J. Zool., Lond. (1988) **214,** 269–284

Reproductive biology of Nilgiri tahr, *Hemitragus hylocrius* (Mammalia: Bovidae)

CLIFFORD G. RICE

Department of Wildlife and Fisheries Sciences, Texas A & M University, College Station, TX 77843, USA

(*Accepted 26 May 1987*)

(With 8 figures in the text)

The reproductive biology of Nilgiri tahr (*Hemitragus hylocrius*) was studied in Eravikulam National Park, Kerala, India from August 1979 to September 1981.

The rutting season occurred during the monsoon (July and August) and the main birth season was January to mid-February. Gestation was estimated at 179 days.

Three females which lost their first young in 1981 conceived 18 to 21 days post-partum. One female conceived of her second young while the first was 15 days old. The remainder of the individually identified females gave birth to one young ($n=40$) or none ($n=4$).

Infant mortality was highest during the first two weeks after birth. Young born during the monsoon also had a high mortality rate (0·50/week).

Oestrus during the rut was discontinuous in 1980 and 1981. Periods of frequent oestrus corresponded with periods of low rainfall with a mean lag time of 4·9 days.

The ultimate factor determining the birth season in Nilgiri tahr appears to be weather. The main birth season is timed so as to minimize thermal stress.

Several proximal factors may be important in stimulating reproductive activity. These include photoperiod, temperature, the presence of males in mixed groups, and nutrition. The photoperiod response is unusual in that Nilgiri tahr evidently respond to the abrupt decrease in apparent day length associated with the onset of the monsoon.

The inverse correlation of rainfall and oestrous activity may have been effected through the sudden decrease in thermal stress on the females or heavy rainfall (5·7 cm/day) masking pheromonal stimulation.

The pattern of lactation anoestrus observed in Nilgiri tahr approximates results obtained from some studies of domestic Caprini.

Nilgiri tahr females are presumably able to increase their lifetime reproduction by giving birth twice in one year. However, this strategy seemed counterproductive in 1981 as survival was low for second offspring.

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Present address: Wildlife Conservation International, New York Zoological Society, Bronx, NY 10460, USA

0022-5460/88/002269 + 16 $03·00

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Introduction

The distribution of Nilgiri tahr (*Hemitragus hylocrius*) is restricted to the hills of South India known as the Western Ghats. About 17 populations scattered along the crest of this range total approximately 2200 individuals (Davidar, 1978). *Hemitragus hylocrius* is congeneric with the Himalayan tahr (*H. jemlahicus*), which occurs along the southern flanks of the Himalayas, and the Arabian tahr (*H. jayakari*), which inhabits the arid mountains of Oman. Nilgiri tahr are classified as endangered by the Government of India and as vulnerable by the IUCN (Goodwin & Holloway, 1972).

Nilgiri tahr occur in unstable groups of up to 150 animals with males forming smaller groups of up to 20 individuals outside the rut. Social behaviour of this species has been described by Schaller (1971) and Rice (1984). Predators on Nilgiri tahr include leopard (*Panthera pardus*), Asiatic wild dog (*Cuon alpinus*), and humans (Rice, 1986).

All wild Nilgiri tahr populations are found from 7–10 °N, making them the world's most equatorial wild caprid, but tropical influences are greatly mitigated at the altitudes at which most occur. The Nilgiri tahr's habitat is neither temperate nor tropical. It is dominated by one season of heavy rainfall, the monsoon, and annual temperature fluctuations are not pronounced. This paper describes the reproductive biology of Nilgiri tahr, and interprets it in the context of this environment.

Study area

Eravikulam National Park is located in the High Range of Kerala, India at about 10 °N latitude, 77 °E longitude. The main body of the park is a rolling grassy plateau at about 2000 m, surrounded by steep slopes and cliffs. These peripheral escarpments and adjacent grasslands are the primary habitat of Nilgiri tahr (Rice, 1984). The Nilgiri tahr population in Eravikulam National Park is about 550 animals (Rice, In press).

Rainfall measurements from the adjacent Vaguvarrai Estate averaged 409 cm annually (1967–79). Four seasons are discernible (Figs 1 and 2): (1) winter, December to February; (2) pre-monsoon (or summer), March to May; (3) (south-west) monsoon, June to August; and (4) post-monsoon (or north-east monsoon), September to December.

There was almost no rainfall during the winter and skies were generally clear and winds light. Frost blanketed grassy hollows on colder nights. Thundershowers increased through the pre-monsoon, with easterly winds rising up to about 30 km/h. About three-quarters of the annual rainfall occurred during the monsoon. The sun was seen on only about half the days during the monsoon (usually briefly), with overcast and misty conditions predominating. Diurnal insolation gain and nocturnal radiant heat loss were consequently minimal, and it was not uncommon for daily maximum and minimum temperatures to be only 1 or 2 °C apart. Westerly winds often reached an estimated 80 km/h (strong gale). Post-monsoon mornings were usually clear, but clouds, mist and thundershowers often developed during the day while winds were easterly and variable.

