THE DIEL ACTIVITY PATTERN OF INDIAN PYTHON (*Python molurus molurus* Linn) AT KEOLADEO NATIONAL PARK AND SOME FACTORS INFLUENCING IT

DISSERTATION SUBMITTED TO THE SAURASHTRA UNIVERSITY, RAJKOT IN PARTIAL FULFILLMENT OF MASTER'S DEGREE IN WILDLIFE SCIENCE (1991)

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CERTIFICATE

This is to certify that Shri Karmavir Bhatt has carried out an original piece of research in partial fulfilment of his M.Sc. (Wildlife) Degree of the Saurashtra University, Rajkot. The topic of dissertation is "The diel activity pattern of Indian Python (*Python molurus molurus* Linn) at Keoladeo National Park and some factors influencing it". The investigations were carried out at the Wildlife Institute of India, Dehra Dun under my supervision from November 1990 to June 1991. I hereby certify that this work has not been submitted for any degree of any University.

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SUMMARY

This study investigated diel activity pattern of Indian python (*Python molurus molurus* Linn) at Keoladeo National Park Bharatpur. The study was conducted in an intensive study area of 0.5 Sq Km selected after pre sampling survey in the park.

The methodology involved to estimate activity pattern of pythons was monitoring of a permanent transect every four hours, on diel basis, to record python's tracks and sightings. The diel variations in temperature, humidity, burrow microclimate, prey activity and prey abundance were also quantified along with diel activity pattern of python.

Results show a shift in diel activity pattern with seasons. The activity pattern of pythons was diurnal in winter, uniform throughout spring and bimodal crepuscular in summer.

There was no significant correlation between python activity and other factors quantified, though temperature and humidity affected the diel activity pattern considerably. The microclimate variation gradient existing between outside and inside burrow possibly play an important role in occupation of the burrow and this in time influence the surface diel activity pattern. The shift in the diel activity is attributed to seasonal change in the abiotic factors. No relationship between prey abundance and activity pattern

could be established possibly because python's ability to go with out food during the cool season. Other factors not quantified during this study like reproductive behavior, body size and biotic disturbances are suspected to be responsible for the observed diel activity pattern of pythons.

It is concluded that the diel activity pattern of pythons in KNP is not influenced by just one factor but is a manifestation of a combination of various abiotic, biotic and endogenous factors. A temperature sensitive telemetry study would help further in investigating the ecological aspects of this cryptic species.

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Congregation of pythons around a burrow during winter.

CHAPTER 1 INTRODUCTION

1.0 INTRODUCTION

Lower vertebrates are not continuously active but rather have discrete times of the activity daily as well as seasonally (Harker 1958). The broad activity pattern on a 24 hrs time scale is defined as the diel activity pattern of an animal, which tends to vary during different seasons. Owing to the poikilothermic nature of reptiles, characteristics of the thermal environment constitute an important determinant of their activity (Bogert 1949 Porter 1972, Heatwole 1976). Within the constraints imposed by the physical environment, an ectotherm's activity is also influenced by other biological environment (Like food availability, predation avoidance competition, etc) and endogenous factor like reproductive cycles (Heatwole 1976, Gibbons and Semlitsch 1987).

This study deals with the diel activity pattern of Indian rock python (*Python molurus molurus* Linn) at Keoladeo National Park (KNP) Bharatpur. First time such study has been conducted on ecological aspect of snakes in India. The species was selected because of the large body size of Python which makes the species more conspicuous with comparison to other snake species. Population of Pythons being fairly good in the selected study area feasibility of getting a good amount of indirect evidence (which was the main source of information) was high, and the base line information regarding the general ecology and distribution of Python in the national park is available (Ali and Vijayan 1986a, Bhupathy and vijayan 1989).

This study of diel activity of python was conducted during November 1990 to April 1991, comprises of two distinct seasons winter and summer.

In this chapter a review of available literature on the diel activity of snakes and on the Python are dealt with first. The objective, study hypothesis and the organization of the thesis follows there after.

1.1 REVIEW OF LITERATURE :

1.1.1 The Diel Activity Pattern:

Diel activity of snakes with relation to the physical environment has been extensively studied in temperate species (Gibbons and Semlitsch 1987). Literature on the studies based on laboratory condition (Heckrotte 1962) as well from field condition (Landreth 1973, Shine and Lambeck 1985) are available. Most studies document only the timeing of activity, although some have perceived reasons for the pattern.

Studies done by Heckrotte (1962), Landreth (1973) and Sanders and Jacob (1980) on small bodied snakes of family Colubuidae suggested a general trend that at low temperature snakes tend to be diurnal, at intermediate temperature they show a bimodal pattern as of being a crepuscular and at the highest temperature they are nocturnal. Most workers attributed the change in the activity pattern to thermoregulation requirements (Gibbons and Semlitsch 1987).

Various climatic factors like humidity (Shine and Lambeck

1985), Cloud cover (Stewart 1965) and Photoperiod (Yamagishi 1974) apparently do not show any general relation with activity pattern of snakes but rather have some species specific relationship (Semlitsch et.al. 1981).

Hibernaculum fidelity has been reported in several temperate zone species that hibernate in aggregations (Gibbons and Semlitsch 1987). For some species occupation of hibernaculum is apparently a function of environmental temperatures persistent enough to create a change in the thermal gradient within the hibernaculum (Sexton and Hunt 1980), hence relation between environmental factors existing inside the hibernaculum and the activity pattern of snakes is expected.

Apart from physical factors, biological factors like food availability and predator avoidance were also ascribed to be determining the diel and seasonal activity pattern of snakes (Gibbons and Semlitsch 1987). Andren (1982) suggested shift in activity pattern of adder (*Vipera berus)* with response to the food supply. Similarly Shine and Lambeck (1985) investigated activity of file snake (*Acrochordus arafurae)* in Australia where the seasonal shift in activity pattern was attributed to a response to foraging opportunities.

While comparing the activity pattern of Australian and north American snake species, Shine (1979) found out that larger species tend to be active when a majority of the prey items are most active. At the same time, Shine and Lambeck (1985) ascribe activity pattern of Acrochordidae snakes to a response to predators avoidance.

The determinant factor of the snakes activity pattern however, was found to be species specific and could be the result of a combination of ecological, physiological and evolutionary factors.

1.1.2 The Python (*Python molurus molurus* linn):

Reliable information on the ecology of the Indian Rock Python is scanty. However, considerable amount of work has been carried out in captivity on its breeding (Acharjyo and Misra 1978 & 1980, Van Mierop and Bernard 1978, Dattatri 1990), growth rate (Acharjyo and Misra 1980) and behavior (Barker et.al. 1979, Vyas et.al. 1989).

The Indian Python or *Python molurus molurus* (Linn) is the most widely distributed Python species of Indian subcontinent. The python is distributed from Sri Lanka and peninsular India up to Sind in the west and Bengal in the east (Smith 1943, Whitaker 1978, Daniel 1983). Pythons are found in a variety of habitats from cool dense rain forests and mangroves (Daniel 1983) to Dry forest and scrub jungles (Smith 1943, Whitaker 1978, Daniel 1983, Bhupathy and Vijayan 1989), and up to 2000 m above sea level (Sharma & Sharma 1977).

In India, mating of pythons take place in late winter and spring from January to early April (Smith 1943, Whitaker 1978, Daniel 1983, Acharjyo and Misra 1976). While within the present study area Pythons start breeding in the middle of February up to early April (Bhupathy and Vijayan 1989 and Pers observation). Hatching takes place in July-August with onset of monsoon (Bhupathy and Vijayan 1989, Acharjyo and Misra 1979 & 1980, Dattatri 1990). Length at the time of hatching varies from 40 cm to 60 cm (Smith 1949, Denial 1983, Whitaker 1979, Acharjyo and Misra 1979 & 1980; Dattatri 1990). The age of sexual maturity is 3 to 4 years when the snake is 2.18 m (B.C.Choudhury pers comm) to 2.5 m in length (Acharjyo and Misra 1980). Pythons can grow up to 5.8 m in length (Daniel 1983). However, specimens that exceeds 4 m in length are rare (Smith 1943).

Pythons feed on mammals, birds and reptiles indiscriminately, reported food items being Frogs, Toads, Monitor Lizards, Birds, Rats, Hare, Porcupine, Jackal, Chital, and Leopard (Smith 1943, Whitaker 1978, Daniel 1983). However, Bhupathy and Vijayan (1989) states that, birds and mammals constitute the main diet of the pythons in the present study area. Various species have been recorded as prey items of the python, Spotbill duck (Shridharan and Ramchandran 1984), Coucal (Dubey 1985), Purple Moorhen , Painted Stork, Bulbul, Myna, Jackal (Bholu Khan per com), Cotton Teal, Grey Partridge, Redstart, Five Striped Palm Squirrel, Hare and Chital (Bhupathy and Vijayan 1989).

1.3 OBJECTIVE:

i) To record the activity pattern of the python on a diel and seasonal basis.

ii) To investigate relation of climatic and biotic variables with the activity pattern of the pythons.

1.4 HYPOTHESIS :

The central hypothesis in the thesis is that the diel activity pattern of pythons in the study area is related to climatic variables and food availability.

This is further broken in to the following components.

i) The diel activity pattern changes with season.

ii) The diel activity pattern of the Pythons is influenced by environmental variables.

a) Ambient temperature. b) Ambient humidity. c) burrow micro climate.

iii) The diel activity pattern of the Python is influenced by biotic factors like

a) Prey activity pattern. b) Prey abundance.

1.5 THESIS ORGANIZATION:

This thesis is organized into five chapters. The Introduction is followed by a chapter on the study area. Chapter on study area describes the location and the main physical and floristic features of the park and the intensive study area (ISA). Chapter 3 , methods; gives a detailed account of the methods used during the study. Chapter 4, results; describes the findings regarding the hypothesis stated in the section 1.4. Chapter 5, discussion; interprets the results and discusses their significance in relation to biological theory relating to diel activity pattern of the snakes as well as relation to findings from studies carried out earlier on other species of snakes. The main body of the dissertation is followed by the appendices and finally a list of references that have been cited in the text.

Plate 1: A python emerging out of burrow.

CHAPTER 2:STUDY AREA

The study was conducted at Keoladeo National Park (KNP) Bharatpur also known as "Ghana". At KNP the artificial seasonal wetland formed by drainage of Ajan bandh attracts a variety of birds, and is the known wintering ground of western population of endangered siberian crane. The physical and floristic feature of the park are discussed below.

2.0 PHYSICAL ENVIRONS :

2.0.1 Location:

The study area, Keoladeo National park situated between 27' 7.6' to 27' 12.2' N and 77' 29.5' to 77' 33.9' E, is two Km south-est of Bharatpur city. 38 Km South-west of Mathura and 50 Km from Agra. The park, situated at the confluence of the rivers Banganga and Gambiri (Ali and Vijayan 1986).

2.0.2 Boundary:

A masonry wall around the borders separates the 29 Sq.Km park from the surrounding agricultural fields. There are about 14 villages around the park (Fig 1).

2.0.3 Landmarks:

The park is divided into 15 blocks which are separated by dykes or bunds. The park is well knitted with a number of roads and paths. A tar road from main entrance to the Aghapur chowki divides the park into eastern and western half (Fig 1).

There are three major temples in the park namely Keoladeo, Sitaram, and Sotanwala. Human settlements are there in block A and

N. Two major canals pass through the park, Chiksana canal and Ghana canal which are the major source of water to the park (Fig 1) (Ali and Vijayan 1986).

2.0.4 Topography:

The total area of the park is about 29 Sq.Km. It is flat with a genteel slope towards the center forming a depression which constitutes the wetland, the total area of which is about 8.5 Sq.Km. The average elevation of the park is 174 m from mean sea level (Ali and vijayan 1986).

2.0.5 Soil:

Thick alluvial dominates the area. Patches of saline soil are also present. Distribution of saline soil is shown in Fig 1.

2.0.6 Climate:

2.0.6.1 Temperature: Data from 1975 to 1981 have been considered to investigate temperature trends. The average lowest temperature 3.38' C was recorded in January while the highest 46.6' C was recorded in June. The lowest temperature 2.6' C recorded during 1975 to 1981 was in january 1980 while the highest 47.8' C was recorded in june 1981 (Appendix 1, Fig 2) (Ali and Vijayan 1983).

During the study period between Nov 1990 to April 1991, the lowest temperature recorded was 4' C in January while highest temperature 46' C recorded was in April (Appendix 2, Fig 3a).

