PRELIMINARY FINDINGS IN A RADIO TELEMETRIC STUDY ON THE BLACK RHINOCEROS IN HLUHLUWE GAME RESERVE, ZULULAND

by

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SYNOPSIS

In order to obtain more data on the biology of the black rhinoceros, aimed primarily at devising and improving management techniques for this species, use was made of a radio tracking system designed and built by the Council for Scientific and Industrial Research. The equipment and the technique of installing transmitters are briefly described and some preliminary results presented. Transmitters were installed in the posterior horn of seven black rhinoceroses – four males and three females. Operational periods varied from 86 to 253 days. The plotted results and field observations of three of the males indicate that they are probably territorial. Territory size varies from 393 to 465 hectares with overlaps ranging from 0 to 89 hectares. Females, on the other hand, have home ranges that overlap one-another as well as territories of the males. Female home range sizes vary between 583 and 769 hectares. Activity patterns of both males and females show three active periods during a 24 hour period; the hours of darkness being the main feeding period.

1. INTRODUCTION

The black rhinoceros (Diceros bicornis bicornis Linn.) has disappeared almost entirely over most of its former range in the Republic of South Africa. The Zululand game reserves remain the stronghold for the species, the most important being Hluhluwe which supports probably the highest density of black rhino in Africa (Hitchins unpublished data). In view of this, in 1968 the Natal Parks, Game and Fish Preservation Board initiated a four year research project to obtain more data on the ecology and biology of this species aimed primarily at devising and improving management techniques.

The terrain, combined with the nature of the vegetation in Hluhluwe Game Reserve makes continuous observations on black rhino by conventional methods extremely difficult. In 1969 the Council for Scientific and Industrial Research was approached to manufacture radio telemetric equipment suitable for attaching to black rhino. A detailed account of the considerations, early experiments, and equipment has been given by Anderson and Hitchins (1971).

A study area was chosen in which all the black rhinos were known; and furthermore, a study on home ranges had been undertaken in this area between 1962 and 1966 (Hitchins 1969).

The object of using radio-telemetry was to facilitate the collection of data on home range sizes, habitat utilization, activity patterns and on reproduction and post natal care of the young.

2. STUDY AREA

The study area is situated in the north eastern section of the Hluhluwe Game Reserve and occupies an area of approximately 26 sq. km (10 sq. miles). It forms part of the lower catchment of the Manzibomvu stream which contains water in two pools throughout the year. During the dry winter months these pools are the only water supply for all the animals living in this area.

A high range of hills 355 m (1200') a.s.l. bounds the eastern side whilst in the main the area is broken with hills at a lower elevation 183 to 274 m. (600 to 900') a.s.l.

Three main vegetation associations are recognised: closed canopy forests, woodland, and wooded grassland. The wooded grassland occupies about half the study area and borders both forest and woodland communities. The vegetation has been subjected to various environmental influences, including fire and utilization by the various species of ungulates, as well as to man-made management practices. This has resulted in a mosaic of vegetation associations, with numerous secondary types which often partially or wholly obscure the original association from which they have developed.

The area is traversed by numerous roads and tracks, having a total distance of 26 km.

The topography, roads and tracks, tracking stations and the site of the beacon transmitter are shown in Figure 1.

3. EQUIPMENT

(a) Apparatus

The transmitting and receiving apparatus have been described in detail by Anderson and de Moor (1971) and Anderson and Hitchins (1971).

The apparatus consists of:

(i) rhino transmitters

Initially three prototype transmitters were used; they were cylindrical in shape, measured 3,8 x 2,2 cm (mass 48,0 g complete with battery) and contained a single Mallory RMIN cell. These were later modified to accommodate two RMIN cells for greater signal output, the modified versions measuring 5,8 x 2,2 cms (weight 68,0 g). The transmitter loop is a 1 mm diameter copper wire placed inside a thick walled plastic tube. The loop is soldered to two terminals located on the insulated cover of the transmitter case which itself is made of brass and is sealed to the cover.

(ii) beacon transmitter

During the early part of the study an ordinary rhino transmitter was used as a beacon. Later a beacon transmitter was specially constructed to produce a stronger signal than the animal-borne transmitters for obtaining more accurate azimuth information.

(iii) Yagi antenna

The antenna is a twin 2-element Yagi, supported at its centre on a telescopic mast attached to the bumper of a vehicle. At its base is a compass rose, which can be rotated and locked once the reference direction has been found. A pointer is fixed to the vertical support and indicates the angle through which the antenna has been rotated.

(iv) Receiver

The receiver is designed as a portable one with a built in horizontal, telescopic antenna which can be used to guide the observer when locating a study animal on foot.

The unit is compact and of metal construction measuring 30,0 x 14,0 x 14,0 cm (weight 2,8 kg). It is supplied with a signal strength meter which gives clear readings of input signals. For audio location a loudspeaker or earphones may be used. When used away from the vehicle, built in primary cells are the power supply. Used coupled to the twin Yagi antenna it may obtain its power from the vehicle battery or from the built in primary cells.

(b) Methods of installation

After an animal has been immobilised, the posterior horn is thoroughly cleaned using a wire brush to remove any sand particles and other debris present. The site for the transmitter cavity is carefully chosen to allow 18 cm for the transmitter loop. Initially the transmitter cavity was drilled into the lateral surface of the horn. However, with experience gained on wear of the fibreglass covering, the posterior edge of the horn appears to be more suitable.

A portable Honda generator with a Black and Decker (D 720, ½" chuck) two-speed hand drill equipped with a high speed steel power bit, is used to drill the transmitter cavity to a depth of 6,5 - 7,0 cm. The top of the transmitter, when in position, is situated about 1 cm below the surface of the horn and lies at an angle of 30° - 45°, below the horizontal plain of the loop antenna.

The antenna groove is cut horizontally around the horn, using a circular router attached to the power drill.

After placing the transmitter into the cavity, the loop antenna is laid in the groove within an outer covering of plastic tubing and its free end is soldered to the terminal on the transmitter. The trimming hole in the cover of the transmitter is closed by means of a brass plug. The plug, transmitter top and terminals are coated with silicone grease to prevent bonding with the fibreglass covering.

The antenna groove and transmitter cavities are filled with light grade fibreglass (surface tissue), thereafter the horn is covered with several layers of heavy grade fibreglass (chopped strand mat) leaving the top of the brass plug exposed. When the fibreglass/resin is dry the brass plug is removed and the trimmer adjusted, using a specially made screw-driver, until the required signal is heard on the receiver. Optimum setting of the trimmer depends on loop length and the dielectric constant of the material in and around the loop (Anderson pers. comm.). Hence the necessity of setting the trimmer after most of the covering has been added to the horn.

