males and females peaks during the same period of time, which suggests mating activity. However. reproduction doesn't explain the juveniles activity pattern. Still, the juvenile activity pattern mainly reflects the species activity pattern. There are small peaks in activity for both juveniles and young of the year around May. I am not quite sure how important these little peaks are but it may suggest a different selective pressure in the ecology of these young Sistrurus. It is possible that juvenile pygmy rattlesnakes are not entirely sit and wait predators and are wide ranging foragers or they may have a different food source than adults due to their smaller size (Gibbons 1987). They may also be actively avoiding predators. YOYs increase in activity in October merely reflects the dispersal of hatchlings.

Activity and Reproduction

Reproductive cycles of snakes formidably affect their annual activity. I believe that in the mature pygmy rattlesnake population in Long Pine Key, it is the single most important factor influencing the monthly fluctuations in individuals. A model of how the annual activity pattern should reflect reproduction is outlined:

1) During mating, that is, when increased male and female activity coincide, the testis are enlarged where as the ovaries are small and preovulatory. This increase in activity due to mating is followed by a decline in activity by both adult males and females.

2) Females in early vitellogenesis increase in activity due to the extra energy required to yolk up eggs and provide fat reserves for the period of time when females become sedentary and do not eat or reduce feeding.

3) YOYs always occur at one time of the year.

4) YOY recruitment is followed by male and females mating.

Reproduction

Female Reproductive Cycle

The mean lengths of the ovaries from the right side of 8 females are compared to the adult female activity pattern in Figure 10. Eggs are small and in the ovary during the fall. Mean right ovary length from October to December is 30.5 $\pm$ 8.0 mm and the mean right egg length is 2.77 $\pm$ .59 mm. There are only three females collected during the early part of the year. Their right ovaries are hypertrophied and range in length from 40.64 to 80.24 and their mean right egg length is 15.80 $\pm$ 5.94 mm. Eggs are full of yolk and all were still preovulatory. No dead gravid females to date have been collected during the months of May to July. Such a specimen would provide evidence as to the timing of ovulation. Unlike the two earlier females, the one collected in April had white enlargements on the eggs (possibly corpora lutea) suggesting that ovulation should occur shortly. I suspect that vitellogenesis begins sometime around January or February since in December the eggs are still small and unyolked. Ovulation probably occurs in May since clutches are born beginning in early July through early August and females in April have not ovulated. The absence of females from late May to July suggests the low activity characteristic of gravid snakes close to parturition (Reinert 1982, Klauber 1956). Females found in the fall show evidence of giving birth, that is, distended oviducal walls. Renewed activity from September through November follows parturition. Females only have one clutch a year, evidenced by a single burst of YOYs in July and August.

Clutch size

Only one gravid female during the study was held until she gave birth to fourteen snakes on August 3, 1986. This female was caught on May 16, 1986 measuring 55.5 cm in snout-vent length and 205 g in weight and upon palpation appeared to have embryos in the oviducts. The baby snakes ranged in snout-vent length from 17.0 to 19.5 cms and in weight from 5.0 to 6.4 g with an average of 18.38 $\pm$ .37 cm and 5.53 $\pm$ .20 g respectivlely (Table 4). The average size of this clutch is bigger than that which is noted by Klauber (1956), that is, 17.0 cms. The larger baby snakes probably reflect the mother's conversion of energy obtained from a longer activity period; at higher latitudes, snakes are forced into hibernation during the cold months where as in the Everglades the snake community has an extra four to five months of activity.

Only three females were collected with large, yolked, ovarian eggs (Table 5). Increase in clutch size has no correlation with increase in snout-vent length ($p>.05$). Fitch 1970 noted that fecundity depends on body size in most reptiles. However, Gibbons (1972) found no correlation between body size and clutch size in canebrake rattlesnakes. Five females from the fall were collected with small follicles (Table 6). These females also showed no correlation between clutch size and snout-vent length ($p > .05$).

Male Reproductive Cycle

Twenty-four males were examined for reproductive effort (Table 7). Nineteen males were collected in September, October and November, three males in December, one in January and one in March. No significant difference exists between right and left testis size. Figure 11 shows the variance of right testis length with the activity fluctuations during the months of the year. The data is extremely biased toward the fall months since the activity of the snakes has peaked during those months. Although not many male S.m.barbouri are caught between January and August, there is enough data to see that average right testis length peaks in October along with activity. Thus in the fall, the testis are enlarged and spermiogenic and the seminiferous tubules are so enlarged that they could be detected through the capsule of the testis with the naked eye. Also the epididymidis appeared swollen when compared to snakes not caught in the fall. Activity peaks in the fall along with testis size, clearly indicates that mating occurs in this time period. Whereas testis from the spring have small seminiferous tubules and incomplete spermiogenesis. Other studies of reptilian species show this inverse relationship between male and female reproductive cycles; in Mauremys caspica maximum ovarian size coincides with minimum testicular size and during ovarian quiescence the testis show enlarged tubules (Fox 1977).

Birth

Young are born typically in July and early August. Birth occurs in the middle of the rainy season giving the newborn an environment favorable to their survival with plenty of food, and many months ahead of warm, wet weather before the cooler, drier months. If mating occurs in fall (e.g. October) and parturition occurs in the summer (e.g. July), there is a gap of seven months. Ovulation occurs some time after April probably in May. A period of sperm storage in the oviducts must be required. Sperm retention is common in reptiles. Table 8 shows varied lengths of sperm retention from some reptile species (Fox 1977). A similar prolonged survival of spermatozoa is documented for the skink *Hemiergis peronii* which only mates in the fall, although ovulation occurs in the spring (Smyth and Smith 1968). The role of sperm survival in the oviducts is that of permitting fertilization in the absence of males. In October at the end of the rainy season the water table has reached its maximum. The snake is taking advantage of these favorable conditions to mate. Via sperm storage the female is able to postpone fertilization and therefore ovulation and birth until environmental conditions are best for newborns.

Growth and Sexual Maturity

As mentioned previously no recaptures were obtained therefore no direct information was collected on growth rates. However, growth rates can be inferred by size frequency analysis. Figure 12 is a plot of the snout-vent length distribution in the months of July, August and September. Three size classes are distinguished in the distribution. The young of the year are easily detected in the wild by their white to yellow tail tips and are under 30 cms. The snakes ranging from 30 - 40 cms represent animals just completing their first year of life, i.e. juveniles. Snakes larger than 40 cms are adults however an age in years can not be given except to say they are more than two years old. This technique of determining age classes was used by Seigel (1986) for S.catenatus, also by Semlitsch (1984) for S.occipitomaculata. In the spring months the distinction between the young of the year and juveniles in S.catenatus is very similar to S.m.barbouri in Long Pine Key. Average snout-vent length of different age classes are shown in Table 9. The smallest gravid female found in this study was 42.0 cm snout-vent length which implies that females first become sexually mature in their third year. This figure compares to that noted by Klauber (1956) of 39.0 cm. Seigel (1986) estimated sexual maturity at 3-4 years. A plot of the snout-vent lengths of first year snakes by months of the year yields a growth increase of 82% in the first year of life based on linear regression (Figure 13). The snakes increase from an average hatchling size of 18.89 to 28.35 cms after the first year. The baby snakes are able to increase in size at such a tremendous rate because of the extra four to five months of activity in the Everglades as opposed to temperate zones where rattlesnake young of the year are forced into hibernation where very little if any growth occurs. When compared to canebrake rattlesnake in South Carolina (Gibbons 1972), the pygmy rattlesnake grows much faster.

CONCLUSIONS

S.m.barbouri is very different than other rattlesnakes and even from other snakes in Long Pine Key. Its life history strategy is proven to be very successful. Dalrymple (pers. comm.) informs me that to date the pygmy rattlesnake is the most abundant of the 22 snake species found in Long Pine Key.

Its small adult size of about 47 cms snout-vent length attributes to its abundance. The lower absolute energy requirement of a small adult size may allow this snake to be so populous and to adapt more readily to stresses in the ecosystem. Though no sexual difference was found in body size, females comprised a much larger portion of the snakes over 50 cms. Conclusions as to why the median size of females is larger than the males are vague. Many studies have shown that female size is significantly correlated with fecundity, however, in this sample of 8 females with developing eggs, no correlation is found between snout-vent length and clutch size. This sample may be too small to make any definate conclusions.

The majority of the snakes were collected on the road due to the warmth that these ectotherms acquire from it. Though only 14.6% of the data came from the traps, it provided valuable information on habitat use and movements of snakes. In the traps the snakes showed no preference for habitat on an annual basis. Prairies were well populated in late summer and fall as a reflection of the species' activity climax. Males were much more prevelant in the sample especially in the traps suggesting that males move more frequently.

The pygmy rattlesnake has an activity pattern atypical of rattlesnakes. The species' main peak in activity is in October however there is a second, smaller peak in the early part of the year consisting of only gravid females. The main species peak correlates to the end of the rainy season and the highest level in the water table. There is an increase in activity due to a narrow period of time of recruitment of young in July and August. This species activity peak consists of an increase in adult activity due to its close ties to reproduction. The juveniles are also peaking in activity at the same time as the rest of the species.

The data collected on activity and reproductive effort seem consistent with the model hypothesized at the beginning of the study. In the fall when both adult male and female snakes are most common, they are mating. Male activity drops thereafter until it peaks again next fall. Gravid female activity also drops but rises shortly thereafter. Gravid females found during this time have yolked eggs and appear to be in search of food to supply their added energy needs. Female activity drops again prior to parturition in late May and June and July. Young are born in the middle of the rainy season in July and early August. Samples used in the analysis for reproductive effort were lacking in males during the early part of the year and in females from May and June. The female recieves sperm from the male in October, stores the sperm until ovulation, starts vitellogenesis in January or February. Ovulating in May, she gives birth in July. The females' ovaries are small in the fall and enlarged in the spring. The male mates in October when his testis are enlarged; during the spring the testis are small.