2.0.6.2 Humidity: The mean monthly humidity varies from 44 to 74% RH. The lowest was recorded in the month of April and highest in November (Ali and Vijayan 1986). During the study period minimum humidity was recorded in March 18%, while maximum was recorded in January 75% (Appendix 3, Fig 3b).

2.0.6.3 Rainfall: The information available from the past studies (Ali and Vijayan 1983) it appears that most of the precipitation in Bharatpur is from South west monsoon which sets in by the end of june and continues up to september. The average mean rainfall ranged from 27 to 52 cm between 1982 and 1985 (Appendix 4: Fig 2). The peak period of rains is usually August.

2.1 BIOTIC FEATURES:

2.1.1 Vegetation:

The vegetation at KNP can broadly be classified in to two- aquatic and terrestrial (Ali and Vijayan 1983, Perennou and Ramesh 1987). The terrestrial vegetation is close to the Babul forest described by Champion and Seth (1968) under the northern dry mixed deciduous forest.

On the whole 282 species of plants have been identified in the park, consisting 41 species of trees, 32 of shrubs, 156 of herbs, 24 of climbers and 39 of grasses (Ali and Vijayan 1986). Detailed account of the flora of KNP is given in Ali and Vijayan (1983).

2.1.2 Fauna:

Vijayan (1987) gives detail list of fauna of KNP. The reported Icthyofauna consist of 50 species of fish while the herpetofauna consists of 5 species of amphibian, 7 species of turtles, 8 species of lizards and 13 species of snakes. Reported snake species are Indian Python (*Python molurus*) Common Sand Boa (*Eryx conicus*), Jhon's Sand Boa (*Eryx johni*), Common Wolf Snake (*Lycodon auticus*), Common Kukri (*Oligodon arnesis*), Checkered Keelback (*Xenochrophis piscator*),Rat Snake (*Ptyas mucosus*), Cat snake (*Boiga trigonata*), Common Krait (*Bungarus caenuless*), Cobra (*Naja naja*) and Russell's Viper (*Vipera russelli*). Except russells viper and Kukri Snake all other snakes species were either noticed or their signs noticed during the study period.

Apart from the above mentioned lower vertebrate, 317 species of birds and 27 species of mammals have been reported from the park.

2.3 DISTRIBUTION OF PYTHON :

The locations where pythons and their signs were noticed are termed as python points (burrows) in this study (plate 1). Pythons were generally found in the saline patches, where porcupine burrows are available. Other than porcupine burrows pythons also use termite mounds and hollow trees as winter shelters (■,Fig 1).

Ali and Vijayan (1986a) and Bhupathy and Vijayan (1989) identified 46 such python points in KNP. However, during the study only 45 python points were identified out of which on 27 Points pythons were sighted at least once in the study period . While at 18 points python signs in terms of slough or tracks were noticed (Appendix 5).

Moreover, few sighting of pythons have also been recorded far from this holes in wetland area specially during later stage of the study period.

2.4 THE INTENSIVE STUDY AREA (ISA):

The study was conducted in an approximately 0.5 sq.Km area of KNP (Fig 1; 4). The broad future of the ISA are given below.

2.4.1 Location:

The Intensive study area was located at "Khanpura " area of KNP. The ISA consist of part of three blocks namely E,F,and I (Fig 1 and 4). The intensive study area was consisting of 8 Python holes, these holes are referred here as P1,P2,P3,P3A,P4,P5,and P6 (Fig 4).

2.4.2 Soil:

Majority of the area has thin saline soil cover (plate 2) whereas, thick alluvial soil is present on the periphery of the ISA where woodlands grasslands and wetlands are present.

2.4.3 Vegetation:

The vegetation of ISA resembles the *Salvadora* shrub described by Champion and Seth (1968) under shrub forest . However, the vegetation can be classified as dry scrub jungle (Ali and Vijayan 1987). The major plant species found in the ISA are *Salvadora persica, S.oleoides, Capparis sepiaria, Prosopis juliflora* and *Acacia nilotica* (Ali and Vijayan 1987; Bhupathy and Vijayan 1989).

The 20.2 hectors of the ISA was grided into 50 m grids and the vegetation categories were mapped. The details regarding the vegetation of ISA is given in appendix 6.

2.5 JASTIFICATION FOR SELECTION OF ISA:

The selection of ISA was based on the following criteria.

a) Feasibility of method : The method selected to investigate the diel activity pattern involved monitoring of the indirect evidence like tracks. The chances of getting tracks depend on the presence of soil hence the area for study should have thin loose soil which can highlight the python tracks. The method involved intensive monitoring of track by day and night, hence the ISA was selected which is safe as well as accessible.

b) Population of python: The probability of getting tracks also depends on the number of pythons present in the area. Previous study conducted by Ali and Vijayan (1986a) and Bhupathy and Vijayan (1989) reports that python point area (ISA) has maximum number of pythons (Approximately 30-40 individuals). The census conducted by forest department and the author during the study period also suggested similar results.

c) Disturbance: Disturbance can cause considerable change in the diel activity, hence while selecting the ISA this aspect was taken in to consideration. Enquiries with concerned people during pre sampling survey revealed that disturbance is even in majority of the areas hence this criteria was overlooked there after.

Fig.1 General features of Keoladeo National Park

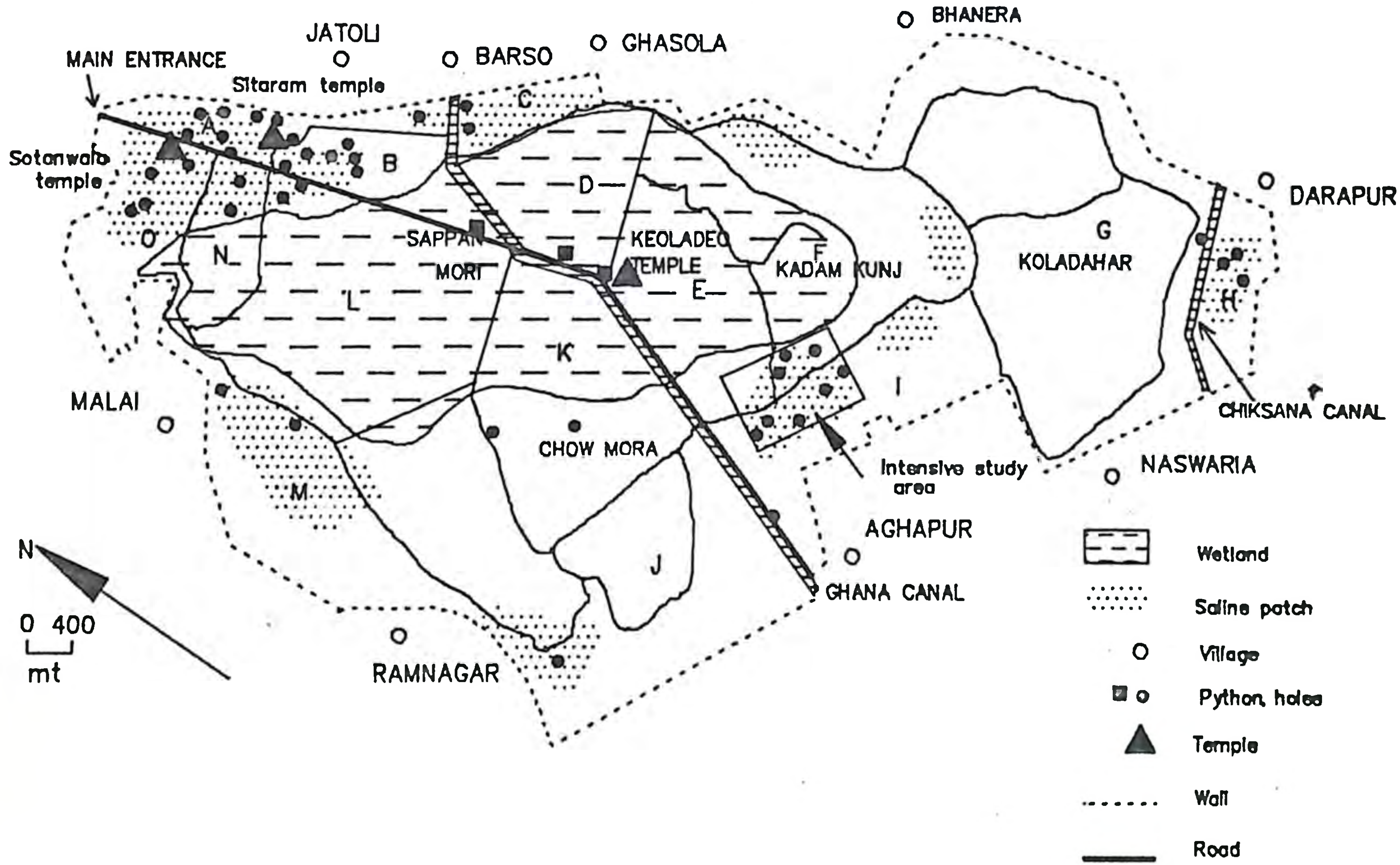


Fig 2: Monthly Mean Temp\Ppts at KNP.
(Adapted from Ali & Vijayan 1986)