The trimmer hole in the transmitter cover is closed with a brass screw which is inserted by lightly glueing it to the end of a screw-driver. The hole through the glass fibre is plugged using red 'plasticine'. This enables relocation of the trimmer should it require readjustment at a future date. The entire surface is again covered with another layer of heavy grade fibreglass (chopped strand mat) paying special attention to the trimmer hole. Finally a fine weave fibreglass cloth is applied to the whole area.

Table 1 shows the installation times of the various transmitters.

TABLE 1. Time taken to complete successive stages of installing transmitters (in minutes).

STAGE	PROTOTYPES TRANSMITTERS				MODIFIED TRANSMITTERS		
	A	B	C	E	D	E	F
drilling transmitter cavity	5	9	4	9	7	7	7
cutting groove for loop antenna	7	6	2	6	12	7	19
fitting transmitter and loop antenna	5	20	8	8	9	5	5
initial fibreglass covering	17	18	7	13	13	7	17
tune transmitter and seal trimmer hole	5	4	6	10	1	4	2
final fibreglass covering	14	7	22	14	13	13	15
TOTAL INSTALLATION TIME	68	88	65	104	101	70	100

Note :

In the prototype transmitters it was found that the trimming condenser was rather sensitive and it was considered likely that transmitter failures were caused by movement of the trimmer due to mechanical shocks to the transmitter during the everyday activities of the rhino. (Anderson pers. comm.) It was therefore decided to modify all transmitters, necessitating their removal from rhinos and replacing them with modified units.

By using a steel burr in the power drill, the fibre glass covering was removed to locate the 'plasticine' plug in the trimming hole. Once located, the fibreglass was removed around this point until the transmitter was completely uncovered. The loop antenna was cut at the two terminals and removed from the plastic tubing - this obviated any damage to the cutting tools during the later stages of the operation. The transmitter components were removed from the brass casing by releasing the soldered joint of the transmitter cover. Extracting the brass transmitter case was the most difficult part of the operation, and it could only be removed by destroying it completely.

After redrilling the transmitter cavity to the required depth and recutting the antenna groove the operation was continued as described.

(c) Operation of transmitters

The operational history of the transmitters is presented in Table 2.

TABLE 2. Operational history of transmitters.

Transmitter	Sex	Age	Date Installed	Date Stopped	No. of days
C *	♀	9 yrs	10.11.69	8.12.69	21
			12. 1.70	13. 5.70	122
			19. 5.70	26. 1.71	253
A *	♂	11 yrs	13.11.69	20. 3.70	129
J			28.12.70	28. 6.71	183 +
B *	♂	M	4.12.69	15. 3.70	102
G			28. 9.70	28. 6.71	274 +
E	♀	8 yrs	12. 1.70	12. 1.70	0
H			23. 9.70	17.12.70	86
F	♂	M	23. 9.70	28. 6.71	279
D	♀	M	30.12.71	28. 6.71	181 +
E	♂	M	5. 1.71	10. 4.71	96

M = mature animal ; * = prototype transmitter ; + = still operating

(i) Prototype

Transmitter C

During the initial installation on the 10th November 1969 it rained during the whole operation. 21 days later the transmitter stopped working and it was not until the 12th January 1970 that the animal could be re-immobilised and the transmitter checked. It was found that the final covering of fibreglass had failed to bond, probably due to the rain wetting it, and the tuning hole had become exposed and clogged with foreign matter. As soon as the moist debris was removed the transmitter started functioning again.

On the 13th May 1970 the transmitter again ceased to function and the animal was re-immobilised a few days later. The fibreglass covering was still in perfect condition but did, however, show signs of abrasion on the lateral surfaces of the horn. The trimmer cavity was located and opened and the transmitter retuned.

The transmitter finally ceased functioning after a further 253 days. The total operational life of the transmitter was 396 days.

Transmitter A

This operated for 129 days. According to Anderson (pers. comm.) the transmitter had a loose connection which caused the pulser to stop in the off condition.

This transmitter was later replaced by a modified transmitter J.

Transmitter B

Pulsing ceased after 21 days with the transmitter in the 'on' condition. It continued functioning in this condition for a further 81 days which gave an accelerated test of the RMIN cell.

Replaced by modified transmitter G.

Transmitter E

The rhino, on awakening from the immobilising drugs, charged and made contact with a vehicle parked some distance away. After this episode only extremely weak signals could be heard at close quarters for a few days before they ceased altogether.

Replaced by modified transmitter H.

(ii) Modified type

Transmitter E

Prototype transmitter E was removed, modified and later placed in another rhino. Operation of this transmitter ceased after 96 days due to excessive abrasion on the lateral surfaces of the posterior horn resulting in the antenna groove becoming exposed and the antenna loop being broken and protruding from the groove.

Transmitter F

After 264 days the signal pulse rate became extremely rapid and continued in this condition until the transmitter stopped 15 days later.

Transmitter H

Ceased operation after 86 days for reasons unknown. No sign of exposure of the transmitter or loop antenna was noted.

At the time of writing three transmitters - J, G and D - are still in operation and functioning perfectly.

(d) Problems

The greatest problem in this study was the supply of the radio transmitters. As will be noted in Table 2 the first prototype transmitters were installed in 1969, followed by the first of the modified transmitters in September 1970 and finally the last batch in December 1970, the latter still not completing the original order.

The first beacon transmitter had an unusual characteristic of being non-functional from 1700 to 0700 hours. This consequently greatly reduced the night tracking periods. Furthermore, on cold, overcast days the beacon would not function at all. These problems were later overcome by the Council for Scientific and Industrial Research by their supplying a modified beacon transmitter.

4. FIELD STUDIES

(a) Methods

30 fixed stations were established at points along the various roads in the study area (see Figure 1). Most of the stations were situated on high ground

providing excellent sites for the purposes of obtaining radio fixes. Temporary tracking stations were periodically established as and when necessary depending on the locality of the study animals. The siting of the tracking stations was controlled largely by the position of the beacon transmitter, which had to be in line of sight.

Past experience of daily movements and activity patterns dictated the tracking routine. Radio fixes were taken twice daily; in the early morning and late afternoon.

Each radio fix was obtained by taking 2 or 3 bearings and plotting the vectors on field maps at a 1:10,000/scale. Efforts were made to obtain bearings from stations rendering maximum auditory signals. The time of each fix was recorded.

In addition to the normal tracking routine several observations were made at different times of the day and during the night. Range size was calculated by joining all the outermost radio fixes and sightings and then measuring the area so enclosed by planimetry.

Five consecutive evenings were spent in the vicinity of water points, whilst further periodic checks were made over three consecutive evenings in order to establish if there was any change in drinking frequency.