Average hatchling size acquired in the study was larger than the average hatchling size cited for the subspecies in general (Klauber 1956). The gravid females are able to take advantage of the mild winters and yield bigger neonates. Unlike temperate rattlesnakes, S.m.barbouri in Long Pine Key has a extra four to five months to acquire energy reserves for gestation. It is estimated that during their first year of life S.m.barbouri has an extremely high growth rate of 82% that is attributed to the relatively mild winters of the Everglades that allows for continuous activity. After their first year they attain a length of about 28 cms. After the second year, snakes usually average around 32 to 36 cms. Snakes larger than 40 cms are classified as adults; this size is usually attained by the third year.

Throughout the manuscript, references are made to limitations in the sample. There is a strong bias in data toward snakes in the fall. Not enough snakes have been collected during the spring and summer to do a complete reproductive ecological study. Moreover, histological analysis would provide further evidence for the reproductive cycles.

Table 1 : All data except gonadal measurements on <u>Sistrurus</u> <u>miliarius</u> <u>barbouri</u> in Long Pine Key, Everglades National Park (N = 212) (+ before the date indicates the snakes either found dead on the road or in the traps and that were dissected for analysis of reproductive effort).

DATE	SNOUT-VENT LENGTH(cm)	TAIL LENGTH(cm)	WEIGHT (g)	HABITAT	SEX
+01-16-87	24.0	3.5	10.0	Road	YOY
01-03-86	24.5	3.0	13.0	Road	YOY
+01-04-85	47.5	7.5	49.5	Road	Adult male
02-23-86	21.0	2.2	6.0	Road	YOY
02-02-85	47.0	6.4	100.0	Road	Adult female
02-08-86	55.5	7.0	85.0	Road	Adult female
03-15-86	-	-	-	-	-
03-30-86	-	-	-	-	-
03-19-86	31.0	5.5	20.0	Pine	YOY
03-14-86	41.0	4.7	65.0	Road	Adult female
+03-04-87	46.0	7.0	101.4	Road	Adult male
+03-18-86	47.0	5.5	122.7	Road	Gravid female
+03-20-87	53.0	6.0	140.0	Road	Gravid female
03-08-85	60.0	7.5	132.0	Road	Adult female
04-04-86	-	-	-	-	-
04-02-86	23.5	4.0	20.0	Pine	YOY
04-19-85	27.5	2.5	-	Road	YOY
+04-17-87	32.5	4.5	-	Hammock	Juv. male
04-23-86	40.0	6.0	52.0	Road	Adult male
+04-23-87	42.0	4.5	60.0	Road	Gravid female
04-09-86	50.0	7.7	89.0	Donut	Adult male
05-28-86	23.5	3.6	15.0	Road	YOY
05-17-85	25.5	3.0	12.3	Road	YOY
05-31-86	27.0	3.3	15.0	Road	YOY
05-16-86	28.0	2.0	15.0	Road	YOY
05-16-86	29.0	4.5	20.0	Road	YOY
05-07-86	29.5	5.3	10.7	Road	YOY
05-20-86	32.0	5.4	19.3	Road	YOY
05-23-86	32.0	4.6	25.0	Road	YOY
05-19-85	32.5	3.9	28.0	Road	Juv. female
05-16-86	35.0	4.0	30.0	Road	Juv. female
05-07-86	36.0	4.3	33.0	Road	Juv. female
05-19-84	36.2	5.2	38.0	Road	Juv. male
05-16-86	55.5	6.0	205.0	Road	Gravid female
05-30-86	61.0	8.0	160.0	Road	Adult male
06-13-86	-	-	-	-	-
06-13-86	28.7	4.4	20.0	Road	YOY

Table 1 continued ...

06-07-85	33.5	4.5	25.7	Road	Juv. male
06-08-84	40.5	6.5	60.0	Road	Adult male
06-11-86	45.5	6.3	70.0	Donut	Adult male
06-17-85	48.0	6.1	92.0	Prairie	Adult male
07-18-86	16.3	2.0	4.7	Road	YOY
+07-18-86	16.6	2.3	4.3	Road	YOY
07-29-85	17.7	2.5	4.3	Road	YOY
07-29-85	17.8	2.5	5.3	Road	YOY
07-26-85	18.5	3.0	4.4	Road	YOY
07-24-85	18.6	3.0	4.3	Road	YOY
07-19-84	19.0	3.0	10.0	Road	YOY
07-26-85	19.2	2.7	5.3	Road	YOY
07-29-85	19.3	2.4	5.6	Road	YOY
07-29-86	19.3	2.4	6.9	Road	YOY
07-22-86	20.0	2.0	6.7	Road	YOY
07-22-86	20.0	2.2	4.9	Road	YOY
07-29-85	30.5	4.3	33.0	Road	Juv. male
07-29-86	32.0	3.7	22.0	Road	Juv. female
07-26-84	33.0	5.0	25.0	Road	Juv. male
07-15-86	35.0	4.7	20.0	Road	Juv. male
07-29-85	35.0	4.5	45.0	Road	Juv. male
07-22-86	40.5	4.5	35.0	Road	Adult femal
07-08-85	48.5	7.1	86.6	Road	Adult male
08-10-86	-	-	-	-	-
08-10-86	-	-	-	-	-
08-29-86	-	-	-	-	-
08-02-85	17.0	2.3	4.3	Road	YOY
08-13-86	17.7	3.2	3.8	Road	YOY
08-01-86	17.7	2.4	3.7	Road	YOY
08-23-85	17.7	2.6	4.4	Road	YOY
08-13-86	18.3	3.0	3.8	Road	YOY
+08-26-86	18.5	2.4	3.7	Road	YOY
08-01-86	19.0	2.5	4.6	Road	YOY
08-26-85	19.2	2.5	5.0	Road	YOY
08-23-85	19.4	2.7	5.8	Road	YOY
08-25-85	20.0	2.6	5.5	Road	YOY
08-31-84	20.0	2.5	6.5	Road	YOY
08-26-85	20.3	2.4	6.8	Road	YOY
08-23-85	20.7	2.7	6.4	Road	YOY
08-12-85	20.7	2.5	8.6	Road	YOY
08-24-84	21.5	3.3	8.0	Road	YOY
03-31-84	29.5	5.0	10.5	Road	Juv. male
08-13-84	32.0	4.3	27.0	Pine	Juv. female
08-05-86	33.0	4.1	29.5	Road	Juv. female
08-23-85	35.0	4.5	30.0	Pine	Juv. female
08-15-84	37.0	5.0	50.0	Road	Juv. female
08-26-85	45.0	-	76.3	Prairie	Adult female
08-05-86	47.5	6.5	77.1	Prairie	Adult male
08-01-86	48.0	7.0	65.0	Road	Adult male
08-12-85	48.5	5.5	66.2	Road	Adult female
08-12-85	50.5	6.8	27.0	Road	Adult male
08-08-84	54.0	8.5	95.0	Prairie	Adult male
09-12-86	-	-	-	-	-

Table 1 continued ...

09-05-86	-	-	-	-	-
09-12-86	17.0	3.0	4.3	Road	YOY
09-07-86	17.6	3.5	5.0	Road	YOY
09-23-85	18.2	2.6	5.1	Road	YOY
09-02-85	18.7	2.7	5.9	Road	YOY
09-12-86	19.0	3.0	5.5	Road	YOY
09-17-86	19.0	3.2	8.8	Road	YOY
+09-19-86	20.0	2.6	6.2	Road	YOY
09-17-86	21.0	2.5	7.6	Road	YOY
+09-19-86	21.6	2.6	7.8	Road	YOY
09-04-84	23.0	3.5	6.5	Road	YOY
09-30-84	24.5	2.9	10.7	Road	YOY
09-17-86	27.5	4.0	20.0	Road	Juv. female
09-05-86	32.0	4.1	25.0	Road	Juv. female
09-07-84	34.0	6.0	39.0	Road	Juv. female
09-12-86	35.0	4.0	35.0	Hammock	Juv. female
+09-19-86	35.5	5.0	33.2	Road	Juv. male
09-23-85	37.7	4.4	33.7	Road	Juv. female
+09-07-84	38.5	6.0	38.1	Road	Adult male
+09-09-84	38.8	5.8	40.0	Road	Adult male
09-20-85	43.9	-	58.3	Road	Adult female
09-14-84	44.0	6.0	70.0	Road	Adult female
09-19-84	44.5	6.5	60.0	Donut	Adult male
09-07-86	45.3	5.4	-	Road	Adult female
+09-25-86	46.0	7.0	68.0	Road	Adult male
+09-07-84	46.5	7.0	36.4	Road	Adult male
09-21-84	47.0	3.5	67.1	Road	Adult male
09-28-84	48.0	5.0	80.2	Hammock	Adult female
09-20-85	50.9	6.1	67.0	Road	Adult female
10-05-84	19.0	3.5	5.3	Road	YOY
+10-22-86	19.3	2.4	6.8	Road	YOY
+10-31-86	20.0	2.5	6.6	Road	YOY
+10-22-84	20.3	3.1	7.4	Road	YOY
10-09-85	20.7	3.0	9.3	Road	YOY
+10-22-86	21.4	2.8	7.8	Road	YOY
+10-15-86	22.0	3.0	6.7	Road	YOY
+10-10-86	22.0	2.5	9.2	Road	YOY
+10-22-86	22.0	3.1	8.9	Road	YOY
10-05-84	22.5	4.5	8.3	Road	YOY
+10-31-86	23.0	3.1	10.3	Road	YOY
10-04-85	23.5	3.4	10.3	Road	YOY
10-25-85	23.7	2.2	11.3	Road	YOY
+10-17-86	24.0	3.8	10.4	Road	YOY
+10-04-86	24.5	3.5	12.8	Road	YOY
+10-27-85	24.5	3.3	18.4	Road	YOY
10-11-85	25.5	3.1	16.6	Road	YOY
10-10-84	26.0	3.2	10.7	Road	YOY
+10-03-86	27.0	4.5	12.0	Road	YOY
+10-08-86	31.0	3.5	24.3	Road	Juv. female
10-12-84	33.0	4.0	23.9	Pine	Juv. female
+10-23-84	34.5	5.2	30.2	Road	Juv. male
10-12-84	36.0	5.5	45.4	Pine	Juv. male
+10-24-84	36.0	6.0	90.6	Road	Juv. male

Table 1 continued ...

