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# Flamingo breeding on the Etosha Pan, South West Africa, during 1971

by
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## I. ABSTRACT

The Etosha Pan is at present the only known breeding reservoir of Greater Flamingo *Phoenicopterus ruber* and Lesser Flamingo *Phoeniconaias minor* in Southern Africa. A million or more birds of both species were present between February and September 1971, being attracted to the temporary lagoon formed by above average rains. An unknown number of *P. ruber* nested between February and May, whilst 27 000 of this species were at the nests in May. An unknown number of *P. minor* nested in May-June, occupying the same sites as *P. ruber* when the latter species had stopped breeding. In July-August 54 000 *P. minor* nested. Nesting sites were typically isolated by extensive mudflats but could be reached by land in July, enabling a breeding study of *P. minor* to be undertaken for the first time in Southern Africa. At least 30 000 young of *P. minor* were produced and for the first time the flightless chicks, accompanied by a few adults, were observed trekking up to 80 km across the drying pan to reach water. This ability, coupled with adult feeding of young throughout the fledging period, resulted in 70% fledging success.

## II. INTRODUCTION AND HISTORY

Flamingoes have probably been attracted to the Etosha Pan over a period far exceeding the relatively short time during which they have been recorded there (30 years). Only recently was it possible to gain access to all parts of the Pan. Before the acquisition of four-wheel-drive vehicles and light spotter aircraft (which could land on the treacherous surface) the Pan remained an area largely closed to investigation. In 1971 an opportunity arose to study the breeding of flamingoes on the Etosha Pan for the first time because the ideal conditions created by good rains induced tens of thousands of these birds to nest there.

### Previous Records of Flamingoes

Mr. J. J. Theron, S.W.A. Administration's Tourism Branch, recalls between 1941 and 1946 stories of flamingoes told by the bushmen living on the fringes of the Etosha Pan. They maintained that whenever the flamingoes bred they built their nests near a large island in the eastern area of the Pan. The island referred to is obviously the one situated 13 km northwest of Okerfontein, the main area in which the flamingoes bred in 1969 (Rocher pers. comm.) and again in 1971 (Fig. 1).

The first reliably recorded evidence that flamingoes breed on Etosha Pan was in 1956 when "a pair, accompanied by young birds, not yet able to fly, was encountered on June 22nd at a permanent spring on the Namutoni road" (Bigalke R. C. *in litt.*).

The earliest published record of both species of flamingo occurring on the Pan and its neighbourhood is by Sauer and Sauer (1959 a, b; 1960) when they identified Greater Flamingo *Phoenicopterus ruber* L. and Lesser Flamingo *Phoeniconaias minor* Geoffrey during November of the 1957 rainy season.

In August 1959 Rocher found old flamingo nests and one desiccated egg on the Pan and in May 1963 he discovered two flamingo eggs near the mouth of the Oshigambo river (Sauer and Rocher, 1966).

During August-September 1963 Winterbottom (1964) reports unfledged birds of both species on the Pan. As a follow-up to the observations, members of Winterbottom's expedition assisted the Division of Nature Conservation and Tourism in the rescue of about 150 flamingo pulli. Rescue was necessitated by the drying of the shallow flood areas which left the chicks stranded in the northern part of the Pan, about 50 km from water. More than 80 of the chicks were taken to the Ekuma river whilst the remainder were ringed and released near Fischer's Pan (Winterbottom 1964).

In November 1964 Sauer and Rocher (1966) came across more than 100 flamingo eggs scattered in a depression in the southwestern section of the Pan, near Gonob (Fig. 1). The nest mounds had apparently been flattened by heavy rains which drifted the eggs and left them embedded in the clay. They also found "countless bits of eggshells" and came to the conclusion that "it may have been several hundred birds that nested here". From their measurements of whole eggs they are of the opinion that both species of flamingoes had nested at this spot. Inundation of the area must have resulted in the abandoning of the nests. No evidence exists whether the nesting was successful as flamingoes often lay without completing the hatch (Allen 1956, Brown and Root 1971) and randomly dropped eggs are common amongst flamingoes (Allen *ibid.*).

In 1968 flamingoes also nested on the Pan to the northwest of Okerfontein and unfledged chicks were observed by aircraft (Theron pers. comm.).

Nesting attempts by flamingoes have therefore been reliably recorded on the Etosha Pan five times in the past 16 years, i.e. 1956, 1963, 1968, 1969 and 1971.

Examination of Namutoni's rainfall records since 1956 (date of first breeding record) showed that every time the flamingoes were recorded nesting the annual rainfall had exceeded 500 mm. During the remaining years the rainfall ranged between 237 — 465 mm with the exception of 1966 when 523,3 mm was measured. It may well be that flamingoes nested in 1966 but were not observed. Present evidence indicates that when more than 500 mm is recorded, flamingoes are likely to nest on the Etosha Pan.

## III. DESCRIPTION OF THE AREA

The Etosha Pan is a flat, saline depression of 6 133 km², at an altitude of 1 100 m. It occupies the central and north-western sectors of Etosha National Park (formerly "Game Reserve No. 2") at lat. 19°S, long. 16°E. It has a maximum east-west extent of 120 km and is up to 55 km broad.

In Pliocene times the Cunene river flowed into the Oshana (Lake) Ekuma, of which the Etosha Pan is a present day remnant. The river later moved its course northwards to the Ruacana Falls area, cutting off the lake's water supply. In the drying process the Pan's sandy-clay soil became brackish and wind erosion deepened the depression. Bounded by porous Kalahari calcrete on the southern shore, the floor is now an impermeable clay (Wellington 1938).

The Pan has never been full of water in living memory, but it is subject to periodic, partial flooding during the rainy season which usually extends from December to April. Direct rainfall accounts for only a small portion of the Pan's water, the majority being supplied by three rivers: the Ekuma, Oshigambo and Omuramba Ovambo (Fig. 1). The Ekuma and Oshigambo draw their water from the adjacent flood plains of Owambo, the Bantu homeland to the north of Etosha National Park. Their mouths form deltas in the north-western corner of the Pan, about 13 km apart. The Omuramba Ovambo receives its water from a catchment area to the north-east of Etosha, the main depression flowing into Fischer's Pan which is a relatively small, eastern extension of the main Pan body.

All three rivers are seasonally dry. Depending on the amount of rain falling they flood the Pan to varying degrees and in dry years may not form running rivers at all. They then merely comprise a series of disconnected pools and the Pan consequently will hold only the direct rainfall (Stark pers. comm.).

During the period of partial flooding the Pan holds large sheets of shallow water, usually not exceeding a metre in depth and in places only a film of water a few centimetres deep will cover large areas. When dry the flood area is a hostile stretch of salt-crusted, cracked, sandy-clay blocks. Vast, loose, sandy plains are encountered in those areas not subject to flooding.

The climate of the Etosha Pan can at best be described as harsh. In the late summer months sudden, heavy thundershowers are interspersed with lengthy periods of hot sunshine. In the rainless winter the days are warm, with cloudless skies, and the nights cold. Easterly winds prevail and gust at speeds of 30 knots over the surface of the Pan. During the winter months they are extremely dry and evaporate the shallow water rapidly. An annual evaporation of 2 700 mm has been measured (Wellington 1938).

Mean annual rainfall of Etosha National Park is about 430 mm. It varies from 419 mm at Okaukuejo which lies on the western edge of the Pan to 440 mm at Namutoni Fort situated on the eastern edge (Weather Bureau, Windhoek). February is the month with the mean maximum rainfall (110 mm). Rainfall records have been kept from 1901 — 1971 (Okaukuejo) and 1902 — 1971 (Namutoni). Occasionally extreme precipitations occur as was the case in 1950 when a total of 975 mm was recorded at Namutoni and again in 1946 when the same area received only 90 mm.

In the summer of 1970/71 the mean maximum daily temperature at Ombika Gate (Fig. 1) was 32,4°C, and 28,4°C the following winter. Peaks of 38,1°C and 32,0°C respectively were recorded. Mean minimum daily temperatures of 1971 were 17,4°C (summer) and 6,8°C (winter), with 0°C the lowest recorded (Weather Bureau, Windhoek).

## IV. THE 1969 FLAMINGO RESCUE

Niethammer and von Schwind (1969) describe the plight of tens of thousands of flamingo chicks on the Pan when the water surrounding the nesting sites dried up, leaving unfledged birds stranded. Whilst the parents were forced to abandon the area in search of other feeding grounds the chicks began wandering aimlessly over the dried Pan in search of water.

On June 1, 1969 the first masses of straggling, dying chicks made their appearance near Namutoni Fort and the Nature Conservation Branch of SWA Administration initiated the largest bird rescue operation to date in Southern Africa. During "Operation Flamingo" approximately 20 000 chicks out of an estimated 100 000 were caught by a labour force of 52 men. Fourteen vehicles transported the chicks to Fischer's Pan which still held water, where they were released.

The mortality incurred during capture and transport was only 3% but tens of thousands met their death by thirst, hunger and large scale predation before they could be rescued (Rocher and Stark pers. comm.). A further 450 carcasses were retrieved from Fischer's Pan within 1 — 2 weeks after rescue. Post mortem examination of a sample of specimens showed that the majority had died of starvation (Ebedes 1969, *in litt.*). The total mortality after rescue is unknown as many of the dead and dying would have been taken by scavengers.

There is no record whether the parents subsequently found and fed the transported young although Ebedes *(ibid.)* records adults in Fischer's Pan during this period.

## V. THE 1971 SEASON

An above average rainy season commenced in October 1970 and ended in April 1971. A total of 514 mm was recorded at Namutoni, the measuring point nearest the flamingo breeding grounds. In

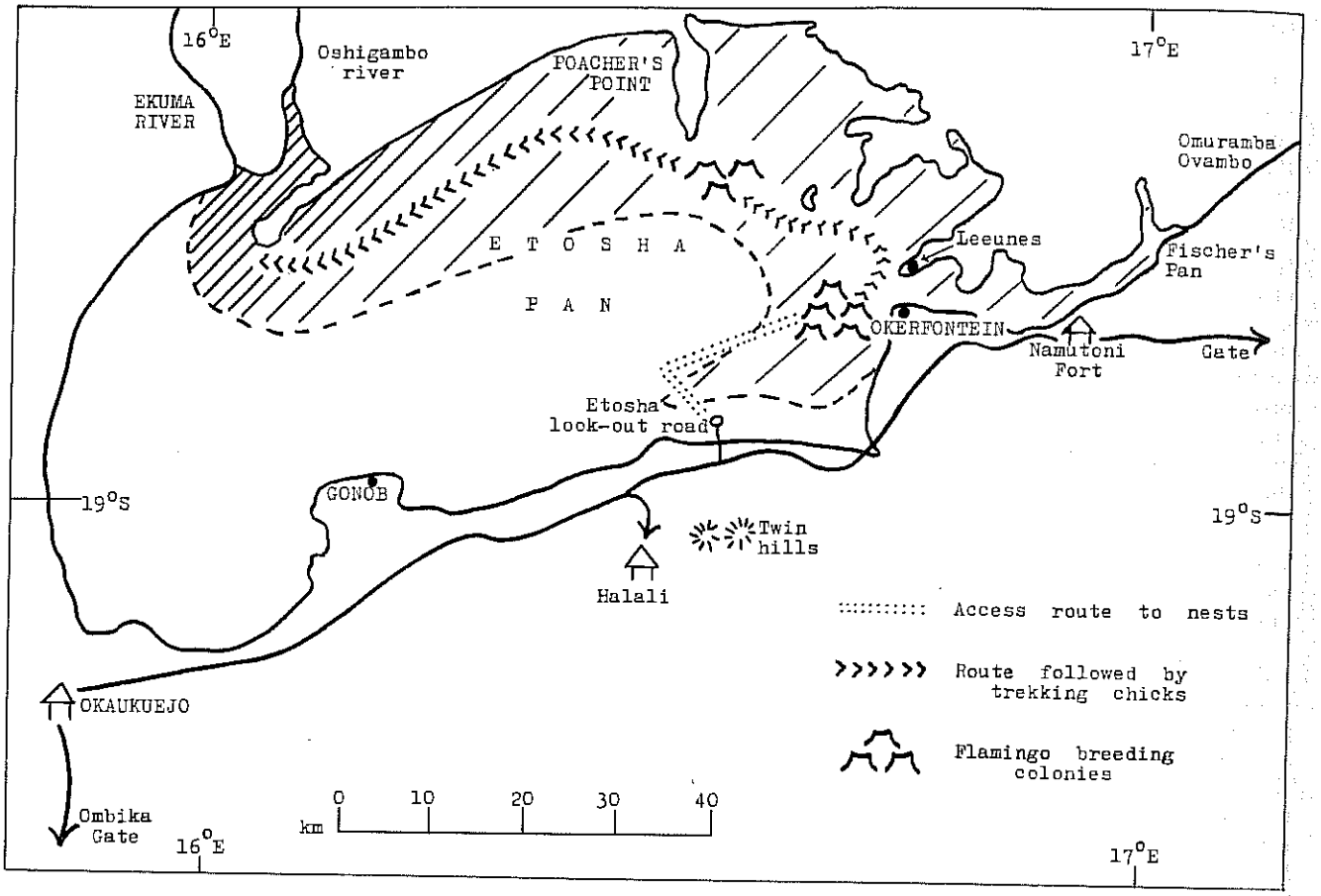


Figure 1. Etosha Pan showing area flooded in 1971.

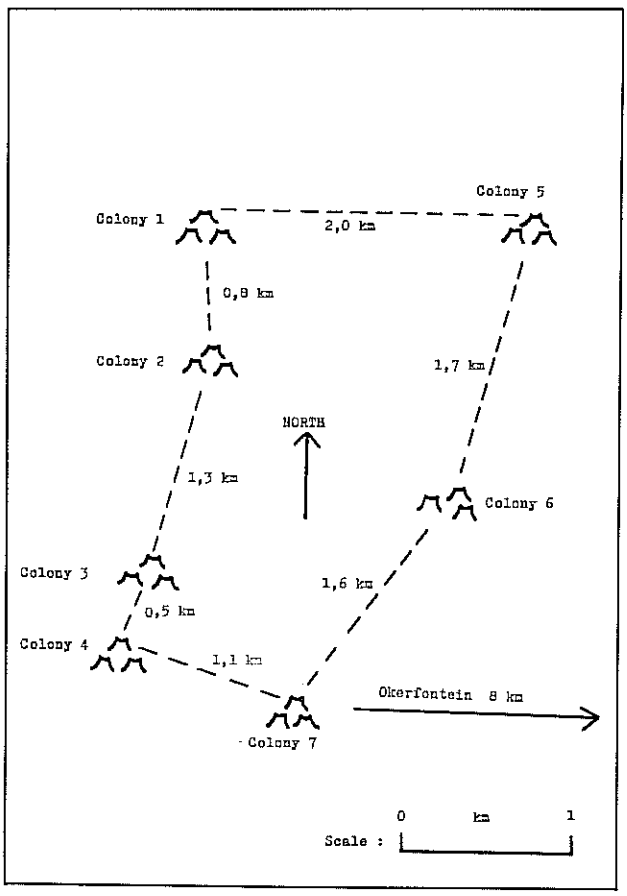


Figure 2. Distribution of flamingo breeding colonies near Okerfontein.

addition to the good rains falling on the Pan the three supplying rivers ran strongly from heavy rains north of Etosha National Park. The Ekuma river was the most important contributor. This resulted in approximately 40 per cent of the Pan's area (2 500 km$^2$) being covered by water at the end of March.

The main body of water, coming from the Ekuma and Oshigambo rivers, swept along a natural slight depression in the Pan which commences at their deltas and runs from west to east along the northern section before swinging south at Poacher's Point. There the water was supplemented by the Omuramba Ovambo's flow and this succeeded in pushing the headwaters westwards along the Pan's southern side to a point directly opposite the "Etosha look-out road" (Fig. 1).

The net result was a vast, semi-circular, shallow lagoon. It reached its greatest depth at the Ekuma-Oshigambo deltas, probably a metre or more, and gradually shallowed to a few centimetres in the Okerfontein-"Etosha look-out road" area. In length it extended 150 km and was 25 km at its widest point where the three rivers' waters joined in the Leeunes area.

## 1. Flamingo Nesting Sites

The floodwaters attracted huge numbers of both species of flamingoes to the Pan. At one stage (May 1971) it was estimated that there were at least one million and possibly more, feeding on the rich supply of micro-organisms which bloom in the Pan's special conditions.

The flamingoes chose two areas in which to nest: a single colony 4 km south of Poacher's Point (Fig. 1) and a second area 8 km offshore westwards of Okerfontein where seven distinct nesting colonies were established over an area of about 5 km² (Fig. 2). About 80 — 90% of the breeding took place at the Okerfontein site, the remainder being at the Poacher's Point colony.

The nesting colonies were barely visible from the edge of the Pan at Okerfontein and then only from an elevation of 4 m using 8x binoculars. They could best be seen in the early morning but by 10h00 the mirage effect made visibility poor and in the afternoon the suspended dust raised by the frequent easterly winds usually hid the colonies from sight. From Poacher's Point which is a peninsula rising steeply above the surrounding Pan the single breeding colony could be seen throughout the day owing to the relative proximity of the nests.

## 2. Breeding of Greater Flamingo

The presence of large numbers of birds prompted the use of a light aircraft for undertaking reconnaissance flights over the Pan. The main purpose of these flights was to ascertain whether breeding was taking place and, if so, to keep a constant watch on the progress made by the young. With the memory of the 1969 flamingo rescue still fresh the Nature Conservation Branch of the SWA Administration required forewarning of any similar condition appearing in 1971.

I did an aerial survey on May 8 after being informed of the existence of large breeding colonies at Okerfontein and Poacher's Point in April (du Preez pers. comm.).

The aircraft used was a Piper PA 18 with a minimum flying speed of 72 km/h. An altitude of 300 m above the nest colonies was maintained initially so as to lessen the likelihood of the adult birds taking to flight. At this height the breeding birds remained virtually undisturbed and it was possible to assess the numbers present.

Brown and Root (1971) observe that "aerial surveys appeared to disturb the flamingoes very slightly, if at all". Certainly, when the aircraft flew below 300 m, many brooding birds rose from their nests, but they tended to run first, followed by their chicks. They only flew if the aircraft continued circling. This disturbance appeared short-lived, for when it had passed over the colonies the birds resettled almost immediately.

Using hand tally counters and a counting unit of 1 000 birds it was estimated that at the Okerfontein nesting site a total of about 22 000 adults were present. Since some birds will have been absent from the breeding colonies during the count (i.e. feeding) the number actually breeding is almost certain to have been greater.

The distribution amongst the colonies was:

| Colony No. | Estimated No. of Adult Birds |
|---|---|
| 1 | 2 500 |
| 2 | 7 500 |
| 3 | 5 000 |
| 4 | 2 500 |
| 5 | 250 |
| 6 | 250 |
| 7 | 4 000 |
| Total | 22 000 |

At Poacher's Point a single breeding colony estimated at 5 000 adult birds was seen.

From the air and viewed through 8x binonculars all the birds breeding at this date were identified as Greater Flamingo. On subsequently examining enlargements of photographs taken of these breeding colonies the occasional Lesser Flamingo was seen amongst them although it could not be determined whether they were breeding at this time.

Both at Okerfontein and Poacher's Point large numbers of chicks were seen but no attempt was made to count them because they had not grouped together into masses but were scattered amongst the colonies. Eggs were also observed but no number could be estimated because many adult birds remained sitting on the nest even when the aircraft flew below 300 m.

The survey was continued along the flooded area and from a point opposite Leeunes vast numbers of feeding flamingoes were found. They were grouped in small and great flocks, extending 100 km to the Ekuma-Oshigambo deltas. The numbers were so great that it became necessary to use a unit of 10 000 for counting. A total of 1 050 000 adult flamingoes of both species were estimated to be present with *P. ruber* very much in the minority (roughly 5 — 10%).

The breeding colonies, situated where they were, ruled out the possibility of access by land at this stage. A boat would have been impractical because of the shallow water and further flights to check on the drying out of the area surrounding the nests was the only method available.

## 3. Breeding of Lesser Flamingo

The next survey flight could not be undertaken before July 5. It showed that the water around the Okerfontein breeding colonies had dried up noticeably and large patches of mud were appearing in several areas of the Eastern lagoon.

The aircraft landed on one of the driest areas next to Colony 1, a hazardous undertaking.

Inspection of the nests showed nearly all breeding stages present, from freshly laid eggs to mobile young. The water still present was very shallow and in many places only a film of moisture covered large areas which had turned into slushy mudflats. The danger of a repetition of the 1969 situation was evident and preparations were made to commence a rescue operation as soon as the young flamingoes showed distress.

I did a further aerial survey on July 8 and found a radical change at the Okerfontein colonies compared to the survey in May. Firstly, the area was drying out rapidly and the waterline had receded beyond the nests of four of the seven original colonies. These four "dry" colonies showed breeding activity, while no birds remained on nests at the three colonies still partly surrounded by water.

Secondly, only Lesser Flamingo were to be seen at the breeding sites and thirdly, a large mass of young had formed about 2 km to the east of the nesting colonies in an area which still held some water. Smaller bands of chicks were scattered around the nesting areas.

Visual estimates gave a total of 48 000 adult birds present, these being divided amongst the colonies as follows:

| Colony No. | Estimated No. of Adult Birds |
|---|---|
| 1 | 5 000 |
| 2 | 27 000 |
| 3 | 10 000 |
| 4 | 6 000 |
| Total | 48 000 |

The number actually breeding was almost certainly greater since some birds will have been absent during the count.

The largest mass of chicks which had broken away from the nests and formed to one side was estimated to contain 10 000 — 12 000 in number with not more than 80 adults amongst them (Pl. 1). There were at least the same number of chicks in smaller, tightly packed groups which were distributed between the nesting colonies so that altogether as many as 20 000 — 30 000 Lesser Flamingo chicks were present in addition to the birds still incubating eggs.

Continuation of the survey showed that the waterline of the main lagoon had receded some 10 km north-east of the Okerfontein colonies and commenced at a point opposite Leeunes. From here it curved in an unbroken stretch to the Ekuma-Oshigambo deltas. The Omuramba Ovambo held no water and Fischer's Pan had dried up by mid-June. At Poacher's Point there were again only Lesser Flamingoes nesting: a single colony estimated at 6 000 adult birds with a grouping of chicks, about 2 000 strong, formed to one side.

a) Access to the Nests

Until July access to the breeding colonies had been limited to aerial surveys. It now became necessary to have a route prepared for vehicles in the event of a rescue.

An amphibious, two-passenger, motor-powered vehicle was made available for this purpose. It had six wheels, all of them driven by the engine, and weighed 200 kg. The tyres were designed for low-pressure driving and could be deflated to 0,1 bar (1,5 psi).

On July 10 an attempt was made to reach the breeding colonies from a point on the southern shore of the Pan near Okerfontein (Fig. 1). At a distance of 6 km into the Pan the mudflats were encountered. They became progressively more slushy until, after a further 400 m, the vehicle became ineffective. Here the clay assumed a consistency of porridge and the vehicle bogged down so that its belly lay on the slush. Further progress on foot was not attempted because of the ever-increasing depth of mud.

The nearest breeding colony was estimated to be 3 km distant and it was decided to find a route around the mud in an attempt to reach the colonies from the northern side. The laying of a route over this type of surface must be attempted with extreme caution as a heavy four-wheel-drive vehicle can become inextricably bogged down.

It was found practical to send the light amphibious vehicle on a series of zig-zagging forays along the edge of the mudflats to test the firmness of the surface.

Thereafter a standard four-wheel-drive vehicle was driven at a speed of at least 50 km/h into the mudflats at an angle to allow for a curving return to solid ground if the mud became impassable.

In this manner a route was laid by crossing firmer mudflats 16 km to the east of the original attempt. It began at the "Etosha look-out road" and led north into the Pan for 8 km before swinging north-east for a further 16 km (Fig. 1). It was thus possible to drive by vehicle from the edge of the Pan to Colony 1 in a matter of half an hour.

b) Observations on Breeding of Lesser Flamingo

Detailed observations on the nesting of the Lesser Flamingo commenced on July 11 at 17h00. A camping site was selected 150 m from the nests at the edge of Colony 1. It was the closest distance at which camp could be made without visibly disturbing the birds, apart from the initial reaction they invariably displayed to human presence. From the camp a slow approach by vehicle permitted the observer to come within 20 paces of some brooding birds as they appeared to largely lose their natural fear of man, especially at hatching time.

For most of the following 24 hours the estimated 4 800 adult flamingoes in this colony were kept under close observation. At the same time photographs were taken and sound recordings made.

(i) Voice and Activity

From a distance the noise coming from the colony sounded similar to surf or a waterfall. The birds showed alarm at the arrival of the camping party but soon thereafter the colony came to rest.

At sunset (18h28) there was a general upsurge in noise intensity and activity. Several flights of adults flew off across the mudflats. The activity continued into the evening and at intervals throughout the night flamingoes could be heard calling as they flew overhead. By moonlight these groups were seen to comprise between 40 and 100 birds per flight.

From 23h30 to 01h00 a microphone was laid well into the nesting area by crawling on hands and knees amongst the birds. Disturbance was limited to the nearest birds retreating temporarily. Within a short time the person recording was surrounded by flamingoes returning to their nests. At this close range the noise emanating from the colony was deafening. The high-pitched, two-syllabelled "qchu-rrep" of the chicks could be easily separated from the deeper nasal "gharronk" of the adults. An incessant calling-and-answering between chick and adult appeared to lay the general noise pattern in the colony. It was interspersed by frequent adult bickerings which were a change of tone to several short, nasal "gha-gha-gha's", uttered in quick repetition.

Towards sunrise (07h23) there was a heightening of the noise in the colony and several flocks of birds landed, presumably on return from feeding in the lagoon. The "flyways" mainly followed the curve of the mudflats to water and to a lesser extent the birds flew directly over the dry Pan on a shorter link-up route. As the day warmed the colony gradually settled down to a low-intensity calling and reduced activity.

Any sudden movement from observers immediately brought reaction. Brooding birds would rise from their nests and move away from the colony, accompanied by mobile young. Sometimes flocks of several hundred adults would take to wing in fright and circle overhead before resettling themselves.

(ii) Adult Behaviour at Nest

Breeding birds very often, though not always, perform a ritualistic mounting of the nest before settling on the egg. In these instances the bird approaches the nest with a normal, upright walking gait. On reaching the nest the neck is lowered so that the bill is poised over the egg in an "orientation" position. Thereafter one foot is placed on the rim of the nest to take the bird's weight and the wings are spread wide as a balance. The "free" leg is then extended beyond the tail and vigorously shaken well away from the nest.

Leg positions are exchanged and the shaking repeated. The neck is held low throughout the leg-shaking. Thereafter the bird settles normally on the nest, ruffling its feathers and swaying slightly from side to side to bed itself down firmly over the egg, its legs folded and extending beyond the tail.

Altogether several thousands of this leg-shaking ritual were observed. It was performed equally at colonies where the surface was still slushy and at colonies which were completely dry.

Lumps of wet clay adhering to the parents' webbed feet, which would otherwise be transferred to the nest cup and accumulated onto the egg-shell, are in this way shaken free. An egg coated with layers of hardened clay would have its porosity affected as well as presenting a physical barrier for the hatching chick. The leg-shaking of the adult therefore certainly appears to have survival value for the embryonic young. Gallet as quoted by Allen (1956) recorded that flamingoes in the Camargue colony, France, shook their feet clear of mud when they mounted the nest. Brown (1957) also mentions a similar behaviour in a breeding colony in Northern Rhodesia.

Adults returning to a nest were often seen to nudge the egg, shifting its position, before settling on it. When hatching occurred parent birds paid increased attention to the egg and adopted an alert attitude, replying frequently to the shrill calls of the emerging chick (Pl. 2). It has been suggested by Brown (in press) that the voice is imprinted on the chick while it is hatching and immediately afterwards. This may enable the chick to recognise its parent by sound alone.

On one occasion a mobile chick was seen squatting on its parent's back whilst the latter sat on the nest. The chick's head protruded through the furled wing of the adult.

Defecation by brooding adults was often found to be directed at a particular side of the nest. This was proved by the concentration of droppings which were eventually piled in a strip on the outside surface. Where three or four nests formed a tight group the droppings were mostly accumulated in a single area at a point where the nests adjoined. This indicates that the adult bird may always face in the same direction when incubating the egg or brooding the chick. In the case of grouped nests it will certainly have an advantage if all occupants face outwards from a central point. Their vigilance towards the surrounding area will increase whilst the likelihood of continuous territorial displays towards each other will decrease.

(iii) Alarm, Territorial and Threat Displays by Adults

In a tightly packed nesting colony adult bickerings are frequent but were never seen to develop beyond lunging with the head and neck or an occasional peck. Open fighting in a flamingo breeding colony seemingly never occurs. Nest mounds often adjoin each other and brooding birds can be seen squatting peacefully in very close proximity, their bodies almost touching.

The territory which an adult defends when nesting is limited to the area it can cover from the nest with neck extended. When a flock of adults return from flying they settle on the outskirts of a colony, requiring several paces to run when alighting. Birds from a returning flock then split up and, walking through the colony to their respective nests, often inadvertently pass too close to a brooding bird. The latter will immediately assume a threatening attitude by raising its long scapular feathers in the typical "chrysanthemum" posture, (Ali 1945 cited by Allen 1956 and Uys *et al.* 1963, Brown and Root 1971). The neck is extended, swaying sideways, and the bill held open in a scything movement. These bickerings are short-lived and after "squaring-up" to each other the intruder will continue on its way.

Avian scavengers such as the Grey-headed Gull *Larus cirrocephalus* often visit the Etosha Pan flamingo colonies and perch amongst the nests. They are tolerated by the breeding birds but when they venture too close the flamingoes assume a similar threat posture (Pl. 3). No attack by a Lesser Flamingo on a gull was seen and the latter, being a more agile bird, did not allow such a situation to develop.

"Mass alarm" was noticed whenever the colonies were approached and also when aircraft passed low overhead. The "chrysanthemum" posture would be adopted and the majority of birds would rise simultaneously from their nests to walk off and resettle a short while later.

(iv) Age at First Breeding

At the Okerfontein breeding colonies several adult Lesser Flamingoes still showed the distinctive grey plumage on head and neck of the young bird (Pl. 3). They were seen sitting on eggs and with chicks. Brown *(in litt.)* mentions that partly grey, young Lesser Flamingoes have been seen building nests and laying eggs at Lakes Hannington and Nakuru. The colonies at Lakes Magadi and Natron which produced young were without exception full pink adults.

The Etosha observation gives rise to two possibilities: either the Lesser Flamingo is capable of reproduction the season following its hatching or the adult retains its immature plumage until the second year or longer.

No flamingoes bred on the Etosha Pan during the previous season (1970) but they did in 1969. Therefore the birds under discussion must have bred elsewhere in 1970 and migrated to the Pan for the 1971 breeding if they were in their first year. Alternatively they could be the Etosha chicks from 1969 which had partly retained the immature plumage into the second year.

(v) Colony Size and Nesting Density

After the last breeding birds had left the Okerfontein area it was possible to estimate the number of nests in each colony and to determine the density of nest groupings.

A total count of the nests in Colony 1 was made by dividing the area into blocks with stakes and recording the nests in each block on a hand tally counter. The following totals were obtained:

| | |
|---|---|
| "Loose" nests (scattered around main group) | 818 |
| Nests in concentrated area adjoining main group | 1 327 |
| Nests in main group | 5 281 |
| Total | 7 426 |

The nests in the remaining large colonies were estimated by counting the number in a 100 m² sample area in the main group of each colony and multiplying by its total area. Outlying nests which invariably surround a group were added. In the small colonies (5 and 6) a total count was made.

The sizes of the Okerfontein colonies were:

| Colony No. | Total No. of Nests | |
|---|---|---|
| 1 | 7 426 | (actual count) |
| 2 | 22 100 | |
| 3 | 12 000 | |
| 4 | 4 200 | |
| 5 | 476 | (actual count) |
| 6 | 413 | (actual count) |
| 7 | 8 700 | |
| Total | 55 315 | |

Comparing the number of birds counted from the aircraft when detailed survey began on July 8 (48 000) it can be seen that about 45% of the total number of nests at Okerfontein were occupied at that time. The number of nests in the single colony at Poacher's Point was later calculated at 4 500 and on July 8 there were 6 000 birds present, giving an occupancy of about 65%.

A total of almost 60 000 nests, made by both species of flamingo, were therefore built on the Etosha Pan during 1971.

Nesting density of Okerfontein Colonies 1 to 4 was determined by counting the nests in five random 100 m² areas in each colony. The results are reflected in Table 1.

A wide range of nesting density occurred within the colonies and between the colonies. It is higher than recent figures from Lake Magadi, Kenya where Brown and Root (1971) recorded a range of 14 — 153 nests per 100 square yds. (average 55). Colonies with this nesting density were termed "grouped" by Brown and Root *(op. cit.)*. On an earlier occasion Brown (1955) found the average density of nests on Lake Hannington to be 1,4 per square yd. which tallies with the overall average of the Okerfontein colonies.

(vi) Nest Measurements

Colonies 1 and 4 contained two extreme nest structures. The former had small, worn and crumbly

structures because it was the first colony to become dry whilst the birds were still breeding. The latter, situated further out in the mudflats, stayed wet for a longer period, allowing the birds to maintain the nests in better condition.

Ten nests, taken at random from each colony, were measured. The data are set out in Table 2.

Table 1. Nesting Density: Okerfontein Colonies.

| Colony No. | No. of 10 m x 10 m Samples | No. of Nests in 100 m² | Colony Average | General Average |
|---|---|---|---|---|
| 1 | 1 | 66 | | |
| | 2 | 53 | | |
| | 3 | 111 | 80 | |
| | 4 | 31 | | |
| | 5 | 140 | | |
| 2 | 1 | 40 | | |
| | 2 | 62 | | |
| | 3 | 265 | 146 | 140 |
| | 4 | 265 | | |
| | 5 | 100 | | |
| 3 | 1 | 62 | | |
| | 2 | 105 | | |
| | 3 | 168 | 117 | |
| | 4 | 135 | | |
| | 5 | 116 | | |
| 4 | 1 | 118 | | |
| | 2 | 229 | | |
| | 3 | 280 | 218 | |
| | 4 | 184 | | |
| | 5 | 278 | | |

Table 2. Nest Measurements at Okerfontein.

| Colony No. | Mass (kg) | Height (cm) | Base (cm) | Nest Cup (cm) | | | Angle of sides (degrees) |
|---|---|---|---|---|---|---|---|
| | | | | Diameter | | Depth | |
| | | | | Inside | Outside | | |
| 1 | 20 | 18 | 40 | 17 | 26 | 3,0 | 60 |
| | 25 | 20 | 42 | 16 | 25 | 3,0 | 60 |
| | 23 | 18 | 43 | 17 | 28 | 3,5 | 50 |
| | 27 | 20 | 47 | 16 | 25 | 3,5 | 70 |
| | 19 | 19 | 35 | 16 | 25 | 4,0 | 60 |
| | 19 | 15 | 40 | 15 | 26 | 3,5 | 45 |
| | 18 | 17 | 38 | 14 | 24 | 2,5 | 50 |
| | 20 | 17 | 39 | 16 | 25 | 3,0 | 60 |
| | 32 | 21 | 50 | 18 | 30 | 2,0 | 70 |
| | 20 | 19 | 42 | 17 | 25 | 3,5 | 55 |
| Average | 22 | 18 | 42 | 17 | 25 | 3,5 | 55 |
| 4 | 71 | 40 | 56 | 14 | 25 | 3,5 | 75 |
| | 52 | 38 | 40 | 14 | 23 | 2,5 | 75 |
| | 55 | 37 | 54 | 17 | 24 | 2,0 | 75 |
| | 85 | 38 | 51 | 17 | 24 | 2,5 | 75 |
| | 55 | 39 | 47 | 17 | 24 | 2,5 | 80 |
| | 8 | 11 | 38 | 14 | 22 | 3,0 | 50 |
| | 15 | 15 | 38 | 19 | 26 | 3,0 | 70 |
| | 6 | 5 | 36 | 16 | 25 | 1,5 | 30 |
| | 11 | 8 | 40 | 15 | 25 | 4,5 | 45 |
| | 10 | 12 | 41 | 16 | 26 | 3,0 | 50 |
| Average | 37 | 25 | 44 | 16 | 24 | 3,0 | 60 |

The nests in Colony 4 are 15 kg heavier on average than Colony 1. They are also taller, but the bases, nest cups and angle of sides are virtually the same. It will be noted that the last five nests measured in Colony 4 showed a sharp drop in mass and height. They were built on a "platform" raised 30 — 40 cm above the surrounding pan. The platform was formed by the clay of previous closely grouped nests which were flattened and compacted by the weight of subsequent breeders. (It will be seen from Table 1 that Colony 4 did in fact reflect the highest nesting density.) The platform accounted for 60% of the colony's area.

