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Female reproductive cycle of *Nycteris thebaica* (Microchiroptera) from Natal, South Africa

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Receipt of Ms. 23. 6. 1981

Abstract

Investigated monthly changes in the female reproductive organs and the reproductive cycle of *Nycteris thebaica*. Monthly changes in ovarian and vaginal activity were characterized by two peaks. The first, between April and early June, culminated in estrus, while the second, occurred between July and August during pregnancy and is thought to be a relict from polyestrous ancestors. The reproductive cycle was characterized by copulation and fertilization in early June, a five month gestation with parturition in early November, approximately two months of lactation, and a period of anestrus between termination of lactation and onset of proestrus in April.

Introduction

The family Nycteridae includes a single genus of about ten species that occurs in Africa south of the Sahara and in Egypt, Israel, Arabia, and on Madagascar. One species, *N. javanica*, occurs in Malayasia (HAYMAN and HILL 1971). Perhaps as a result of all but one species of this family occurring in Africa, a continent on which study of chiropteran biology has been limited, it has received little attention.

No aspect of the estrous cycle or associated changes in the female reproductive tract have been described although the reproductive cycles of tropical members have been reported. The tropical reproductive cycle is characterized by monotocy, polyestry with post-partum estrus between pregnancies, and a gestation of between two-and-a-half and three-and-a-half months.

In the present study area *N. thebaica* was present at coastal localities throughout the year but at inland areas occurred only during winter, between April and September. Migration did not occur between known coastal and inland localities and the summer roosts of the inland populations were not found.

In the present study area it has been shown that hibernation occurs in *Rhinolophus clivosus* (LAYCOCK 1976), *Miniopterus schreibersi* and *M. fraterculus* (BERNARD 1980a) and

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Z. Säugetierkunde 47 (1982) 12–18

ISSN 0044-3468 / InterCode: ZSAEA 7

Hipposideros caffer (BERNARD 1980b). The reproductive cycles of *Rhinolophus clivosus* (LAYCOCK 1976) and *Myotis tricolor* (BERNARD 1980b) include a period of sperm storage and delayed ovulation during winter, those of the two *Miniopterus* species include a period of delayed implantation during winter (BERNARD 1980a) while that of *Hipposideros caffer* includes a period of retarded embryonic development during winter (BERNARD 1980b).

Nycteris thebaica did not hibernate in the present study area during winter and the aim of this study is to describe the estrous and reproductive cycles of this species and to see if and how they have been modified when compared with the tropical reproductive cycle.

Materials and methods

63 specimens of *N. thebaica* were collected from four roosts (caves and disused mines) in Natal (c. 29° S) during 1977 and 1979.

Specimens were killed by asphyxiation with carbon dioxide and the female reproductive tract removed under a dissecting microscope. Tissues were fixed in Bouin's fixative and stored in 70 per cent alcohol. After routine embedding sections were cut at 5 µm and routinely stained with Ehrlich's haematoxylin and eosin.

Description of the estrous and reproductive cycle has been based on an histological examination of monthly changes in the ovaries, uterine horns, and vaginas. All microscopic measurements were made with an optical micrometer. Follicular diameter was calculated from two measurements taken at right angles to each other, so that one measurement always included the greatest diameter. Mean thickness of the uterine horn wall, endometrium, and vaginal epithelium were calculated from about ten measurements per specimen.

Where sample size was more than ten, mean values have been given plus or minus two standard deviations. Where sample size was less than ten, the mean alone has been given.

Results

Monthly changes in the ovaries

Monthly changes in ovarian activity were quantified by measuring the diameters of all secondary and Graafian follicles and plotting mean monthly diameters (Fig. 1). In *N. thebaica* there was a marked difference in mean monthly follicular diameters from the two ovaries and for this reason they have been treated separately. In *N. thebaica*, which was monotocous and monestrous, there were two periods of Graafian follicle development.

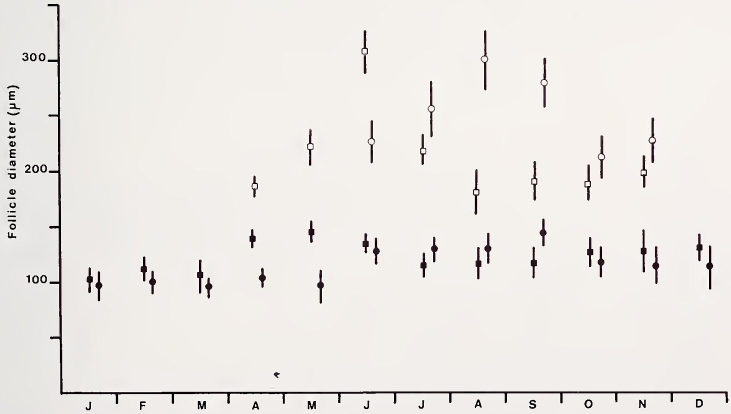

Fig. 1. Monthly changes in secondary and Graafian follicle diameter. Open symbols indicate mean monthly Graafian follicle diameter and closed symbols mean monthly secondary follicle diameter. Square symbols are measurements from the right ovary, circles from the left. Vertical lines represent $\bar{X} \pm 2SD$

The first, between April and June, occurred in the right overy and resulted in an ovulation in early June, while the second period occurred in the left ovary between July and August and did not result in an ovulation.