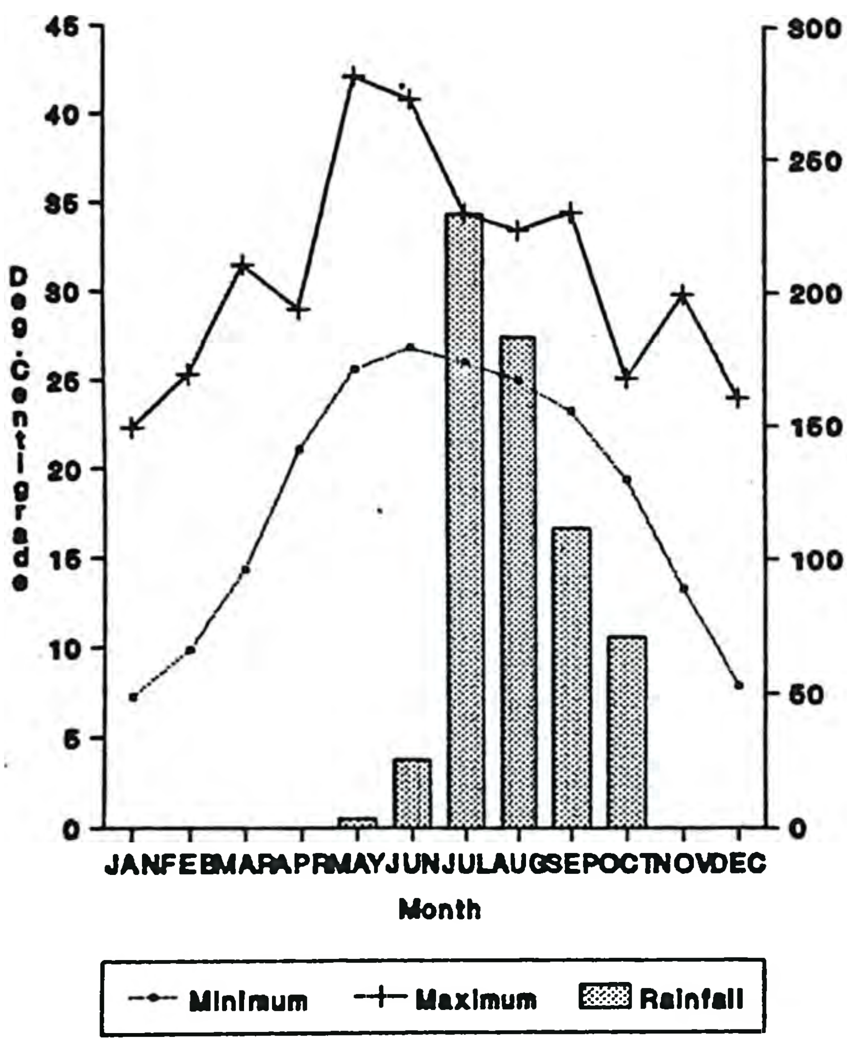


Fig3a: Weekly Fluctuation of Temperature
During study Period

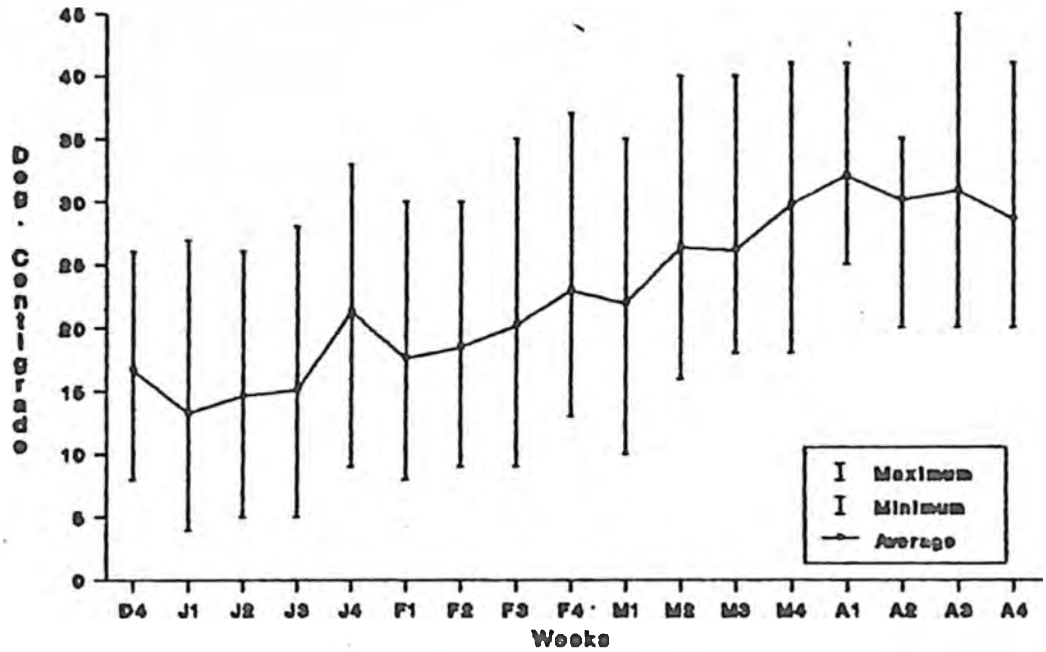


Fig3b: Weekly Fluctuation of humidity
During study Period

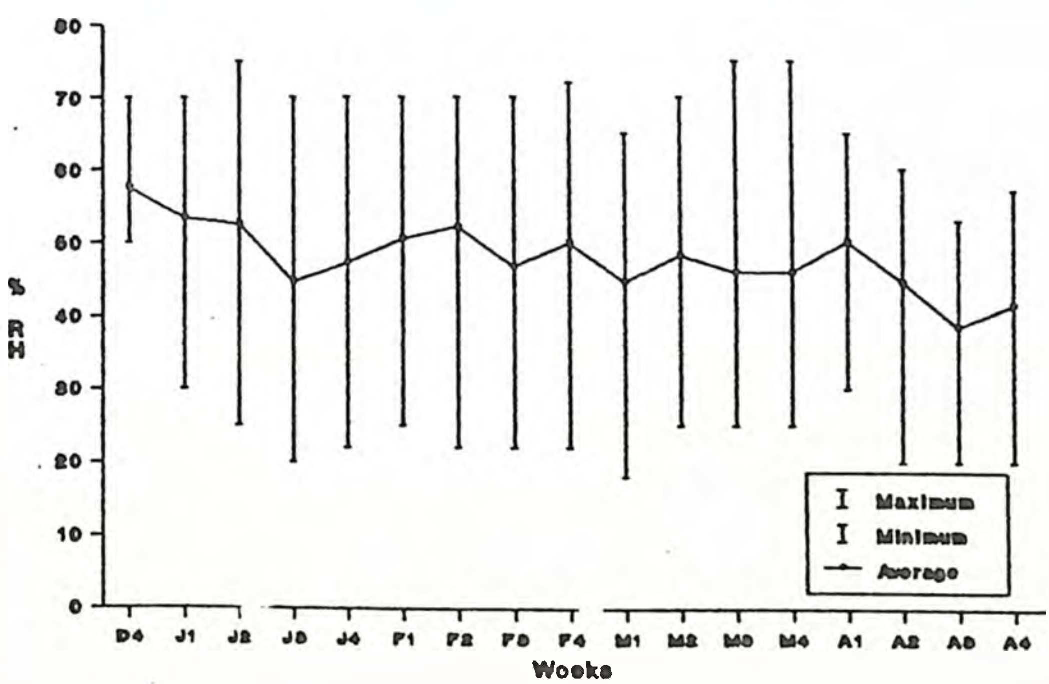
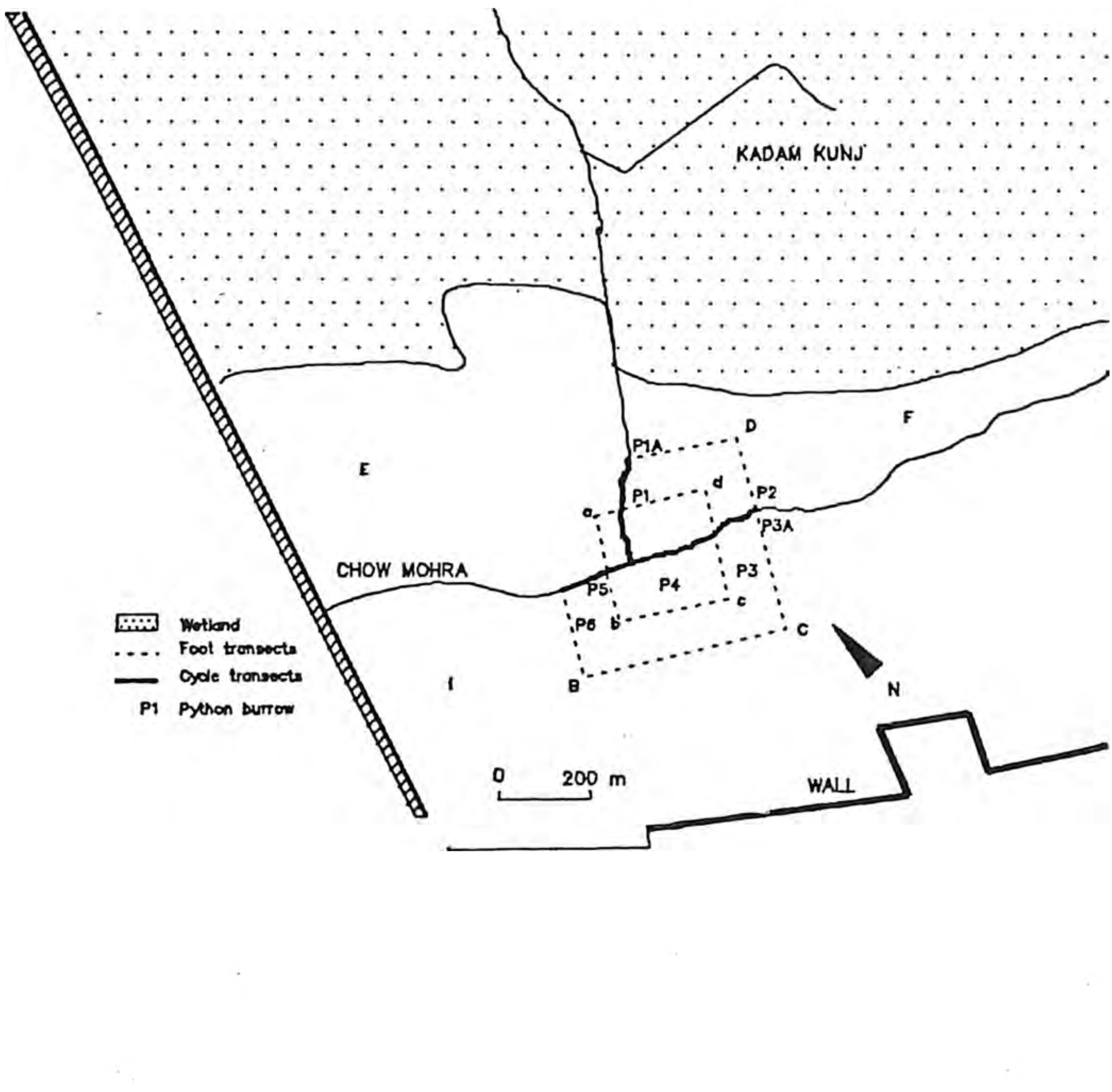


Fig.4 Map of intensive study area with transects and Python burrow shown



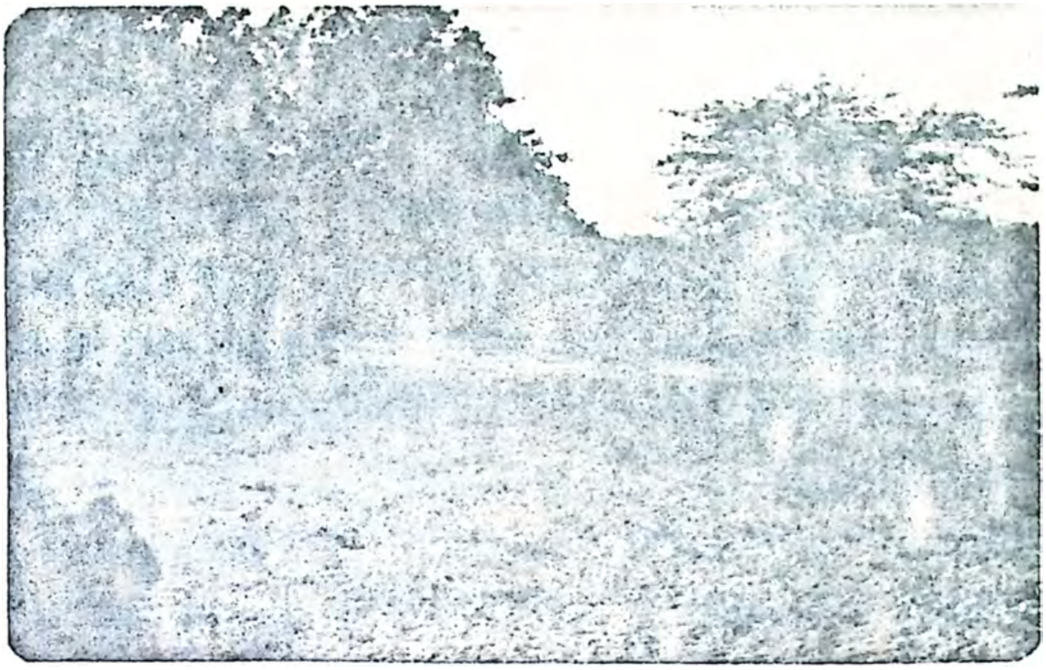


Plate 2: The intensive study area. A typical python habitat.

Plate 3: A python track. Arrow depicts direction of movement.

CHAPTER 3: METHODS

To know the activity trends of snakes numerous methods have been employed like use of radio tagging, trapping, road sampling, transect count and studying the snakes in simulated conditions. The employed methods give information about activity in different level. The diel activity can be measured in indices like active, inactive to the details of proportions of time spent on different activities on seasonal as well as diel basis.

Temperature sensitive radio tagging of the snakes has proved to be highly effective method to investigate relation between diel activity and the various factors (Gibbons and Semlitsch 1987).

In the present study field work from November, 1990 to April 1991 was concentrated on documenting:

(i) The diel activity of pythons in different seasons.

(ii) The diel and seasonal variations of factors which are likely to affect the diel activity of pythons. Ambient temperature and relative humidity, burrow microclimate in form of its temperature and humidity and biotic factors in terms of major prey's activity and preys availability (relative abundance) in season.

In this chapter the field as well the analytical methods used for fulfilling the objectives are described.

3.1 DIEL ACTIVITY OF PYTHONS

The methods employed to estimate diel activity of pythons is similar to methods employed by Bider (1968) and Metzger (1973) to know diel activity pattern of a population of animals.

3.1.1 Field methods:

In intensive study area (Fig 1) two square transect were laid. The relative positions of all python points with respect to the transect in ISA are shown in Fig 4. In outer square (ABCD) part of transect from road near P1 to road near P6 was not sampled as the soil cover there was not conducive for getting indirect evidences in form of tracks and sighting of pythons. The total length of outer square transect (ABCD) was approximately 1.4 km (Road to B-240m, BC-450m, CD-450m and D to Road-240). The inner transect (abcd) was of 1km in length with sides of 250m each.The existing mud road passing through the ISA was used as a bicycle transect and was monitored regularly on bicycle after completion of foot transect.