Proof of older nests existing in this platform was obtained by digging down to its base. At least six layers of previous nests were found; the levels being distinguished by egg-shell fragments and feathers. A raised platform, created over the years, will have a very real advantage when unusual floods or wind-blown surface waves occur. Allen (1956) refers to a flamingo nest whose vertical section revealed a sequence of six shallow cups, complete with feathers and egg-shells.

### (vii) Weather Conditions and Nest Temperatures

At the Okerfontein colonies shade temperatures ranged from 1°C (06h00) to 32°C (15h00) while the relative humidity (whirling hygrometer) dropped from 85% to 23% during this period. The prevailing winds were easterly and started to blow from 09h00 to 14h00 after which it calmed. There were no clouds. Visibility was generally poor due to the fine powdery clay in suspension and at 5 km the breeding colonies were lost to sight. Mirage effect was great: at 3 km an Ostrich on the Pan could be mistaken for another vehicle. Temperatures (°C) measured at the nests and on the surrounding Pan are given in Table 3.

Table 3. Nest and Pan Temperatures.

| Position | Colony 1 (dry) | | Colony 3 (wet) | |
|---|---|---|---|---|
| | Nest cup | Dry Pan | Nest cup | Pan mud |
| Shade | 26 | 30 | 26 | 34 |
| Sun | 33 | 35 | 32 | 38 |
| 3 cm depth | 19,5 | 21,5 | — | — |
| 18 cm depth | 14,5 | 15,0 | — | — |

The nest cup was cooler by 2—8°C than the surrounding Pan. This is probably due to two factors. Firstly the cup is raised above the Pan's surface and receives cooler air and secondly the underlying nest mound was wet 3 cm below the surface, exposing a greater area to cooling evaporation. Although probably not critical in a late breeding season, already past midwinter, a cooler nest cup will definitely have survival value in the hot summer months (Brown and Root 1971). The survival value of a cooler nest cup is clearly illustrated by Brown and Root (*op. cit.*) who report a temperature difference of 25°C (25°C—50°C) between the top

of the nest and nearby mud on Lake Natron. The East African flamingo breeding colonies are apparently exposed to far higher temperatures than those on the Etosha Pan.

(viii) Inundation of Nests

Colonies 5 and 6 each contained between 400 — 500 flamingo nests. This is low in number for a bird usually nesting in large groups. The nests showed inundation by rising waters earlier in the season. They were situated well to the east of the larger colonies in an area which was more under water. It appears that the rising flood had partly disintegrated the nests, discouraging the birds. Aided by the prevailing easterly winds the eggs had been drifted towards the other colonies. Several hundred addled eggs were lying on the surface, partly embedded in the clay. The eastern part of Colony 7 also showed some water erosion.

(ix) Water Analyses: Physical and Chemical

Samples of Pan water were taken on July 14 in an area where the majority of Lesser Flamingoes had gathered to feed. Similarly, water from the Ekuma river was sampled where these birds were present. The sampling was repeated on September 19 when the Pan had almost dried up and the birds were leaving, some resettling in the Ekuma river.

The analyses are given in Table 4.

The earlier sample of Pan water is chemically unfit for consumption by man or animal because of the high amount of total dissolved solids (> 3 000 unacceptable) and the high sulphate and fluoride content (Dept. of Water Affairs — S.W.A. Branch, Report No. C 8031). Nevertheless, Lesser Flamingoes fed in this area of water in their greatest numbers (*c.* 1 000 000).

The corresponding sample of Ekuma river water is chemically fit for consumption by man or animal and can be classified as "soft water" (Water Affairs No. C. 8030). Only a few hundred Lesser Flamingoes were present at this part of the river.

The later samples show that the Pan's water contained nearly twice the salt of seawater and precipitation of calcium salts had already begun (Water Affairs No. C 8283). The water in the Ekuma river had at this stage reached the salinity of seawater and also showed calcium salt precipitations (Water Affairs No. C 8284). At this time there were still large numbers of Lesser Flamingoes on the Pan (*c.* 200 000) whilst the Ekuma river and its blind side branches held about 30 000.

Brown (1958) has found that Lesser Flamingoes require a constant source of relatively fresh drinking water, apparently more so than Greater Flamingoes. It is therefore of interest to note that the Ekuma river contained potable water until July but by September no fresh water existed. Yet the Lesser Flamingo was apparently able to subsist on this highly alkaline and salty liquid only. It again underlines this species' ability to exist under conditions which would be intolerable to other animals.

Water Analyses: Hydrobiological

On July 14 separate 0,8 litre samples of water and sediment were taken from an area in the Pan where the greatest number of Lesser Flamingoes had gathered to feed. Ten per cent formalin and 50% alcohol were used separately as preserving fluids. The analyses appear in Table 5.

Cyanophytes (blue-green algae) were dominant in both the water and sediment and were especially plentiful in the former. The dominant genus is *Anabaena*. The only diatom species observed (sediment) was *Navicula halophila* (Grunow) Cleve and is a brackish water species, recorded on a number of occasions from SWA (Schoeman *in litt.*).

The East African lakes, Magadi and Elmenteita, also contain amongst other cyanophytes *Oscillatoria* spp. whilst the stomach content of Lesser Flamingoes collected on Lake Naivasha was rich in *Navicula* spp. (Ridley *et al.* 1955).

The water samples were repeated on September 16 when the Pan held mainly slush. Samples of Ekuma river water were also taken then because a movement of birds to the river system was evident. The analyses appear in Table 6.

Table 4. Water Analyses of Pan and Ekuma River.

| Date | Sample | Physical examination | | Chemical analysis (ppm) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | pH | Conductivity | Total dissolved solids (180° C) | Total Alkalinity (as $CaCO_3$) | Total Hardness (as $CaCO_3$) | Calcium Hardness (as $CaCO_3$) | Magnesium Hardness (as $CaCO_3$) | Sodium (as Na) | Potassium (as K) | Sulphate (as $SO_4$) | Nitrate (as N) | Nitrite (as N) | Silica (as $SiO_2$) | Fluoride (as F) | Chloride (as Cl) |
| 14/7/71 | Pan | 9,2 | 26 000 | 20 175 | 1 335 | 25 | 13 | 12 | 7 820 | 111 | 890 | 0 | 0 | 40 | 6 | 10 400 |
| | Ekuma | 7,6 | 1 900 | 1 365 | 140 | 50 | 21 | 29 | 482 | 10 | 104 | 7 | trace | 25 | 0,5 | 600 |
| 19/9/71 | Pan | 9,2 | 67 000 | 61 380 | 4 450 | 25 | 10 | 15 | 22 650 | 300 | 3 700 | trace | 1 | 40 | 6,6 | 29 850 |
| | Ekuma | 9,4 | 45 000 | 34 030 | 2 700 | 35 | 16 | 19 | 12 800 | 106 | 2 790 | trace | trace | 40 | 5,4 | 15 800 |

Table 5. Hydrobiological Analyses of Pan Water and Sediment.

| Date | Analysis | Sample | Contents | Numbers |
|---|---|---|---|---|
| 14/7/71 | Macro | Pan Water | Nil | — |
| | | Pan Sediment | Muscid pupa (aquatic?) | 1 |
| | | | Small ostracods + shells | 11 |
| | | | Cladoceran ephippia | 2 |
| | | | Chironomid (head only) | 1 |
| | Micro | Pan Water | Cyanophytes — *Anabaena* — *Nodularia* — *Oscillatoria* | plentiful |
| | | | Small nematodes | few |
| | | Pan Sediment | Cyanophytes — *Anabaena* — *Nodularia* — *Oscillatoria* | less plentiful |
| | | | *Navicula halophila* | 5 |

Table 6. Hydrobiological Analyses of Pan Slush and River Water.

| Date | Sample | Contents | Total number of individuals present in 0,8 litre water |
|---|---|---|---|
| 16/9/71 | Pan slush | *Moina* sp. | 4 000 |
| | | *Moina* sp. ephippia | 510 |
| | | *Daphnia* sp. ephippia | 1 |
| | | Ostracoda | 2 |
| | | Cyanophyta- *Oscillatoria* sp. | — |
| | Ekuma water | *Moina* sp. ephippia | 3 |
| | | *Daphnia* sp. ephippia | 3 |
| | | *Diaptomus* sp. | 2 |
| | | Ostracoda (several spp.) | 181 |
| | | Diptera, Chironomid larval head capsules | 8 |
| | | Ceratopogonid — *Bezzia* type larvae | 1 |

It is interesting to note that whilst a film of water still overlies the slush, Lesser Flamingoes will remain. An estimated 200 000 were still on the Pan when it contained about 150 km² of this slush while 30 000 were present along 20 km of river which held open water.

(x) Hatching

At 08h00 on July 12 a hatching egg at the edge of Colony 1 was taken and kept under observation. A roughly circular peck-hole of 10 mm had already been opened and the egg-tooth of the chick was visible. Repeated, high-pitched calls were emitted frequently. At 11h00 the chick had succeeded in breaking open about one third of the shell but by 14h00 had made no further progress and appeared exhausted by its effort.

The chick was then aided by removing the remainder of the egg-shell carefully by hand.

Its hatching position was with feet tucked against the body, neck twisted to the right and head and eyes sheltered between the right wing and the body (Pl. 4).

By 16h00 this chick was sitting upright and the down, hitherto sleeked and damp, had taken on a fluffy appearance. It was marked, returned to the nest and could be found on the following two days when it appeared to be quite healthy. The fact that assistance was required by the hatching chick supports observations on the Greater Flamingo where the parent actively aids the hatching with its bill (Brown and Root 1971).

Another egg showing a peck-hole was marked and left in the nest. It took 24 hours to hatch completely and the chick was healthy when observed a day later. This appears to be an extraordinary length of time for hatching and may have been related to the disturbance which my presence caused to the parents during part of the time. Brown (1958) recorded a similar hatching time for Greater Flamingo although he later mentions that the species may hatch in only three hours (Brown and Root 1971).

A total of 31 nests which formed a group at the edge of Colony 1 were each marked and their positions noted. The contents of these nests were examined daily over a period of three days, after which the mobility of some chicks made further observations unreliable.

From the data the following facts were obtained:

a) Egg length varied 10 mm (75 — 85) and width varied 6 mm (47 — 53). None of the eggs showed noticeable discoloration due to the light colour of the surrounding Pan soil.

b) Weight of newly-hatched chicks (less than 24 hours old) ranged from 73 g to 98 g and was probably influenced by the fact that some had already been fed or had eaten part of their egg-shell. These chicks had an average culmen and tarsal length of 23 mm and 36 mm respectively.

c) Two out of 23 chicks died within 24 hours of hatching and a further 5 were missing from the nest after 72 hours.

d) Of the 21 chicks 9 were light grey and 12 were distinctly darker grey to varying degrees.

e) Four days after the last observations a check showed that a further 3 of the 8 eggs remaining had hatched. When the colony was finally deserted the remaining 5 eggs were opened. Two were infertile (weights of 90 g and 81 g) and 3 contained well-developed embryos. Thus a total of 5 out of 31 eggs failed.

Although the data obtained are indicative of the composition of a nest group within a colony, the human factor must be considered. It caused the adults to leave the nests for considerable periods and especially disturbed the young approaching mobility.

(xi) Chick Development

The natal down of a newly-hatched Lesser Flamingo is one of several shades of grey. The straight bill is not yet hardened and is reddish-pink with the white egg-tooth surrounded by a black-tipped upper mandible. Most striking of all are the legs and feet: they are bright coral red and puffy, giving them a rubbery appearance. This tallies closely with Brown and Root's observations (1971). The author also found distinct shades of grey amongst individuals in first down (Pl. 5). Gradations from the palest grey to a dark charcoal were seen and remained distinguishable until the appearance of the second down which was a darker grey. Brown and Root (1971) found Lesser Flamingo chicks generally to be a darker grey than those of Greater Flamingo in the early stages but that in many individuals the young chicks of the two species were indistinguishable.

Chicks less than 24 hours old were unable to support themselves on their legs. At 48 hours they could stand albeit very shakily and for only short periods. Seventy-two hours after hatching, chicks tried to escape the approach of a human but they tumbled and fell off the nest and only managed a few metres before squatting down again, usually sheltering in one of the hollows adjoining another nest. A chick's strength appeared to increase markedly after the fourth day and it would run away rapidly when approached. By the time chicks were a week old they could move with suprising agility over the hard, cracked surface of the Pan. This age coincided with a hardening of the tarsi which turned a dull black.

These observations on the transition from immobility to mobility by Lesser Flamingo pulli run parallel to what Brown and Root (1971) witnessed in the East African breeding colonies.

(xii) Chick Behaviour on Nest

Newly-hatched, immobile chicks (less than 72 hours old) peck often at the nest substrate. During this exercise the tip of the beak is wet and small particles of soil adhering to its tip are subsequently swallowed. The nest, composed of Pan soil, is rich in minerals and it is likely that the chicks in this manner obtain essential mineral elements .

Samples of Pan soil and nest cups were taken for analysis. The results are reflected in Tables 7 and 8. The X-ray diffractogram of the untreated soils revealed two peaks at 4,5°A and 3,05°A which could not be identified. After washing the soils with water and centrifuging however, these particular peaks disappeared from the diffractogram which leads to the conclusion that they were water-soluble salts, possibly Na and K salts (Easton, *in litt.*).

The reason for the apparently low particle size totals is because the free lime and organic matter have not been included in the particle size analysis. Thus by adding 6,3% and 8,2% to the totals for the Pan and nest soils, they would read 87,3% and 87,2% respectively. This indicates an organic matter content (including moisture) of about 12,7% (Easton, *in litt.*).

The soils are almost identical in some respects but differ somewhat in others. The nest soil has a higher phosphate, $CaCO_3$ and nitrogen content which is probably due to the presence of drop-

Table 7. Mineralogical Analysis by X-ray Diffraction (°A)

| Soil untreated | | Clay fraction (washed) | | Minerals possibly present |
|---|---|---|---|---|
| Pan soil | Nest soil | Pan clay | Nest clay | |
| a | | b | | |
| 12,8 | 12,8 | 12,8 | 12,8 | Vermiculite, Chlorite |
| 5,7 | 5,7 | 5,7 | 5,7 | Mullite, Polygroshite (?) |
| 4,5 | 4,5 | — | — | water soluble salts |
| 3,45 | 3,45 | 3,45 | 3,45 | Kaolin |
| 3,05 | 3,05 | — | — | water soluble salts |
| 2,9 | 2,85 | (2,9) | (2,9) | $CaCO_3$, $CaSO_4$ |

a = X-ray diffraction results (degrees Angstrom) of the samples without any pretreatment.

b = X-ray diffraction results (°A) of the samples after separating and washing the clay fraction only.

Table 8. General Soil Analysis.

| Type | | | Pan Soil | Nest Soil |
|---|---|---|---|---|
| Particle size distribution | | | | |
| coarse sand | (2—0,5 mm) | | 1,3 % | 0,7 % |
| medium sand | (0,5—0,2 mm) | | 0 % | 0 % |
| fine sand | (0,2—0,02 mm) | | 22,3 % | 17,9 % |
| silt | (0,02—0,002 mm) | | 38,8 % | 34,6 % |
| clay | (< 0,002 mm) | | 18,6 % | 25,8 % |
| ph (1:1 soil//distilled water) | | | 10,1 | 10,1 |
| Resistance (soil paste, 15,5°C) | | | 0 | 0 |
| $CaCO_3$ | | | 6,3 % | 8,2 % |
| Nitrogen | | | 0,04% | 0,21% |
| Moisture | | | 7,75% | 7,15% |
| Water-soluble cations | | | | |
| | (me/100 g) | Mg | 0 | 0 |
| | | Ca | 0,10 | 0,11 |
| | | Na | 66,71 | 94,19 |
| | | K | 1,37 | 2,77 |
| Plant—available nutrients | (me/100 g) | Mg | 0,25 | 0,25 |
| | | Ca | 15,75 | 17,25 |
| | | K | 26,90 | 46,10 |
| | (ppm) | P | 37 | 420 |

pings, egg-shells and feathers. The high sodium content of the Pan soil appears to be a feature of flamingoes' breeding lakes (cf. Brown and Root 1971). The sodium and potassium content of the nest soil is greater and could be due to accumulation of salty slush used in nest construction.

The chicks also pecked at and ingested considerable amounts of their egg-shell within the first few days of hatching (Pl. 6). This behaviour seems typical of the species (Allen 1956, Brown 1958). A freshly hatched chick is surrounded by egg remnants. These gradually diminish and by the time the chick vacates the nest very little, if any, egg-shell remains. Egg-shells from adjoining nests are later also taken when, for example, the neighbouring occupant has died. Ingestion of egg-shell by the chick is probably associated with its need for a substantial reserve of calcium because the stubby tarsi and short neck of the young bird must, for survival purposes, rapidly grow out of all proportion to the rest of its body (Prof. L. M. Smith, Orange Coast College, California, by personal communication).

Older chicks, which had been deserted by their parents and raised in captivity at Okaukuejo, fed freely on crushed egg-shells of flamingo and domestic fowl. This habit continued until their bill curved to an extent which precluded pecking from the ground (Berry and du Preez unpubl.).

Strong ejection of faeces by the chick occurs and from the time it can stand on the nest the watery excreta is squirted as much as a metre away. This bowel action leaves the nest cup relatively clean.

Chicks pecked one another when they came into contact at the nests but did not inflict injury beyond the loss of some down. Whether this reaction was continued when they later grouped together in tightly concentrated masses could not be determined due to the distance these groups kept from the observer.

### (xiii) Stomach Contents

Ten newly hatched chicks, abandoned by their parents, were killed and the contents of their alimentary canals taken for floristic analysis. Similarly, samples were taken from ten mobile chicks (age about one week) (Table 9). The samples were preserved in two separate mediums, alcohol and formalin, final concentrations of 80% and 4% respectively being desirable (Schoeman *in litt.*).

Table 9. Micro and Macro Analyses of Alimentary Canal Contents.

| Chick Age | Contents |
|---|---|
| Less than 24 hours | Algae *Navicula halophila*<br>1 copepod<br>egg-shells |
| Older than 24 hours | Algae *Navicula halophila*<br>egg-shells<br>down |

The analyses are disappointing as most of the algae had been partially digested and damaged by the action of gastric acids. With regard to sampling procedure it is therefore necessary to slaughter the chicks immediately after a feed. The alimentary canal must then be immediately removed and its contents rinsed with distilled water in order to counteract digestive juices (Schoeman *in litt.*).

The stomachs of ten chicks, just mobile (3 — 4 days), were found to be hard and packed with egg-shell fragments. Average weight of egg-shells per stomach was 0,8 g (0,1 g — 1,7 g).

### (xiv) Rectal Temperatures

Rectal temperatures of ten chicks were taken immediately after death and averaged 40°C (39,2 — 40,4°C). This is somewhat lower than the body temperature of captive young flamingoes in Nassau (42,2 — 43°C,average 42,7°C) (Dr. A. Soltys cited by Allen 1956).

### (xv) Feeding of Chicks

When a chick is fed by an adult on the nest it lies on its belly or squats on its tarsi. Feeding is preceded by a rhythmical side-to-side swaying of the chick's head and neck which is held upwards and extended slightly forward, the beak open. The chick usually emits loud calling before the feed and during the feed the calls soften into a continuous gurgling. The parent gives the food, standing motionless, its head and neck arched below the level of the body. The adult usually faces in the same direction as the chick when feeding it. Occasionally a chick is fed by the parent facing towards it. The parent's bill tip appears to touch the opened lower mandible of its chick and the feed is often temporarily interrupted by the adult which pauses to shake its head at intervals, apparently to get rid of accumulated liquid.

Feedings last 2 — 5 minutes and are seen relatively few times in the day. Those that were seen took place in the late afternoon (17h00 — 18h00) and only two feedings were observed towards midday (11h00). The Etosha breeding colonies were most active at night during which period the adults flew frequently to the feeding grounds. It is therefore likely that the young are fed mainly at night.

Once a chick was observed to repeatedly nuzzle the feathers at the base of the neck of a brooding parent. The adult then rose and commenced to give the food.

After feeding the adult straightens itself, shakes its head and may flap its wings. Very often thereafter it commences preening.

### (xvi) Grouping of Young

Chicks older than one week tend to form small bands within the nesting area. As these grow larger they detach themselves from the nests and form

compact, bigger groups some distance away (Brown and Root 1971).

By mid-July a huge mass of unfledged flamingoes had formed about 2 km east of the Okerfontein colonies, drawing its supply of chicks from all four of the breeding colonies simultaneously. This "nursery" had first been observed by aircraft on July 8 and was then estimated to contain 10 000 — 12 000 chicks. It subsequently increased to between 20 000 and 30 000 young.

A sharp division between older and younger chicks in the nursery was apparent. The older chicks had advanced to the stage where their black primary feathers were visible when they exercised their wings, which was often. In height they were about two-thirds the size of an adult and had developed whitish plumage on the scapulars, sides and tail which showed up clearly against the dull grey of the secondary down. Their head and necks however remained totally grey. The younger chicks did not mingle with the feathered pulli although together they formed one composite nursery. The effect of the division between feathered and downy chicks was so distinct that when viewed from the ground the nursery resembled a field of tall grass which had been cleanly mowed halfway across its diameter (Pl. 7). The young chicks were about 20 cm in height and adults were mostly seen amongst them during an afternoon of viewing. Only an occasional adult was observed amongst the partly-feathered young.

The two distinct age groups of the chicks in the main nursery support Brown (1955) and Brown and Root (1971) who consider the Lesser Flamingo to be a highly-synchronized breeder. The Etosha nursery indicates that at least two "waves" of breeding (the term is taken from Allen (1956)) by this species occurred on the Pan in 1971 with each synchronized colony occupying and re-using the existing nests.

Approaching the nursery on foot was attempted but at about 500 metres it merely moved off deeper into the mudflats, escorted always by only a few adults. The nursery retreated to mud which became progressively more slushy and it was found that flamingo chicks can run across this quagmire a good deal faster than a human. I had therefore to content myself by studying the nursery at a distance through binoculars. Owing to the distance no feeding of chicks by adults could be observed.

Later that afternoon a small party of adult birds detached themselves from Colony 1 and escorted their progeny across the mudflats towards the nursery which was about 2 km away. Both parents must have accompanied their chicks because there were 12 adults and 6 pulli. When a chick lagged behind the group two adults would remain with it and were identified as male and female on the strength of their size alone (Brown and Root 1971). Chicks rested at intervals during this march, squatting on their tarsi. These breakaway groups would continue slowly on their way until they reached and became absorbed by the main nursery (Pl. 8).

(xvii) Abandoning of the Nests and Hatching Success

*Okerfontein Colony 1*

At the time of the first close quarter observations (July 11) 4 800 adults were estimated to be present. By July 14 this number had reduced sharply to 2 800 adults. The impression gained was that this colony had almost completed its hatching. On July 18 there were only 168 adults remaining. They were restless and flights of 20 — 30 birds flew up and circled for lengthy periods.

At 12h00 about 90 adults took to wing and did not return, leaving 80 adults at the nests. Fifty chicks, deserted by the flown birds, afterwards started moving in two groups into the Pan. By 17h00 they were still squatting 200 metres away from the edge of the colony and some showed signs of distress. Ten were caught and taken to Halali and Okaukuejo for observation.

Two days later (July 20) Colony 1 had been deserted by all adults and the chicks remaining had either succumbed or been taken by avian predators. Sixty-five freshly dead pulli were found at the nests together with 152 eggs as yet unbroken by bird scavengers. The hatching success must nevertheless have been high if account is taken of the fact that nine days earlier there were 2 400 breeding pairs present. Egg breakage during incubation can be considerable and has been calculated at 10 — 20% (Brown 1958) while Allen (1956) considers a loss of 20 — 30% of eggs and small chicks quite normal. Hatching success is therefore lower than would seem apparent at first. Thus from the number of unhatched eggs left in Colony 1 (152) and the presence of 2 400 pairs when the colony's hatching was near its peak, the hatching success would appear to be more than 90%. A figure of between 70 — 80%, taking breakage into account, will be nearer to correct.

*Colony 2*

On July 12 a first brief visit by vehicle was paid to this colony. It was the largest grouping of nests on the Pan in 1971, with about 25 000 birds present and remained so until July 15. Yet on July 18 not a single adult was seen and inspection showed that they had deserted *en masse* leaving an estimated 12 000 eggs and about 50 chicks.

The surface around this colony was dry, as at Colony 1 but with only a thin crust which often broke, causing me to sink up to the knees in underlying slush.

No simple explanation can be given for the mass desertion. Only Colony 1 had been used for observation, with five days spent in close proximity to it. Colony 2 was visited once prior to its desertion and then not more than half an hour was spent there. The aircraft had flown over all colonies and human interference could therefore not be a governing factor. The distance and extensive mudflats to the south made access by mammalian predators most unlikely.

It seems likely that the desertion of Colony 1 between July 14 — 20, after peak hatch, influenced Colony 2 which lay 0,8 km away. The synchronized nature of flamingoes' breeding must be taken into account in such a case and the desertion of nests by a colony which has successfully concluded its breeding, such as Colony 1, may well trigger off the same response in an adjoining colony, such as Colony 2, which has still to reach peak hatch. This tendency will be heightened if conditions for breeding are becoming unfavourable, in this case the drying of the nesting area. When a large sample of eggs from Colony 2 was opened it was in fact found that 70% held young and developed embryos with 2% starting to hatch.

The net result was the total failure of Colony 2 during the latter part of the breeding season, although it had probably been occupied by successful breeders earlier in the year. The chicks which were present were taken by predatory birds or died of hunger and exposure. The vast field of abandoned eggs was thereafter gradually reduced by avian scavengers until no whole egg could be found a month later.

*Colony 3*

On July 23 there were about 9 000 adults with eggs and chicks of varying sizes. Some juvenile birds, already strong fliers, remained attached to this colony. It still held water in its centre due, it was later discovered, to small saline fountains.

By July 27 the colony had decreased to 6 500 adults and eggs were still plentiful.

Only 1 000 adults remained on August 7 and during the observation period small groups of older chicks, accompanied by the parents, broke away and moved off in the direction of the main nursery, which was by now out of sight of the breeding colonies. The remaining birds were markedly apprehensive when approached and groups of 100 and more took readily to flight, circling and resettling nervously at the edge of the nest area. No scavenging or predatory birds were seen.

On August 8 a cautious approach was made. Five hundred adults remained and it was evident that they were on the verge of abandoning, being the last flamingoes breeding at Okerfontein.

The colony held 350 adults a day later and these were restless, with flights constantly rising and settling. A significant occurrence took place at 11h00 when a lone adult was observed about 1 km away on the Pan, walking towards the nests. As the bird slowly approached it was seen to be escorting a small chick, apparently back to the colony. A Tawny Eagle *Aquila rapax* hovered overhead and eventually drove off the parent, which was by now close to the colony, and took the chick. A second Tawny Eagle joined it. This incident added to the colony's restlessness as all birds left their nests, mostly flying off and only 50 remained, milling about in confusion. At 13h00 on August 9 these last adults flew off and by that evening it was apparent that they would not return. Closer inspection revealed that the fountains erupting amongst the nests had created a death-trap for young chicks. About 120 young had become caught in thick, foul-smelling black mud and their efforts to free themselves had only embedded them further in the slush. Twenty of the stronger chicks managed to extricate themselves on approach and most of these were taken to Halali for care. The remaining chicks could not be reached and slowly became mired down. They were later shot.

The late season hatching success here was probably higher than Colony 1 (85 eggs left by 4 500 pairs) and could have reached 80%. Because of the treacherous slush not all dead young could be accounted for, having been trampled under the surface by other birds. Nine feathered young, probably near fledging, were found dead in a single clump in the mud.

*Colony 4*

Between July 8 and 22 the number of adults declined from 6 000 to 3 000. A rapid decrease followed and a day later 1 500 adults remained. This dwindled to 250 on July 24, when hatching had been virtually completed.

No adults remained when the colony was inspected on July 26. Twenty-eight chicks were found in deep, dry hollows created by earlier nest-building. Unable to escape, most of these had succumbed, leaving 8 chicks in a weakened state. They were removed for care.

A total of 62 whole eggs, mostly containing developed embryos had been left. Colony 4 therefore had a high hatching success, estimated 80 — 90%.

(xviii) Egg Sampling

One hundred eggs were sampled at random by taking 50 along each of two diagonals crossing Colony 2. These eggs were measured (Figs. 3, 4 and 5).

Similarly, a further 300 eggs were opened and their contents examined (Table 10).

Table 10. Egg Contents of Colony 2 (300 eggs)

| Stage of Development | Embryonic Phase | | | Pipped Eggs | *Undeveloped Eggs |
|---|---|---|---|---|---|
| | Pre-gastrula | Differentiation | Late Embryonic | | |
| Number | 41 | 62 | 149 | 5 | 43 |
| Percentage | 14 | 20 | 50 | 2 | 14 |

* Undeveloped Eggs = infertile
= decomposed
= newly-laid

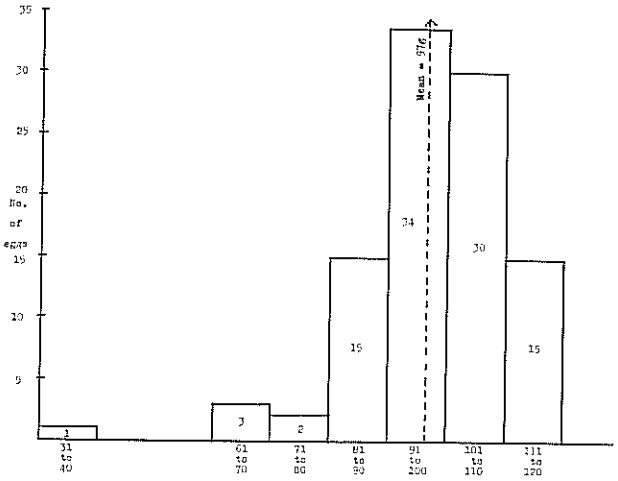


Figure 3. Mass of 100 eggs (g).

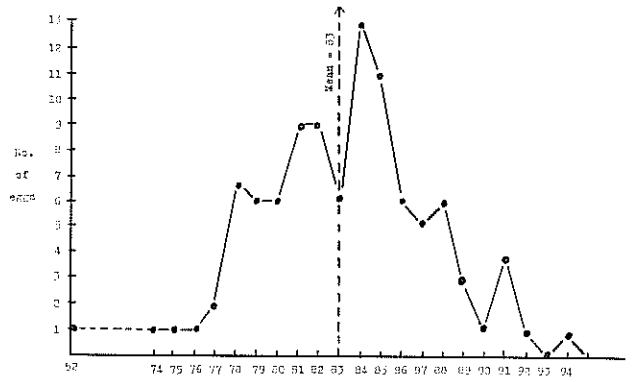


Figure 4. Lengths of 100 eggs (mm).

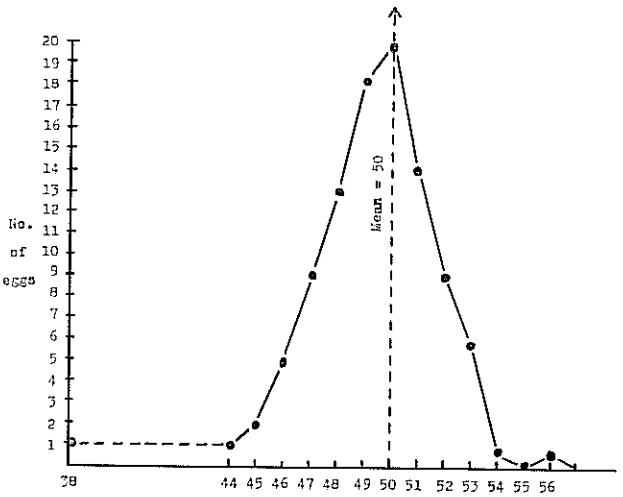


Figure 5. Widths of 100 eggs (mm).

The marked variation in egg size prompted a search for the smallest and largest eggs which could be found. The smallest had a mass of 22 g, measured 46 x 34 mm and a tiny, undeveloped yolk. The largest had a mass of 123 g, measured 90 x 55 mm and contained a developed embryo. Average size of a sample of eggs collected at Lake Natron was 78,5 x 49,3 mm (Brown and Root 1971). These and the Etosha eggs are both well below the average for *P. minor* of 87,2 x 54,4 given by Allen (1956).

In the course of looking at thousands of nests not one nest cup was seen to hold more than a single egg although often a second egg, usually addled, lay near the base of a nest.

(xix) The Trek to Water

It is characteristic of flamingo pulli to congregate in the vicinity of the nesting area in large groups (Brown 1955, 1958, Meinertzhagen 1958, Brown and Root 1971). The groups contain mobile chicks of distinctive age classes and these later move several kilometres away from the nests, accompanied by fewer and fewer adults.

Previous reference has been made to the formation of a typical clustering or "nursery" of chicks at the Okerfontein colonies and a proportionately smaller one at the Poacher's Point colony.

Until July 23 the Okerfontein nursery remained visible from the nesting colonies and was 3 km distant. Thereafter it disappeared from sight and could not be seen even by scanning with binoculars from the vehicle's roof (4 m). The following day I set out on foot from a point where the vehicle could go no further in the mud, in an attempt to locate the vanished nursery, but no sign of it could be found.

An aerial survey was requested and on July 26 showed a radical change in the nursery's position and its numbers. It was 8 km from the nests, moving northwards as shown by tracks which were easily distinguishable as broad bands in the soft clay. In size it had decreased to contain 10 000—15 000 young.

Flying towards Poacher's Point the broad trails of spoor were encountered, leading towards the single flamingo nesting colony which existed there. At the perimeter of these nests a mass of 15 000—20 000 chicks had congregated, far more than the 6 000 birds there could have produced. It was evident that the majority of the Okerfontein nursery had trekked 30 km across the mudflats, following the curve of the receding water-line which by then only just encompassed the Poacher's Point colony.