Location of the females at regular intervals was possible using the telemetric equipment. Furthermore, any female accompanied by a telemetrised male was always investigated to establish whether she was in oestrus or not.

In addition to merely plotting radio fixes, it was also found possible to monitor activity patterns using the equipment. When an animal was at rest, either standing or lying down, an unwavering signal was received; standing and lying down were considered as states of inactivity but it was not possible, with any degree of accuracy, to determine the exact state of repose of an animal on the signal behaviour alone.

Conversely, if an animal was actively moving around, engaged in either walking or feeding, the signal fluctuated continuously as the head was moved around. It was therefore possible to determine activity by the behaviour of the signals both audibly and on the signal strength meter.

Observations were made at night to confirm the movements assumed from the routine afternoon and morning fixes as well as to obtain data on nocturnal activities. When working at night readings were taken at 15 minute intervals to check on both activity and bearing.

When a radio fix was made the activity of the rhino was recorded at that time. If more than half of the observations in a particular hourly period were of animals in an active state, this was taken to be a period of activity. A major proportion of the diurnal activities was confirmed by visual observation. All such records were pooled to arrive at the data presented in Table 4, separately for males and females.

(b) Results

(i) ranges

The twice daily radio fixes of each of the study animals are shown in Figures 2 to 8. The range boundaries are indicated, and were drawn from the routine fixes as well as the supplementary ones and from visual observations. Figure 9 illustrates the position and extent of overlap of all the ranges in relation to one another.

Table 3 shows the range sizes and the areas of overlap between individuals.

TABLE 3. Range size and overlap of study animals in hectares.

Sex	Transmitter	Range size	Overlap area between rhino						
			A/J	B/G	E	F	C	D	H
♂	A/J	466		5	89	2	365	121	357
♂	B/G	393	5		0	342	115	0	212
♂	E	418	89	0		0	274	397	277
♂	F	366	2	342	0		112	0	205
♀	C	668	365	115	274	112		303	601
♀	D	583	121	0	397	0	303		308
♀	H	769	357	212	277	205	601	308	

(ii) drinking frequency

From the observations made over five consecutive evenings together with the periodic three-evening duration confirmatory checks, it was ascertained that all the study animals went to the watering points at the onset of darkness. Drinking times varied from 1900 - 2100 hours in summer to 1730 - 2100 hours in winter.

(iii) habitat utilization

The concentrations of the radio fixes in certain areas are clear in Figures 2 to 8, and may be explained by the fact that during the summer months all the animals show a preference for the hills and ridges. These areas are utilized as rest and mid-morning feeding areas. This characteristic is very marked in males A, B/G and E. During wet weather conditions the rhino do not move up onto the hills but remain on the hillslopes and in the valleys. Unfortunately, very little telemetric data is available for the winter period but observations indicate that the hills and ridges are rarely utilized, most of their time being spent in the wooded areas in the valleys. The results obtained also indicate a preference for certain vegetation types within their ranges.

(iv) reproduction and post natal care of young

Due to the time period over which transmitters were installed only one observation on copulation was obtained as a result of telemetry. None of the females produced a calf during the period of investigation.

(v) activity patterns

The daily activity patterns of males and females are given in Table 4 and Figure 10.

TABLE 4. Activity patterns of black rhino as revealed by radio tracking.

Time Period	MALES				FEMALES			
	No. of observations			% active	No. of observations			% active
	active	not active	TOTAL		active	not. active	TOTAL	
0400-0500	4	8	12	33,3	4	1	5	80,0
0500-0600	14	89	103	13,6	10	37	47	21,3
0600-0700	24	138	162	14,8	32	64	96	33,3
0700-0800	20	121	141	14,2	29	40	69	42,0
0800-0900	9	41	50	18,0	13	21	34	38,2
0900-1000	3	20	23	13,0	3	9	12	25,0
1000-1100	2	6	8	25,0	1	2	3	33,3
1100-1200	3	17	20	15,0	4	4	8	50,0
1200-1300	2	12	14	14,3	1	2	3	33,3
1300-1400	4	17	21	19,0	3	4	7	43,0
1400-1500	14	21	35	40,0	8	11	19	42,0
1500-1600	42	82	124	34,0	29	24	53	54,7
1600-1700	117	104	221	53,0	69	33	102	67,6
1700-1800	101	12	113	89,3	46	9	55	83,6
1800-1900	25	-	25	100,0	11	1	12	91,7
1900-2000	34	-	34	100,0	11	-	11	100,0
2000-2100	24	-	24	100,0	10	-	10	100,0
2100-2200	24	-	24	100,0	10	-	10	100,0
2200-2300	24	-	24	100,0	10	-	10	100,0
2300-2400	24	-	24	100,0	10	-	10	100,0
2400-0100	33	-	33	100,0	11	-	11	100,0
0100-0200	30	-	30	100,0	12	-	12	100,0
0200-0300	29	-	29	100,0	7	1	8	87,5
0300-0400	19	1	20	95,0	7	1	8	87,5
TOTAL			1314				615	

5. DISCUSSION

The data obtained in this study indicate that two types of range occupancy occur, namely territories by males, and home ranges by females.

The concept of territoriality in black rhino has been rejected by Schenkel (1966), whilst Goddard (1967) and Hitchins (1969) found no evidence to support it. Both the latter authors favoured the application of the alternative concept of occupation of home ranges.

Essentially, the black rhino is a solitary species, and the nature of its habitat in most parts of its range, and particularly in Hluhluwe Game Reserve, does not enable interactions between individuals to be easily observed. This is in contrast to the square-lipped rhinoceros, which is easily observed, and in which territoriality has been reported by Owen-Smith (1971).

The results of the present study, whilst being largely circumstantial owing to the lack of observation of interactions, do seem to indicate a similar situation to that found in square-lipped rhinoceros. Males A/J, B/G and E show this most clearly: there is no overlap in the areas utilised by B/G and E, and both animals use separate watering points. A small overlap of 5 ha occurs between B/G and A/J, and again the two animals drink at separate waterholes. The common ground occupied by A/J and E amounts to some 89 ha, but this is a ridge down which both animals have to move in order to reach the same waterhole. Despite this, no interactions between the two individuals were recorded as they appeared to "stagger" their drinking times.

It will also be seen from Figures 3 and 5, that males B/G and F share almost identical ranges, a phenomenon also found in square-lipped rhino, and explained by Owen-Smith (1971) as being a manifestation of dominancy by one adult male over another, the latter being what was termed a "subsidiary bull", which takes no part in breeding. It is interesting to note that observations made prior to this study showed males A/J, B/G and E all took part in mating, whilst F was never seen to do so. In this instance it is concluded that B/G is dominant over F on the basis of his occupancy of the more favoured high ground during the day in the summer months. At no stage did F venture beyond the lower slopes, spending most of his time in the valleys. The two individuals always maintained a distance of no less than 100 metres between each other.

