Reproductive biology of *Pipistrellus mimus mimus* (Wroughton) in the Indian desert

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Abstract

Investigated the reproductive biology of the Pygmy Pipistrelle, *Pipistrellus mimus mimus* (Wroughton) in the western Rajasthan, India. Male bats remain fecund throughout the year. The littering activity is for twelve months, January to December, when 8.3 (November) to 85.0 (August) percent females are found to be pregnant. The litter size varies from 1–3, average being 2.2. Pre embryonic losses in the population varies from 4.5 to 13.5 %, the average being 5.7. No post embryonic mortality was observed. Rainfall has indirect influence over regulation of bat populations through regulating insect diversity and abundance.

A comparison of the reproductive biology of *P. mimus* has been made with *P. mimus* in Nanded (Central India), Calcutta and Ceylon and mammals inhabiting Indian desert in general.

Introduction

The state of Rajasthan which includes over 60 percent portion of the Great Indian Thar Desert (24.5–30.5° N : 60–70° E), harbours a varied and rich fauna of bats, comprising sixteen species spread over two suborders and seven families (Advani and Vazirani 1982). Although some information on feeding behaviour (Advani 1981a, b; Sinha and Advani 1976) is available, there is a large gap in our knowledge about reproduction patterns of bats inhabiting this arid and semi-arid biome of the Indian subcontinent.

In an attempt to fill up this lacuna, present communication deals with results of the investigations pertaining to reproductive biology and behaviour of the Indian Pygmy Pipistrelle, *Pipistrellus mimus mimus* Wroughton, 1899 (Chiroptera: Microchiroptera: Vespertilionidae), which is one of the most abundant bat species throughout India, inhabiting residential environment. The seasonal and monthwise breeding pattern of any bat species has been studied for the first time in the Indian desert.

Material and methods

During various periodical and monthly faunistic surveys, *P. m. mimus* were collected from 1976 to 1980 in Jodhpur (26° 18′ N; 73° 01′ E) and Pali (25° 50′ N; 73° 20′ E), two districts of western Rajasthan. Soon after collection, bats were sexed and dissected. Ovaries and uterine horns of both sides were examined under binocular microscope for the number of corpora lutea and implanted embryos respectively. For detection of lactation, the teats in females were examined. In males, epididymal smears were investigated for the presence of sperms. Data thus obtained during several visits in five years, was compiled monthwise to find out year round fluctuations in the reproductive pattern of this species.

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Results

Female fertility

Pregnant females were collected during all the months of the year from January to December and the prevalence of pregnancy ranged from 0.08 (in November) to 0.85 (in August) the average being 0.45 on an annual basis (Table 1). Two peaks of reproduction activity were observed, one in spring season, February–March and another in post rainy months, July–August (see Fig.).

Table 1

Monthwise break up of the collection of adult females and prevalence of pregnancy during various months

Months	Adult females Pregnant	Lactating	Nonpregnant	Total	Prevalence of pregnancy
January	8	3	14	25	0.3
February	15	4	6	25	0.6
March	14	6	–	20	0.7
April	8	11	1	20	0.4
May	6	9	3	18	0.3
June	10	5	6	21	0.5
July	17	5	1	23	0.7
August	17	3	–	20	0.9
September	10	8	1	19	0.5
October	6	9	4	19	0.3
November	2	7	15	24	0.1
December	2	5	13	19	0.1