Between Poacher's Point and the Ekuma peninsula no sign of chicks was found and areas of mudflats were already exposed. At this stage it appeared as though the majority of young would become stranded at Poacher's Point because the shallow lagoons on the Pan disappear with astonishing rapidity in the dry months.

Envisaging that a rescue of the chicks still remaining near Okerfontein was imminent, it was decided to lay a provisional rescue route from there diagonally across the Pan to a point near the mouth of the Ekuma river. Here water would be available well after the rest of the Pan had dried.

The projected route was first flown over by aircraft to obtain a compass bearing to be followed on the ground. Apart from the twin dolomite hills at Halali no other objects can be used as landmarks when driving across the flat expanses of Etosha Pan.

On the 7th of August four-wheel-drive vehicles, equipped with a two-way radio, left the Okerfontein colonies on a 310° compass bearing (NW). The Pan's surface, although appearing completely smooth from its edge, becomes very uneven with ribbed ridges of wind-blown sand, making it difficult to maintain a straight course. Hardened salt eruptions appear at intervals along the way. After 30 km all land is lost to sight when the Halali hills disappear in the haze.

Abandoned ostrich eggs were seen occasionally, some lying 20 km from the Pan's edge. A single, addled flamingo egg was found 15 km north of Gonob.

The distance from the Okerfontein nests to the Ekuma mouth totalled 90 km and took 1½ hours non-stop driving. A subsequent aerial survey showed that the tracks followed a semi-circular curve, and that a bearing of 270° (W) had been inadvertently followed due to a tendency to favour a course too far south.

The problem of access by land vehicle to the Okerfontein nursery remained however, due to at least 5 km of wet clay separating the chicks from the nearest dry ground.

In order to maintain a constant check on the condition of the chicks a helicopter survey was undertaken on August 6. It confirmed the nursery sightings made on July 26 and also reported unfledged flamingo chicks between Poacher's Point and the Ekuma peninsula (Ebedes pers. comm.).

This was verified by the author on August 9, when another aerial survey proved beyond doubt that a long-distance trek was being successfully undertaken by the chicks. Fewer than 1 000 remained near Okerfontein and these were 15 km north of the nests. All appeared to be in strong condition. At Poacher's Point the number of unfledged young had also decreased, from over 15 000 to 4 000 and the nesting area had been occupied by White Pelicans *Pelecanus onocrotalus*.

Examples of the chicks' movement was provided between here and the Ekuma peninsula: a compact group of 300 young were found moving away, 5 km west of the Poacher's Point nests. On approach about 150 scattered, half running, half flying in the direction of the water which was at least 40 km distant. The rest, unable to fly, followed running. A second group of 250 unfledged and 200 partly-fledged young was encountered 8 km before the start of the water which by now extended east of the Ekuma peninsula for only 20 km. They too reacted to the aircraft's presence by making directly for the water.

The sighting of four separate nurseries containing in all more than 20 000 chicks at the edge of the water confirmed that unfledged young of Lesser Flamingo are capable of walking a total distance of 80 km to escape unfavourable conditions. During the 1969 flamingo rescue some unfledged young reached the waters of Fischer's Pan by walking 25 km (Nature Conservation report 1969).

A day later another flight was made. Six small groups of chicks (less than 100 each) were seen between Poacher's Point and Ekuma peninsula. All were marching westward to the water (du Preez pers. comm.).

Poacher's Point, usually attainable overland, affords a good elevation from where to watch the flamingoes at a distance. At 13h00 on August 19 a group of chicks detached from the sedentary nursery there and moved slowly to the west.

Approach to the nests was limited by a narrow ring of water similar to Colony 3 at Okerfontein. No active fountain was found but the nesting area is slightly elevated above the Pan, suggesting either an area compounded by previous nest building or a hardened salt eruption. Smooth, rounded, small stones are plentiful in this elevated area.

The next day I undertook an aerial survey with Mr. de la Bat, Director of Nature Conservation, SWA, along the entire area between Okerfontein, Poacher's Point and Ekuma. Fewer than 100 young of the original Okerfontein nursery remained and they were nearing Poacher's Point. The latter area held 1 500 unfledged young and three groups of 20—50 chicks were found moving 12, 20 and 40 km respectively west of Poacher's Point towards the water. All groups which had completed the trek to water were again massed together and now formed two nurseries totalling an estimated 25 000 chicks. These later merged into a single nursery.

A flight on September 14 showed that the trek had been successfully completed. No living chicks remained between Okerfontein and Ekuma peninsula. The surface was sufficiently dry to permit a landing at the Poacher's Point nests where only a few hundred carcasses could be found in the area previously occupied by the migrating young.

A continual fledging of young from the nursery at Ekuma peninsula was observed during many subsequent visits by land. By September 20 there remained only a small percentage which could not fly well (2 000 out of 25 000-plus). The Pan was virtually dry and the Ekuma delta's lagoon on the adjacent side of the peninsula held the last remaining water.

The breeding season was considered complete on October 17 when no unfledged flamingoes could be found at the Ekuma delta.

The total mortality of Lesser Flamingo chicks between hatching and fledging is difficult to estimate as the breeding colonies could only be reached by land when hatching was well advanced. When the nesting areas became accessible there was no evidence of unusual mortality amongst chicks. During the remainder of the breeding season which included the 80 km trek undertaken by the chicks, no mass mortality was observed, although numbers of weaker chicks must have succumbed *en route* to the water. Before trekking started the original nursery at Okerfontein was estimated to contain 30 000 unfledged birds. When this nursery had moved to the Ekuma delta area it contained about 25 000. Therefore 5 000 unfledged chicks could have perished but this figure will be reduced when account is taken of the fact that a number of young will have fledged during the trekking period (about 30 days). I am of the opinion that no more than 3 000 out of 30 000 chicks died during the nursery period.

It can be assumed that the normal mortality of small chicks (i.e. at the nests) is in the region of 20% (Allen 1956). Add to this a further probable 10% mortality during the nursery period. The fledging success of the Lesser Flamingo on the Etosha Pan during 1971 can thus be estimated at about 70%.

## VI. GENERAL DISCUSSION

### 1. Parental Feeding of Young

A few adults which perform the function of "nursemaid" (Brown 1958) are always in the sedentary nurseries as well as in the trekking groups of chicks. As most of the observations on movement of young were done by aircraft it was not possible to witness adults feeding chicks.

If adult birds feed the chicks throughout their development and whilst the young are massed in a more or less stationary nursery (Brown and Root 1971) there is no reason why this should not occur when the chicks are trekking. It is more likely that feeds are delivered by adults than the possibility that the young can walk a great distance to water without nourishment. They certainly could not have fed themselves at such an early age and even had they been able to, no water existed *en route*.

Whether each parental pair attended only to its own chick during the sedentary nursery period at Okerfontein, the trek and finally the second sedentary nursery period at Ekuma is a moot point. At the nest chicks are attended by their parents (Brown and Root 1971) and this is substantiated by observations in Etosha during 1971.

### 2. Moult to Flightlessness

The phenomenon of nuptial moult in Lesser Flamingoes has been observed during at least four seasons at Lake Natron, East Africa (Brown and Root 1971) whilst observers of Greater Flamingo breeding colonies have not found it (e.g. Uys *et al* 1963).

I found about 6 000 adult Lesser Flamingoes in a flightless condition near the Ekuma delta on August 9. All nesting had ceased at this date. The inability of these birds to become airborne was noticed during a routine survey. At 150 m altitude all other flamingoes along the route flew off at the aircraft's approach and a flock remaining on the ground was conspicuous. To test the sighting further a low swoop was made over them but they could only scatter by running with wings outstretched and flapping. They were unable to fly and gaps could be seen in the black primary and secondary flight feathers, giving the wings a scraggy appearance.

### 3. Migration

Both species of flamingo frequent the SWA coastal lagoons, particularly Walvis Bay and Sandwich Harbour. They do so regularly during the last half of the year when Etosha Pan is dry and leave again, flying a northbound course when the rains start (Gaerdes 1971 and personal observation).

At Walvis Bay lagoon they seem to vary around 15 000 to 20 000 individuals with occasional high influxes occurring. A peak of 40 000 individuals of both species was present on October 20, probably due to the successful season on the Etosha Pan. At Sandwich Harbour lagoon I have observed a maximum number of 5 000 of both species, also in October. *P. ruber* is usually in the majority.

Reports of flamingoes throughout Southern Africa are numerous and the first record of successful mass breeding by *P. ruber* was recorded in 1960 (Uys *et al.*, 1963). None of the literature indicates flamingo numbers approaching the size of the Walvis Bay flocks, although Maclean (1960) reports seeing *P. ruber* in "huge flocks at the Orange River mouth". During a recent survey of estuaries and lagoons of the South African coastline the largest gathering of flamingoes (*c.* 20 000) was seen at Walvis Bay (Dr. J. R. Grindley, Director of Port Elizabeth Museum and Oceanarium, by personal communication).

The developed nature of Southern Africa leaves no area, except Botswana, where large numbers of flamingoes would not soon become known and it must be concluded on present information that only a small percentage of Etosha's flamingoes migrate south of the Pan. If the combined number of flamingoes in South and South West Africa (Etosha apart) is taken at between 50 000 and 100 000 it is only 5—10% of the numbers present on Etosha in 1971.

Migration between Etosha, Lake Ngami and the Makarikari pans seems likely (Fig. 6). These are the areas in Southern Africa where massing of flamingoes on the scale of a million or more takes place. Migration between South-western and East Africa possibly exists although Brown (*in litt.*) feels that the absence of records between these areas indicates separate populations.

## 4. Ringing

Two separate ringing operations on flamingoes have been undertaken in Etosha National Park. In 1963 some 60 rescued young were ringed (Winterbottom 1964) and during the massive 1969 rescue operation 1 500 near-fledged birds of both species were ringed (Ebedes and Dixon pers. comm.).

Two birds have to date been recovered, both from the 1969 ringing. One dead bird was recovered in Walvis Bay lagoon on 27/vi/69 having flown 530 km to the south-west of Etosha within 15 days. A second bird was found dying near Möwe Bay, West Coast one month after ringing and had covered 430 km (S. A. Ornithological Society communications, 1969), (refer Fig. 6).

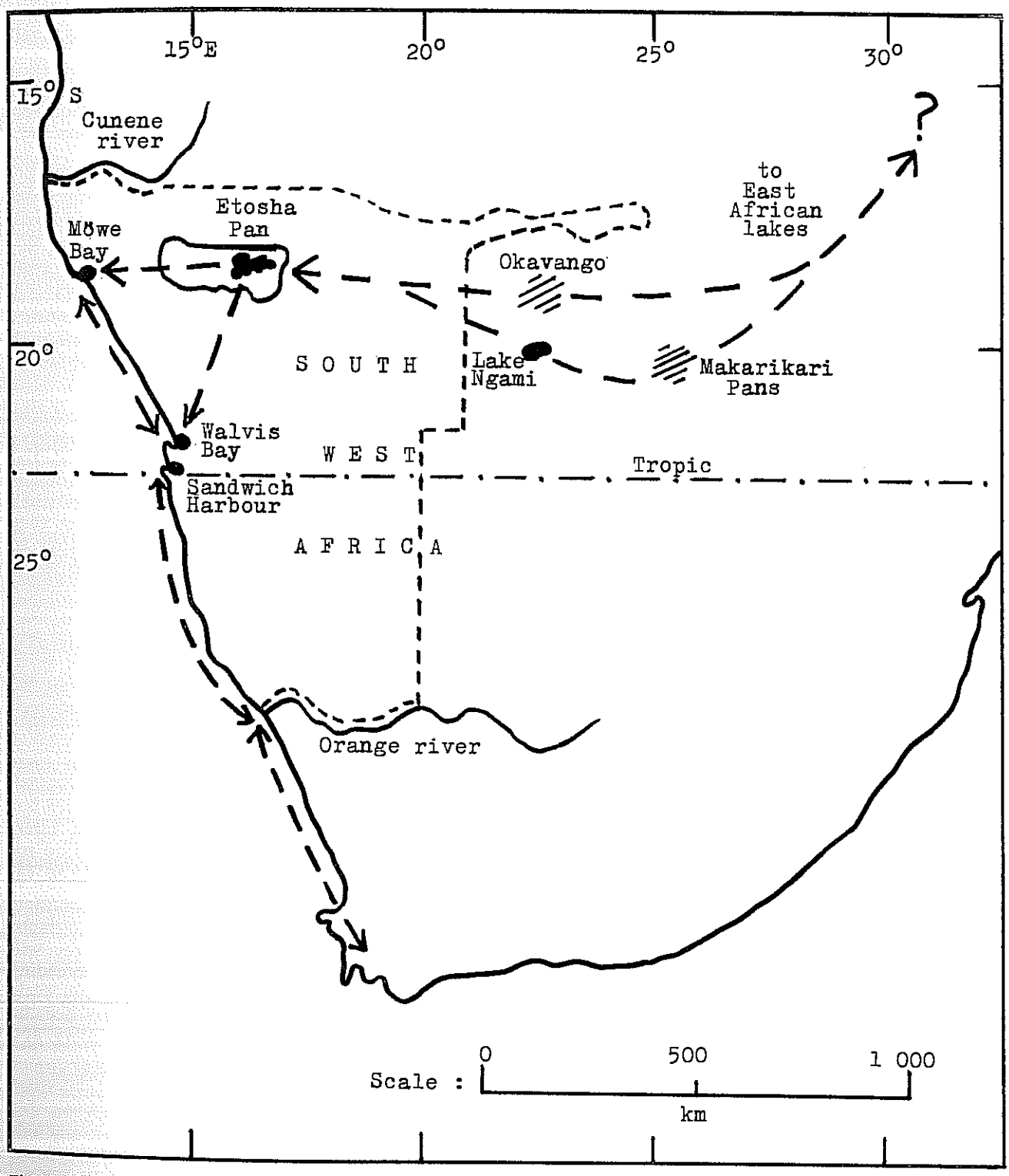


Figure 6. Main probable migration routes of flamingoes from Etosha Pan.

Ringing of flamingo pulli in Etosha has been made possible by rescue operations and this was also the case at Lake Magadi, East Africa (Brown and Root 1971). Large scale ringing may solve some of the mystery still surrounding these birds but apart from the opportunity afforded by a rescue it will be very difficult to reach healthy young flamingoes on foot. It will also be inadvisable to create the disturbance at the breeding grounds which such activity will cause.

## 5. Predators and Scavengers

Few predatory animals venture far into the Pan but the flamingoes are unable to escape the attention of predatory and scavenging birds. Loss caused by these however was minimal as their number was small.

The predators, in order of importance were:

Tawny Eagle *Aquila rapax*. The regular presence of only two birds during the observation period at Okerfontein made it likely that a single pair was frequenting the colonies. They probably caused more damage by the apprehension their presence created amongst the breeding colonies (an example has been mentioned) than by the few chicks they took. No adults were seen to be killed by them.

Grey-headed Gulls *Larus cirrocephalus*. These were occasionally seen to peck a newly-hatched chick to death when human presence caused an adult to leave the nest. They were the most numerous predators and about 30 were at times seen at a colony. There were always a few present until mid-August.

Pied and Black Crows *Corvus alba* and *C. corvus*. Not more than a pair of each species was seen at once and they were irregular visitors. They killed small chicks at the perimeters of the colonies but did not venture in amongst the breeding birds.

Bataleur Eagle *Terathopius ecaudatus*. A pair was observed once, circling above the Poacher's Point colony but were never seen alighting on the Pan.

The only scavengers present were:

Lappet-faced Vulture *Torgos tracheliotus*. Eight vultures were the most seen together at the nests. No other vulture species was found near the flamingoes. They played a passive role, sitting about 200 m from the edge of the colonies. Occasionally they would fly closer to scavenge a corpse. They were not seen to take a healthy bird although they have been recorded killing chicks at Lake Magadi (Brown and Root 1971).

Once three vultures were found amongst the nests and the nearest flamingoes had merely moved 10 m away. The rest of the colony appeared undisturbed by the vultures' proximity.

A group of trekking chicks often had one or two vultures in attendance and sickly or weak young were probably taken as soon as they dropped out of the march.

Grey-headed Gulls and crows. Because the availability of dead chicks always exceeded the demand by scavengers, the gulls and crows were disinclined to eat anything more than the soft viscera of freshly dead chicks. The carcasses which lay untouched soon dessicated and mummified on the salty surface of the Pan. Their scavenging abilities were emphasized at Colony 2 where 12 000 eggs lay abandoned. They relinquished the carcasses in other colonies and concentrated on the eggs, leaving not one whole within a month.

## 6. Allied Breeding Species

Bird species sharing the hostile conditions of the Etosha Pan with the flamingoes undoubtedly do so because its isolation affords them protection.

Ostrich *Struthio camelus*. Along the route to the Okerfontein colonies a cock and his retinue, presumably three hens, was observed from time to time. They later began nesting about 2 km from the track and 10 km from the Pan's edge, on dry ground. Their nest was visited briefly to avoid disturbance and 24 eggs were present. The male was mostly seen incubating during the day. Several other incubating cocks were seen offshore from Gonob when doing aerial surveys. Their nests were about the same distance into the Pan.

White Pelicans *Pelecanus onocrotalus* were the most closely allied breeding species. At Poacher's Point hundreds of pelicans appeared at the flamingo nests during the Lesser Flamingo's breeding cycle. Their numbers later grew to more than 2 500 breeding pairs and it is possible that they may have terminated the flamingo's occupancy of the nests (Brown, in press; Berry, Madoqua to be published).

Grey-headed Gulls, Grey Heron *Ardea cinerea*, Sacred Ibis *Threskiornis aethiopicus*, Glossy Ibis *Plegadis falcinellus* and Spoonbill *Platalea alba*. These five species nested together in the Pan, on a small island at the edge of Okerfontein, well apart from the flamingo colonies.

## 7. Human Disturbance

It cannot be overemphasized that human interference at flamingo breeding colonies must be restricted to as few persons as the collecting of essential data will allow.

Sightseeing parties seeking sensational photographs of flying birds cannot be condoned as they will invariably cause severe disturbance to breeding birds. This is valid throughout the breeding cycle but especially so with late breeders who become very apprehensive at the sight of intruders and may desert hatching eggs and young *en masse*.

My study periods at the Okerfontein colonies were responsible for a percentage of mortality to unhatched eggs and immobile chicks. Fortunately this was small. Studies should be carried out quietly, taking the utmost care to move slowly.

Aircraft over the breeding colonies must be strictly limited to essential surveys, for although disturbance is temporary, it unsettles the birds. Allen (1956) includes low-flying aircraft in the types of human disturbance most likely to cause a flamingo breeding colony to desert its nests completely. In his words "the result is stark terror". Various civil aviation authorities in North and Central America have prohibited flying at an altitude below 2 000 ft over flamingo colonies (Allen *ibid.*). The Etosha Pan forms part of a proclaimed game reserve and the breeding and feeding places of the flamingo should be sacrosanct.

### 8. Insecticides in Eggs

Lake Nakuru in Kenya forms one of the key points in the ecology of the East African flamingoes. Recently, due to pollution of the lake by the inhabitants and industry of Nakuru town, the flamingo's position has become jeopardised (Thomson 1971). A similar parallel can be drawn in the case of the Etosha flamingoes due to the threat of pollution from Owambo.

The Etosha Pan's water comes largely from the drainage supplied by rivers originating from that territory.

Since 1965 health officials have conducted an anti-malarial spraying campaign in Owambo, using chlorinated hydrocarbon insecticide. A yearly amount of 120 000 kg of 5% DDT is now applied as an indoor spray to the upper walls of tribal huts (Health Services communication 1971).

To monitor the possible build-up of insecticide in the food chain, eggs of the Lesser Flamingo were sampled at the Okerfontein nests in 1971 and submitted for analysis.

The results indicate that in relation to world standards extremely low quantities of insecticide residues are present, but that there are nevertheless at least three different insecticides and their metabolites already present in the eggs. They are DDT (<0,013 ppm), TDE (0,097 ppm), DDE (0,19 ppm), dieldrin (<0,03 ppm), $\alpha$-BHC (<0,01 ppm) ß-BHC (0,01 ppm), $\gamma$-BHC (<0,01 ppm) (Gibbs and Pienaar, unpublished results).

It is not known at what level insecticides will become hazardous to the flamingo or its ability to reproduce successfully. Eggs will have to be monitored in future breeding seasons.

## VII. CONCLUSIONS

The Etosha Pan is presently the only known, regularly used mass breeding ground of flamingoes in Southern Africa. It experiences periodically favourable conditions for flamingo breeding. Both *Phoenicopterus ruber* and *Phoeniconaias minor* have been reliably recorded there since 1957 and unfledged young were observed in 1956. On two subsequent occasions abandoned pulli were rescued on the drying Pan.

In 1971 ideal conditions attracted more than a million of both species of flamingo to the Pan where at least 10% bred. *P. ruber* initiated the breeding and estimates give 27 000 birds breeding in May. The total number of *P. ruber* present could not be assessed because both species intermingled at the feeding grounds. However they were far fewer in number than *P. minor* and were roughly estimated at 50 000 — 100 000. A total of 54 000 *P. minor* were seen breeding in July and August. Thus the total number of flamingoes known to have bred was 81 000.

If the number of nests present (*c.* 60 000) is an indicator then it means that a further 40 000 flamingoes could have bred. It must however be remembered that nest building does not always result in egg-laying (Brown and Root 1971).

Chicks hatched from April until August and, judging from later observations on fledged young, *P. ruber* hatched its chicks until mid-May. Similar observations on *P. minor* indicate that their chicks hatched between the end of May and August 9, the latter being an exact date.

The greatest loss was the desertion of 12 000 eggs by *P. minor* in one of five colonies.

There are some imponderable figures (number of eggs laid, number of eggs broken during incubation) which preclude accurate estimations on the breeding success of *P. minor*. However, I have set out the figures available so as to give some idea of the results of *P. minor's* breeding from the time when close range observations became possible in July until the end of the 1971 season. (Breeding success by both *P. minor* and *P. ruber* prior to this was not recorded).

Breeding success of *P. minor:*

| | |
|---|---|
| No. of birds present | 1 000 000 |
| No. of birds at nests | 54 000 |
| Percentage breeding | 5—6 |
| No. of eggs | ? |
| No. of chicks hatched | 30 000 |
| * Probable percentage hatching success | 50—60 |
| No. of chicks reared | 22 000 |
| Percentage chicks fledged from hatching | 70 |

* percentage calculated from number of eggs deserted at four out of five breeding colonies minus an assumed egg breakage of 10-20% during incubation.

After reaching a peak of more than one million in May the number of flamingoes declined gradually to 200 000 (including juveniles) by September and all birds had left the main Pan by mid-October, partly resettling in the Ekuma river system.

The reasons for the apparently exceptional breeding success in 1971 are:

(i) good rains which converted a large area of the Pan into a temporary lagoon,

(ii) the extended breeding period of six months,

(iii) ability of the unfledged young to walk long distances to water when the Pan dried.

Trekking by the chicks did not take place simultaneously. Splinter groups detached themselves periodically from the main nursery and reformed into a replica of it at the end of the trek. Adult birds accompanied and must have fed the chicks throughout this period. It is probable that each chick is fed by its parents only.

Moult to flightlessness in *P. minor* was observed in a flock of about 6 000 adults.

Only a small percentage of Etosha's flamingoes migrate to South Africa and a likelihood of movement between the Pan, Botswana and East Africa exists.

Mass ringing of unfledged flamingoes is at present limited to the opportunity afforded when rescue of distressed birds takes place.

Predators and scavengers were limited to avian species by the extensive mudflats surrounding the nests. They made little impression on the population but eagles can cause late breeders to abandon their nests.

The most notable allied breeding species of flamingoes was the White Pelican.

Uncurbed human disturbance at breeding colonies unsettles flamingoes and should be limited to visits for study purposes only.

Pollution of the flamingo's food chain by insecticides already exists in Etosha. Although only minute quantities are present it is a serious indicator of future danger.

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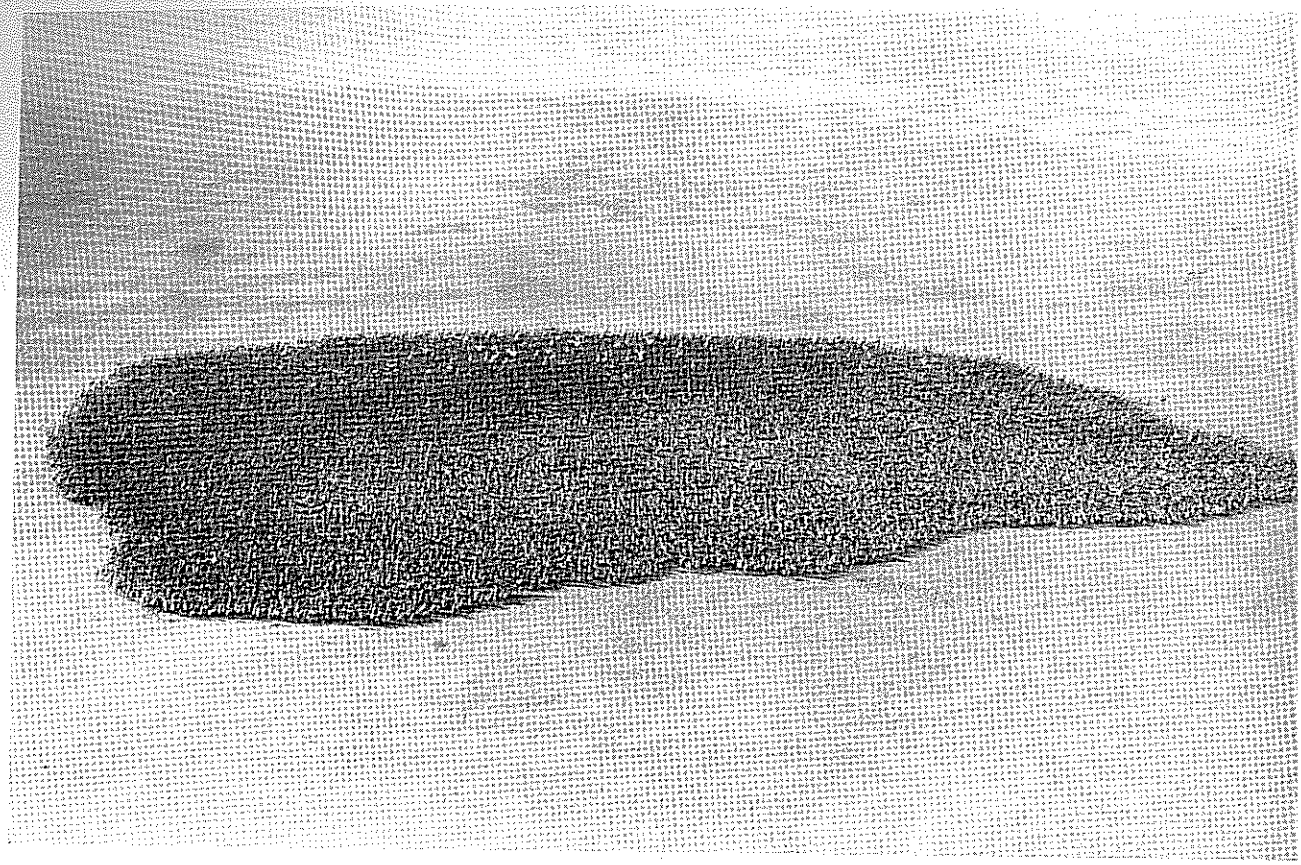

Plate 1. An aerial view of the main nursery of Lesser Flamingo chicks on July 8.

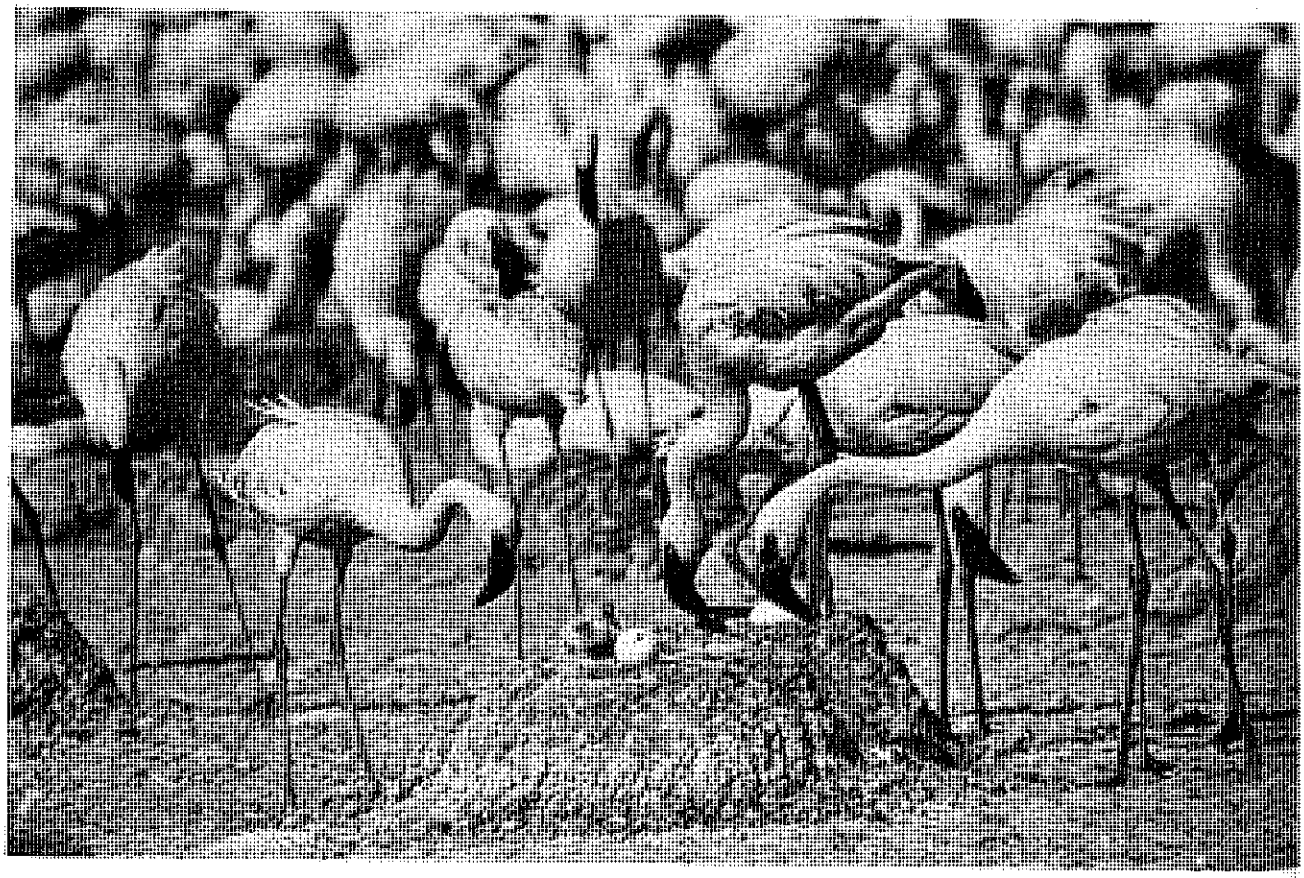

Plate 2. At the time of hatching the parent birds' attention to the egg increases. The pock-hole in the egg-shell can be seen

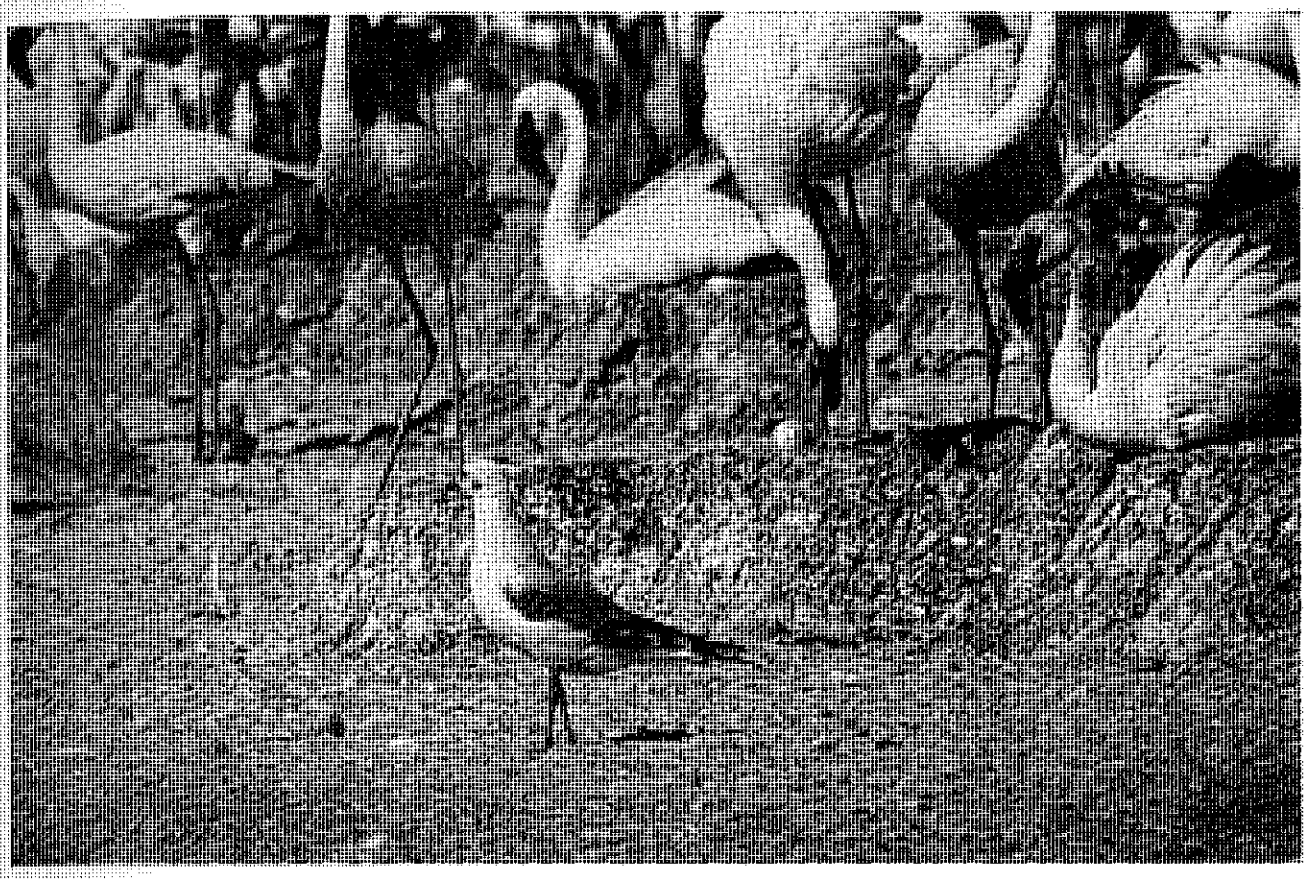

Plate 3. An intruding Grey-headed Gull arouses a threat display from a breeding Lesser Flamingo which adopts the typical "chrysanthemum" posture. The flamingo still shows immature plumage on its head and neck.

Plate 4. The hatching of a Lesser Flamingo may take up to 24 hours.