10-11-85	38.2	5.7	44.4	Prairie	Juv. male
10-03-84	38.5	6.1	43.5	Road	Juv. male
10-18-85	39.0	5.5	34.2	Prairie	Juv. female
10-15-85	40.8	6.0	56.3	Prairie	Adult male
+10-08-86	41.0	6.5	53.0	Road	Adult male
10-04-85	41.0	6.1	47.0	Road	Adult male
10-02-84	41.5	6.1	42.8	Road	Adult male
10-03-84	43.5	6.6	47.5	Road	Adult femal
+10-24-86	44.3	7.0	73.0	Road	Adult male
10-12-84	45.0	6.5	101.1	Pine	Adult male
+10-17-86	46.5	7.0	100.0	Donut	Adult male
+10-29-86	46.5	6.8	73.3	Road	Adult male
10-09-85	46.8	7.2	90.0	Hammock	Adult male
+10-17-86	47.5	7.0	90.0	Road	Adult male
10-09-85	47.6	7.6	84.7	Road	Adult male
+10-15-84	48.0	8.2	65.8	Road	Adult male
10-27-85	49.5	7.2	108.5	Donut	Adult male
+10-10-86	49.5	7.5	108.0	Road	Adult male
+10-31-86	50.0	6.4	82.9	Road	Adult male
+10-08-86	51.0	5.5	114.6	Road	Adult female
10-06-85	51.7	7.3	120.0	Road	Adult male
10-23-85	52.0	6.7	88.7	Road	Adult female
10-02-84	52.5	6.4	75.6	Road	Adult female
+10-26-84	54.0	9.0	70.5	Road	Adult male
+10-26-86	54.5	7.5	136.1	Road	Adult male
10-02-84	57.5	8.1	160.3	Road	Adult male
10-16-85	57.8	7.6	196.5	Road	Adult male
11-08-86	-	-	-	-	-
11-17-85	21.4	2.7	7.0	Road	YOY
+11-05-84	22.0	3.0	7.0	Road	YOY
11-17-85	22.7	2.8	12.8	Road	YOY
+11-07-86	23.0	3.6	10.0	Road	YOY
+11-04-86	23.5	2.8	12.1	Road	YOY
+11-04-86	24.5	3.2	11.0	Road	YOY
+11-14-86	25.5	4.0	15.1	Road	YOY
11-16-86	26.0	3.0	11.3	Road	YOY
+11-14-86	27.5	4.0	17.3	Road	YOY
+11-07-86	28.0	3.6	19.0	Road	YOY
11-01-85	30.3	4.5	22.3	Road	Juv. male
11-14-84	34.5	5.3	27.0	Prairie	Juv. male
11-27-85	36.7	4.8	29.5	Prairie	Juv. male
11-02-84	37.0	4.9	34.3	Road	Juv. male
+11-07-86	38.5	4.5	40.0	Road	Juv. female
+11-07-86	40.0	6.3	55.0	Road	Adult male
+11-04-86	40.3	6.0	60.3	Road	Adult male
+11-05-85	41.0	5.2	49.6	Road	Adult femal
11-12-85	42.4	5.8	55.0	Pine	Adult male
11-06-85	42.7	5.8	48.8	Pine	Adult male
+11-05-84	43.0	7.0	53.3	Road	Adult male
+11-14-86	44.0	5.0	46.0	Road	Adult femal
+11-19-86	45.0	6.5	68.0	Road	Adult male
11-05-84	45.5	6.5	71.0	Road	Adult male

Table 1 continued ...

11-26-84	46.5	6.6	100.0	Prairie	Adult male
+11-07-86	49.0	6.5	87.8	Road	Adult male
11-02-84	50.5	7.2	99.1	Prairie	Adult male
11-27-85	60.0	8.0	101.2	Road	Adult female
+12-05-86	18.5	2.3	5.0	Road	YOY
12-02-84	19.0	2.0	7.0	Road	YOY
+12-16-86	21.5	3.5	7.0	Road	YOY
+12-14-86	22.0	3.0	8.0	Road	YOY
+12-14-86	31.0	4.0	24.0	Road	YOY
12-01-85	33.5	4.3	25.8	Road	YOY
+12-14-86	41.5	6.0	50.8	Road	Juv. female
12-28-84	42.0	6.0	61.0	Road	Adult male
+12-16-86	43.0	7.5	70.2	Road	Adult male
+12-14-86	43.5	5.5	49.5	Road	Adult male
+12-14-86	49.5	7.5	123.5	Road	Adult female
12-13-85	50.0	6.9	82.4	Road	Adult male
12-30-84	53.0	7.0	93.5	Prairie	Adult male

Table 2: Sexual differences between mean snout-vent length, tail length, relative tail length, and weight in adult S.m.barbouri. Mean ± confidence levels are given. Gravid females were not included in the weight comparison (N = 55 males and 24 females).

	Male	Female
Snout-vent length (cm)	46.78 ± 1.34	48.11 ± 3.20
Tail length (cm)	6.81 ± 0.23	5.86 ± 0.55
Relative tail length	0.1460 ± 0.0038	0.1207± 0.0052
Weight (g)	79.52 ± 8.83	73.48 ± 12.18

Table 3: Total numbers of S.m.barbouri collected during the study and their distribution based on sexual differences and habitat types. Ten snakes were seen on the road but were not sexed.

	Male	Female	YOY	Total
Prairie	11	2	0	13
Pine	4	3	2	9
Hammock	2	2	0	4
Donut	5	0	0	5
Total traps	22	7	2	31
Roads	52	34	85	181

<u>Table 4</u>: Snout-vent length, tail length and weight of a clutch of hatchlings of <u>S.m.barbouri</u> born 08/03/86 in captivity.

Snout-vent length (cm)	Tail length (cm)	Weight (g)
17.0	2.5	5.0
18.0	2.6	5.3
19.0	3.0	5.4
18.0	3.0	5.4
18.0	3.0	5.5
18.0	3.1	5.1
17.5	2.5	5.3
19.5	2.4	6.4
19.0	2.5	5.7
19.0	2.8	6.1
18.8	2.7	5.8
18.0	2.4	5.5
19.0	2.5	5.4
18.5	2.4	5.5
Mean ± C.L.		
18.38 ± .37	2.67 ± .14	5.53 ± .20

Table 5: Reproductive measurements of adult females with yolked ovarian eggs (N = 3).

Date	Snout Vent Length (mm)	Weight (g)	Right Ovary Length (mm)	Right Ovary Width (mm)	Left Ovary Length (mm)	Left Ovary Width (mm)
3/18/86	47.0	122.7	80.24	19.75	50.30	17.26
3/20/87	53.0	140.0	70.20	16.10	65.32	15.18
4/23/87	42.0	60.0	40.64	9.92	25.22	9.19
MEAN ± C.L.	47.3 ±6.3	107.6 ±48.6	63.69 ±23.77	15.26 ±5.74	46.95 ±23.39	13.88 ±4.84

Right Egg # (mm)	Left Egg # (mm)	Mean Right Egg Length (mm)	Mean Left Egg Length (mm)
5	4	15.90±.98	15.15±2.97
7	7	20.90±1.06	19.97±1.85
5	6	10.61±1.25	10.19±3.06
5.67 ±1.33	5.67 ±1.76		

Table 6: Reproductive measurements of adult females with unyolked, small follicles (N = 5).

Date	Snout Vent Length (cm)	Weight (g)	Right Ovary Length (mm)	Right Ovary Width (mm)	Left Ovary Length (mm)	Left Ovary Width (mm)
10/08/86	51.0	114.6	41.96	4.88	23.48	4.74
11/05/85	41.0	49.6	19.82	4.58	11.76	2.50
11/14/86	44.0	46.0	27.86	3.71	18.20	3.20
11/27/85	60.0	101.2	37.02	4.20	28.00	5.60
12/14/86	43.5	49.5	25.73	4.76	23.95	4.83
MEAN ± C.L.						
	47.9 ±6.9	72.18 ±29.50	30.48 ±7.97	4.43 ±.43	21.08 ±5.60	4.17 ±1.14

Right Egg # (mm)	Left Egg # (mm)	Mean Right Egg Length (mm)	Mean Left Egg Length (mm)
10	9	3.55+.61	2.82+.80
3	10	2.43+.76	3.36+.95
15	11	1.88+.80	2.22+1.01
7	10	2.72+.82	2.66+.36
7	5	3.25+1.24	3.69+1.71
8.4 ±4.0	9.0 ±2.1		

Table 7: Reproductive measurements of adult males of *S.m.barbouri* (N = 24)

Date	Snout Vent Length (cm)	Weight (g)	Right Testis Length (mm)	Right Testis Width (mm)	Left Testis Length (mm)	Left Testis Width (mm)
01/04/85	47.5	49.7	7.78	2.96	10.21	3.50
03/04/87	46.0	101.4	9.18	6.68	9.02	6.08
09/07/84	38.5	38.1	6.84	5.16	5.92	5.69
09/09/84	38.8	40.1	8.14	3.10	8.50	3.98
09/25/86	46.0	68.0	14.08	7.68	9.14	6.21
09/07/84	46.5	36.4	10.32	2.74	11.00	1.79
10/08/86	41.0	53.0	10.64	5.36	10.44	5.23
10/24/85	44.3	73.0	8.86	8.18	8.60	9.84
10/29/86	46.5	73.3	8.98	6.71	10.86	6.76
10/17/86	46.5	100.0	10.13	7.26	11.35	7.24
10/17/86	47.5	90.0	12.80	7.08	13.45	8.36
10/15/84	48.0	65.8	11.84	5.40	8.86	3.19
10/10/86	49.5	108.0	11.12	7.50	9.86	7.95
10/31/86	50.0	82.9	10.78	7.27	11.11	6.23
10/26/84	54.0	70.5	9.84	5.00	7.06	4.23
10/26/86	54.5	136.1	13.80	9.33	11.60	8.58
11/07/86	40.0	55.0	9.85	6.96	10.32	5.84
11/04/86	40.3	60.3	8.32	7.36	7.20	7.18
11/05/84	43.0	53.3	10.47	5.44	8.96	6.35
11/19/86	45.0	68.0	9.22	6.74	6.74	6.76
11/07/86	49.0	87.8	10.28	5.08	10.80	6.50
12/14/86	41.5	50.8	8.78	5.98	7.90	6.96
12/16/86	43.0	70.2	10.73	6.72	11.34	5.71
12/14/86	49.5	123.5	5.36	5.10	7.94	4.20
MEANS ± C.L.						
	45.7 ±1.8	68.5 ±11.0	9.91 ±.83	6.23 ±.68	9.35 ±.86	8.22 ±4.30

Table 8: Varying lenghts of sperm retention in the oviduct for reptilian species (Fox 1977).