The corpus luteum of *N. thebaica*, which was at least partially extruded from the ovary, was seen in one specimen collected in early June and four in July, but was absent from specimens collected during the remainder of the gestation. The diameter of the corpus luteum increased between early June and early July and decreased between early and late July (see Table). The corpus luteum comprised one type of luteal cell which was characterized by a large, faintly stained nucleus and prominent nucleolus. The mean diameter of the luteal cells decreased slightly between early June and early July, although their appearance remained constant, and decreased markedly between early and late July (see Table).

Table

Changes in mean corpus luteum and luteal cell diameters in micrometres

Showing increasing corpus luteum diameter between early June and early July and decreasing diameter between early and late July

Date	No.	Mean corpus luteum diameter	Mean luteal cell diameter
6–6–'79	1	390,0 µm	13,7 µm
2–7–'79 7–7–'79	3	516,3 µm	13,0 µm
24–7–'79	1	390,0 µm	9,7 µm

There was very little interstitial gland tissue in the ovaries of *N. thebiaca* and its cells, which were small with prominent nuclei, underwent no noticeable change in size or appearance during the year.

Monthly changes in the vagina

Monthly changes in the vagina were quantified by measuring thickness of the vaginal epithelium and plotting mean monthly thickness (Fig. 2).

In *N. thebaica* there were two periods of epithelial development, both of which coincided with development of Graafian follicles in the ovaries. Between October and March there were no cell divisions in the stratum germinativum and the epithelium

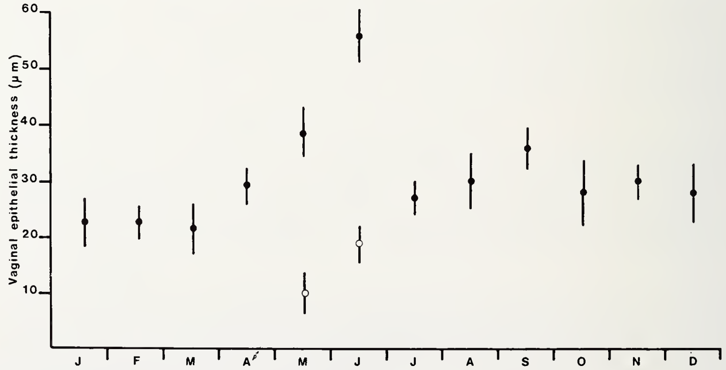

Fig. 2. Monthly changes in thickness of the vaginal epithelium. Closed circles represent mean monthly thickness of vaginal epithelium and open circles mean monthly thickness of cornified layer. Vertical lines represent $\overline{X} \pm 2SD$

maintained a more or less constant thickness. During this period the epithelium comprised between five and nine layers of nucleated cells.

Between April and early June the epithelium underwent a period of development. During April the outer layers of nucleated cells were fusiform in shape and during May the first superficial layers of cornified cells were present. In early June the cornified layer had reached a maximum thickness of 25,0 μm. Delamination of the cornified layers and some of the underlying nucleated layers occurred during mid- and late June and in July the epithelium comprised approximately eight layers of nucleated cuboidal cells. Between April and late June leucocytes were present in the epithelium.

During August and September there was a second increase in monthly epithelial thickness (Fig. 2). During this period there was no development of a cornified layer and the epithelium comprised nucleated cells only. During late September and early October there was a second period of epithelial delamination.

The contents of the vaginal lumen changed with changes in the epithelium. Nucleated cells were present throughout the year but were abundant during the two periods of delamination. Cornified cells and leucocytes were present during the first period of delamination in June. Spermatozoa were seen in the vagina of one specimen collected on 6 June, prior to ovulation.

Monthly changes in the uterine horns

Monthly changes in the uterine horns have been quantified by measuring thickness of the uterine horn wall and endometrium and plotting mean monthly thickness (Fig. 3).

Between December and March the endometrium maintained a more or less constant thickness and the uterine glands were short, straight and few in number.

Between April and June the thickness of the right uterine horn wall increased greatly while that of the left horn was less marked. These increases were the result of hypertrophy and hyperplasia of the endometrial cells and increased thickness of the myometrium. During this period the uterine glands increased in number and length.