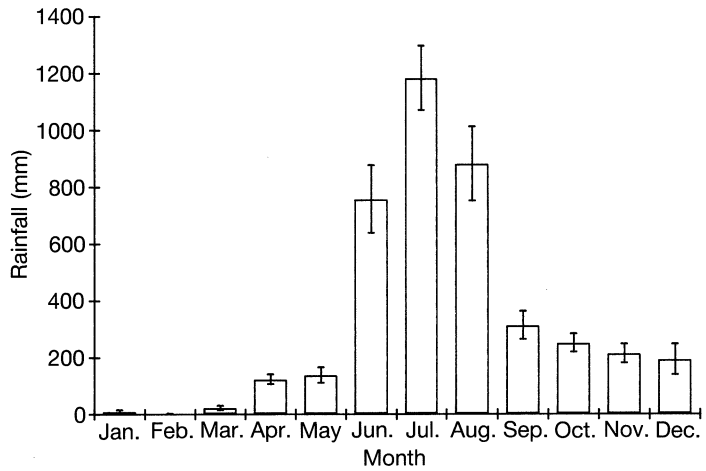

FIG. 1. Mean monthly rainfall (±standard error) for Eravikulam National Park. Rainfall figures provided by Vaguvarrai Estate. Means are for 1967–1979.

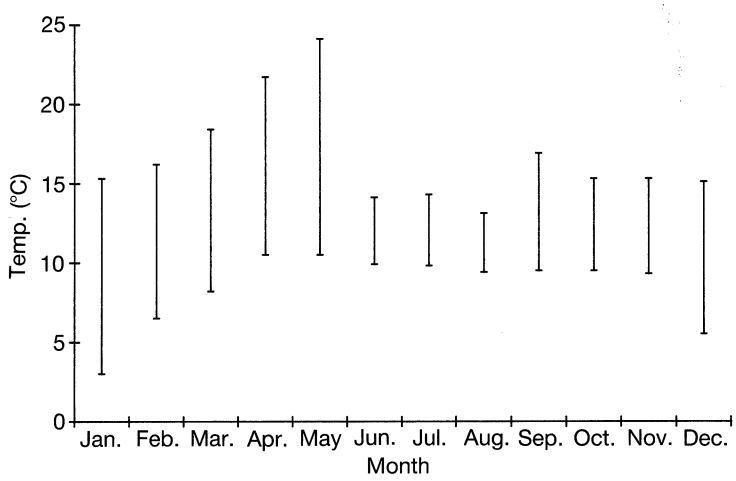

FIG. 2. Mean monthly maximum and minimum temperatures at Eravikulam Hut, Eravikulam National Park, September 1979–September 1981.

The grassland was burned by managers or trespassers during the pre-monsoon. The extent of burning varied from year to year (Rice, 1984, In press).

Methods

This study was carried out between August 1979 and September 1981. One subpopulation of about 120 animals (located between Vaguvarrai Estate and Eravikulam Hut) was habituated to my presence (Rice, 1984) and studied intensively.

In 1981, oestrus was determined by noting copulation, tolerance for mounting, and high frequency of courtship displays. Oestrus dates for 1980 were obtained by backdating from 1981 birth dates, based on a gestation period of 179 days (see below).

Fifty-one adult females were marked with colour-coded collars modelled after those used by Taylor (1969) and Clarke & Henderson (1978). Offspring were not marked, so their presence was determined on the basis of social interactions with their mothers.

Tahr less than 1 year of age were termed young. Mortality was assessed weekly as 0 if an individual young was recorded both at the start of one week and the start of the week following. A mortality of 1 indicated that the young was not recorded the following week, although its mother was. Variation in mortality of young according to month of birth and age was assessed by least squares analysis of variance.

Relationships between the occurrence of oestrus and weather were investigated with the aid of cumulative sum analysis (Woodward & Goldsmith, 1964). Weather parameters included were rainfall, maximum temperature, minimum temperature, wind and sunshine. Wind was estimated by a subjective scale: 0 = calm, 1 = light breeze, 2 = moderate wind, 3 = strong wind, and 4 = high wind, approximately equivalent to 0–5, 6–20, 21–35, 36–50 and 51+ km/h, respectively. Values for sunshine were either 1 (sun seen that day), or 0 (sun not seen).

Cumulative sum analysis identifies points of significant departure from a trend in sequential measures. Stages were defined by the intervals between turning points. A break in 1980 conceptions in late July–early August did not yield statistically significant turning points, but was considered biologically significant, and these turning points were included in the subsequent analysis. On the assumption that there was a delay of at least one day between changes in the weather and its effects on oestrus, the number of days between turning points in oestrus records and the most recent turning points in the weather parameters was considered the time required for the change to affect oestrous activity (lag time). A slope index of the cumulative sum graph during each stage was recorded as positive (+1), or negative (−1). The slope for weather parameters was zero (0) if there were no earlier turning points in the weather parameters, or if the previous turning point was already recorded for an earlier oestrus turning point. A correlation index was then calculated by multiplying the slope index for the oestrus cumulative sum graph by the slope index for the appropriate stage in the weather parameters.

All statistical tests were applied at the 0·05 level of significance.

Results

The annual reproductive cycle

Evidence from this study indicated that Nilgiri tahr gave birth to one young at a time. Detailed information on reproduction was obtained during the birth and rutting seasons of 1981. I was not able to track reproductive activity closely during the 1980 rut, but gestation estimates (of varying precision) were of 177, 178 and 179 days. Winbigler (pers. comm.) reported one gestation period of 180 days in captive Nilgiri tahr. Overall, my best estimate is 179 days.