Male territories vary in extent from 393 to 466 ha. Female home ranges however, were considerably larger, varying from 583 to 769 ha in size. This,too, is a similar situation to that observed in square-lipped rhino, the female home ranges overlapping with one another extensively, and embracing at least part of several male territories (Owen-Smith 1971). One positive instance of a male attempting to prevent a female from leaving his territory was observed.

There is no seasonal change in the home range size in females, although a marked preference for different habitats is clearly shown in the study. In winter they make greater use of the thickets in the valleys, and in summer they prefer the more open wooded grassland.

Finally, there is no doubt that the use of radio telemetric equipment greatly facilitated the study of drinking frequency, range utilization and nocturnal activity. Had all the transmitters been installed within a short period it would have been possible to obtain information on encounters between males and females on a frequency basis and to curtail field work on the project a good deal sooner.

It is intended to publish a more detailed account of this study at a later date, when the managemental implications of the results obtained have become clearer.

6. ACKNOWLEDGEMENTS

I would like to thank fellow officers of the Natal Parks Game and Fish Preservation Board for all their help in the field, in particular to Dr M.E. Keep, Messrs. K. Rochat and P. Phelan; and to Mr J. Vincent for discussions and editing the manuscript. I am extremely grateful to Dr F. Anderson of the Council for Scientific and Industrial Research for his continual assistance and advice pertaining to the radio tracking equipment.

7. BIBLIOGRAPHY

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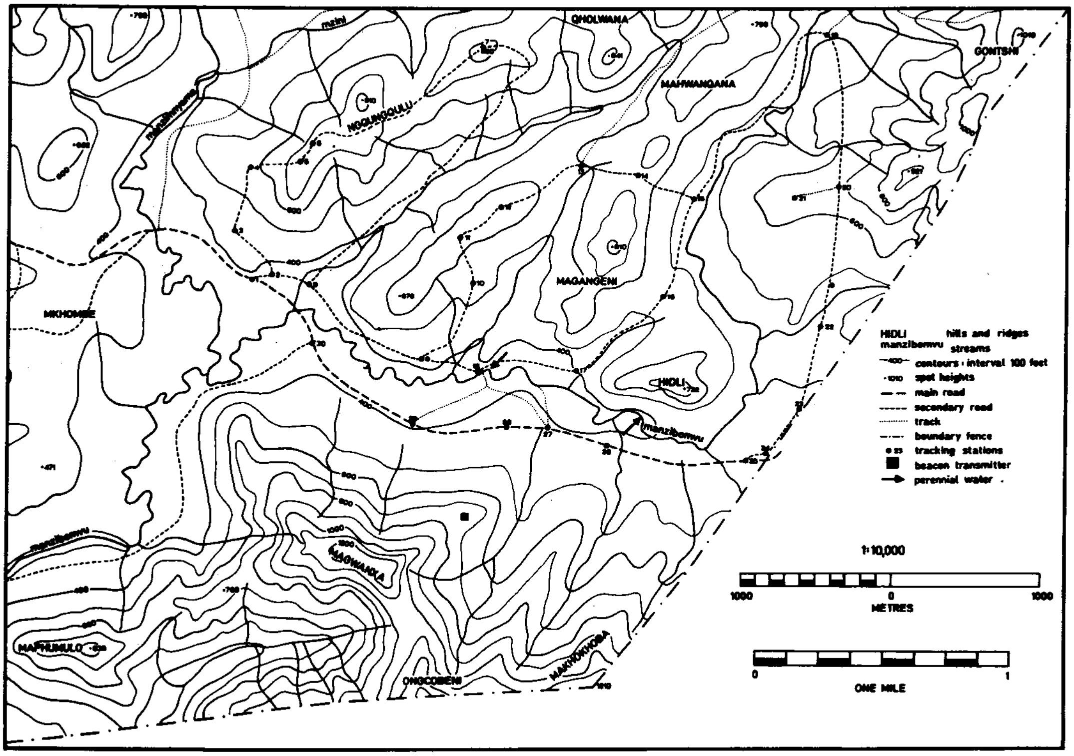

Figure 1: Map showing topography, roads and tracks, tracking stations and site of beacon transmitter