Plate 5. Two newly-hatched Lesser Flamingoes from adjoining nests. Although they are almost identical in age, their natal down is markedly different in its shade of grey.

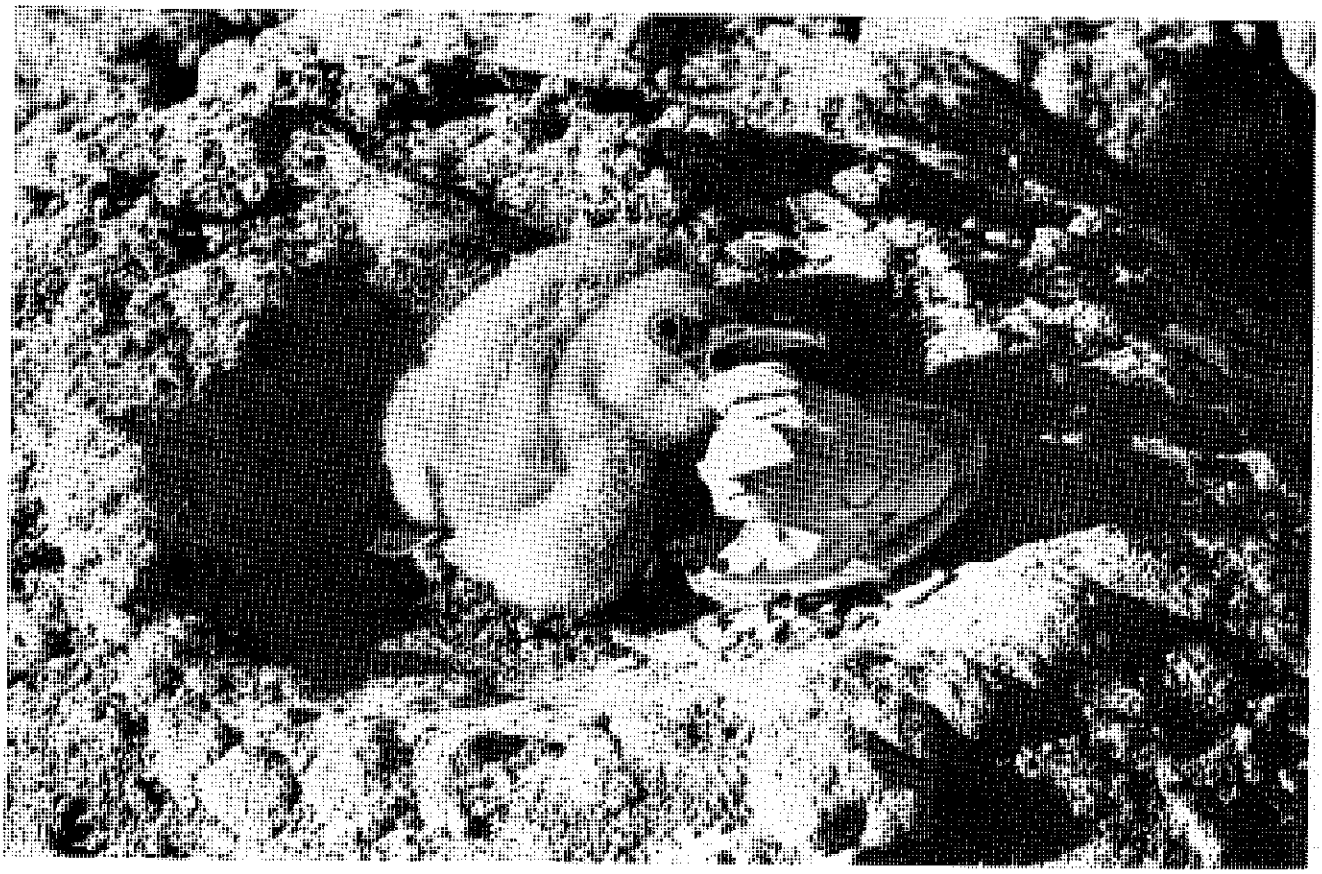

Plate 6. A newly-hatched Lesser Flamingo, still immobile, eats its egg-shell vigorously.

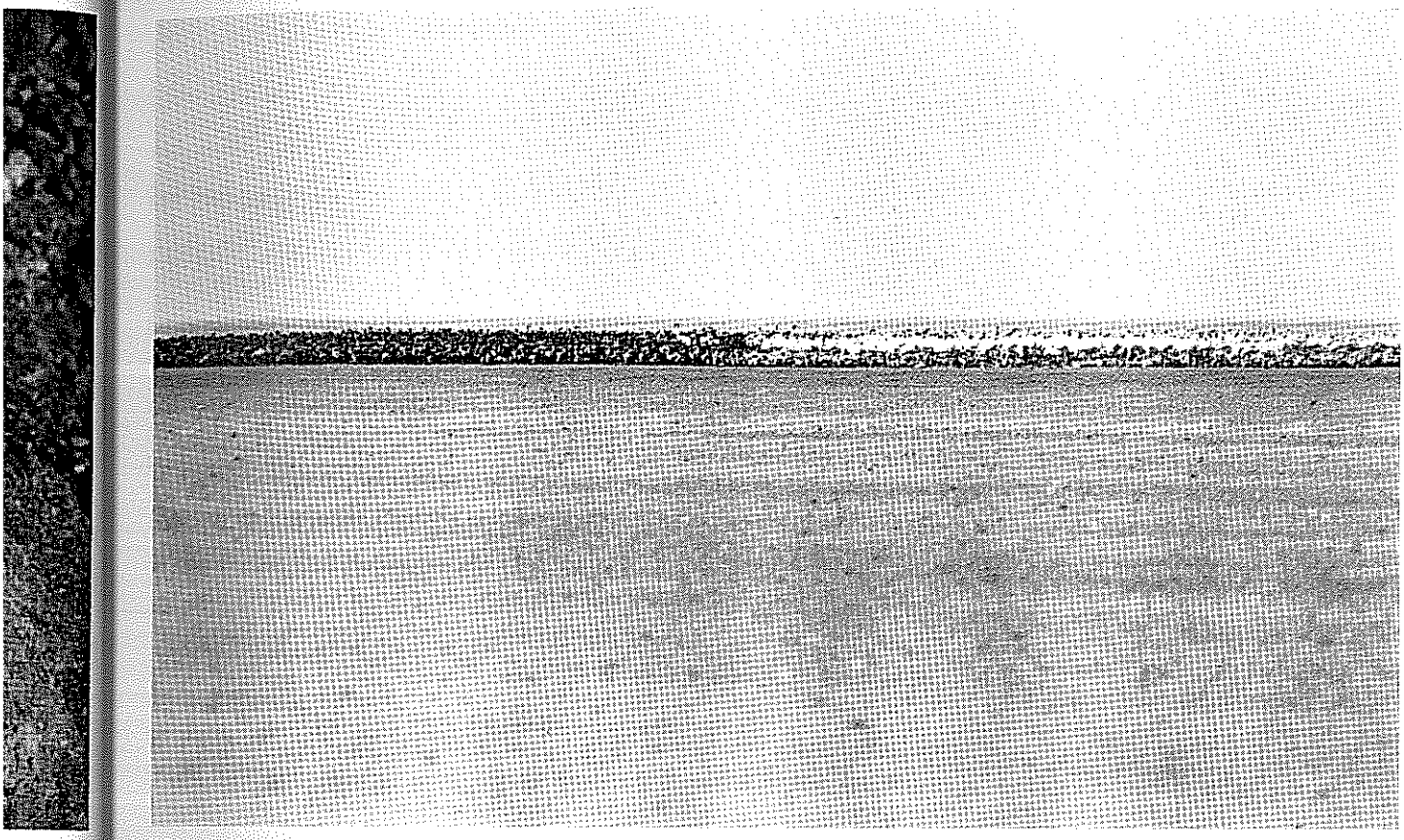

Plate 7. In the nursery there was a sharp division between downy young (with adults) and partly-feathered young.

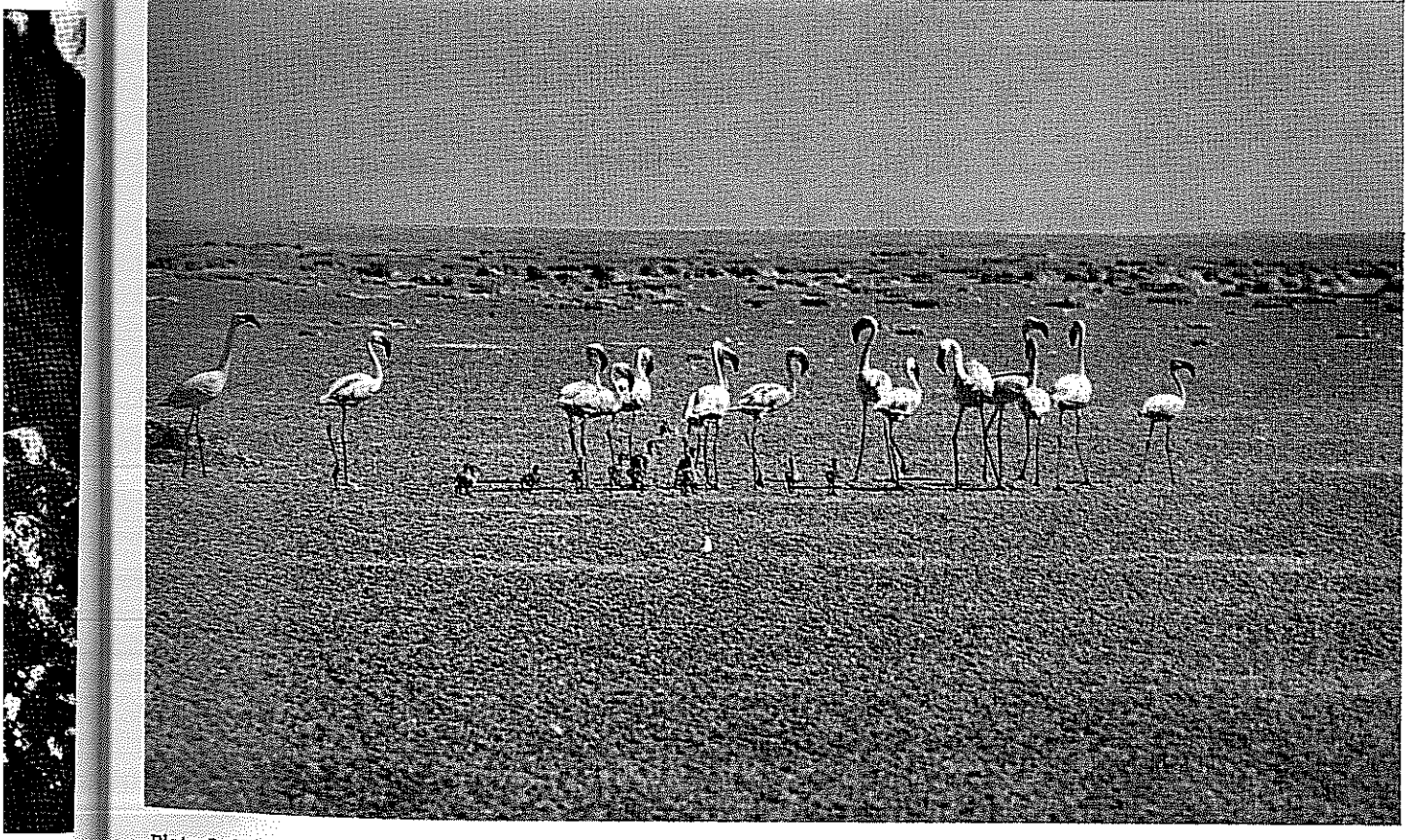

Plate 8. When chicks become sufficiently mobile the parents escort them from the nests to join the main nursery.

# Activity patterns shown by Hartmann Zebra *Equus zebra hartmannae* in South West Africa with reference to climatic factors

by
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## I. INTRODUCTION

The daily activity of mammals has, until lately, been somewhat neglected, their other behavioural aspects, such as social behaviour having attracted more of the researcher's attention. Recently however, the daily activity of the black rhinoceros *Diceros bicornis* was studied in detail in Kenya, (Schenkel & Schenkel, 1969) and in South West Africa (Joubert & Eloff, 1971). In addition three papers have appeared in the East African Wildlife Journal. In the first of these, Spinage (1968) advocates the standardization of procedures for the study of ungulates. In his study of the defassa waterbuck *Kobus defassa ugandae* he uses the same method for quantitative study of activity, used for zebu cattle *Bos indicus* by Rollinson, Harker & Taylor (1956). Clough and Hassam (1970) used the same method in their study of the daily activity of the warthog *Phacochoerus aethiopicus*. Both these papers (Spinage as well as Clough & Hassam) however, are based on short observation periods of two to three days and a very limited number of animals (one waterbuck and three warthogs). The third paper, however, by Owen (1970) on the sitatunga, *Tragelaphus spekei*, is based on the number of sightings recorded in each hour of the day during a sample of 284 days over 15 months. Elsewhere in his study on the Burchell's zebra Klingel (1967) spent eight days and five nights to work out their activity pattern over 24 hours. During this period he watched a large number of animals and every 15 minutes noted how many of the animals were grazing, standing, lying or walking.

This present paper forms part of a larger research project on the ecology and behaviour of the Hartmann zebra in South West Africa which was carried out from the latter half of 1968 until June, 1971. For the larger project various study areas throughout the Hartmann zebra range was used. Most of the information in this paper however was collected at the Daan Viljoen Game Reserve.

The Daan Viljoen Game Reserve is located just outside Windhoek, 28 km by road or 14 km as the crow flies. It is approximately 4 000 hectares in extent, but the area in which the Hartmann zebra are confined is just over 1 100 hectares. It lies on the eastern side of the Khomas Hochland and is severely dissected by the Augeigas River and tributaries which form a part of the upper reaches of the exoreic drainage system of the Swakop River. The Game Reserve is approximately 1 800 metres above sea level in extremely broken, hilly country. The hills are composed of wheathered mica-schists with steep slopes, especially on the eastern sides. The steepness of the slopes is mainly due to the geomorphological characteristics of the parent material. The drainage lines are very well marked and run in a series of parallel ravines in a northerly direction each with lesser side branches from east to west.

The vegetation may be classified as montane savanna (South West Africa vegetation map by W. Giess,

Herbarium, Windhoek). The vegetation on the hills are mostly open with scattered trees. Most of the tree growth is restricted to the drainage lines. On the hills the most prominent tree is *Acacia hereroensis*, averaging about 4 metres high. Most of these trees are stunted although in sheltered areas they grow higher. Other trees on the ridges are *Ozoroa crassinervis* and *Combretum apiculatum*. Both the *Acacia* and *Combretum* show a marked browse line as well as extensive damage caused by kudu *Tragelapus strepsiceros*. In the drainage lines the dominant tree growth is formed by *A. karroo, A. giraffae* and *Ziziphus mucronata*. The tall shrub layer is formed by *A. mellifera* var. *detinens, A. hebeclada, A. reficiens* and *Euclea undulata. Rhus lanceolata* frequents the drainage lines while on the slopes one finds *Rhus marlothii*. The dominant perennial grasses consists mainly of *Anthephora pubescens; Enneapogon cenchroides; Schmidtia* ssp.; *Stipagrostis uniplumis* and *Aristida meridionalis*.

The area has a strongly seasonal climate with regard to both temperature and precipitation. Winters are almost totally rainless and virtually cloudless, and with exceedingly low humidity. Precipitation occurs as summer convectional rainfall, with an annual mean of approximately 375 mm. During the summer months the relative humidity is extremely variable. Marked fluctuations in temperature, both daily and annual, occur. Summers have very high sun temperatures, but experience strong radiational cooling after sunset. Winter temperatures are fairly low (often near freezing) at dawn but rise rapidly after sunrise.

## II. METHODS

The study area at the Daan Viljoen Game Reserve was visited monthly for periods of a week or longer. An attempt was made to visit the area always during the two middle weeks of each month. Observations were always made from a vehicle. The procedure normally followed, consisted of locating a group of zebras as shortly as possible after first light. These animals were then observed from the vehicle at distances that varied from approximately 50 to 200 metres until last light in the evenings. The observer always attempted to have a drainage line between himself and the hill or slope occupied by the zebras, as this seemed to make them more at ease.

Notes on their activities were jotted down at five minute intervals. At these times it was noted how many of the group of animals watched were actually grazing or performing other activities. At halfhour intervals the irritation caused by insects was measured. To do this the number of times an animal twitched its tail in one minute were counted. For accuracy a stopwatch and tally counter was used. This was done with three animals in a group and the average determined. Social behaviour was observed and noted down throughout the observation period. The various activities were then divided into either half-hour time intervals and the percentage of animals performing a certain activity determined. In other activities the number of observations during a one-hour time interval were determined. For the figures delineating grazing only observations made during 1970 are used. Each figure is based on one day each month so that the specific activity, temperature and relative humidity for that particular day could be correlated.

## III. GENERAL DAILY ACTIVITY PATTERN

### a) Nutritional activities

Grazing: —

This behaviour pattern showed daily variations. It is, however, the activity that filled the best part of each day and when compared with other activities, is relatively stable. It was found that not all the animals were grazing at or shortly after first light. Normally, however, from within half an hour after first light the grazing activity intensified to become one of the major feeding periods of the daylight hours. After two to three hours the activity slowed down considerably, with some of the animals grazing while others rested or engaged in other activities.

Even during the rest periods of the day hardly any time passed without some of the animals starting to nibble for a few minutes. The grazing activity intensified again from about 15.00 hours and normally reached its highest intensity shortly before last night. During the rest of the day the grazing pattern was rather erratic with feeding activity taking place at a rather leisurely place.

From the grazing activity graphs (based on one average day for each month), it will be seen that it rarely happens that more than 90 per cent of the individuals in a family group graze together at any one time. This is due to the fact that the activity percentage is based on half-hour time intervals, each consisting of six observations. If, however, the five minute observation periods are analysed independently, it is found that one hundred per cent of the family groups were observed to be grazing together for 4,8 per cent of the total number of observations per day during February; for October this figure rose to 20,8 per cent. The reason for this dramatic increase during October will be discussed under seasonal variations. The periods when 100 per cent of the family group were grazing were normally during the early morning or late afternoons, viz. during the two major daylight grazing periods. The fact that these animals do not normally all graze together at any one time probably results in increased vigilance.

While the animals are busy grazing there is a slow but almost continual forward movement. This movement normally takes a zig-zag course. While

thus grazing the animal moves a considerable distance to left and right of its forward direction; the zig-zags may be anything up to 100 metres. As soon as the animals come across a patch where the grasses are more palatable, the legs of the zig-zag pattern may shorten to a few metres. Sometimes while grazing in this pattern, the animal moves back during the zag on nearly the same line taken during the zig part of the movement. This manoeuvre then brings them back to almost the same place were the zig-zag movement was initiated, sometimes as much as an hour earlier. This zig-zag mode of grazing nearly always follows the contours of the area in which the animals are grazing. Despite this, the animals sometimes stand grazing with head pointed down the slope or facing up the slope. While a family group is grazing it is notable how many of the animals are facing the same direction. According to field observations this occurs with an average of 62 per cent per family group under observation. The advantages if any, of this behaviour are not known.

Another very conspicious behavioural trait is the lack of synchronized grazing between the dominant male and the rest of the family group. Normally he only starts his grazing activities long after the females have started in the morning and always continues some time after they have lessened their grazing intensity. It is doubtful whether this behaviour can be attributed to vigilance on the male's part. During this period of inactivity he always assumes the posture of sleep. Where, on a number of occasions during these periods an alarm was given, it was noticed that it was nearly always done so by one of the females. It is of course possible that the male rests after having been vigilant throughout the night. Indications are, however, that the females have to feed longer owing to the drain of lactation. Some times a mare and her foul graze independently, away from the main concentration, sometimes as far as 200 — 300 metres distant, before moving back again.

Nutritional activities of foals: —

Foals start grazing within a few days of being born, although they remain dependent on their mothers until weaned. Figure 1 shows the daylight suckling pattern of Hartmann zebra foals. This shows clearly that although suckling occurs throughout the day, two peak periods exists. These are between 08.00 hours and 10.00 hours in the morning and then again from 14.00 hours onwards in the afternoon.

The two above-mentioned peaks coincide with the major feeding periods of the family group. The foals when desirous of suckling show a definite behavioural pattern. The foal approaches the female who normally is grazing and walks in under her neck rubbing its side against her shoulders (laterally and anteriorly). This normally forces the female to stop her forward movement while still grazing. The foal continues with this "crossing the bows" movement and ends up head to tail alongside the female and starts suckling. During the study period this movement by the foal was initiated in 49 per cent of the time from the right hand side and in 36 per cent of the time from the left side of the female. On 15 per cent of the occasions the foal tried suckling from behind between the hindlegs of the female. This latter approach was invariably unsuccessful, while the percentage of success with the former two approaches was quite high. The behaviour described above might be what Tinbergen (1951) called a social releaser. These are, according to Tinbergen, properties — either such of shape and/or colour, or special movements serving to elicit a response in another individual, usually a fellow member of the same species.

Newly born foals nurse with a very high frequency throughout the day. On the average about an hour passed between "feeds". The actual suckling lasts from 50 seconds to 75 seconds. The foal then waits approximately 10 seconds before nursing again for never longer then 15 seconds. While the foal is suckling the females sometimes sniff at the anogenital area of the foal. As the foals grow older the number of times they suckle during the day declines while the actual time spent suckling shortens to approximately five to 15 seconds. Their attemps to suckle also become less successful. This is especially noticeable from the time when they reach the age of approximately six months. This forces them to spend more time grazing. They are weaned when they reach the age of approximately 10 months.

Drinking: —

Where the zebra are hunted they normally come down to water during the night. Sometimes late evening, before 22.00 hours, but more likely during the early morning hours after 04.00 hours. In areas where they are protected or not disturbed, as at waterholes high in inaccessable mountains, they drink any time throughout the day. This behaviour was observed at the rainwater pans on the Naukluft Mountain plateau, and certain localities along the Kuiseb River, as well as in the Daan Viljoen Game Reserve. They may visit the water at any time throughout the daylight hours with peaks during the hours from approximately 07.00 hours to 09.00 hours and again from 19.00 hours. During the other hours of the day water is, however, also visited with a certain regularity. When water is available they may drink daily, sometimes even twice daily, viz., early morning and late afternoon. It is not certain how long they can remain without water during the hot day conditions but during the rainy season they might go two or more days without drinking (See figure 2).

b) Social activities

Hierarchy: —

Activities between the females of a family group to affirm social status occur throughout the day. These activities, however, reach a low point during the high intensity grazing activity of the two

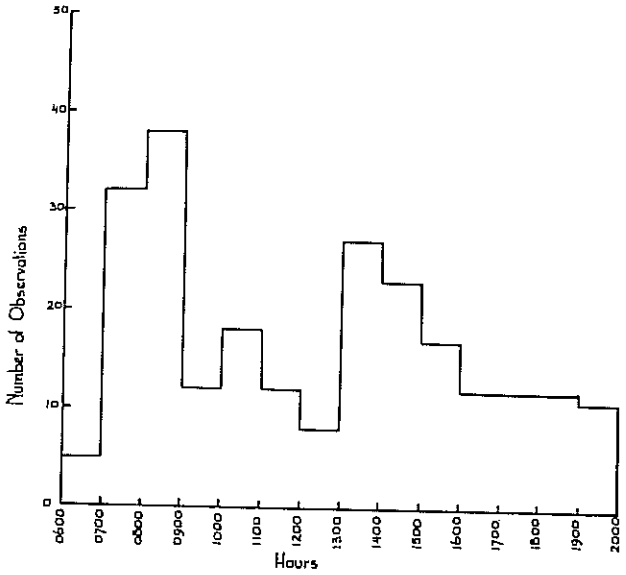


Figure 1: Daylight Suckling Pattern of Hartmann Zebra Foals.

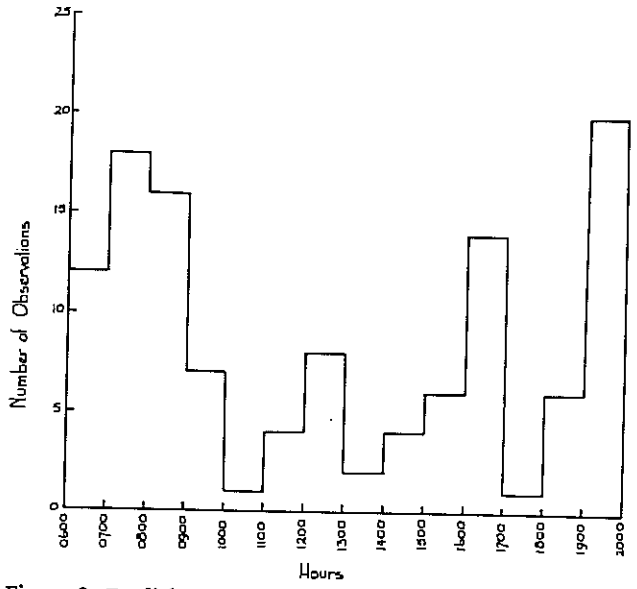


Figure 2: Daylight Drinking Pattern of Hartmann Zebra.

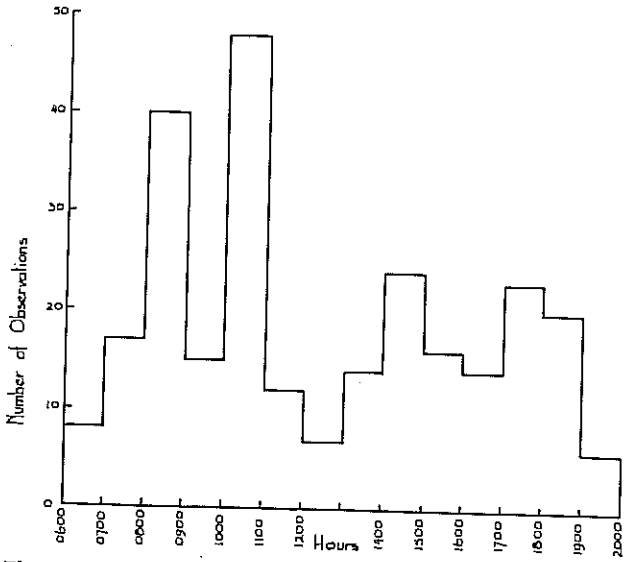


Figure 3: Hierarchal activities of Hartmann Zebra Females.

major grazing periods. Inversely, however, rival activities become more marked as the percenta of animals occupied with grazing activities d creases. Figure 3 shows a period of high intensi activity from approximately 09.00 hours. The oth figures illustrating comfort movements viz. rubbi and rolling also show increased intensity from abo the same time. This no doubt increases the con petion for the best shade, rubbing posts and a be ter position in the dust-bathing sequence.

Playing: —

This activity is indulged in mainly by the foals i a family group and the immature animals in th bachelor groups. In the former, play consists mostl of the running/chasing variety while with the latte it becomes more serious and consists mainly of pla fighting. Play occurs almost throughout the day a can be seen in figure 4, but with an apparen higher intensity during the morning hours. Thi high intensity playing from 07.00 hours to 10.0 hours coincides with the major morning activit period (See figure 4).

Mating: —

Mating activity occurs throughout the day as show by figure 5. Unlike most other activities howeve it shows a higher intensity during the afternoo from 13.00 hours.

Greeting rituals: —

The rituals observed by dominant males whenever two family groups happen to meet do not vary at different times of the day. This behaviour is caused by the chance meeting of groups and no pattern is discernible.

c) Comfort activities:

Resting: —

This is a very noticeable or marked activity in the Hartmann zebra. While resting they invariably do so in the shade of a tree. Even during some of the relatively cooler winter months zebra indulge in this activities. As shown in figure 6 this happens from as early as 07.30 hours in the morning thus shortly after first light. No animals were ever recorded standing in the shade later than approximately 17.30 hours. No clear correlation can be found between the time most animals seek shelter in the shade and the peak of the temperature curve, apart from a small increase in this activity between 13.30 hours and 15.00 hours. A large percentage of the family groups under observation normally sought shelter in the shade. Usually, however, one or two individuals wil stay out in the sun, either resting or grazing.

When resting, these animals normally adopt the posture shown when in deep sleep. This is by hanging their heads low — below shoulder height — with the ears held at right angles with the rest

of the body and parallel to the ground. Depending on the amount of disturbance caused by insects the tail is switched in a regular rhythm.

Dust bathing: —

Zebra are compulsive dust-bathers. This activity is carried out with a very high frequence throughout the day and throughout the year. There is no clear indication of what advantage this is to the animal. One can only guess that it might be to lessen disturbance by insects. However, there is no decline in the rate at which this activity is performed during the winter months when the insects causing the disturbance are virtually absent. From figure 7 one may see that dust bathing shows a clear pattern with peaks after the morning's grazing activity declines and then again before the afternoon's grazing activity reaches its peak. Insect irritation cannot be shown to have any clear peaks. However, there can be no doubt that insects do cause certain amount of dust-bathing especially when the animals are resting in the immediate vicinity of dust bowls. It is thought however that dustbathing is mainly "maintainance of the hide" activity.

Dust bowls are normally located at predictable places, usually on saddlebacks or ridges on mountains or in the bottoms of the valleys that dissect the Khomas Hochland. They are usually situated in sandy or loamy soil and are aproximately 2 to 2½ metres across and anything up to 30 centimetres deep. Sometimes there are a few located close to one another. Newly graded roads are also used. To lie down, a zebra bends its forelimbs and stands on its knees. It then lowers the hindquarters to the ground. Getting up, it gets onto its knees and then with a jerk pulls the hindquarters onto its feet. While lying down in the dust-bowl it lies flat on its side, also resting the head on the ground. It then twitches the tail working dust in between the higher parts of the hindlegs. It will then roll onto its back and back to the original position — it never completely rolls over. Foals however, sometimes do. After doing this three or four times it will get up and then lie down on its other side. The whole performance is then repeated. Sometimes the animals lie in this position in the dust-bowl for a several minutes before getting up.

Lying down: —

Adults were seldom seen to lie down except when about to indulge in a dust-bath. On the only two occasions that adult animals were observed to lie down the animals concerned were pregnant mares, heavy in foal. In both instances they did not lie down for longer than 25 minutes. Foals however, lie down very often especially between 09.00 hours and 18.00 hours with peaks during 09.00 hours to 12.00 hours and 16.00 hours to 17.00 hours as illustrated by figure 8. The length of time spent lying down varies between 5 minutes and 35 minutes, with the average being 18,2 minutes (102 observations). One interesting aspect is that in all the above-mentioned cases of lying down the foals

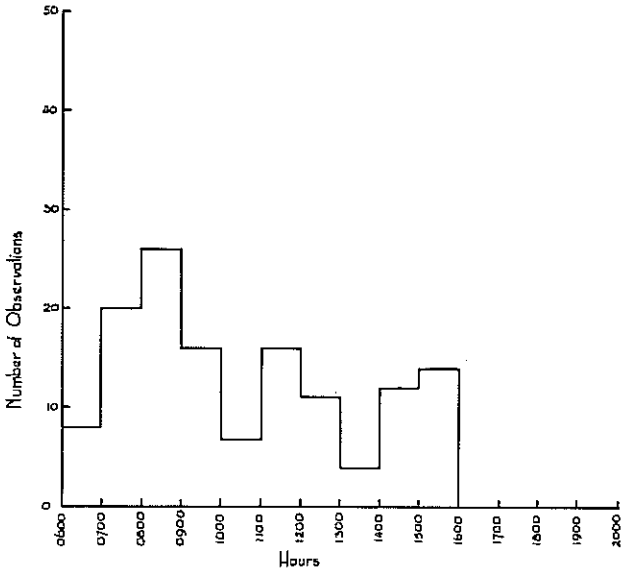


Figure 4: Playing Pattern of Hartmann Zebra Foals.

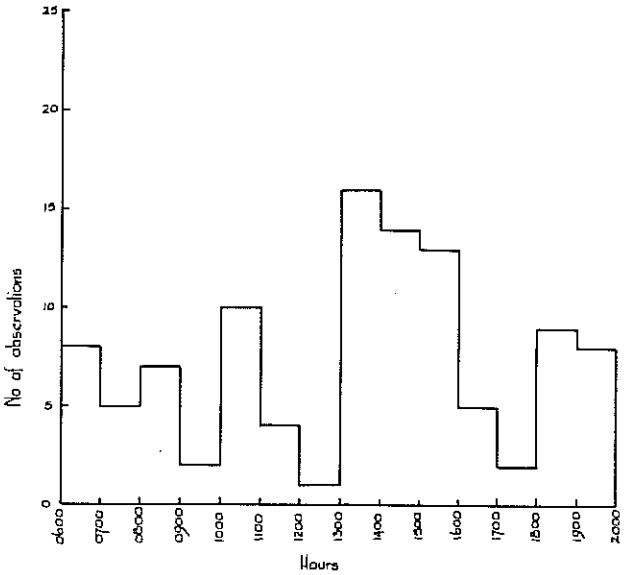


Figure 5: Pattern of Mating Behaviour in the Hartmann Zebra.

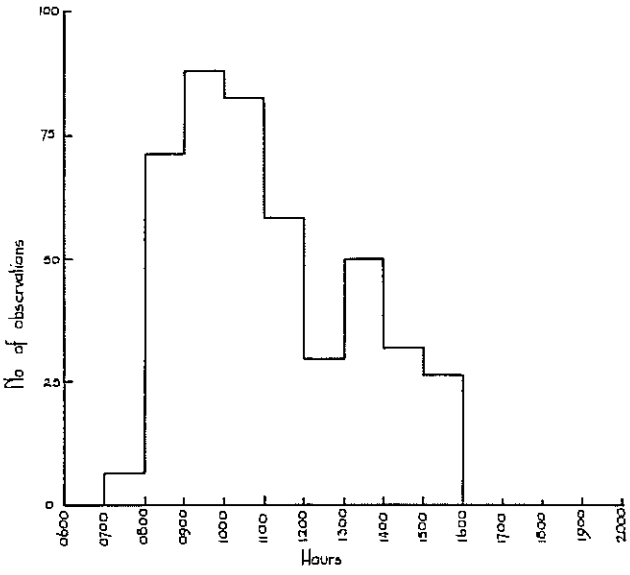


Figure 6: Resting in the Shade Pattern of Hartmann Zebra.

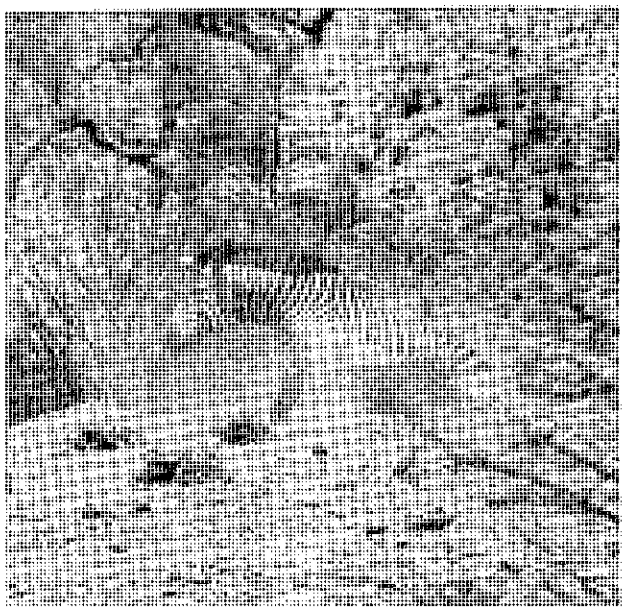

Plate 1. A Hartmann zebra rising with the front part of its body first.