Species	Delay between copulation and fertile eggs
Copperhead (*Agkistrodon c. mokasen*)	11 days
Krait (*Bungaris fasciatus*)	2-4 months
Brown snake (*Storeia dekayi*)	3 months
Garter snake (*Thamnophis sirtalis*)	6 months
King Cobra (*Naja naja*)	6 months
Prairie rattlesnake (*Crotalus v. viridis*)	12 months
Indigo snake (*Drymarchon corais*)	52 months

Table 9: Average snout-vent length for different age groups of *S.m.barbouri*. Values for after one and two years were taken from May through September. Values for average hatchlings were calculated from July and August.

	Snout-vent length (cm) in $\bar{X}\pm$C.L. (N)	
	Male	Female
Largest individual	61.0	60.0
Average adult	46.78±1.34 (55)	48.11±3.20 (24)
Average after 2yrs	33.53±1.71 (8)	33.42±1.45 (12)
Average after 1yr	28.35±1.86 (9)	
Average hatchling	18.89±0.50 (27)	

Figure 1: Size frequency of S.m.barbouri in Long Pine Key, Everglades National Park (N = 202).

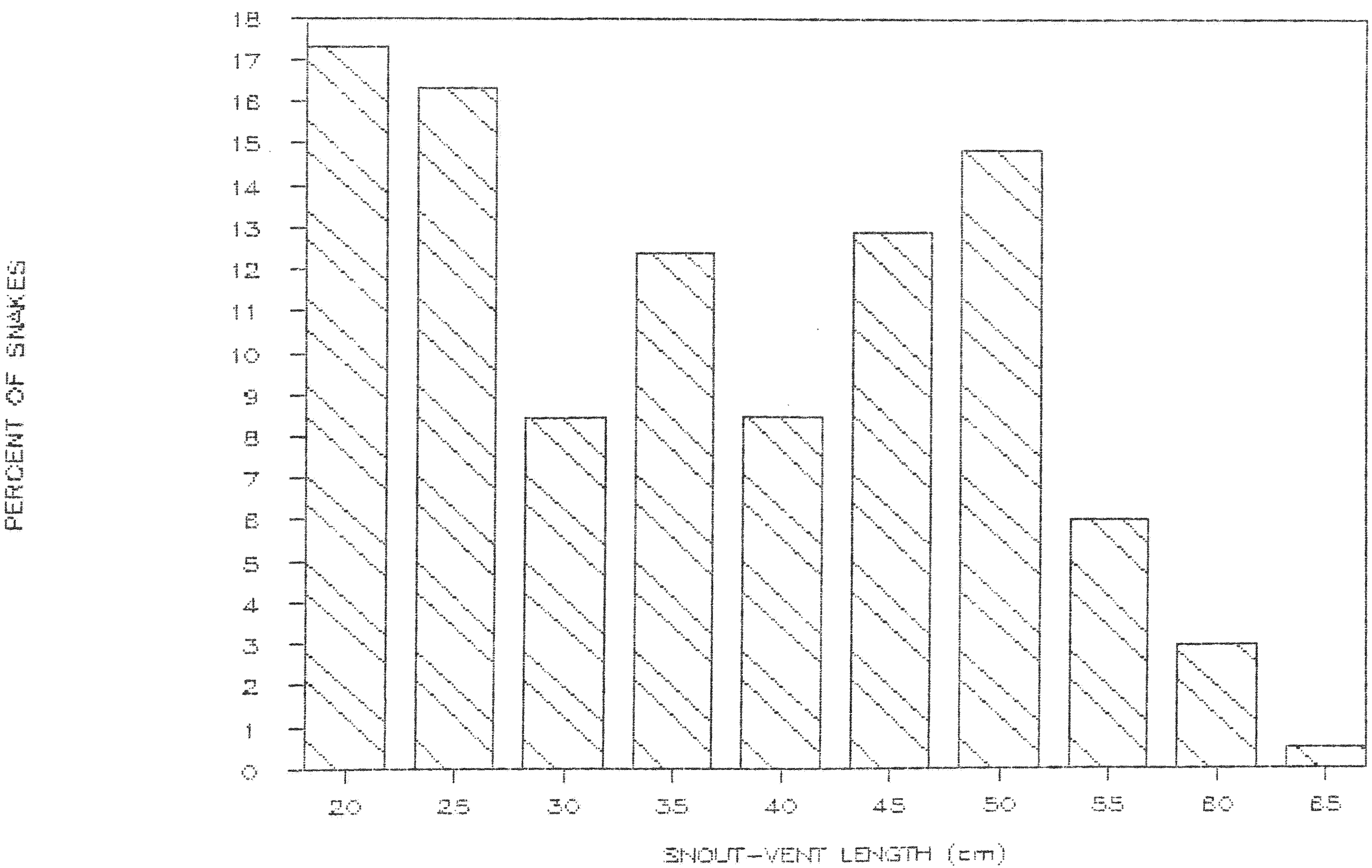

PERCENT OF SNAKES
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
20
25
30
35
40
45
50
55
60
65
SNOUT-VENT LENGTH (cm)

Figure 2: Sexual differences in size distribution of adult *S.m.barbouri* (N = 54 males and 24 females).

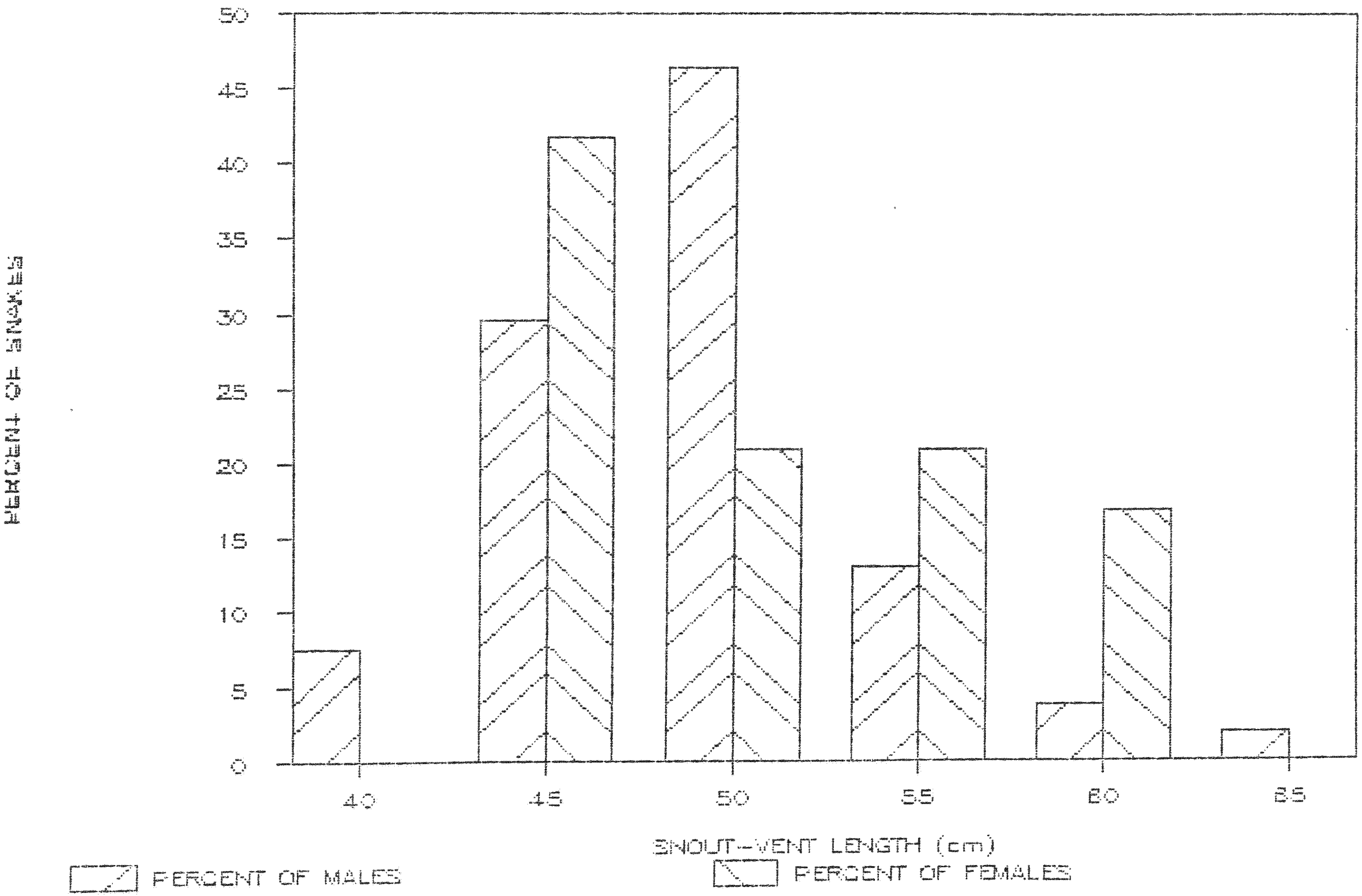

PERCENT OF SNAKES
50
45
40
35
30
25
20
15
10
5
0
40
45
50
55
60
65
SNOUT-VENT LENGTH (cm)
PERCENT OF MALES
PERCENT OF FEMALES

Figure 3: Species activity pattern for *S.m.barbouri*. The species is most common during the second half of the year (N = 212).

Figure 4: Comparison of rainfall per month to the number of S.m.barbouri collected from January 1984 through December 1986 at Long Pine Key. Rainfall is measured in inches and snakes are represented as actual number caught during that month (Rainfall data was obtained from Dalrymple) (N = 207).