In 1981, the first young was observed on 10 January and this was considered the start of the birth season. From then until births declined in mid-February, females in the Vaguvarrai subpopulation were monitored daily. Because of the large number of collared females, it was possible to keep track of all births (Fig. 3). There was a gap in births between 23 January and 31 January.

In captivity, Nilgiri tahr gave birth throughout the year (Wilson, 1980). Forty-four birth to conception intervals averaged 15·5 weeks (median = 14·4), much shorter than the 26 weeks that would result in births at annual intervals (Wilson, pers. comm.; Brady, pers. comm.). Captive females in Trichur, Kerala, India showed similar reproductive patterns (Potti, 1966). Females

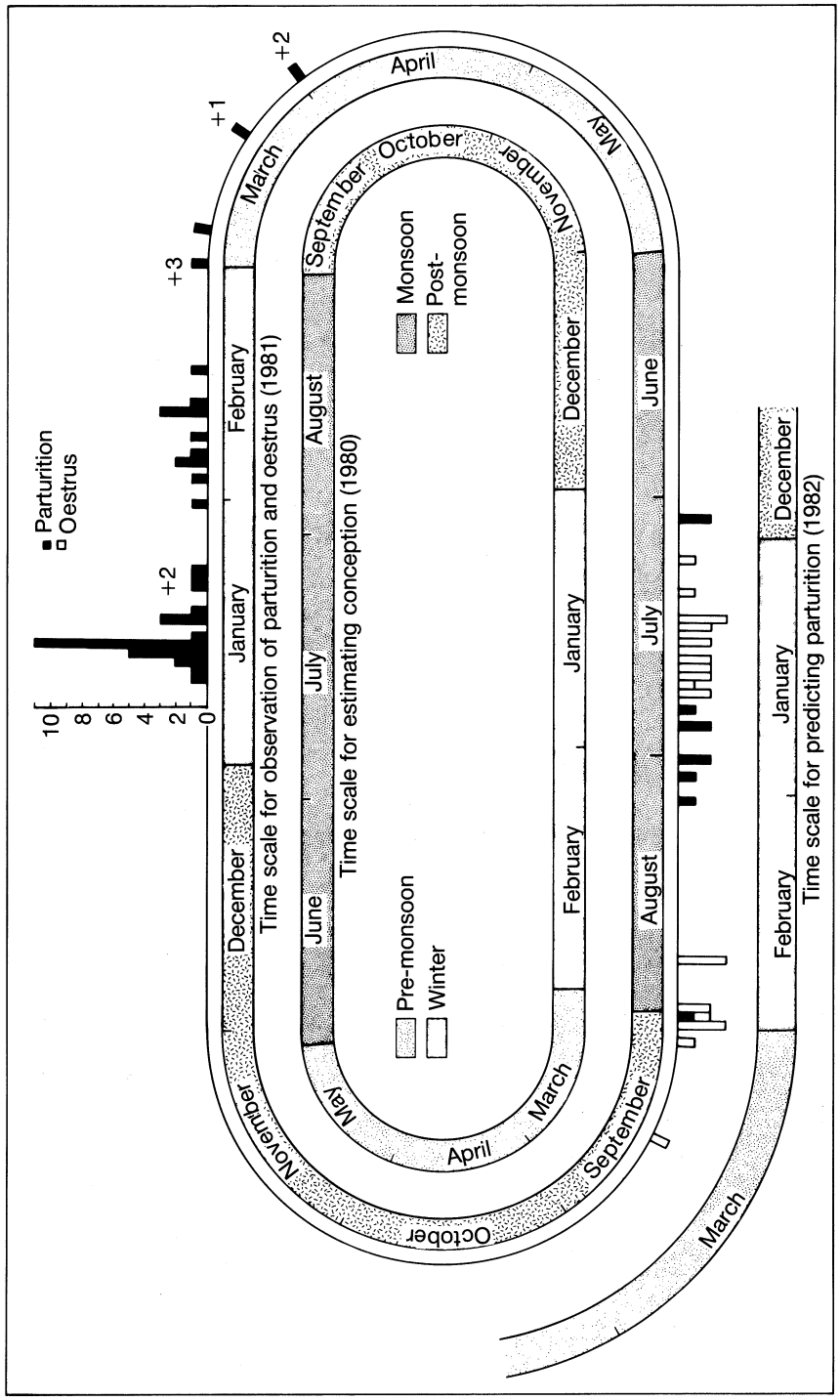

FIG. 3. Reproductive activity of Nilgiri tahr. Histograms show observed births and oestrus for 1981. Scales for estimating 1980 conceptions (from 1981 births), and predicting 1982 births (from 1981 oestrus) are also given.

TABLE I

History of six females which gave birth during the monsoon

1st birth	Last record of 1st young	Maximum age of 1st young	2nd birth	Birth to conception	Death to conception
12 Jan. 81	12 Jan. 81	0 days	28 Jul. 81	18 days	18 days
15 Jan. 81	29 Jan. 81	14 days	01 Aug. 81	19 days	5 days
18 Jan. 81	29 Jan. 81	11 days	06 Aug. 81	21 days	11 days
13 Jan. 81	23 Mar. 81	69 days	26 Jul. 81	15 days	−54 days
(17 Feb. 81–26 Feb. 81)*	—	—	01 Sep. 81	(8–17 days)	(8–17 days)
(30 Dec. 80)**	—	—	03 Jul. 81	(6 days)	(6 days)

*Female was absent from all records and suspected of giving birth to a young that did not survive to be recorded

**Female was seen in isolation, probably associated with birth

whose young died or were hand raised did not conceive again at significantly shorter intervals than those that raised their young. Six captive females first conceived at an average age of 19 months (maximum = 24, minimum = 14, mode = 16; Wilson, pers. comm.; Brady, pers. comm.).