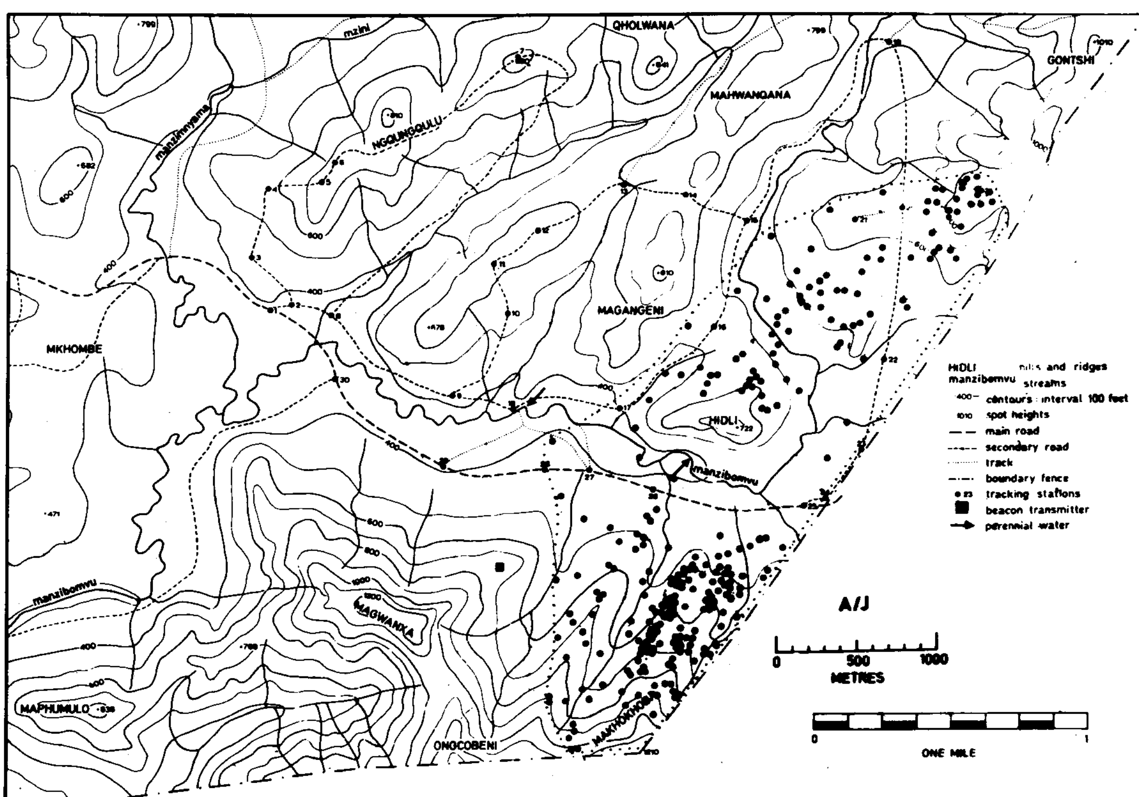

Figure 2: Routine radio fixes and range of male A/J

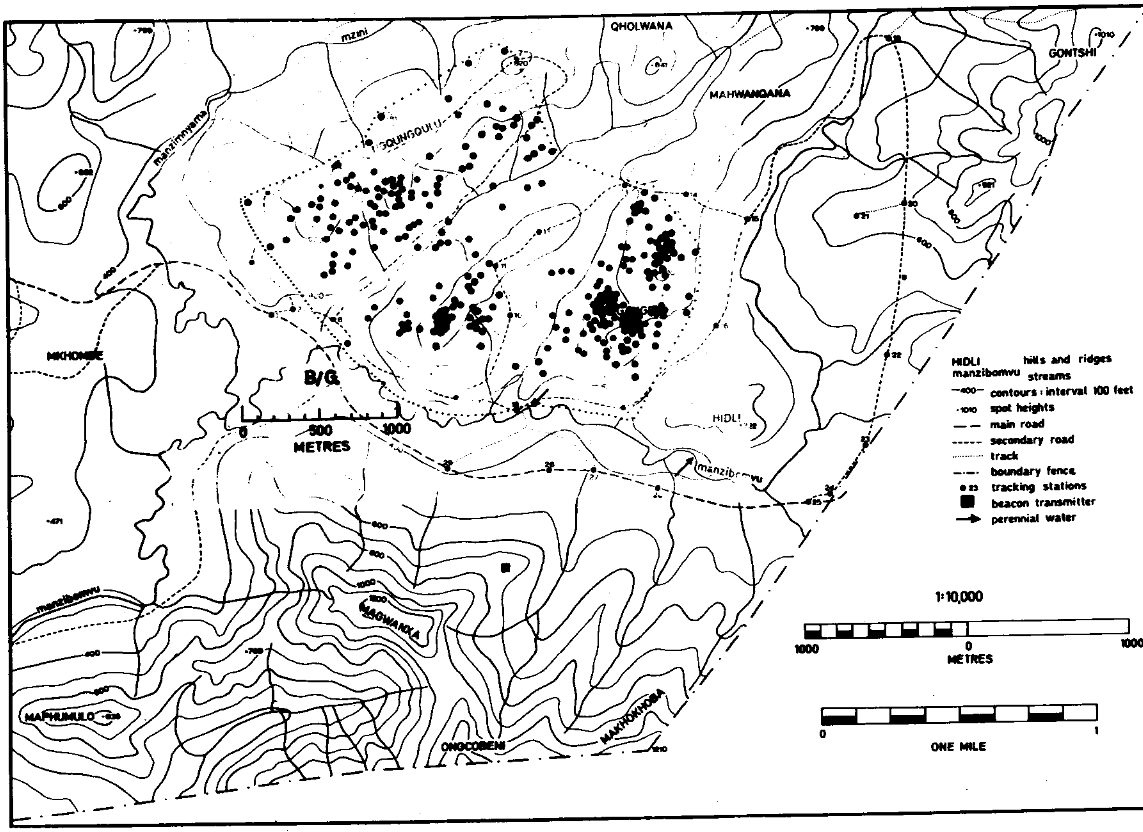

Figure 3: Routine radio fixes and range of male B/G

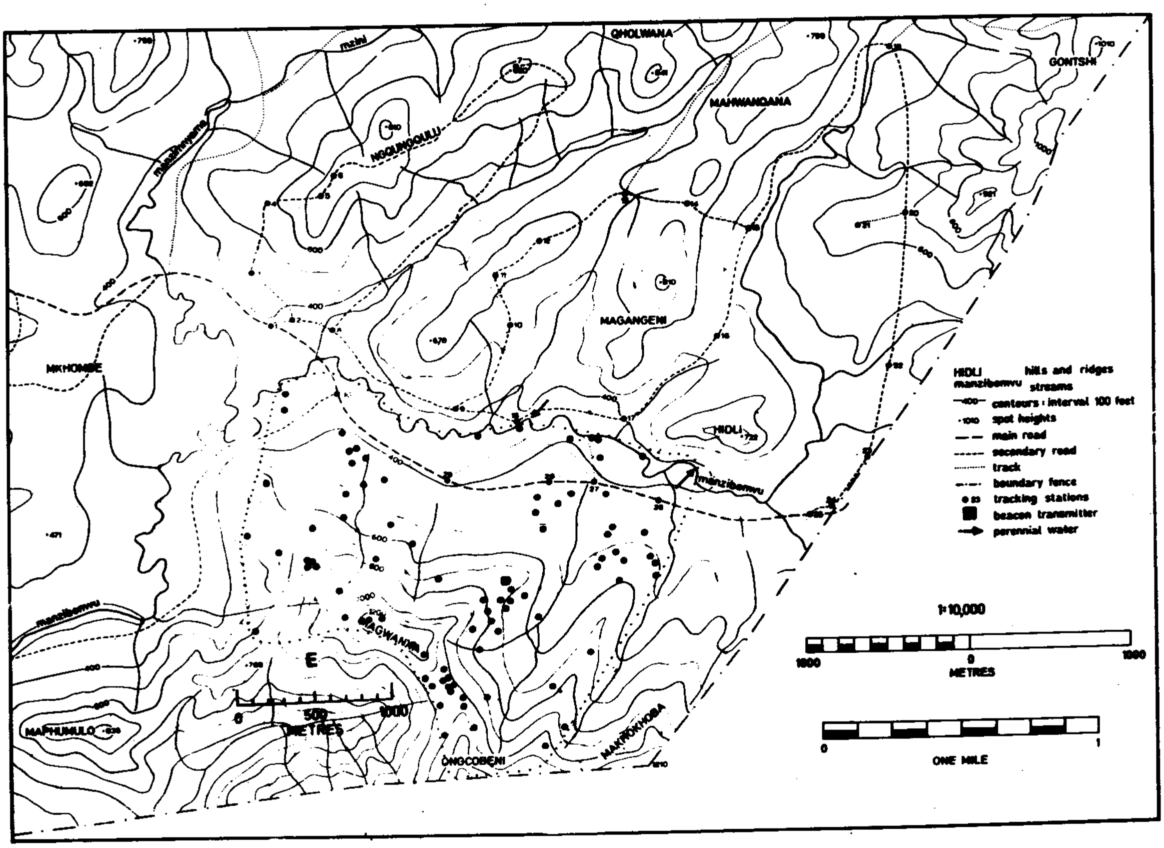

Figure 4: Routine radio fixes and range of male E

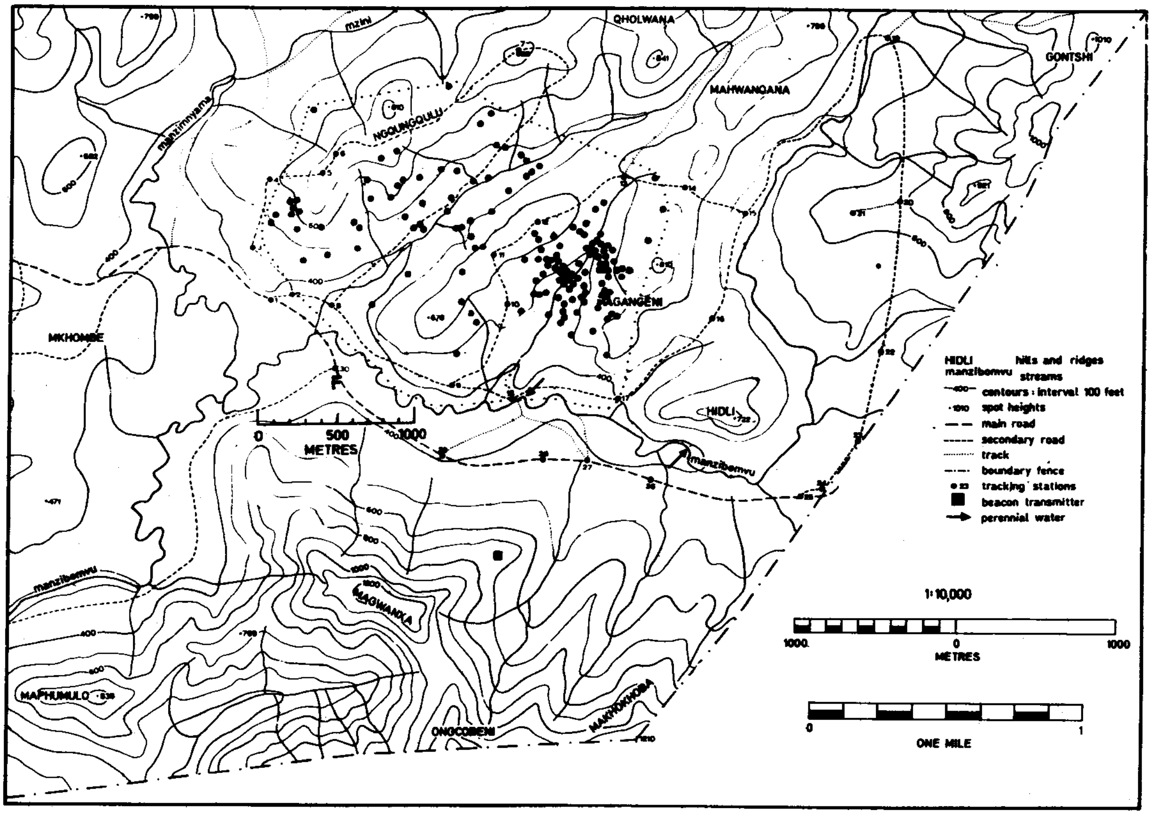

Figure 5: Routine radio fixes and range of male F

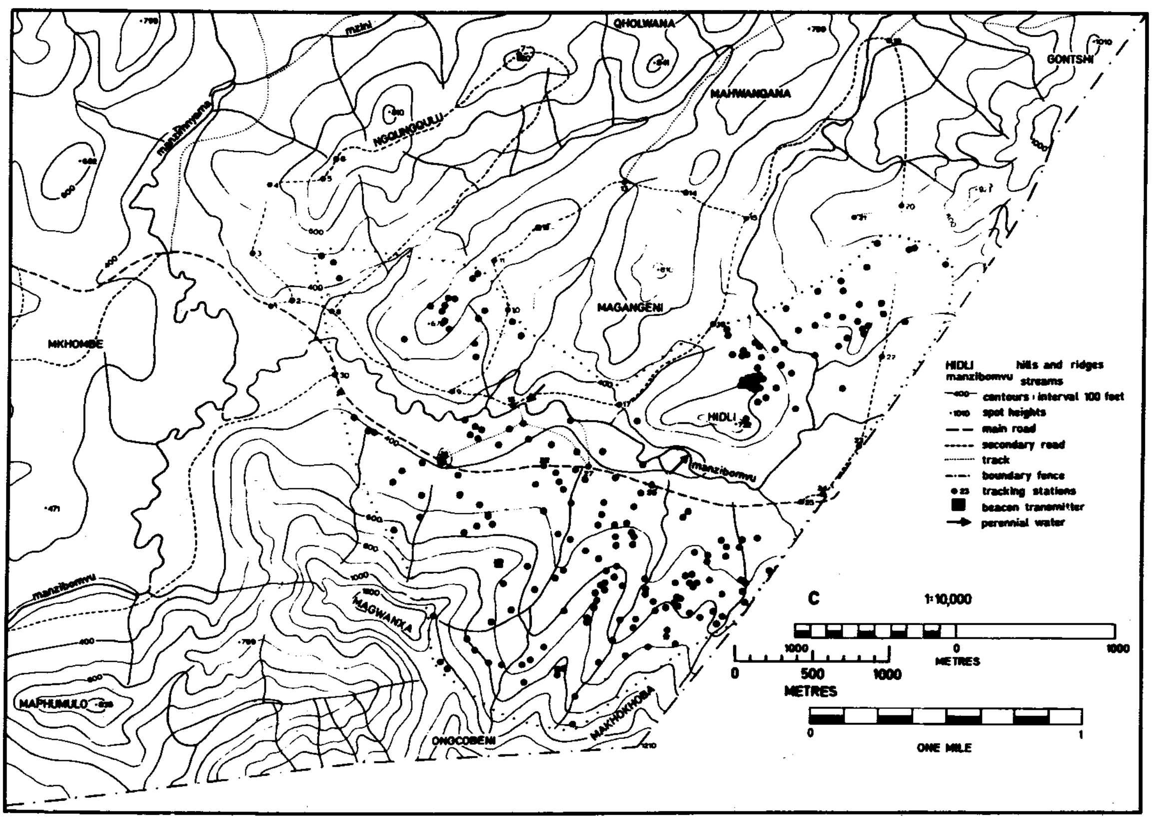

Figure 6: Routine radio fixes and range of female C

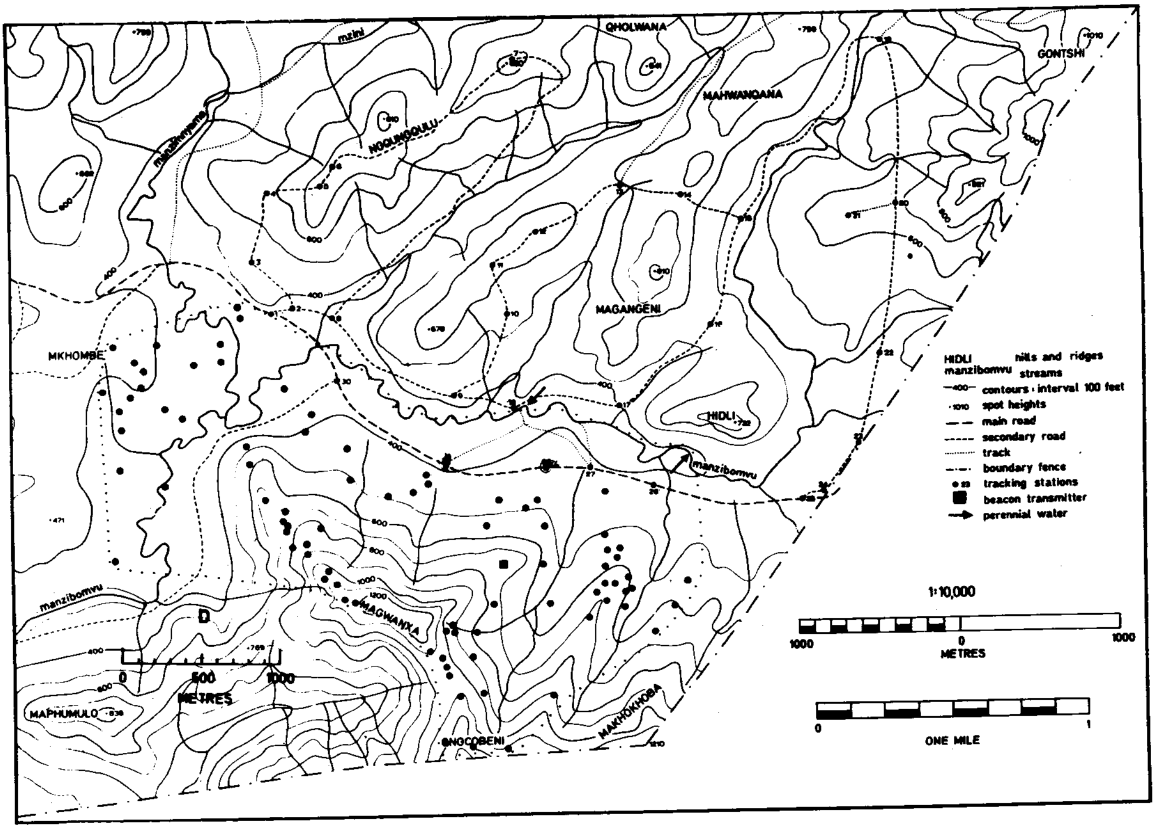

Figure 7: Routine radio fixes and range of female D

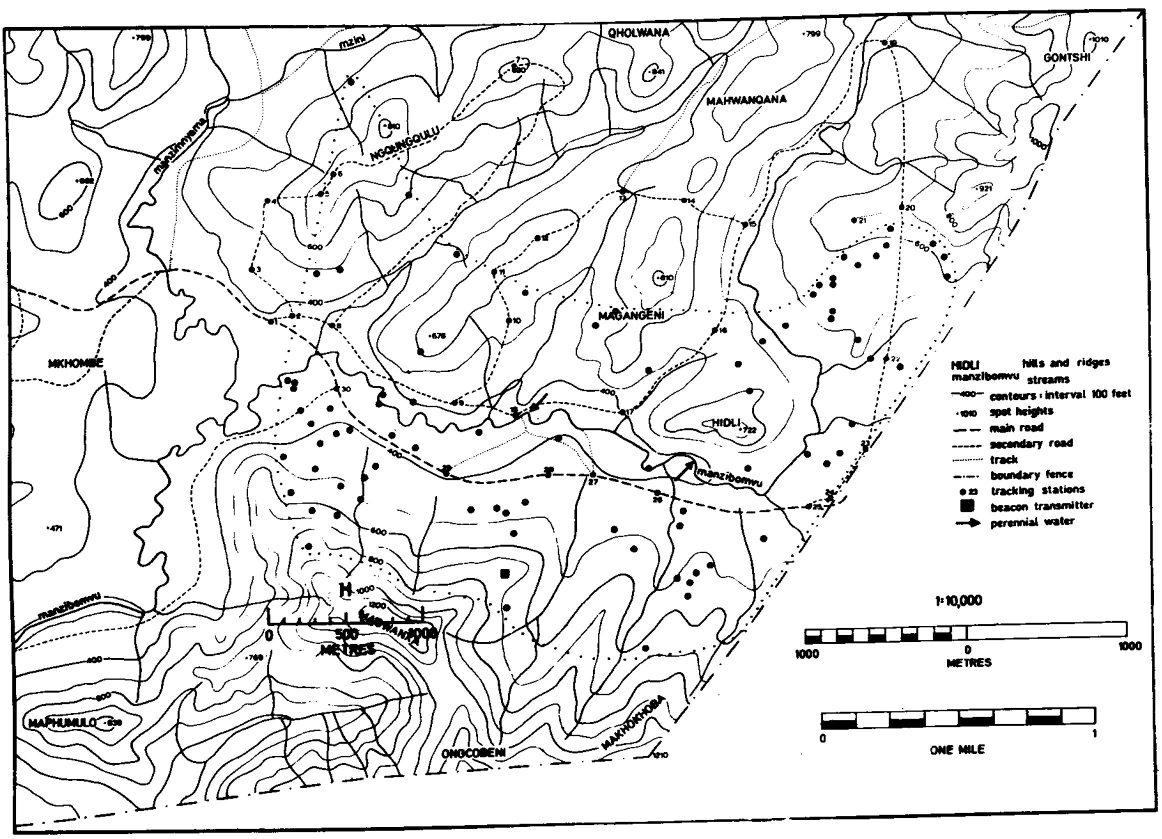