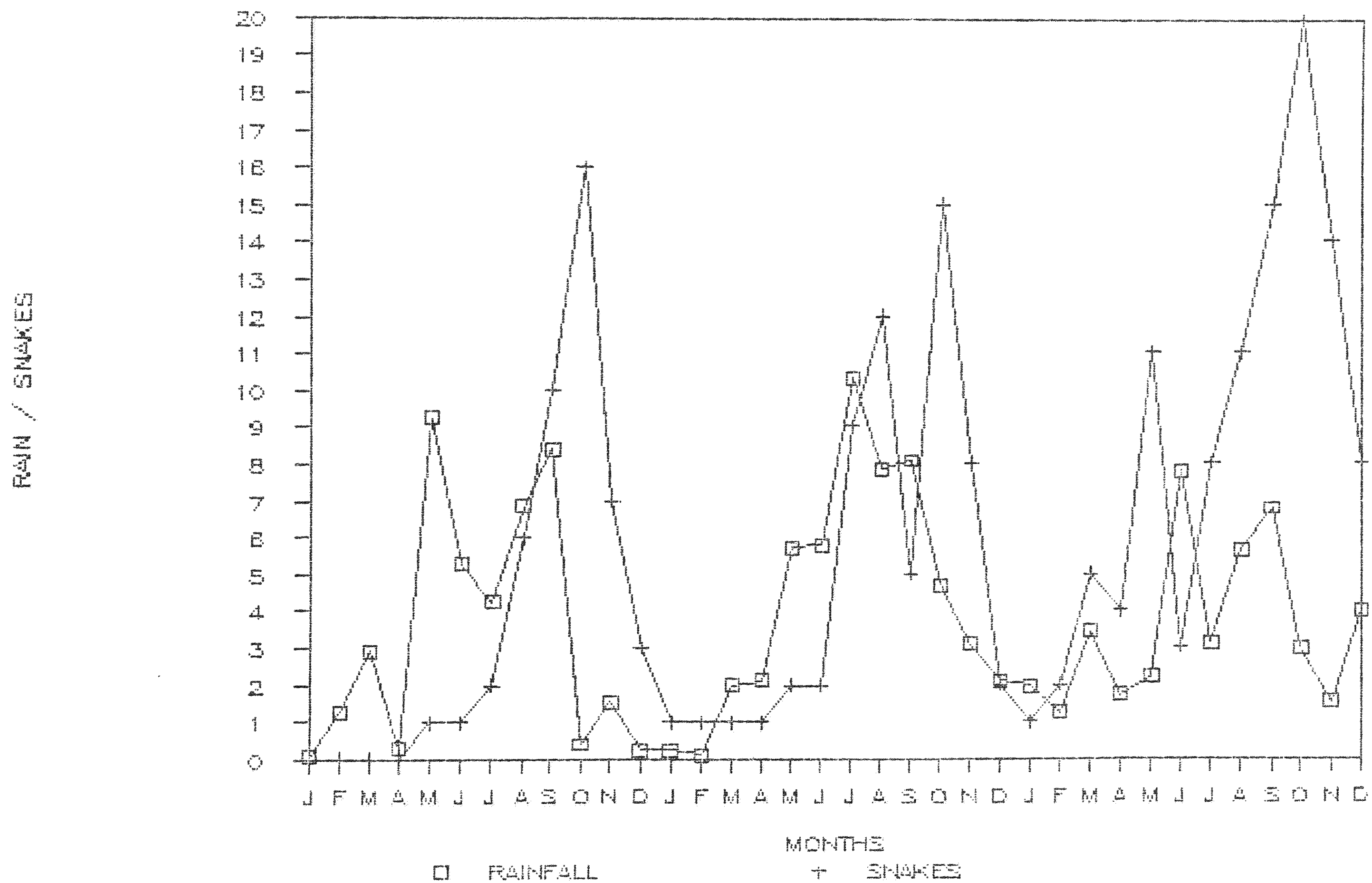

RAIN / SNAKES
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
MONTHS
RAINFALL
SNAKES

Figure 5: Comparison of adult male and female activity patterns of *S.m.barbouri* (N = 55 males and 24 females).

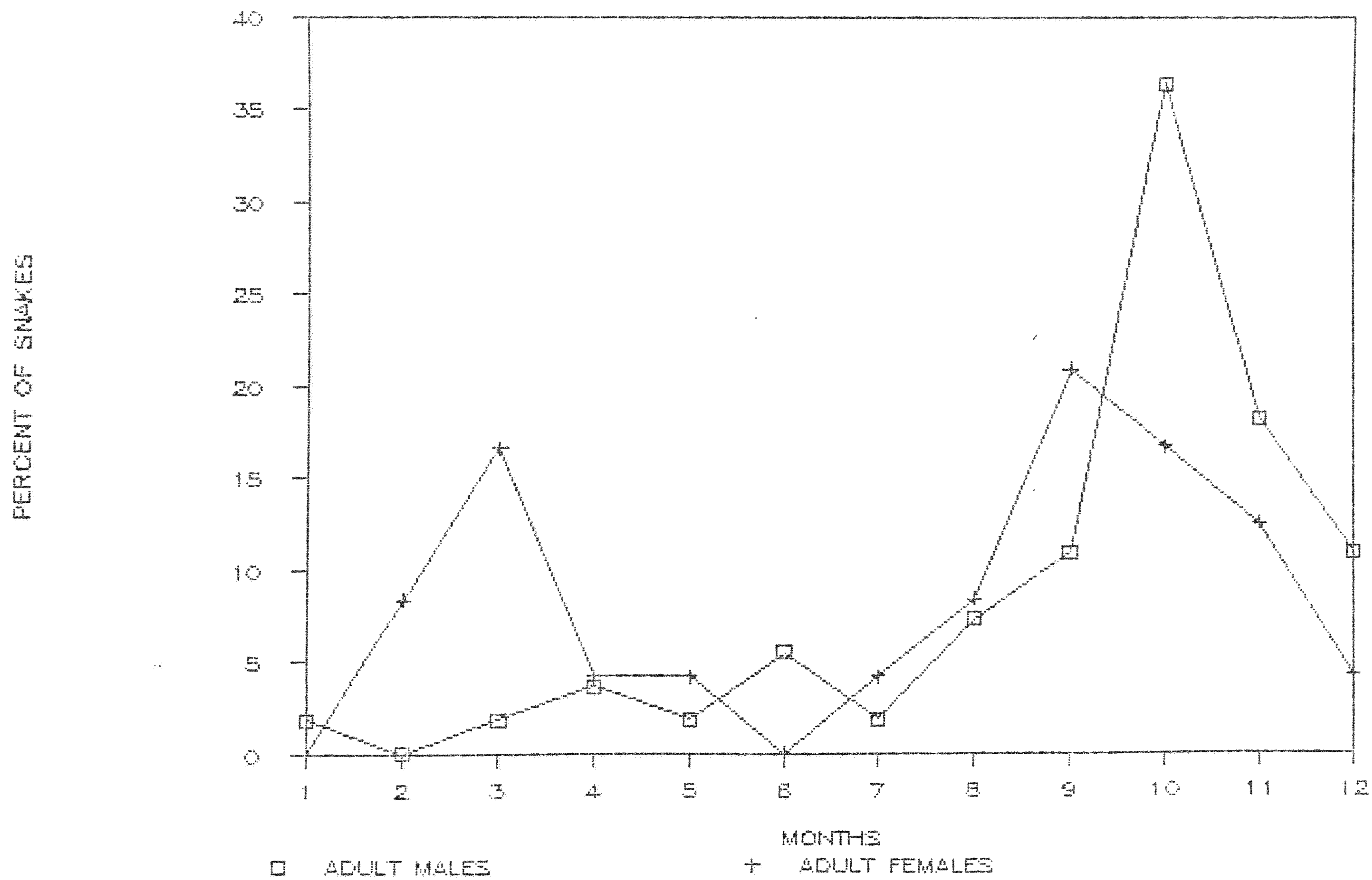
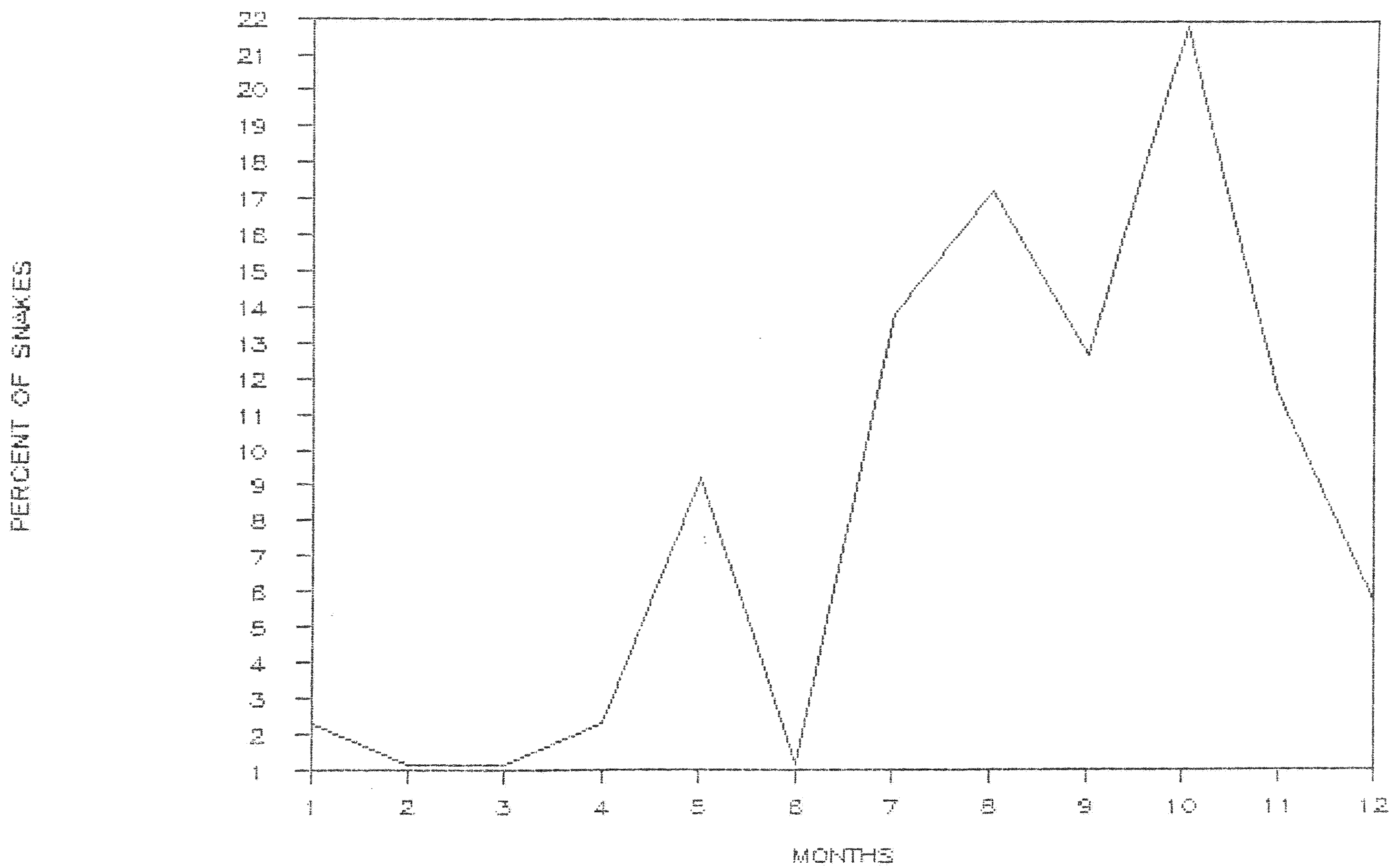
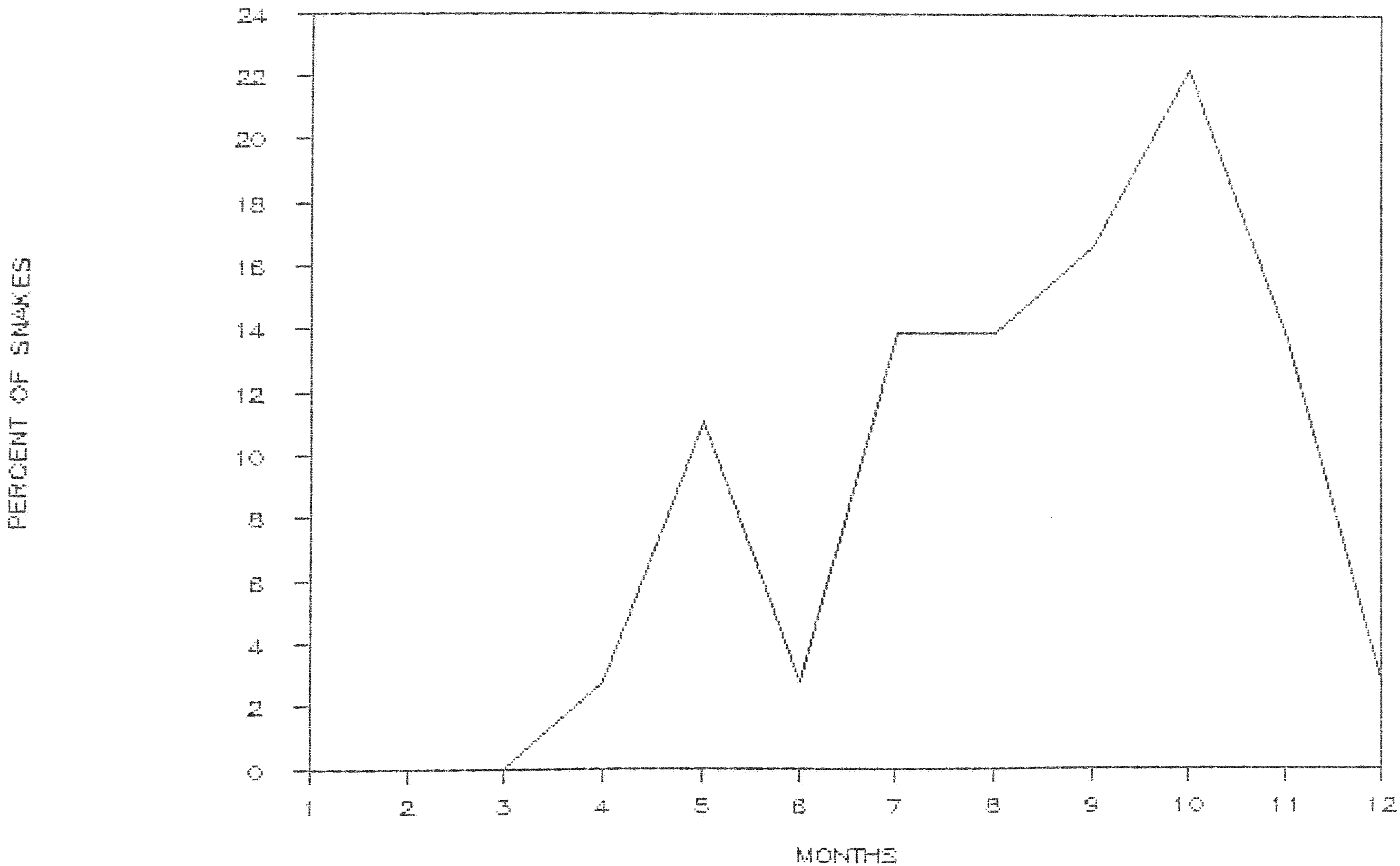