In 1981, oestrus was recorded for 28 females (Fig. 3). As with births, there were two distinct periods of oestrous activity, but they were separated by a gap of 32 days. Only one female was recorded in oestrus twice, at an interval of 49 days (15 July–02 September).

In 1981, there was also a series of births which occurred during the monsoon (Fig. 3). Of the six of these that were to collared females, four were to females known to have given birth in the winter (Table I). Estimation of conception date for the second young by backdating from the first appearance of the second young indicated that three of the females conceived 5–18 days after their first young died at ages of 0–18 days. The fourth female conceived while her young was still living, although it died two months later. All of these four females conceived 2–3 weeks after their first births. There is some evidence that the remaining two collared females which gave birth during the monsoon also gave birth in the winter (Table I). The young of four other females also died before the middle of March and within two weeks of birth, but a second birth was not recorded. All four were continuously present in records from July–September when second births would have been expected. Thus about 50% of the females whose young died at an early age gave birth to a second young in the same year.

The mean date (Caughley, 1977) of winter births in 1981 was 26 January (median = 17 January), and the mean date for monsoon births was 29 July (median = 28 July). The mean date of oestrus during the 1981 rut was 04 August (median = 22 July), equivalent to a mean date of birth on 30 January (median on 17 January). These three means had similar distributions ($s = 19{\cdot}13$, $17{\cdot}07$ and $21{\cdot}93$, and $n = 43$, 10 and 31, respectively). All births in 1981 had a mean date of 02 March ($s = 74{\cdot}71$, median = 22 January), and combining 1981 winter births with those predicted for 1982 yielded a mean date of 28 January ($s = 20{\cdot}26$, median = 18 January).

Records of oestrus and weather parameters are presented in Fig. 4 with their respective cumulative sum graphs. Periods of rainfall were highly negatively correlated with oestrous activity (Table II), with a mean lag time of 4·9 days. That is, about five days after rainfall diminished, oestrous activity increased and about five days after rainfall increased, oestrous activity