A day was divided into six four hourly time classes starting from 0000 hrs. to 2400 hrs. The above mentioned transect were walked every fours hour for sampling the diel activity of pythons. The day and night time classes were sampled on two subsequent dates.

During sampling for diel activity pattern on transect two parameters were noted.

(i) Indirect evidence of activity in form of number of fresh tracks (plate 3) encountered on transect every four hours. In order to avoid double counting of tracks during each sampling the fresh tracks were either obliterated or marked.

(ii) Number of sightings of pythons and their activity at the time of sighting.

3.1.2 Analytical method:

The basic assumption involved here is that the frequency of encountering of fresh tracks on the permanent transect is a function of the actual activity level existing in the population.

The activity level for time class t can be measured as activity index which is expressed as:

$$AI = \sum_{1}^{n} Tr/n = \text{Tracks/Sampling efforts}$$

Tr is number of tracks encountered in the time class t and n is the number of sampling done in the time class t.

Preliminary sampling was done in the month of November 1990 and the samples after 1 December 1990 were taken for discussion. From 1 December, every month was divided into two halves described here as a period, hence whole study span from 1 December 1990 to 30 April 1991 was divided into 10 such periods. From period December I to February I was regarded as winter whereas from February II to April as summer, as the minimum temperature starts rising from February II half (Fig.3a).

3.2 ABIOTIC FACTORS

3.2.1 Climatic factors

Two climatic variables ambient temperature and abient humidity and its relationship with the diel activity pattern of pythons were investigated.

Ambient temperature and ambient humidity were recorded by thermohygrograph installed in a standard Stevenson screen. The Stevenson screen was located approximately 2 km from ISA.

The ambient temperature and humidity records at 0000 hr, 0800 hrs, 1200 hrs, 1600 hrs and 2000 hrs, on the day of sampling for activity pattern were taken for comparison with the diel activity pattern for the corresponding time classes. Mean temperature and humidity for each time class for each 10 Periods (Ref. sec 3.1.2) were calculated thereafter. All analytical tests were done on these with AI for that particular time class and Period.

3.2.2 BURROW (HOLE) MICROCLIMATE:

Python burrow microclimate in terms of burrow temperature and humidity were measured.

Burrow temperature and humidity at 60cm to 100cm depth of python burrows were measured with help of Thermohygrometer (323i Trace modal England) tied on extensible rod. This variables were consistently measured for two selected burrows P5 and P6 throughout the study.

Mean of burrow temperature and humidity for each time class of each Period was compared with the diel activity pattern for corresponding time class and period.

3.3 BIOTIC FACTORS

3.3.1. Prey activity pattern:

As mentioned in section 1.1.2 birds and mammals constitute major diet of pythons. Birds above Myna size and mammals between squirrel and female chital size were considered as prey of pythons in the present study area. To know the general diel trends in activity pattern of prey in ISA, a basic assumption was made that the number of these prey items encountered on the permanent transect is a manifestation of the activity of the prey.

While walking permanent transect as mentioned in section 3.1.1, number of prey were counted using a tally counter. Mean number of prey encountered for each time class in each Period was assessed as an activity index of prey activity for that particular time class and period.

3.3.2 Prey availability:

The prey species (Birds above Myna size and mammals between squirrel and female chital size) sighted on ground were only used for estimation of prey availability. The availability for each month from December 1990 to April 1991 was measured in the form of relative abundance. Index for relative abundance of prey species was measured as described by Riney (1982).

$$P = Z / 2XY$$

Where, P = Relative abundance for the transect; Z = Number of prey species seen on ground; Y = Length of transect line (here 2400 m); X = Mean sighting distance.

The permanent transect was walked six to eight times from 20th to 25th of each month. Equal number of transacts in the morning and evening were walked.

Availability of rodents was estimated by help of Sherman traps. Sherman traps were used along the transect to trap medium sized rodents (50-150 gms). The locations of such trapping stations are shown in Fig.5. Twenty two Sherman traps are placed for four consecutive nights. The trapped rodents were latter released, at the same site.

The relative abundance index used for rodents availability is: RI = Successful traps / Trap nights.

Trap night = Number of nights * number of traps.

The total prey availability (P*RI) were than corelated to the diel activity of pythons to see the effect of the former on the latter.

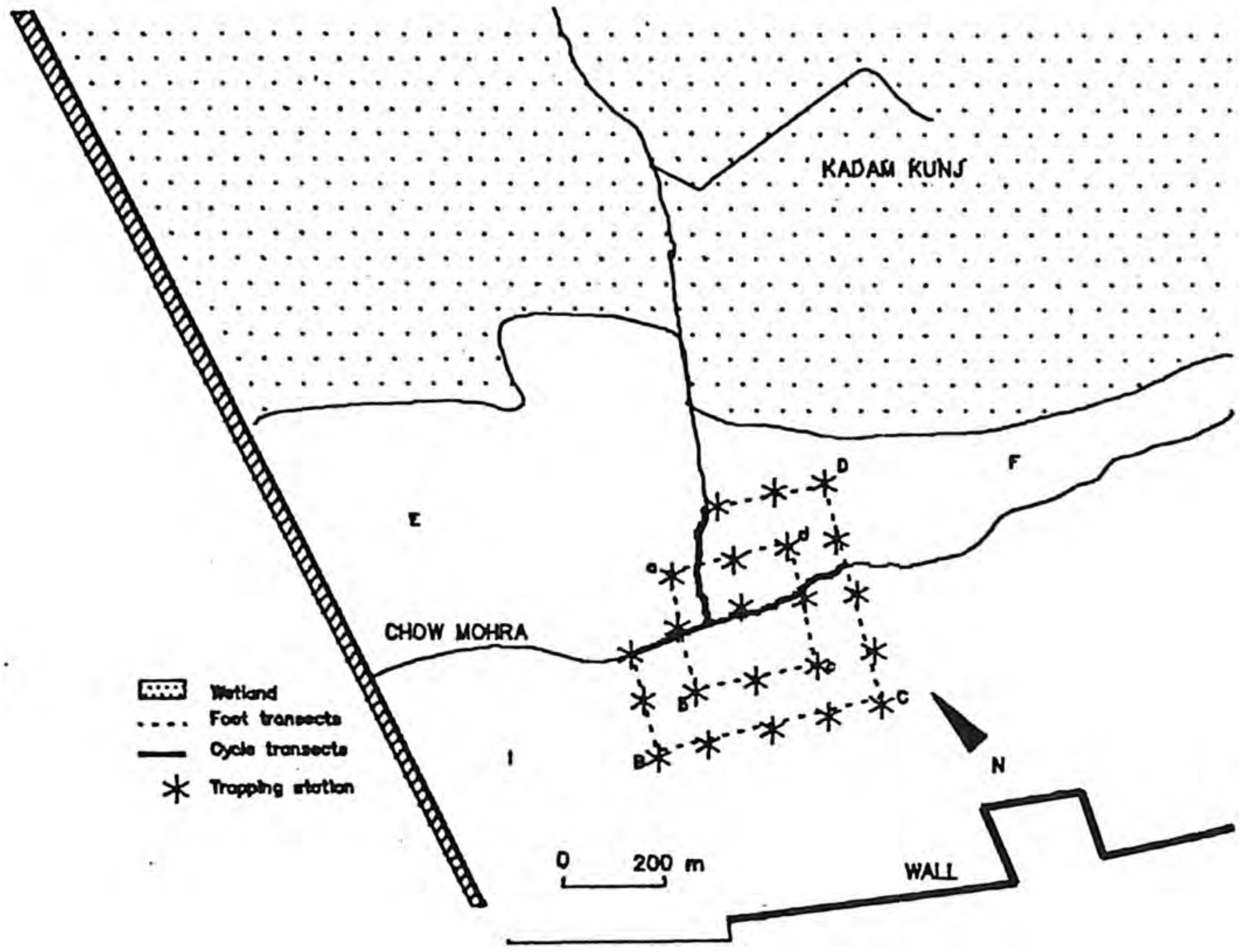
3.4 STATISTICAL ANALYSIS

Because of lack of knowledge about the normality of the sampling as well as small sample size, non parametric statistics have been used in the analysis. However parametric statistics were also applied wherever necessary. Siegel (1956) was used for the non-parametric statistics. Whereas, Sokal & Rohlf (1981) was the main text for parametric statistics.

Because of unknown direction of normality, all tests are two tailed unless mentioned otherwise; a significance level of 0.05 has been used throughout to indicate biological meaning.

Analysis has been done manually as well as by computer statistical package SPSS/PC+.

Fig. 5 Position of Trapping stations



CHAPTER 4: RESULTS

Results of diel activity pattern and seasonal pattern in it are presented first, followed by results of the factors that were collected parallel to the activity pattern. Finally the relation of the activity pattern and the factors are given.

The intensity of sampling for activity pattern of pythons and factors for each time class and period are given in Appendix 7.

4.1 THE DIEL AND SEASONAL ACTIVITY PATTERN:

The number of tracks encountered in each time class and period is given in Appendix 8. Total of 161 tracks were encountered in the ISA during the study duration. While maximum numbers of tracks were encountered in period March I. Maximum of which was seen in the time class 16-20 hrs.

The activity index AI (Ref. section 3.1.1) calculated are given in Table 1. The graphical representation of the diel activity trends are given in Fig.6.

In present study the observed diel activity pattern can be described as following. In fig 6 the diel activity of python is shown for complete study span. The activity peaks in early period (Dec-I) was bimodal, the activity level was low and the peak was at the time of sunrise (4-8 hrs). The second peak though smaller was found in post noon time between 12-16 hrs. There after there exists a shift in the peak activity for next two periods (Dec-II and Jan-I). Both these periods have similar unimodal activity trend; the peaks were at mid noon time (8-16 hrs). In Jan-II the activity spreads towards late hours of the day; two peaks can be observed one at mid noon, other at late evening. In february-I activity was there in early morning and early night. The february-I was a period when there was activity more or less even throughout the day but one distinct peak at sunset time (16-20 hrs)can be observed, the activity ceases at night and again resumes after morning hours. This is typical of spring activity which is evenly spread with little fluctuations. However, in April I and II the activity pattern trend was typical of summer with distinct bimodal activity pattern.

Oneway analysis of variance (ANOVA) was conducted to see the difference in the activity levels in each of the time classes. ANOVA suggests that there is significant difference between activity levels of time classes ($F = 4.7204$ $P = 0.0012$).

Moreover, Kruskal-Wallis analysis of variance was also conducted, the test also suggests similar result that there are significant differences between the activity level of each time class (x^2=19.4280 $P = 0.0016$). Activity was highest in time class 4-8 hrs(AI = 1.5648 -+ 1.4305).

However, the activity levels shift greatly with in a specific time classes of the day to another. Oneway ANOVA conducted on AI by period suggest that there does not exist any difference in activity level of each period ($F = 1.3169$ $P = 0.2527$). Kruskal wallis test also suggest that there is no difference in activity levels of each periods.

The most active period for pythons during the study was February II (Mean AI = 1.5476 -+ 1.4305), the transition between winter and summer.

Sightings of python was also considered as an indication of activity. The maximum sightings (29 individuals) of python occurred in Jan-II in the time class 12-16 hrs, followed by sightings of 24 individuals in Feb II in 8-12 hrs. The sightings of individuals in each time class and period are shown in Fig.7. The fig shows the shift in sighting of individuals by periods as well by time.

Monthly mean activity level[1] was measured to estimate the monthly activity levels. The results of the monthly activity is given in Table 5(a). Maximum activity was observed in the month of March (AI = 1.0933 -+ 0.6761), and minimum activity was found in December (AI = .2727 -+ 0.3138). ANOVA conducted on monthly activity level suggests that there does not exist any difference in activity level of each month (F = 1.316 P = 0.2527).

4.2 THE FACTORS:

In order to see the favorable or most used temperature class, all the observations were pooled and than the mean activity level in each temperature class was measured. Higher mean activity was present in temperature class 16-30' C (Fig 8). However, high amount of variation (Mean AI= 1.08 -+1) in the temperature class 16-20' C was observed hence this class can be ruled out and it can be

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[1]Monthly mean activity level was estimated to correlate it with the total prey availability data which was calculated for each month

concluded that 20-30' C was the most used temperature class.

