ECOLOGY AND BEHAVIOUR OF THE BLACK RHINOCEROS

Diceros bicornis Linn. 1758

IN MASAI MARA GAME RESERVE

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"A thesis submitted in fulfilment
for the Degree of Master of Science
in the University of Nairobi."

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DECLARATION

(1) I John G. Mukinya declare that this thesis is my original work and has not been presented for a degree in any other University.

Signature John G. Mukinya

Date 19/9/73

(2) We Dr. John B. Sale and Dr. C.J. Pennycuick declare that this thesis has been submitted for examination with our approval as University supervisors.

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Date 2nd September 1973

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SUMMARY

The ecology and behaviour of Masai Mara Game Reserve rhinoceros was studied from May 1971 to August 1972.

At the end of August 1972, the entire Mara rhino population consisted of 108 animals of which 73% were adults and 27% were immature animals which accompanied their mothers. The adult population consisted of 54% males and 46% females.

The density of black rhino in the Mara Game Reserve is 0.07/km^2 considering the entire reserve area (1530 km^2) and 0.14/km^2 considering the area occupied by rhinos (749 km^2). The recorded highest individual distribution area density was 0.23/km^2. There was no noticeable difference between the mean densities obtained from the ground and aerial count though an aerial count was not carried out in the Triangle area.

In the entire study area, 13 rhino distribution areas were known. Each of the 13 distribution areas had rhinos which associated with each other but individuals from one distribution area were never observed associating with individuals from another distribution area. The movement of rhinos out of the reserve was neglegible.

Rhinos were distributed over the plains, grassland with scattered trees, slopes of hills and thickets along river courses. Rhinos appeared to prefer areas with abundant cover for shelter, food, water, and with absence of human and domestic animals.

The sex ratio of adult females: adult males was 1:1.1

and for immature females: immature males was 1:3.2. Out of 28 immature rhinos 11 were not sexed due to some difficulties hence the sex ratio for immature rhinos cannot be interpreted with confidence.

The entire rhino population was divided into four age classes. Age class I representing individual rhinos from 0 - 1 year old, class II from 1 - 2 years old, class III from 2 - 4 years old and class IV over 4 years old.

Although rhinos are known to mate at any time of the year, individuals of the Mara population were observed mating during the period between September and April. Usually this is the hot period of the year.

Mortality of adults and calves was found to be very low. Only one adult rhino died during the study period and none of the calves died.

On social organization, black rhinos are solitary animals but occasionally, adult males and adult females can be observed together particularly during the feeding hours or during mating periods. Sub-adult rhinos are solitary but they can sometimes be seen joining their mother and in the case of females, joining adult males. The only form of organization which is rather permanent is mother-calf unit which is frequently observed until the time when calf leaves the mother. On some occasions mother-calf unit is observed associated with single adult male.

Rhino's pattern of association strengthens bond

between mother and its calf and weakens the bond between adult individual rhinos. Group defence from enemies is minimal and individual rhino is left to defend itself alone. This pattern of association, on the other hand, makes it difficult to locate rhinos in the wilderness other than the times when they are on open areas carrying out their other daily activities.

Rhinos have home ranges which are generally shared by males or females in the adjacent home range. The size of home range is dependent on available food, cover, water, mating activities and domesticated animals. The home range size varied with social units. Females with calves had larger home ranges than single females or single males. Females with calves move a lot looking for palatable herbs and shrubs. Movements of rhinos within their home ranges, either daily or seasonal, causes a considerable degree of home range overlapping. No indication of territorial behaviour was observed. Because rhino tend to remain attached to some particular area, the density can be quite high in some areas and less in other areas depending on the number of individual rhinos occupying these areas. In the game reserves or national parks the rhino attachment to particular areas makes it possible for rangers to have a rough estimate of areas to take tourists. Also this attachment to particular area limits the degree of association with other rhinos other than its neighbours. Rhinos were also observed associating with the buffalo,

giraffe, topi and wildebeest living within rhinos home ranges.

Black rhino in Mara were observed feeding on varieties of plants with preference for Solanum incanum and Acacia species. About 70 different plants species from 30 different botanical families were recorded. During the rainy periods a variety of palatable herb are easily available and it is during these periods that rhinos were observed selecting a wide variety of herbs and shrubs. However, during the dry period most of the herbs and shrubs dry up and climax of shortage of food is observed during the burning period which normally occurs during the dry period.

It was observed that rhino's pattern of food selection is dependent partly on relative density and relative frequency of plant species used. Rhinos were observed feeding mainly in open grass and scrub with scattered trees habitats. These two habitats mainly carry most of rhino's food.

Rhinos in Mara were observed to feed mainly on regenerating vegetation. Branches with leaves, and branches with leaves and inflorescences were mainly eaten. A portion of plant ranging from 7 to 26 cm is mostly swallowed by rhino. In some cases leafless remnants of plants were found uprooted.

Observations indicated two feeding peaks within twelve hours of the daylight. One feeding peak is in the morning and the other in the afternnon. However, other

minor activities may be observed during the feeding peaks.

There is no competition for food with other animals. Wild animals using the same plants used by rhinos have different feeding levels. Rhinos in Mara were observed to be mainly ground feeders.

Rhinos were observed to visit salt licks in distribution area A. Other animal species like topi and buffalo were also observed in this salt lick places. Salt lick places contained sodium, magnesium, potassium and calcium.

Rhinos were observed drinking water mainly from sunset or just after the sunset. However, there is no doubt that they also drink early in morning or spend most of their night time near the water places because they were mostly located in the morning near the water places walking to their feeding grounds.

Mating was observed mainly during the period from September to April. However, though no record was made, rhino can mate at any time of the year.

Wallowing is mainly limited to the rainwater pans or standing water along the seasonal streams or rivers. Wallowing takes place during mid-day which is normally the hot part of the day. However, wallowing actitivities were frequently observed during the wet days rather than during dry periods. This is probably due to availability of water in the rainwater pans. After wallowing rhinos were observed rubbing their bodies against a tree, tree branch or termite mound.

Rhino maintain dung piles. Some of the dung piles are along tracks frequently used by the rhinos to the water places or to feeding areas. Over 90% of dung observed was scraped. Dung piles were also observed being shared and the degree of sharing dung piles may depend on how often the part of the home range where the dung piles are located is used by another rhino. Rhinos have no definate urinals and were not observed defecating and urinating simultaneously.

Rhinos normally walk as observed during the feeding hours. However, when disturbed they can run at a speed of 60 km/h. When running, females with calves are followed closely behind by their calves but sometimes, though rarely, calves can be observed leading their mothers into sheltering places.

Rhinos were observed resting during the mid-day if they were not wallowing. Rhinos were observed lying down under a tree shade or resting while standing next to a tree which provided shade.

Rhinos reaction to strangers reveal that a rather small number of tendencies are involved in varying proportions. These tendencies are curiosity, fear, anger and inertia.

A number of other lines of possible research are suggested.

Chapter I

INTRODUCTION

I - 1 Taxonomic Position, Fossil History, Description And Distribution In Africa

(a) Taxonomic Position

Black rhino is within the group of the order Perissodactyla. The order perissodactyle in infraclass Eutheria is divided into two suborders namely Hippomorpha and Ceratomorpha. Suborder Ceratomorpha has two superfamilies namely Tapiroidea and Rhinocerotoidea. Superfamily Rhinocerotoidea has one family, Rhinocerotidae which is divided into two subfamilies Rhinocerotinae (one-horned Rhinos) and Dicerorhininae (two-horned Rhinos). Subfamily Dicerorhininae has got three species namely Didermocerus sumatrensis (Sumatran Rhinoceros), Ceratotherium simum (White Rhinoceros) and Diceros bicornis (Black Rhinoceros). Taxonomic classification of Black Rhino, Diceros bicornis (my study animal) is shown on Table I - 1.

(b) Fossil History

Among all vertebrates there is, perhaps, no group whose fossil history is better known than that of the order Perissodactyla, the "odd-toed" ungulates. Although represented at the present day by but a few species of tapirs, horses and rhinoceroses, perissodactyls were numerous throughout the Tertiary (10 to 70 millions of years).

Among all the perissodactyl groups, the most

complicated fossil history is that of the Rhinocerotoidea, the rhinoceroses and their relatives. At present there survive of the rhinoceroses only a few forms in the Old World tropics, but throughout most of the Tertiary they were exceedingly numerous in the northern continents. It seems certain that they were derived from early tapiroids, perhaps in several parallel lines; they have, however, tended to diverge considerably from that group. As contrasted with most equids, rhinoceroses have tended to grow to large size, usually with comparatively short, stout limbs in which digital reduction has proceeded at a slow pace, for the fifth digit in the hand was present in some Oligocene and even Miocene forms, and a monodactyl stage has never been attained.

The rhinoceroses may be divided into three families, of which the most primitive and unspecialized are the members of the Hyracodontidae, the "running rhinoceroses", such as Hyracodon of the North American Oligocene and its forerunners in the late Eocene of both North America and Asia. Hyracodon was somewhat more specialized for a cursorial life than the tapiroids, with long slim legs and but three toes on front as well as hind feet. These evolutionary advances were very similar to those found in the contemporary horses but were not continued for the group disappeared before the close of the Oligocene, perhaps because of unsuccessful competition with these rivals.

An early side branch, possibly derived from the

primitive hyracodonts, was that of the family Amynodontidae. These forms are found in the late Eocene and Oligocene of both Eurasia and America and persisted in Asia until the Miocene. They had about the general size and proportions of a hippopotamus, and the conditions under which their remains are found suggest that they were river-living forms. Metamynodon of the America Oligocene had short, massive limbs, still retaining four short toes in front and three behind.

All remaining forms are commonly placed in a third family as early true rhinoceroses, the Rhinocerotidae. It seems certain that these types were derived from early running rhinoceroses, but Eocene forerunners are presented only by poorly known types. The true rhinoceroses first became prominent in the Oligocene and tended to large size and stout limbs, while the premolars became rapidly molarized. Prohyracodon of the Eocene and Trigonias, Subhyracodon, Caenopus, and related forms from the Oligocene of North America and Europe appear to represent the central stock of the true rhinoceroses. Four toes were still present in front in Trigonias, but the outer toe had disappeared in Caenopus. The primitive Oligocene rhinoceroses were hornless.

A number of later Miocene and Pliocene genera, such as Aceratherium of Eurasia and certain rarer American contemporaries, show relatively little change from the primitive pattern.

An early branch from the Caenopus stock is that

represented by Diceratherium of the American Miocene This genus was quite similar to its Oligocene ancestors except for the fact that the males possessed small horns; but, unlike those of other later horned rhinoceroses, these horns were placed side by side at the tip of the nose.

Equally prompt to appear was a much more spectacular and aberrant group including Baluchitherium, huge hornless forms from the Oligocene and early Miocene of Asia. These were the largest of known land mammals.

Beyond the Oligocene, rhinoceroses became relatively rare in America and died out during the Pliocene; in Eurasia, on the other hand, there are numerous and varied genera in Miocene, Pliocene, and even Pleistocene deposits.

Turning now to the East African Pleistocene record, both the black and white rhinoceros have been found at Olduvai Gorge, Tanzania. Diceros bicornis does not occur in the lower portion, the early Pleistocene. In Kenya a small, extinct rhinoceros from the late Miocene of Fort Ternan, that appears to be collateral development of differing from Diceros in a combination of primitive and progressive features was reported by Hooijer (1968).

Today there are five species of rhinoceros alive three in Asia and two in Africa. The largest of the Asiatic forms is the Great Indian Rhinoceros (Rhinoceros unicornis), which is confined to jungle and grassland area of Nepal, Bengal and Assam. Like the African Black Rhinoceros (Diceros bicornis) it has a pointed, prehensile

upper lip, but unlike the African forms, it has only one large horn. The other Asiatic rhinos are the Javan Rhinoceros (Rhinoceros sondaicus) which is smaller, horned usually only in the male, and practically extinct; and the Sumatran Rhinoceros (Didermocerus sumatrensis) which has two horns and a hairy coat.

The White Rhinoceros (Ceratotherium simum) is confined today to two distinct and separate areas. In the more northerly of the two they are found in Uganda, the Zaire, and the Sudan. In South Africa they occur in Zululand. In both areas, they live in thorny Savannah, but subsist almost entirely on grasses, using the trees for cover, shade and rubbing.

The Black Rhinoceros is the more common of the two African species. Unlike the white, or Square-lipped Rhinoceros, this species has an upper lip that is long pointed, forming a prehensile organ. Black rhino is a browser. Like the White rhino it has weak vision, but the senses of smell and hearing are acute. A similar condition of vision, smell and hearing is also noted with Malayan and South American Tapirs.

(c) Description

Skin

The black rhinoceros is a large, bulky and thick skinned animal. The skin is neutral grey to blackish brown, but often takes the colour of the soil on which the animal lives due to its wallowing and dust bathing

activities. It is hairless except for the tail tuft and fringe on the ear pinnae (Guggisberg 1948). Flanks often with deep folds. The upper lip is drawn out to a prehensile tip.

Size

Mature animals vary in mass from 700 to at least 1,270 kg (King 1969) with little difference between the sexes. Stewart and Zaphiro (1963) recorded, minimum adult mass of 1,000 kg. Guggisberg (1948) recorded mass of about 1,100 kg. The shoulder height is from 1.40 to 1.60 m and the length from the tip of the nose to the root of the tail measured along the body curve is 3.7 m.

Horns

Two horns, posterior and anterior can always be noticed on mature animals. However, there is a degree of sexual dimorphism (Hamilton and King 1969): in the male the posterior horn is usually much shorter than the anterior while in the female both horns tend to be of similar length. Gertie, the famous Amboseli rhino, had a horn of about 1.21 m long and horns of 1.35 m have been recorded (Guggisberg 1948).

Dentition

The normal dental formula of the black rhinoceros is Deciduous:

$$\left[I\frac{0}{0} ; C\frac{0}{0} ; P\frac{4}{4}\right] \times 2 = 16$$

Permanent:

$$\left[I\frac{0}{0} ; C\frac{0}{0} ; P\frac{4}{4} ; \text{or } \frac{3}{3} ; M\frac{3}{3}\right] \times 2 = 24 - 28$$

The teeth are peculiar (Ritchie 1963), there being no incisors or canines in either jaw. The first premolar is often missing in older animals especially in the lower jaw. The adult black rhinoceros normally has four premolars (Goddard 1970) and three molars. The sequence of eruption being from anterior to posterior. The three molars are massive, ridged structures and are the principal teeth used in feeding. The development, eruption and consequent wear is similar in both the mandible and maxilla, but the maxillary dentition usually develops slightly ahead of the mandibular dentition.

The teeth consists of dentine and enamely only, no cement being present.

(d) Distribution In Africa

The black rhinoceros is fairly widely distributed over Africa, though today much less than formerly (Ritchie 1963). Its present distribution is tragic when compared with a hundred or even fifty years ago. It has disappeared entirely from vast areas of Africa

and in many parts where it still exists, it is in small numbers. Formally it occupied most suitable areas from the Cape to the Blue Nile and from Somalia to the Cameroons.

Today in Africa black rhino is found in Malawi, Rhodesia, Zambia, Tanzania, South West Africa, Somalia, Sudan, Nigeria, Rwanda and Burundi.

In Kenya black rhinoceros is distributed all over the country's dry land with exception of the areas which are highly settled particularly Central Province. They are in abundance in Tsavo National Park, Masai land, Ukambani, North-eastern Province, Turkana and Samburu Districts.

In the past, this species has been eliminated from much of west and south-west Kenya by the spread of settlement and cultivation. It has also been reduced in north-east Kenya and in Rift Valley by poaching and severe drought. However, continued poaching and drought may in future eliminate completely the existence of black rhino in Kenya. Map I - 1 shows the distribution in Kenya at present and elimination since 1885.

I - 2 Previous Studies

Much work has been done on black rhinoceros for the past decade particularly by J. Goddard. Goddard (1966) carried out field study on mating season, precopulation behaviour, copulation and post-copulation

behaviour, polygamy-polyandry and competition between males. Goddard's (1969) aerial census of black rhinoceros using stratified random sampling in Tsavo National Park gives data on estimates of crude densities. Goddard (1968, 1970) gives information and data on habitat and food preferences (plant species used by black rhinoceros) of two black rhinoceros population in Northern Tanzania, one population occupied the Caldera of Ngorongoro and the other the vicinity of Olduvai Gorge on the eastern part of the Serengeti plains. Goddard's other works on black rhinoceros include age criteria and vital statistics of a black rhinoceros population in Tsavo National Park (1970), a note on age at sexual maturity in wild black rhinoceros in Ngorongoro (1970) and black rhinoceros vocalisation in Ngorongoro (1970).

Schenkel (1969) carried out a field study on ecology and behaviour of the black rhinoceros in Tsavo National Park East which details the impact of the rhinoceros on its habitat, relationship between other vertebrates, intraspecific intolerance and aggression, group formation, non-ritualized behaviour patterns, reaction to other large animal species including man, ritualized behaviour and mother-child-unit.

Freeman and King (1969) reported relation among various linear measurements and weight for black rhinoceros in Kenya. Hamilton and King (1969) reported the movement and the size of home range of rhinos after

they are released in Nairobi National Park.

Work on capture and translocation, immobilization of the black rhinoceros after using drugs has been reported by King (1965) and (1969).

Other work on black rhinoceros has been carried out by Denney (1969), Ritchie (1963), Joubert and Eloff (1971), Grzimek "Rhino belong to everybody" (1964), Stewart and Zaphiro (1963), and Stewart and Talbot (1962). These authors have tried to understand the black rhinoceros and the world in which it lives. Their work has been used as a part of my references.

I - 3 Aim And Scope Of This Study

This study, was aimed at gathering data on distribution and density of black rhino in the Reserve itself. Population dynamics, social organisation, feeding and drinking habits, other activities and habitat in which black rhinoceros lives were also investigated. Thus, the study further aimed at providing basic data on which to base future management policy.

I - 4 Methods

The study work started in May 1971 and ended in August 1972. Very little knowledge of the study area was available and therefore the first two and half months were spent on acquainting myself with the area. Several problems were encountered in the area

particularly because of the difficult terrain. During this survey period I was able to select methods for individual animal identification, animal census, sex and age identification, food species, food availability, home range, horizontal density of vegetation and other behavial studies. Indeed it is rather difficult working with an animal like black rhinoceros which is difficult to locate in the bush, except at certain times of the day particularly when feeding or carrying out other activities while standing. Even on grassland, while grass is up to a height of 1.5 m or over it becomes difficult to sight the animals due to obstruction. A rhino lying down can be passed by unnoticed within a short distance from the observer. Due to numerous streams and large rivers with few bridges and drifts, more problems were encountered in the course of following the animal.

The black rhinoceros can be approached to a distance of 35 m, perhaps because the visial powers are limited but it needs to be remembered that the black rhinoceros has got very good senses of smell and hearing. Thus, checking the direction of the wind by movement of branches, before approaching the rhino keeps it undisturbed. Movement of other animals around may make a rhino dash away. Being aware of such problems, the applied methods were very practical and quite feasible. Methods used in individual identification and determination of home ranges are described below but other methods used are described in the result sections.

Individual Identification And Home Range Determination

(a) Individual Identification

There are many methods which have been used in the past for identifying ungulates. Methods involving capturing, marking for identification and releasing the animals were impracticable for me since they are very costly, require a team of people and are time consuming particularly when working with a large number of animals.

The other method which is much cheaper and mostly used is identifying animals by recognition of natural marks which are recorded on photographs. This method was used in this study. A short wheel base Land-Rover with an opening on the top of front compartment to facilitate good viewing of the animals was used. A pair of binoculars 8 x 30, Zenith was used. In addition, a 35 mm Nikkormat Camera, with f/4.5 - 300 mm and Reflex-Nikkor f/8 - 500 mm lenses was used. Tri X. black and white films with ASA. 400 were used throughout the study period. The processing and printing of the films was done by Nilestar Camera Company Limited, Nairobi.

Searching for black rhinos started at 0600 hours in the morning and ended at around 1900 hours in the evening. When a rhino was encountered, the direction of approach was decided, then advancement make. Data on cuts on the ears, shape of horns, sores, wrinkles on the face (from the base of the anterior horn to the edges of the upper lip) were obtained. Pictures were then taken

of the left, right and the full face of the rhino. The rhino was given a number which was recorded on the same sheet on which field information was recorded. If it was accompanied by its young, the young was also numbered by using mother's number plus letter "B". The locality, time, and date first seen was recorded.

When films were processed and printed, a photograph of each rhino was glued to a 13 x 20 cm card. A file of photographs was taken into the field and a given animal was readily identified if it had been seen before. The three major characteristics used were ears, horns, and wrinkles of the face. Each of them was divided into four parts. The ear was divided into two halves by having an imaginary mid-line running from the root of the ear to the tip. The two halves were then divided equally giving four quarters which were numbered 1, 2, 3, and 4 from right for the left ear and from left for the right ear. The horns were also divided into four quarters with lines running from the tip of one nostril to the other and from the middle point of the upper lip to the base of the horn (Plate I - 1). In all of the animals studied, the wrinkle joining the two nostrils was always continuous and straight. The wrinkles between the base of the horn and the lip varied from 5 to 11 in number, and were numbered alphabetically from the upper lip to the base of the horn. The characteristics of each wrinkle were recorded. In all cases wrinkle "a" was considerably shorter than the

others and also cut the mid-line. The wrinkles got longer towards the base of the horn. Variations in the wrinkles were greatly noted particularly in the upper two quarters above the nostril base line. Branching above the nostrils, discontinous before reaching mid-line, joining another wrinkle and cross over were the common noted variations.

The wrinkles, marks on the ears and the shape of the horns as indicated on the photograph were checked against the individual animal and identification clarified each time a rhino was encountered during the field work.

In 1963, Dr. Hans Klingel, formerly of the Serengeti Research Project, used the technique of horn and ear identification on part of the rhinos population at Ngorongoro Crater, recording 26 animals. Goddard (1966) pointed out that identification by horns alone can be misleading, especially among rhinos with relatively small horns. Indeed, some rhinos, especially those with thin rapier-like horns break their horns, making identification uncertain. However, other than breaking, young rhinos grow to a fuller size and so do their horns creating a change in the shape of the horns, though this may be a gradual change. The ears too may have additional cuts or get completely cut off. For such cases, use of the pattern of wrinkles on the face can be a considerable aid in conjuction with horns and ears for identification.

Using this technique of identification it was shown

that 108 rhinos live in Masai Mara Game Reserve.

(b) Home Range

The technique used in mapping home ranges for rhinos in Mara was by checking the movement and locality of the rhinos. I had aquainted myself with various points on the ground which were readily identified on the map compiled from maps drawn by Survey of Kenya, scale 1:50,000, sheet 145/3 and 4, and 158/1 and 2, series Y 731 (D.O.S. 423) dated 1965-67. This map is SK 69 Edition; 1, 1967, and it shows clearly roads, tracks, hills, springs, waterholes, boreholes rivers and swamps which, as shown on the map existed during the study period. The location of the rhinos on the ground was approximated on this map and then transferred to another map, scale 1:50,000 with 1 km^2 grids, which I had compiled from Survey of Kenya maps, 1966, Series Y 731 (D.O.S. 423), edition 4-SK sheets 145/4, 144/2, 145/3, 145/1, 144/4 and edition 3-SK, 1965 sheet 158/1 and also edition 3-SK 1967 sheet 158/2. These maps were arranged in such a way that they formed Masai Mara Game Reserve and its surrounding areas. The Mara area was traced on a transparent paper which was then xeroxed to give field working maps. For the field use each side of 1 km^2 grid was divided into 10 parts (each 2 mm) which were used in approximating the location. Location points were joined for each rhino and the size of home range was calculated by computing

the area of a polygon which resulted from connecting the peripheral points of locations.

I - 5 Study Area

(a) Location And Area

Masai Mara Game Reserve, the study area, is in Narok District within Rift Valley Province of Kenya. It lies approximately between 34° 45' and 35° 25' East of Greenwich and approximately 1° 13' and 1° 45' South of the Equator. The boundaries of the reserve are shown on Map I - 2.

Masai Mara Game Reserve, like other Game Reserves and National Parks in Kenya, has animals protected by laws of Kenya as laid down in Wildlife Protection Act Cap 376. The law makes it illegal to hunt without official permission and/or permits. It is meant to ensure the conservation of all indigenous animals and plants.

The study area is 1530 km^2 (approx. 600 sq. miles) as calculated from Narok Map, Scale 1:250,000, Series 7503, sheet SA - 36-8, edition 2-SK.

It is of importance to mention that Masai Mara Game Reserve is contiguous with Serengeti National Park in Tanzania.

(b) General Description

The study area varies from hills to plains and river valleys. The land slopes down from Ngama Hills

to Meta - Mosee plains, Burrungali - Lorogot plains, then rises up gently from Mara river to the foot of Siria Escarpment (Plate: I - 2a and b). The escarpment has steep slopes. The land lies between the altitude of 1524 and 2134 m above sea level. A greater part of the Reserve is a plain enclosed by Lonojoroi, Kuka, Olentoroto, Ngama, Elebaan, Ol Doinyo Loiro, Naito hills and Siria Escarpment.

The area is well drained, and the drainage can be described as dendritic, radial and trellis in nature. Okejo Rongai, which feeds into Mara river with its tributaries, Angarrani and Okejo Gem, has a dendritic stream pattern. Streams from Olempito hill feed into Okejo Gem while streams from Engate Pusi hill feed into Angarrani. Okejo Rongai dries up during prolonged absence of rain.

The Talek river which drains its water into Mara river has a dendritic stream pattern drainage. It collects water from Orobile, Segamani and Ngama hills. Also, like Okejo Rongai, Talek river dries up during the prolonged period of absence of rain. Jagartiek, Ololorok and Ngorlop drain from Naito hill into Talek river. Kebololet which drains into Sand river, Sekara and Olcorro Loldobai which drain into Mara river all form radial drainage from Olempito hill area. Sand river drains from Loita and Ndarakwa hills. Mara river, holds its water the year round. It is the only major river in the area.

Thus, as a whole, the study area has a net of rivers

and streams which supply animals with water for drinking. During wet periods, the streams are full and there are many low spots in the open plains where standing water accumulates. As the weather becomes drier, so does the ground surface until in the height of the dry seasons the only sources of water are the major water courses like Mara and Sand river.