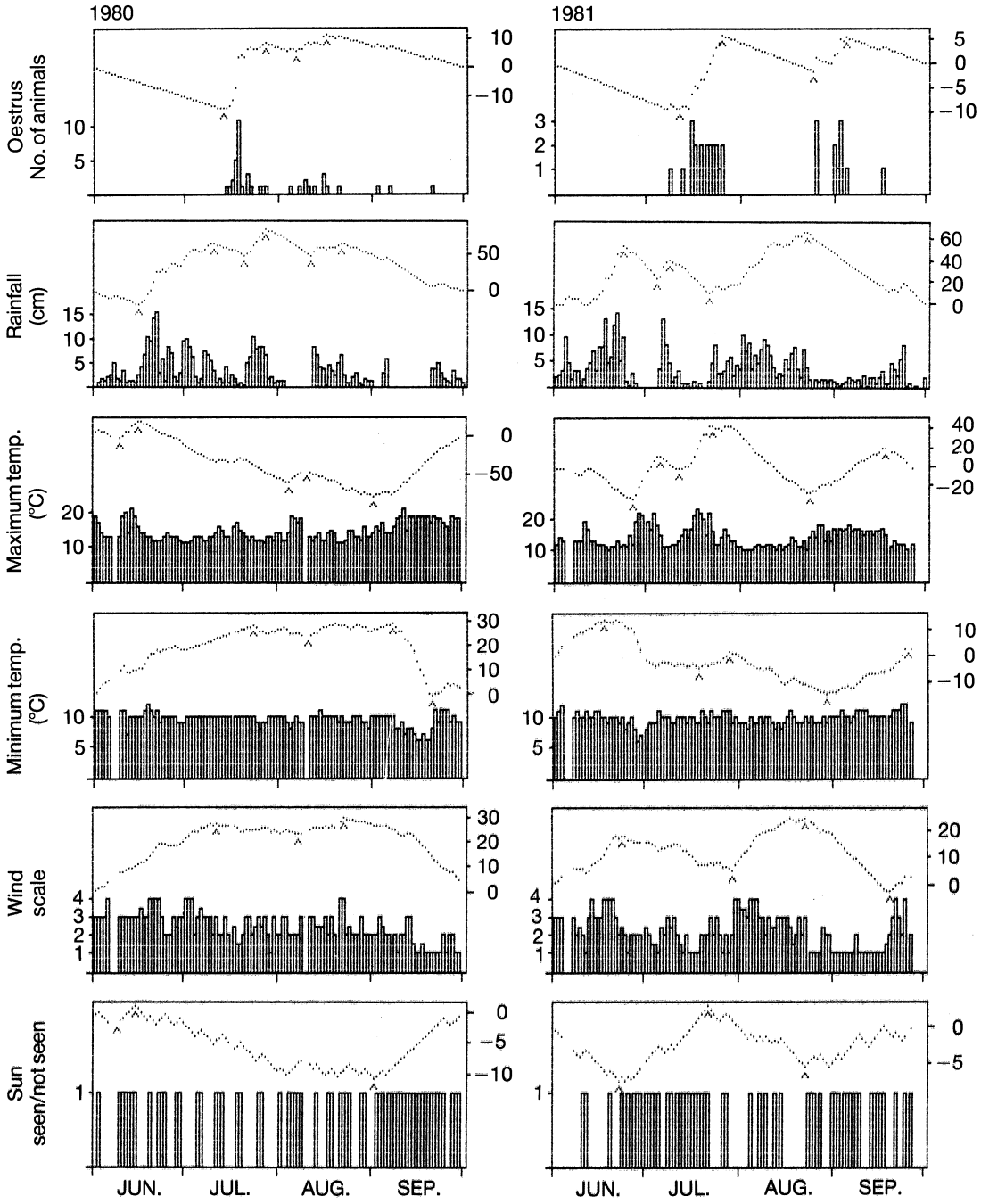

FIG. 4. Observed values and cumulative sum graphs of oestrous activity in Nilgiri tahr in 1980 (back dated from birth records) and 1981 (observed) and weather parameters. Turning points indicating trend changes are marked by a caret (^).

TABLE II

Correlation indices and lag times for oestrous records of 1980 and 1981 and weather parameters. See text for method of calculation of the correlation index. Start = start of stage of oestrous activity, end = end of stage of oestrous activity

Weather parameter	Correlation index			Mean lag time			*n*		
	Start	End	Both	Start	End	Both	Start	End	Both
Rainfall	−1·00	−0·75	−0·88	4·5	5·3	4·9	4	3	7
Maximum temperature	−0·25	0·25	0·00	12·0	3·0	9·8	3	1	4
Minimum temperature	−0·50	−0·50	−0·50	25·5	6·0	15·8	2	2	4
Wind	−0·75	−0·25	−0·50	7·3	9·0	7·8	3	1	4
Sun	0·25	0·25	0·25	2·0	4·0	3·0	1	1	2

TABLE III

Summary of analysis of variance of Nilgiri tahr young mortality

Source of variation	*F*	*d.f.*	*P*
First vs. second births	20·128	1	0·000
Month of birth of young	14·252	6	0·000
Age of young in months	4·602	8	0·000
Month of birth × age	2·719	10	0·003

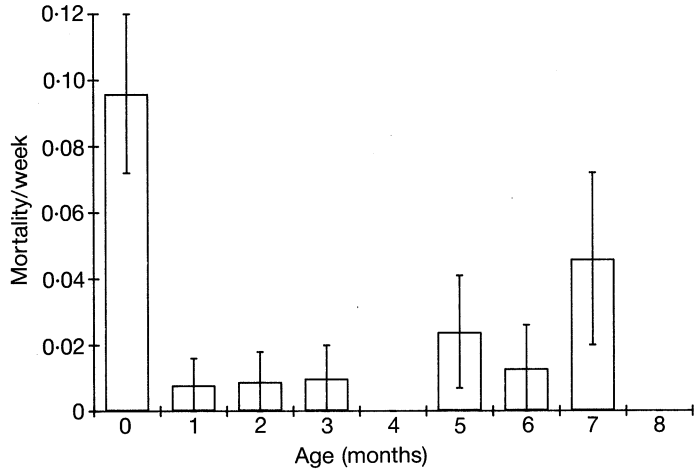

FIG. 5. Mean weekly mortality (±standard error) by age for Nilgiri tahr young.

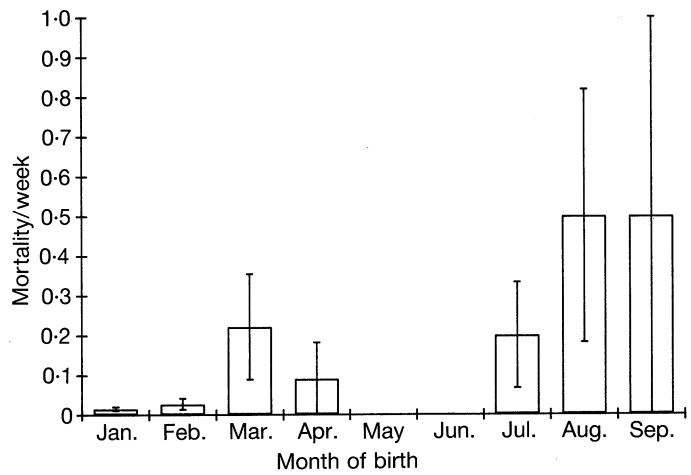

FIG. 6. Mean weekly mortality (±standard error) by month of birth for Nilgiri tahr young (no young were born in May or June).

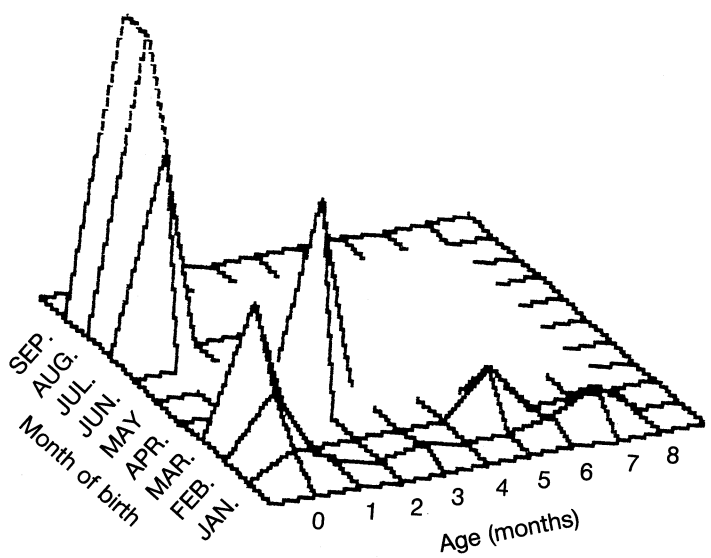

FIG. 7. Mean weekly mortality by month of birth and age for Nilgiri tahr young (no young were born in May or June).