Ambient temperature, ambient RH, burrow temperature, burrow RH and prey activity pattern were measured parallel to the activity pattern of pythons. Ambient temperature and burrow temperature showed similar trend that during night hours burrow temperature was slightly higher than the ambient temperature. Whereas, at day time burrow temperature was slightly lower than the ambient temperature. The peak of the temperatures were noted during 12-16 hrs time class during winter, which shifts to 16-20 hrs time class in summer. Moreover, trough of temperatures was observed during 0-4 hrs time class which consistently remain same for whole of the study span (Table 2: Fig 9).

Ambient RH and burrow RH showed similar but inverse trend that during day time burrow humidity was higher than ambient humidity. Whereas, at night burrow RH was lower than the ambient RH (Table 3: Fig 10).

The diel activity pattern of prey is shown in Fig 11, the pattern was consistently same for all the periods; there were two distinct peaks at morning and evening hours. moreover, the level of the prey activity decreases with on set of summer.Prey availability was measured in the form of Total prey abundance every month, the results obtained of it is given in Table 5b.

4.3 THE RELATION BETWEEN FACTORS AND ACTIVITY PATTERN:

Pearson correlation coefficient was calculated to see the relation between the factors estimated and the activity pattern of pythons. However, scatterploat between activity index and the factors doesn't suggest any linear relation between them. Moreover, stepwise multiple regression was tried with the current set of data none of the variables (factors) were correlated at Preset P value of .05.

The pearson correlation coefficient calculated for activity index with each of the variables is given in following table:

Factors	Correlation	Relationship	P Value
Ambient temperature	0.1696	+ve	0.225
Burrow temperature	0.2591	+ve	0.031
Ambient humidity	-0.1731	-ve	0.215
Burrow humidity	-0.2555	-ve	0.065
Prey activity	0.2337	+ve	0.092

Owing to the small sample size of the monthly activity index and the prey abundance mentioned in section 4.2, spearman's rank correlation was calculated between monthly activity index and Total prey abundance (Table 5a, 5b). The derived spearman's correlation coefficient was Ts = -0.5 which was not significant at p level of 0.05.

Table 1: Activity Index (AI = $\sum_{1}^{h}$ Tr/n) in each time class and period.

Time class / Period	0-4 hrs [1]	4-8 hrs [2]	8-12 hrs. [3]	12-16 hrs [4]	16-20 hrs [5]	20-24 hrs [6]	Mean AI [95%]
DEC I	0	1.33	0	0.33	0	0	.2478 (± 0.5604)
DEC II	0	*	.33	1.00	0	0	.2664 (± 0.5396)
JAN I	0	0	0	0.67	0	0	.1111 (± 0.2856)
JAN II	0	0	1.33	0.67	1.14	0	.5238 (± 0.6439)
FEB I	0	2	2	0	0.40	0.40	.8000 (± 0.9934)
FEB II	0	.75	1.00	1.33	2.80	.33	1.0361 (± 1.0336)
MAR I	.25	2.75	2.20	0.20	3.29	0.60	1.5476 (± 1.4305)
MAR II	0	1.00	.50	1.00	0.67	0.67	.6389 (± 0.3898)
APR I	0	2.25	1.33	0	1.50	0.33	-9028 (±.9745)
APR II	0	4.00	0.67	0	0.50	0	.8611 (± 1.6423)
MEAN AI	.0250	1.5648	.9367	.5200	1.0295	.2333	
(95% CI For Mean)	(±0.0566)	(±1.0142)	(±0.555)	(±0.3467)	(±0.8414)	(±0.1911)	

Table No.2: Mean Ambient and burrow temperature in each time class and period.

Time class / Period	0-4 hrs A	0-4 hrs B	4-8 hrs A	4-8 hrs B	8-12 hrs A	8-12 hrs B	12-16 hrs A	12-16 hrs B	16-20 hrs A	16-20 hrs B	20-24 hrs A	20-24 hrs B
DEC I	*	*	*	*	*	*	*	*	*	*	*	*
DEC II	9	11.20	*	*	23.0	19.47	24.0	20.20	14.0	14.97	9.33	13.00
JAN I	7.67	12.20	9.33	10.30	19.0	17.83	23.67	21.43	15.25	17.40	7.67	11.23
JAN II	9.25	11.18	18.60	17.38	23.33	24.00	28.33	23.37	17.86	20.33	1.20	17.40
FEB I	11.60	15.76	16.0	17.93	23.0	21.40	26.0	26.08	19.20	20.94	14.40	16.12
FEB II	13.50	15.10	21.75	22.93	23.75	23.25	24.00	21.27	18.80	23.94	15.33	19.00
MAR I	15.25	20.08	18.25	19.08	26.40	24.70	34.40	29.22	22.86	28.36	20.00	20.64
MAR II	23.33	25.84	30.00	29.40	36.90	32.20	36.50	32.70	31.33	32.80	28.00	24.73
APR I	25.00	25.30	27.50	27.88	38.33	36.63	38.33	35.90	32.00	33.38	29.00	31.07
APR II	20.00	22.75	21.50	24.65	34.00	32.73	42.33	41.57	31.50	32.85	25.00	27.75

* No sampaling
A= Ambient
B= Burrow

Table No.3: Mean Ambient and burrow relative humidity (% RH) in each time class and period.

Time class / Period	0-4 hr A	0-4 hr B	4-8 hr A	4-8 hr B	8-12 hr A	8-12 hr B	12-16 hr A	12-16 hr B	16-20 hr A	16-20 hr B	20-24 hr A	20-24 hr B
DEC I	*	*	*	*	*	*	*	*	*	*	*	*
DEC II	51.5	50.2	*	*	48.3	52.4	54.0	54.0	60.0	56.8	68.3	64.2
JAN I	67.0	67.5	57.0	69.0	47.0	47.5	40.6	48.3	46.0	56.0	61.3	68.2
JAN II	63.7	62.1	44.0	46.7	26.3	41.1	26.6	45.5	45.7	50.5	58.7	62.5
FEB I	61.0	56.4	45.0	54.4	31.8	43.1	35.5	41.8	49.6	49.2	60.4	59.4
FEB II	60.5	55.8	46.5	39.2	32.5	49.0	31.6	52.3	51.8	45.2	52.3	59.4
MAR I	56.5	49.5	60.5	54.7	52.2	52.0	29.6	50.5	39.1	46.7	47.4	53.1
MAR II	53.3	56.3	45.0	52.1	33.5	55.6	29.5	55.1	40.6	46.1	53.3	48.7
APR I	57.5	59.2	61.5	62.9	51.3	52.7	42.0	47.0	39.2	42.8	52.0	54.0
APR II	53.0	60.4	47.5	49.7	35.3	46.5	26.6	34.7	31.5	42.3	49.0	59.1

* No sampaling
A= Ambient
B= Burrow

Table-4: Mean number of prey animals encountered in each time class and period (Prey activity index)

Time / period	0-4 hrs	4-8 hrs	8-12 hrs	12-10 hrs	16-20 hrs	20-24 hrs
DEC I	10.33	92.67	68.67	72.00	12.67	2.0
DEC II	2.50	*	15.67	50.00	4.33	1.67
JAN I	2.67	55.00	24.00	74.33	8.50	1.33
JAN II	3.50	62.20	25.67	54.33	12.43	2.25
FEB I	3.20	52.00	36.00	54.00	8.40	1.20
FEB II	1.00	51.75	29.50	47.00	6.00	0.67
MAR I	4.75	53.00	31.00	51.40	21.00	0.80
MAR II	4.33	43.00	36.00	49.50	10.00	1.00
APR I	5.50	34.00	13.67	38.67	11.25	1.67
APR II	8.50	36.00	14.00	35.67	8.75	4.00

* No sampaling.

Table 5 (a): Means of activity level of python for five months

Month	Mean	95% CI for Mean
December	.2727	- .0411 to 0.5865
January	.3175	- .0010 to 0.6359
February	.9181	.3277 to 1.5084
March	1.0933	.4171 to 1.7694
April	.8819	.1023 to 1.6616

Table 5(b): Prey abundance the index for prey availability for five mont during the study period.

Month	Birds and small mammals abundance (Per hectare) (P)	Rodents (per trap night) RI (RI)	Total p avilabl (P*RI)
DEC	16.223/ha	0.0568	.9216
JAN	34.44/ha	0.1136	3.9123
FEB	11.36/ha	0.0909	1.0326
MAR	10.16/ha	0.034	.3454
APR	6.2133/ha	0.0568	.3529

Fig 6: The diel activity of Pythons on seasonal basis.

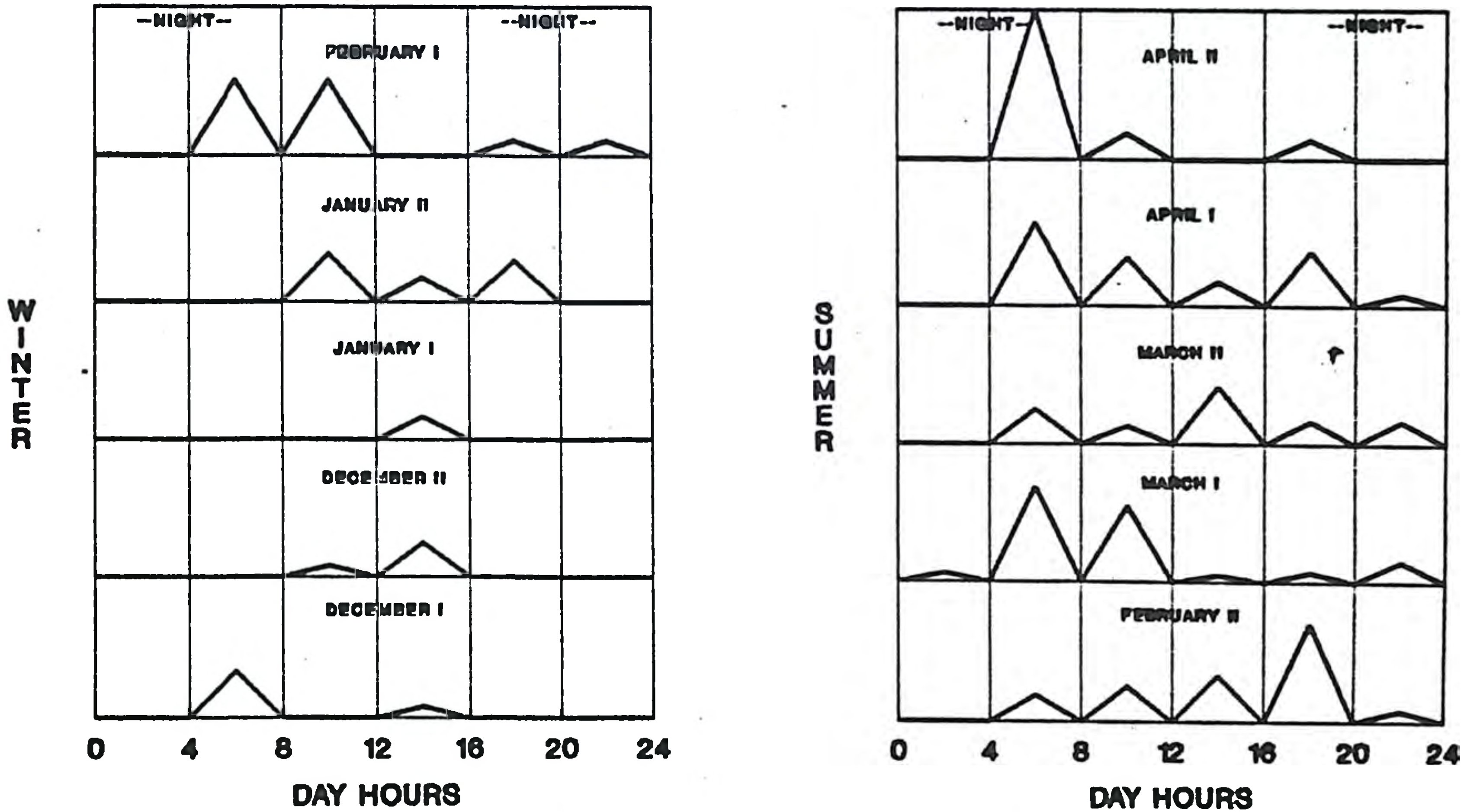
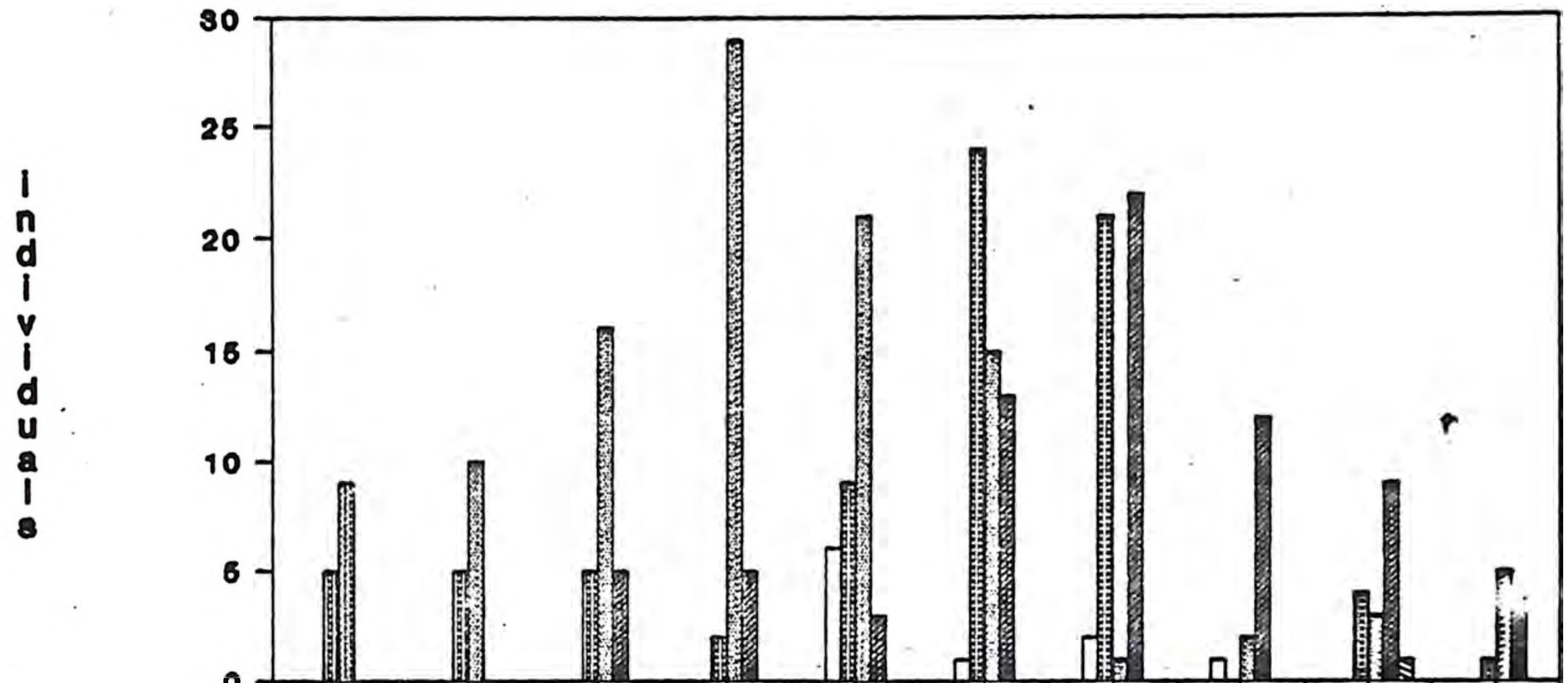