(c) Habitats

The vegetation of the study area varies greatly. Four habitat types studied were grassland plain, scrub, riverine bush and forest. Rhinos were found in these habitat types. To determine the horizontal density of vegetation in the various rhino distribution areas in the study area, a cover "density board" (Wildlife Investigational Techniques, 1963) was used. This board (Plate I - 3) is 1.85 metres in height with each 30.48 (foot) centimetres marked off and numbered from 1 to 6. The assistant places the density board in the cover to be measured and an observer reads the figures which are unobscured by cover along a predetermined compass line at a distance of one chain (19.8 metres). If there is no cover, the reading is 21 (1, 2, 3, 4, 5 and 6 together); if cover completely obscures the entire board the reading would be zero. Thus a series of readings, or the average of these data, would give some measure of the density of the cover.

In each of the 13 areas occupied by rhinos two transects

were marked out each with 30 points. The measurement were taken in February 1972.

A suggested classification of such readings, in a manner which would render them amendable for use on cover map is:

Per cent obscurity	Classification
16	Scarce Cover
33 to 66	Medium Cover
66 and over	Dense Cover

$$\text{Per cent obscurity} = \frac{\text{Sum of obscured numbers on the board}}{\text{Sum of all numbers on the board}} \times 100$$

A brief description of each habitat type is given below.

(i) Plain Habitat

Plain habitat covers Meta, Mosee, Burrungali and Lorogot plains. Its vegetation is of medium height, 0.6 to 1.5 m (2 - 5 ft). It has horizontal density cover ranging from 5 to 25 per cent obscurity; and according to Wight's (1938) classification of cover by obstruction to vision it falls under scarce. I refer to this area as open grassland. The dominant plant species are Themeda triandra Forsk, Setaria sphacelata (Schumach), Pennisetum mezianum (Leeke), Solanum incanum L., stands of Acacia species, such as Acacia hockii De Wild. and Acacia drepanolobium Sjoestedt. Also on the plains particularly lowland grassland there are Dichrostachys cinerea (L.), Becium species and Commelina species.

Within the plains there are thicket islands, less than 5km^2 in area, dominated by Croton dichogamus Pax. Within these readings on the density board were zero, so per cent obscurity was 100%.

(ii) The Scrub Land

The scrub land covers most of the areas around Omisingiyoi, Kebololet, Ngama hills, Ol Olojigoshin and hills in the Triangle area. The horizontal density cover ranges between 13.5% to 35.0%. The vegetation is over medium height of 0.6 - 2 m (2 - 6 ft). It can be classified as grassland - bush - woodland habitat. The major grass species are Themeda triandra; Pennisetum mezianum, Setaria sphacelata and Sporobolus pyramidalis Beauv. The major woody plants are Dichrostachys cinerea, Acacia hockii, Commiphora sp. Grewia sp., Croton dichogamus, Cordia ovalis, Acacia brevispica, Lippia javanica and Solanum incanum. Numerous stands of Indigofera sp., and Maerua edulis are found.

(iii) Riverine Habitat

This habitat is found along the rivers and streams. It forms narrow strips of dense cover with a cover height of over 2 m. Climbing plants like Glycine sp., are found among the bushes. It is found adjacent to the open grassland and it mainly supplies cover to the animals living in grassland habitat.

(iv) Forest Habitat

Forests are found along Mara river, on slopes of Ngama hill and Olentoroto - Ol Lalata hills. The woody plants are over 3 m high with intermediate bushes in between them.

(d) Temperature

Measurements were available from a meteorological station located at Keekorok Lodge within the study area and operated by the survey of Lakes Victoria, Kyoga and Albert. The daily mean maximum temperature ranges from 18^{o} - 30^{o}C. while daily mean minimum temperature ranges 12^{o} - 14^{o}C. Temperatures were taken and recorded each day at 0900 hours from maximum and minimum thermometers.

(e) Rainfall

Since the area involved is comparatively small the positioning of the annual isohyets is not easy owing to the lack of records. Therefore long-term rainfall records, the observed variability in the annual rainfall which makes such long-term records necessary for the calculation of the mean annual rainfall were not available.

During the study the distribution of rainfall was irregular. There was one long but discontinuous rainy season extending from April to August. The period from September to November was rather dry, December was wet, January, again was rather dry but February was wet.

Monthly total rainfall ranged from 15.9 mm to 242.3 mm with peaks in April, May, August, December and February. Rainfall data were recorded each day at 0900 hours (Table I - 2)

(f) Relative Humidity

Relative humidity records were taken at 0900, 1200 and 1500 hours from wet and dry bulb thermometer. The results show that humidity was much higher at 0900 hours and much lower at 1500 hours. The daily range at 0900 hours was from 56.5% to 81% with a high peak in the month of February. At 1500 hours it ranged from 41% to 59.5%. Thus as a whole it was noted that the humidity is high in the mornings and lower in the afternoons.

Table I - 1

Taxonomic Standing

Order: Perissodactyla (odd-toed ungulates)

Suborder: Ceratomorpha

Superfamily: Rhinocerotoidea

Family: Rhinocerotoidae

Subfamily: Rhinocerotinae (one-horned rhinos)

Genus: *Rhinoceros*

Rhinoceros unicornis (Great Indian Rhinoceros)

Rhinoceros sondaicus (Javan Rhinoceros)

Subfamily: Dicerorhininae (Two-horned Rhinos)

Genus: *Didermocerus*

Didermocerus sumatrensis (Sumatran Rhinoceros)

Genus: *Diceros*

Diceros bicornis (Black Rhinoceros)

Genus: *Ceratotherium*

Ceratotherium simum (White Rhinoceros)

Table I - 2

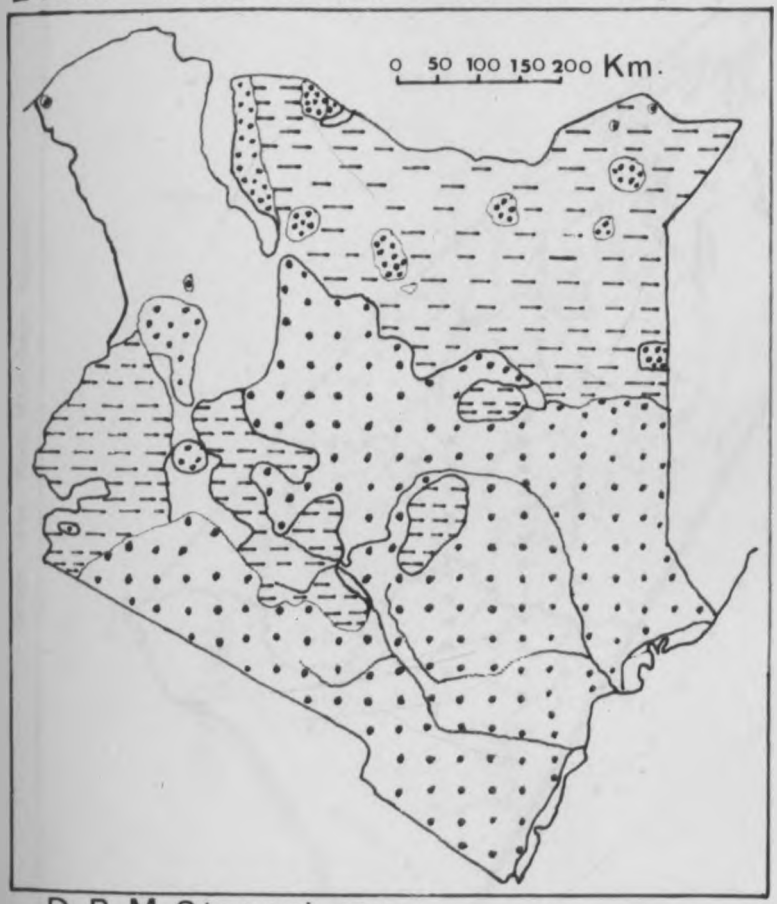
Rainfall

Monthly Total Rainfall (in mm)

1971	January	65.8
	February	54.2
	March	37.5
	April	146.6
	May	127.5
	June	37.6
	July	73.0
	August	242.3
	September	25.4
	October	39.8
	November	15.9
	December	150.9
1972	January	53.0
	February	132.3
	March	68.5
	April	20.7
	May	49.9

Map I-1

Black Rhino Distribution In Kenya



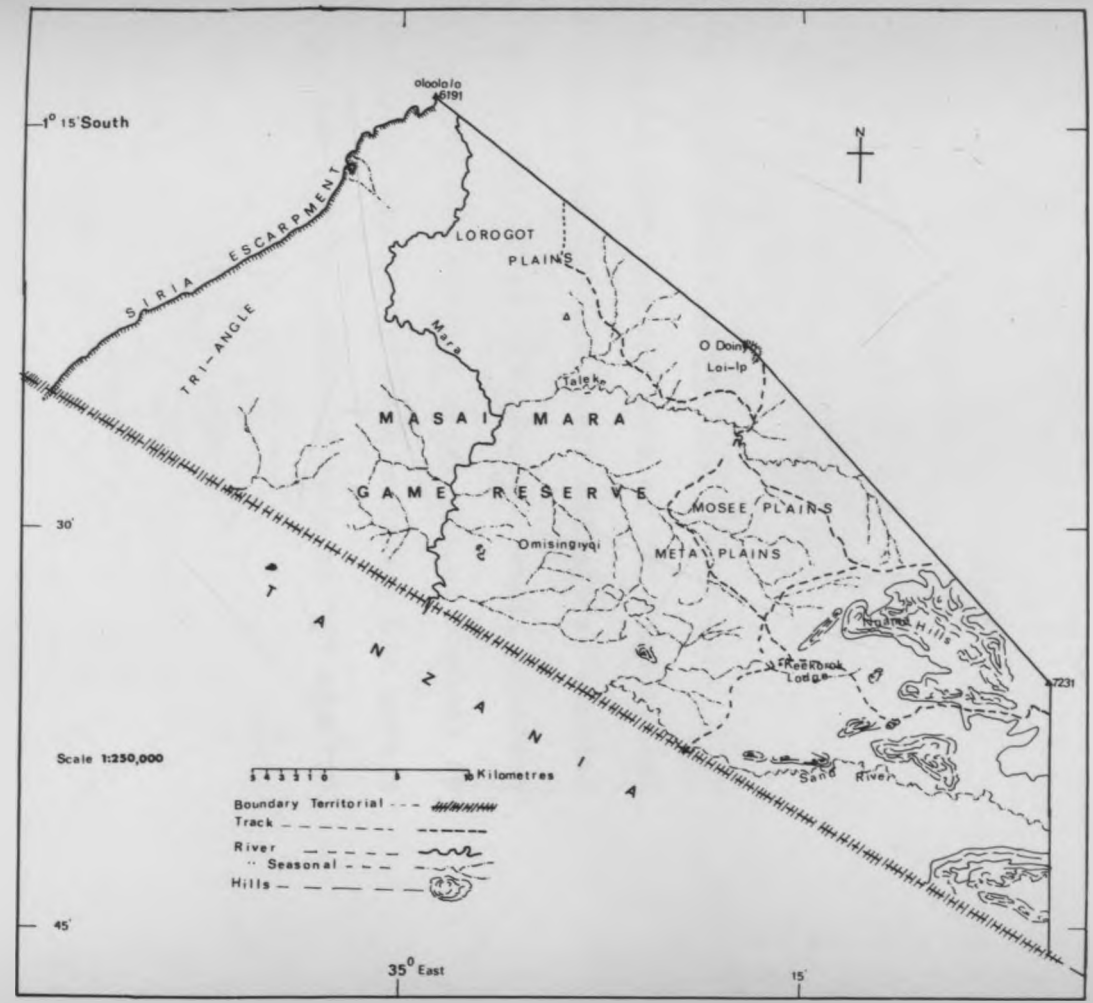
D.R.M.Stewart 1970

Present Distribution ----- 

Eliminated since 1885 -- 

Map 1-2

Study Area, Masai Mara Game Reserve

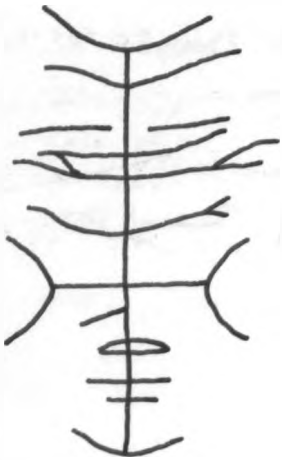


Explanation

Plate I - 1a

Animal Identification

Male rhino Number 63 showing a cut on the ear. The wrinkle "a" is much shorter than wrinkle "b". Wrinkle "e" in the first quarter does not cut the vertical line. Wrinkle "g" is curved and branches at the end in the third quarter and wrinkle "h" curves and meets wrinkle "i" in the second quarter. Wrinkle "j" is discontinuous towards the vertical line.



Explanation

Plate I - 1b

Animal Identification

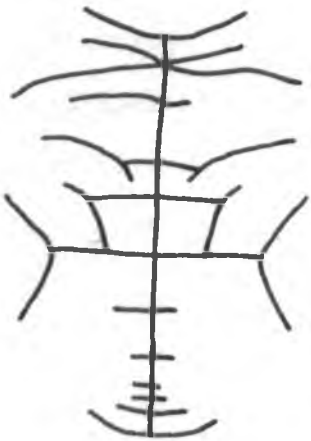
Male Rhino number 53 showing a V-cut on the ear. The edges of the ears very hairy. The wrinkle "c" curves downward in the fourth quarter, wrinkle "d" cuts the vertical line then immediately ends in fourth quarter, wrinkle "e" in the fourth quarter, "f" branches off in second quarter, wrinkle "g" branches of on both ends in the second and fourth quarter and the upper branches meet the wrinkle "h".

Explanation

Plate I - 1c

Animal Identification

Male rhino number 21 with normal ears. Wrinkle "f" branches upward and the two branches one in the second quarter and the other in the third quarter meet wrinkle "g", wrinkle "h" curves downward in second quarter and the third quarter with a bar line joining them hence the bar line cutting the vertical line, wrinkle "i" cuts the vertical line and ends immediately after cutting the line. Wrinkle "j" and "k" crosses each other at the vertical line.



Explanation

Plate I - 1d

Animal Identification

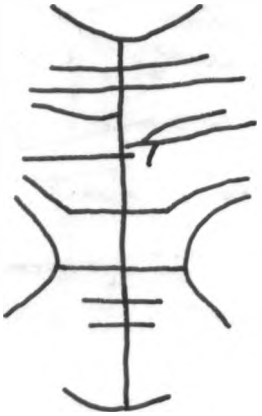
Female rhino number 17 showing normal ears. Wrinkle "a" and "b" meet at the ends in the first quarter. Wrinkle "d" in the fourth quarter never cuts the vertical line, wrinkle "f" branches off in the third quarter - curves upward and meet wrinkle "g" in the second quarter. Wrinkles "i" and "j" cross each other at the vertical line.

Explanation

Plate I - 1e

Animal Identification

Female rhino 50 showing a U-cut on the ear. Wrinkl "e" cuts the vertical line and ends immediately aft cutting the line in the third quarter, wrinkle "f" branches off towards the vertical line and the upper branch meet with wrinkle "g" which ends at the verti line in the third quarter. Wrinkle "h" in the secon quarter ends at the vertical line.



Explanation

Plate I - 2a and b

Study Area

(a) Study area as viewed from Ngama Hill Siria Escarpment.

(b) Ngama Hills from Posse Plains.

a

b

Explanation

Plate I - 3

A board used in measuring horizontal density of vegetation.


6
5
4

Chapter II

DISTRIBUTION AND DENSITY

II - 1 Distribution

(a) Rhino Distribution Areas

The term "Distribution" according to Mosby (1963) when applied to animals means the geographic range of an organism at a given time or the pattern of occurrence of organisms in an area at a given time. The word "Distribution" is used in this paper to mean as defined above. However, in this paper "Distribution area" means the general total area which is occupied by a group of rhinos whose individuals carry out their daily activities within or about such an area. The limit of each distribution area was established through repeated observations of an individual rhino's position and mark them on a map. The repeated observation supplied data on individual home range, and a combination of several adjacent home ranges formed a distribution area. Results on home ranges are discussed later in Chapter IV.

It is obvious that the movement of rhinos may not be restricted to such an area but if one was to look for rhinos in the Masai Mara Game Reserve one would find them in these distribution areas. Observations revealed that there are areas in the Reserve which are not occupied by rhinos. Areas occupied by rhinos were lettered alphabetically (Map II - 1) and used in this paper as such.

(b) Present Distribution

Very little is known about the past distribution of the black rhino in Masai Mara Game Reserve. According to the information received from Mr. Tipis, warden incharge of the Reserve, there are no rhinos translocated into the Reserve since it was established in 1949. Mr. Tipis also reported that from the time when the Reserve was established rhinos have been being seen in various areas of the Reserve, particularly in the Triangle, Omisingiyoi, Mosee, Meta and Burrungali plains.

Prior to the establishement of the Reserve, this area was being grazed by the Masai people who are nomadic in nature. Cultivation or over settlement has not taken place in the area.

As revealed by 1948 and 1967 aerial photographs of the Masai Mara Game Reserve taken by Survey of Kenya, there is very little change in habitat which has occurred in response to grazing by domestic livestock, burning or destruction by elephant. At the time of this study, Mr. Simon Taiti was carrying out studies on vegetation survey of the Reserve and he also remarked that the habitat has changed very little since 1948.

Today the field study has revealed that there are 13 distribution areas in the entire Reserve which are occupied by rhinos as shown on Map II - 1. Each of these areas accommodate rhinos which are resident in that particular area and there were no observations made

on known individuals in any area wandering into another distribution area. This is due to the fact that rhino's requirements were available in each area.

As stated by Goddard (1970) rhinos are not restricted to one type of habitat. Goddard (1970) noted that rhinos in Tsavo National Park were distributed over grassland, bush-grassland, scrub-bush-grassland, bush-scrub, and grassland-woodland habitats. A similar pattern of distribution was noted with the Mara population where above habitats occur. Distribution areas D and E covered areas with thickets and scattered trees on the slopes of Ngama and Oliborsoil hills. Distribution areas B and I were on grassland with few thicket islands. Most of distribution areas F, J, K, and L was covered by bush with scattered trees while distribution areas G and H were covered by riverine bush emerging into grassland. Grassland with scattered trees and bush on hill slopes covered most of distribution area C. Scattered trees with dense thickets along rivers dominated most of distribution area A. Results show that a large number of rhinos were distributed over the areas with scattered trees and dense thickets along rivers. This is probably due to a need for cover which is abundant in the bush with scattered trees habitat (Plate II - 1). Thus habitat has a great influence on distribution particularly with respect to cover, food and water.

(c) The Influence Of Habitat On Distribution

(i) Food Availability

Data on food availability were collected in the month of February 1972, however, at this time the major plant species used by the rhinos for food were known to me through direct observations on feeding rhinos. Single animals were followed when feeding and the variety of bushes, shrubs and herbs browsed by rhinos identified. (The method used in food plants identification is later described under feeding habits).

To determine whether the availability of food determined the distribution of the rhinos, plant species used by the rhinos were sampled in various distribution areas. Areas not occupied by the rhinos were not sampled. The density of individual rhinos in each distribution area was not the same with another distribution area (Table II - 1).

For the purpose of this study Point Centered Quarter method was used. A series of points were choosen in the field according to an objective procedure, most usually by pacing a fixed distance along a predetermined compass line.

The space around each point was divided into four quarters. Within each quarter, the tree nearest to the point was chosen; its distance from the point, its basal area and its species determined. These values for the four trees in the four quarters were recorded on a

specially prepared data black sheet.

In this method only herbs, tree and shrubs, under 2 metres high, used by rhinos were noted. In each distribution area transects running from stream banks up the slopes were followed. Each transect had 30 points. The aim was to calculate relative density and relative frequence of each food species and finally total density of all food plants per distribution area. Data on relative frequency and relative density were obtained and the results discussed in Chapter V. Table II - 2 shows the result of density of food plant in each distribution area. Calculation for Point Centered Quarter Method were made using:

$$\text{Relative density} = \frac{\text{Individuals of species (counted in all points}}{\text{Total individuals of all species (in all points)}} \times 100$$

$$\text{Relative frequency} = \frac{\text{Number of points at which species occur}}{\text{Total number of points sampled}} \times 100$$

$$\text{Total density of all species} = \frac{\text{Unit area}}{(\text{Mean point-to-plant distance})^2}$$

Unit area = 10,000m^2/hectare, if distances are measured in metres.

The area of each distribution area was calculated and the total number of food plants easily calculated. The results showed that food plants used by the rhinos were available in each distribution area although the density varied. However, when the areas are burnt, most of the herbs are destroyed by fire and soon after the rain they regenerate. Despite this temporary shortage of food plants, it appears that larger distribution areas, with more rhino density (not necessarily high density), density of rhino is directly related to density of palatable food plants.

(ii) Water

Permanent water supplies are available in each distribution area. Mara river, Sand river and Talek river are the main water supplies but during excessively dry period Talek and Sand river dry up. In addition there are numerous seasonal streams which supply water to the rhinos in each distribution area. Dams which hold water all the year round have been constructed, and there are two of such dams in distribution area B, three in area E and one in area C, Plate II - 2. In distribution area B, there are seasonal swamps where rhinos were seen drinking.

Due to buffalo's wallowing activities water pans

along the streams are deepened and widened. They are shaded by riverine bush and are able to hold water throughout the dry period.

Triangle area, unlike other areas is poorly watered though occasional thunderstorms occur. Rhinos in this area depend on the streams running down from Siria Escarpment and hills within the area. At the height of drought period rhinos depend on Mara river.

As observed, rhinos in distribution area A were in close reach of permanent water supplies, mainly the Mara river and seasonal swamps which may have contributed to its high rhino density.

(iii) Cover

Vegetation cover is probably a major determinant of the distribution of rhinos in Masai Mara Game Reserve. The Mara rhino population like other rhino populations elsewhere need sheltering vegetation. During hot day rhinos often rest and sleep in the shade of a tree or as in the case of the Mara population, in the dense bush. In this way rhinos are protected from direct sun's rays and wind, and cannot be detected easily by man, who is the main enemy.

In over 90% of the observations when rhinos are disturbed by man on foot, in a car or an aircraft, rhinos ran into dense bush where they stood motionless, watching and flapping ears as shown on Plate II - 3. It was observed that it was difficult to drive them out of

these bushes. Rhinos were followed in the morning when coming out of drinking places on their walking and feeding routine. Towards noon, if not wallowing they got into thickets and at around 1600 hours or 1700 hours they could be seen walking out of the thickets to more open places where they were observed feeding. In distribution area A, thickets which supplied cover for rhinos were found to be numerous and within a short reach. The partly open areas are covered by scattered trees. Most other distribution areas, unlike distribution area A, have small islands of thickets in the middle of wide open grassland. Map II - 2 shows the vegetation cover type as revealed by the study on the vegetation survey which was being carried out by Mr. Simon Taiti at the time of my project. Distribution area A is mainly dominated by Croton dichogamus bushland community along the river and streams. This is an evergreen community. The dominant plants are Croton dichogamus, Teclea villosa and Tarenna graviolus. The Themeda grassland community is dominated by Themeda triandra. The remaining area of distribution area A is a complex community composed of Acacia hockii, Dichrostachys cinerea, Commiphora trothae, Commiphora africana and Lannea stuhlmannii. The ground dominated by Becium angustifolia, Commelina sp., Hyparrhenia filipendula and Aristida adoensis. In this distribution area Croton dichogamus bushland community was purely used by rhinos for cover while most feeding observations were in the complex community and a few

observations in Themeda grassland community.

In distribution areas B, G and I Croton dichogamus bushland community and Acacia drepanolobium community supplied cover to the rhinos while Setaria - Themeda grassland community was mainly used as feeding ground.

In distribution area D Croton dichogamus bushland, Acacia drepanolobium woodland, Acacia hockii woodland, Combretum - Heeria - Acacia hockii woodland and Termite mound communities supplied both cover and feeding grounds. However, rhinos were observed feeding in complex and Themeda grassland communities. Acacia hockii woodland, Croton dichogamus woodland and complex communities dominated most of distribution area A. A small area of this distribution area was covered by Acacia gerrardii woodland and Termite mound communities. Distribution areas C and H were both dominated by riverine Croton dichogamus bushland, Balanites aegyptiaca woodland, Termite mound and Themeda grassland communities.

Considering the entire Masai Mara Game Reserve, rhinos were distributed in the areas which are mainly Croton dichogamus bushland and complex communities. These two communities cover much of the area in distribution area A where a high rhino density as compared with other distribution areas was recorded.

The areas dominated by Acacia gerrardii and purely open Themeda grassland communities tended not to be occupied by rhinos as shown on Map II - 1. These include a part of Lorogot plains, a part of Triangle

area along Kenya-Tanzania boundary, some parts of Meta plains and the area East of Eserusopia - Ngama hills.

(d) Human And Domesticated Animal Interractions

By law, Masai are not allowed to graze their cattle in the Reserve. However, just outside the Reserve boundary there are Masai settlements, and during the height of dry periods they cross the Reserve boundary with their cattle which graze within the Reserve. They put their new Manyattas or Bomas adjacent to the Reserve boundary. During the study period there were seven Manyattas placed in different location near the Reserve boundary. In order to find out the number of domesticated animals and human population in each Manyatta I carried out a census in January and February 1972. It was found that the Manyatta near distribution area D, there were 100 people with 3,000 head of cattle, 200 head of goat and 100 head of sheep. Their cattle were daily grazing in the Reserve, and as observed the rhinos which used to live in the areas where cattle were grazed moved towards Posee plains. The Masai were still in the same area even at the closure of the study period and during their presence none of the rhinos in this distribution area was found in the area occupied by the Masai people.

Around Talek there was another Manyatta with 30 people, 3,000 head of cattle, 2,500 head of goat, 3,500 head of sheep and 50 donkeys. They grazed over most of

the distribution area B and J. Again observations were made where some of the rhinos in these areas moved away for some time due to the presence of cattle and were later seen in their usual areas when Masai had shifted their Manyatta to another place.

Around the junction of Kiligolis and Keekorok road, near distribution area H, there was another temporary settlement and the same effect on the rhinos as in the other settled areas was observed.