Plate 2. A Hartmann zebra rubbing itself against a tree.

did so in direct sunlight. On no occasion was one of them observed to seek the shelter of a tree to lie down in the shade. When lying down they did so flat on their sides with their heads also resting on the ground.

Rubbing: —

This nearly always takes place while the animals are resting in the shade of a tree or under overhanging rocks. Animals were very seldom seen to interupt their grazing, just to rub themselves. The boles of trees were used to a very great extent in this activity although rocks were utilized sometimes. The brunt of this rubbing activity was normally directed at the neck and the side of the body. If the bole grew at an angle or if a rock was used the animal would try and straddle it to rub the insides of the hind legs and the rear part of the body. The face itself was very seldom attended to in comparison with the rest of the body. Only when a broken-off branch was available would this be used for scratching around the eyes and ears and sometimes the neck. They sometimes use the hooves on their hind feet to scratch their faces (See figure 9).

Grooming: —

No grooming between adults of a family group was ever noticed and only very seldom between mare and foal. Between foal and mare it was noticed with little more regularity. This amicable behaviour by the foal no doubt serve to promote the maternal instinct in the female and also as a mechanism inhibiting aggressive behaviour in the female. When observed between mare and foal as well as between foal and mare it normaly consisted of nibbling the neck and mane. No "licking" was ever seen such as is common with artiodactyls and certain carnivora. (See figure 10.)

Disturbance caused by insects: —

That Hartmann zebra are disturbed by insects is quite obvious from their behaviour in switching and twitching their tails extensively at certain times. Observations in the field first led me to believe that insect activity is closely correlated with temperature and not to light. This seemed to be confirmed by the fact that the zebra showed signs of disturbance by insects only an hour or more after first light (thus after the air had reached a certain temperature) and continued for a certain length of time after the sun had set (thus not limited by daylight or the lack of it). When the field data was processed and graphs drawn the picture did not seem so clear, especially when viewed on a daily basis. True, insect activity apparently only started after the environmental temperature had reached a certain level. However, instead of the insect disturbance intensifying with the rising

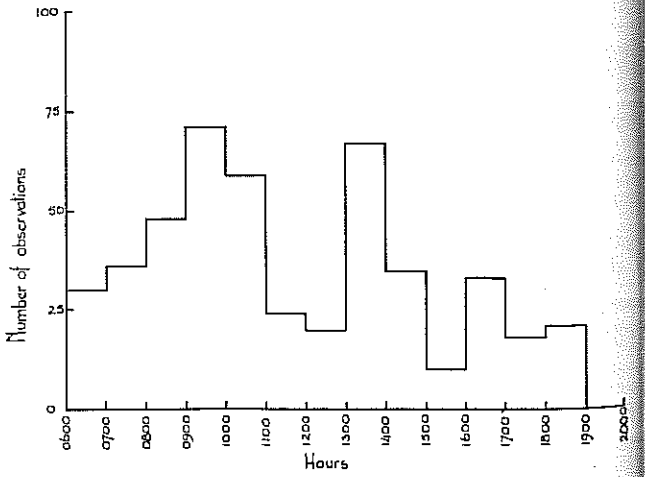


Figure 7: Dustbathing Pattern of Hartmann Zebra.

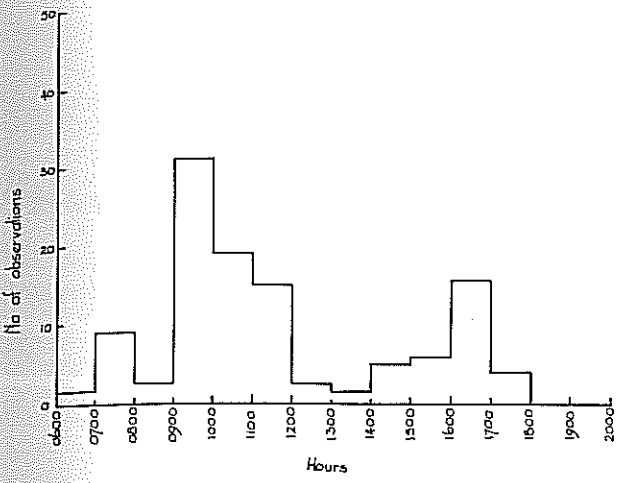


Figure 8: Lying down Pattern of Hartmann Zebra.

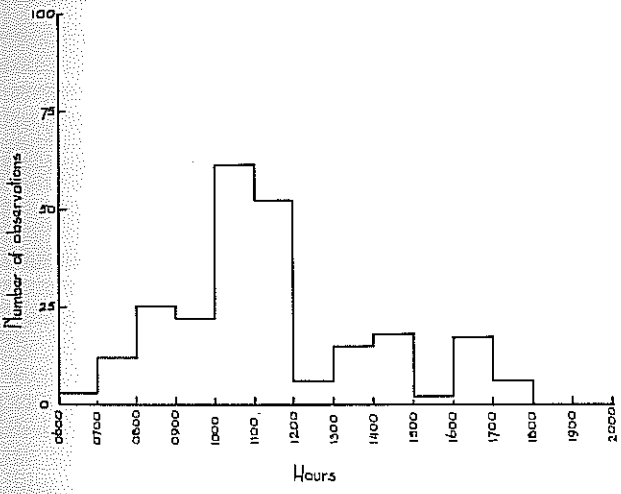


Figure 9: Rubbing Pattern of Hartmann Zebra.

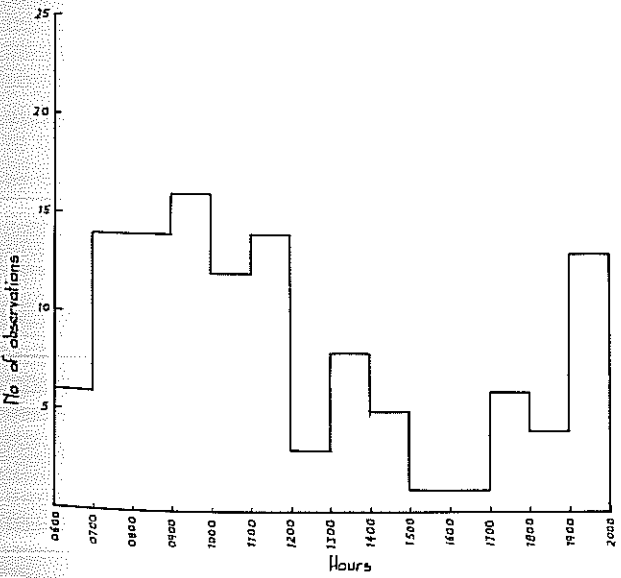


Figure 10: Grooming Pattern of Hartmann Zebra.

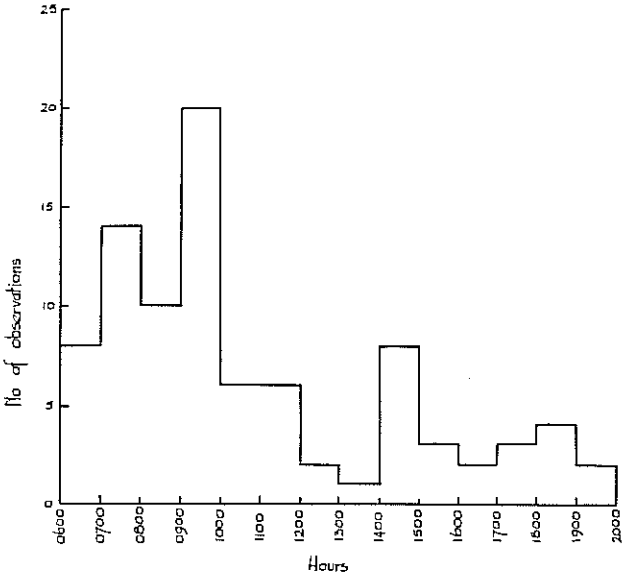


Figure 11: Defaecation Pattern of Hartmann Zebra.

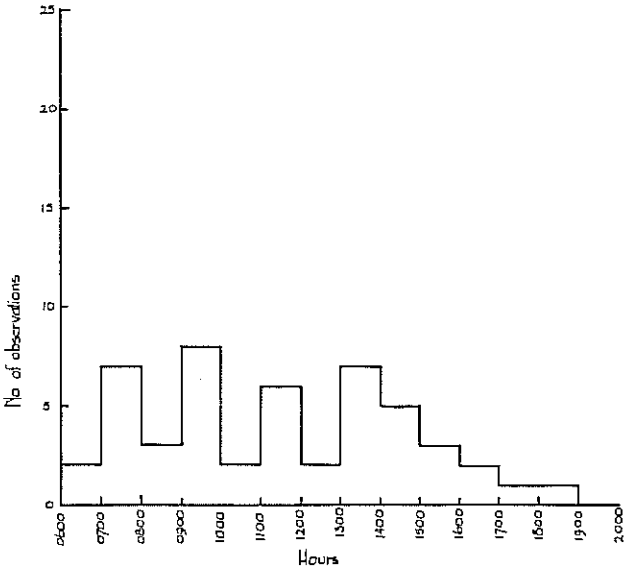


Figure 12: Urination Pattern of Hartmann Zebra.

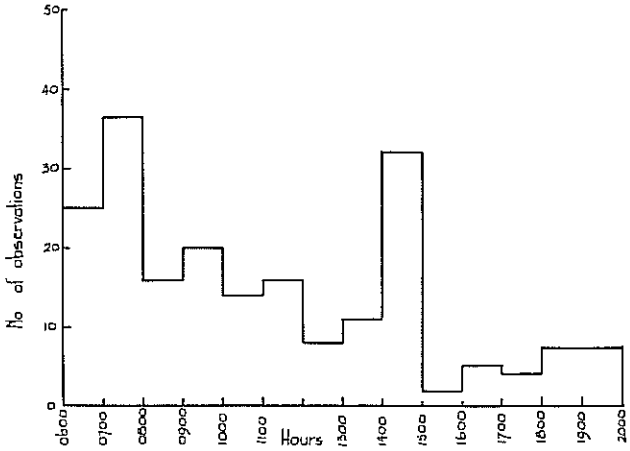


Figure 13: Walking without Grazing Pattern of Hartmann Zebra.

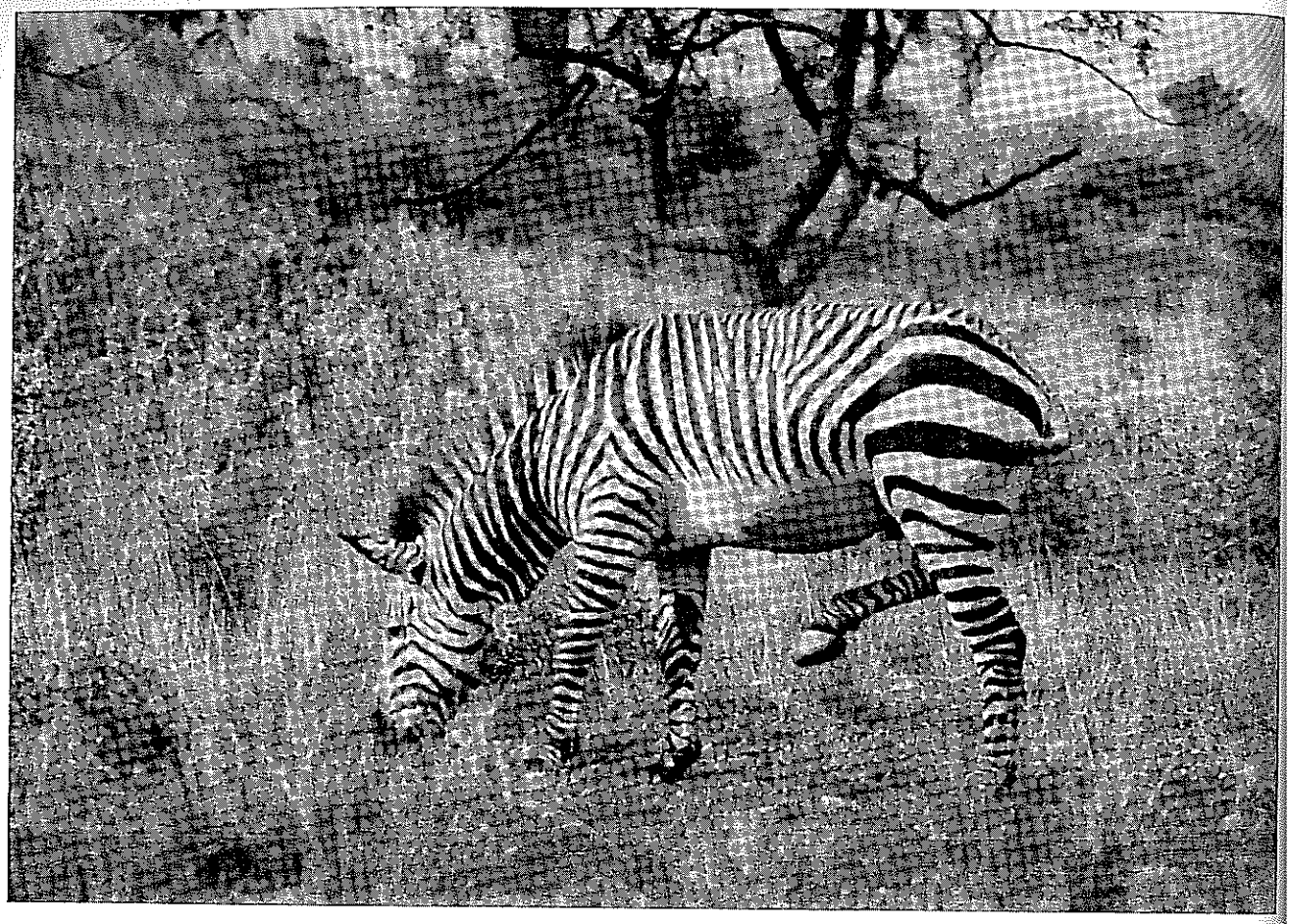

Plate 3. A Hartmann zebra male showing signs of irritation caused by insects — switching of the tail and stamping of the feet.

in temperature it remained very erartic. This may be due to either of the following factors.

- — certain microclimatic influences which could not be measured.
- — insects are very localixed in their distribution and only irritate the animals as they move through these distribution areas.

This latter theory might be the reason why certain individuals are some times much more agitated by insect activity than individuals fifty metres away which showed hardly any sign of irritation.

d) Sanitary activities

Defaecation: —

In the field, animals defaecated any number of times, varying between three and eight times a day. Figure 11 shows clearly that although defaecation can take place at any time during the day, this activity reaches a peak during the morning high intensity grazing period. It was noticed sometimes that when one animal in a zebra group defaecated it acted as a expression movement and nearly all the other animals would then follow suit.

Urination: —

Urination does not take place simultaneously with defaecation although it can precede or follow it with only a short interval. Acording to figure 12 an animal urinates throughout the day, normally any number of times between five to thirteen, during daylight hours.

e) Other activities

Under this heading all the movements necessary for animals to fulfil their daily needs, additional to those dealt with above, will be discussed.

The major activity here consists of walking while not actively grazing. This takes place throughout the day. From figure 13 it may be seen that this activity starts in the morning with a high incidence. It then declines gradually; and it suddenly intensifies again dramatically to a high peak during the period 15.00 to 16.00 hours. Most of the other activities discussed elsewhere have a very low intensity during this time interval with the exception of grazing activity which shows a tendency to increase. It is possible that the peak shown on the figure, together with the peak between 07.00 to 08.00 hours, is caused by the animals moving into better areas for grazing. The high, early

morning, intensity could also be attributed partly to movement to, and from, water.

Klingel (1967) found that the Burchell's zebra have a specific sleeping place to which they retire every evening. In the morning they leave this sleeping place and walk to the grazing area, sometimes as far as 13 kilometres away. No such behaviour was ever noticed in the Hartmann zebra, in the Daan Viljoen Game Reserve or any other study area. They would spend their nights anywhere in the Game Reserve and start feeding at that particular place in the morning. The distance covered by day by the Hartmann zebra varies considerably and depends on such factors as condition of the grazing and season of the year. On the average they cover approximately one to three kilometres per day, grazing and at the most, five kilometres going to water. Even at the Naukluft Mountain Zebra Park and in the Khomas Hochland they would be remarkably sedentary.

Running caused by fright or other alarms happens throughout the day with no clear patterns as would be expected.

## IV. SEASONAL VARIATIONS DUE TO THE INFLUENCE OF CLIMATE

Owing to the lack of instruments and facilities to measure microclimate it is difficult to assess the influence of climatic factors on the behaviour of the Hartmann zebra in a more than a general way. This paper will therefore deal only briefly with the innumerable possible combinations of those physical factors which may have an effect on the behaviour pattern. The Hartmann zebra is so well adapted to changes in its habitat brought about by changing physical factors that only very subtle changes in its activity patterns were observed. Furthermore it is only because of the repetitive nature of some of these "subtle changes" in their behaviour that one can, albeit with a certain amount of trepidation, try to link them to the annual changes in climate. In this regard, the physical factors that cause the most marked change in their activities are temperature and rainfall.

### a) Nutritional activities

Grazing: —

From the figures (figures 14 to 25) depicting the grazing patterns and daily temperatures for the various months no obvious nor dramatic change is immediately visible. On studying the figures more closely however, three factors regarding the temperature come to one's notice.

(i) That the grazing patterns for the colder months (June, July and August) are not so extremely irregular as for the warmer months (October, November, December and January). During these latter months the grazing intensity is initially very high, being higher than 70 per cent at first light. It then has a number of high peaks during the day, with periods in between of very low grazing intensity. Bligh and Harthoorn (1955) in East Africa have shown with the aid of radio telemetry that animals lose much body temperature while standing inactive in the shade. (See figure 26.) This irregular grazing pattern shown by Hartmann zebra during the hot months thus could be an adaptation, the animals grazing in the sun until their body temperature reaches a certain peak then retiring in to the shade to lower their body temperature.

(ii) The daily temperature at first light has an apparent effect on the intensity of grazing at this time of the day. During June ,July and August the temperatures fell to below 20°C at daybreak. In each case only about 40 per cent of the animals under observation grazed at first light. During the rest of the year the percentage of animals actively grazing at first light is well over 50 per cent.

(iii) Another interesting aspect is the change in the time of highest grazing intensity during the various months of the year. During the more temperate months of April, May and September about an equal amount of very high intensity grazing takes place during the morning and afternoon. During the cold months of June, July and August after an initial burst, apparently just to satisfy their immediate needs, the animals stand around sunning themselves. As the temperure rises so does the grazing intensity increase. The bulk of the most concentrated grazing takes place during the afternoon.

(iv) Despite the fact that the grazing pattern for October is erratic it still has a very high intensity. This is most probably due to the flush of green grass on the veld after some showers of rain fourteen days earlier.

Another behavioural trait modified by climate is the orientation of the body to physical stimuli. It is a well known fact that black surfaces absorb more heat than do lighter coloured or white surfaces. Although no experimental physiological proof exists it appears from the behaviour shown by Hartmann zebra that this may influence their behaviour. As can be seen from figure 27 a zebra standing broadside on displays a body surface with a light: dark ratio of approximately 1:3. When facing away however, this ratio changes to approximately 3:1. This fact, combined with the difference in total body surface when viewed laterally and posteriorly makes the orientation of body surfaces to physical stimuli an important factor in the adaptation of the Hartmann zebras to their environment. This behaviour was especially marked during the early mornings of the colder months of the year. During these months they would also frequently sun themselves throughout the day at regular intervals especially if the environmental temperature was below approximately 20°C. This orien-

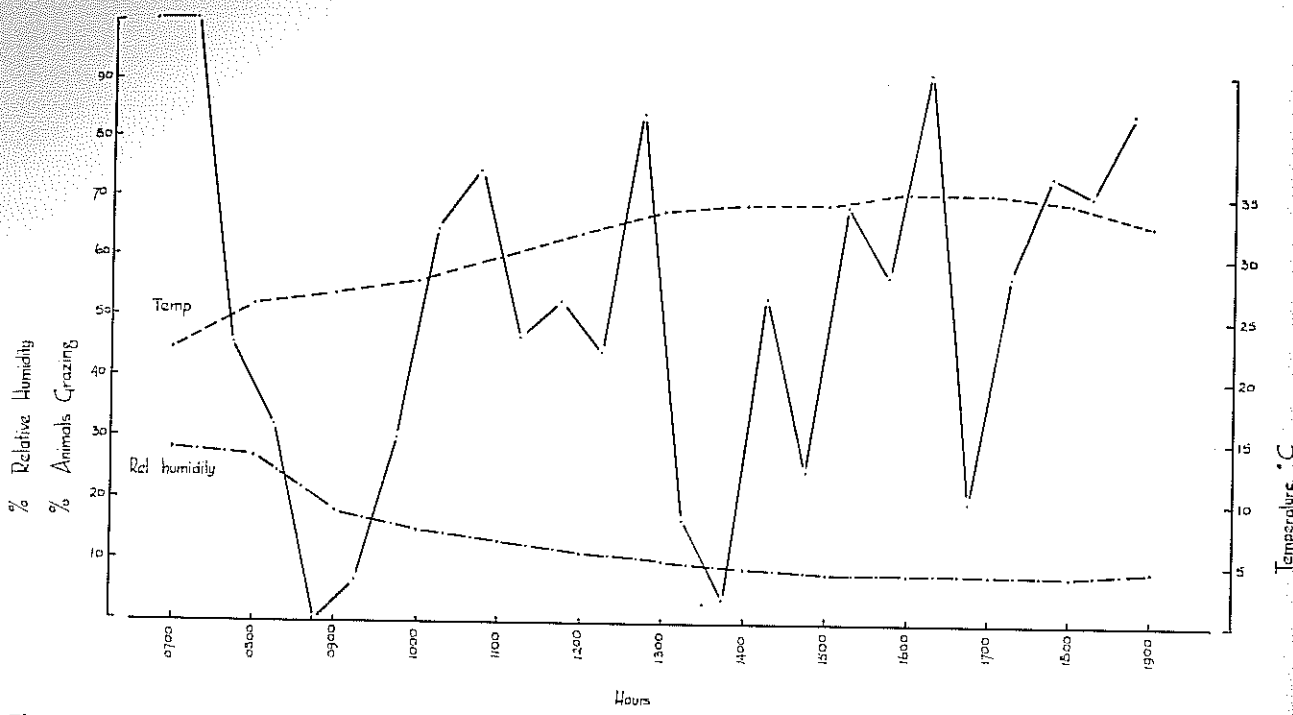


Figure 14: Grazing Pattern for January.

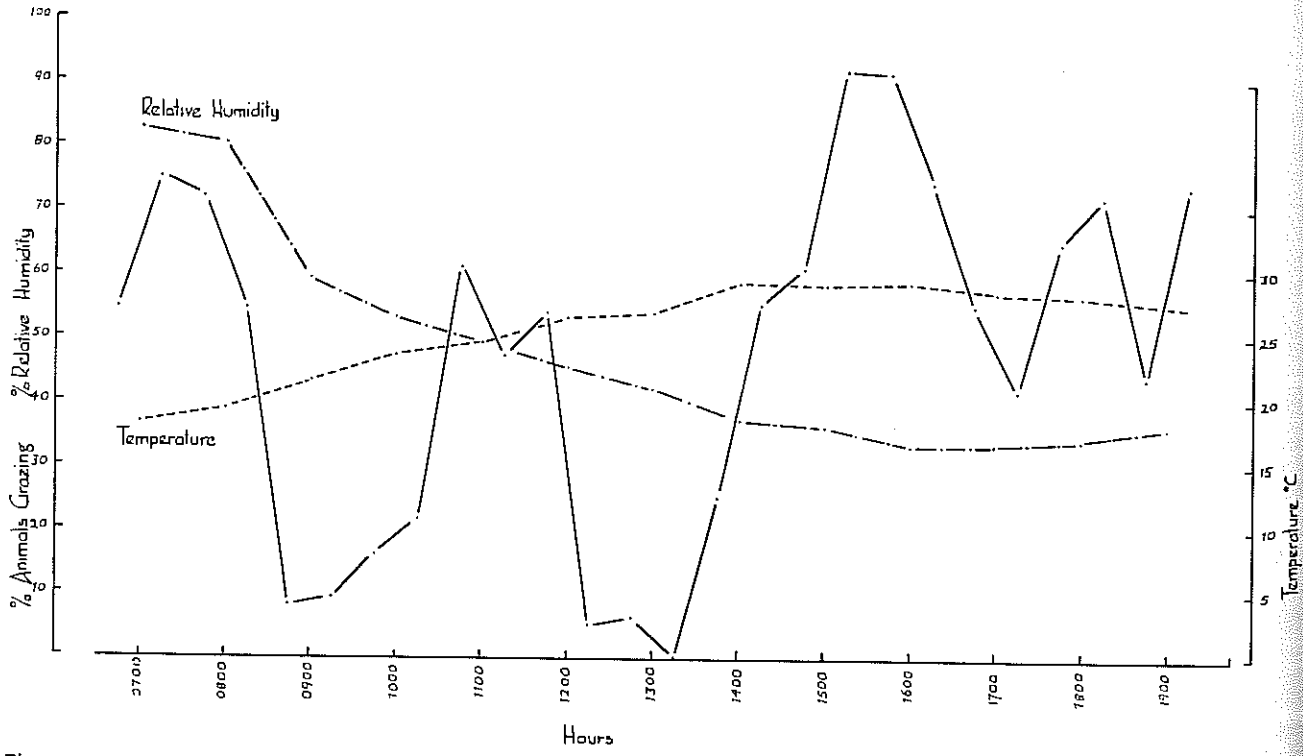


Figure 15: Grazing Pattern for February.

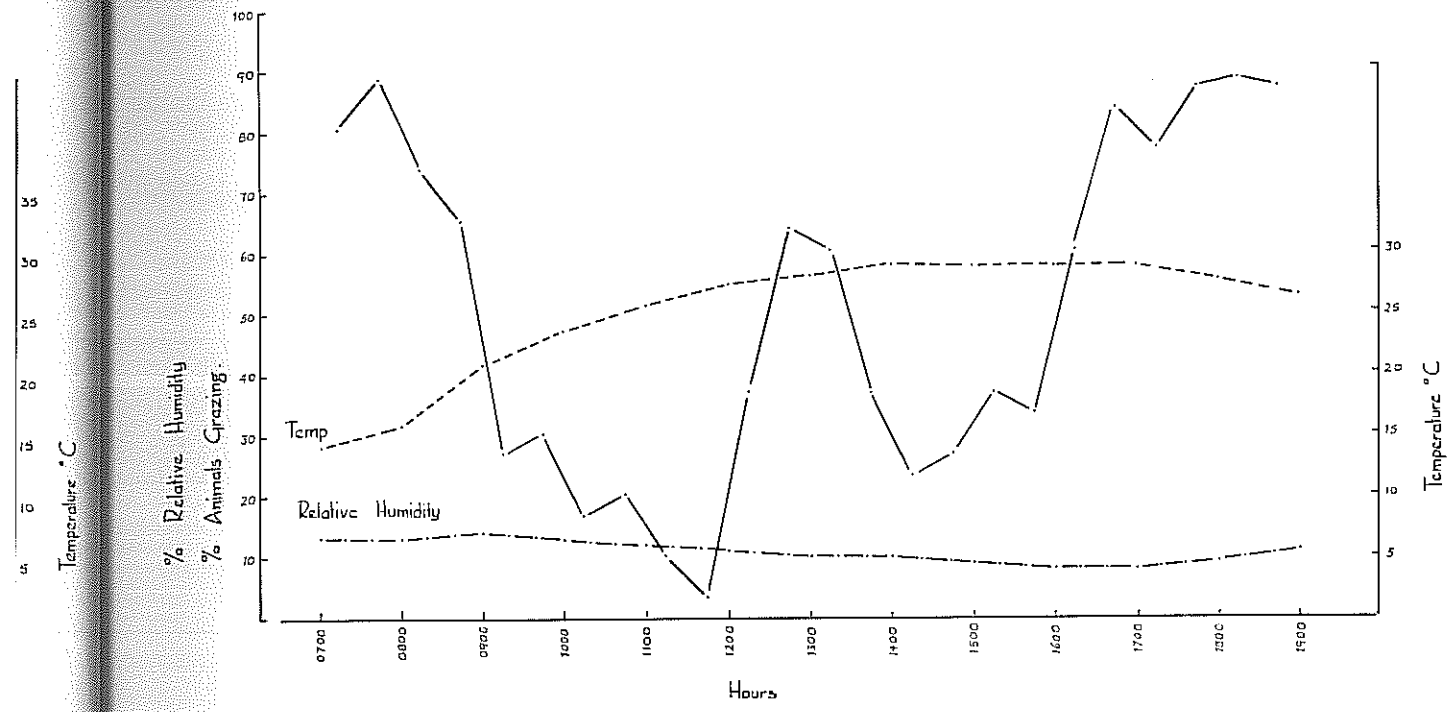


Figure 16: Grazing Pattern for March.

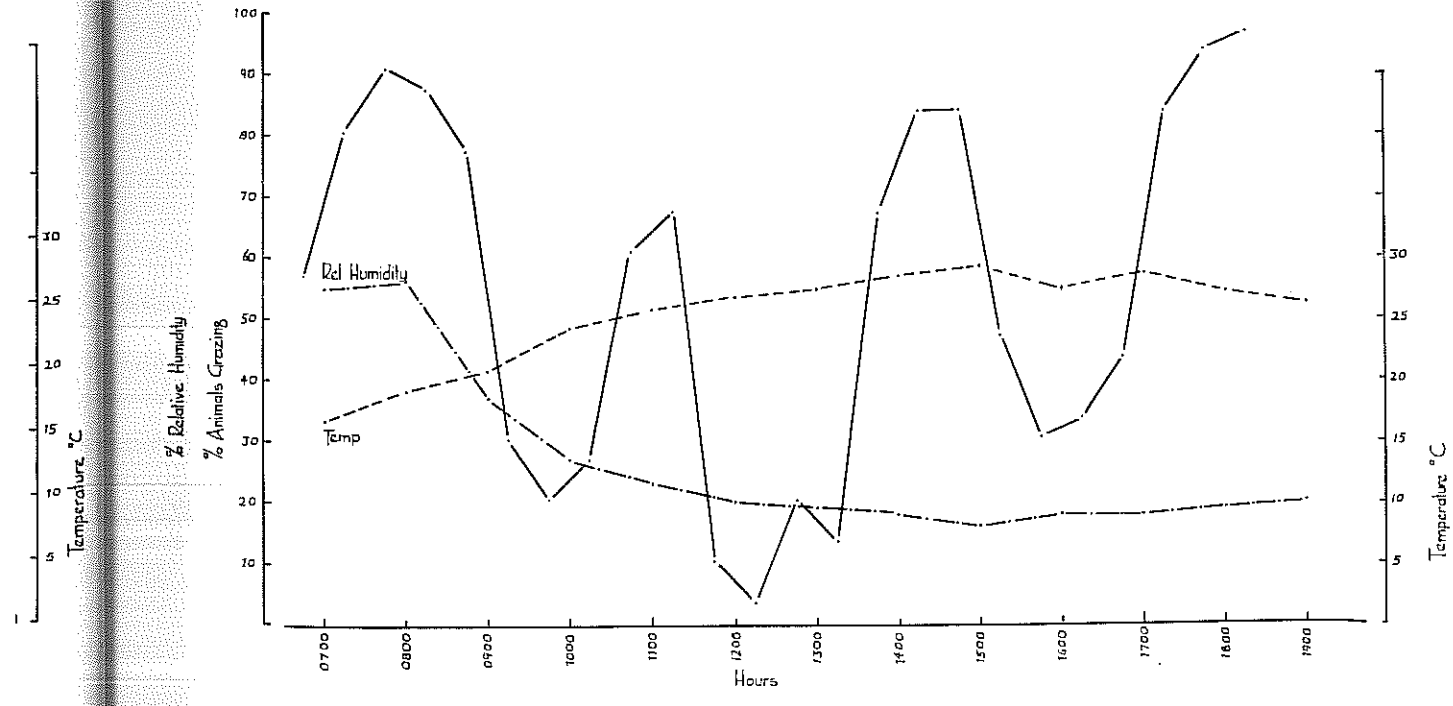


Figure 17: Grazing Pattern for April.

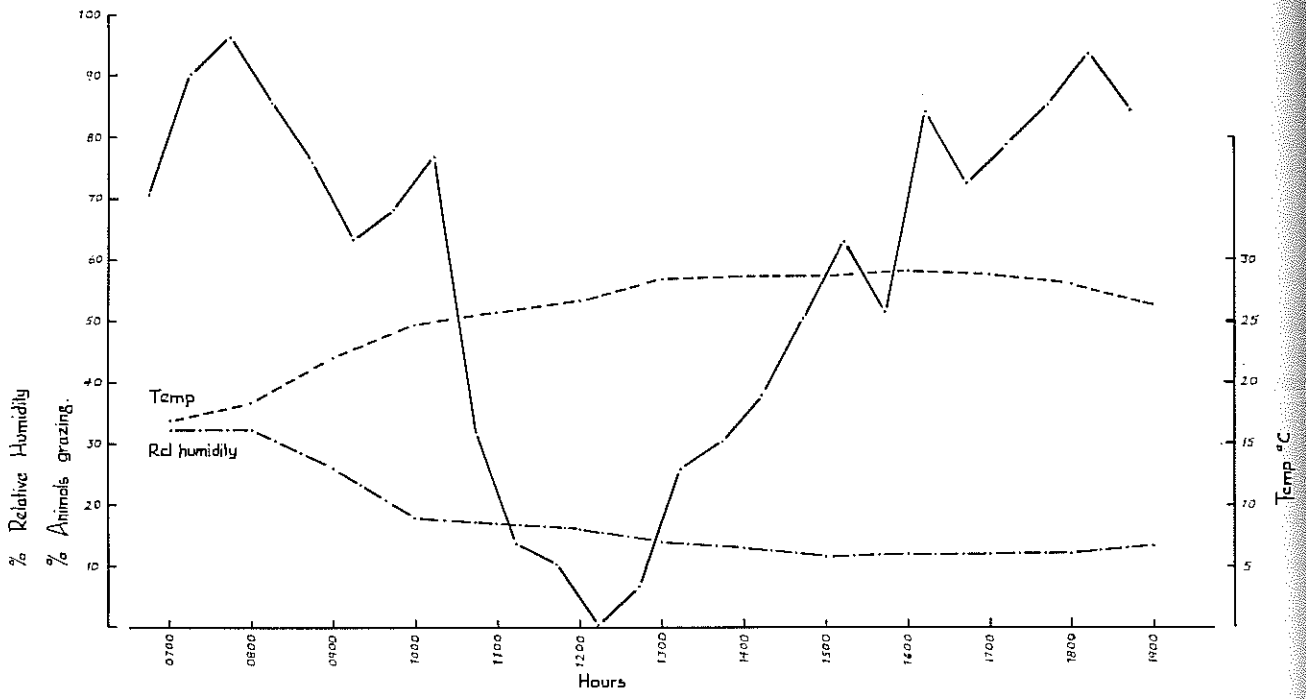


Figure 18: Grazing Pattern for May.