PERCENT OF SNAKES
40
35
30
25
20
15
10
5
0
1
2
3
4
5
6
7
8
9
10
11
12
MONTHS
ADULT MALES
ADULT FEMALES

Figure 6: Activity pattern of the young of the year of *S.m.barbouri* (N = 87).



PERCENT OF SNAKES
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
1
2
3
4
5
6
7
8
9
10
11
12
MONTHS

Figure 7: Activity pattern of juvenile *S.m.barbouri* (N = 36).



PERCENT OF SNAKES
24
22
20
18
16
14
12
10
8
6
4
2
0
1
2
3
4
5
6
7
8
9
10
11
12
MONTHS

Figure 8: Comparison of adult and juvenile male activity patterns (N = 54 adult males and 18 juvenile males).

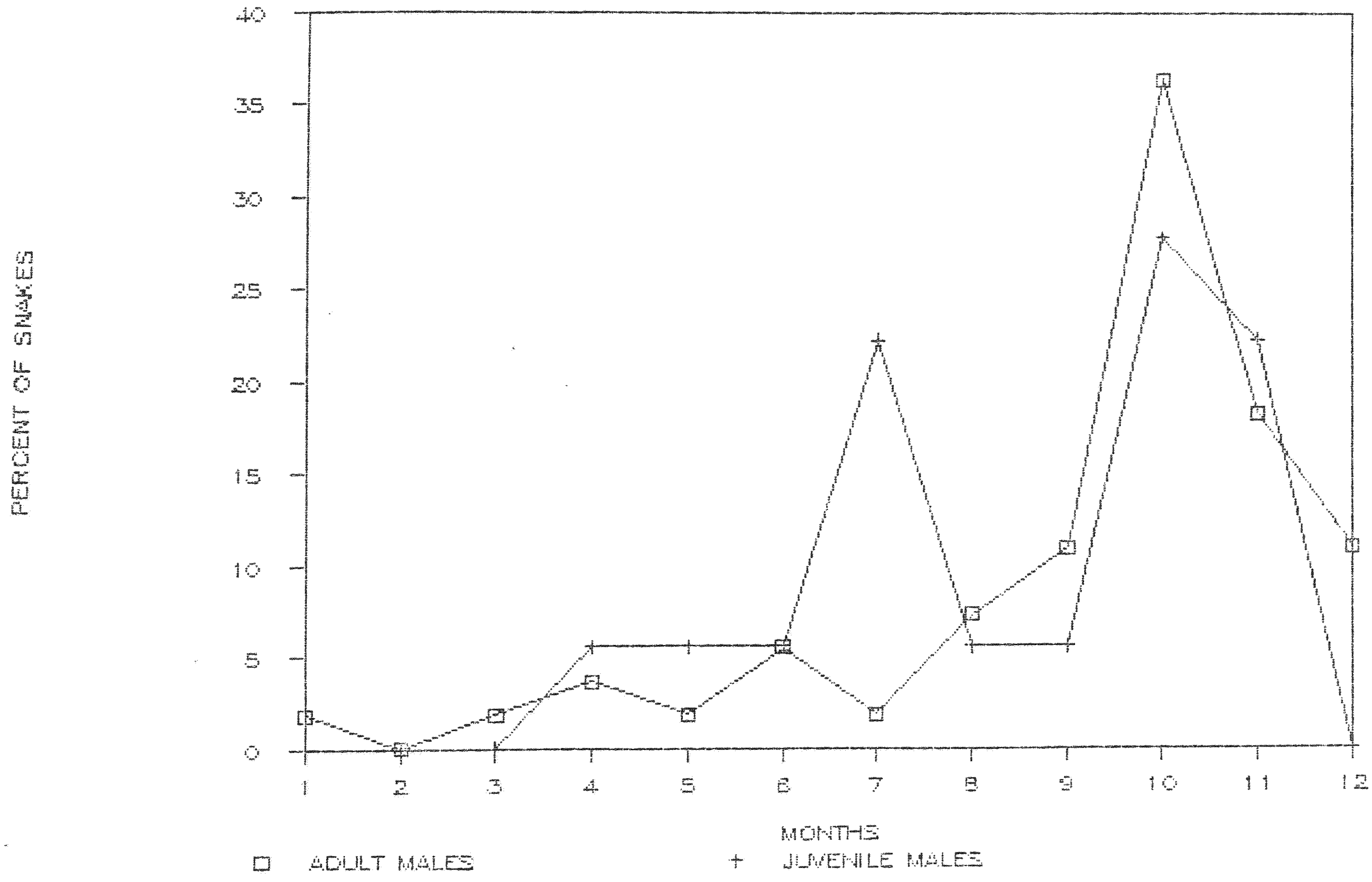

PERCENT OF SNAKES
0
5
10
15
20
25
30
35
40
1
2
3
4
5
6
7
8
9
10
11
12
MONTHS
ADULT MALES
JUVENILE MALES

Figure 9: Comparison of adult and juvenile female activity patterns (N = 24 adult females and 18 juvenile females).