Just near Ol Oldugai hill there are two permanent Manyattas with 200 people, 3,000 head of cattle, 50 head of goat and 200 head of sheep. Rarely were rhinos seen in the areas occupied by the Masai people. However, when Masai moved their cattle into the Reserve the rhinos in distribution area E moved towards the Eserusopia area. With the permanent settlement at Keekorok Lodge and Ol Olojigoshi - Losegin area rhinos in distribution area E are restricted to Eserusopia area. As also revealed by the study on rhino density, distribution areas E and D each has a low density and rhinos in each area move a lot perhaps due to human and domesticated animals presence.

II - 2 Density

(a) Ground Count

An obvious method of determining a population is to count or capture all of the individuals. However, this method is practical only under special circumstances. When a population is counted completely then a true census

(count), not an estimate, is obtained. The simple way to determine the size and composition is by a direct count of the number present in a given area.

A direct count method was carried out in the study area by searching for the black rhinos on the plains, wooded grassland, scrub and forest. The search lasted from 0600 to 1900 hours daily. When a rhino was encountered for the first time, a photograph was taken, identification marks recorded, sex determined, the date and locality where found noted as described under methods. Each new individual rhino seen and identified was added to the total count. The count continued for the entire period of study to check for new adult individuals and new borns.

Problems were encountered in searching for rhinos. The major one was in locating the rhinos. It was difficult to sight individual rhinos between 1130 to 1530 or 1600 hours. Normally this is the period when rhinos rest in the thickets, wallow or lie down on open grassland. Most of the rhinos were sighted between 0600 to 1130 hours and 1600 to 1900 hours. These are normally feeding periods.

The other problem was disturbance from a moving vehicle or movement of other animals near the rhino. This problem was reduced by checking the direction of the wind with use of movement of grass or tree branches. The rhino was then approached against the wind. Occasionally observed rhinos turned around, affecting the time taken in

identification by obstruction of identification marks either by vegetation or by being on the hidden side of the rhino's body. However, despite these problems, the method used was found to be practicable. At the end of the study period a total of 108 rhinos had been identified and found to be residents of Masai Mara Game Reserve.

As described above, rhinos did not occupy the whole Reserve, but lived in 13 discrete distributions. The area of these distribution areas was determined from a map by a dot grid method. It was found that, out of 1530 km^2 (the area of the Reserve) only an area of 749 km^2 was occupied by the rhinos. Thus, densities can be calculated for the area of the entire Reserve, for the total area occupied by rhinos, or for each distribution area.

The mean density of black rhinos in the entire study area is 0.07/km^2 (0.18/sq. mile). Within just the areas which are occupied by rhinos, (749 km^2) the density was 0.14/km^2 (0.36/sq. mile).

Movement out of and into a distribution area was checked. Observations indicated that the entire number of rhinos in each distribution area form a resident group of rhinos for that particular distribution area. Thus the density for each distribution area is consistant all the year round and it can only change due to birth of new individuals or death of living individual animals.

The rhino density and area of each distribution

area is shown on the Table II - 1. In addition the number of rhinos, in each distribution area is shown. Distribution area I has almost the same density as distribution area A.

Over 50% of the rhinos are distributed over the plains. These distribution areas are A, B, G, I and J. The total number of rhinos in these distribution areas are 65 covering an area of 312 km^2. Their density is 0.21/km^2. The other distribution areas have 43 rhinos covering 437 km^2. Their density is 0.10/km^2. The calculated rhino density for each distribution area is also compared with each other in the form of a chart figure II - 1.

(b) Aerial Count

An aerial count was carried out on 2nd June, 1972. Two sampling areas were chosen (a third had to be rejected for lack of aircraft time). These consisted of distribution areas E and D (Sample I) and distribution areas A, B, G, I and J (Sample II). A 25% aerial count in each sampling area was to be carried out. For each of the sampling area a base line was selected on a Map, and this was divided into 200 m sectors (200 m being the chosen strip width) representing the width of potential sampling strips across the area. Each potential strip was numbered. The number of such strips needed to cover the whole sampling area was counted and 25% of this count calculated. Then random numbers equal to 25% of

potential strips for each sampling area were picked from Telephone Directory to identify which potential strips should actually be flown. Flight lines for these strips were marked on the Map. In Sample I two strips were randomly picked twice, but each was flown only once, the results of each strip being used twice in the calculations. In Sample II this applied to three strips. Thus in Sample I 13 strips were flown and in Sample II 20 were flown.

A Piper P.A - 12 "Cruiser" aircraft was used. Flights were made parallel to the strips at a height of 61 m from the ground being determined by use of a "shadow marks" (Pennycuick 1969). Counts in Sample I were done from 0920 to 1325 hours and in Sample II from 1430 to 1645 hours.

Some strips were close to each other in each sampling area and probability of counting the same animal twice was expected. However, none of the cases where a rhino was counted twice was observed. Great care was taken to look only between the ribbons. The pilot rarely acted as an observer as he devoted most of his attention to keeping the aircraft on the required flight line. The rhinos were found either walking, standing or laying down. A large number of rhinos located in Sample II were accompanied by young ones.

The population estimate was obtained using Jolly (1969) "Ratio Method" equation:

$$\hat{Y}_{(1)} = \frac{\hat{Y}}{\hat{Z}} Z$$

$$\hat{Y} = N\frac{\Sigma y}{n}$$

$$\hat{Z} = N\frac{\Sigma z}{n}$$

$$\text{Var } \hat{Y}_{(1)} = \frac{N(N-n)}{n}\left(s_y^2 - 2\hat{R}s_{zy} + \hat{R}^2 s_z^2\right)$$

Where

$$s_y^2 = \frac{\Sigma y^2 - \frac{(\Sigma y)^2}{n}}{n-1}$$

$$s_{zy} = \frac{\Sigma zy - \frac{(\Sigma z)(\Sigma y)}{n}}{n-1}$$

$$s_z^2 = \frac{\Sigma z^2 - \frac{(\Sigma z)^2}{n}}{n-1}$$

Where

$\hat{Y}_{(1)}$ is population estimate by Ratio Method.

$\hat{Y}$ and $\hat{Z}$ are calculated as given above.

$\frac{\hat{Y}}{\hat{Z}}$ is a ratio of an estimate of the average animal density per unit area.

Z is the total area under survey (sampling area).

z is the area of each sampled unit.

y is the number of animals counted in one sampling unit.

n is the number of sampling units counted.

N is the number of sampling units needed to fill up the whole area.

$\hat{R}$ is the mean density given by ratio $\frac{\hat{Y}}{\hat{Z}}$.

Σ denotes summation over.

The total number of rhinos sighted from the air and the area of each sampling unit is shown on Table II - 3. Using the data obtained from the aerial count the estimate of rhinos in Sample I is 28.37 $\pm$ 23.50 at 95% confidence limit. Rhinos in Sample II were estimated to 102.46 $\pm$ 44.27 at 95% confidence limit. The rhino mean density for Sample I is 0.125 while that of Sample II is 0.272.

The total ground count for Sample I was 14 rhinos and for Sample II was 65 rhinos. This show that the ground count results are within the standard error limits calculated from the aerial results. However, as mentioned by Jolly (1969) the standard error of the population estimate is unduly large probably due to the fact that rhinos were sighted in clumps and in many of the strips no rhinos were sighted.

Table II - 1

Density, Area And Number Of Rhinos In Each Distribution Area

Distribution Area	No. of Rhinos	Area in km^2	Density per km^2
A	31	133	0.23
B	10	52	0.19
C	14	160	0.09
D	8	52	0.15
E	6	62	0.09
F	3	23	0.13
G	5	30	0.16
H	3	22	0.13
I	11	45	0.24
J	8	52	0.15
K	4	68	0.06
L	1	21	0.04
M	4	23	0.17
Total 13	108	749	0.14 (.36/sq. mile)

Table II - 2

Density of Food Plants In Each Distribution Area

Distribution Area	Rhino Density per km^2	Food Plants Density per 10 m^2
A	0.23	295,100
B	0.19	224,661
C	0.09	143,323
D	0.15	203,602
E	0.09	398,282
F	0.13	245,923
G	0.16	376,207
H	0.13	359,435
I	0.24	481,715
J	0.15	216,601
K	0.06	518,050
L	0.04	685,000
M	0.17	323,400

Table II - 3

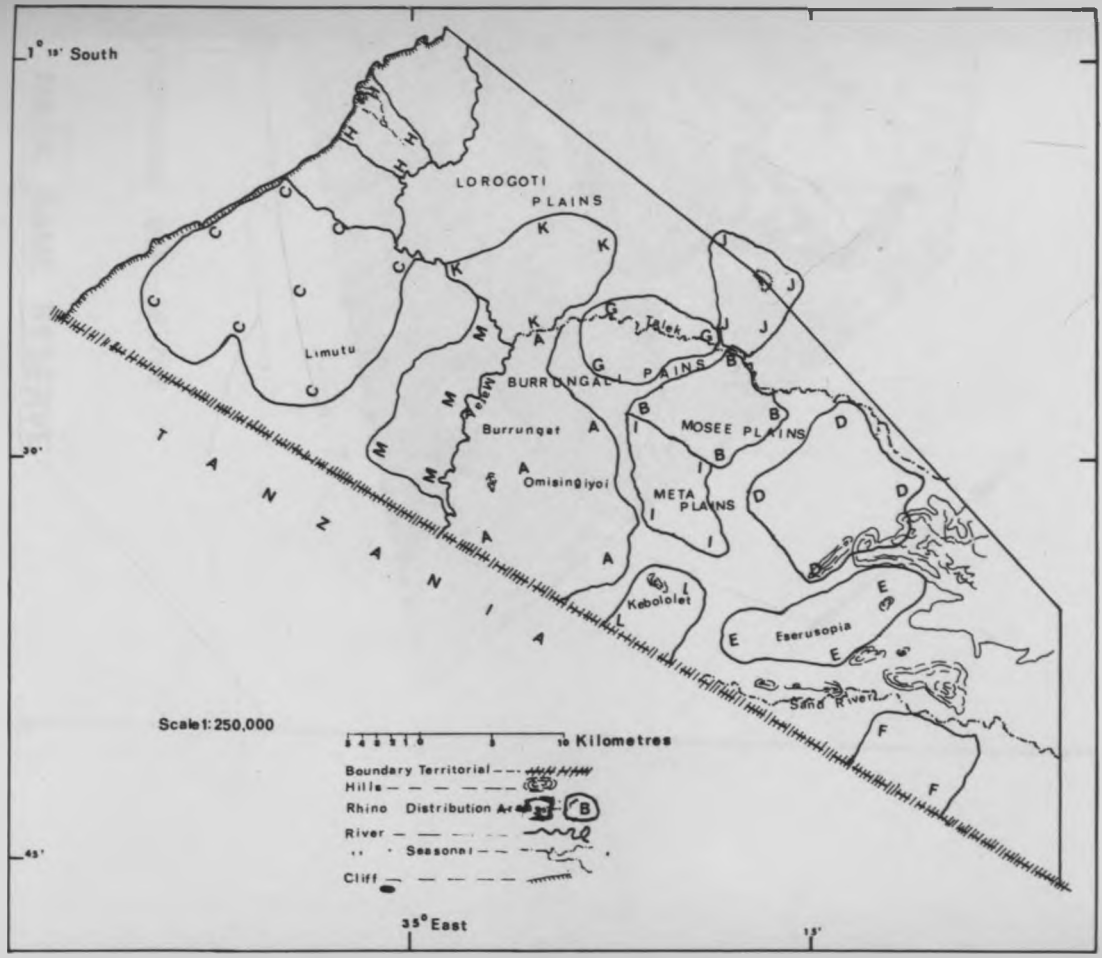
Results of Aerial Count of Sample Area I (226.50 km^2) and II (376.32 km^2)

Sample Area I			Sample Area II		
Strip No. (n)	Area in km^2 (z)	Rhino Sighted (y)	Strip No. (n)	Area in km^2 (z)	Rhino Sighted (y)
1	2.40	0	1	3.28	0
2	2.48	0	2	3.36	0
3	2.56	0	3	3.36	1
4	2.56	0	4	3.44	0
5	2.56	0	5	3.44	0
6	2.56	0	6	3.44	0
7	2.64	0	7	3.44	0
8	2.72	3	8	3.52	0
9	2.72	0	9	3.52	4
10	2.72	0	10	3.52	1
11	2.80	0	11	3.52	0
12	2.80	0	12	3.52	0
13	2.80	0	13	3.52	1
14	2.80	2	14	3.52	4
15	2.80	0	15	3.52	4
			16	3.52	2
			17	3.60	1
			18	3.60	2
			19	3.60	0
			20	3.60	0
			21	3.60	1
			22	3.68	1
			23	3.68	0
Total	39.92 = (Σz)	5 = (Σy)		80.80 = (Σy)	22 = (Σy)

Rhino Estimate = 28.37 ± 23.50
Standard Error = 12.013
Rhino mean density = $0.125/km^2$
Total Rhino ground count = 14

Rhino Estimate = 102.46 ± 44.27
Standard Error = 22.59
Rhino mean density = $0.272/km^2$
Total Rhino ground count = 65

Map II-1
Rhino Distribution Areas
Masai Mara Game Reserve



Map 2

A VEGETATION MAP OF THE

MASAI MARA GAME RESERVE

by Simon Taiti . 1973

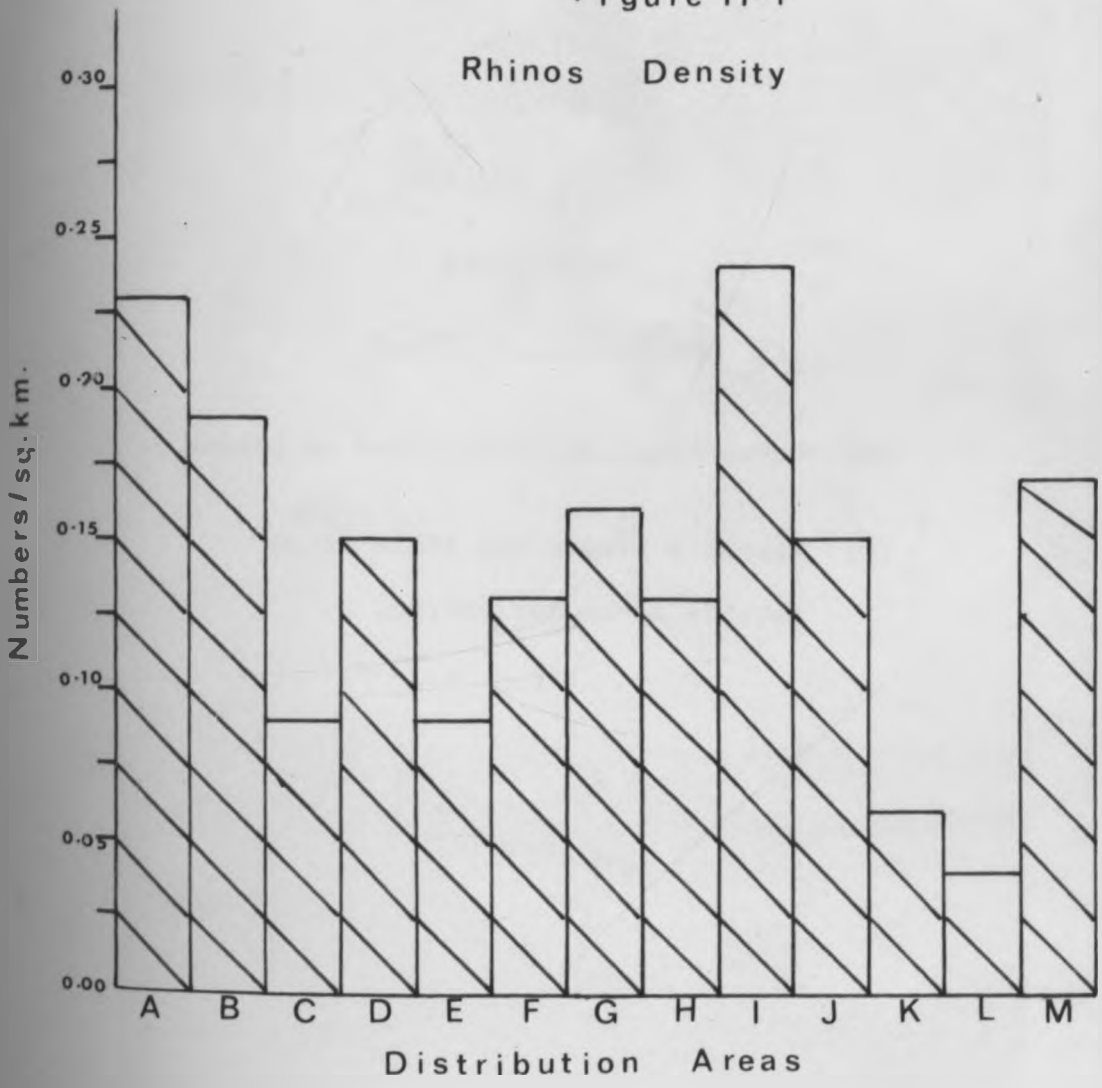
LEGEND

- Game Reserve Boundary
- International Boundary
- Roads
- Rivers
- Contours in feet

Rhino distribution area

Figure II-1

Rhinos Density



Explanation

Plate II - 1a and b

(a) Cover along drainage lines on plains.

(b) Thickets around the hills which provide cover for rhinos.

a

b

Explanation

Plate II - 2a and b

(a) A dam in distribution area b which holds water through out the year.

(b) A water pan dug by wallowing animals which is another source of water during the wet period.

a

b

Explanation

Plate II - 3a and b

(a) Female rhino accompanied by a calf running into the bush for cover after an alarm.

(b) A male rhino which has run into the bush for cover trying to find the direction of the alarm.

a

b

Chapter - III

POPULATION STRUCTURE

III - 1 Population Composition

(a) Total Size

Studies on population composition were carried out during the entire period of the project. As mentioned earlier, when a new rhino was sighted it was recorded as adult, sub-adult or immature accompanying the mother as the case may be using Schenkel's (1969) classification of rhino age by comparison of body growth.

At the end of the study period in August 1972, 108 rhinos were known to occupy the entire study areas. The list of all rhinos identified is shown on Table III - 1. Since the entire Mara rhino population occupied 13 different distribution areas it was decided to work out the size and composition for each area which would also enable one to compare each area with another though the calculations were based on the total population. The results showed that distribution area A made up 29% of the entire population while other areas considered individually made less, with the lowest record of 0.9% in distribution area L. Some distribution areas such as B, D, E, F, H, K and L showed a low percentage of immature rhinos (both sexes) because of a low percentage of female rhinos which were accompanied by immature rhinos. Only 25% of the total adult females

observed in the study area were found not accompanied by the young ones. The percentage of the total population in each distribution area is shown for adult rhinos (both sexes) and immatures in Table III - 2.

(b) Sex Ratio

External sex organs were used in sexing rhinos in the study area. Rhinos, like other mammals have two separate openings for digestive system and the urogenital system. Both openings were jointly used and in addition to this it was assumed that an adult rhino closely associated with a calf was its mother and therefore a female.

The penis of the male is easily seen and sexing is easiest. With the use of binoculars the sex of each rhino was determined. It was observed that when a rhino was urinating, defecating, walking or standing in good position sex was determined quickly. This is due to the fact that when a rhino is urinating or defecating the tail is raised up and the urogenital and digestive systems opening areas are more visible. Also the level of urine direction is lower in males because of location of penis parallel to the lower side of belly while that of female is higher. When a male is walking the penis becomes more visible from the back because of the alternating position of hind legs.

Problems were experienced in sexing the very young juveniles because sex organs were not readily visible.

Also for the adult rhinos sexing proved to be difficult when sex organs were obstructed from vision by vegetation as shown on Plate III - 1.

Among the 108 rhinos observed 97 (87.3%) were sexed including all adults. The result showed that the entire population comprised of 38.7% adult males, 32.4% adult females and 26.1% immature animals. Of all immature animals 40% (11 immatures) were not sexed hence not considered in the sex ratio. In the entire population males out numbered females in the ratio of 1.2:1 (55 males and 42 females). However, the ratio of the adult males: adult females (42 adult males and 38 adult females) is 1.1:1. This ratio is not significantly different from the sex ratio of 1:1 for adult animals reported by Klingel (1966), Schenkel (1969) and Roth (1968).

The sex ratio in each distribution area was calculated for adult males and females and for immature males and females which is shown in Table III - 3. Except for the distribution area L, the ratio of adult males: adult females is reasonably constant among the distribution areas. For immature rhinos the results may not be representative and cannot be interpreted with confidence.

(c) Age Structure

Conventional methods for ageing rhinos involve examination of dead specimens (Goddard, 1970) and these could be applied to the living Mara population. Instead it was decided to use individuals from the Mara rhino

population whose date of birth was known. Their pictures were taken and their body growth compared with the other individuals. Also photographs of the rhinos born during the study period were taken at different time during the study period and body growth compared, Plate III - 2 a, b, c, d, e, f, and h. This method was very useful for rhinos which accompanied their mothers, and the rhinos which had just left their mothers. A considerable use of Schenkel's (1969) age criteria by body growth was used. Mature rhinos whose horn growth was similar in length and shape to those rhinos which had young ones were considered to be over 4 years. This was based on the Goddard's (1970) and Schenkel's (1969) information that rhinos attain sexual maturity at age from 5 to 6 years and full growth at age from 8 to 10 years.

Using this method, rhinos were classified into four age groups. Group I whose age was 0 - 1 year, Group II whose age was 1 - 2 years, Group III whose age was 2 - 4 years and Group IV whose age was over 4 years. It was assumed that rhinos under one year which formed age Group I were juveniles, between one and two years which formed age Group II were immatures (¼ to $\frac{2}{3}$ of the mother's height), between two to four years, which formed age Group III, were sub-adults about to leave their mothers, or had left their mothers, and over four years formed age Group IV whose individuals were fully grown males and females with or without juveniles accompanying them. Rhinos in age Group IV could have been classified into

further age group but this was not attempted since it would have required crania and mandibles from dead animals.

The results showed that the entire Mara population had 7.2% of rhinos in age class I, 7.2% in class II, 11.7% in class III and 73.1% in age class IV. Age class IV comprised of 54% males and 46% females. Out of the entire adult females, 75% were accompanied by the young ones (28 juveniles and immatures) which formed age group I and II. There is an indication that there is a high proportion of adult rhinos due probably to a relatively low adult mortality.

Age group distribution for each distribution area was calculated based on the entire Mara population and the results shown in Table III - 4. Age Group IV was represented in each distribution by 0.9 to 20.7% of the total population. Age Group III was fairly represented by 0.9% to 3.6% of the total population while age Group I and II were poorly represented in most distribution areas.

The observations were only made for a period of one year which can be considered to be very short for detailed report on age structure.

III - 2 Reproduction

(a) Age At Sexual Maturity

Goddard (1970) reported that females in Ngorongoro attain sexual maturity at the age between 3.8 to 5.7 years

or over. However, black rhinos living under wild condition attain sexual maturity at an earlier age than some specimens raised in zoological gardens (Goddard, 1967). A check on mating behaviour of sub-adult male and female rhinos was made but none of the sub-adult rhinos were observed mating. Adult males were never observed mating with sub-adult females. In addition no sub-adult (age class III) female rhinos were met with a young one. The sub-adult rhinos which were assumed to be 3 to 4 years old (age class III) appear, therefore not to have achieved sexual maturity. Observed mating behaviour was recorded only among rhinos assumed to be over 4 years old (age class IV).

(b) Gestation Period

No data were collected on gestation period for the Mara rhino population. However, the available literature reveal that gestation period for rhino is 450 to 540 days (Goddard, 1967). Ulmer (1958) gives 450 to 480 days. Two calves produced in the Kobe Oji Zoo had gestation periods of 470 and 462 days (Goddard 1967). A record from the Hanover Zoo in Germany gives 469 days (Dittrick 1966). As mentioned by Goddard (1967), a female at Ngorongoro was in receptive oestrus on 7th April, 1965 and produced a calf during the last week of June 1966, giving a gestation period of approximately 446 days.

Three rhinos were observed mating on 22nd September, 1971, 18th October, 1971 and 24th March, 1972 but

unfortunately they had not given birth at the end of the study period.

(c) Interval Between Calves

The intervals between calves in rhinos varies. According to Goddard (1967) interval between calves for rhino population at Ngorongoro was recorded as being 25, 28 and 29 months. As for the Mara population rhino No. 8 had its second calf in January 1969 (as reported by warden incharge of the Reserve) and the third calf in February 1972. This gives interval of 25 months. All the rhinos in age class I, II and some in III accompanied their mothers, and this suggests that the interval between calves for the Mara rhino population is more than 24 months since age class I was assumed to have individuals from 0 - 1 year, class II from 1 - 2 years and class III from 2 - 4 years. There was a total of 28 rhinos which accompanied their mothers.

III - 3 Mortality

(a) Adult mortality

Mortality play a significant role in rhino population dynamics. A search of rhinos which might have died from any cause was made in the entire study area. Four rhino skulls which were assumed to be less than 2 years old were collected from Posee plains. Female rhino (number 6A) was found dead in the Triangle during the months of November

1971. From the information obtained from the Senior Game Warden, 11 rhinos have been reported dead since 1963. Two of these rhinos were speared by the Masai people living around Talek, but the cause of death for the other rhinos was not known. The data collected on death of rhinos were not reliable, and could not be used in prediction of adult mortality rate.

(b) Calf Mortality

Again no data are available for calf mortality in the study area due to the fact that no calf was found dead either at the time of birth or at a later time. It was observed that all calves noted accompanied their mothers in their daily activities. At all times calves fed next to the mothers and even during resting periods they were always found close to their mother. This sort of association of calf and mother offers a great chance of protection from enemies such as man, lions and hyenas. At any time of disturbance from other moving animals or vehicles, calves were found leading or following their mothers too closely into the bush for shelter. On the other hand calves were observed to be more alert on any disturbance. A longer period is needed for gathering data on mortality of rhino in Mara where chances of death were observed to be very low.

III - 4 Limiting Factors

In general, population may be regulated in two ways; by density-dependent or by density-independent factors or events. With density-dependent mortality, the mortality rate increases with increasing population density and decreases with decreasing population density, Owen (1966). The availability of food and the pressure exerted by predators seem to act density-dependently on most populations Owen, (1966), but this does not mean that food availability and predator pressure always act in this way.