diminished (the mean lag times for the start and end of oestrous activity were not significantly different). Maximum temperature showed no consistent effect. Minimum temperature was sometimes negatively correlated with oestrous activity, but lag times were so variable that this correlation probably has little meaning. Wind also showed a negative correlation with oestrous activity, and this was more noticeable with regards to the start of oestrous activity. The weak correlation between sun and oestrous activity was probably a result of increased likelihood of sunshine with lower rainfall. Thus the distribution of oestrous activity and the differing patterns for 1980 and 1981 can be accounted for primarily on the basis of rainfall during the rutting season.

Young mortality

The average weekly mortality for young between 8 January and 30 September 1981 was 0·028 (equivalent to an annual rate of 1·47, $n = 849$ young weeks). Results of the analysis of variance are summarized in Table III. Mortality was much higher for second births (0·231/wk) than for first births (0·025/wk). Mortality was highest during the month of birth (Fig. 5). Within the first month, mortality was higher during the first two weeks (0·156/week and 0·132/week for young of age 0 and 1 week, respectively), after which it declined to rates comparable to subsequent months (0·030/week and 0·029/week for ages 2 and 3 weeks, respectively). Young born during the monsoon experienced high mortality (Fig. 6), with those born in the pre-monsoon having a higher mortality than those born in winter. The interaction between age and month of birth (Fig. 7) showed two features: (1) mortality during the first month of life increased with the lateness of birth; and (2) mortality was greater during the monsoon (left to right diagonal on the response surface) than before the monsoon, and the younger the young at the start of the monsoon, the greater was the increase.

Adults and yearlings seemed little affected by adverse weather, but the cold, wet, windy monsoon evidently stressed young born at that time. Several were seen standing shivering in a crouched position.

Discussion

An average annual rainfall of 406 cm ranks Eravikulam National Park among the wettest areas in the world. Most of this rain falls during the three-month monsoon. There is virtually no rainfall during the winter, and temperatures throughout the year are relatively mild. This contrasts to the environment of most caprids inhabiting mountainous terrain in temperate climates in which low temperatures and heavy snowfall may occur. These differences have significant implications for the reproductive biology of Nilgiri tahr.

Factors influencing the timing of breeding have been classified as ultimate (those which affect the survival of the offspring) and proximate (those which act as stimuli for reproductive activity; Baker, 1938). Selection favours those genotypes which respond to proximate stimuli in such a manner that offspring are born at the best time determined by ultimate factors.

Ultimate factors

Possible ultimate factors include predation, plant phenology and thermal stress. Intensive predation may favour a constricted birth season (Estes, 1976), but there was no indication of this for Nilgiri tahr.

No detailed measurements on plant phenology were made, but a broad pattern was evident. The grassland dried during the winter, but fresh new growth replaced this early in the pre-monsoon if the grassland was burned. Abundant moisture during the monsoon stimulated growth, with increased senescence following during the post-monsoon. If the effects of plant phenology on quality and quantity of forage were important factors in determining the timing of births, the birth season would be expected in the pre-monsoon (if the grassland had been burned with sufficient frequency and for long enough in the past to have an effect), or during the monsoon. However, the main birth season is in the winter, which is probably the time of lowest forage quality, indicating that plant phenology has little effect on the timing of births in Nilgiri tahr.

At Eravikulam, thermal stress is incurred by adverse weather, particularly low temperatures, rain and wind. Temperatures at Eravikulam were moderate (Fig. 2), and probably not important when considered alone. In fact, most births occurred when minimum temperatures were at their lowest and maximum temperatures were intermediate. Thermal stress is greatest when the factors of low temperature, high wind and high rainfall are combined to maximize convective and conductive cooling. Rainfall has an additional effect associated with increased cloud cover, thereby reducing radiant heat gain. Combining these factors, thermal stress should be greatest during the monsoon, somewhat less in the post-monsoon, even less in the pre-monsoon, and least in the winter. The best way for Nilgiri tahr to avoid thermal stress of young would be to give birth at the start of the longest period when these factors are minimal. The young would then be able to attain adequate size for effective thermoregulation before the time of greatest thermal stress. This is clearly the case, as most births occur in January and February.

The higher mortality for young born after February (Fig. 7) further supports this thesis. Although there were no early births, weather conditions during December and the first week in January were suboptimal in that there was still some rain and frequent mist (in 1979–80 and 1980–81). We may conclude that weather, as it affects thermal stress, is the primary ultimate factor in determining the birth season of Nilgiri tahr at Eravikulam. This contrasts with North American mountain sheep (*Ovis canadensis* and *O. dalli*) in which the timing of the birth season has 'evolved primarily in response to predictability of vegetative growth' (Bunnell, 1982).