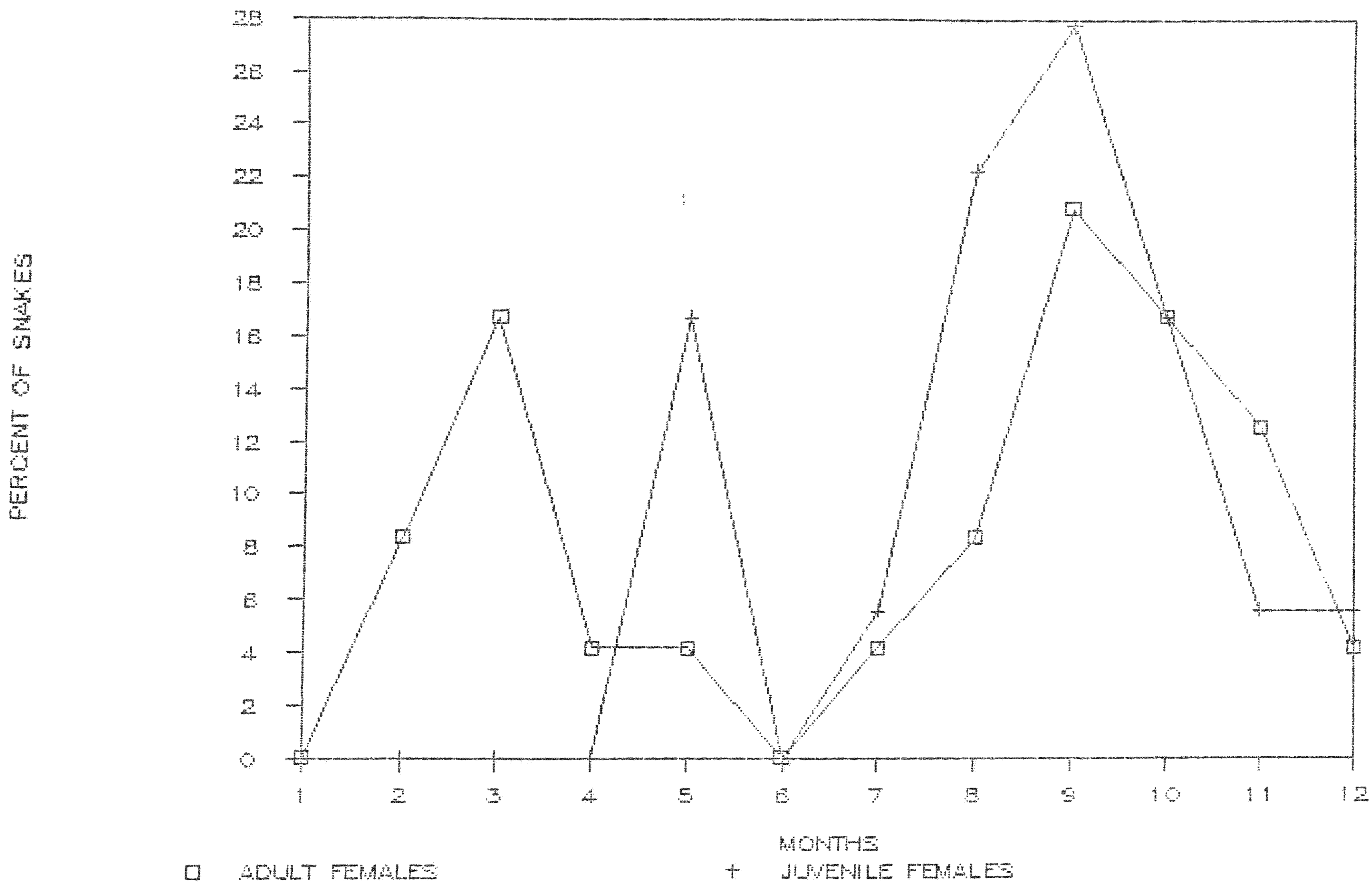

PERCENT OF SNAKES
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
1
2
3
4
5
6
7
8
9
10
11
12
MONTHS
ADULT FEMALES
JUVENILE FEMALES

Figure 10: Comparison of mean right ovary length and activity of adult females (N = 8).

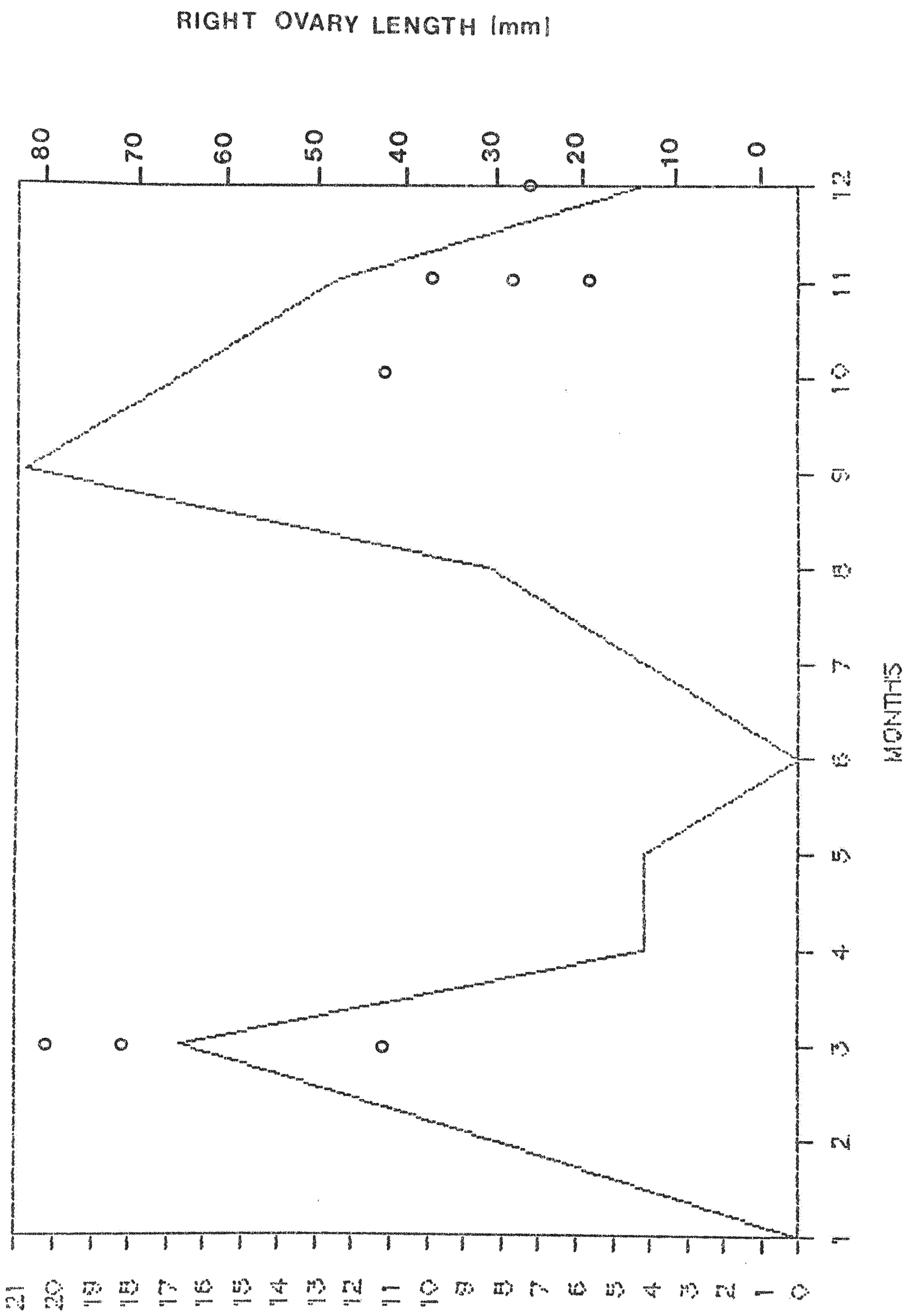

RIGHT OVARY LENGTH (mm)
MONTHS
0
10
20
30
40
50
60
70
80
1
2
3
4
5
6
7
8
9
10
11
12

Figure 11: Comparison of right testis length and activity pattern of adult males (N = 24).