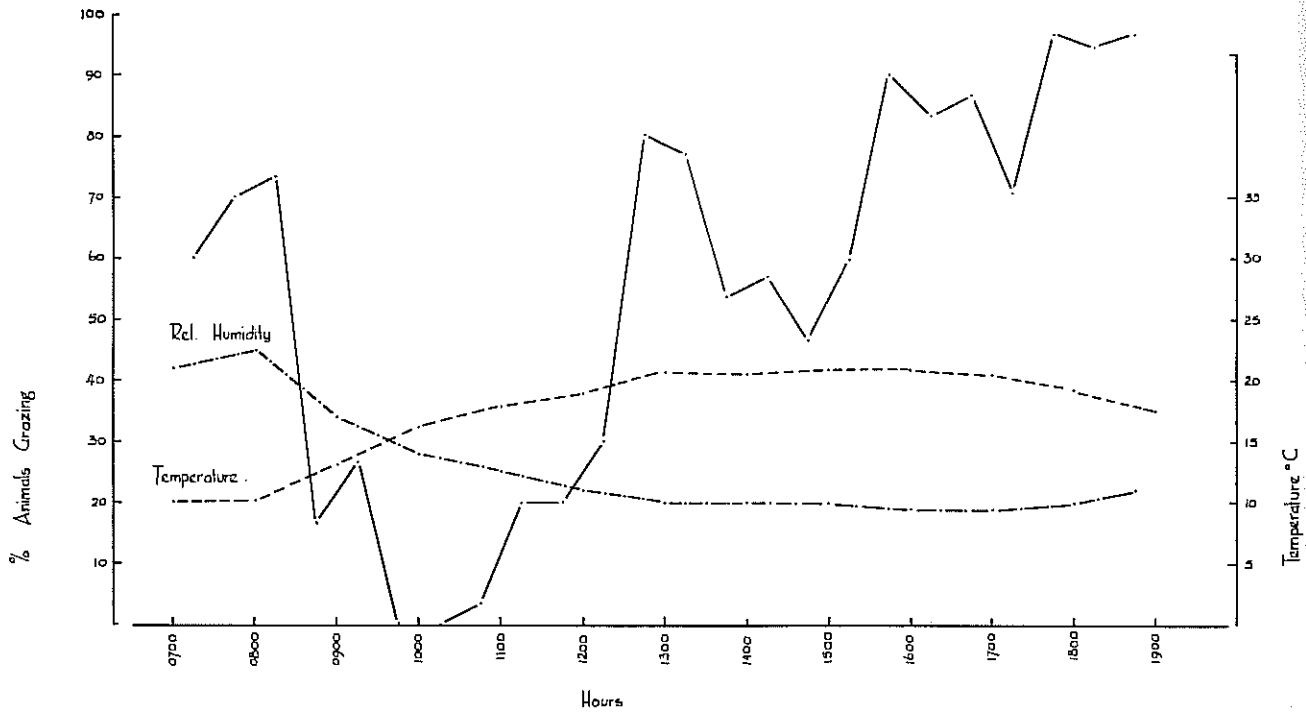


Figure 19: Grazing Pattern for June.

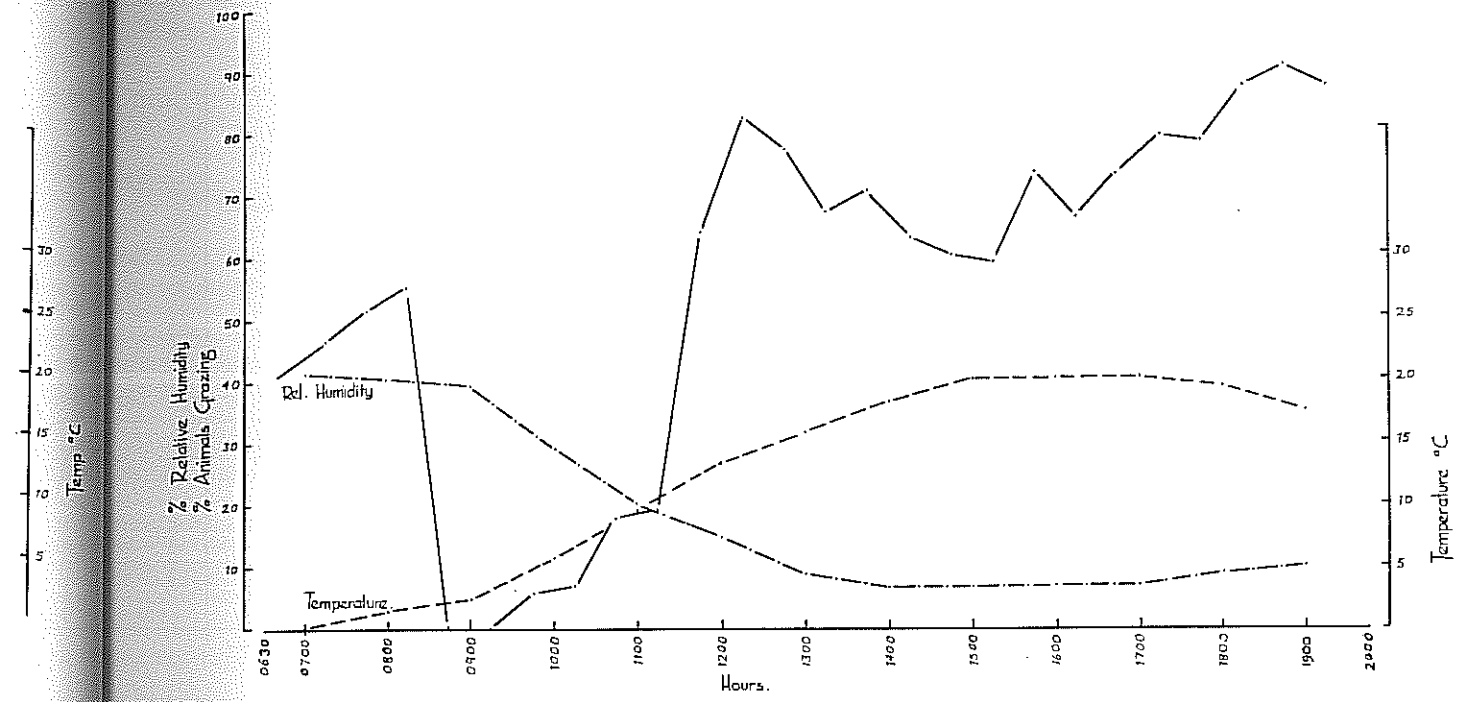


Figure 20: Grazing Pattern for July.

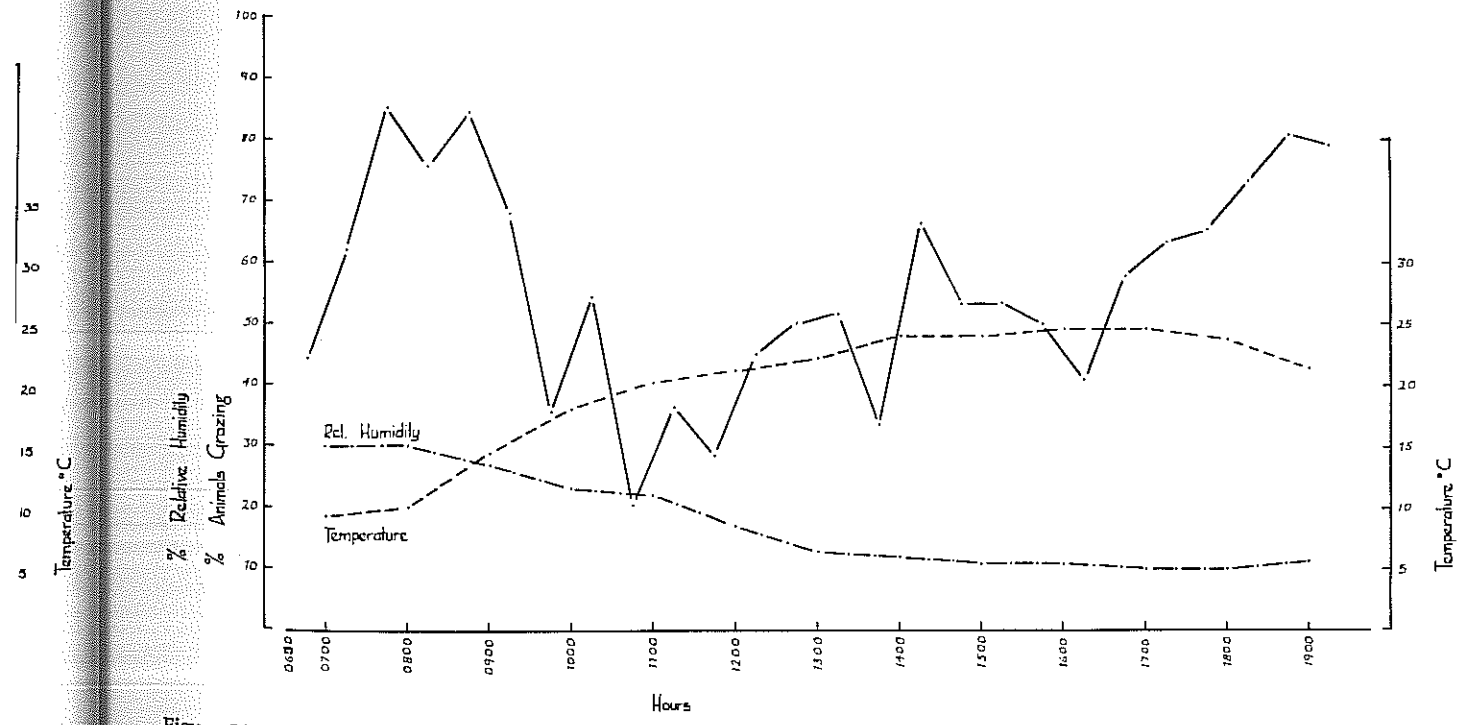


Figure 21: Grazing Pattern for August.

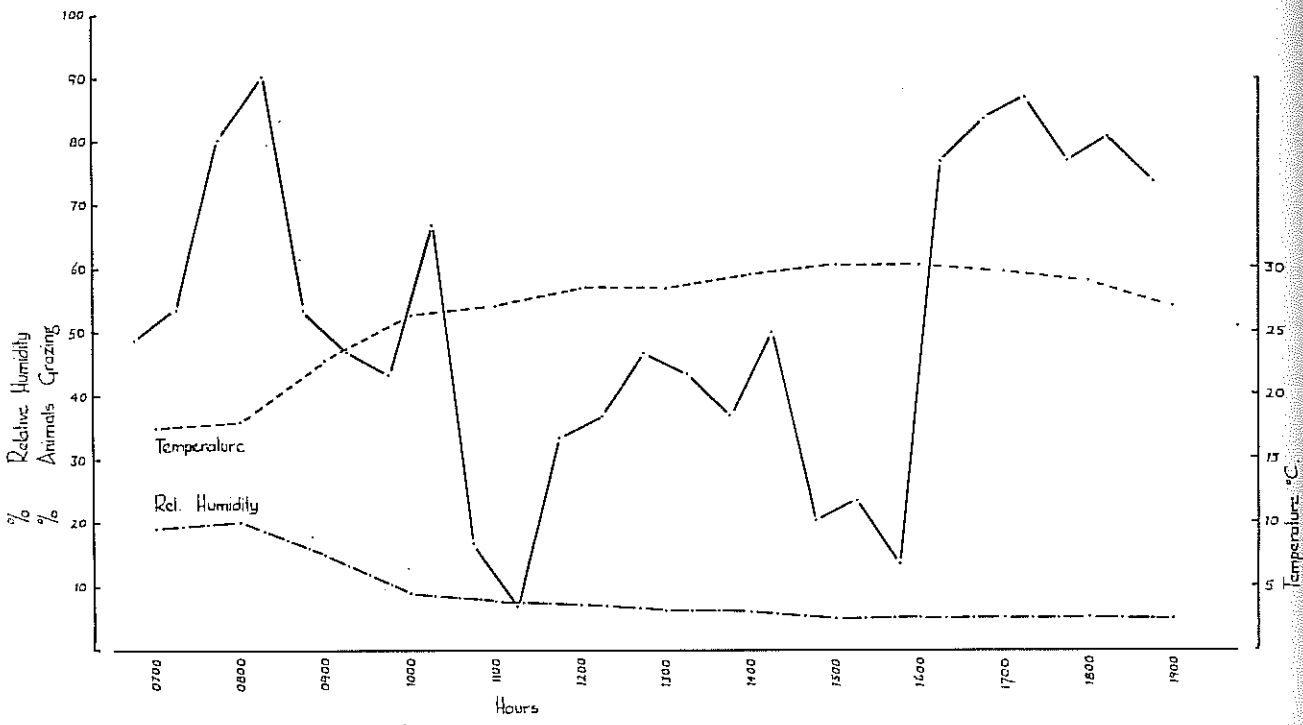


Figure 22: Grazing Pattern for September.

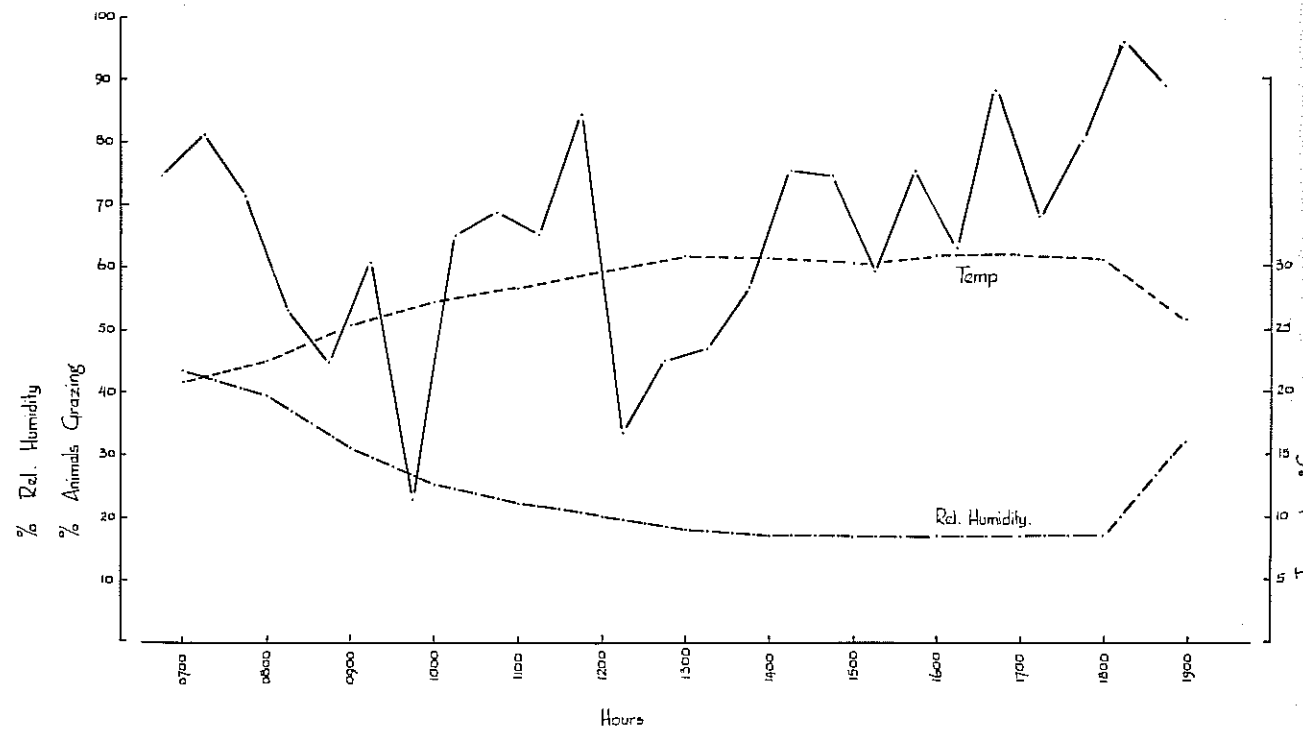


Figure 23: Grazing Pattern for October (Rain — Green flush).

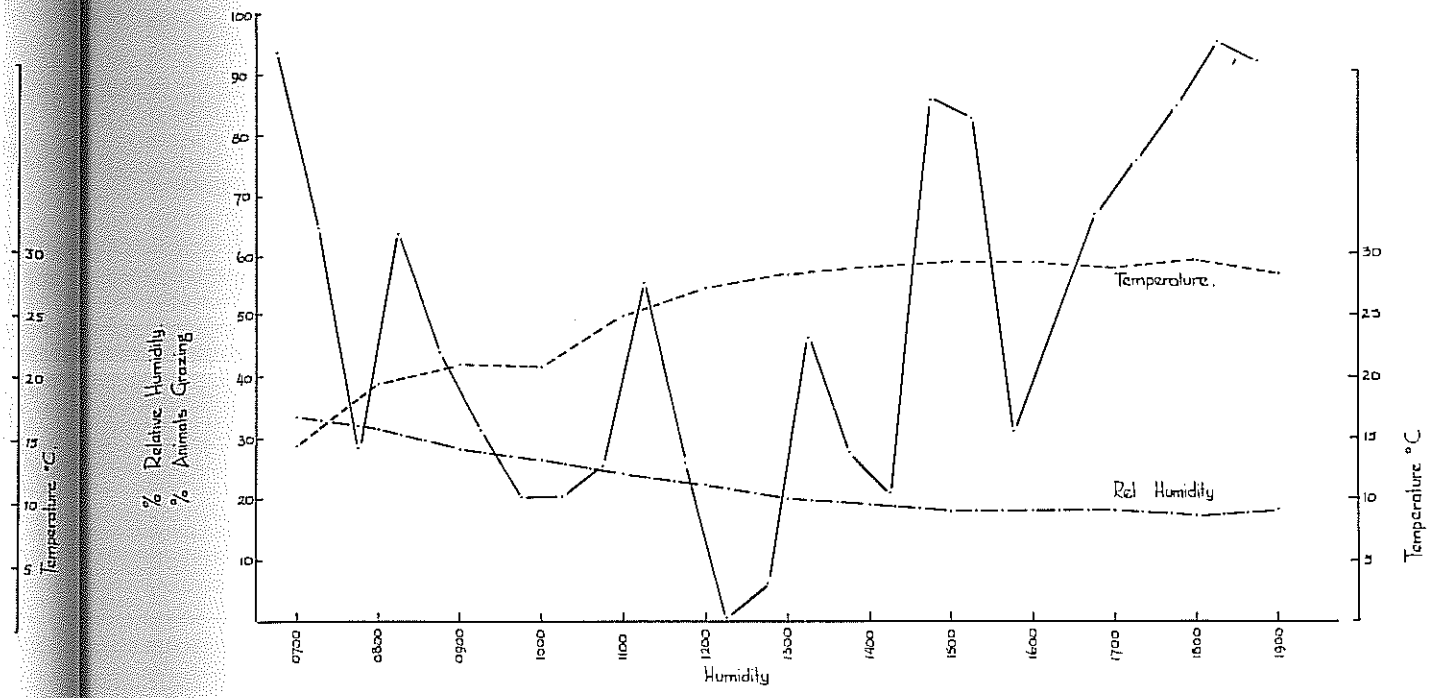


Figure 24: Grazing Pattern for November.

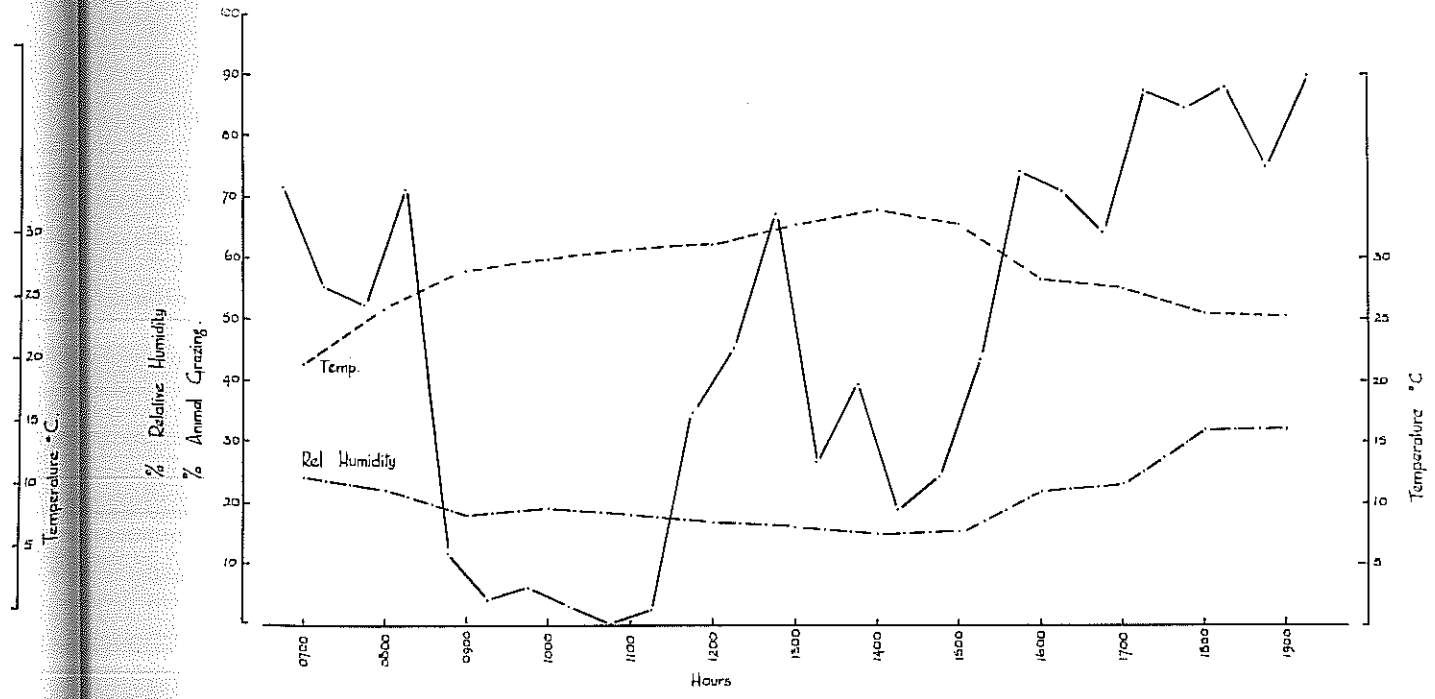


Figure 25: Grazing Pattern for December.

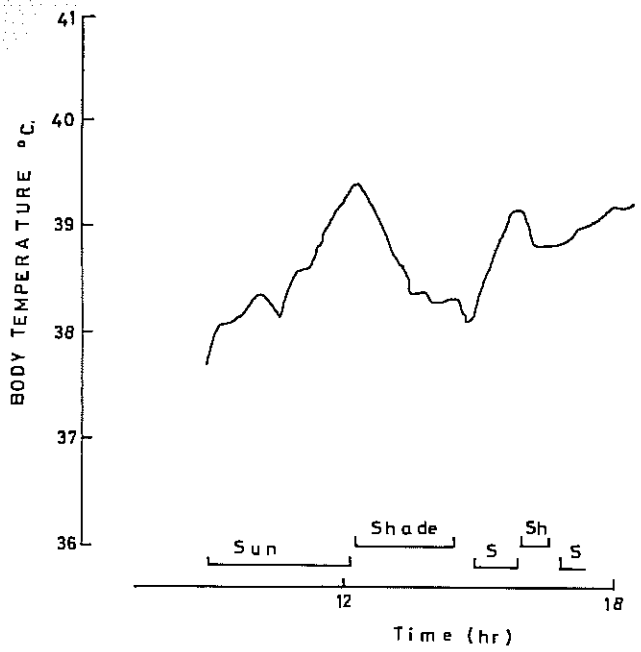


Figure 26: The deep body temperature of a 2-year-old Black Rhinoceros (After Bligh and Harthoorn 1965).

tation of the body to gain maximum absorbsion of heat, however, was not limited to the winter months. Even during the early mornings of summer months they would sometimes orientate themselves laterally to the rising sun — apparently to raise their body temperature. When the environmental temperature however, rose above approximately 25°C the zebras would normally orientate their bodies with the posterior end towards the sun while grazing. This of course means that more of the lighter shaded body surface for less absorption is presented towards the sun.

Another facet of this orientation to ameliorate the effect of temperature is the way in which Hartmann zebras tend to use the upper third of hill slopes more frequently than the lower two thirds during the heat of the day in warm weather. This is possibly a means of making full use of the cooling effect of breezes. The sometimes unpleasantly cold westerly wind in the study area was avoided by grazing on the lee sides of hills. Wind has very little other effect on the grazing pattern as zebra show no other apparent orientation towards the wind.

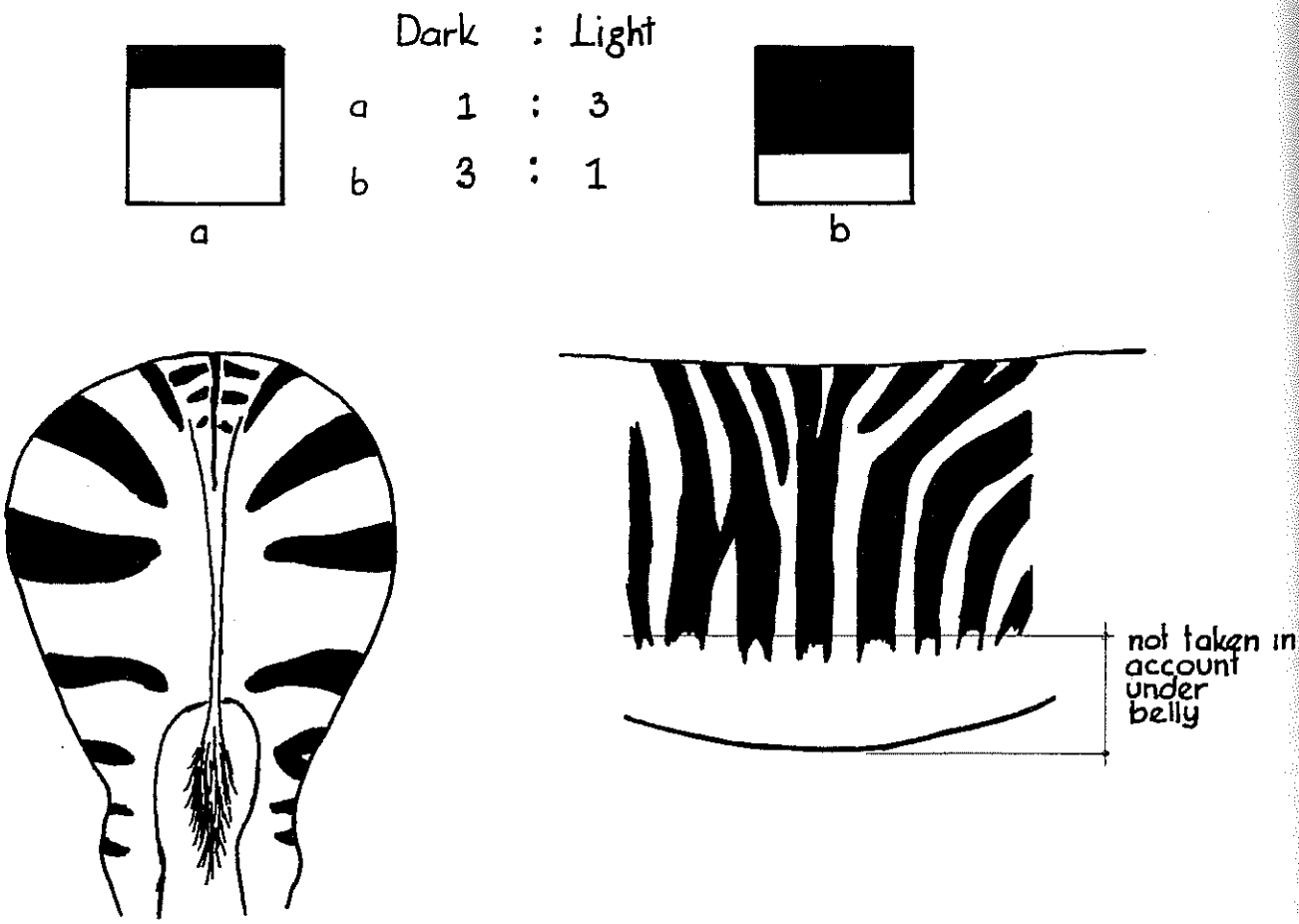


Figure 27: Dark and Light Ratios in Lateral and Posterial views.

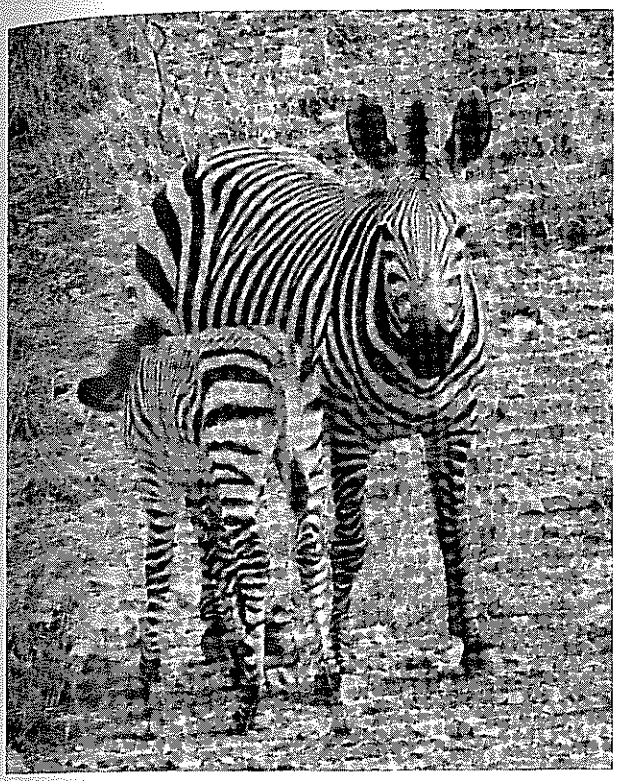

Plate 4. A Hartmann zebra foil suckling.

Relative humidity has no conspicious micro-climatic influence on the grazing pattern of the Hartmann zebra.

Nutritional activities of foals: —

Seasonal variation of the nursing behaviour of the foals is completely indirect. As the Hartmann zebra breeding season reaches an apparent peak during the rainy season it follows that most of the foals are older during the autumn and winter and accordingly suckle less.

Drinking: —

As already stated the Hartmann zebra drinks more frequently during the hot, dry months of October, November and sometimes December. During this time they visit the waterholes at least once a day.

b) Social activities

The social activity patterns of Hartmann zebras appear to be only slightly affected by seasonal variation of climatic factors. Only two, slightly interrelated aspects, are indirectly influenced by climate. As Hartmann zebra have a peak breeding period during the rainy season it stands to reason that mating activity occurs with higher frequency during this period. In correlation with this the foals, as they grow older, indulge more and more in play with other foals in the family group.

c) Comfort activities

Resting: —

There is no significant difference in the total amount of time spent resting during the various seasons of the year. The percentage of animals seeking shelter in the shade of trees during the different months of the year, on the other hand, shows a very marked difference. As may be seen in figure 28 the number of animals seeking shade varies from remarkably high during the warmer months of the year to absolutely none during July.

It is interesting to note that animals resting in the shade also show a definite behaviour pattern. They always distribute themselves one, or in the case of a female with a foal, two, to a tree. They nearly always stand with their posterior ends close to the tree while facing outwards. Although they are in the shade they still frequently orientate themselves with their posterior ends to the sun as well. This latter might be to make full use of the denser shade of the bole of the tree.

Disturbance caused by insects: —

As already discussed the intensity of disturbance caused by insects does not show a clear pattern on a daily basis, apart from the fact that their activity normally only starts after the environmental temperature has reached a suitable heat. However, on a monthly basis a very clear pattern is discernible. As may be seen in figure 29 the irritation activities caused by insects were very pronounced during the warmer months but decreased until June and July when no irritation caused by insects was recorded. During August and September their influence is also very limited but suddenly increases markedly in October. This sudden increase in irritation from an insect population may be as result of the early October rains. Disturbance by insects thus show a correlation with temperature and rainfall which is proven by determining the "arid" months (See figure 29). The temperature and rainfall graphs in this figure are based on the mean of observations over 26 years. The graph of insect disturbance is unfortunately only based on two years observations (1969 and 1970) during which time the area received good rains during October 1970. Coetzee (1967) quoting Gaussen (1954) used this consideration of mean monthly precipitation and temperature to determine the "arid" months. The "arid" months are determined by plotting mean monthly temperature and rainfall on the same graph using a scale in which 40 mm mean rainfall corresponds to 20°C mean temperature.

d) Sanitary activities

No seasonal variations could be recorded.

e) Other movements

A limited amount of migration stil occurs in the Khomas Hochland and in the Kaokoveld. With the

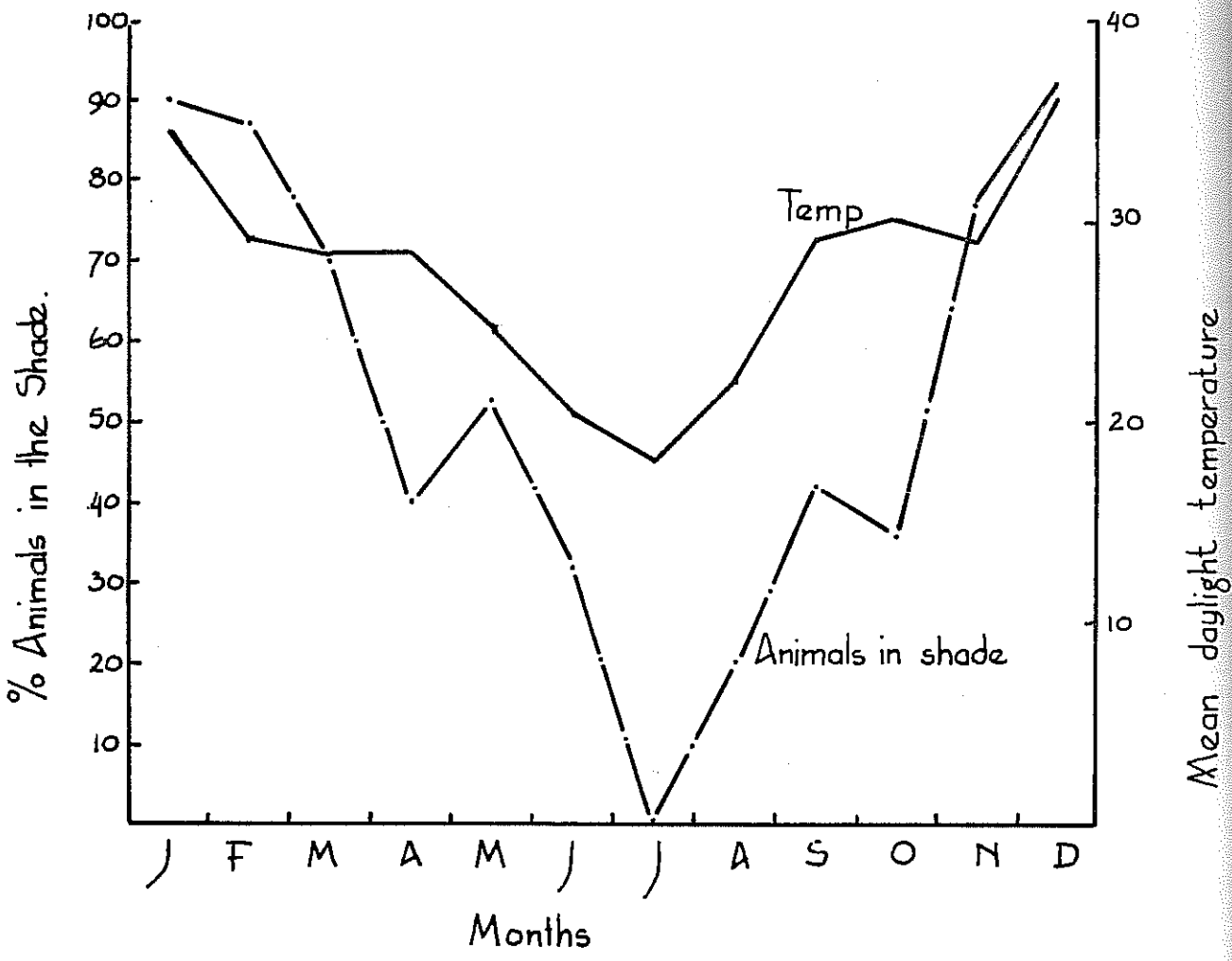


Figure 28: Monthly Pattern of Animals resting in the Shade.

onset of the rainy season as soon as the pre-Namib plains receive their first rains the Hartmann zebra move out of the mountains onto these plains. If unhindered they stay here until the grazing deteriorates after the first cold spells.