Between fertilization in early June, and early August, after which removal of the fetus and placenta prevented measurement of the endometrium, there was an increase in myometrial thickness. Although thickness of the myometrium was not measured an

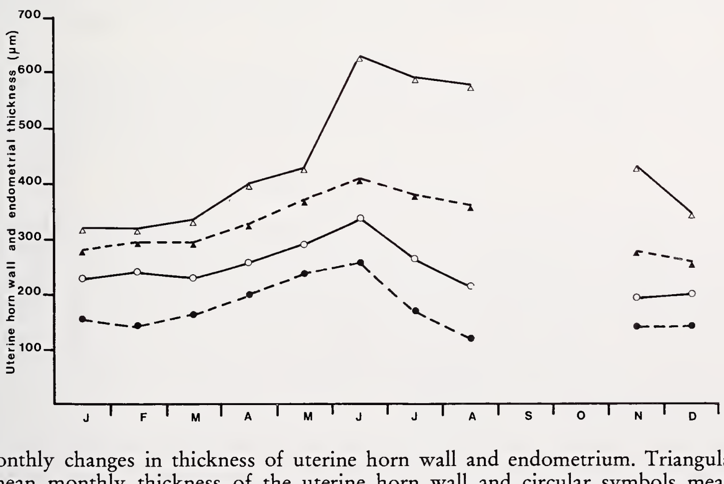

Fig. 3. Monthly changes in thickness of uterine horn wall and endometrium. Triangular symbols indicate mean monthly thickness of the uterine horn wall and circular symbols mean monthly thickness of endometrium. Open symbols are measurements from the right uterine horn, closed symbols from the left

estimate of its thickness can be obtained by comparing changes in the proportion of the uterine horn wall thickness that the endometrium comprised.

After parturition, which occurred in early November, the lumina of the uterine horns were filled with cellular debris, erythrocytes, and leucocytes.

Estrous cycle

In *N. thebaica* the proestrous condition occurred during April and May and was characterized by the presence of developing Graafian follicles in the ovaries and development of the vaginal epithelium and uterine endometrium. Estrus occurred in early June and was characterized by the presence of a single preovulatory Graafian follicle in the right ovary, sexual receptivity, as indicated by spermatozoa in the vagina, and the presence of a layer of cornified cells on the vaginal epithelium.

Estrus was followed by a short period of metestrus in mid- and late June when delamination of the vaginal epithelium occurred and the right oviduct of one specimen contained a morula. Pregnancy lasted for about five months, from early June to early November, and was followed by a two month period of lactation/anestrus. Although lactation had ceased by mid-January the anestrous condition lasted until the onset of proestrus in April. Anestrus was characterized by the absence of Graafian follicles from the ovaries and undeveloped vaginal epithelium and uterine endometrium.

Gestation period of *N. thebaica*

The length of the gestation period has been estimated from specimens collected at Umdoni (30°24′S, 30°42′E) during 1979. Of two specimens collected on 6 June one had a preovulatory Graafian follicle in the right ovary while in the other fertilization had recently occurred and there was a morula in the right oviduct. Of three specimens collected on 5 November, two were lactating and one was still pregnant. This is a period of approximately 152 days.

Discussion

With the exception of the second period of follicular development, the significance of which will be discussed later, monthly changes in the reproductive organs of *N. thebaica* were typically mammalian.

The corpus luteum of *N. thebaica* disappeared within two months of ovulation, a phenomenon that has been described in *N. luteola* (Matthews 1941) and *Hipposideros caffer* (Bernard 1980b). It is interesting to note that in both *H. caffer* and *Nycteris thebaica* the corpus luteum is at least partially extruded from the ovary, suggesting that its early degeneration may be associated with extrusion from the ovary.

Members of the family Nycteridae are basically African in distribution with one species, *N. javanica,* occurring in Malaysia (Walker 1964). There has been no previous complete study of the reproductive cycle of a member of this family, although two authors have reported on some aspects of reproductive cycles of tropical nycterids. Matthews (1941) reported that at c. 3°S in Tanzania *N. hispida* and *N. luteola* are monotocous and polyestrous, with at least two gestations separated by a post-partum estrus. However, Matthews was unable to give an estimate of gestation length or whether polyestry was seasonal or continuous.

Anciaux de Faveaux (1978) has summarized all available reproductive data for members of this family and has suggested reproductive cycles that are in many cases based on limited data but which reveal several trends common to tropical species. *N. aethiopica* from tropical latitudes north and south of the equator is monotocous and polyestrous, with about three pregnancies per year and a gestation length of approximately three-and-a-half months. *N. macrotis* (= *N. aethiopica*, Adam and Hubert 1976) at c. 1°S (Rwanda) is monotocous and seasonally polyestrous with at least two pregnancies per year separated by a post-partum estrus. The gestation period is about two-and-a-half months. *N. thebaica* from 11°S (Katanga) is monotocous and seasonally polyestrous with two or more pregnancies per year, separated by a post-partum estrus. The gestation period is approximately three months.