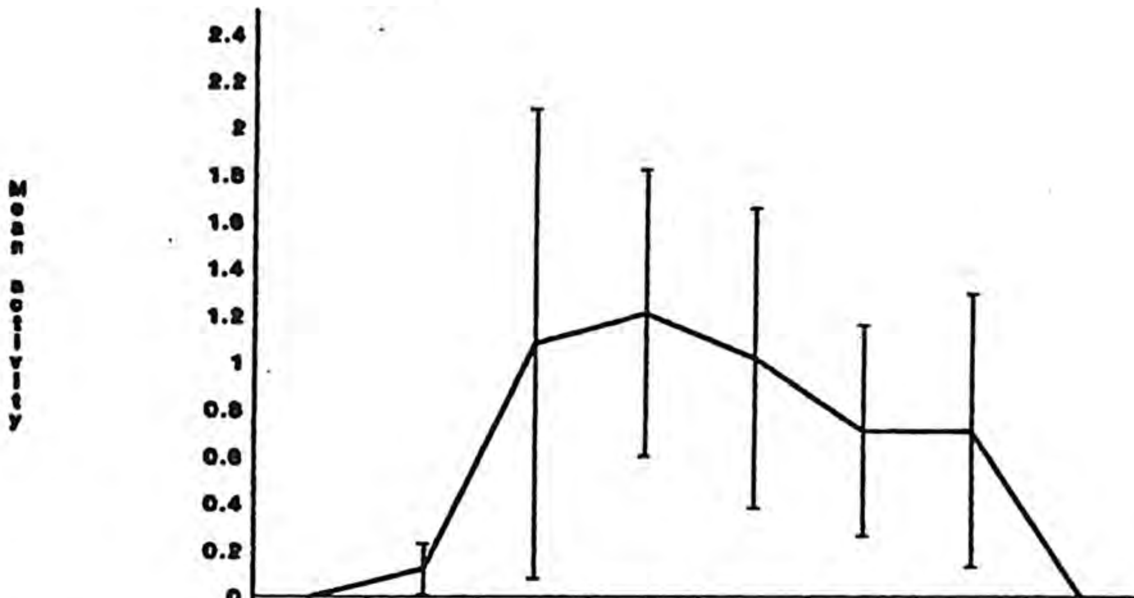
Fig 7 Sightings of python in different time class and period.



	Dec I	DEc II	Jan I	Jan II	Feb I	Feb II	Mar I	Mar II	Apr I	Apr II
0-4 hrs	0	0	0	0	0	0	0	0	0	0
4-8 hrs	0	0	0	0	6	1	2	1	0	0
8-12 hrs	5	5	5	2	9	24	21	0	4	1
12-16 hrs	9	10	16	29	21	15	1	2	3	5
16-20 hrs	0	0	5	5	3	13	22	12	9	4
20-24 hrs	0	0	0	0	0	0	0	0	1	0

Period

Fig 8 Used temperature class for activity.



	5-10.9	11-15.9	16-20.9	21-25.9	26-30.9	31-35.9	36-40.9	41-45.9
Upper CI limit I	0	0.23	2.08	1.82	1.66	1.16	1.29	0
Lower CI limit I	0	0.01	0.08	0.6	0.38	0.26	0.13	0
Mean activity —	0	0.12	1.08	1.21	1.02	0.71	0.71	0

Temp class

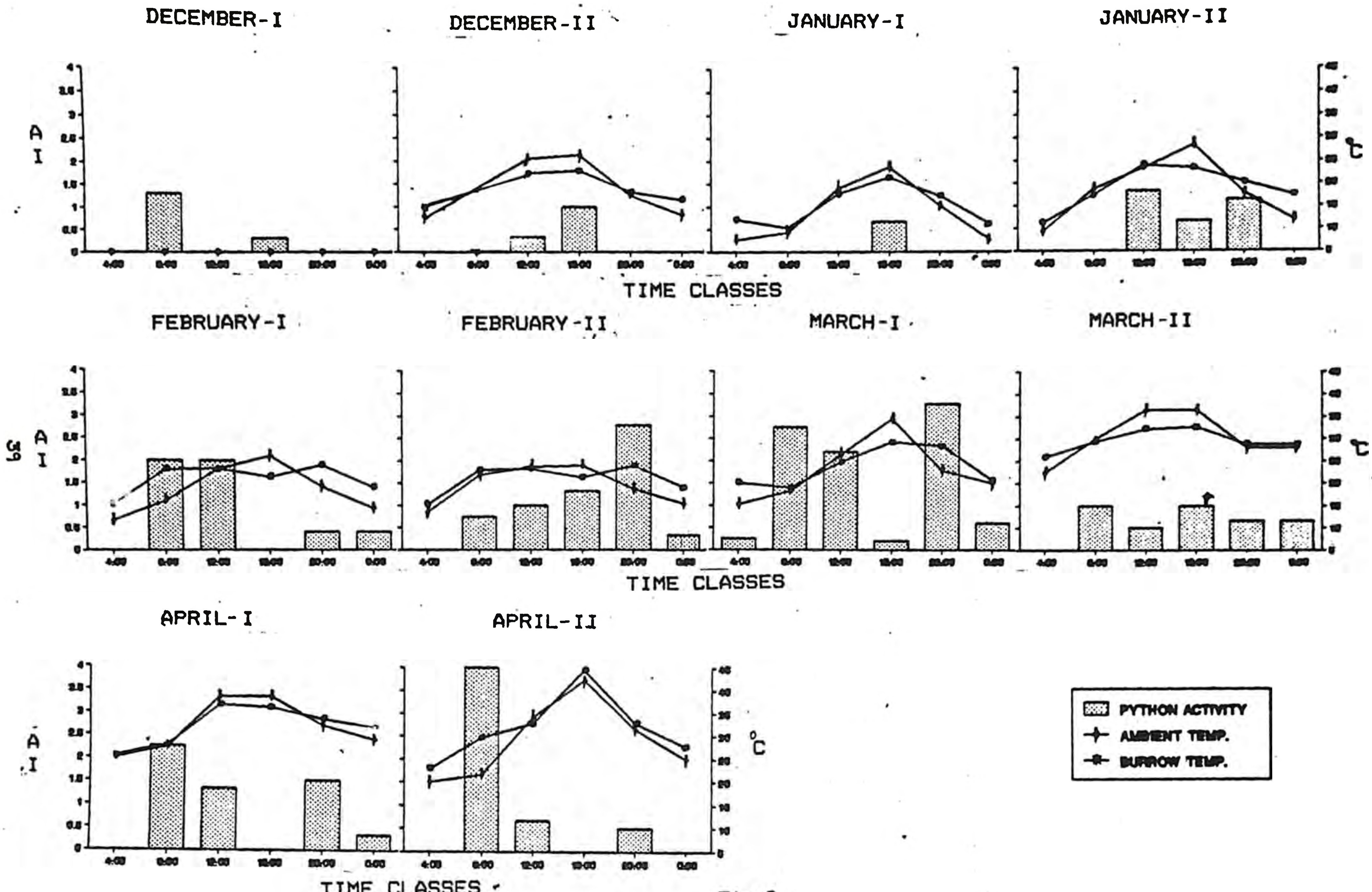


Fig 9: Relationship of Python activity with ambient temperature and burrow temperature