Figure 8: Routine radio fixes and range of female H

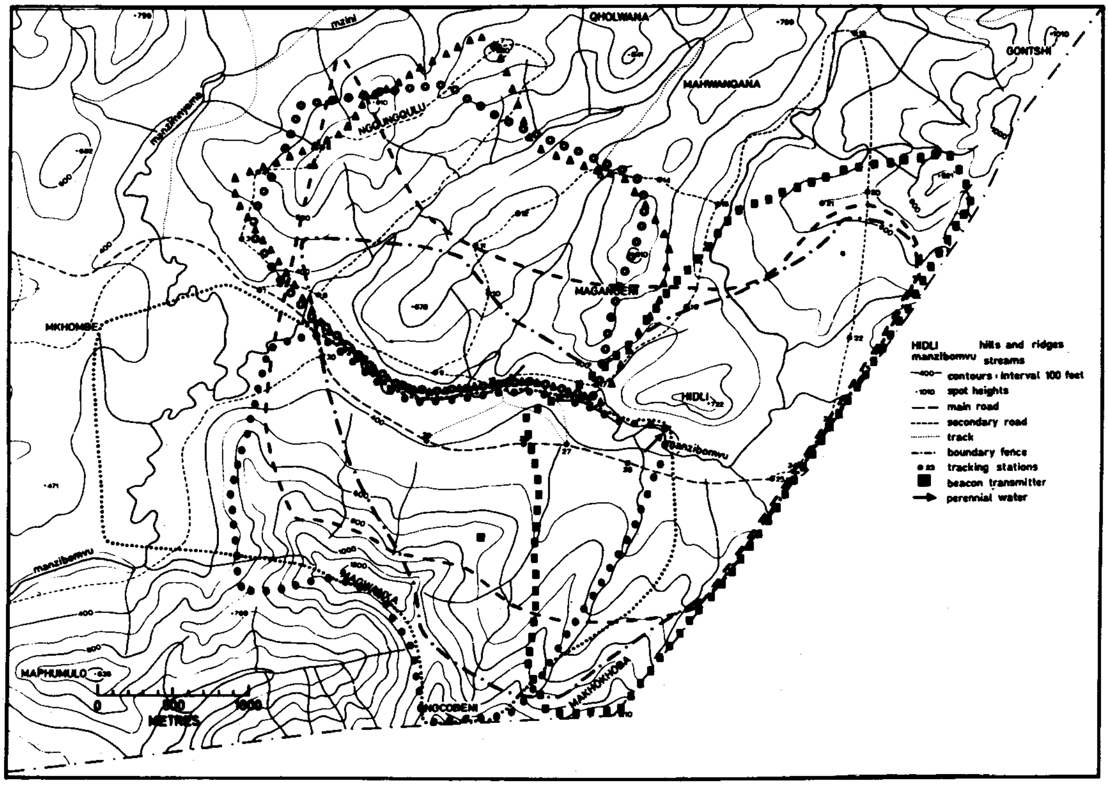

Figure 9: Overall range patern of study animals

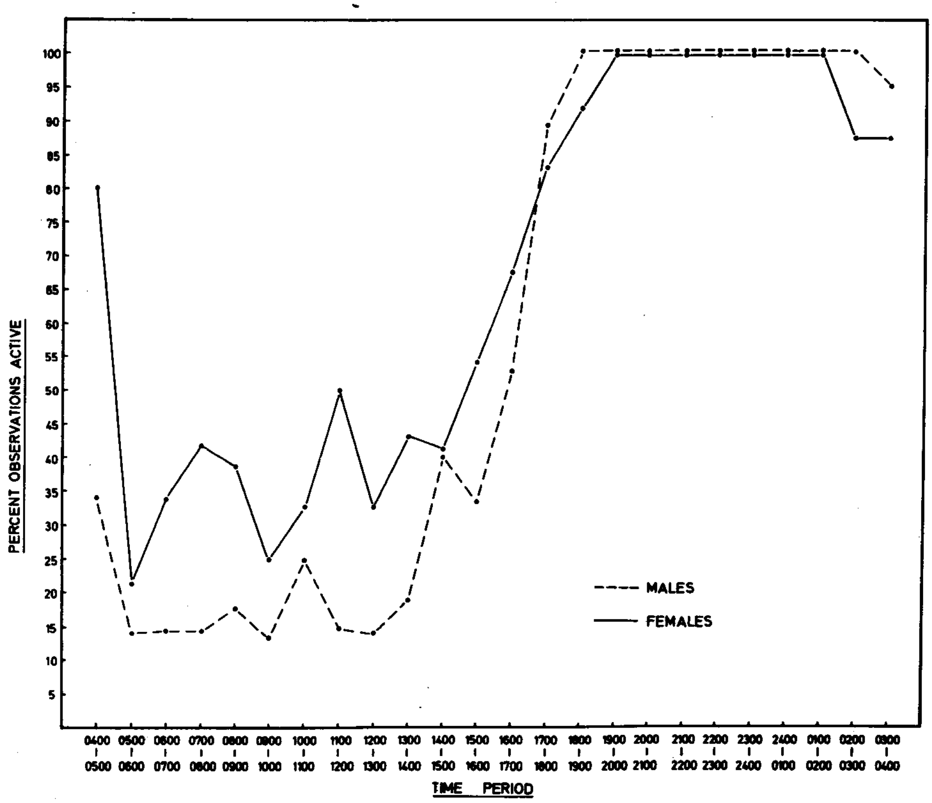

Figure 10: Activity patterns of male and female study animals

DISCUSSION ON PAPER BY P.M. HITCHINS

QUESTION : Prof. R.C. Bigalke (Dept. of Forestry, University of Stellenbosch.
Why do you distinguish between territorial males, subsidiary males and females occupying home ranges?

ANSWER : P.M. Hitchings. Females have large overlapping home ranges but males use territories with hardly any overlap except for the occasional subsidiary male who occupies territory identical to that of a territorial male but takes no part in mating. These concepts are actually based on observations over a six to seven year period prior to this study and are also confirmed by another telemetric study at present in progress in another area.

QUESTION : Dr. M. Milner (University of Cape Town Medical School).
This is very exciting work. What future investigations related to these particular studies are envisaged?

ANSWER : P.M. Hitchins. The main object of research in regard to the Black Rhino is population dynamics but nevertheless one has to understand more of the ecology of the species. Telemetry will enable new areas to be studied to determine range sizes and range utilization and what the animals' requirements are within the ranges, especially regarding vegetation. Once the distribution of the animals within the area studied is known, a vegetation transect is done : the various plant species are recorded, whether utilized or not, and if so, the extent to which they are utilized is estimated. This information will be compared with the results from other study areas.