Density-independent events are environmental factors whose effect is not related to the density of the population, Owen (1966). Density independent mortality seems to occur when their is a sudden environmental change that affect all members of population equally. It appears then density-dependent events tend to maintain a population at relative stability at a certain level which depends upon the particular environment. If most populations are limited primarily by density-dependent event, it follows that as members tend to rise there must be competition for resources among individuals. Competition is likely whenever animals share the same controlling factors; that is to say, when there are not enough resources available, some individuals die while others survive. However, there is not much indirect evidence that competition for food is the chief limiting factor for many animal population appeared

relatively stable. There must, therefore, be some factors which maintained the population at its level. It was then decided to obtain information on predation, environmental changes and possible parasites.

(a) Predation

Cattle ranching makes an important contribution to the economy of Masailand with the result that the larger carnivores have been partially eliminated. For example, lions, Panthera leo massaica, Neumann, which raid Masai Bomas are translocated into Masai Mara Game Reserve resulting in a large lion population in the reserve. From the ground result there are about 200 lions living in the study area but no single observation which was made on lion killing a rhino. Out of 70 observations made 30 were observed of lions killing zebra Eguus burchelli Matschie, 20 on giraffe, Giraffa camelopardalis Linn., 5 on wildebeest Gorgon a. mearnsi, Swynnerton and Hayman, 10 on buffalo, Syncerus caffer Sparrman and 5 on waterbuck, Kobus defassa Matschie.

In Mara there are large numbers of zebra, buffalo, wildebeest and giraffe. The only figures available on the numbers of these animals for western Masailand including the reserve as a whole come from a comperative aerial count of May 1961 (Stewart and Talbot 1962a, 1962b). The results of that count, in part, showed the following:

Wildebeest : 239,516

Zebra : 171,873

Buffalo : 21,832 (± about 10%).

On the other hand hyenas, Crocuta crocuta, Erxleben were found to feed mostly on remnant of lion kill but one observation was made on a group of hyenas killing a wildebeest. In most cases, during the migration lions were found to follow behind migrating zebras and wildebeest out of the study area, thus reducing the number of lions in the study area. During the migration there are few of zebras and wildebeests left behind. These few wildebeests and zebras together with buffalos and giraffes supply food to the Mara resident lions. As observed lions and hyenas appeared to prefer the animals they were observed killing rather than rhinos.

Although it seldom happens, various references can be found in literature of rhino being attacked and sometimes killed by lion (Ritchie, 1963 and Guggisberg, 1966). No record can be found of rhino being killed by a lion in Masai Game Reserve since it was established.

The most important predator is man. In East Africa rhino are primarily killed by poachers for horns. According to Huxley (1961), the poachers receive from 14 shillings to 20 shillings per kilogram. The legal auction price in Mombasa during the first ten months of 1960 was between 180 shillings and 188 shillings per kilogram for rhino horn. The annual total of rhino legally and illegally killed in Kenya is estimated at 675 to 950.

At present, due to adequate protection of game in the Masai Mara Game Reserve, most poaching on rhino is outside the reserve. For many years major Temple-Boreham, former Game Warden in charge of Narok area including the reserve kept these areas free from any significant poaching. However, in the area surrounding the reserve, especially to the north and east some poaching does occur. This is in the form of killing by arrows, spears, rifles and snares lines. Cases of Masai people spearing rhinos in self deffence along the reserve boundary has been reported by the warden in charge of the reserve. However, the magnitude of poaching along the boundary is very low.

The Triangle area is known to be frequently visited by poachers from Tanzania. Their effort has been mainly directed towards plains animals for meat and probably for trophies. But due to the wide distribution of rhinos in the Triangle area, it is difficult for the poachers to seek them out.

(b) Vegetation And Water

Some areas of Kenya National Parks, like Tsavo National Parks are faced with periodic droughts which result in death of rhinos and elephants. Periodic droughts were experienced in Tsavo in 1961 and 1971. However, unlike Tsavo, Masai Mara Game Reserve is not at danger of facing a drought. As mentioned earlier vegetation for food, and water is readily available. However, with the frequent burning which is done twice

a year, the suitable rhino habitat may be changed to grassland in years to come. This change may affect rhino population by eliminating vegetation cover used by the rhinos.

(c) Diseases, Parasites And Associated Flies

Very little is known of disease that affect black rhino in the study area. However, the available literature records various parasites and flies which have been found living in or on the black rhino. Schenkel (1969) noted several species of biting flies such as Rhinomusca brucei, Lyperasia species, Tabanus species and Glossina pallipides Austen. Tabanus and Glossina visit rhinos only for a blood meal.

In addition Schenkel (1969) noted some ticks such as Rhipicephalus humeralis, Rondelli, Rhipicephalus simus Koch, Rhipicephalus pulchelius, Gerstacker, Amblyomma gemma, Donitz, Amblyomma sparsum, Neumann, Dermacentor rhinocerinus, Denny, and Hyalomma rufipes Koch. All these are ectoparasites.

Talbot and Talbot (1963) reported the occurrence of some ectoparasites in Masailand which lived on wildebeest and rhino. These were Rhipicephalus sp., Hyalomma albiparmatum Schulze and Schlottke, Amblyomma variegatum Fabricius and Rhipicephalus appendiculatus Neumann. Both Rhipicephalus evertsi (Red-legged tick) and Boophilus decoloratus is mainly found in cattle but rarely in buffalo and zebra. Probably due to wallowing

activities in buffalo and rhino, it is easy for the rhino to pick the tick from wallowing holes and also from the vegetation when the ticks fall off the other animals. By far, red-legged tick is a vector of East Coast Fever of cattle and blue tick is the most important vector of two cattle diseases, redwater and anaplasmosis. There is a possibility though not examined during the study period that diseases carried by these tick may affect rhinos which live in the areas where Masai graze their cattle.

Two species of tsetse fly, Glossina swynnertoni and Glossina pallidipes, are relatively common in the bush parts of the Masailand. However, only Glossina pallidipes was noted living around Ngama hills, and in most cases it was observed biting rhinos and buffaloes. Both species are capable of carrying trypanosomes which cause trypanosomiasis in cattle.

Schultz and Kluge (1960), Tremlett (1964) and Round (1964) reported that parasite Stephanofilaria dinniki live in most of the black rhinos observed to have open sores on the sides of their bodies. Some rhinos in the study area were observed having sores on their bodies but the cause of these sores was not known.

Density-independent events are likely to occur in Masai Mara Game Reserve due to change in habitat, shortage of food and water though this is not stated with confidence. The rhino population in Mara tend to be increasing with a steady rate giving slim chances of density-dependent events. Competition for rhino food

plant (discussed in Chapter V) was observed to be very low.

III - 5 Longevity

Time did not allow an investigation into the actual age of adult rhinos. However, Ritchie (1963) reported that a rhino in captivity lived for over 20 years. Ritchie (1963) further commented that there is no reason to suppose that they might not live to 40 years or even more, either in captivity or in the wild state.

Goddard (1970) in his age classification of crania and mandibles collected from dead rhinos in Tsavo National Park estimated rhinos in age class XX to be individuals who were 35 years old. Some longevity records of black rhinos in zoological gardens reveal that one female in London lived for 22 years and 7 months (Flower, 1931), one male in Chicago lived 25 years and 5 months (Crandall, 1964) and another male in Chicago (Rabb) lived for 34 years.

As mentioned in the earlier chapter, Goddard (1970) and Schenkel (1969) reported that rhinos attain full growth between 8 to 10 years old. Within the Mara rhino population adult males and adult females accompanied by the young ones were observed to have attained full growth. Among them, there are rhinos which are well known to the warden in charge of the reserve since it was established in 1950. This then suggests that there are rhinos in Mara which are over 20 years old.

Table III-1

LIST OF RHINOCEROS IN MASAI MARA GAME RESERVE

Distribution Area	1st seem	Rhino No.	Age class	Male	Female	Unsexed
A	21/5/71	1A	IV		X	
"	21/5/71	1B	III	X		
"	21/5/71	2A	IV		X	
"	21/5/71	2B	I			X
"	21/5/71	3	IV	X		
"	21/5/71	4	IV	X		
"	8/8/71	13	IV		X	
"	11/8/71	23	IV	X		
"	11/8/71	24A	IV		X	
"	11/8/71	24B	III		X	
"	12/8/71	25	IV	X		
"	14/8/71	28A	IV		X	
"	14/8/71	28B	II			X
"	14/8/71	29	IV	X		
"	14/8/71	30	IV	X		
"	14/8/71	31A	IV		X	

Table III - 1
(Continued)

Distribution area	1st seen	Rhino No.	Age class	Male	Female	Unsexed
A	14/8/71	31B	II		X	
"	14/8/71	32	IV	X		
"	22/9/71	42A	IV		X	
"	22/9/71	42B	II			X
"	29/9/71	50A	IV		X	
"	29/9/71	50B	III		X	
"	21/10/71	51	IV		X	
"	21/10/71	G 52	IV		X	
"	14/1/72	66	IV	X		
"	14/1/72	67	IV		X	
"	14/1/72	65	IV	X		
"	14/1/72	68	IV	X		
"	14/1/72	69	IV	X		
"	12/2/72	73 A	IV		X	
"	12/2/72	73 B	III	X		

Table III-1

(Continued)

Distribution Area	1st seen	Rhino No.	Age class	Male	Female	Unsexed
B	4/6/71	7	IV	X		
"	4/6/71	8A	IV		X	
"	4/6/71	8B	II	X		
"	4/6/71	10	IV		X	
"	4/6/71	11A	IV		X	
"	4/6/71	11B	II		X	
"	13/8/71	27	IV	X		
"	24/9/71	44	IV	X		
"	24/9/71	45	III	X		
C	3/6/71	6A	Died in No. 1971		X	
"	3/6/71	6B	III	X		
"	14/7/71	18A	IV		X	
"	14/7/71	18B	I			X
"	10/8/71	19	IV		X	
"	10/8/71	20	IV	X		

Table III-1
(Continued)

Distribution area	1st seem	Rhino No.	Age class	Male	Female	Unsexed
C	10/8/71	21	IV	X		
"	16/8/71	34	IV	X		
"	16/8/71	35A	IV		X	
"	16/8/71	35B	I	X		
"	21/9/71	39	IV	X		
"	21/9/71	40	IV	X		
"	27/9/71	48A	IV		X	
"	27/9/71	48B	I			X
"	17/2/72	76	IV	X		
D	10/6/71	16	IV		X	
"	23/10/71	58A	IV		X	
"	10/1/72	62	IV	X		
"	25/11/71	63	IV	X		
"	18/11/71	64	IV	X		
"	25/3/72	78	IV	X		
"	25/3/71	79	IV		X	
E	9/6/71	14	IV	X		

Table III-1
(Continued)

Distribution area	1st seen	Rhino No.	Age class	Male	Female	Unsexed
E	9/6/71	14	IV		X	
"	11/6/71	17A	IV		X	
"	11/6/71	17B	III		X	
"	21/10/71	54	IV	X		
"	8/1/72	61	IV		X	
F	10/11/71	86	IV	X		
"	10/11/71	87A	IV		X	
"	10/11/71	87B	III	X		
G	12/8/71	26	IV	X		
"	29/9/71	49A	IV		X	
"	29/9/71	49B	II	X		
"	15/2/72	74A	IV		X	
"	15/2/72	74B	III	X		
H	23/5/71	36	IV	X		
"	21/9/71	41A	IV		X	
"	21/9/71	41B	II			
I	22/11/71	37	IV	X		
"	19/11/71	59	IV	X		
"	10/5/72	80	IV	X		
"	10/5/72	81A	II		X	

Table III-1
(Continued)

Distribution area	1st seen	Rhino No.	Age class	Male	Female	Unsexed
I	10/5/72	81B	II		X	
"	10/5/72	82A	IV		X	
"	10/5/72	82B	IV			X
"	10/5/72	83	IV	X		
"	9/7/72	84	IV	X		
"	9/7/72	85A	IV		X	
"	9/7/72	85B	I			X
J	23/9/71	43A	IV		X	
"	23/9/71	43B	III	X		
"	15/2/71	43C	I			X
"	23/10/71	56A	IV		X	
"	23/10/71	56B	II	X		
"	17/11/71	57	IV	X		
"	23/11/71	60	IV	X		
"	26/3/71	77	IV		X	
K	20/1/72	70	IV	X		
"	20/1/72	71	IV	X		
"	20/1/72	72A	IV		X	
"	20/1/72	72B	III	X		

Table III-1
(Continued)

Distribution Area	1st seen	Rhino No.	Age class	Male	Female	Unsexed
L	21/10/71	53	IV	X		
M	7/6/71	12A	IV		X	
"	7/6/71	12B	III			X
"	27/9/71	46	IV	X		
"	27/9/71	47	IV	X		

Table III - 2

Percentage of Total Population of rhinos Found in each Distribution

Distribution Area	% Total Population	% Adult Male	% Adult Female	% Immature both Sexes
A	28.8	9.9	10.8	7.2
B	9.0	3.6	3.6	1.8
C	12.6	5.4	3.6	3.6
D	7.2	3.6	2.7	0.9
E	5.4	1.8	2.7	0.9
F	2.7	0.9	0.9	0.9
G	4.5	0.9	1.8	1.8
H	2.7	0.9	0.9	0.9
I	9.9	4.5	2.7	2.7
J	7.2	1.8	2.7	2.7
K	3.6	1.8	0.9	0.9
L	0.9	0.9	-	-
M	3.6	1.8	0.9	0.9

Table III - 3

Sex Ratio Of Males, Females And Immatures In Each Distribution Area

Distribution Area	Adult		Immature		Unsexed	Sex Ratio	Young
	Male	Female	Male	Female		Adult Male: Adult Female	Immature Male: Female
A	11	12	2	3	3	1:1.09	1:1.5
B	4	4	1	1		1:1	1:1
C	6	4	2		2	1:0.67	
D	4	3	1			1:0.75	
E	2	3	1			1:1.5	
F	1	1				1:1	
G	1	2	2			1:2	
H	1	1			1	1:1	
I	5	3	1		2	1:0.6	
J	2	3	2		1	1:1.5	
K	2	1			1	1:0.5	
L	1					1:0	
M	2	1				1:0.5	
Total 13	42	38	13	4	11	1:0.99	1:0.31

Table III - 4

Age Structure In Each Distribution Area

	No. Of Rhinos And Age Classes				% Of Total Population			
Distribution Area	I	II	III	IV	I	II	III	IV
A	2	2	4	23	1.8	1.8	3.6	20.7
B		2	1	7		1.8	0.9	6.3
C	3		1	10	2.7		0.9	9.0
D			1	7			0.9	6.3
E			1	5			0.9	6.3
F			1	2			0.9	1.8
G		1	1	3		0.9	0.9	2.7
H		1		2		0.9		1.8
I	2	1		8	1.8	0.9		7.2
J	1	1		5	0.9	0.9	0.9	4.5
K			1	3			0.9	2.7
L				1				0.9
M			1	3			0.9	2.7
Total 13	8	8	13	79	7.2	7.2	11.7	73.1

Explanation

Plate III - 1

A female rhino accompanied by a calf covered by grass half way up hence sexing by geniteria becomes a problem.

Explanation

Plate III - 2a and b

(a) A five weeks calf accompanying the mother. The calf was born in February 1972.

(b) About a year old calf.

Both (a) and (b) represent age class I of 0 - 1 year old.

a

b

Explanation

Plate III - 2c and d

(c) A calf about a year old. The picture was taken in June 1971.

(d) The same calf one year later June 1972.

Both (c) and (d) represent age class II of 1 - 2 years old.

c

d

Explanation

Plate III - 2e and f

(e) A sub-adult rhino which left mother in January 1972. The picture was taken in December 1971.

(f) A sub-adult which had left the mother. This rhino was born in 1969.

Both (e) and (f) represent age class III of 2 - 4 years old.

e

f

Explanation

Plate III - 2g and h

(g) An adult female rhino which has a calf.

(h) An adult male rhino.

Both (g) and (h) represent age class IV of over 4 years old.

g

h

Chapter IV

SOCIAL ORGANIZATION

IV - 1 The Group Composition And Changes Year Round

Social organization in some form is evidently the general rule among animals populations and likely to be found virtually every where. However, social groups combine two apparently opposite qualities of cohesion, which draws the individuals together, and mutual antagonism, which tend to keep each individual at a distance from its neighbours.

At first sight, at any rate there seems no obvious reason for expecting that the benefits of sociality would all need to be in some fundamental way inter-connected. Thus Tinbergen (1953) groups social co-operation into quite distinct categories according to the ends it serves, concerned respectively with (i) mating (ii) care of the family, (iii) group life and (iv) fighting.

To understand group organization within the Mara rhino population, group composition and its changes at any time of the year were investigated. The Mara rhino population was divided into five major categories namely adult male plus female without young one, adult female with young one, single adult male, single adult female and sub-adults of either sex. Other four minor categories were observed making a total of nine categories as shown on figure IV - 1.

The method used for this study was through group observation. When a rhino or a group of rhinos was encountered, individual rhinos were identified. Data on date seen, sex, age class and number of individuals in the group were recorded. Each separate sighting of a rhino at different times of the day throughout the study period was taken as an observation. Study on group composition was carried out jointly with other studies on census, feeding and other daily activities which offered a chance of meeting the rhino more often. The results are presented in accordance with categories studied.

(a) Adult Male-Female Without Young One

Adult male-female association within the Mara rhino population was found to be unstable. Goddard (1966) and later Schenkel (1966) noted similar results on their studies of rhino association. In the Mara, I observed that a female may visit a male or male may visit a female whose home range is adjacent and remain in the same company for at least a day or two and then separate. Sometimes such companionship occurred weekly or within two weeks period. During the mating season male-female association was observed more frequently. On 10 occasions it was observed that a single adult male or female was noted alone on one day in the evening but on the following day in the morning and the entire day both were observed together. This suggest that meeting usually takes place

during the evening feeding hours or during the night activities. However, during the mating season, when a female is on heat, a female-male association was frequently observed. During the mating season, female-male association was observed to last for a period of one to four weeks or with a temporary separation of one to three days in a week. For example, male No. 14 was found accompanied by female No. 15 every time it was encountered at different time of the months from 9th June, 1971 to 12th January, 1972. Male No. 7 was noted accompanied by female No. 10 each day it was encountered from 19th October, 1971 to 12th January, 1972. Male No. 3 and female No. 13 were in the same company from 21st to 25th September, 1971. In case of male No. 7 and female No. 10, when they separated on 12th January, 1972, each was located alone until 7th May, 1972 when they were seen together again. As for male No. 3 and female No. 13 they were again seen together on 24th February 1972. Adult male rhinos are essentially solitary and they tend to avoid company. Although they have a home range similar in size to that of females without young, they do not wander evenly over the whole range as do females. Adult females can be seen wandering around familiar areas where they were earlier located together with the male. Out of a total of 176 observations, 17 were of adult single males accompanied by single adult females, making a total of 9.7% of the total observations.

(b) Adult Females With Young Ones

Probably the only stable social group in the black rhino population is the mother-calf unit as observed by schenkel (1969). This appears to be true for rhino population in Mara. Out of 176 observations, 62 were made on the mothers accompanied by young ones making a total of 35% observations. This group unit persists until when the mother mates again and even during the time of pregnancy up to about four weeks prior to birth, when the young one leaves the mother. Occasionally the young which has left the mother can be seen within a short distance from the mother with a new calf, particularly during the feeding hours. At times it can be seen following behind the mother but never within a distance of 5 m from the mother. A few observations were made on the calves which left their mothers during the study period. Rhino No. 43A left its mother in January 1972. From the time when rhino No. 43A and 43B were first seen on 23rd September, 1971 up to the end of December, 1971, each time they were encountered they were found together. However, in January 1972, rhino No. 43B (young) was some times observed to be alone feeding or resting while the mother, No. 43A was located at a distance of about 1 km from the young feeding or resting. During the same month, on very few instances, they were both found together during the feeding hours. In February 1972 rhino No. 43B was always seen alone either walking, resting or feeding within the home range of the mother. On 15th February,

1972, the mother, No. 43A was located accompanied by the new calf about 2 km from where older calf No. 43B was used to be seen. Later, on five occasions rhinos No. 43A, 43B, and 43C were located feeding but rhino No. 43B (older calf) was about 500 m from its mother with a new calf. Rhino 43B was heading to the direction of its mother. As from March, 1972 to the end of August 1972, rhino No. 43B was always located alone. Similar observations were made on rhino No. 8A and 8B, 1A and 1B and 17A and 17B.

It was observed that the calves which left their mothers were almost the size of their mothers in height. Goddard (1967) mentioned that the mother will not tolerate the old calf when the new offspring arrives. It was found that with the Mara population intolerance of the old calf does not start with the arrival of the new offspring but it starts a few weeks prior to birth of the offspring. There was not any degree of aggression noted but the association bond between the mother and calf gradually becomes loose.

In case of calves not about to leave their mothers, the association bond is very strong. In most cases, the new born calf follows behind the mother closely or walks at the side of the mother. The distance from each other is less than 2 m when resting; the calf lies down next to the mother with their heads facing the same direction. When running the calf follows the mother but in some cases it can be seen leading the mother into the bush for

shelter. Most of the observations on the mother with a calf were made during feeding hours. It was noted that the calf always fed close to the mother but not more than 5 m from the mother. The calves were noted feeding behind, front or side of the mother but always heading in the same direction.

All the calves classified under age class I, II and some in class III were observed accompanying their mothers during the study. The females accompanied by the young made about 40% of the total Mara rhino population and because of their movement within their home ranges for food they were encountered more often than single males or females which are sedentary in nature.

(c) Adult Males

Adult males were often found alone but this does not mean that they do not join with other group units. Out of 176 observations, single males were observed on 66 occasions, making 38% of total observation. Association between two or more adult males is very rare. Only once were two males found together without any other rhinos present. However, individual males can be found joining a mother-calf unit at the time of feeding. This was noted on 14 occasions which made up about 8% of total observation.

(d) Adult Females

Adult females, like adult males, tend to live alone

other than during mating periods (discussed in Chapter VI) when their association with adult males is more frequent. Only on 16 occasions were individual adult females found alone, making a total of 9% of all observations. There was no observation made where a single adult female was found in the company of another single adult female.

(e) Sub-adult

Sub-adults here refer to young rhinos which have left their mothers and occupy their own home range. This age group did not have many individuals who could be studied in details. However, male No. 44 and female No. 45, both the offspring of female No. 8, (information from warden) were found accompanying each other during feeding periods. During the day, they were found resting in the bush together. Sometimes female No. 45 was seen following its mother No. 8 during feeding hours. Mother No. 8 was accompanied by its young, No. 8B. This meant that male No. 44 was left alone since it was not seen around them. In January, 1972 female No. 44 was found in the company of male No. 9 - for two weeks. It was assumed that they were together for mating purposes.

As mentioned before, rhino No. 43B, was living alone as from February, 1972 when its mother got a new offspring, but it could be found following behind the mother during their feeding hours. Rhino No. 6B, after the death of its mother lived alone but on three occasions it was found feeding and resting within a short

reach of female 35A with its young No. 35B. Rhino No. 6B was also noted taking shelter in a thicket where rhino 35A and B normally shelter.

In conclusion sub-adults normally live alone but they can also be seen joining females with young ones, either their mothers or other adult females.

Ritchie (1963) said that a cow is never accompanied by a bull when she has a very small calf. This is not the case with the Mara population because on seven occasions a bull has been seen with a cow having a two to three months old calf. Observations were made on two different cows and two different bulls which had adjacent home ranges.

(f) Group Size

The most frequent group encountered, as previously mentioned was the mother young unit which comprised two individuals. The other one is a lone adult male or adult female; and a group of two adult rhinos comprising male and female. A party of three is also frequently observed which comprises an adult male and a female with a calf, Plate IV - 1.

Other observations on rare occasions have been made on parties of four comprising mother and calf, its older sub-adult male and an adult female feeding together. A group of five was also noted once, comprising a mother with a calf, two adult males and a single adult female. Another observation was once made on a party of seven, comprising

two mothers with their calves, a sub-adult female and two adult males. One observation was made on a party of eight, comprising two mothers with their calves, a sub-adult male and female which belonged to one of the mothers with a calf, and an adult male and female.

The parties of four to eight individuals are not permanent and the individuals in these parties separate after two to four hours except for the mother-calf units. The party of four previously mentioned was observed around 1700 hours. Individuals in this party were feeding within 100 m from each other. They were observed for a period of 1½ hours, and during this period the two sub-adults in the group fed heading to their regular sheltering places. On the following day they were searched for from 0600 hours to 0900 hours and the two sub-adults were located 2 km from the place they were previously found feeding. The mother with a calf was located about 1 km away from the previous evening location. Individuals in this party had adjacent home ranges. The party of five was observed around 1100 hours. They were resting close to each other and when I approached them the adult male and female ran in one direction, one male ran alone in the opposite direction, and the mother with a calf ran to a distance of 800 m and then stoped. I left the mother with a calf undisturbed and moved to another area but when I passed in the same area at around 1630 hours I could only locate the mother with the calf feeding near

the place I had left them around mid-day.

The party of seven was observed at around 0900 hours and the rhinos in this group were on the move. They were not very far away from the water hole and it was assumed that they were coming from the water hole. I followed them because they were all heading in the same direction but by 1100 hours all had separated except the mother-calf unit. The party of eight was observed wallowing in different holes close to each other on open grass from 1400 hours to 1600 hours. After wallowing they were observed feeding heading in different directions, except for the calves which accompanied their mothers. On the following day they were searched for in the same area but none of them was located.

(g) Influence on Numbers In a Group

The size of the group of two or more individuals except for mother-calf unit is variable throughout the year. They are influenced by daily movements for feeding, wallowing, drinking and salt licking. Mating season and seasonal movement of rhinos were found to influence the number in a group.

A group of two or three individuals who share home ranges have been found wallowing in the same area though not in the same hole simultaneously. This is more frequent during the rainy season. After wallowing they were observed feeding in the same area. Observations on wallowing were made on rhinos in distribution area B

and it was noted that during the rainy period, rhinos in this distribution were located feeding after wallowing in the same wallowing area at around 1630 hours from May 1971 to July 1971. During the dry period (October, November and December 1971) rhinos in distribution area B were in most cases located wallowing in the holes along the valleys individually (except for the mother-calf unit) and during the feeding hours they were also observed singly. In January, February and March, another wet period the same group of rhinos were located as a group feeding and wallowing in their regular wet period wallowing place.