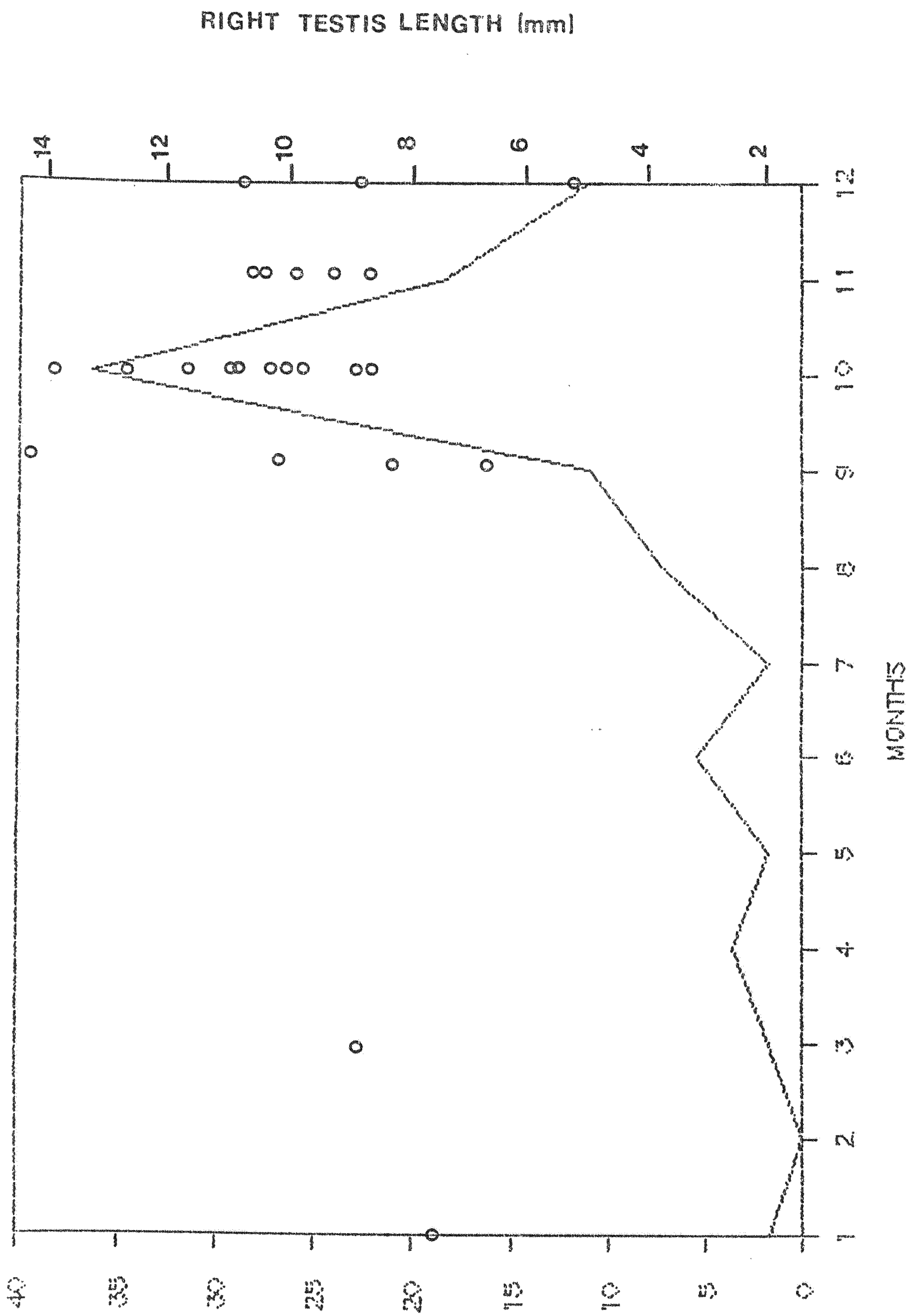
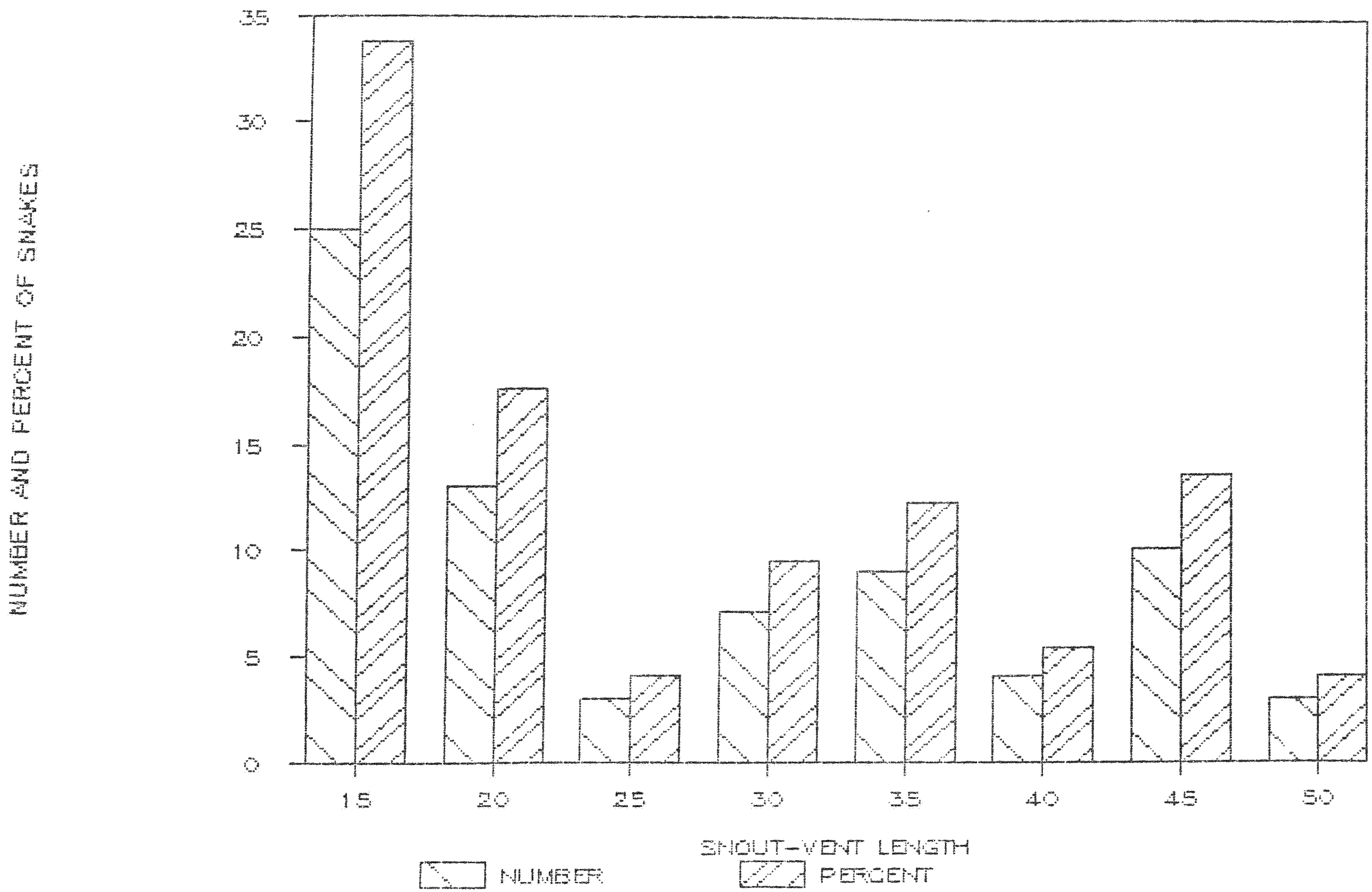
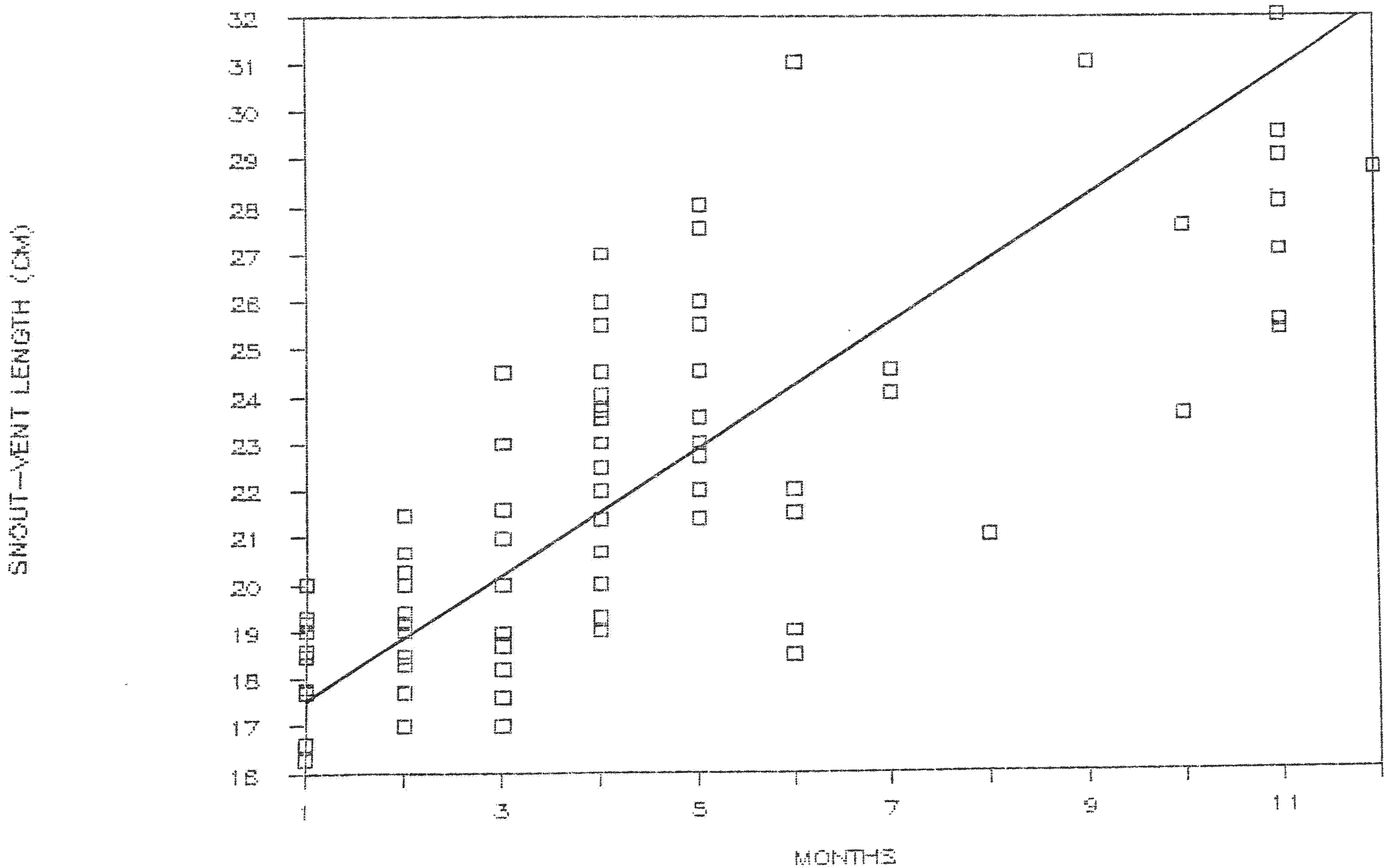

RIGHT TESTIS LENGTH (mm)
14
12
10
8
6
4
2
MONTHS
1
2
3
4
5
6
7
8
9
10
11
12

Figure 12: Snout-vent length distribution for S.m.barbouri in the months of July, August and September (N =74).


NUMBER AND PERCENT OF SNAKES
0
5
10
15
20
25
30
35
15
20
25
30
35
40
45
50
SNOUT-VENT LENGTH
NUMBER
PERCENT

<u>Figure 13</u>: Comparison of young of the year snout-vent length to months of the year. First month in the x axis correlates to July which is the first month in the growth year of the newborns. A growth rate of 82.94% was calculated via linear regression ($y = 17.28+1.00x$) ($N = 87$).


SNOUT-VENT LENGTH (CM)
32
31
30
29
28
27
26
25
24
23
22
21
20
19
18
17
16
1
3
5
7
9
11
MONTHS

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