## V. DISCUSSION AND CONCLUSIONS

Although the daily activity patterns of individual animals and even those of various family groups vary a basic pattern is perceivable. As already mentioned these activity patterns are variable and affected by innumerable possible combinations of such factors as climate, vegetation, time of day, time of year, location and interactions with other individuals or groups. Normally however, the daily routine can be summarized as follows: A period of high intensity grazing from approximately first light in the morning followed by dust-bathing and/or resting (in the shade or not, depending on circumstances). While resting in the shade approximately 80 per cent of all rubbing activities takes place. The question as to whether the animals stand in the shade for shelter or for rubbing activities is easily answered. There are nearly three times as many observations of animals just standing in the shade as there are of animals actually rubbing themselves. In the middle of the day major periods of grazing are alternated with periods of dust-bathing. This is then followed by the build up to another major grazing period. Most of the other social activities aimed at enforcing the family bond take place throughout the day. It does, however, show a slightly higher incidence of occurring outside the high intensity grazing periods.

The climatic factors which show the most marked influence on the activity patterns of the Hartmann zebra are temperature and rainfall. In this respect temperature has an influence on the time of day when the bulk of the grazing activity takes place. During the summer months this activity is very erratic, apparently to offer the animals an opportunity to lose body temperature in the shade. During the temperate months of autumn and spring an equal amount of time is spent grazing in the mornings and afternoons. During winter, however, the bulk of the grazing takes place during the afternoon. Field observations further show that the Hartmann zebra have also adapted their behaviour

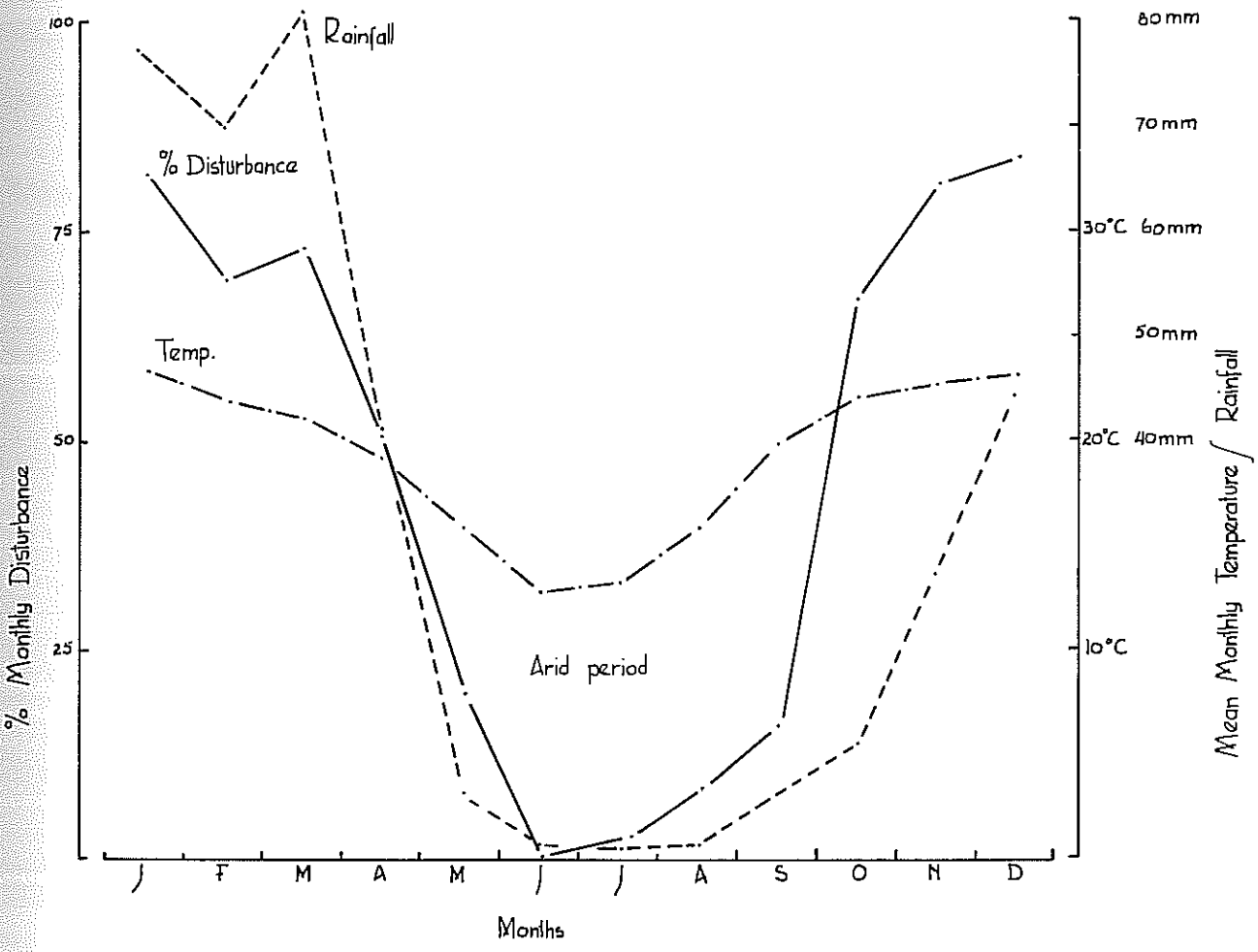


Figure 29: Relationship between % Disturbance by Insects and "arid" period.

to gain full advantage from their colouring pattern. They use their relatively darker shaded sides for heat absorption in cold mornings and their lighter coloured posterior parts for radiation of heat during hot days. Disturbance by insects also seems to follow the seasonal variation of climate regarding temperature and rainfall.

In conclusion it may therefore be said that the daily activity pattern of Hartmann zebra is definitely influenced by climatic factors. They have, however, adapted themselves to the climate of their preferred habitat by evolving certain remarkable behavioural traits to ameliorate the more unfavourable climatic effects.

## VI. ABSTRACT

Free-living Hartmann zebra at the Daan Viljoen Game Reserve, Khomas Hochland, were studied over a two-year period. Attention was given to nutritional, social, comfort and sanitary activities and the various activity patterns determined. Different macro-climatic factors that may influence this behaviour were considered. Although daily activity patterns were variable a basic pattern was perceivable. Temperature and rainfall were the two climatic factors which had the most marked influence on daily activity. Disturbance caused by insects also followed the seasonal variations of climate regarding temperature and rainfall. Hartmann zebra has adapted itself to the climate in its habitat by evolving certain behavioural characteristics.

## VII. ACKNOWLEDGEMENTS

I am indebted to the Director of Nature Conservation and Tourism, Mr. B. J. G. de la Bat for guidance and my colleaques at the Daan Viljoen Game Reserve for assistance during my periodic visits there. My grateful thanks are also due to Mr. Boshoff of the Meteorological Station, Windhoek; Mr. C. G. Coetzee for assistance during the preparation of the paper and Prof. R. Logan, with Mr. M. J. Penrith and P. J. van der Westhuizen for critically reading through the draft. Mr. J. J. Ellinckhuijzen assisted with the preparation of the figures.

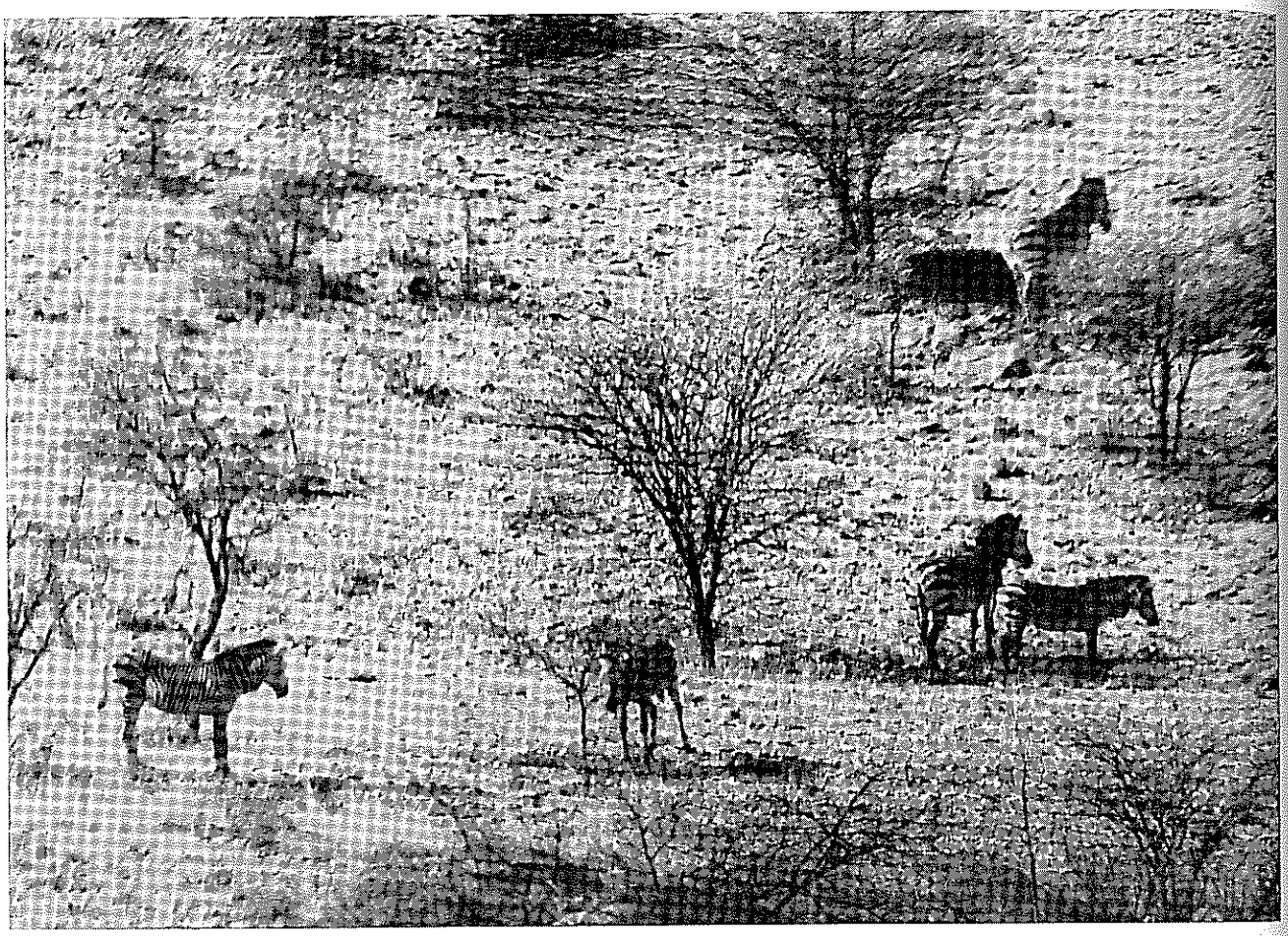

Plate 5. A breeding unit of Hartmann zebra resting in the shade of trees. Note that the individuals are restricted one to a tree or a female and her foal to a tree. They also show an orientation of their backs towards the sun.

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# The Black Tern *Chlidonias nigra* (L) in South West Africa

by
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## I. ABSTRACT

The occurrence of the Black Tern in South West Africa is documented, with a review of earlier records. Field identification is easier than current South African field guides suggest, which may have caused the species to be frequently overlooked. Notes on the biology of the species in South West Africa are given, including observations of commensal fishing with grebes.

## II. INTRODUCTION

During late 1968 a number of small terns were observed by one of us (R.J.) at the Walvis Bay sewage ponds. They differed from accompanying White-winged Black Terns *Chlidonias leucoptera,* but were also clearly not Whiskered Terns *C. hybrida.* These birds were provisionally identified as Black Terns in non-breeding plumage, but efforts to collect specimens failed. Varying numbers were, however, seen on most visits to the ponds up to May 1969, when the Black Terns were still in non-breeding dress whereas the few remaining White-winged Black Terns all wore at least partial breeding plumage.

In late 1969 Black Terns were observed at Sandwich Harbour and four specimens were collected by H.B. in April 1970. Measurements and moult details appear in the table. One specimen (♀) was sent to the British Museum (Natural History) for confirmation. It was identified as "almost certainly" of the European race *Chlidonias nigra nigra* (L.), which would be expected on geographical grounds (Mrs. B.P. Hall, pers. comm.). This and two other specimens were deposited respectively at the State Museum, Windhoek; the Transvaal Museum, Pretoria; and the South African Museum in Cape Town. The remaining specimen has been retained in our Departmental collection. Mr. H. von Schwind has since drawn our attention to the existence of an earlier specimen in the collection of the State Museum, Windhoek (see below). The above appear to be the only southern African specimens currently extant in southern African museums.

## III. EARLIER RECORDS

Although not accepted on the South African list prior to 1970 (McLachlan and Liversidge 1957, Clancey 1965-66, Winterbottom 1969), several earlier records of *C. nigra* in South West Africa exist. Bierman and Voous (1950) recorded the Black Tern visually off the south-western coast, while Sauer and Sauer (1960) observed numbers in northern South West Africa and even succeeded in mist-netting and ringing several. As far as we are aware, the first southern African specimens of *Chlidonias nigra* were collected in 1965 by visiting German

ornithologists P. Becker and J. Pilaski (Pilaski 1967; Becker, unpubl. ms.) in the area of Swakopmund and Walvis Bay. One specimen was deposited with the Landesmuseum Hannover (Germany), while the other is at the State Museum, Windhoek. Mr. von Schwind (pers. comm.) informs us that he and several other local and visiting ornithologists have seen the species occasionally on the coast, the numbers seemingly fluctuating from year to year.

## IV. STATUS IN SOUTHERN AFRICA

The Black Tern may well be commoner in the subcontinent than presently thought, since it is barely mentioned in South African literature and can be overlooked as the common *C. leucoptera*. In support of this possibility we mention a most interesting note by Bromley (1952) describing lake terns at Welkom, O.F.S.. Bromley distinguished two kinds, the second of which had "duskier grey upper wings and (a) rather dusky grey tail" as compared to the first (*C. leucoptera*). Furthermore, their call-notes differed slightly. Bromley first considered that they were Whiskered Terns *C. hybrida,* but discounted this possibility since all the terns which subsequently were seen in breeding plumage, were *C. leucoptera*. It seems more likely, however, that the second kind of tern was in fact *C. nigra,* which resembles. *C. leucoptera* far more closely than does *C. hybrida*, and the description as well as the lack of breeding plumage in late autumn and winter parallel our own observations closely.

Pilaski (1967) has suggested that the development of the fishing industry along the coast may have directly influenced the appearance of *C. nigra* in South West Africa. Our own observations (see below) seem to show that the Black Tern is not as dependent on the waste products of this industry as Pilaski apparently thought. Nevertheless, his suggestion remains a possibility, since it appears that the Black Tern has become an increasingly common visitor along the South West African coast.

## V. FIELD IDENTIFICATION

McLachlan and Liversidge (1970) are altogether too cautious in discounting the possibility of field distinction between *C. hybrida, leucoptera* and *nigra* in winter plumage. Peterson, Mountfort and Hollom (Revised Edition, 1966) give a quite adequate treatment of diagnostic field characters in these species, both illustrations and text. In brief ,the best distinction between non-breeding *C. leucoptera* and *C. nigra* is the dark shoulder smudge on the flank of the latter. Other differences readily become apparent when the birds are observed carefully in mixed groups: *C. nigra* has a darker grey, more uniform dorsum with strongly contrasting white collar, the cap is neater, the bird is slimmer, the tail fork slightly more pronounced and the bill less stubby than in *C. leucoptera.*

## VI. BIOLOGY

The Black Tern seems to occur in small flocks along the West coast. It is frequently found in company with White-winged Black, Whiskered, Arctic *Sterna macrura* and Common *S. hirundo* Terns (Pilaski 1967; Becker, unpubl. ms.; pers. obs.). We have observed *C. nigra* mainly along sandy beaches near lagoons, and at the lagoons themselves as at Sandwich Harbour and Walvis Bay; also at sewage ponds at Walvis Bay and Swakopmund, and on the semi-fresh pools at Sandwich Harbour.

The feeding actions and flight of *C. leucoptera* and *C. nigra* seem to be identical. The Black Tern has, however, also been observed to pick at and presumably eat fish scales cleaned off by fishermen along the beach, while Pilaski (1967) recorded it feeding on effluent from local fish factories. We have also observed Black Terns fishing commensally with Black-necked Grebes *Podiceps nigricollis* in Sandwich Lagoon. The terns wheeled about, screaming, over the flock of grebes which appeared to be catching small fish with short dives near the surface. The terns would dip down continually to the water around and in amongst the grebes, although it was impossible to see what they were catching. The whole performance lasted, in two instances, for about 35 and 15 minutes respectively, during which time the terns followed the grebe flock for up to 200 metres along the lagoon shore. On these occasions we have heard them call, the sound being much as described by Bromley (*loc. cit.*).

## VII. ACKNOWLEDGEMENTS

We would like to thank Mrs. B.P. Hall and Mr. D. Goodwin of the British Museum (Natural History) for checking a specimen for us, and Mr. H. von Schwind of the S.W.A. Scientific Society for generous and valuable discussion and assistance with the literature and local records.

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Table 1. Measurements of *Chlidonias nigra* (mm).

| Specimen No. | Length | Culmen | Tarsus | Tail | Wings | | Total Body Weight (g) | Rectal Temperature (°C) |
|---|---|---|---|---|---|---|---|---|
| | | | | | Left | Right | | |
| 1 ♂ | 234 (9¼ ins) | 25,5 | 17,0 | 69,5 | 183 | 182 | 51 | 41,7 |
| 2 ♀ | 239 (9½ ins) | 26,0 | 17,5 | 71,0 | 191 | 190 | 52 | 37,1* |
| 3 ♀ | 240 (9½ ins) | 26,0 | 16,0 | 70,5 | 189 | 190 | 59 | 41,4 |
| 4 ♀ | 240 (9½ ins) | 26,5 | 16,5 | 73,0 | 220 | 200 | 58 | 40,5* |

* Birds wounded during collection and killed in the hand before temperature was taken.

Table 2. Wind and tail moult of *Chlidonias nigra* **

| Specimen No. | Primary Wing Feathers | | | Tail Feathers | |
|---|---|---|---|---|---|
| | Number Present | Moult of Number(s): | | Number of Pairs Present | Moult of Pair Number: |
| | | Left | Right | | |
| 1 | 10 | 6 and 7 | 6 and 7 | 6 | 1 |
| 2 | 10 | 4 | 4 | 6 | No moult |
| 3 | 10 | 6 and 7 | 6 and 7 | 6 | 1 |
| 4 | 10 | 6 and 7 | 5 and 6 | 6 | No moult |

** All specimens were in winter plumage.

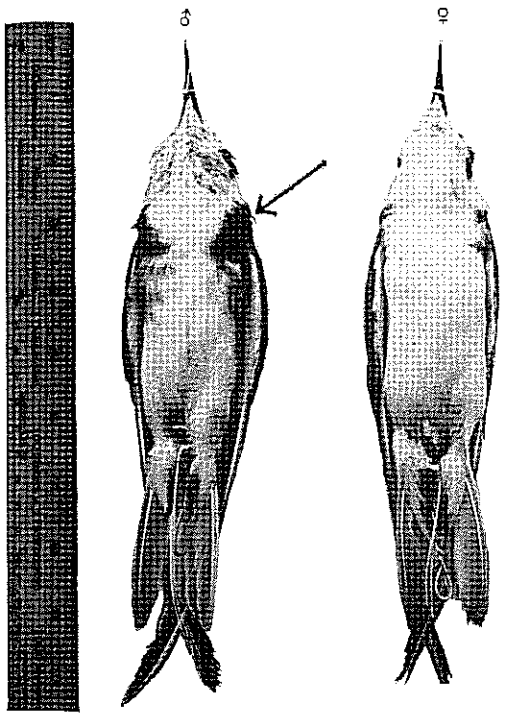


Plate 1. *Chlidonias nigra* (winter plumage) Ventral.

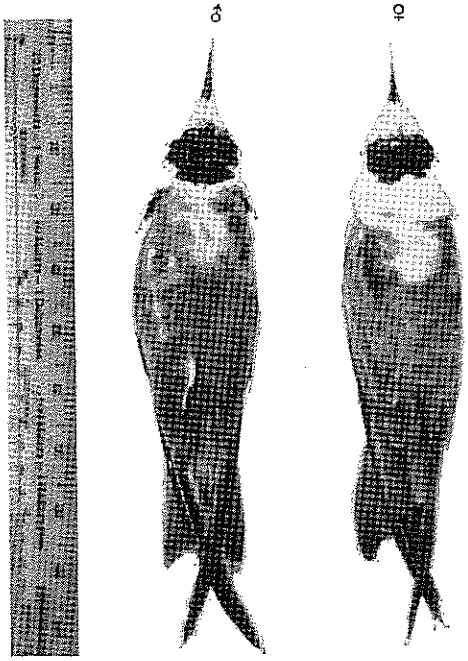


Plate 2. *Chlidonias nigra* (winter plumage) Dorsal.

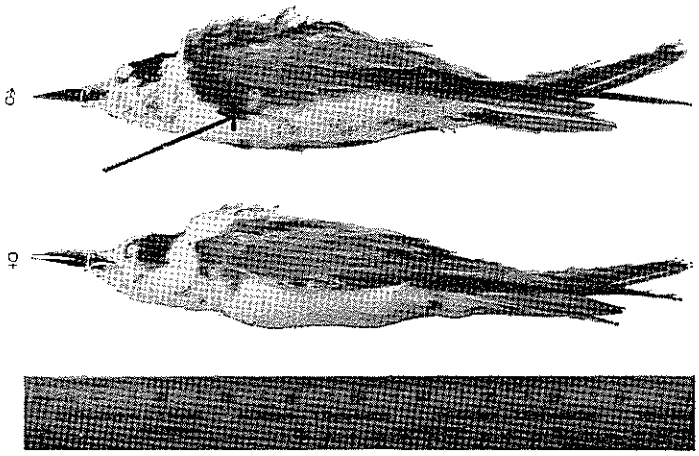


Plate 3. *Chlidonias nigra* (winter plumage) Lateral.

# Notes on the Damara Rockjumper, *Achaetops pycnopygius*

by
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and
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## I. INTRODUCTION

Comparatively little is known of the general biology of this bird. It is restricted in range to the central plateau of South Western Africa, from about Windhoek northwards to Southern Angola. In the east it extends as far as the borders of the Kalahari and in the west to the escarpment base but not into the Namib desert.

## II. TAXONOMIC HISTORY

The Damara Rockjumper was originally described in 1852, by Strickland and Sclater, under the name *Sphenoeacus pycnopygius*, indicating that they regarded it as a relative of the Grassbird, *Sphenoeacus afer*. Subsequent to this original classification, the bird has been variously placed by different authors. Hoesch and Niethammer (1940) assigned it to the genus *Chaetops*, containing the true Rockjumpers. Roberts (1940) placed it in a genus named by him *Achaetops*, in the family Timaliidae, containing at that time the babblers and true rockjumpers. Delacour (1946) in a review of the Timaliidae states simply that *Achaetops* belongs in the family Sylviidae. McLachlan and Liversidge (1970) in their second revision of "Roberts Birds of South Africa" make no change from the original. White (1962) fuses *Achaetops*, *Melocichla* and *Sphenoeacus* into the genus *Sphenoeacus*, fam. Sylviidae. MacWorth-Praed and Grant (1963) place the bird in the family Sylviidae, near to *Melocichla*, but retain the generic name *Achaetops*.

The South African Ornithological Society List Committee (Second Report 1958) remove the genera *Pinarornis*, *Chaetops* and *Achaetops* from the family Timaliidae and place them in the family Turdidae. In a subsequent Report (No. 8, 1964) this same committee remove *Achaetops* to the Sylviidae. In the recent S.A.O.S. Check List (1969) no change is made and *Achaetops* is assigned a position in the Sylviidae between *Sphenoeacus* and *Melocichla*.

While neither of us are taxonomists, we have some evidence, particularly of the breeding biology of *Achaetops*, that indicates its affinities with *Sphenoeacus*.

## III. HABITAT

In the Windhoek area the species frequents the rocky slopes of hillsides, particularly the lower slopes bordering dry watercourses. In this respect it resembles *Sphenoeacus*, which inhabits similar areas in the moister eastern parts of Southern Africa.

## IV. BEHAVIOUR

Both McLachlan and Liversidge (1957) and MacWorth-Praed and Grant (1963) mention that the bird is shy. This is to a certain extent true, although the nature of the habitat and the bird's cryp-

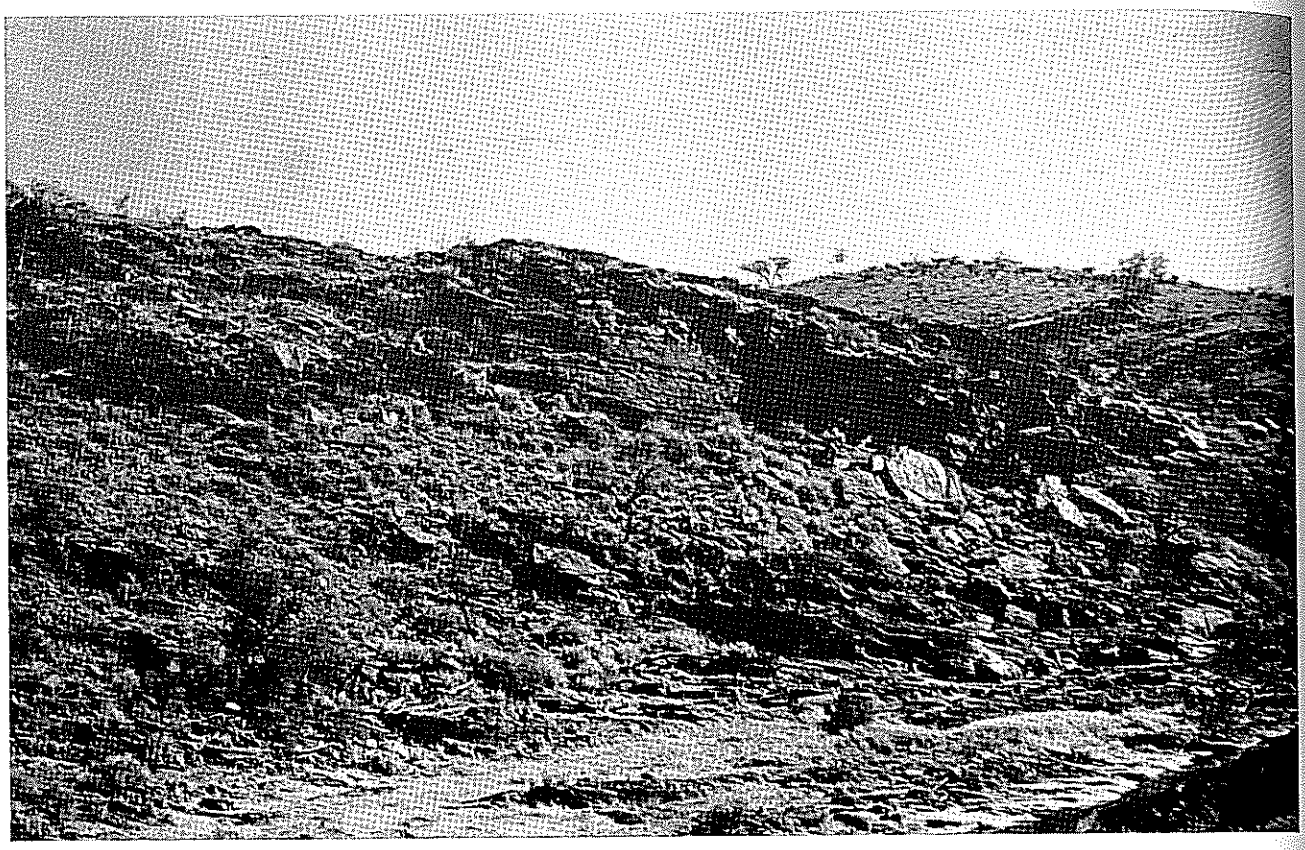

Plate 1. Typical Rockjumper habitat. The nest is situated on the grassy scree in the left centre of the photograph.

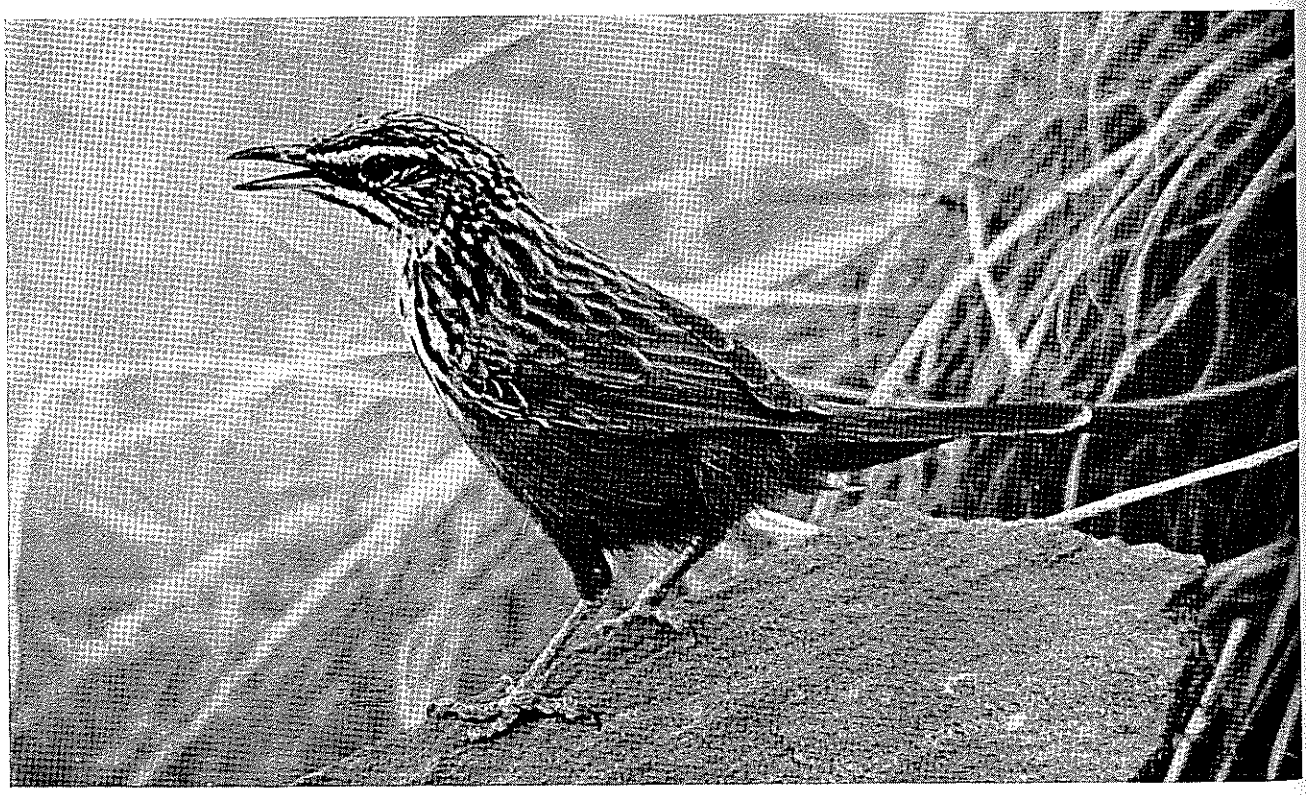

Plate 2. Adult Damara Rockjumper. The nest is situated in the grass behind the bird, to the right.

tic colouration make it difficult to see. MacDonald's (1957) observation that by watching the skyline one will eventually see the bird is true, and by following this method it is easy to locate and thereafter to keep the bird in view.

When singing from call posts in the early morning and evening the birds are not at all shy and will permit very close approach. Birds disturbed in the vicinity of their nests make no attempt to hide themselves but rather choose prominent perches from which to give their alarm call, as do most species of birds.

We can in no way give credence to MacWorth-Praed and Grant's statement that its general habits appear to be those of a chat.

When feeding young in the nest, the adults make use of a standard route to and from the nest. This extends even to the use of particular perches on each trip. Mr. P. J. Buys has succeeded in photographing the birds by stripping all the branches from a bush used by them on such an approach route to the nest, leaving only one perch for the adult bird. Such drastic action did not cause the birds to stop using this bush as a perch. Despite this fixed route to the nest, it is not easily located.

## V. VOICE

Both standard South African reference works refer to a beautiful warbling song. This is most frequently heard at dawn or dusk, although not exclusively at these times. The song is a clear, liquid, bubbling whistle, which can be given as: "tip, tip, tootle, ti, tootle, tootle, too" with varying numbers of "tootles" before the final "too". This call has been admirably recorded in Daan Viljoen Game Park by Martin (1971). The bird is adept at mimicry and various calls of several other species are interspersed in its own song.

When mildly alarmed near the nest or with fledglings the bird uses a phrase of the song "tootle tootle", somewhat muted, or louder sounding almost like "hoo-boy, hoo-boy".

The true alarm call is a harsh, drawn out "cheer' r'r'r". This was seldom heard from a pair of birds that had a nest containing one chick. It was however frequently heard when searching areas for nests which were not found. It is thought therefore to be primarily a warning call to flightless young out of the nest.

Winterbottom (1964) draws attention to the similarity between the songs of *Achaetops* and *Sphenoeacus*. In our opinion this is true in that both species utter bursts of a warbling type of song. Whereas that of *Sphenoeacus* in the Transvaal is a jumbled, bubbling series of notes uttered in rapid succession, that of *Achaetops* is a more measured and deliberate utterance of clear whistling notes. Mrs. M.K. Rowan of the Percy FitzPatrick Institute of African Ornithology, in discussing *Achaetops* with the senior author concurred that the song of the Grassbird in the Western Cape was also very similar to the song of *Achaetops*.