Daily movement for water to the water holes brings individual rhinos together. In most cases rhinos 43A, 43B and 57 were located at 0630 hours about 1 km from the water hole walking towards the feeding grounds. Also in the evening, around 1830 hours they were located walking towards the water hole. A similar observation was made on rhinos 35A, 35B and 34. However, for the rhinos sheltering in the thickets along Mara river a group of two or more individual close together were observed only during the feeding hours.

During the mating season from September to April, a group of adult male and adult female with or without young was more often observed than in the rest of the year. Observations of this group composition were made on rhinos 8A, 8B and 7; 10 and 7; 1A, 1B and 3; 2A, 2B and 4; 13 and 3; and 16 and 78. Rhinos in each of these

groups were located together in most cases but in some cases the individuals separated and then rejoined as described later under section on mating.

The group of seven previously mentioned was located near a salt licking place in distribution area A. Rhinos in this group were coming from the salt lick hole because when I went to the hole I found fresh foot prints. Such a group size was observed only once.

Since permanent drinking places are not evenly distributed in all distribution areas throughout the year, individual rhinos move to other places within their home ranges to get water. Also during the dry period when most of the area is burnt, rhinos move around in their home ranges searching for palatable herbs. These movements are seasonal since they were only observed during the dry period. Rhinos were observed not to move all in the same area hence minimizing the chance of meeting for the rhinos having adjacent home ranges. On the other hand the mating season is not continous throughout the year; despite many field hours, no mating was observed during the period from May to August.

IV - 2 Home Range

Dice (1952) stated that home range is an area over which an individual animal habitually travels while engaged in its regular daily activities. This area includes all the animal's feeding, resting and breeding sites.

Wynne-Edwards (1962) gave four basic types of home ranges; each implying established rights to seek food. These are solitary and exclusive which is frequently defended; solitary and overlapping which is usually defended; gregarious and exclusive; and gregarious and overlapping. Apparently rhino home range would fall under solitary and overlapping but not defended.

The sedentary habits of rhino have long been known and most workers remarked on this. Shortridge (1934), noted that they often attach themselves to one particular area about 16 km in diameter. Stenhardt (1924) mentioned that they seem to have "established headquarters". Ritchie (1963) stated that on returning from water no serious feeding took place until the rhino "gets to his home ground". Guggisberg (1966) also noted that under suitable conditions black rhinos are very sedentary.

To collect data on home range, 5 individual adult males, 3 adult females accompanied by their calves and 2 adult females, making a total of 10 rhinos were studied. This represented three of five major social units. The study was carried out in four different distribution areas, namely distribution areas A, B, E and J as shown on Map IV - 1.

Each day, during the study period rhinos were sought by vehicle and when encountered the individual rhino was identified, sexed and location recorded. Care was taken not to disturb the rhino since any

disturbance would force the rhino to run away. If the rhino was located in the morning it was later sought in the afternoon to find out whether it has moved a greater distance. In most cases rhinos sighted in the morning were sighted in another area in the afternoon and in some cases they were not located anywhere until the following day. It was observed that it was easier to sight rhinos during the wallowing or feeding periods other than any other period of the day.

Each day, a different location for each individual rhino was marked on the map by a dot followed by the identification number of the rhino. The outer dots were joined to form a minimum-area convex polygon. To compute the area, the Reseaus or Area computer transparent sheet, described in Technical Instruction No. 1, obtained from Survey of Kenya was used. The Reseaus had 16 large squares and each of the large squares had 100 small squares. Each of the small squares had four dots. One small square represented 0.1 acres at scale 1:2500. Using the formula described in Technical Instruction No. 1 for use at other scales, $(\frac{1}{2500} \div \text{R.F.})^2 \times 0.1 \times$ Number of squares equals the area in acres. R.F. is the Representation Fraction and for this purpose is $\frac{1}{50,000}$, $\therefore (\frac{1}{2500} \times \frac{50,000}{1})^2 \times 0.1$ acres equals the area of small squares which is 40 acres.

However, 1 mile^2 (2.56 km^2) is equal to 640 acres thus, 40 acres represented 0.16 km^2. Since there were 4 dots in one small square, then the area represented by one

dot was found to be 0.04 km^2. The sizes of home ranges were first recorded in number of dots which were multiplied by 0.04 to give area in km^2. The results of sizes of home ranges are shown on Table IV - 1.

(a) Size

(i) Adult Single Males

Male home ranges ranged from 6.6 to 18.6 km^2 with a mean size of 12.1 km^2 (Table IV - 1). Males number 3 and 4 had a small size of home range, 7.1 and 6.6 km^2 respectively.

(ii) Single Females

Female home ranges ranged from 12.7 to 14.9 km^2 with a mean range of 13.8 km^2 (Table IV - 1). The mean range for single females is almost as that of 12.1 km^2 for single males suggesting that their home ranges are of similar sizes.

(iii) Females Accompanied By Their Calves

Females with young had a large size of home ranges in comparison to single males and single females. The size of their home ranges ranged from 13.6 to 22.7 km^2 with mean of 17.8 km^2 (Table IV - 1). However, rhinos No. 43A, 43B, 56A and 56B had relatively small size of home ranges as compared with other females with young studied.

(b) Influence On The Size Of Home Range

(i) Differences Within Group Units

The group units studied were single males, single females and females with calves. It was noted that single females and single males have similar sizes of home ranges. This is not only for the Mara rhino population alone because Goddard (1967) found that the size of home range for single female for Ngorongoro population was 14.8 km^2 while that of single male was 15.6 km^2. Males and even single females spend most of their day time resting in the bush; hence their movements are within the areas around the sheltering places.

However, females with young tend to move more looking for food and orientating their calves with the other areas within the home range. Thus they tend to have larger home ranges. When the females meet with males they usually follow males or males may follow females into their home ranges and by doing so they extend the range into new areas.

(ii) Differences Between Group Units Using Similar Habitats

There is not much difference in the size of home ranges for group units which used similar habitat. This is indicated by the results obtained on rhinos No. 3 and 4 (both single adult males in distribution Area A). Rhino No. 7, 27 and 10 (two adult males and an adult female in distribution area B). Rhinos number 14 and 15 (an adult male and an adult female in distribution area E) which

had the same size of home range because they were mostly encountered together. The home range sizes for each rhino studied is shown on Tables IV - 1. Rhino numbers 3 and 4 had almost the same size of home range. Home range size for rhino number 27 was larger than that of rhino number 7 because it covered an area with widely separated thicket islands. However, home range size for rhino number 7 and 10 was similar. The number of study animals for each social unit in each distribution was small and to make a good interpretation a large number of rhinos in each social unit would have to be studied.

(iii) Overall Influence of Habitat Type On Home Range Size.

It is likely that the size of the home range varies considerably according to the availability of food, surface water and vegetation for shelter. Study on food availability indicated that food is available within a short reach in each rhino home range except during the dry period when burning is observed destroying most of the palatable herbs. When individual home range sizes in each distribution area is compared with available food per 10 m^2 (Table II - 2) in the distribution area, the results indicate that the size of home range does not decrease with increasing food plant density. This may indicate that there is enough food available for each rhino in the

distribution area and the range of rhinos movement is not determined by food availability.

Surface water is available within short reach during the wet periods but during the dry period some of the water pans and streams dry up causing the rhinos to move near the available water sources.

This kind of movement was noted with rhinos in distribution areas E and B and is discussed in the section under seasonal movement.

The availability of cover for shelter does influence the size of home range for rhinos in Mara. Rhinos which occupied areas with over 60% cover for shelter had their home range sizes being less than 15 km^2. This is clearly indicated by home range sizes for rhino numbers 3, 4, 1A, 1B, 14, 15, 17A, 17B, 43A, 43B, 56A and 56B. Map II - 2 shows cover for shelter available in various distribution area. Rhinos in distribution area B which had 50% cover for shelter had a minimum size of home range of 12.72 km^2 and a maximum of 22.68 km^2.

Thus in distribution area A as revealed by results of rhinos number 3, 4, 1A and 1B, movements which could cause an extended range were minimal. The rhinos locations are shown on Map IV - 1a. As compared with rhinos in distribution areas B shown on Map IV - 1b, area E on Map IV - 1c and J on Map IV - 1d, male rhinos in distribution area A had smaller home range sizes than males number 14, 7 and 27 in distribution areas E and B respectively. Also rhinos number 1A and 1B as compared

with other rhinos with calves (8A, 8B, 17A and 17B) in distribution areas B and E respectively had smaller size of home range. Single females number 10 and 15 in distribution areas B and E respectively had almost the same size of home range. Male number 27 had a much larger size of home range than other males in the same distribution area because its regular feeding grounds were far away from watering places. Rhinos number 43A, 43B, 56A and 56B gave a very unusual results because it was difficult to locate them and when located they were close to their regular routes to the feeding grounds from the watering places.

In conclusion, rhinos living in areas with abundant cover and short reach of permanent water had smaller home ranges than rhinos living in areas where some sources of watering places regularly used to dry up. Distribution areas A and B and E had almost similar habitat types and as it has been revealed, the results of the individual home range sizes are similar.

(c) Other Influences On Home Range Size

The other factors which influence rhino home range size are seasonal movements, fire, mating activities and domesticated animals.

(i) Seasonal Movements

There is a considerable variation between the range during the wet and dry season as noted by Goddard (1967). He noted that during the wet season the home range which

is utilized is greater because of the larger variety of palatable plants available at this time of the year while in the dry season rhinos tend to occupy only the part of its home range in close proximity to marshes and water. Indeed habitat is a major determinant of the variation with seasons. In the dry season, rhinos in distribution E and B tend to move more resulting in an increased home range size as revealed by their locations. As for distribution J a reverse condition was observed. The range is greater during the wet season. Rhinos in distribution A had the same range for dry and wet periods with exception of rhino 1A and 1B. Table IV - 2 shows the range during the wet and dry periods.

During the dry season, as it is traditional for the Masai to burn vegetation prior to rain to allow a chance for new regeneration much of the Masai Mara Game Reserve is burnt. From the middle of September to middle of November 1971 whole of the Triangle, Burrungali, Ol misingiyoi, Angata, Meta, Siana and Ngama hills were burnt. In March - April, 1972, the whole of Kebololet, Posee and Ilkeekorok areas were also burnt. Fire is not properly controlled and a considerable large area is burnt at one time. Grasses, herbs and shrubs which are not fire resistant are largely destroyed. As a result rhinos were forced to move their usual home range boundaries looking for food. The Acacia plant species which are resistant to fire could be the sources of food, but most of their leaves are left dry after fire. As soon as the rain

started regeneration of palatable vegetation was observed over the burnt areas and the rhinos were seen back within boundaries of their usual home ranges.

(ii) Mating Activities

During the mating period, which was observed to start in September and continues to April, some individual rhinos were seen wandering in other rhinos home ranges. In a number of observations female number 13 was seen walking into the home of male number 3, and after mating male number 3 followed female 13 back to her home range. A similar case was noted with male number 7 and female number 10. Again here female number 10 walked into home range of male number 7 where it stayed for a few days. After mating, both moved into home range of female number 10 and they were noted to be together for a considerable time. Later, male number 7 moved back into his home range and after two weeks female number 10 followed male number 7. They were not seen for three weeks but on the 7th May, 1972, each was seen in its usual home range in which each lived up to the end of the study period.

(iii) Domesticated Animals

From January to April, 1972, Masai people were seen grazing their cattle in Posee plains, Siana, and Ol Doinyo Loip hill. As observed, rhinos never associated with cattle. The rhinos moved away to other parts of their home

ranges and even beyond their boundaries where cattle never used to graze. This was found to affect the movement of rhinos in distribution areas B, D, E and J.

At the close of April 1972, there was no more grazing of cattle in the reserve and in May rhinos were seen occupying the parts of their home ranges which had been grazed by the Masai.

(d) Overlapping Of Home Range

Goddard (1967) found that in Ngorongoro one male shared 40% of his home range with another adult male, and in five adjacent ranges on the Caldera floor a mean of 35% of each range overlapped with one or more other ranges. Home ranges within the Mara rhino population are no exception. The degree of overlapping was noticeably high particularly with rhinos in distribution area B, where a large number of rhinos shared adjacent ranges as shown on Map IV - 1. Rhino 17A and 17B had their range 41% overlapping with rhino numbers 14 and 15 range. The mean overlapping range for distribution area A was 32.1%, distribution area B 57.1% and for distribution area J 1.1%. Considering the entire home range study the mean range overlap for males is the same as for females with young 49.6% and 46.3% respectively, while for single females is higher with 72.8% overlap. Table IV - 1 shows percentage overlap for each individual rhino home range.

IV - 3 Territory

The question of the existence of territory in rhinos still remains unanswered. Goddard (1967) stated that territorial behaviour among individuals of a community is not apparent in the species, however, if a 'stranger' of either sex enters the community, territorial tendencies may become apparent, especially if the conflict of interest concerns two adult males. This is the case with the Mara population. However, I here find it better to discuss first the criteria for territoriality which has in past been used with impala and Uganda kob; and which I used in determining territoriality in rhinos.

(a) Criteria For Territoriality

Leuthold (1970) stated, "The term "territory" has been variously defined (e.g. Tinbergen 1936, Noble 1939, Nice 1941); but all definitions include the defense of an area as the most important characteristic of territorial behaviour. According to these definitions, the best evidence for territoriality would be the observation of defensive behaviour, or intolerance towards conspecifics within a given area.

However, in many animal populations it is difficult to observe actual defensive behaviour, as this may be "diluted" into inconspicuous displays between males that apparently know each other". In rhino, it was necessary, in addition, to distinguish between the defense of an area

and the defense by a male of a female with or without young one.

"Therefore, additional criteria were formulated which could provide at least indirect evidence for or against territoriality". They include the following:

(i) "The proportion of observation of two or more males together, compared with observations of single males".

(ii) "Repeated observations of a known single male in the same location, with and - more important - without females".

(iii) "Observation of the same known male in the same area but with different females on different occasions".

(iv) "Observation of the same females with different known males in different locations".

(v) "Observation of a new male in an area where a known male had been seen repeatedly; at the same time, the original male should be seen elsewhere, without females. (This would amount to an exchange of territorial males.)"

"No single criterion was to be considered decisive by itself, but if several or all of them were fulfilled, territoriality was likely to exist in the population studied. Conversely, if several of them were not fulfilled, the occurrence of territorial behaviour would be doubtful".

(b) Indirect Evidence For Territoriality

"The relevant data are presented in the order of the criteria listed under section (a), accompanied by the corresponding numbers".

(i) In the entire study area, 37.62% of all social groupings recorded were single males, 0.57% a male with another male, 9.69% male with a female and 7.98% male with a female accompanied by a calf. However, the 5 males selected from territorial studies were observed 8.3% of all social groupings alone and 9.8% with a female in specific areas (common feeding and resting grounds), while 40.5% of all social groupings were with a female and 40.5% alone in unspecific area. Male rhinos are known to be extremely sedentary and also solitary.

(ii) All observations of the 5 selected males are summarized in Table IV - 3. These particular males were selected because (1) they were seen relatively frequently during the study of their home ranges and (2) they were sometimes observed accompanied by a single female or female with a calf. Male rhinos have definable home ranges and within these home ranges, they are sometimes found with females and sometimes without.

(iii) Of 5 study males only 2 were found to associate with more than one female at different times.

(iv) Out of six well-known females, three were seen

at different times with different males (two each) and the other three were seen with only one male each.

(v) No single observation was made on a new male in an area where a known male had been seen repeatedly. Observations were made on males feeding in areas where some different males were previously observed feeding. At the time of location, the original males might not be located elsewhere, alone or with another rhino i.e. home ranges overlap. As all the criteria listed above have not been fulfilled, it was decided to look into other behaviour patterns such as defensive and marking which might add more information in determining existence of territory in rhino.

(c) Defensive Behaviour

Not a single actual fight was witnessed with any male against any other male.

However, in distribution area E while following male No. 54 it encountered male No. 14 resting in a thin bush. When both sighted each other, male No. 54 stopped at a distance of about 6 m. Male No. 14 lowered the head, rolled the eyes, flattered ears, raised the tail and then curled its upper lip emitting a screaming groan. Male No. 54 remained motionless but it kept on looking at male No. 14. When male No. 14 screamed rhino No. 54 lowered its head and immediately both of them ran away, each in

opposite direction from each other.

These two rhinos do share a part of their home ranges and previously both were found feeding in the same area near each other, accompanied by a female with a young one. Generally, the two males were not repeatedly seen in the area where disturbance occurred; and most likely such aggressive behaviour was probably due to disturbance of male No. 14 (which was resting) by male No. 54.

(d) Marking Behaviour

"Many territorial mammals deposit scent marks in their territories, either through faeces and/or urine, or as products of special scent glands (Hedger 1949). In Thomson's gazelle, Walther (1964a) found that olfactory marking occurs in all adult males and, by itself, provides no evidence for territoriality; but it does play an important part in the behaviour of several territorial antelopes". Therefore, this aspect was also investigated in the rhino.

During the present study, some rhino dung heaps were found in certain location and others were found scattered within the home range. Dung heaps found on certain location were along tracks followed by rhino when going to water places or from range to the other. The dung found scattered within the home range are dropped during the feeding periods. In some observation new dung was found on an old dung heap which might be used

as an indication that the rhino living in that part where the old dung heap was located had moved to another area. On the other hand rhinos were found to urinate anywhere within the home range but not at certain areas. Schenkel (1966a) found that urination and defaecation have no marking function and are very poorly ritualized.

In conclusion, as all the criteria listed under sections (a), (b) and (c) have not been fulfilled, it is doubtful that territorial behaviour exists in the rhino populations of Masai Mara Game Reserve.

Table IV - 1

Home Range Sizes For Adult Males, Adult Single Females And Adult Females With Calves

Distribution Area	Rhino No.	Sex	Range Size in km^2	Overlap Area in km^2	% Overlap	% Cover Available
A	3	Male	7.12	0.88	12.30	77
A	4	Male	6.64	4.92	74.00	77
B	7	Male	13.32	12.48	93.70	50
E	14	Male	14.92	7.92	53.83	93
B	27	Male	18.60	2.64	14.19	50
B	10	Female	12.72	11.68	91.82	50
E	15	Female	14.92	7.92	53.83	93
A	1A	Female (+)	13.60	5.80	42.64	77
B	8A	Female (+)	22.68	12.48	55.40	50
E	17A	Female (+)	17.32	7.92	41.00	93
J	43A	Female (+)	5.60	0.08	1.42	81
J	56A	Female (+)	9.52	0.08	0.80	81

Female (+) - Female accompanied by a calf.

Table IV - 2

Home Range Sizes For Dry And Wet Periods In km^2

Distribution Area	Rhino No.	Wet	Dry
A	3	7.12	7.12
	4	6.64	6.64
	1A and 1B	5.76	7.96
B	7	10.32	3.00
	8A and 8B	9.05	3.63
	10	5.36	7.36
E	14 and 15	2.16	12.76
	17A and 17B	10.44	6.88
J	43A and 43B	4.00	6.52
	56A and 56B	4.00	1.60

Table IV - 3

Observations Of 5 Known Males In (i) For Territoriality

Male rhino No.	Number of observation					
	With another Male	In specific location		In unspecified location		Total
		With a female	Alone	With a female	Alone	
3	x	2	1	1	3	7
4	x	x	2	x	6	8
7	x	2	x	7	2	11
14	1	x	x	9	x	10
27	x	x	x	x	6	6
Total 5	1	4	3	17	17	

Key To Map IV - 1

Rhino Home Ranges

(1) Solid line (-)... boundary for entire individual home range.

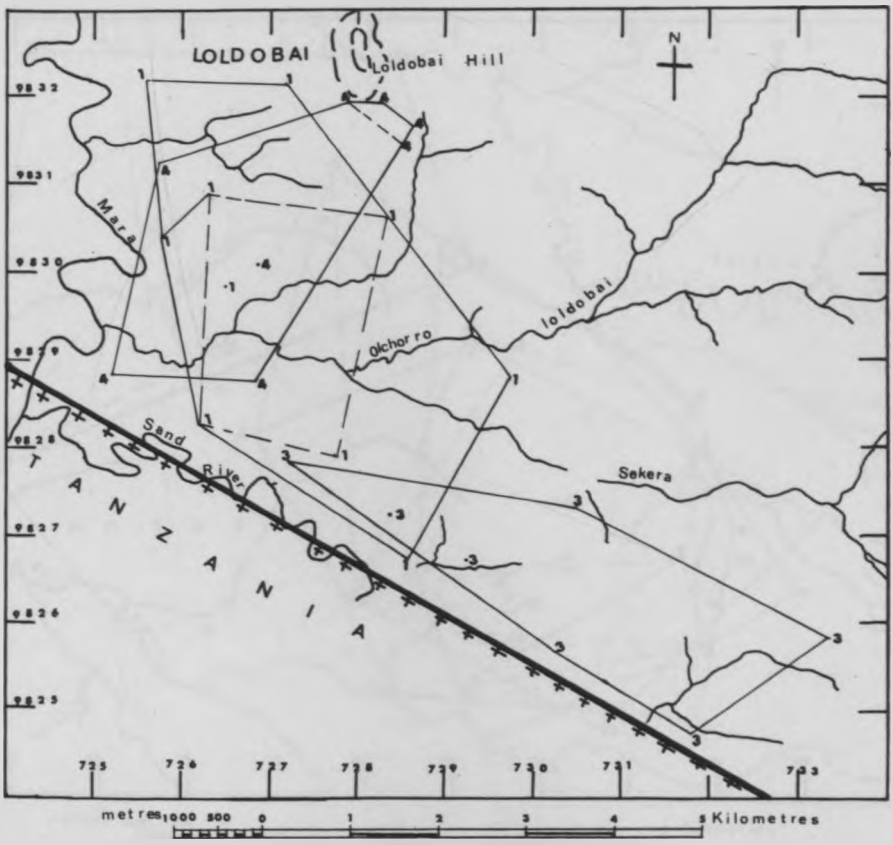
(2) Broken line (--) joining solid line --- boundary separating wet and dry home ranges for individual rhino observed.

(3) Single number (7) --- peripheral of home range.

(4) Number (.7) preceded by a dot --- other locations of rhinos within the home range.