To summarize these data, it would appear that the reproductive cycles of tropical members of this family are characterized by monotocy, polyestry which may be seasonal or continuous, the occurrence of a post-partum estrus, and a gestation period of between two-and-a-half and three-and-a-half months.

The reproductive cycle of *N. thebaica* from c. 29°S (present study) differs from the tropical pattern in two significant ways. Firstly, *N. thebaica* ist monestrous and secondly, the gestation period is approximately five months. Both these changes are exactly what should be expected with the move from tropical into subtropical and temperate latitudes where the season suitable for reproduction is too short to allow polyestry. Pearson et al. (1952) and Racey (1973) have shown that, in *Plecotus townsendii* and *Pipistrellus pipistrellus* respectively, the gestation period can be experimentally lengthened by decreasing ambient temperature and/or food supply. Although *Nycteris thebaica* did not hibernate, it is believed that the relatively long gestation in the present study is caused by one or both of these factors.

The second period of Graafian follicle development that occurred during pregnancy in the left ovary of *N. thebaica* ist probably a relict from its polyestrous ancestors. Maximum Graafian follicle diameter in the left ovary was reached two-and-a-half to three months after ovulation, a period that corresponds with the length of the tropical gestation period.

Bernard (1976) described parts of the male reproductive cycle of *N. thebaica* from specimens collected in the present study area. Spermatogenesis begins in March and spermatozoa are released to the epididymides in late May, indicating that the male and female reproductive cycles are synchronized.

The estrous cycle of *N. thebaica* at c. 29°S was characterized by a five month pregnancy/luteal stage and a three month period of anestrus. Although the estrous cycle of a tropical member of this family has not been described it can be assumed that the pregnancy/luteal stage will be shorter and that, where polyestry is continuous, there will be no period of anestrus.

Acknowledgements

I would like to thank the following: Professor J. Meester for supervising this research and critically reading this manuscript; Mrs. N. Cook for typing this manuscript and the C.S.I.R. and University of Natal Research Fund from whom financial assistance was received.

Zusammenfassung

Weiblicher Fortpflanzungszyklus von Nycteris thebaica (Microchiroptera) aus Natal, Südafrika

Der Fortpflanzungszyklus weiblicher *Nycteris thebaica* aus Südafrika wird auf Grund histologischer Untersuchungen an Ovar und Genitaltrakt beschrieben. Die Dicke des Vaginalepithels und die Durchmesser De Graafscher Follikel erreichen im Jahreslauf zwei Maxima. Das erste zwischen April und Anfang Juni entspricht dem Oestrus. Das zweite Maximum, bei dem es nicht zur Eibildung kommt, scheint ein Rest polyoestrischer Fortpflanzung zu sein, wie sie bei *N. thebaica* in den Tropen vorkommt. Das Corpus luteum ist – zum Teil durch Ausstoßung aus dem Ovar – zwei Monate nach der Ovulation verschwunden. Begattung und Befruchtung erfolgen Anfang Juni. Die Tragzeit beträgt fünf Monate, und die Jungen werden zwei Monate lang gesäugt. Der Anoestrus dauert anschließend bis zum Einsetzen des Prooestrus im April.

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Feeding ecology of *Tadarida aegyptiaca thomasi* in the Indian desert

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Receipt of Ms. 15. 6. 1981

Abstract

Studied the Egyptian free-tailed bat, *Tadarida aegyptiaca thomasi*, collected from various districts of Rajasthan. It is primarily an insectivorous species. Coleoptera, Lepidoptera, Orthoptera, Hymenoptera and Diptera are preferred in all main four seasons, while termites are consumed in all except winter season. Occurrence of ground dwelling insects, caterpillars, spiders, larger bodied insects and water beetles in stomachs have been discussed in light of morpho-ethological adaptations of species. Presence of bat's own fur in stomach coincides with the breeding season of the species. Presence of various polyphagous insect pest species of crops in feeding menu of bats show that this species can play a promising role in biological management of harmful insects.

Introduction

The Egyptian free-tailed bat or Wrinkle-lipped bat, *Tadarida aegyptiaca thomasi* Wroughton (Chiroptera, Molossidae) is one of the most abundant species in Rajasthan which is part of the Great Indian Thar Desert (24.5–30.5° N : 60–70° E). Associated with warmer arid and semi-arid regions, of which it is well adapted both ecologically as well as

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Z. Säugetierkunde 47 (1982) 18–22

ISSN 0044-3468 / InterCode: ZSAEA 7