Proximate factors

Experimental work on domestic Caprini gives us some indication of proximate factors which may be important in timing reproduction in Nilgiri tahr. These factors include photoperiod, temperature, presence of the male, and nutrition. Although there is not a precise model for the way in which photoperiod influences the timing of reproduction (see Fletcher, 1974), its effect has been amply demonstrated. In ewes, artificially decreasing day length results in oestrous activity (e.g. Yeates, 1949; Godley, Wilson & Hurst, 1966), and this is terminated by increasing day length (Yeates, 1949). Hafez (1952) showed that in domestic sheep a sudden decrease in day length stimulated oestrus, with a lag time of 10–19 weeks.

Decreasing or a sudden drop in temperature can also hasten the onset of oestrus (Dutt & Bush, 1955; Godley, Wilson & Hurst, 1966). Schaller (1977) and Lovari (pers. comm.) also reported an increase in rutting activity in wild Punjab urial (*Ovis orientalis*), bharal, Kashmir markhor (*Capra falconeri*), and chamois (*Rupicapra* sp.), associated with a sudden drop in temperature.

Oestrus in female domestic Caprini may also occur in response to the introduction of a male with a lag time of 2–3 weeks (Sinclair, 1950; Schinckel, 1954; Shelton, 1960), although the response can be in less than one week (Ott, Nelson & Hizon, 1980; Chemineau, 1983). Knight & Lynch (1980) showed that an increase in ovulation was prompted as much by the presence of wool and wax from the ram as it was by the presence of the ram itself. Shelton's (1980) work implied effects of the sight and sound of the male as well. In wild chamois (*Rupicapra pyrenaica*), there is an 18-day lag between the time males start forming their harems (around 4–8 November) to oestrous activity (around 22–26 November; Lovari, pers. comm.).

Nutrition can also affect the timing of reproduction; good nutrition having the effect of advancing breeding (Nievergelt, 1966; Jewell & Grubb, 1974).

Several of these factors may influence the timing of reproduction in Nilgiri tahr. Nilgiri tahr do not respond to photoperiod in the same manner as do other temperate Caprini in that the breeding season is at the end of the period of increasing day length rather than at the end of the period of decreasing day length. However, at the latitude at which Nilgiri tahr live (10 °N), the difference between maximum and minimum day length is only 1 h 10 min and the maximum rate of change in day length is 46 sec/day (Nautical Almanac Office, U.S. Naval Observatory, 1986). At 30 °N (the Himalayas), the difference between maximum and minimum day length is 3 h 52 min and the maximum rate of change in day length is 120 sec/day. On the other hand, for Nilgiri tahr, the onset of the monsoon with nearly constant 100% heavy overcast has a great effect on perceived day length. It may be that Nilgiri tahr respond to the sudden decrease in day length in a manner similar to that reported for sheep by Hafez (1952). If this is the case, it would appear that they have lost the response to gradual change in photoperiod. Captive Nilgiri tahr at 35°N (Memphis, TN, USA) do not breed seasonally. Likewise, they do not breed seasonally on the coast of Kerala (100 km from Eravikulam) where the monsoon is not so severe.

The onset of the monsoon is accompanied by a sudden drop in (maximum) temperature (Fig. 2) and this may also stimulate reproductive activity. The captive tahr in Memphis are probably not exposed to a similar abrupt, long-lasting reduction in temperature.

Oestrous activity generally corresponded with periods of higher male density in mixed groups (Fig. 8), but it is difficult to separate cause and effect. It is possible that females in or near oestrus and the number of males in mixed groups interact in a feedback loop, where females which come into oestrus early attract males which in turn stimulate more females to come into oestrus.

Experimental work has focused on treatments which stay constant over time so remarks on the mechanism by which weather, particularly rainfall (Table II), determines oestrous activity must be somewhat speculative. At Eravikulam, stages of high rainfall averaged 5·7 cm/day. Such heavy rainfall could 'drown' pheromonal communication from male to female. Another possible mechanism is the inhibition of ovulation through depressed nutritional condition induced by thermal stress. Although mortality was not significantly increased for females during the monsoon as it was for young, it is reasonable to suppose that thermal stress of a magnitude sufficient to increase mortality in young would have some impact on adults. That is, during periods of high rainfall, females must devote considerable energy to thermoregulation, and the reduction of rainfall may be physiologically similar to a sudden improvement in nutrition leading to subsequent ovulation.

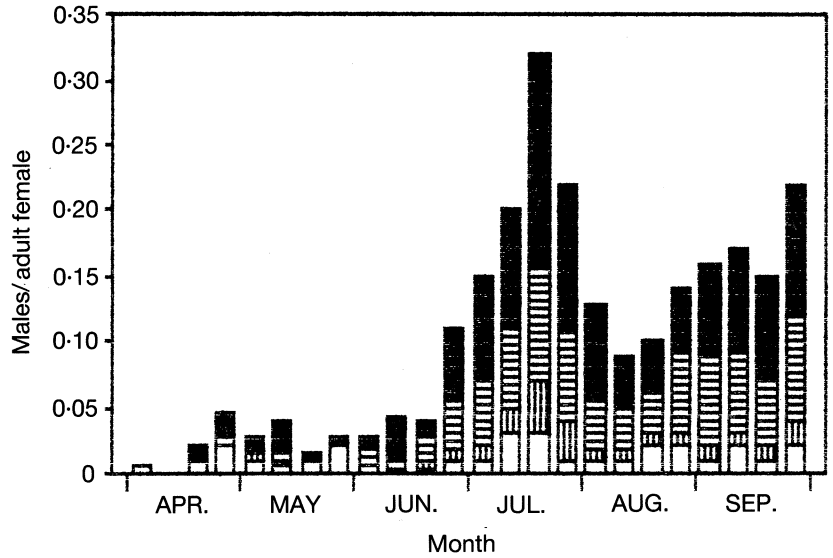

FIG. 8. Average number of males of the four oldest classes per adult female in mixed groups weekly from April–September, 1981. Approximate ages of classes are: □ S2 = 8+ years; ▥ S1-2 = 7 years; ▤ S1 = 6 years; ■ DBM = 5 years.