Map IV–1a

RHINO HOME RANGES
AREA A

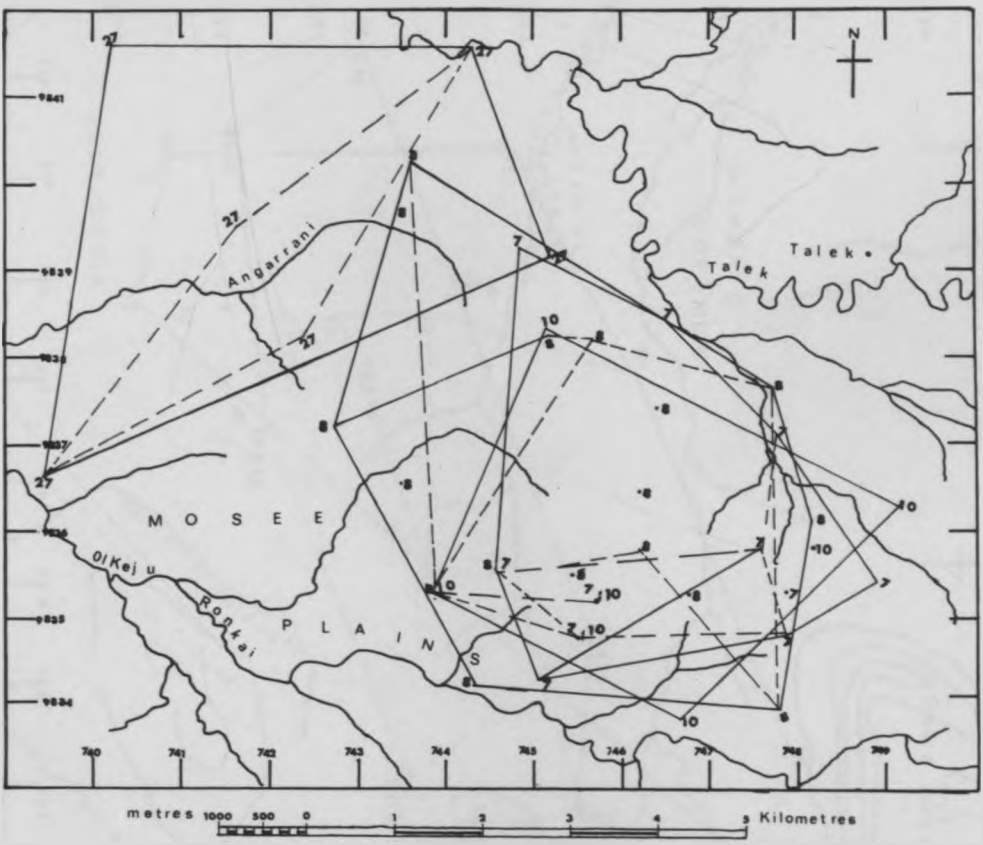


Scale 1:50,000

Map IV-1b

RHINO HOME RANGES

AREA B

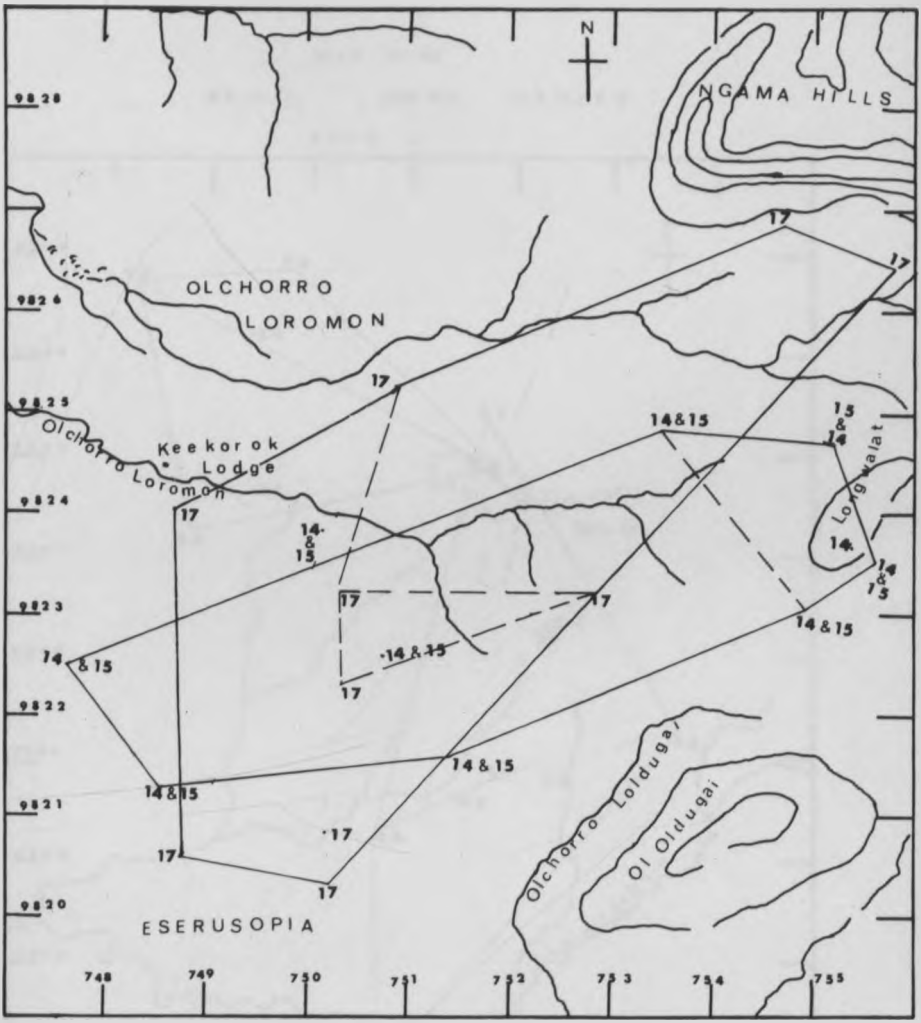


Scale 1:50,000

Map IV-1c

RHINO HOME RANGES

AREA E

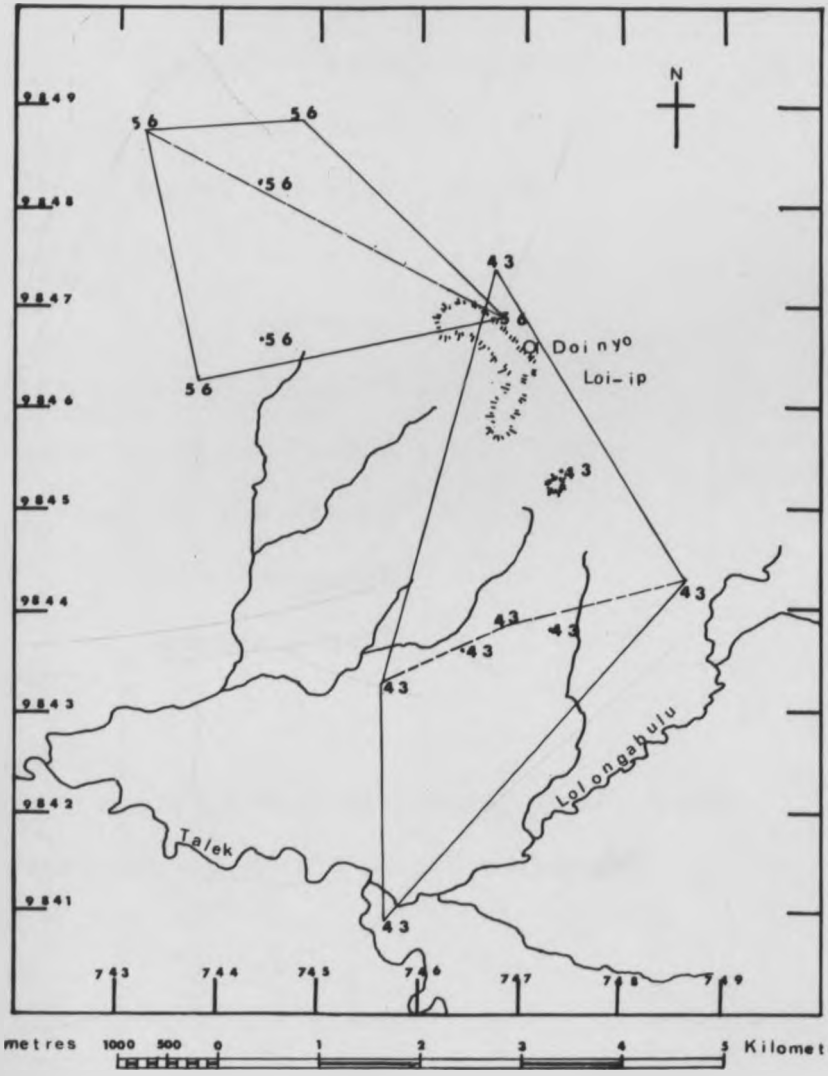


Scale 1:50,000

Map IV-1d

RHINO HOME RANGES

AREA J



Key For Figure IV - 1

Social Organization

A - Male and male

B - Male alone

C - Male and female

D - Male and female with young

E - Male and young

F - Female and young

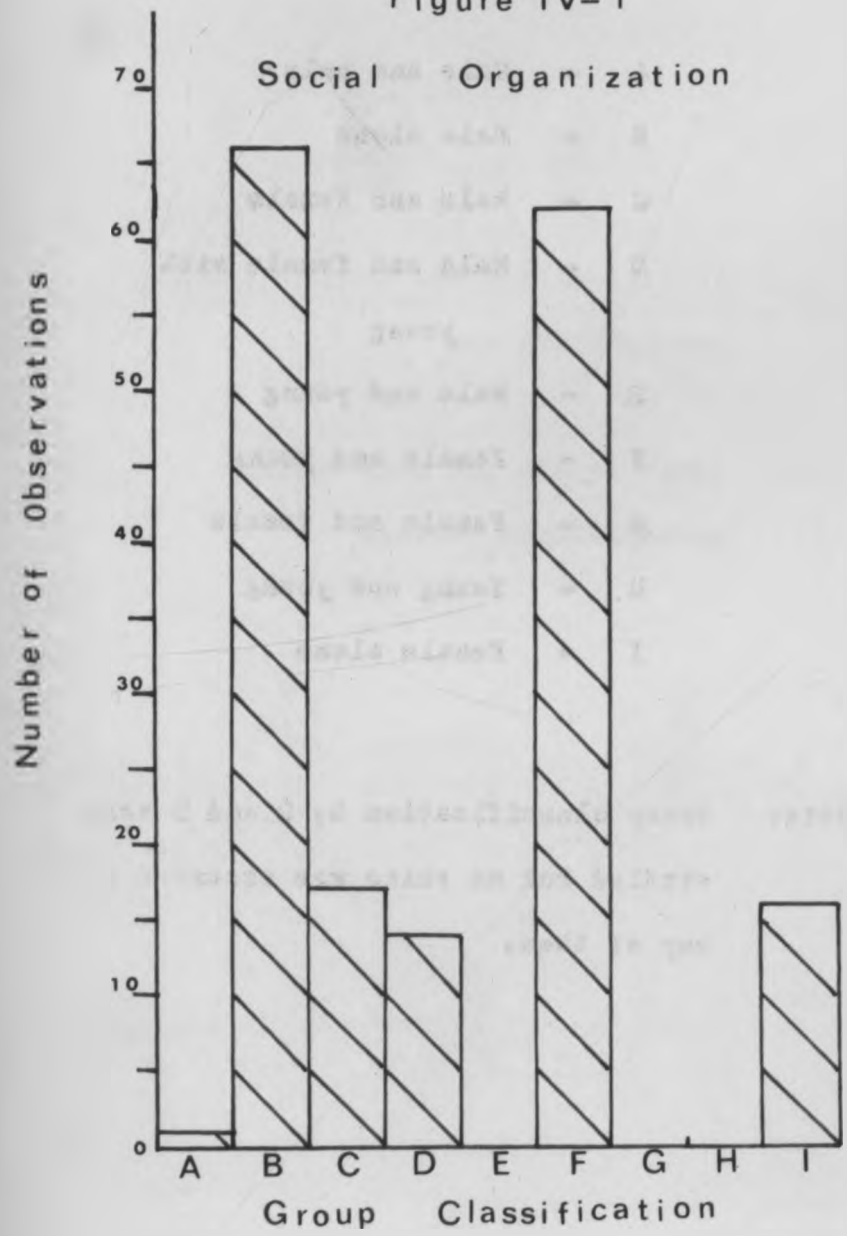
G - Female and female

H - Young and young

I - Female alone

Note: Group classification E, G and H were studied but no rhino was observed in any of them.

Figure IV-1


Social Organization
Number of Observations
70
60
50
40
30
20
10
0
A
B
C
D
E
F
G
H
I
Group Classification

Explanation

Plate IV - 1a and b

(a) Adult female rhino without a calf accompanying it.

(b) Adult female and male during precopulation period.

a

b

Explanation

Plate IV - 1c and d

(c) A sub-adult rhino which has left the mother.

(d) A male rhino accompanied by the calf.

c

d

Explanation

Plate IV - 1e and f

(e) Three adult rhinos together.

(f) One female without a calf in company of another female accompanied by its younger calf, and its sub-adult male calf.

e

f

Chapter V

FEEDING AND DRINKING

Feeding and drinking habits for the Mara rhino population were studied through direct observation on feeding or drinking rhinos. Goddard (1970) used the same method in his study of food preferences of black rhino in Tsavo National Park.

In my study area, a total of 25 rhinos from different distribution areas were studied at different times of the day during the entire study period. These 25 rhinos were some of the entire Mara known rhinos living in the wilderness.

The study on feeding and drinking was done jointly with the observations on resting, running, standing, wallowing, mating and walking activities explained in a later chapter. The search for rhinos started at 0600 hours and continued throughout the day until 1900 hours. Night observations on feeding were not made due to the fact that driving within the reserve after 1900 hours was prohibited. Again it would have been difficult to locate the rhinos in the bush since they did not have permanent feeding grounds and even when observed during the day they were found feeding as well as walking. Night observations were made only for drinking habits.

On the course of searching for rhinos, if a feeding rhino was sighted from a distance, it was identified with the help of a pair of binoculars and then approached by a

Land-rover carefully. When the vehicle was about 200 m away from the rhino, the vehicle was stopped. The rhino identification was checked again and if correct, the data on the rhino's number and time located feeding were recorded. I then moved out of the vehicle and started looking for the rhino track. It was easy to locate the track when a rhino passed over tall grass because the grass was bent by rhino's legs towards the direction the rhino was heading. In places where the grass was low, rhino foot prints were looked for. When the track was identified a check for the fresh cut on the plant species by the feeding rhino was made covering a distance of 2 m on each side of the track. When the plant cut was located it was examined as to whether it was that hour's cut or a cut made at an earlier time. Fresh cuts were noted to be still wet and fallen leaves green after half an hour from the time the cut was made. Cuts over a period of an hour from the time when made on hot days were noted dry and if the doubt arose as to which animal species made the cut, the observation for that particular plant cut was ignored.

When the cut was identified as being made by a rhino, the vegetation cut was identified and if the plant could not be identified on the spot, a specimen was collected, tagged and then placed in a plastic bag. The specimens collected were later in the evening pressed and preserved for later identification by the East African Herbarium or by Simon Taiti who was making a vegetation survey in the

study area.

For each plant found cut by the rhino for food, data on its scientific name, height of remnant, height of uneaten plant of the same species within 30 cm from remnant, parts of the plant eaten, condition of remnant as to whether uprooted or not and the date of observation were recorded.

The observations on each individual rhino continued until the rhino changed to another activity. Any feeding activity observed for a period of over half an hour and either continued or followed by another activity was considered as a separate individual observation and data was recorded for feeding hours but where observation was less than half an hour, data were collected for the list of plants eaten by rhinos. Each separate branch of the same or different plant species found cut by a rhino along the rhino feeding track was considered as a separate observation which provided the plant species list. A similar pattern of observation was repeated each time a rhino was encountered feeding each day for the period from May 1971 to August 1972.

There was no equal time spent on each observation for each rhino. In some cases, observations were disturbed by other moving animals, red-billed oxpecker, Buphagus erythrorhynchus Stanley, or from the confussion and alarm produced by human scent which used to cause the rhino to run away. Wind direction, if it was against the rhino direction, used to minimize disturbance from me or

vehicle because the rhino was followed behind on foot. The longest period each rhino was observed feeding continuously was 4 hours. The results on feeding are explained below.

V - 1 Feeding Hours

A total of 253 observation of varying periods from half an hour to four hours on different individual rhinos in the entire reserve were recorded. It was noted that rhinos located in the early morning were found close to the watering places either walking or walking with little feeding activities. However, Joubert (1971) reported that rhinos are known to start feeding at 0600 hours or shortly after 0600 hours.

As observed, very few records were listed for rhinos found feeding between 0600 to 0700 hours. Serious feeding was usually observed to commence shortly after 0700 hours and continued up to around 1200 hours. 24.5% of the total observations were recorded between this period with a great number of observations between 0900 to around 1200 hours. This covers a large part of the morning when the sun is not very direct. Few observations were recorded between 1200 to 1400 hours. 3.9% of the total observations were recorded for the period between 1200 to 1400 hours.

Another serious feeding period was recorded between 1400 to 1900 hours. This represented 71.6% of the total observations.

Further, the results revealed that there are two

daily feeding peaks, one in the morning and the other in the afternoon. The afternoon feeding period is generally preceded by wallowing and resting activities as will be noted in the section under wallowing and resting explained in Chapter VI. Figure V - 1 shows the spread of the feeding peaks.

During the wet period some rhinos were observed to wallow before 1100 hours or continue feeding even during the period between 1200 to 1400 hours. Generally, rhinos can feed at any time of the day light and probably at night. Joubert (1971) pointed out that a captive black rhino in south-west Africa, rested most of hours from 2000 to 0500 hours with few feeding observations between 0100 to 0630 hours. Joubert (1971) also mentioned that the activities of the animal during the night was more or less comparable to its normal activities in nature; and the day light activities of the captured rhino corresponded with the day time activities in nature.

V - 2 Plant Species Fed On

Table V - 1 shows the list of food plants found eaten by the black rhinos in Mara throughout the study period. This represents over 70 plants species from 30 different families. Families Capparidaceae, Euphorbiaceae, Gramineae, Labiatae, Malvaceae, Mimosaceae, and Papilionaceae are fairly well represented and each of them has four or more plant species used.

The observed plants eaten were grouped into three

one covered period from May to September 1971 when most of the vegetation was green. Generally, this is the period prior to burning of vegetation and it also represented the vegetation growing during the wet period. The list of plants used during the wet period is shown on Table V - 1.

Category two covered the period from October 1971 to the end of January 1972 when most burning was observed. Normally the period from October to January is dry although some rain fell during the month of December. Table V - 1 shows the list of plants eaten during this period.

Category three covered the period from February to May 1972, the period in which regeneration on vegetation previously burnt was observed. In addition this is another wet period in which regenerating vegetation is fairly low in height. Table V - 1 shows the list of plants used for the period from February to May.

V - 3 Food Preference

For each of the three previously mentioned categories food preferences were determined. It involved the number of individual plant species observed used during the entire period of each category.

During the period from May to September 1971 black rhinos were found to use a fairly large proportion of the species identified and listed on Table V - 1. This is

simply because a variety of palatable herbs and shrubs are readily available. However, rhinos were frequently observed feeding on Solanum incanum, Acacia hockii, Maerua edulis and Dichrostachys cinerea. Grasses were observed not cut separately but cut together with the selected herbs or shrubs in one rhino's bite. Table V - 1 shows food preference for this period.

During the dry period, green herbs were not readily available since they were dried up or they were destroyed by fire. Plant species in the families Mimosaceae, Tiliaceae, Solanaceae and Simarubaceae were frequently used, with a preference for Acacia species, Grewia species, Solanum incanum and Balanites aegyptica. Plant species in the families Mimosaceae, Tiliaceae and Simarubaceae found in Mara are fire resistant and two weeks after burning new leaves were observed growing on these plant species thus providing fresh food. It was also observed that most of the plant species which were not seriously destroyed by fire on open grassland were over a metre higher than the grass height. Table V - 1 shows food preference for period between October and February.

During February to May 1972, most of plants species had regenerated or were regenerating in all burnt areas. This period again offered a wide variety of food plants. Preferences were noted for Solanum incanum, Dichrostachys cinerea, Maerua edulis, Grewia species, Acacia species and Ormocarpum trichocarpum. Food preference for this period is shown on Table V - 1.

Results also indicated that there are plants species which were used throughout the year. These were mainly Acacia species, Dichrostachys cinerea, Ormocarpum trichocarpum, Solanum incanum and Maerua edulis.

V - 4 Parts Of Plants Eaten

Goddard (1970) noted that in Tsavo black rhinos ate tips of shoots, stems, leaves and inflorescence more than they ate inflorescence only, leaves only or stems only. In Mara, a similar pattern was observed. Rhinos ate stems, leaves, inflorescence and tips of shoot.

It was observed that most of the plants cut, the cut was made below the clump of branches with leaves and inflorescences for the herbs. However, in some plants, cuts were observed on single branches while other braches on the main stem were not cut. Also remnants of main stem of Solanum incanum were observed indicating that branches on the main stem were eaten by rhinos. In some cases, leafless main stems of Solanum incanum were found uprooted and branches with leaves eaten.

Measurements were taken from the ground level for the remnants of the plants and the total uneaten parts of the same plant species close to the remnants. An estimate of the portion of plant eaten was obtained and the results shown on Table V - 2. The result shows that the portion of plant eaten range from 7 to 26 cm. In some instances total uneaten plants could not be located close to the remnants hence their measurements were

ignored. In addition, some parts of plants cut may not have been swallowed creating doubt on the portion eaten of the plant cut off. Thus the measurement shown on the Table V - 2 were considered rather general. Plate V - 1 shows rhinos feeding habits including the conditions of plants cut or not cut by rhinos.

V - 5 Influence On Browsing of Vegetation

Temporary and permanent changes on habitat has much influence on browsing of vegetation. As has been mentioned earlier, it is traditional for Masai people to burn areas where domesticated and wild animals live to encourage grazing for animals. This burning occurs annually. However, vegetation which is fire sensitive is kept at minimal height. As for the plants which are fire-tolerant, they finally, after prolonged period of repeated burning die away hence changing the habitat to grassland. Here it should be remembered that it is not only the fire alone which can cause these changes for there are other factors such as elephant damage and overgrazing. There appears to be a trend in this change in Masai Mara area. As a result an animal like black rhino is left to browse on herbs, shrubs and bushes which are less than 2 m high within open grassland.

As observed, rhinos were found to feed on regenerating vegetation. The vegetation was cut off and leafless remnants left standing or completely uprooted. The remnants start regenerating but within a year fire damage

on regenerating vegetation is observed. This burning cycle indirectly forces rhinos to browse mainly on regenerating vegetation and by doing so reduces the rate of plant growth.

However, the rate of browsing of vegetation by rhino is affected by the rhino's other daily activities. During the wet periods black rhinos spend a reasonable portion of the day wallowing rather than walking and feeding or resting in the bush. This also appears to be the case during the hottest part of the day when rhinos take to resting earlier in the day because of heat.

From the above mentioned information, it may therefore be deduced that rhino do play a role in the management of vegetation as also suggested by Frazer Darling (1960).

V - 6 Competition With Other Animals

The only other residents browsers in the study area are giraffe, impala, Grant's gazelle, eland, Thomson's gazelle and elephants. However, as mentioned by Joubert (1971), impala, topi and waterbuck normally feed on or do not feed on the same main food plants of the rhino, and if they do it would only be the leaves and extreme tips of the branches. Giraffe, rhino and elephants to an extent feed on the same plant species but at different levels and could therefore utilize plants without any competition. Black rhino has been observed feeding on lower parts of *Acacia hockii* which has been browsed by giraffe on many instances. Also black rhino was noted

feeding on plants pulled down by elephants.

Mitchell (1966) found that in two habitats in Zambia, viz. plateau and valley, the rhino was able to hold its own amongst heavy ungulate concentration simply because elephants and other large mammals do not utilize rhino food plants to any great extent.

In the study area an elephant and giraffe aerial count was carried out together with rhino aerial count and the results indicated an estimate of 85.1 ± 73.7 and 563.5 ± 376.7 elephants in sample areas I and II respectively; and 351.8 ± 115.3 and 242.2 ± 138.3 giraffe in sample areas I and II respectively at 95% confidence limit. No count was made in Triangle area because of shortage of time. Darling (1960) reported that during his study period there were 750 giraffe, 500 elephants, 5,000 impala, 4,000 topi and 500 waterbucks.

During my study, few elephants were observed to be residents of Mara. During rainy period, elephants were observed to pass through the reserve from Mara-Sand rivers area to destinations outside the reserve boundary towards Aitong area. The number of giraffes estimated are residents of the Mara Game Reserve and their presence gave no threat to the rhino population.

V - 7 Significance Of Rhino's Pattern Of Food Selection

Generally, rhino's pattern of food selection may be mainly determined by (a) habitat and (b) availability and abundance of food selected. In Chapter II habitat and food

availability were discussed and their results together with the results of food habits previously discussed in this chapter were used to provide information on pattern of food selected.

(a) Habitat

Black rhinos in Mara were observed eating about 70 species from 30 botanical families. Rhinos were observed to be strongly selective for herbs and shrubs.

In all habitat types studied, rhinos were predominantly "ground" feeders, concentrating on relatively small herb and shrubs. About 90% of total observations were recorded on open grassland and scrub with scattered trees habitats. These two types of habitats as compared to riverine bush, bushes on slopes of hills and forests carry more of the palatable, regenerating herbs and shrubs. Only about 10% of the observations made on rhino feeding within riverine bushes and bushes on slopes of hills. No observations were made on rhinos feeding in the forests. These observations reveals a marked tendency for rhinos in Mara to feed on open areas rather than in bushes or forests.

As observed, during the wet periods rhinos were found to feed close to the areas they were observed wallowing. These were mainly on less sloping open grassland and scrub with scattered trees habitats. Even during the dry periods when rhinos were observed wallowing in waterpans along riverine bushes, they were found to

leave bushes for more open areas to feed.

(b) Availability And Abundance Of Food Plants

Pattern of food selection for some plants is related to their availability and abundance of food plants. As can be noted on Table V - 3, Solanum incanum, Acacia hockii, Dichrostachys cinerea and Maerua edulis had a high percentage in their relative density and relative frequency for both open grassland and scrub with scattered trees habitat, in most distribution areas. However, Acacia drepanolobium, and Croton dichogamus showed a lower percentage of relative density and relative frequency.

In considering food preferences (Table V - 1) plant species which had a high percentage of relative density and relative frequency were highly selected by rhinos. A similar degree of selection was also noted on Acacia drepanolobium and Croton dichogamus despite their low percentage.

Also there are some plants which were not sampled during the time when studies on food availability were carried out. These plants were not merely ignored but they were not close to the sampling points. This indicated that their relative density and relative frequency were very low, although found eaten by rhinos. Similarly plants with very low relative density and relative frequency were less selected.

In general rhinos were observed to select a wide variety from the spectrum of plants available. On many

occasions, I observed rhinos feeding through a homogeneous herb patch, and selecting only certain specimens of the same plant species. These plant species were mainly Solanum incanum, Acacia hockii, Dichrostachys cinerea and Maerua edulis. Rhinos were mainly observed to select only the green plants and this behaviour is particularly noticeable during the wet periods. However, during the dry period and particularly in the process of burning, rhinos were observed feeding on semi-dry branches of Acacia hockii. Apparently rhino can detect which individuals of plant species have a nutritive value. Grass is eaten, predominantly with selected plant during the wet periods, but it constitutes a relatively small proportion of the diet and is usually rejected.

Burning did not appear to have any marked unfavourable effect on the habitat of the rhino. During the burning period, some rhinos had their home ranges completely burnt but rhinos did not leave the area, but continued to browse on the charred shrubs without obvious adverse effect. The regeneration of Acacia and Commiphora species which was stimulated in some areas, favoured the rhinos.

V - 8 Salt Licks

Two salt licking places were noted in distribution area A. Rhinos, as well as other animal species particularly topi were observed frequently visiting the salt lick for salt. Rhinos, on few occasions were

observed during the day time licking salt. However, rhino foot prints were checked in the evenings as well as the following mornings to find out whether rhinos visited salt lick holes. Previous rhino foot prints were destroyed by sweeping the ground each day the hole was visited. It was found out that rhinos visited the holes at night more frequently than they did in the day. This may be probably due to the fact that these holes were each about 1 km from the streams where rhinos used to take water.

To determine minerals in these salt holes, samples were collected using the same technique applied for soil samples and taken to Kabete Soil Laboratory for analysis. The results showed presence of Sodium, Magnesium, Potassium and Calcium as indicated on Table V - 4.

V - 9 Drinking Habits

The drinking habits of the rhino vary from locality to locality and from season to season. Each individual in each home range is well acquainted with the locality of drinking places within its home range.

In Mara, rhinos were observed drinking from sunset or just after the sunset. Observations on rhinos drinking permanently from Mara and Sand rivers were not observed because of thickets along the rivers which could not be penetrated on foot during the hours of darkness. However, rhinos using water hole or dam in distribution area B were observed. These drinking places were close to my camp and

also were situated on areas void of thickets.

The rhinos were waited for near the dam or water hole from 1730 to 2100 hours and sometimes to 2200 hours four times a week from October to end of November 1971 and from February to end of March 1972. The observations were alternated between the two holes each having two nights of observations each week. Each time an animal was heard drinking it was spotted with the help of spotlight during the absence of moonlight but in the presence of moonlight the spotlight was not used. Records were only made for rhinos alone.

It was observed that there is a preference for rhinos drinking at night, as there was no drinking observed between 0600 and 1800 hours. Rhinos were observed to drink usually between 1800 to 2100 hours, but there is no reason to suggest that rhinos cannot drink at any other time of the night since observations were not made throughout the night. Results on drinking are shown on Table V - 5.

During the time of taking water, a rhino takes time for the process may last from 20 to 30 minutes with frequent intervals. After drinking, rhinos were observed to walk away from the dam or water hole slowly but if disturbed it used to stay longer trying to find out the source of disturbance. If the source of disturbance could not be located the rhino walked to the nearby bush or wandered around. In some cases, some of these rhinos were found about 1 km from the dam or hole

on the following morning walking away to their normal feeding and resting areas. This indicated that they spent the night near the water hole or dam. Similar locations on other rhinos not drinking from the two studied drinking places were observed and this could suggest that they were drinking at the same hours as the rhinos studied or at hours from midnight to 0600 hours.

During the wet periods, rhinos were not frequently observed drinking from the water hole or dam and it was assumed that they depended mostly on water from waterpans within the home ranges. But during the dry period, when most of the streams and waterpans were dry they depended mainly on the dam and the water hole.