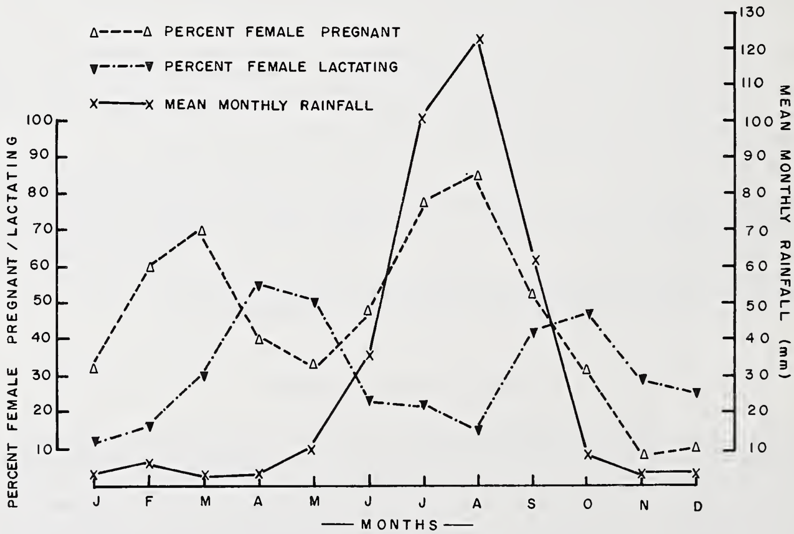

Fig. The reproductive intensity of female *P. m. mimus* in relation to the mean monthly rainfall in the Indian desert

Production of ova

As evidenced from counting of corpora lutea in ovaries of freshly killed pregnant females, the production of ova ranged from 2.0 to 2.3 per pregnant female, average being 2.15 (Table 2).

Table 2

Preimplantation losses in *P. mimus mimus*

Months	Total embryos	Total corpora lutea	Preimplantation loss	Percent
January	16	17	1	5.9
February	31	33	2	6.1
March	28	29	1	3.4
April	15	17	2	11.8
May	12	12	–	0.0
June	20	23	3	13.0
July	34	38	4	10.5
August	32	37	5	13.5
September	21	22	1	4.5
October	12	12	–	0.0
November	4	4	–	0.0
December	4	4	–	0.0
Total	229	248	19	7.7

Litter size

With an average of 2.0, the number of implanted embryos varies from 1.9 to 2.1 per female (Table 3). The highest frequency of litter having three implanted embryos, was observed in February, May, July and September in case of one female specimen in each month. While the lowest number, one, was witnessed in summer months (April and May) and then monsoon months (July and August). However, on an annual basis, left and right uterine horns had about equal numbers of implanted embryos, but the number of corpora lutea was greater in the left ovary than in the right one.

Table 3

Monthwise average number of embryos per pregnant female in *P. mimus mimus*

Months	Total number of embryos	Average number of embryos per pregnant female
January	16	2.0
February	31	2.1
March	28	2.0
April	15	1.9
May	12	2.0
June	20	2.0
July	34	2.0
August	32	1.9
September	21	2.1
October	12	2.0
November	4	2.0
December	4	2.0

Embryonic mortality

Preimplantation losses were determined by comparing numbers of implanted embryos and the number of corpora lutea visible in ovaries under biocular microscope following Rana and Prakash (1979). The pre-implantation mortality ranged from 0.0 to 13.5 the average being 5.7 per month (Table 2). The intensity of loss in left uterine horn was more than double of the right one. Maximum pre-implantation percent loss was observed in August. In all the 115 pregnant females, there was no post implantation losses as evidenced by absence of embryos in mummified stage.

Superfoetation

In March and then in September, as evidenced from relative sizes, the foetuses of different ages were encountered in the two uterine horns of one female in both months with sizes ranging from 1.5 mm to 6 mm suggesting a case of superfoetation.

Male fecundity

As determined by the presence of sperms in the epididymis, the adult male individuals of *P. m. mimus* remain fecund throughout the year, though at a lower rate of only 30 to 40 percent during winter months of December and January. This perhaps may be due to conservation of sperms in winter months.

Sex ratios

The bats were sampled through removal method (Tuttle 1974) in all months of the year. There was about equal proportion of male: female in the subadult stage of *P. mimus* populations but it titled in favour of females (67.7 percent) in the adult stage (Table 4) as also observed by Gopalakrishna et al. (1975) in Central India with adult sex ratio being 64.6 : 35.4 (♀ : ♂).