Maximizing reproduction

One method Caprinae females have to maximize reproduction is by varying the number of young they give birth to per year (Bunnell, 1982). Most Caprinae give birth to only one offspring at a time, but twinning is prevalent among Caprinae in Asian desert habitats (Schaller, 1977); presumably this occurs in response to favourable nutrition prior to the rut.

Wild tahr rarely give birth to twins. Caughley (1970) found only one set of twins in the 515 pregnant Himalayan tahr females he examined, but the twinning rate in the London Zoo was 8% (Zuckerman, 1953). Writers around the turn of the century thought that Nilgiri tahr produced twins (see Jerdon, 1874; Fletcher, 1911), but more recent observations indicate that only one young is produced both in the wild (Schaller, 1977; Davidar, 1978; this study) and in captivity (Waterhouse, pers. comm.; Wilson, 1980). However, Davidar (1978) reported one observation of twin foetuses.

Instead of twinning, some female Nilgiri tahr increase their number of offspring by conceiving twice in one year when the initial offspring dies at an early age. Perhaps all females are capable of oestrus 2–3 weeks after giving birth, but this is suppressed through effects of suckling and/or lactation. Evidence for similar suppression of post-partum oestrus in domestic Caprinae is equivocal. Some workers have reported shorter periods of anoestrus and a higher percentage of females coming into oestrus during a specified period after birth for females whose lambs have been weaned early (0–3 days) compared to later weaning (30+ days; e.g. Mallampati, Pope & Casida, 1971; Sefidbakht, Makarechian & Ghorban, 1971; Gould & Whiteman, 1973; Restall & Starr, 1977; Lawson, Forrest & Shelton, 1984), although the anoestrous period is usually shortened by only a few days. Others have reported no such effect (e.g. Whiteman, Zollinger, Thrift & Gould, 1972; Sefidbakht & Farid, 1977). These differences may be due to the influences of

species or breed, locality or season. Shevah, Black, Carr & Land (1974) reported that 47% of 17 ewes whose lambs were weaned at one day of age showed oestrus within three weeks, whereas only 3% of 33 ewes which raised their lambs came into oestrus in the same period. These figures closely match those given here for wild Nilgiri tahr. Lactational suppression does not appear to function in captivity, where female Nilgiri tahr often conceive while suckling their previous young. Perhaps this suppression is not effective at higher levels of nutrition (found in captivity), as has been reported in studies of domestic sheep (Hunter & Van Aarde, 1973).

By conceiving and giving birth twice in one year, Nilgiri tahr females are presumably able to increase their lifetime reproductive output by 'replacing' young lost to early mortality. However, as a means of increasing lifetime reproductive success, this strategy seemed counterproductive, at least in 1981. Only one of the 10 young born during monsoon survived to the end of September. The monsoon was not particularly severe in 1981, but because of the late and restricted burning of the grassland in this area in the pre-monsoon, it is suspected that forage quality may have been lower than normal. Thus, mortality for monsoon births may not always be so high.

Conclusions

Like other Caprini, Nilgiri tahr reproduce seasonally, but the season differs in response to impacts of weather and, in contrast to New World sheep, it seems independent of plant phenology (Bunnell, 1982). Rather than responding to the proximal influence of gradually changing day length, Nilgiri tahr are apparently stimulated by the abrupt reduction in day length at the onset of the monsoon. The concurrent reduction in temperature and the increase in the number of adult males occurring in mixed groups may also influence the timing of reproduction. A discontinuous distribution of oestrus through the rut has not been reported in other Caprini.

Some wild Caprini bear twins but Nilgiri tahr rarely, if ever, do so. However, they exercise the option of making a second attempt at raising a young if the first one dies at an age of less than two weeks.

Funds for this study were provided by the American Institute of Indian Studies, the Caesar Kleberg Program in Wildlife Ecology, and Wildlife Conservation International of the New York Zoological Society. I am grateful to these organizations and the US Fish and Wildlife Service for providing essential logistical support. The permission to work in Eravikulam National Park granted by the Government of India and the Kerala State Government is gratefully acknowledged.

Members of the High Range Wildlife Preservation Association provided invaluable assistance with daily logistical needs. I.P. Prem kindly provided rainfall figures for Vaguvarral Estate. Thanks are also due to P.R. Chandran, J. Lewis, C. Penny, C. Brady and C. Wilson for sharing information on their captive Nilgiri tahr. The College of Santa Fe generously provided access to their mainframe computer.

E. Dierenfeld, V. Geist, M. Hutchins, F. Koontz, S. Lovari, E. Rice, J. Stover, C. Wemmer and an anonymous reviewer provided valuable criticism on an earlier draft of this report.

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