Drinking places were communal for herds of buffalos, elephants and group of lions were seen drinking from the same water hole or dam.

Table V - 1

ood Plants Eaten By The Black

Masai Mara Game Reserve

od from May to mber 1971			Period from October 1971 to February 1972			Period from February to May 1972		
ts	No. eaten	% of total	Plants eaten	No. eaten	% of total	Plants eaten	No. eaten	% of total
	8	0.32				x	7	0.42
	5	0.20						
						x	5	0.30
	3	0.12				x	10	0.60
	7	0.28						
	27	1.08				x	21	1.26
			x	25	1.75			
	45	1.80	x	45	3.15	x	35	2.10
	70	2.80				x	65	3.90
	55	2.20	x	35	2.45	x	45	2.70
	10	0.44				x	5	0.30
			x	18	1.26	x	29	1.74
	180	7.20	x	91	6.36	x	120	7.20
	15	0.60				x	15	0.90

riod from May to ptember 1971			Period from October 1971 to February 1972			Period from February to May 1972		
ants ten	No. eaten	% of total	Plants eaten	No. eaten	% of total	Plants eaten	No. eaten	% of total
			x	2	0.14			
x	35	1.40						
x	9	0.36				x	31	1.86
x	32	1.28	x	14	0.98	x	20	1.20
x	11	0.44						
						x	8	0.48
x	7	0.28				x	48	2.88
x	18	0.72						
x	98	3.92	x	137	9.59	x	80	4.80
			x	10	0.70			
x	14	0.56						
						x	13	0.78
						x	17	1.02
						x	7	0.42
x	42	1.68						
x	33	1.32						
x	8	0.32	x	6	0.42			
x	25	1.00				x	15	0.90

Period from May to September 1971			Period from October 1971 to February 1972			Period from February to May 1972		
Plants eaten	No. eaten	% of total	Plants eaten	No. eaten	% of total	Plants eaten	No. eaten	% of total
x	17	0.68	x	15	1.05			
						x	18	1.08
x	15	0.60				x	3	0.18
						x	10	0.60
x	80	3.20	x	12	0.84			
x	2	0.08				x	11	0.66
						x	2	0.12
			x	2	0.14			
						x	2	0.12
x	3	0.12						
x	5	0.20						
x	172	6.88	x	29	2.03	x	50	0.24
x	14	0.56	x	78	5.46			
x	35	1.40				x	19	1.14
x	355	13.40	x	157	10.99	x	178	10.68
						x	31	1.86
			x	37	2.59			
						x	15	0.90
x	259	10.36	x	238	16.66	x	167	10.02
x	11	0.44	x	15	1.05	x	13	0.78
						x	8	0.48
x	3	0.12						
x	5	0.20						

Period from May to September 1971			Period from October 1971 to February 1972			Period from February to May 1972		
Plants eaten	No. eaten	% of total	Plants eaten	No. eaten	% of total	Plants eaten	No. eaten	% of tota
x	9	0.36						
x	12	0.48	x	10	0.70			
x	75	3.00	x	22	1.54	x	37	2.22
x	28	1.12	x	16	1.12	x	98	5.88
x	43	1.72				x	23	1.38
x	3	0.12						
x	35	1.40	x	122	8.54			
x	450	18.00	x	102	7.14	x	274	16.44
x	5	0.20						
			x	7	0.49			
						x	45	2.70
x	70	2.80	x	205	4.35	x	75	4.50
x	52	2.08				x	70	4.20
						x	9	0.54
						x	11	0.66

Table V - 2

Record Of Parts And Height Of Remnant In Comparison To Uneaten Plants

Plant	Sample size (plants)	Part eaten	Height of remnant in cm. (mean)	Height of uneaten in cm. (mean)	Portion eaten in cm. (mean)
Dichrostachys cinerea	405	S	22	48	26
Commelina sp.	66	S	13	29	16
Ormocarpum sp.	142	J	15	30	16
Orthosiphon parvifolius	92	J	6	11	7
Acacia senegal	31	S	12	20	8
Maerua edulis	391	J	33	23	10
Acacia hockii	670	S, J	20	38	18
Solanum incanum	626	S, J	21	40	19
Acacia drepanolobium	92	J	17	28	11
Acacia brevispica	201	J	40	27	13
Balanites aegyptiaca	157	J	20	30	10
Commiphora sp.	235	S	18	28	10

J = Leaves, stems, and inflorescence

S = Stems and leaves of tips of shoots

able V - 3

plant food sampling

	D		E		G		H		I		J		K	
% R.F	% R.D	% R.F	% R.D	% R.F	% R.D	% R.F	% R.D	% R.F	% R.D	% R.F	% R.D	% R.F	% R.D	% R.F
46.66	23.75	45.00	13.86	13.62	27.86	20.00	31.54	29.40	31.66	66.66	25.00	23.80	22.50	50.00
20.00	15.00	40.00	18.34	13.72	10.18	22.22	7.50	8.32	17.50	40.00	25.00	23.04	25.00	52.21
13.33	2.50	10.00	5.04	6.81	7.59	7.50	9.96	14.70	10.00	33.33	21.25	16.66	19.50	32.00
30.00	2.50	10.00	3.93	5.88	10.18	22.22	10.00	16.64	11.25	30.00	5.00	7.68	7.50	15.00
	15.00	30.00	5.04	4.54	6.32	7.50	23.24	14.70	21.66	33.33	12.50	14.28	12.50	28.90
10.00			14.41	11.76	6.48	18.52	35.00	12.48	6.25	40.00	12.50	7.68	12.50	28.90
	18.75	40.00	45.36	36.32	2.52	5.00	18.26	23.52	18.33	53.33			2.50	7.95
	20.00	50.00			0.92	3.70	10.00	16.64	7.50	20.00			3.80	5.25
73.30							1.66	2.94						
			1.31	1.96										
6.66	2.50	10.00	3.93	5.88							19.50	22.59	22.50	41.19
	6.25	15.00	15.72	17.64					3.75	15.00	1.25 22.50	2.38 19.20	15.13	29.77
26.66	5.00	20.00	2.62	3.92					1.66	6.66	1.25 7.50	2.38 7.68		
	7.50	20.00	9.17	7.84	2.77	7.40			5.00	15.00	2.50	3.84	2.50	6.62
10.00	7.50	15.00	15.12	22.00	20.25 30.55	15.00 55.55	8.40	6.12	8.75	14.33	22.50 7.50	21.42 11.52	7.50	17.18

density. a = Transect run on open grassland.

frequency. b = Transect run on wooded grassland.

Table V - 4

Results Of Chemical Test Of Salt Holes

Soil samples	A_1 SAL.	A_2 SAL.
pH - H_2O	7.2	7.4
pH - KCL	5.5	6.0
E.C. (mmhos/cm^2)	0.09	1.6
Ca (m.e. %)	11.2	7.0
Mg "	2.9	3.2
K "	0.5	1.0
Na "	1.4	8.8

Abbreviations

E.C. = Electrical Conductivity.

(mmhos/cm^2) = Millimhos.

m.e. % = Milliequivalent percentage.

A_1 SAL. = Salt lick place 1.

A_2 SAL. = Salt lick place 2.

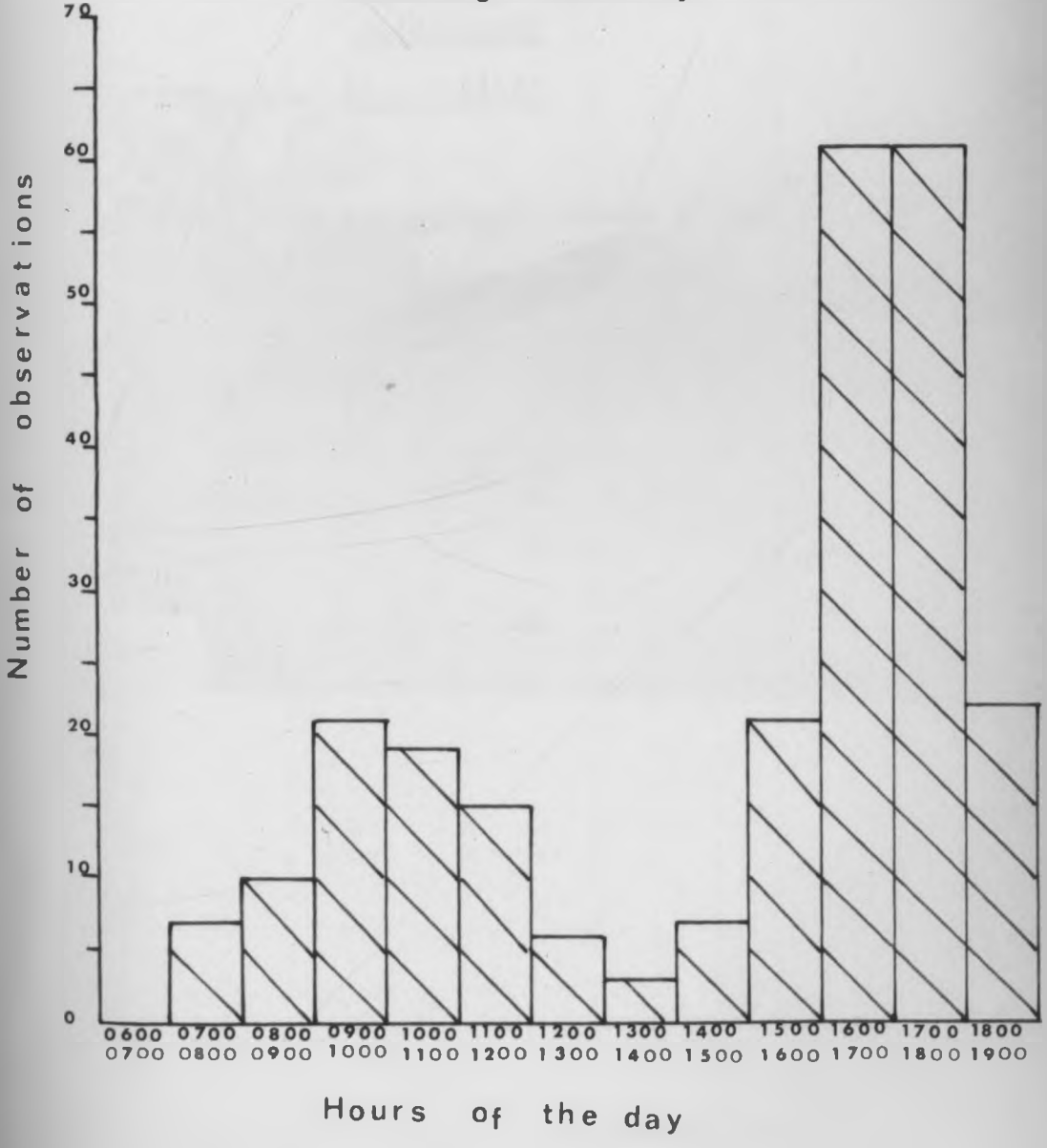
Table V - 5

Record Of Rhino Drinking Hours

Months	Period	Number of observations									
		Dam					Water hole				
		1700 to 1800	1800 to 1900	1900 to 2000	2000 to 2100	2100 to 2200	1700 to 1800	1800 to 1900	1900 to 2000	2000 to 2100	2100 to 2200
October 1971	Dry		2	2	2	1		1	2	3	
November 1971	Dry		1	3	3			2	3	2	
February 1972	Wet		1	1	2			1	2		
March 1972	Wet			2				2	1	1	
Total			4	8	7	1		6	8	6	

Figure V-1

Feeding Activity



Explanation

Plate V - 1a

(a) A branch of an *Acacia* tree pulled down by an elephant and later browsed by a rhino.

a

Explanation

Plate V - 1b and c

(b) *Solanum incanum* which has not been browsed by a rhino.

(c) *Solanum incanum* remnants after being browsed by a rhino.
((b) above was just next to (c)).

b

c

Explanation

Plate V - 1d

(d) An *Acacia hockii* branch cut off by a rhino and another not cut.


d

Explanation

Plate V - 1e

(e) A browsed condition on an *Acacia* tree.

e

Explanation

Plate V - 1f and g

(f) Rhino browsing on an *Acacia* bush about 2 metres high.

(g) Rhino browsing on *Solanum incanum* which is about 30 centmetres above the ground.

f

g

Chapter VI

OTHER ACTIVITIES

Apart from feeding and drinking there are other major activities which are carried out by rhinos either daily or less frequently. These are wallowing and rubbing, resting, defecation and urination, and mating. Direct observations were made on these activities when rhinos were encountered but in case of sharing dung piles an experiment was conducted.

VI - 1 Mating

Ritchie (1963) stated that mating takes place at any time of the year but a great number of females come in season between September and November whose conformity was unusual. Goddard (1966) collected data in Ngorongoro Crater which tend to support Ritchie's statement.

As observed, rhinos in Mara were found to mate during the period between September and April. This is normally the hot period of the year. No observation of mating was made during the other period of the year. Information reported here were observed on rhinos 3, 13, 7, 10, 16 and 78 as shown on Table VI - 1.

In general there was no degree of awareness of mating for each of the three pairs studied until the time when male in each pair was encountered attempting to mount or in the course of other studies was observed mounting. However, prior to copulation both male and female were

found feeding together or one of them was previously seen in the other's home range. Rhinos in each pairs had adjacent home ranges. On 21st September 1971, at around 1830 hours female No. 13 was encountered just, by the road from Keekorok to Triangle heading towards Sand river. This rhino was already in male No. 3's home range. I followed behind it slowly and finally it entered the bush near the place where male No. 3 was generally observed feeding. However, on the following day at 1300 hours both rhinos were encountered near the place where female No. 13 was encountered on previous evening. On the first glance male No. 3 was observed to have mounted female No. 13. I approached them but before I could get to about 200 m, male No. 3 caught our smell or heard the noise of my vehicle and all at once it dismounted. They both looked to our direction at the same time turning the ears to various direction. This behaviour of looking and turning ears lasted for about 15 minutes then both of them started feeding and wandering around at the same time. Female rhino was observed to be ahead of male rhino at times. They had not fed for long when male rhino was observed feeding too close to female rhino. They both stopped but female first being infront of male rhino. The male sniffed the vulva while female remained standing. In about one to two minutes of sniffing the male lifted the head and rested it on the female's rump. The male, then lifted the front legs and tried to mount. Male's front feet were placed on female's shoulder and

after less than three minutes of mounting male rhino dismounted. Both were observed to be silent when male rhino had mounted. After dismounting both of them started feeding and wandering again. They were always both close to each other. They fed and wandered for about thirty minutes and finally observed feeding heading to each other. When they were about 2 m apart they both stopped, female first, looked at each other and then female turned and started feeding again. Male rhino followed it feeding slowly and when female rhino stopped male rhino came close behind it, stopped and then sniffed the vulva and after sniffing lifted the head and rested it on the female's rump followed by lifting of male's front legs and tried to mount but female tried to walk away and male dismounted. The same pattern of feeding and wandering and then mounting was repeated three times but no copulation was achieved in any of them. After the last attempt both rhinos fed as they walked. They walked for a distance of 500 m and entered into a thinly wooded bush. I followed them and stopped at about 20 m from them. With the help of a pair of binoculars I observed the male rhino to sniff the vulva and then rested the head on the female's rump then followed by lifting of front legs whose feet finally rested on females shoulder. The male was observed to thrust forward twice, then rested its chin on female's shoulder. The female had its head lowered. The tail of the male was held down and in a short time the female

made a low-pitched squeal. This noise, I suppose indicated that coitus was achieved.

The coitus took about a minute but after coitus the male remained mounting but the female started walking hence the male dismounted. Female rhino walked away first while male rhino remained standing. After two minutes of standing male rhino followed the female rhino and both walked without feeding to a distance of 1 km and then entered into the bush. Copulation patterns are shown on Plate VI - 1. The entire observation was made for two hours but it was observed that five minutes lasted from the time when male rhino mounted female, coitus achieved and them male dismounted.

Similar observations were made on male No. 7 and female 10 on 18th October, 1971; and also on rhinos 16 and 78 on 24th March, 1972. The pattern is the same except that the number of attempted mounting vary but at least more than two. With the three different pairs observed there were more than two attempts made by male to mount female before the final successive attempt.

Spinage (1962) expressed the opinion that a male rhino may remain in presence of a female after mating. However, the studied male and female rhinos for each pair in Mara were observed to associate with each other before and after copulation. Two weeks before found mating male No. 3 and female No. 13 were seen twice at different days feeding together within male No. 3 home range. After

mating, they were occasionally found together feeding but in most instances male No. 3 was located alone up to the end of January 1972 when they were observed individually each in its home range.

In case of male No. 7 and female No. 10 they were seen together once in June 1971. In a number of observations between June and September 1971 male No. 7 was encountered feeding together with female No. 8 accompanied by its young. However, between the end of September and the day of mating (18th October, 1971) male No. 3 and female No. 10 were encountered feeding together on four different occasions. After mating both were occasionally met together and some times singly feeding up to May 1972. During the same period, sometimes male No. 7 was also observed again in company of female No. 8 and its young. Similar observations were made on male No. 78 and female No. 16.

As stated by Goddard (1966) the mating bond is governed by the size of the home range of the male, which, the female in oestrus uses. In case of male No. 7 and female No. 10, female used 80.4% of male No. 7 home range. This was also true for the other two pairs although studies on home range was not done for all of them.

VI - 2 Wallowing and Rubbing

Studies on wallowing were made through direct observation on wallowing rhinos. Each time a rhino

was encountered wallowing on different days and different hours was recorded as an observation. The study on wallowing and rubbing was studied throughout the study period.

The results on wallowing indicated that rhino wallow at any time between 0900 to 1600 hours. There were no observations recorded on wallowing before 0900 hours and after 1600 hours which are the periods they were observed mostly feeding. Most of the observations on wallowing were recorded between 1200 and 1600 hours and a few between 0900 to 1100 hours. Table VI - 2 shows the record of observations monthly and hourly, and Figure VI - 1 shows total wallowing activities per hour of the day. During the wet periods, rhinos were frequently found wallowing as compared with the dry periods. On wet periods wallowing was observed in holes within their home ranges and particularly the ones in rhino's feeding grounds. During the dry periods rhinos were observed wallowing in marshes or in the waterpans along the streams.

The wallowing animal smears itself with mud on both sides of its body by either resting on mud or by rolling over mud such that the whole body including the face is smeared with mud. Plate VI - 2 shows rhinos immediately after wallowing. As has been mentioned by Goddard (1967) this is a method of cooling, and disposes of excess heat accumulated in the body during the day. However, I assume that during the wet periods mud looses heat very

slowly and wallowing animal uses it for warming effect. During the hot days mud get heated very slowly and rhinos uses it for cooling effect.

After wallowing rhinos were usually observed rubbing their bodies against a tree or a termite hill. The rubbing animal leans against a tree or termite hill and rubs its body by a forward and backward movement of the body. To rub in between the hind legs a rhino was observed to place a branch of a tree between the hind legs and by slightly lifting one of the hind legs it performed a forward and backward movement hence rubbing the body against the branch.

VI - 3 Defecation And Urination

As it has been mentioned by Schenkel (1969), the black rhino does not drop its dung indiscriminately, but it maintains "lavatories" within its home range. This is also true for the Mara rhino population. It was observed that special dung places occur frequently along tracks particularly the tracks used by the animals going to drink water or on their frequent movement from one area of the home range to another.

Most piles were observed to be next to a small tree or bush as shown on Plate VI - 3. However in some cases dung piles were found in areas where there was no tree, bush or any other obstacle. The defecating rhino faces away from the dung pile with its back near the tree or bush, stretches the body backward such that the hind legs

are in a forward position and front legs in a backward position (Plate VI - 4), lifts the tail and then defecates and scrapes dung as they land on the ground with both hind legs alternately. Scraping results in breaking up and spreading out the fresh dung balls. While scraping two shallow ditches are dug into the dung and even into the soil underneath. In some cases the tree or bush was observed damaged by being knocked down. After defecating the rhino leaves the place immediately.

Over 90% of the observations showed that dung were scraped particularly the ones dropped by rhinos over one year old. It was observed that rhinos under one year sometimes attempted to scrape dung though no dung balls were broken, but in most cases they just merely dropped the dung balls with no scraping.

In some instances, when rhinos were disturbed or excited by a moving vehicle or other animals they were observed to defecate. On several occasions I had to chase rhino to try to get a better picture. However, when they got to the bush they were observed to defecate shortly. At the time of defecation they were also observed to look eargerly on the direction of disturbance. Similar observations were also made when I approached a rhino but at a distance heard the noise of the vehicle but could not locate the vehicle. The rhino became excited, moved towards the source of noise and then back again. When the disturbance was prolonged without

rhino located the source, they were observed to defecate or urinate. The defecation is made on a fresh ground which has not been defecated before and the scraping is more emphasized.

The function of scraping together with the normal defecation needs more investigation. This appears to be a natural behaviour for all rhinos. Obviously the case of a domesticated cat Felis domestica L. is known to us, where a cat digs a hole drops the waste and then covers it with soil and in case where it does not dig a hole, it tends to push some objects to the waste by using legs. On the other hand the scraping of fresh dung leaves a trail of scent traces along the track it follows, since it rubs its hind legs in its own fresh dung and the soles are covered with smelly substances which are on each footprint while the rhino is moving.

However, there is no way to consider this scent traces as a sign of territorial marking, as it is in many scent - marking mammals especially in territorial species.

An experiment was conducted to determine whether dung piles are shared. This involved collecting fresh dung from dung piles of known rhinos and placing it in another dung pile of another known rhino in a different distribution area. Fresh dung were placed in the evening and checked on following day for more fresh dung. To confirm new deposition of dung pile a mark was made on translocated dung and new deposition on the mark made

indicated that a rhino had defecated on pile. Also the nature of the dung pile prior to placing the translocated dung was recorded. Dung dropped at night were still found wet on the following morning. Table VI - 3 shows the result of sharing dung piles. It was observed that over 50% of the dung removed from a dung pile of another individual in another distribution area had fresh dropping on them. It was also noted that some individuals defecated on their own dung piles where dung from another individual was not placed. There was no degree of selectivity as to sex.

The deposition of fresh dung depended on how frequently the rhino used the track along which the dung was placed. The tracks leading to the watering places were before investigated and they were found to have frequent deposition of the dung, hence they were selected to be more suitable for this investigation. The chance of another rhino using the same track and probably using the dung pile cannot be ignored.

Generally, during observations on other studies it was noted that a female accompanied by a calf used the same dung pile sometimes, probably due to the fact that they are always together.

There are no localized urinals for the rhinos as it is with defecations. Rhinos were observed to urinate at any vegetation particularly when feeding. However, when a rhino was followed behind its usual route it was noted sometimes to aim the urine at a bush or a shrub. As

observed with defecation when some of the rhinos were disturbed or excited by a moving object which they could not locate at once they were observed to urinate.

Schenkel (1969) mentioned that when urinating, males stand motionless and release a continous slightly pulsating stream of urine downwards and backwards on to the soil. The female releases urine in a continous vertical stream without pressure which is "interrupted" and "pulsating" towards the end of the process. I noted that when disturbed, male rhino ejected one to seven bursts of urine horizontally backwards. As for female a single squirt containing a small quantity of urine is ejected.

On three occasions an adult male was observed sniffing on urine ejected by an adult female rhino. After sniffing, it lifted the head up and performed 'Flehmen' behaviour by opening the mouth slightly and folding the lips towards outward with a slight puffing of the nose. This behaviour is common with mammals particularly prior to copulation.

VI - 4 Walking And Running

"Movement is one of the chief means by which the higher animals maintain themselves within the fairly wide limits of ecological normality" (Darling 1936). It was observed that with the black rhino, movement is primarily induced by bodily requirements for example the need to feed and or to quench a thirst or it may be induced by any

disturbance. Rhinos under normal conditions particularly, when feeding, walk around looking for palatable vegetation. When heading to water rhinos walk directly to the water hole, dam or river as the case may be without interrupting the walk by feeding.

A disturbance or an alarm can cause a rhino to run at a high speed. Rhinos were followed in the course of taking pictures but the moment they started running they could go at a speed of over 60 km/h. When they are running they tend to gallop. The tail is held straight backward, lifted up or coiled and lifted up. Female with a calf run close to each other, either the calf to the side of the mother or following behind close to the mother. The calves almost run at the same speed as mothers.

VI - 5 Resting

Goddard (1967) pointed out that the absence of shade does not appear to affect the black rhino adversely for they were observed lying close to shade in extremely hot sun. However, the animal show a marked preference for sleeping in sand or dust depressions. Most frequently, in Mara, rhinos were found lying down under a tree shade or resting while standing next to a tree which provided shade. Only on few occasions were the rhinos found resting in a shadeless place during a hot day. Plate VI - 5 show rhinos resting under the shade and on shadeless place.

Resting rhinos usually lie upright on their sternum

with their front legs folded backwards and the hind legs stretched forward. The lower jaw rests on the ground. Frequently they can be seen flapping the ears or turning them side to side or forward and backward.

At regular intervals they normally stand up to relieve the cramped posture of sternal recumbency.

Resting of the rhinos can be observed at any time from 0800 to 1700 hours with more observations between 1200 hours and 1530 hours. Generally, between 1200 to 1530 hours, if a rhino was not wallowing or feeding it was resting. Figure VI - 2 shows observations on resting periods.

VI - 6 Aggression To Other Animals

Rhinos have been observed associating with buffalo, Syncerus caffer Sparrman; topi Damaliscus korrigum Ogilby; giraffe, Giraffa camelopardalis Linnaeus and lion Pathera leo Neumann. This was not a continuous association but as for buffalo it appeared to be more close and more frequent.

(a) Buffalo

Because of wallowing activities buffalos were found in close vicinity of rhinos. There were no signs of aggression observed from either species.

Rhino No. 64 on two occasions was found feeding within two metres off a buffalo. Both were aware of each other but the moment they heard the noise of the vehicle on each occasion, each ran in its own direction.

On the other hand rhino No. 16 was observed to be associated with a resident herd of buffalo for a period of over two months. It was sometimes spotted in the middle of buffalo herd and when the buffalos lay down to rest, the rhino remained feeding and walking.

Both species showed a considerably high degree of close association which never resulted in any incident of aggression.