Table 4

Monthly variations in sex ratios of adults and subadults of *P. mimus*

Months	Adults			Subadults		
	Females	Males	Males %	Females	Males	Males %
January	25	13	34.2	2	2	50.0
February	25	14	35.9	6	6	50.0
March	20	9	31.0	6	7	53.8
April	20	10	33.3	10	9	47.3
May	18	7	28.0	7	7	50.0
June	21	8	27.6	4	4	50.0
July	23	8	25.8	4	3	42.8
August	20	10	33.3	14	12	46.1
September	19	10	34.5	9	9	50.0
October	19	9	32.1	4	6	60.0
November	24	12	33.3	4	2	33.3
December	20	11	35.5	1	1	50.0

Recruitment of subadults

Two peaks were observed one from February to May and another from August to September concerning the percentual recruitment of subadults in the free-living population of *P. minus* (Table 5). The first peak coincides with a peak in percent population of lactating females (Fig.). Among subadults, there was predominance of females (57 %) in the attached young ones, while males were captured in relatively high preponderance (55 %) among free newly weaned subadult individuals (Table 6). Exept in January and December, young ones attached to breasts of females; were collected in all months, whereas, free living subadults occurred in all months though in lower densities in January, July and December. The sexual maturity is attained when the animal weighs 2.0 grams or above in both sexes. After birth, the subadult stage continues per 30–40 days, after which the bat becomes adult and sexually mature.

Table 5

Monthwise percent recruitment of subadults in entire population of *P. mimus*

Months	Adults*	Subadults**	Total	Recruitment of subadults %
January	38	4	42	9.5
February	39	12	51	23.5
March	29	13	42	30.9
April	30	19	49	38.7
May	25	14	39	35.7
June	29	8	37	21.6
July	31	7	38	18.4
August	30	26	56	46.4
September	29	18	47	38.3
October	28	10	38	26.3
November	36	6	42	14.3
December	31	2	33	6.0

* Body weight 2.0 g and above; ** Body weight 0.5–1.9 g (up to 30 to 40 days after birth).

Table 6

Attached and free subadults in the population of *P. mimus* during various months

Months	Subadults			
	Attached		Free	
	♂	♀	♂	♀
January	–	–	2	2
February	4	4	2	2
March	4	4	3	2
April	3	6	6	4
May	5	4	2	3
June	–	3	4	1
July	2	3	1	1
August	8	10	4	4
September	1	2	8	7
October	3	2	3	2
November	–	2	2	2
December	–	–	1	1
Total	30	40	38	31

Discussion

The Pygmy pipistrelle, *Pipistrellus m. mimus* differs from most of the Indian species of bats like *Megaderma lyra* (Ramaswamy 1961) and *Scotophilus wroughtoni* (Gopalakrishna 1947) which have a sharply restricted annual reproductive cycle. However, it resembles the Indian emballonurid bat, *Taphozous longimanus* (Gopalakrishna 1955) and Dormer's bat, *Pipistrellus dormeri* (Madhavan 1978) in having an unrestricted breeding season. In contrast to two peaks of the reproductive activity (May–June and then September–October) obtained in case of *P. mimus* inhabiting Nanded (19° 2′ N; 73° 3′ E) in Central Indian (Gopalakrishna et al. 1975) the populations inhabiting the Indian desert had two peaks in spring (February–March) and then in monsoon months (July–August), with peak values of 70 and 85 percent respectively (Fig.).

The first (February–March) as well as the second (July–August) peaks in the reproduction of *P. mimus* are regulated by abundance of insects in the Indian desert during these periods, coinciding with maturity of winter crop and post rainy months respectively. Termites constitute major component of diet of *P. mimus* (Advani 1981a) which contain 42 percent of protein in their bodies (Phelps et al. 1975), enough for supporting gestation and lactation in mammals (Richardson et al. 1964). At Nanded (Central India) peaks in reproduction were observed in May–June and then September–October, before and after the period of maximum rainfall (1000 mm) respectively. In Calcutta (North-eastern India) two sucklings were found attached to female of *P. mimus* (Sinha 1970), whereas, in Ceylon (Phillips 1922) female carried young ones in March, May and December.