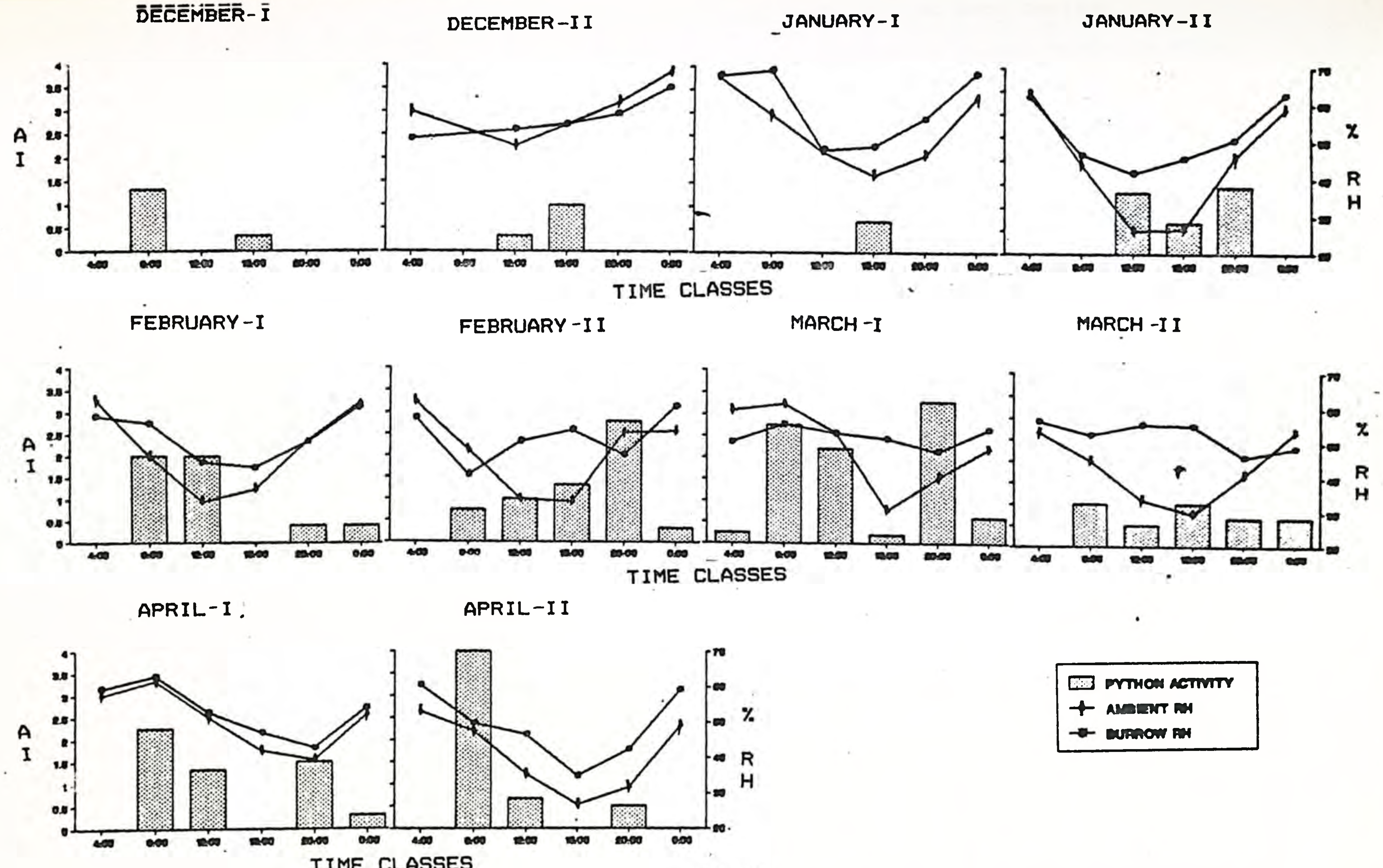


Fig 10: Relationship of Python activity with ambient RH and burrow RH for each period.

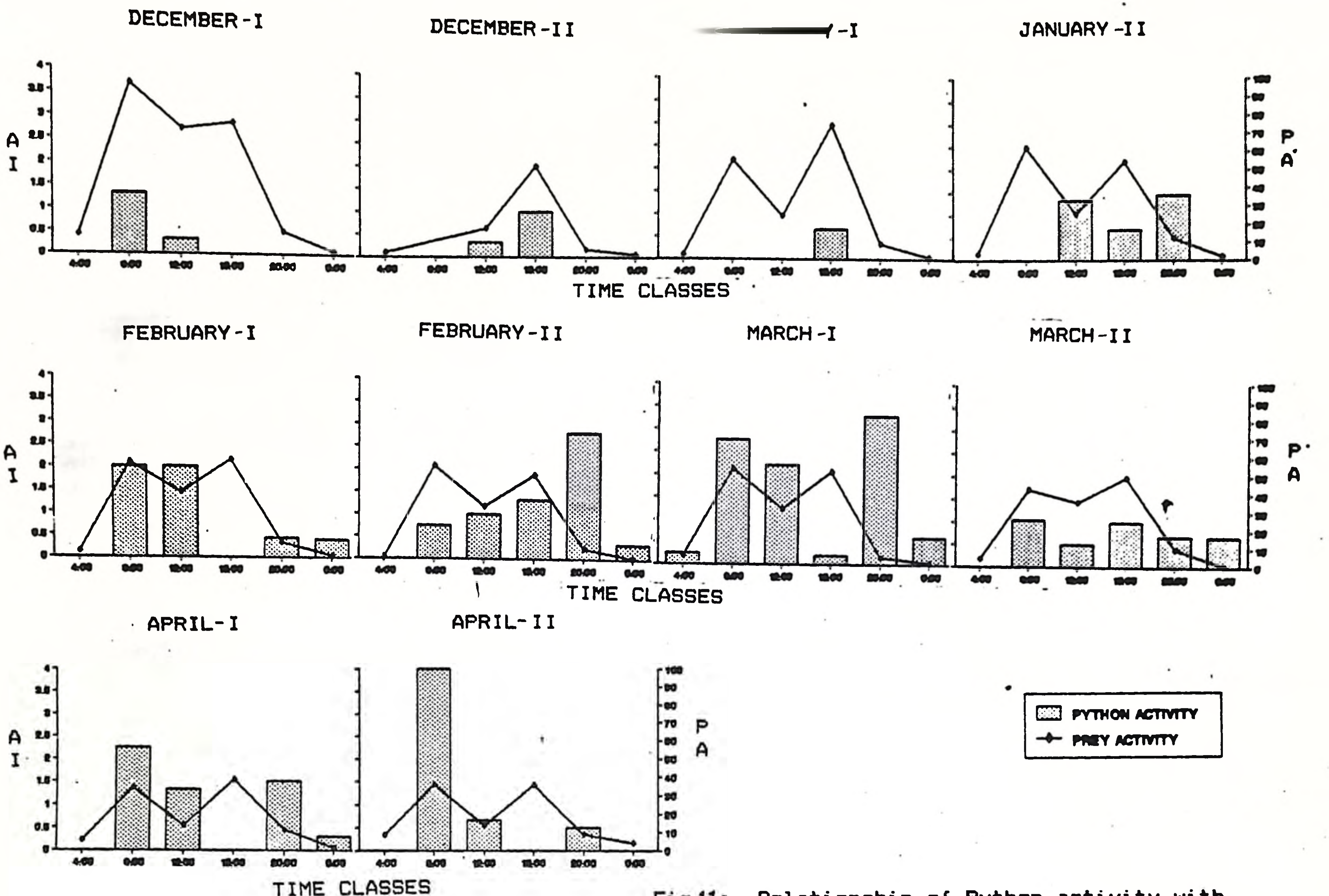


Fig 11: Relationship of Python activity with prey activity for each period.

CHAPTER 5: DISCUSSION

As the central aim of this study was to estimate the diel activity pattern of the python, the obtained results of the diel activity (Hypothesis 1) are discussed first followed by the relationship of diel activity pattern with each of the factors which have been quantified with diel activity pattern (Hypothesis 2). In end the limitations of the methods and the practical applications of the present study are discussed.

5.1 THE DIEL ACTIVITY PATTERN:

The results of the statistical tests applied to the activity (Ref. Sec 4.1) pattern support the conclusion that there is seasonal shift in diel surface activity, and there is significant variance in activity levels within the 24 hours time classes. The variance in activity level of periods however, was not significant.

The observed trend of diel activity pattern is different by many respects from the previous works done on small bodied snakes by Heckrotte (1962), Landreth (1973) and Sanders & Jacob (1980). Python have uniform diel activity pattern in spring which becomes bimodal (crepuscular) in summer. Whereas, the smaller snakes studied by the above mentioned workers had unimodal (nocturnal) diel activity pattern in summer and bimodal activity pattern in spring. The results obtained in KNP does not even agree with the work done by Slip and Shine (1988) on diamond pythons (*Morelia spilota*) in Australia were its movement irrespective of season was found during early hours of the day. Moreover, work done on *Eryx*

conicus a close relative of pythons by Griffiths (1984) demonstrates that the species is exclusively nocturnal. However, results of this study agree with Platt (1969) who found two species of *Heterodon* were active early morning and late afternoon on hot days and primarily active in late morning on cooler days.
However, the trend obtained on diel activity pattern based on indirect evidences (tracks), which is manifestation of only one type of activity--moving. Other than the moving activity there were many other activities like basking and other postural thermoregulatory activities; which can be broadly classified as stationary activities. The sighting data (Fig.7) indicates that during winter sightings of pythons were considerably high, and the sighting frequency tends to decrease with the onset of summer months. The trend from sighting data is totally opposite to the trends got from the tracks data.

The decrease in sighting of the pythons with onset of warmer months can be explained on the basis of two reasons.

a) Emigration of pythons from ISA: The most frequent place where sightings were high were near burrows in winter, which was winter congregation of the pythons similar to described by Brown and Parker (1976) and Brown et.al. (1982) for temperate snake species. By onset of spring, as mentioned by Sexton and Hunt (1980), Jacob and Painter (1980) and Huey et. al. (1989) the availability of precise thermoregulatory microclimate increases and the movement from the hibernaculum commences towards breeding and foraging grounds. Similar event had happened in pythons also as it is evident from the tracks data, that more tracks were encountered during summer periods and sightings at burrows decreased (Appendix 8, Fig 7). These signifies that most of the pythons were moving out of the ISA after spring.

b) Change in basking behavior: The posture of the python which can make it conspicuous is its stretched body while basking. With the onset of warmer months requirement for basking decreases and resulting in a decrease in sightings of pythons during summer. Telemetry work done by Slip and Shine (1988) on diamond pythons also attribute the decrease in sightings in warmer months to the alteration in the basking behavior.

5.2. RELATIONSHIP OF THE ACTIVITY WITH ABIOTIC FACTORS:

In this section all the abiotic factors have been discussed under one heading as it is found that it might create ambiguity in knowing the true relationship between all of these factors if discussed separately.

Looking at the relation of the activity with ambient temperature it should be noted that during certain temperature classes the pythons were activity (Fig 8). The temperature class 20-30'C was found most conducive and it can be referred to as the favorable temperature class for activity. Fig 8. also gives an idea about the theoretical relation between temperature and the activity. The relation found from this figure is curvilinear such type of curvilinear relation between temperature and activity has been noted by many other workers (Semlitsch et.al., 1981, Gibbons and Semlitsch 1987). The relationship is also responsible for not getting significant correlations between activity and temperature.

The trends in activity pattern observed can be explained on the basis of temperature trends up to a certain extent. As would be expected, there was an increase in activity with an increase in temperature as in December II and January II half (Fig. 9). It should be noted that the increase in temperature does not always increase the activity, rather peak activity occurs only at the favorable temperature class (20-30' C). The activity is more dependent on the occurrence of the favorable temperature class in time and space (Grant & Dunham 1988). In winter most activities occurred during middle of the day; as the season progresses, favorable temperature would occur earlier and later in the day or at night. This would result in changes in the diel activity rhythms with change in the periods, the changes being the result of the change in the time of day at which the favorable temperature occurred(Grant and Dunham 1988).

The argument therefore holds good to the relation of activity and temperature only during winter months (December 1 to February 1). Moreover, these periods can be called temperature dependent periods. In summer, activity tends to be completely bimodal; the peaks occur at sun rise and sun set time. This can be explained on the basis of Peterson's (1987) experiment on Garter snakes, he found that during morning snakes warm up quickly and attained preferred body temperature for movement, hence the activity at this time can be observed. The movement (activity) also rises up the body temperature of snakes further (Johnson *et.al*.,1975) and snakes seeks a microclimate where it can radiate out the extra heat which has been attained by movement. Johnson et.al. (1975) noted in Australian pythons that at this stage pythons enter into subterranean environment which is characterized by a stable microclimate. Similar phenomenon was also noticed at KNP, the burrow temperature tended to be little less than ambient temperature (Fig.9) during day time; which further strengthens the theory put forward by Johnson et.al. (1975) and Peterson (1987). Moreover, Peterson (1987) found that the rate of cooling inside the subterranean atmosphere was considerably less than the prior heating rates. This phenomenon is suspected to be cause of lull activity during day time in summer, where some amount of movement can occur in order to utilize available favorable micro-habitats outside the burrow. The results (Fig 9) of this study is not in disagreement with the explanation given above.

The present methodology and results did not examine whether the activity rhythms in python is governed by endogenous factors or not. But, the activity trends during the spring months (Feb & March) can be attributed to one such endogenous factor- the reproductive behavior of the pythons. Early worker (Bhupathy and Vijayan 1989) observed that the mating as well as egg laying season of pythons in KNP is from February to March end. During this period the activity pattern can be expected to be partly governed by reproductive behavior. As there could be considerably large movement in search of mate as well oviposition site by pythons can occur. Moreover, the temperature during this period was more or less uniform throughout the day. Both these factors operating during spring periods reflect the activity pattern as evenly spread throughout the day (Fig.6).

The relationship between humidity and temperature (Fig. 9 and 10) would provide a mechanism for immediate compensation of activity. In general, relative humidity and temperature vary inversely with each other. The increase in RH would in part compensate for the decrease in activity by a temperature drop.