(b) Topi

Topi is another animal species which was noted to associate with rhino. Observations were made on rhinos 8A and 8B, 23 and 43A and 43B. These rhinos were observed sometimes feeding on open grassland close to a group of topi. Each of these species appeared not to bother each other but on one occasion a group of topi was disturbed by a passing vehicle and topi ran towards rhino No. 23. The rhino spotted them and when they got close to it the rhino charged them hence diverted their movement to another direction.

(c) Lions

Lions were frequently found resting in areas where rhinos were resting or feeding. However, it was assumed that they were not aware of each others presence for each was noted at a distance from the other. Again lions in the area were noted to move a lot. Lions are rather more active during the night, the period which the rhinos are

less active offering less chances of activities which might bring them close to each other.

(d) Giraffe

Giraffe is another common species which was found feeding close to the rhino. On one occasion rhino No. 14 and No. 15 were observed driving away a group of four giraffes. The giraffe were walking towards the rhinos in an open area. When they were about ten metres from each other the rhinos ran towards the giraffes and all at once the giraffe retreated. The rhinos then stopped, looked at the giraffes, and then ran into the bush near by. On another occasion rhino No. 14 was noted driving away two giraffes in the same area described above.

VI - 7 Reaction To Strangers

In a very general way, all the reactions reveal that a rather small numbers of tendencies are involved in varying proportions. These tendencies are curiosity, fear, anger, and inertion. In attempt to investigate and avoid the stranger a rhino is forced to charge the stranger. Plate VI - 6 shows some of the steps followed by a rhino when charging a stranger.

My study work was mainly ground work and mostly being close to rhinos. However, only on four occasions my vehicle came as close as four metres at most from a rhino. Two of the occasions were not serious but two

of them would have resulted into an accident.

It was my system to check the direction of wind before I approached a rhino. Always I approached a rhino for pictures from front and also against the wind. However, wind sometimes changed the direction and the rhino heard the noise of my vehicle. The noise from the vehicle acted as a source of disturbance.

It was noted that when a disturbance occurred and the rhino could not detect source the rhino kept on turning ears from side to side and forward and backward. When the rhino senses the direction of the noise it walks towards that direction slowly with frequent stops and checking. The animal is curious to find out the object. When rhino gets about 35 m or less from the object the rhino can detect the object.

After detecting the object the rhino usually stops, looks at the object for about two minutes, walks forward, stops and then walks backwards and stops. This forward and backward movement is repeated about two to three times but in some cases there is no repetition particularly when a rhino decides to charge the stranger at once. This forward and backward movement is one way due to fear of the stranger because twice I hooted the vehicle at this stage and at each time the rhinos ran away.

However, next to forward and backward movement stage, the rhino walks slowly towards the object. The head is lowered and the rhino does not make noise at all. When the rhino gets to about 10 m from the object it starts

running in full speed towards the object. This is the time when it usually snorts. The head is usually held low ready to harm the object with horns.

I never waited for the rhino to be less than four metres from the vehicle and as soon as it started running we drove off because the engine for my vehicle was always on during such observation. I had a driver with me at all times and normally when a rhino charged we had to make a sharp turn at an angle less than 90^{o} from rhino track. After making such a turn the rhino runs straight ahead through where the vehicle had stopped. Normally after charging rhinos were not observed stopping near by but ran into the bush nearby.

Table VI - 1

Rhinos Mating Record

Observation No.	Rhinos involved	Date of mating
1	13, 3	22 September, 1971
2	7, 10	18 October, 1971
3	16, 78	24th March, 1972

Table VI - 2

Observations on rhino's wallowing hours

Rhino No.	0900 to 1000	1000 to 1100	1100 to 1200	1200 to 1300	1300 to 1400	1400 to 1500	1500 to 1600
27	1						
9		2			2		
31A & B				2			1
20				1			
49A & B				2	1		
25				1			
21					1		
10					1	1	
1A & B					1		
8A & B					1	1	1
44					1		
18A & B						1	1
66						1	
67						1	
6B						1	
Total	1	2	0	6	8	6	3

Table VI - 3

Results on sharing of rhino dung piles

Dung piles in each Area	Area A1			Area B			Area I			Area A2		
	From Rhino No.	To Rhino No.	Obser.	From Rhino No.	To Rhino No.	Obser.	From Rhino No.	To Rhino No.	Obser.	From Rhino No.	To Rhino No.	Obser.
1	29(M)	10(F)	Yes	10(F)	29(M)	No	80(M)	29(M)	Yes	24A(F)	80(M)	No
2	29(M)	10(F)	No	10(F)	29(M)	No	80(M)	29(M)	Yes	24A(F)	80(M)	No
3	29(M)	29(M)	Yes	10(F)	10(F)	No	80(M)	10(F)	No	24A(F)	10(F)	Yes
4	29(M)	29(M)	Yes	10(F)	10(F)	Yes	80(M)	10(F)	Yes	24A(F)	10(F)	Yes
5	29(M)	80(M)	No	10(F)	80(M)	Yes	80(M)	80(M)	Yes	24A(F)	29(M)	No
6	29(M)	80(M)	No	10(F)	80(M)	Yes	80(M)	80(M)	No	24A(F)	29(M)	Yes
7	29(M)	24A(F)	Yes	10(F)	24A(F)	No	80(M)	24A(F)	No	24A(F)	24A(F)	Yes
8	29(M)	24A(F)	Yes	10(F)	24A(F)	Yes	80(M)	24A(F)	No	24A(F)	24A(F)	No

Key

(M) = Male rhino

(F) = Female rhino

Yes = Deposition of fresh dung observed.

No = No deposition of fresh dung observed.

Figure VI–1

Wallowing Activity

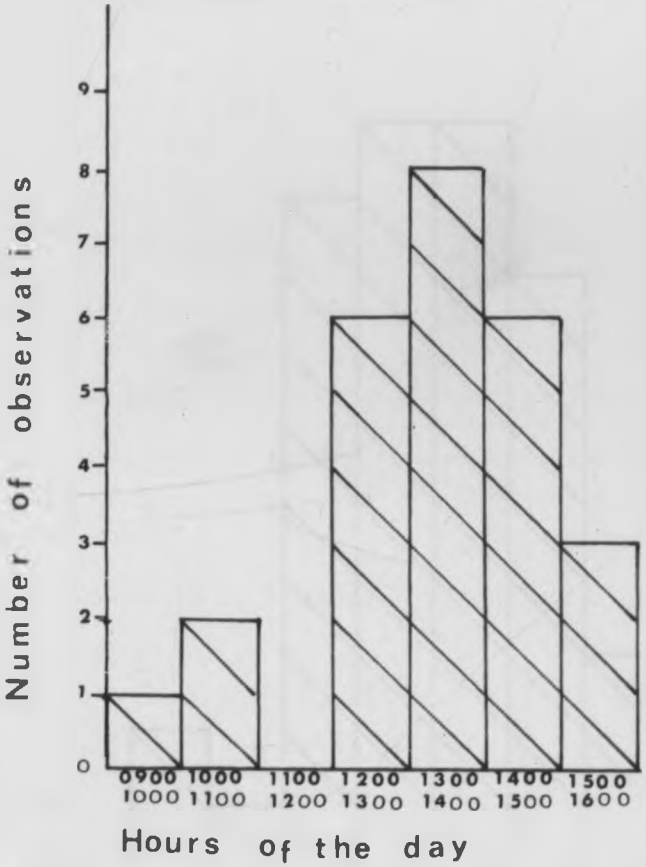
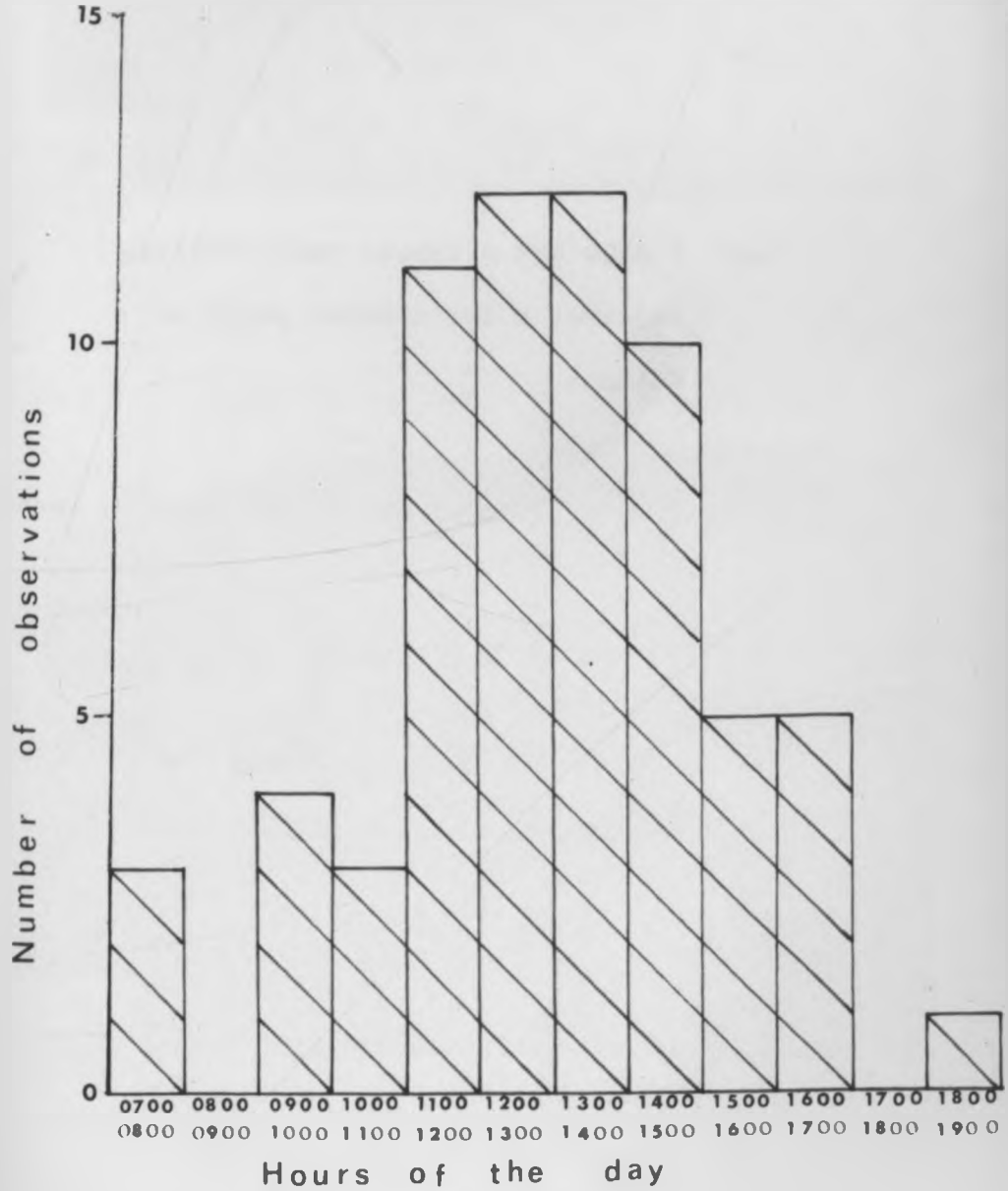


Figure VI-2
Resting periods



Explanation

Plate VI - 1a and b

(a) A male and a female rhino feeding together a few minutes prior to mating.

(b) A male and a female rhino prior to mounting.

a

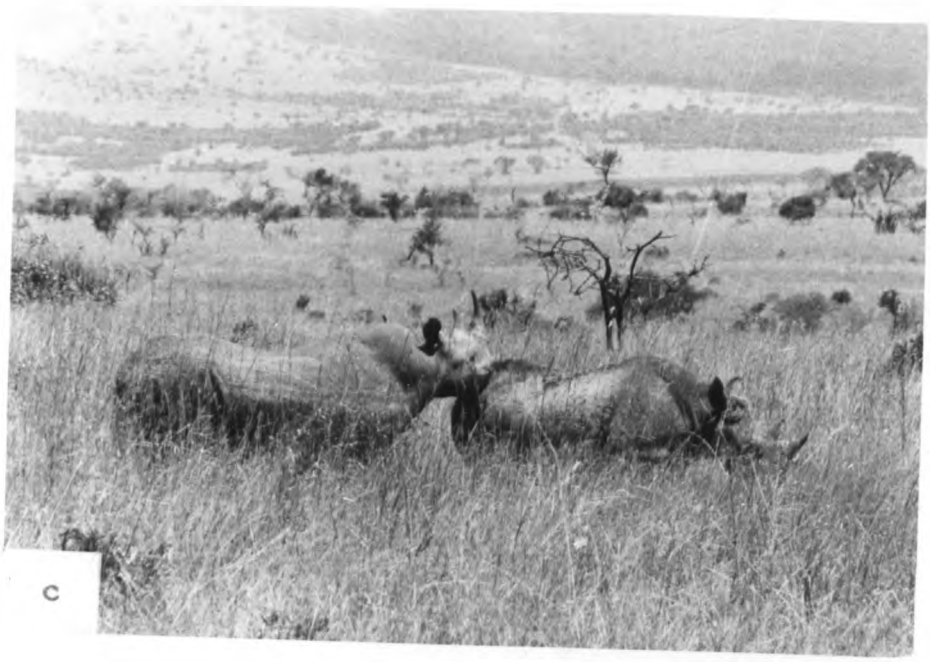
b

Explanation

Plate VI - 1c and d

(c) Male rhino places it chin on the female's rump.

(d) Male rhino mounting.



c

d

Explanation

Plate VI - 2a and b

(a) A rhino showing a part of its body covered by mud after laying in a wallowing hole.

(b) A female rhino with its young both covered by mud after rolling in mud during wallowing activities.

a

b

Explanation

Plate VI - 3a and b

(a) Dung pile deposited next to a bush.

(b) Dung pile deposited next to an *Acacia* tree.

a

b

Explanation

Plate VI - 4a and b

(a) A rhino's standing position when it is about to defecate.

(b) A rhino's standing position while defecating.

a

b

Explanation

Plate VI - 5a and b

(a) And adult male and female rhinos laying down on un shaded ground on a hot day.

(b) A rhino laying down next to an *Acacia* tree.

a

b

Explanation

Plate VI - 5c

(c) An adult rhino about to stand after an alarm. The head is lifted, front legs folded backward and rear legs folded forward.

C

Explanation

Plate VI - 5d and e

(d) An adult rhino laying down under a tree shade.

(e) A rhino resting under tree shade while standing.

d

e

Explanation

Plate VI - 6a and b

(a) The rhino sights the source of an alarm and looks at the object with its tail down.

(b) The rhino lowers the head and gets ready to charge.
Tail lowered down.

a

b

Explanation

Plate VI - 6c and d

(c) The rhino runs towards the object in a rounding manner with its tail raised.

(d) The rhino with its head down and still running when about five metres from the object.

c

d

Chapter VII

DISCUSSION AND CONCLUSION OF THE BLACK RHINO STUDY

Masai Mara Game Reserve is among the leading reserves in Kenya which attracts a considerable number of tourists each year. These tourists, mainly from overseas, are concerned with viewing wild animals, black rhino being one of them. However, black rhino, in general is becoming gradually eliminated in many African countries, and its conservation needs a considerable degree of attention. Rhinos in Kenya, are protected by Kenya laws and in particular there is no hunting allowed within Kenya Game Reserves and National Parks.

General biology of black rhino in Mara discussed here is based on daily observations made between May 1971 and August 1972. This chapter deals mainly with (1) present status of black rhino in Mara as indicated by the results (2) comparison of my results with existing views on rhino as found in the literature and (3) implications for rhino management.

VII - 1 Present Status Of Black Rhino In Mara

The present Mara rhino population is probably one of the healthy, stable and growing population. Majority of adult females were observed accompanied by young rhinos which may indicate that the population is growing. On the other hand the sex ratio of adult males to adult

females was about 1:1 which indicates that there is no disbalance of rhinos sex ratio.

During the entire study period only one adult rhino was found dead and none from other age-classes. This indicates that mortality of rhinos in any age group is very minimal, probably due to small degree of predation, poaching, and natural population regulating factors could not be predicted. Probably if the favourable condition prevail, by 1980, the Mara rhino population may have doubled.

VII - 2 Comparison With Existing Views On Rhino As Found In The Literature

Previous work done on the black rhino for the past few years has been discussed in the introductory chapter of this paper. However, not all of the work done on the black rhino in the past is discussed here jointly with my work.

Darling (1960) estimated the population of black rhino in Mara-Loita area to be 100. Stewart and Talbot (1962) estimate the population of black rhino in the same area to be 54. Stewart and Zaphiro (1963) stated that the density of black rhino in Mara - Loita area was 0.07/sq. mile. The area of their studies was far larger than my study area which indicates that the estimate of black rhino in Mara alone was different from the result given above. Further, it appears that the result of my ground count for Mara (108 rhinos) is higher than their results of Mara-Loita area.

As compared with Goddard (1967, and 1969) the Mara rhino density is similar to Goddard's results for Ngorongoro caldera (0.32/km^2), Olduvai (0.16/km^2) and Tsavo ecological unit (mean between 0.14/km^2 and 0.22/km^2). Joubert and Eloff (1971) reported the density of black rhino in South West Africa to be 0.02/km^2

Stewart (1970) stated that black rhino is distributed in Kenya from sea-level to about 3,500 m in all vegetation types where sufficient cover exists. Ritchie (1963) also stated that rhinos are found from plain and desert to high rain forests and cloud-soaked mountain ranges. Goddard (1966, 1967, 1968, 1969 and 1970) also stated that rhinos are distributed over plains, scrub, marsh and forest habitats. These others observations on rhinos habitats are similar to the habitats occupied by rhinos in Mara.

The Mara area is dominated by the plains, the undulating, flat or slightly convex areas of grassland which may be some thousands of hectares in extent, and often appearing as if paddocked by the narrow bands of shrubby vegetation and occasional trees. The area is well drained and during the dry periods some rivers and streams dry up and some depressions where a certain amount of water may lie in pools or wallow puddled in the soil are observed. Availability of water and food as indicated by Goddard (1967) and (1969) play a major role in rhino distributipn; and this was found to be true for the Mara rhino population.

On population structure Goddard (1970) working with 700 rhinos in Tsavo noted a low cow: calf ratios in some of his very high density strata (between 100:52 and 100: 58) while the low, medium and high strata had a cow: calf ratios of above 100: 58. In the whole of Mara, the cow: calf ratio was 1:0.73 (100:73) which is similar to Goddard (1970) observation for his low, medium and high strata. During the period of my study 4 rhinos in age class III left their mother representing a recruitment rate of about 3.8%. However, as mentioned earlier, over 70% of the females rhinos were accompanied by their calves.

Social organization within rhino population is similar from place to place. As has been reported by Shenkel (1969), Goddard (1967) and Ritchie (1963) rhinos are met with singly, or in pairs or threes. According to Ritchie (1963) a pair is a female and a calf, or an adult male and an adult female; a party of three is usually a cow with one well-grown and one small calf; a solitary animal being most probably a male or nearly full-grown calf which has just left its mother. According to Goddard (1967) adult males are essentially solitary animals. Goddard (1967) also noted that adult females tends toward a solitary existence with her calf, but not as much as adult male. However, Goddard (1967) also observed that immature rhinos are seen alone but attach themselves to other individuals especially other immature animals and adult females as frequently

as possible. Shenkel (1969) reported similar observations.

Similarly rhinos in Mara have the same pattern of association except that single males and female with calf unit are frequently observed. Factors influencing the numbers in the group have not been considered highly by the others but in this paper mating, feeding, and wallowing activities tend to influence numbers in a group other than mother-calf unit. Sub-adult rhinos which have left their mothers occasionally join their mothers or in case of females join males for mating purposes but in most cases they were observed to be solitary.

As mentioned earlier, when sub-adult rhinos join their mothers, they tend not to be very close to them but follow behind them or feed in the areas where the mothers are feeding. When rhino 6A, a sub-adult, lost its mother it was occasionally located alone, but after five months from November 1971, this sub-adult was observed feeding and sheltering together with another mother-calf unit whose home range was adjacent to rhino 6A's mother.

On home range Goddard (1967) stated that single adult males and females have almost the same sizes of home range but single males may have slightly larger home ranges or single females may have larger home ranges than single males depending on the habitat. This applies the same for immature males or females although their home ranges are larger than home ranges for single

adult males and single adult females. Goddard (1967) mentioned very little on home range sizes for females accompanied by their calves. Goddard (1967) also noted that rhinos whose home range was in areas with abundant food and water had smaller home range sizes than rhinos whose home range was on open grassland with seasonal marshes or on areas where water supply was sparse and widely scattered.

In Mara home ranges for single adult males and single adult females were almost the same though not the same sizes as noted by Goddard (1967). Females with calves had much larger home range sizes than single males or single females. There were no studies on home range size carried out for immature rhinos.

The home range for rhinos 1A and 1B, 3 and 4 were in habitat similar to Lerai forest mentioned by Goddard (1967). All other rhinos studied lived in a habitat similar to central Ngorongoro and Olduvai where much of the area was open and during the dry period water supplies were sparse and scattered. These areas were Posee-Meta plains, Ol Doinyo Loip hill area and Eserusopia area. Rhinos whose home ranges covered much of open grassland or areas where water became a problem during the dry period had larger home range sizes than rhinos living on areas with abundant water and cover.

Goddard (1967) noted that home ranges of individuals overlapped considerably. Similar observations were noted for each individual studied in Mara and to a greater extent

with rhinos living on open grassland with less cover and scattered water supplies. Thus in general home range overlapping like home range sizes is influenced by habitat and mating activities for adult rhinos.

On existence of territory Goddard (1967) indicated that territorial behaviour among rhinos is not apparent. Similarly Goddard's findings were found true for the Mara rhino population. Territorial behaviour was checked for rhinos in Mara as mentioned earlier but not enough evidence was obtained to prove existence of territory in this species.

Observations on feeding habits have been explained by Goddard (1968 and 1970). In both papers Goddard found out that rhino feed on variety of plants available in different habitats. However, at certain times of the year rhinos are highly selective, and not all specimens of a particular plant species available are eaten. Goddard also noted that rhinos are predominantly ground feeders and mostly used regenerating plants. Similar observations were made on rhinos in Mara. Mara rhinos were mainly observed on open grassland or areas with scattered trees feeding. They were observed entirely to feed on regenerating vegetation. Food plants with high relative density and high relative frequency were frequently selected during the wet periods although some plants with low relative density and low relative frequency were also selected.

Rhino feeding habits mainly depend on habitat and

condition of vegetation. Rarely were rhinos observed feeding within thickets or bush islands. During the dry periods rhinos were observed feeding on preferred green plant but when burning took place semi-dry Acacia species were mainly used. Burning affect rhinos mainly by destroying herbs and shrubs within grass layer but this condition does not force rhinos to move out of their home ranges. Burning in Mara is usually timed but if the rain does not fall immediately after burning rhinos may face a temporary shortage of food since a considerable area is burnt at one time.

Other activities studied such as mating, wallowing, resting and defecation showed similar results as noted by Shenkel (1969) and Goddard (1967). In Mara, rhinos were found not to wallow daily though wallowing activities are more frequent during the wet period. Wallowing and resting in rhino population usually occurs after morning feeding period and before afternoon feeding period.

VII - 3 Rhino Management In Mara

It is the author's belief that rhino is a key species in management of African vegetation, and that its wanton and drastic reduction in half a century is due to changes in rhino's suitable habitat. The black rhino eats vegetation of coarse and prickly nature which does not seem to be affected by other species. The real threat to rhino lies within themselves because they appear to be unable to extend their range into fresh areas. In these

circumstances rhinos in a country undergoing changes in land use will only survive in sanctuaries, parks, and reserves where their interests are absolutely paramount.

Rhinos in Mara, at present is not at danger of poachers or deliberate killer for poaching is kept within reasonable bounds, and legalised killing reduced. Danger, may only occur from the change in habitat by eliminating cover used by rhinos, shortage of food caused by burning, shortage of water caused by drought or by human settlement in areas occupied by rhinos. The effects of above mentioned changes may not affect the increasing rhino population alone but also other animal populations in the Mara ecological unit.

(a) Burning

Burning is a control method which destroys what is not wanted but does not leave what is wanted. It can destroy a vast area at one time as noted during burning in September to November 1971 and March 1972.

Over the open grasslands and scrub with tree, fire destroys grasses, shrubs and herbs. Plants which are fire-tolerant regenerate after burning and supply fresh food to the plains' animals. Large woody trees gradually die because of repeated burning. Mara area is burnt twice a year and this rate of burning may hasten the rate of changing bushland to open grassland. However, each time there is a burning in Mara fire becomes uncontrolable

because of lack of permanent fire barriers.

The author then suggests that fire barriers be established in Masai Mara Game Reserve and at the same time the rate of burning be re-examined. Fire barriers can be established by improving some of the existing tracks and making new tracks where they do not exist at present, particularly in Triangle area. Burning can be done yearly or once in two years but areas to be burnt need to be selected according to the condition of vegetation.

(b) Water Shortage

As noted during the dry period all the streams and some rivers dry up and rhinos together with other animals depend on water from Mara river, Sand river, Talek river and scattered dams and water holes. Distribution areas B and E each has a dam and at least two water holes. These dams and water holes are far apart from each other and animals which cannot reach them depend on water from waterpans along dried streams and rivers. A prolonged period of drought may occur and water problem may be acute. I feel that earth dams or "hafirs" be constructed in Triangle area, Loldurugi, Meta plains, Burrungali plains, Eserusopia, and Omissingiyoi area. Preferably three dams in Triangle area and two in other areas. These dams would be more suitable along streams which collect water during the rainy period.

(c) Human Settlement

Grazing within the Masai Mara Game Reserve is prohibited but still Masai people are observed grazing their cattle in some parts of the reserve close to their Manyattas. The location of these Manyattas has been previously described. The presence of Masai within the reserve does not only affect the distribution and movements of animal species but also exposes Masai to the danger of being attacked by lions, rhinos, leopards and elephants as observed during the study period. I suggest that these groups of Masai be settled outside the reserve where they can also graze their cattle and probably water sources for their use be established in a way of bore holes or dams.

(d) Suggestions For Further Research

On existing rhino population more prolonged research work is needed on population structure particularly on the aspects of mortality, reproduction and predation, and further investigations on rhino territoriality.

On the other hand, investigations on habitat use considering the biomass of major plain animals in this ecological unit is needed. These sort of investigation may provide information on management of wildlife in this area in near future.

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