Concerning the reproductive features of desert mammals, Bodenheimer (1957) has mentioned that the littering season in mammals of Saharo-Sindian region is late winter. However, *P. mimus,* though found in Saharo-Rajasthani desert, did not confirm this hypothesis, as it breeds throughout the year, with the reduction in reproductive activity in severe winter months of December and January. Whereas, its reproductive biology is in confirmation with that of predominant group of Tharian mammals, the rodents, among which two peaks in breeding activity have been observed in the spring and then the rainy season (Prakash 1971). However, the reproductive pattern of *P. mimus* differs from the predominant insectivorous species of western Rajasthan, the House shrew, *Suncus murinus sindensis* which has a restricted littering activity of seven months from March to September (Rana and Prakash 1979) and has resultant a larger litter size (avg. 4.7) in comparison to *P. mimus,* perhaps to compensate loss in annual productivity, as shrews are reproductively inactive from October to February.

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Zusammenfassung

Zur Fortpflanzungsbiologie von Pipistrellus mimus mimus (Wroughton) in der indischen Wüste

Die Forpflanzungsbiologie von *Pipistrellus mimus mimus* (Wroughton) wurde im westlichen Rajasthan (Indien) untersucht. Die Männchen sind während des ganzen Jahres fortpflanzungsfähig, und Geburten werden während aller 12 Monate des Jahres verzeichnet. Im Jahresverlauf sind zwischen 8,3 % (November) und 85,0 % der Weibchen trächtig. Die Wurfgröße liegt zwischen einem und drei Jungen, im Mittel bei 2,2. Verluste vor der Implantation betrugen durchschnittlich 5,7 %. Regenfälle beeinflussen die Fledermaus-Population dadurch, daß sie sich auf die Insektendichte und -artenzahl auswirken. Die Fortpflanzungsbiologie von *Pipistrellus mimus* aus Rajasthan wird mit den entsprechenden Verhältnissen dieser Art in Nanded (Zentralindien), Kalkutta und Ceylon sowie mit anderen Säugern der indischen Wüste verglichen.

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Respiratory frequency, total evaporative water loss and heart rate in the Kinkajou (*Potos flavus* Schreber)[1]

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Abstract

Studied heart rate, respiratory frequency and total evaporative water loss in kinkajous *(Potos flavus)*. Mean rectal temperature could be regulated within 35.8–37.3 °C at ambient temperatures from 10–33 °C; when exposed to 35 °C it rose to 38.6 °C. Oxygen consumption was lowest between 23–33 °C (basal metabolic rate 0.34 ml O_2/g·h); this is only 71 % of the expected mass-specific value. At ambient temperatures below the thermoneutral zone O_2-uptake increased following the regression line: Y (ml O_2/g·h) = 0.698 − 0.015 T_a (°C). Mean resting heart rate was lowest between 23–28 °C with about 78 beats/min; a minimal rate was measured at 23 °C with 68 beats/min. The mean oxygen pulse was at 170–182 µl/beat at temperatures from 28–35 °C; it rose to 245 µl/beat at T_a = 10 °C. Mean breathing rates during sleep were at 12 breaths/min when exposed to temperatures from 23–30 °C. Lower temperatures led to a slight increase only. At T_a = 33 °C respiratory frequency rose to 29–80 breaths/min and at 35 °C panting started when the rectal temperature had reached a threshold value between 37.5–38.1 °C. Maximal panting rates were at 480 breaths/min. Between 10–25 °C mean total evaporative water loss was at 0.37–0.46 ml/kg·h. During continuous panting it increased to about 1.5 ml/kg·h. However, heat dissipation through evaporative pathways was low: At T_a = 33 °C only about 30 % of the endogenous heat production were dissipated by evaporation and this ratio even diminished during panting due to the simultaneous increase of oxygen uptake.

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