The correlation analysis ($r = -0.1731$ $P<0.05$; Section 4.3), also support the argument of inverse relationship of humidity with activity as mentioned by Heckrotte (1962) and Shine and Lamback (1985). The humidity can significantly affect the desiccation rate of snakes (Heatwole 1975, Lillywhite 1987). The absence of activity during certain time (afternoon time classes) in certain period (February to April) can be explained on the basis of humidity regimes present outside the burrow even though the temperature regimes outside the burrows are favorable . As evident (Fig.10), that very low humidity and high temperature during day time classes can force the python to retire inside the burrow.

The relationship of burrow micro climate is not discussed in detail here as the method employed to quantify the burrow microclimate was found insufficient to give a very realistic picture about burrow microclimate actually used. Though it is evident that burrow provides favorable microclimate to the pythons in all of the periods (Fig 9 & 10) i.e. warmer and drier at night, cooler and moist during day in comparison to the actual micro climate available outside the burrow. Such climatic gradient between burrow and the atmosphere was found affecting the activity pattern of the snakes in many cases (Huey et.al., 1989; Brown and Parker 1976; Jacob and Painter 1980; Sexton and Hunt 1980). It is also known that pythons are considerably active outside the burrow during certain time of day and season even though the physiological conditions are much favorable inside the burrow (Slip & Shine 198.). Such activities can be attributed to the indigenous factors like foraging, body thermal inertia and reproduction.

Whereas, any movement (activity) outside the burrow during much cooler winter months, therefore may be attributed for basking to increase body temperature or inter hole movement done in response to disturbance. Most reptiles including snakes are known not to require food during cold months (Heatwole 1976, Porter 1972). Similarly, movements outside the burrow during summer appears to be for foraging or other endogenous factors such as reproductive behavior.

5.3. RELATIONSHIP OF THE ACTIVITY WITH BIOTIC FACTORS:

In the conceptual model given by Gibbon and Semlitsch (1987), to explain the activity pattern of snake species, two biotic components were greatly highlighted--the prey availability and predator avoidance.

In the present study effect of predator on python was not taken into account as the study by Bhupathy and Vijayan (1989) suspect the presence of any kind of predator of python at KNP. However, Jackal and Hyena may be predating on young and injured adult pythons.

The effect of prey however, was examined in two ways (a) prey activity pattern and b) prey availability. In Fig 11 relationship of prey activity and python activity is shown. During the entire study span the diel activity of prey was consistently the same, with two distinct peaks one in the morning and the other in the evening. The diel activity of the python however, showed great variation (Table 1). Hence the prey activity pattern and diel activity pattern of python showed a very weak correlation (r= .2337 P>0.05).

The extensive review paper by Gibbons and Semlitsch (1987) showed that there is paucity of information on this aspect of snake ecology. However, while comparing the activity pattern of Australian and north American snakes species, Shine (1979) found out that larger species tend to be active when a majority of their prey items are most active.

Prey availability can contribute to python activity pattern. The monthly total prey availability (Table 5b) in the ISA is correlated with monthly activity of pythons (Table 5a,5b; Section 4.3). Spearman's rank correlation coefficient obtained was Ts = -0.6 which is not significant as the sample size is 5 months. The negative relation suggests that as the prey availability increases the python activity decreases. But as this trend is weakly supported by the correlation (p > .05) test no conclusion could be drawn on the basis of this figures. Andren (1982) suggested a shift in activity pattern of adder (*Vipera berus*) with response to the food supply similarly Shine and Lamback (1985) investigated activity of file snake (*Aerochordus arafureac*) in Australia where the seasonal shift in activity pattern was attributed to a response to foraging opportunities.

Pythons during this present study did not show any strong relationship with prey availability as well as with prey activity may be because of their foraging habits in general the python, is a generalis opportunistic feeder. During this study period not a single python was observed feeding. The scat collected were also very few (17). The scanty data suggest that birds constituted 82% of diet and mammals 12%. However, physiological requirement in terms of preferred body temperature for feeding is around 30-32° C (Cogger & Halmes 1960, Webb & Heatwole 1971, Johnson 1972). This may be partly attained during later part, after February II of study, hence food intake during winter can be expected to be very low. Alternatively, the data from Shine (1986) could be used to support argument that foraging frequency is low because of the low energetic requirements and low rate of energy flow in snakes. During cooler months, this theory can be applied further strongly to snakes like python who are ambush feeder unlike active feeder which actually pursue the prey. Hence, all these arguments support the observed inconclusive relationship of python and prey.

Moreover, the methods employed (trapping for rodents and transect count of birds) to quantify the prey availability in KNP were not precise. The low success rate in trapping rodents does not give realistic idea about fluctuations in availability of rodents as well the square transect can give exaggerated figures on the abundance of birds and mammalian prey as a result of possible double counting, this could be one of the reasons for getting negative correlation between prey availability and python activity. Moreover, during winter and spring there was significantly large congregation of prey in ISA when pythons were inactive because of lack of suitable temperature regimes for foraging or other activities.

5.4 LIMITATIONS OF THE METHODOLOGY

While conducting this study the following limitations in the methods were observed :

(i) The timings of sampling - The four hour gaps in sampling give large amount of jumps in collection of diel activity data. The precise time of activity is generally overlooked.

(ii) The chances of getting pythons tracks - Though the saline patch provides such a soil cover in the ISA which can indicate the movement of the pythons in the park, movements in the area with thickets generally escape sampling. Moreover, pythons are found following pheromone trail (moving on the same track) left by other conspecifics. Such movements may also escape sampling.

iii) The precise data on microclimate - Only burrow micro climate was quantified but not the actual microclimate that was utilized by pythons.

(iv) The data on most of the factors were collected on a crude scale which generally can give an unclear picture about the relationship between dependent and independent variables. Many biotic and abiotic factors (e.g., sunshine, day length, soil temperature and biotic disturbances), which can significantly affect the activity pattern, were over looked while doing this study.

5.5 PRACTICAL IMPLICATIONS OF THE STUDY :

Though the study deals with specific ecological aspect of the pythons it can possibly help management in three ways.

(i) By giving baseline information on the activity peaks of pythons: Sightings of this cryptic animal in the park can be improved for 'well behaved' visitors. The data suggest that January could be the best month for watching pythons in the park and the best time could be between 12 hrs to 16 hrs.

(ii) By emphasizing the importance of the saline patch: The saline patch areas in the park which might be considered useless in terms of other wildlife habitat, is the prime habitat for pythons. Hence it demands special protection against disturbance.

(iii) The factor which was not quantified any way was disturbance. It is suspected that disturbance cause by constant presence of viewers on the python holes can considerably change the behavior of the snakes, which eventually can affect the sighting quality as well the activity pattern of pythons in the park.

The suggestions that can be given to management after this brief study are.

a) To provide proper protection to the saline patches and the burrow systems by eliminating exotic thorn bushes e.g. *Prosopis juliflora* and reducing the feral cattle population. On many occasions dead pythons trampled by the cattle were found. Areas with abundant *Prosopis* thorns were avoided by the python therefore removal of such thorns would increase the area utilized by pythons.

b) To control disturbance cause by tourist on the python burrows. This can possibly be done by restricting the visitors to few burrows and educating them through sign boards not to harass pythons by approaching very close to the burrows.

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* Not seen original.

Appendix No.1

Average Temperature for 7 years from 1975-1981 at Keoladeo National Pa

(Adapted from Ali & Vijayan, 1

Month	Minimum temperature			Maximum temperature		
	Lowest	Highest	Average	Lowest	Highest	Average
JAN	3.38	12.00	7.24	17.44	28.11	22.30
FEB	5.10	15.54	9.84	19.40	31.71	25.33
MAR	9.86	20.08	14.34	22.63	37.4	31.47
APR	14.35	27.25	21.01	30.40	44.1	28.96
MAY	21.05	30.58	25.6	35.78	45.64	42.23
JUN	23.3	33.21	26.83	31.35	46.64	40.81
JUL	22.7	29.34	26.04	28.8	39.87	34.31
AUG	22.81	27.44	25.02	28.34	37.02	33.46
SEP	21.10	26.55	23.31	28.21	38.24	34.50
OCT	15.45	23.77	19.45	30.67	37.62	25.18
NOV	9.97	18.32	13.34	23.97	34.36	29.87
DEC	4.75	13.61	7.90	19.44	28.34	24.01

Appendix No.2

Average monthly Temperature during the study period

(December, 1990 - April 1991)

onth	Minimum Temperature			Maximum Temperature		
	Lowest	Highest	Average	Lowest	Highest	Average
ecember Data						
anuary	4	16	8.1	20	31	24.8
ebruary	8	19	11.8	23	40	28.8
arch	10	30	18.3	31	41	36.0
pril	20	30	22.8	38	46	41.4

Appendix No.3

Average monthly RH during the study period (DEC.1990-APR.1991)

onth	Minimum RH			Maximum RH		
	Lowest	Highest	Average	Lowest	Highest	Average
EC						
AN	20	45	29.5	61	75	66.9
EB	22	39	30.25	63	72	[illegible]7.0
AR	18	42	27.2	47	70	62.9
PR	20	40	29.0	50	65	58.1

Appendix No.4

Monthly total rainfall for 1982 to 1985 at Keoladeo National Park

(Adopted from Ali & Vijayan, 198E

Month	1982 cm	1983 cm	1984 cm	1985 cm
JAN	0	16.3	0	0
FEB	0	4.8	0	0
MAR	0	0	0	0
APR	0	25.3	0	0
MAY	8.5	26.7	0	3.1
JUN	10.4	8.6	8.6	25.7
JUL	289.1	63.0	161.1	229.2
AUG	197.7	127.5	142.1	183.0
SEP	32.0	60.0	10.8	111.5
OCT	0	0	0	71.0
NOV	15.6	0	0	0
DEC	9.5	0	0	0
AVERAGE	46.9	27.68	26.88	51.96

Appendix No.5

Distribution of Python holes in Keoladeo National Park

(Ref. Fig.1)

Block	No. of points where signs of pythons observed	No. of points where pythons sighted	Total
A	6	2	8
B	2	7	9
C	-	2	2
D	-	1	1
F	-	3	3
G	1	-	1
H	2	1	3
I	1	5	6
J	-	1	1
K	1	2	3
L	1	-	1
M	-	1	1
N	2	-	2
O	2	2	4
Total	18	27	45

Appendix No.6

Percent occupation of the vegetation categories under different canopy cover at ISA.

(Adapted from Ali & Vijayan 1986)

Vegetation / canopy cover	Prosopis woodlands	Salvadora scrub land	Acacia woodland with dis-continue thickets	Acacia woodland with dense thickets	Tree savanna	% Area under the canopy cover
0.5%	72%	-	-	10%	-	39.5%
5-25%	16.2%	100%	-	-	-	30.8%
25-50%	9.3%	-	-	60%	100%	20.9%
50% & above	2.3%	-	100%	30%	-	8.6%
% Area under the vegetation category	53%	22.2%	8.7%	12.3%	8.6%	

Intensity of sampling for each time class and period

Time class	0-4 hrs	4-8 hrs	8-12 hrs	12-16 hrs	16-20 hrs	20-24 hrs	Total
Period	[1]	[2]	[3]	[4]	[5]	[6]	
December I [1-15]	3	3	3	3	3	2	17
December II [15-31]	2	*	3	3	3	3	14
January I [1-15]	3	3	3	3	4	3	19
January II [15-31]	4	5	3	3	7	4	26
February I [1-15]	5	3	5	4	5	5	27
February II [15-28]	4	4	4	3	5	3	23
March I [1-15]	4	4	5	5	7	5	30
March II [15-30]	3	1	2	2	3	3	14
April I [1-15]	2	4	3	3	4	2	19
April II [15-30]	2	2	3	3	4	2	16
Total	32	29	34	32	45	33	206

* Data not available

Appendix No.8

Number of Tracks encounterd in each time class and period

Time class	0-4 hrs	4-8 hrs	8-12 hrs	12-16 hrs	16-20 hrs	20-24 hrs	Total
Period	[1]	[2]	[3]	[4]	[5]	[6]	
DEC I	0	4	0	1	0	0	5
DEC II	0	*	1	3	0	0	4
JAN I	0	0	0	2	0	0	2
JAN II	0	0	4	2	8	0	14
FEB I	0	6	10	0	2	2	20
FEB II	0	3	4	4	14	1	26
MAR I	1	11	11	1	23	3	50
MAR II	0	1	1	2	2	2	8
APR I	0	9	4	0	6	1	20
APR II	0	8	2	0	2	0	12
Total	1	42	37	15	57	9	161