## VI. NEST

One nest of this species was found at Daan Viljoen Game Park on 23/III/70. Mr. P. J. Buys was kind enough to show us another nest in the collection of the State Museum, Windhoek. Neither of these nests is at all like the descriptions given in the standard South African reference works.

Both these works describe the nest as a thick walled structure of dry leaves and stalks, lined with rootlets. The South African Ornithological Society has no nest record cards for the Damara Rockjumper on its files.

The Daan Viljoen nest was made entirely of grass. It was thick-walled with an outer rim of coarse grass blades which got thinner and thinner until the lining of the cup, composed of fine soft grass. The nest in the State Museum is similar but has a few fine rootlets in the lining.

McLachlan and Liversidge (1970) record the nest as being placed low down in weeds and undergrowth and MacWorth-Praed and Grant (1963) say close to the ground in low bushes. Both the nests described above were situated in the centre of large grass tufts, in each case the grass being *Digitaria dinteri*. Both nests were extremely well concealed. Nest site and nest construction are similar to descriptions given by McLachlan and Liversidge for Grassbird nests and are indeed similar to Grassbird nests found on the Witwatersrand by the junior author.

The Daan Viljoen nest had a prominent "verandah" but the Museum nest did not show this so markedly. Dimensions of the Daan Viljoen nest are as follows:-

| | mm |
|---|---|
| Internal Diameter, | |
| Side to Side | 63 |
| Back to Front | 76 |
| Outer Diameter, | |
| Side to Side | 89 |
| Back to Front | 140 |
| Length of Verandah | 51 |
| Overall Height | 89 |
| Depth of Cup | 57 |

## VII. EGGS

When found, the Daan Viljoen nest contained one chick and two addled eggs.

Both McLachlan and Liversidge and MacWorth-Praed and Grant describe the eggs as white in ground colour. Eggs from Daan Viljoen and those

Plate 3. Damara Rockjumper chick in nest.

in the State Museum, Windhoek are pale buffy pink in ground colour. Markings are small spots of dark red-brown to light red-brown with underlying slaty blotches concentrating to form a ring above the thickest diameter. Measurements of 14 eggs are as follows:-

Daan Viljoen Clutch

21.8 x 16.3 and 22.7 x 16.1

Windhoek District

20.9 x 15.0; 21.5 x 15.5; 21.3 x 15.9; 21.4 x 15.4; 21.0 x 16.2; 21.5 x 15.5; 21.0 x 15.0; 21.2 x 15.0

Waterberg District

21.0 x 15.0; 21.3 x 15.8; 21.6 x 15.3; 21.4 x 15.5

The average measurement of these eggs is 21.4 x 15.5 and the range 20.9 — 22.7 x 15.0 — 16.3.

## VIII. CHICK

It was not possible to weigh the chick in the Daan Viljoen nest; it was, however, fairly well feathered and about half adult size. The tail and wing feathers were about 20 mm long and enclosed for almost half their length in their sheaths. The chick was generally brown in colour and the rufous of the rump and belly was not as marked as in the adults. The black and white streaking of the head and neck, although clearly visible, was also not as marked as in the adults. Bill was brown, the gape light yellow, the iris brown, legs light brown but distinctly darker than the legs of the adults, which are greyish brown.

McLachlan and Liversidge and MacWorth-Praed and Grant state that the chick leaves the nest at an early age, while still flightless. Dr. R. A. C. Jensen (pers. comm.) has found flightless young out of the nest in the Erongo Mountains. The chick described above crouched in the nest and remained still as shown in the photograph. When removed from the nest for photography however, it would not sit still but attempted to escape into the grass, indicating that although still flightless it was almost at a stage when it would be ready to leave the nest.

## XI. SUMMARY

i) An outline is given of the taxonomic history of *Achaetops pycnopygius*.

ii) The habitat preferences of the bird are discussed.

iii) Some field observations of habits are given.

iv) Various calls are described.

v) Nest and nest site are described.

vi) Descriptions and measurements of eggs from various localities in South West Africa are given.

vii) The feathered, flightless young is described.

## X. ACKNOWLEDGEMENTS

Our thanks are due to Mr. C. G. Coetzee, Director of the State Museum, Windhoek, who permitted us access to material in that institution. Mr. P. J. Buys, Ornithologist at the Museum put his field notes at our disposal and much valuable information was extracted from them. Mrs. M. K. Rowan of the Percy FitzPatrick Institute of African Ornithology was extremely helpful when the senior author visited the Institute and our thanks are due to her as well.

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# A note on the challenge rituals of territorial male Lechwe

by
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## I. INTRODUCTION

A number of papers have been published on the lechwe dealing with various aspects of their biology and behaviour (Allen, 1963; Robinette & Child, 1964; de Vos & Dowsett, 1966; and Child & von Richter, 1968). Territorial behaviour of the lechwe was first reported by de Vos & Dowsett (1966). Their paper however considered only the general behaviour pattern of the species and population dynamics of lechwe in Zambia.

During a visit to the Moremi Game Reserve in Botswana in October, 1971, territorial behaviour by territorial male lechwe was observed on the flood plains. With the aid of Mr. Clem Haagner, the well known wildlife photographer, the author was able to obtain a photographic record of the challenge ritual in this species.

## II. THE TERRITORY

Lechwe in the Moremi Game Reserve occur only on the seasonally inundated grasslands of the flood plains. Territories in the area were invariably situated along a stretch of open water or depression containing water. Not all the territories had common boundaries, although most were situated along the verge of open waters. It was found that the territories occupied by the lechwe males never exceeded a diameter of 150 m to 200 m. De Vos & Dowsett (1966) found that the territories of lechwe in Zambia were also small, never exceeding a diameter of 50 to 100 m.

Female herds, sometimes accompanied by sub-adult, non-territorial males apparently had home ranges which would include all, or almost all territories in a specific area. Male herds were noticed grazing in the proximity but no instance was recorded where they crossed or approached territorial soil. Male herds as well as female herds were also noticed in areas where no territorial activity took place.

## III. THE CHALLENGE RITUAL

In most ungulate species a natural selection for the best males takes place. This selection is often achieved through territoriality — as one finds in lechwe. The breeding of these "selected" males, who are also the carriers of important genes, is a basic need in the concept of survival of the species. However, to limit injuries to the "gene reservoir" actual physical aggression between territorial males has to be limited. This is achieved by the evolution of ritualized challenges in the place of lethal contests. In this way, injury to territorial males, through actual combat, is limited without losing the peripherial effect. The challenge rituals of various animal species have been described by a number of ethologists of which Estes's (1968) analizes of the

Plate 1. A lechwe male in a stance for vizual advertisement of his territorial status by showing the light coloured blaze under his throat and erection of his penis. In the background a female herd can be seen grazing. Photo: C. Haagner.

challenge ritual of the wildebeest (*Connochaetus taurinus*) is probably the most detailed.

It was found that challenge rituals in lechwe almost invariably took place on the territorial boundaries — peripheries. Darling (1952) suggested that territorial conflict was actually sought after for the sake of stimulation. This appears to be the case with lechwe. In the challenge ritual of lechwe there are a number of agonistic displays as well as several displacement activities. The approach consists of one of the males slowly moving towards the boundary of his territory. This approach is interrupted by pauses for grazing or the assumption of an erect posture with head held high, hind feet slightly apart, looking into the distance (see plate 1). This may be called the broadside on display. In this stance the almost white blaze under the throat is displayed. This is one of the most important vizual advertisements carried out by the territorial lechwe male on his territory. Sometimes the broadside on display would be accompanied by an erection of the penis. During this movement towards the boundary, the male from an adjoining territory, if not already on the boundary of his own territory, would approach the commen boundary to intercept the approaching male.

A number of individual variabilities exists from here onwards in the sequence of subsequent events. During the following agonistic displays several displacement activities are also shown. On approaching the communial boundary, and one another, they may immediately engage in combat. This combat however, is very ritualized, consisting of butting the heads and locking the horns (see plate 2). Combat activities are usually of very short duration. In some cases the males move, close and parallel to one another down the communial boundary (see plate 3). These patrols are interrupted by frequent displays viz. the broadside on stance and "horning."

Horning has been described in wildebeest (Estes, 1968), Uganda kob (Leuthold, 1966), Impala (Schenkel, 1966) and also domestic cattle. Estes (1968) is of the opinion, with most other ethologists, that horning is a high intensity threat display and this seems to be the case in territorial malel lechwe as well, since this activity is normally only displayed during the challenge ritual (see plate 4).

Plate 2. Two territorial males from adjoining territories about to lock in combat at their commen boundary. Photo: C. Haagner.

It was also noticed that the two territorial males so engaged alternated their threat displays with displacement activities. In plate 4 the male on the right can be seen executing a horning display. The male on the left is doing a displacement activity — an alarm display — so as not to see the challenge directed at him. Almost immediately afterwards the male on the left answers with a broadside on threat display (plate 5) while the male on the right is busy with a displacement activity, in this instance grazing. On occasion, after being engaged in some high-tension displays, one of the males would do a broadside on display and actually ejaculate semen.

Peripherical activity is usually ended by one of the territorial males breaking off the engagement. This is normally done with some displacement activity, for instance grazing away from the communial boundary. The other male then normally also loose interest.

## IV. ABSTRACT

Territorial lechwe males in the Moremi Game Reserve normally occupies territories with a diameter of between 150 to 200 m. Female herds occupy home ranges which encompasses all the male territories. Challenge rituals takes place on communial territorial boundaries. Various agonistic displays as well as displacement activities is described.

## V. ACKNOWLEDGEMENTS

I am indebted to Mr. Clem Haagner who made the visit to Botswana a reality. He is also thanked for permission to use some of the photographs illustrating this paper. Mr. C. G. Coetzee and Mr. M. Penrith is thanked for critically reading through the manuscript.

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Plate 3. Two territorial males from adjoining territories patrolling a communial boundary.

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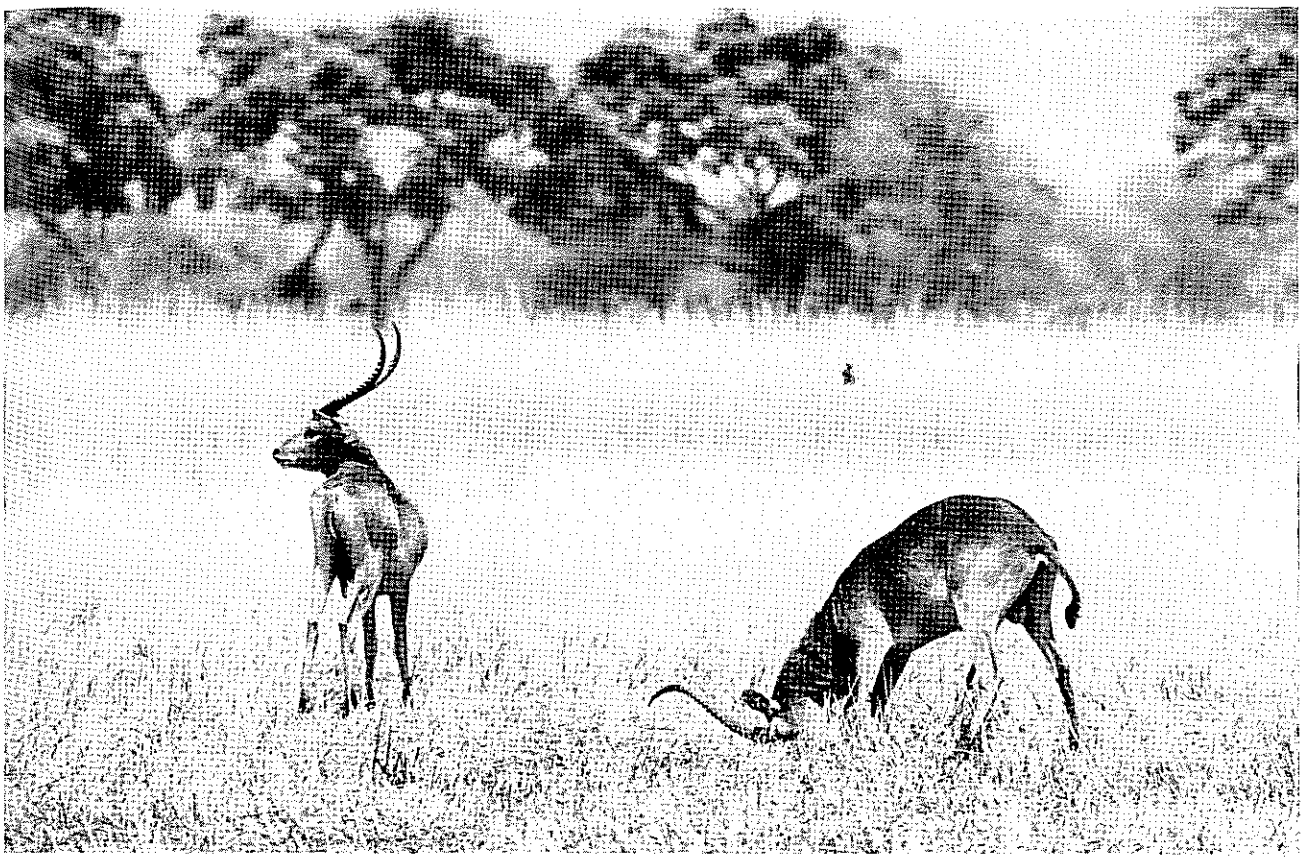

Plate 4. A territorial male busy with horning. Photo: C. Haagner.

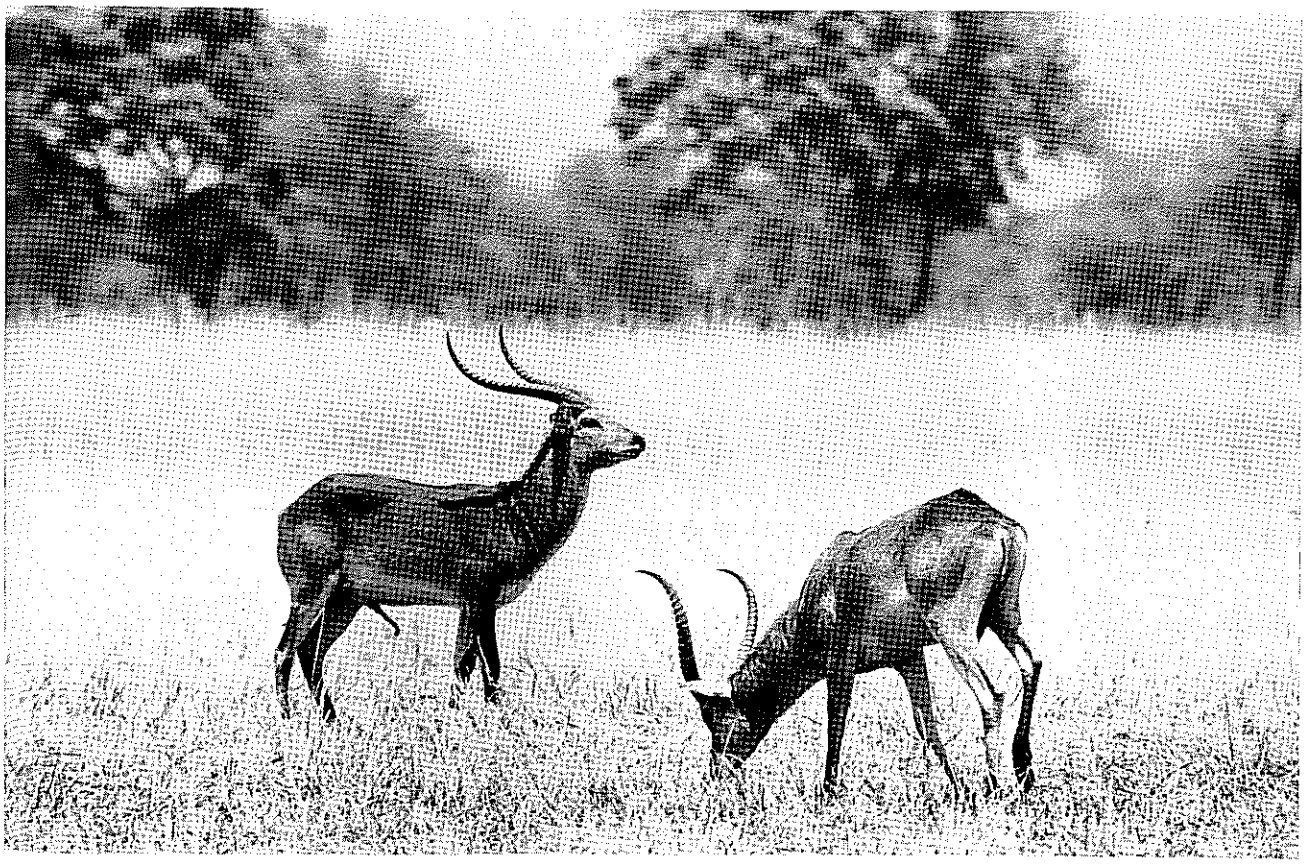

Plate 5. The male on the left is occupied with a threat display while the male on the right is showing displacement grazing. Photo: C. Haagner.

# A simplified punch-card system for recording biological information in the field

by
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## I. INTRODUCTION

Biologists and other research workers in wildlife management are having to rely to an ever increasing extent on biological records and observations by field staff. Field staff, especially those stationed in game reserves, are in a position to obtain a great deal of basic information regarding wild life. This information, especially when records over an extended period of time are available, is of importance for the management of wildlife, both in game reserves and farms and for policy decisions regarding conservation.

Prior to the initiation of the punch-card system in South West Africa, field staff were issued with notebooks for recording their observations. On completion the notebook was handed in and a new one issued. This system had several disadvantages, the more serious being:

(a) As there is no index the only method of finding a specific item of information was by reading through all completed notebooks.

(b) difficulty in deciphering certain handwritings.

(c) due to the nature of their work these notebooks could become soiled, often completely obliterating one or more pages.

(d) loosing an almost complete notebook, could result in the loss of a possible rich source of information.

(e) there was no guide to the type of information required, resulting in uncertainty as to what type of information would be needed by the biologists (this was especially true before formal training for field staff was initiated).

## II. THE PUNCH-CARD SYSTEM

In consideration of the abovementioned problems it was decided to develop a system which would be simple, would enable one to use a filing system for quick retrieval of data and would also serve as a constant guide to field staff as to what information is needed. The choice of a punch-card system was almost automatic. Although much more information can be stored on a punch-card if some type of coding is used, it was decided to keep the card as simple as possible to minimize human errors.

Seven of the more important basic categaries on which information for management is needed, and which could be gathered by the field staff, such as predation, feeding records, game counts, reproduction records, measurements, herd compositions and carcasses found in the field can be recorded on the punch card. On the back of the punch-card instructions regarding the information required for each of these categories, as well as how to use the punch-card, are given. On the front of the punch-card the observer has to note his name, date, time, locality and number of the card. Provision is also made for

the herbarium number of any botanical sample collected as well as any other remarks.

The instructions on the back of the punch-card under each of the seven basic categories mentioned earlier are as follows:

Predation: mark:

(i) predation
(ii) prey
(iii) predator
(iv) method of killing (strangled, neck or back fractured)
(v) date, time of predation.

Additional information to be gathered and noted:

(i) where the predator starts feeding and who feeds first.
(ii) composition (age and sex) of the pride (pack etc.) of predators.
(iii) if possible take bloodsmears and collect skull and lower jaw of prey. Number material collected.

Feeding records: mark:

(i) feeding record
(ii) animal utiziling plant
(iii) browzer or grazer
(iv) plant eaten
(v) rainy or dry season

Additional information to be gathered and noted:

(i) collect sample for herbarium and identification
(ii) note species eaten
(iii) note which part of plant utilized (leaves, flowers or fruits)
(iv) general condition of plant (wilted, dry etc.)

Game counts: mark:

(i) game count
(ii) wet or dry season
(iii) species counted

Additional information:

(i) record counts
(ii) locality (name of waterhole etc.)

Reproduction records: mark:

(i) reproduction
(ii) animal species

Additional information:

(i) number of young
(ii) date first young noted

Measurements: mark:

(i) measurements

Additional information

(i) body circumference (behind shoulder)
(ii) ear length
(iii) shoulder height
(iv) body length
(v) tail length
(vi) hind foot length c.u.
(vii) circumference front foot
(viii) horn length

Herd composition: mark:

(i) herd composition
(ii) herd size (total number)
(iii) number males, females and young
(iv) males or females alone
(v) ages — if possible.

Carcasses found: mark:

(i) carcass found
(ii) possible cause of death (disease — anthrax, predation, etc.)

Additional information

(i) note locality
(ii) gather skull and lower jaw — and number.

The field staff only mark the holes which need cutting. The actual cutting is done by a technical assistant. One punch-card is used for each observation. These punch-cards are returned monthly by the field staff together with their monthly reports. They are then handed over to the biologist and filed in a steel cabinet. The size of these punch-cards is approximately 12,6 cm by 20 cm.

This system has been in use for approximately twelve months and seems to work satisfactory.

## III. ACKNOWLEDGEMENTS

Thanks is due to Mr. C. J. V. Rocher, P. van der Westhuizen, C. le Roux and J. S. du Preez and all other nature conservators who contributed with their valuable discussions and suggestions. I am also indebted to Mr. C. G. Coetzee, Director State Museum and Mr. M. Penrith for critically reading through the manuscript.

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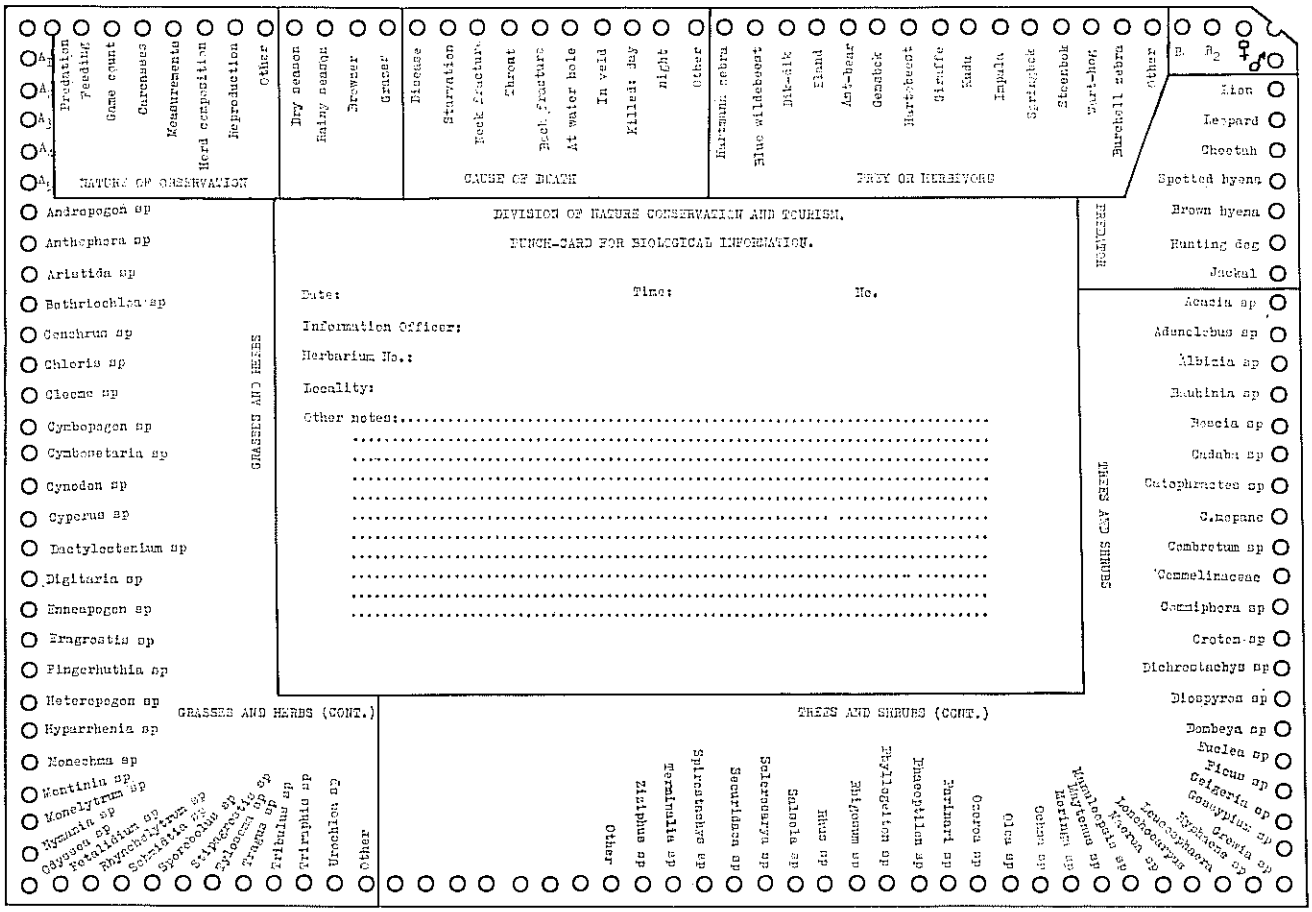


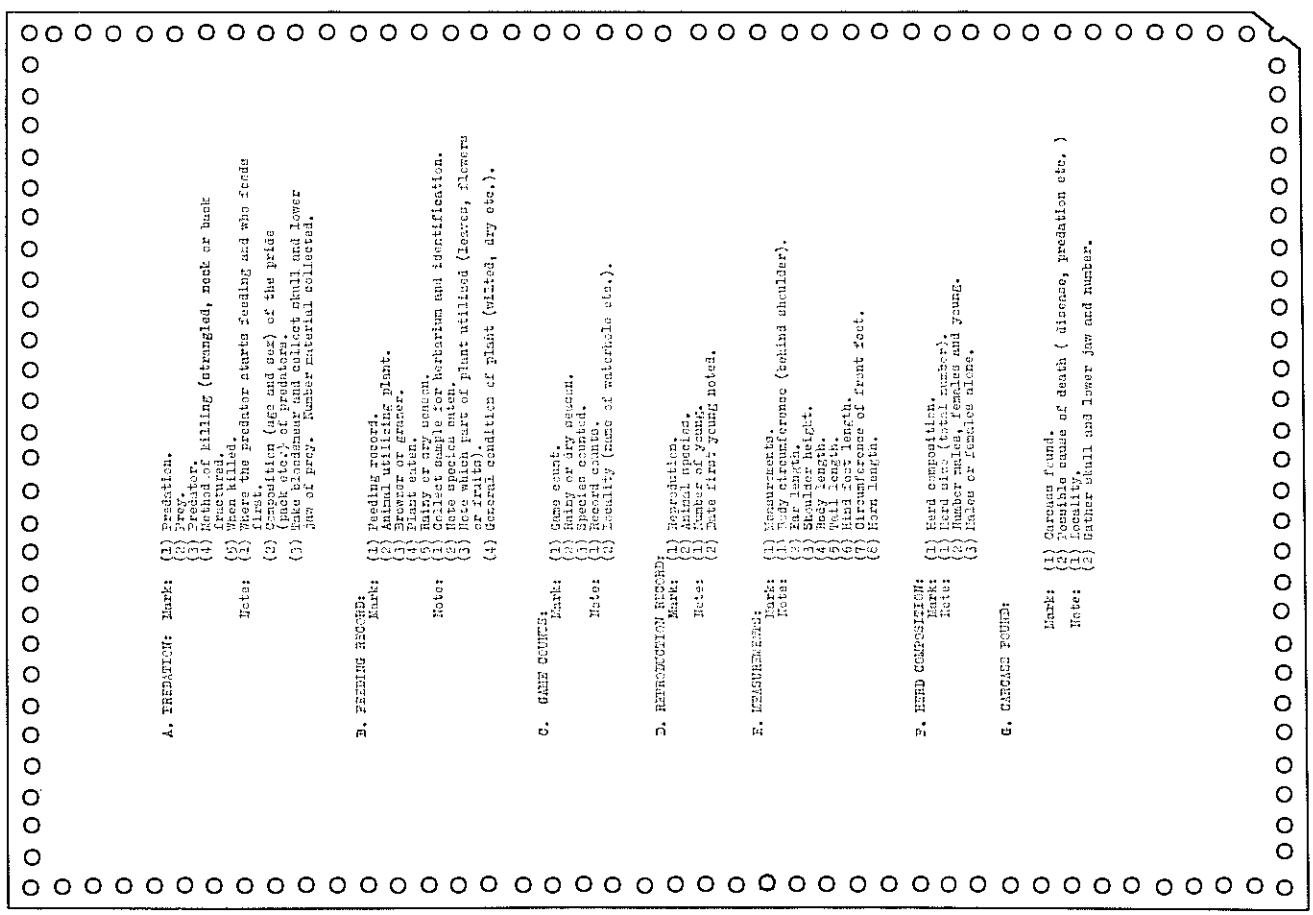


Figure 1. The punch-card at present in use in the Division of Nature Conservation and Tourism.

# The Steppe Eagle *Aquila nipalensis* and other termite-eating raptors in South West Africa

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NOTE: Since this paper was submitted, I have been informed of an extensive study by Brooke *et al.* "A study of the migratory eagles *Aquila nipalensis* and *A. pomarina* (Aves: Accipitridae) in Southern Africa, with comparative notes on other large raptors." *Arnoldia*, in press.

## I. ABSTRACT

Steppe Eagles *Aquila nipalensis orientalis* were recorded in small groups in the Karibib district in January-February 1971. Two specimens were collected, the only previous definite record being Andersson's specimen from the last century. The birds apparently fed exclusively on alate harvester termites, and were found in the company of migrant *Milvus* kites and other raptors.

The probable pattern of movement of the raptor flocks is speculated on, and the 1972 records from the northern Cape claiming a number of highly doubtful new additions to the South African raptor list, are discussed and provisionally rejected.

## II. INTRODUCTION

Sporadic and rather vague records of migrant raptor concentrations in South West Africa appear in the literature (e.g. Andersson 1872, van der Westhuizen 1967, de Villiers 1972). However these gatherings and their movements have not enjoyed the attention they deserve. In January-February 1971 strong rains fell in the Karibib district of central South West Africa (Table 1), resulting in a "termite year" with large flights of the harvester termite *Hodotermes mossambicus* (Hagen). Large flocks of raptors appeared in the area and remained for at least a month, although the groups ranged far and seldom stayed in the same locality for more than a few days. Presumably the pattern of movement followed the pattern of local showers and resultant termite flights.

Table 1. Karibib rainfall (mm)

| | Dec. | Jan. | Feb. |
|---|---|---|---|
| 1970—71 | 5,7 | 31,3 | 193,8 |
| No. of Rain days | 1 | 9 | 18 |
| Dates of showers $\geq$ 25 mm | — | — | 1;13;17 |
| 61-yr Average* | 25,6 | 43,4 | 52,8 |

* 61-yr annual average 205,2 mm
(* Up to 1968 when recording station changed locations)

## III. OBSERVATIONS

On 19 January 1971 a concentration of the raptors fed and roosted just south of Karibib town, on municipal ground. About 1 500 kites were present in an approximate ratio of three Yellow-billed *Milvus migrans parasitus* to two Black *M. migrans migrans* (since the kites tended to group by subspecies, widely varying actual ratios were obtained in different samples of 100 birds). Additionally there were about 20 Lanners *Falco biarmicus*, mostly immatures, and about two dozen large brown

eagles ranging appreciably in size. Most of these appeared to be in adult or near-adult plumage and were identified as Steppe Eagles *Aquila nipalensis,* with one or two of the smallest individuals ascribed tentatively to *A. pomarina,* the Lesser Spotted Eagle. Several distinctively plumaged immature Steppe Eagles were present, but no immature Lesser Spotteds. The dark non-juvenile Steppe Eagles all showed varying amounts of white at the tail-base, were much darker than most Tawny Eagles *Aquila rapax rapax,* and showed a noticeably more slender bill than that species, although there is considerable variation in this as well as other characters.

The raptors were observed to roost in a loose aggregation in small (3-5 m) trees in the open bushveld which showed signs of considerable overgrazing. On the following morning a number of pellets and pellet fragments were collected beneath roosting perches of Steppe Eagles. These consisted entirely of head and other remains of *Hodotermes mossambicus* alates (identified by Dr. W. Coaton, pers. comm.). Two unbroken whole pellets consisted of at least 630 and 930 termite head remains respectively. Attempts to collect specimens of the eagles that evening failed, partly because the majority had moved their roost elsewhere.

On 11 February a small flock of kites (c.60) with about 12 eagles was found feeding on a *Hodotermes mossambicus* flight on the Karibib-Namib Park road about 27 km south of the Swakop River (border of the farm Tsaobis). One eagle was collected, a small individual, which turned out to be an apparently adult Steppe Eagle (sexed as a female on skinning by P. J. Buys of the State Museum, Windhoek). This group of eagles was feeding on the ground. Later the same day a much larger mixed raptor concentration was encountered about 80 km to the north on the Karibib-Usakos road. Another eagle, in apparently sub-adult plumage, was collected from this flock. The second bird was also sexed as female, and was somewhat larger than the first, 2 550 g against 2 350 g, wing 525 mm against 510 mm. Crops and stomachs contained only termites. P. A. Clancey examined and confirmed both birds as *Aquila nipalensis orientalis* Cabanis (*in litt.*).

In the January group of raptors were a number (about 15) of very pale-crowned large falcons which at first were surmised to be migrants of an unrecorded Palaearctic species or race. Two of these "white-headed falcons" were collected, along with an adult Lanner. The former two were found to be juvenile Lanners, and were confirmed as such ("paler . . . than eastern birds . . .") by Clancey (*in litt.*). All five skins have been deposited at the State Museum, Windhoek.

## IV. DISCUSSION

The above records constitute the second verified occurrence of the Steppe Eagle in South West Africa, the first being a specimen collected by Andersson somewhere in Damaraland about a century ago (Roberts 1936, Hoesch and Niethammer 1940, Winterbottom 1971). Three other specimens procured by Bradfield near the Waterberg (Roberts 1928) were subsequently found to be *Aquila pomarina* (Roberts 1934). However, it seems clear that the migrant eagles have been largely overlooked, since a number of reports have come to my attention of eagles in groups feeding on termites in previous years in various parts of S.W.A. (e.g. G. Braine, H. Ebedes, pers. comms.). Specific Steppe Eagle sight records of my own include, besides numerous records from the Usakos and Karibib districts in January-February 1971, one bird in mid-October 1971 along the Okavango River. It seems worth mentioning also considerable numbers of Steppe Eagles feeding on termite flights on overgrazed pans in the Moremi Reserve, Botswana, in November 1971 (the species is not listed by Smithers 1964).

It appears that the occurrence of these migrant raptor aggregations in the south-western parts of the wintering range is sporadic, being at least partly dependent on the particular rainfall and termite-flight pattern of a particular year. Thus in 1972 no concentrations appeared in central South West Africa, to my knowledge; nor were they seen in the Karibib district in the prior two years 1969 and 1970. The focus in 1972 may well have shifted south to the extreme northern Cape, where good rains fell (*vide* Button and Clancey 1972).

An interesting point emerges from the rainfall figures (Table 1), viz. the rainfall in December and January 1970-71 was below normal, yet termites and raptors were already in evidence in mid-January, anticipating (correctly) a good year. Possibly a part of the explanation lies in the extremely scattered rainfall pattern, i.e. the "rain center" or front remained over the district for weeks, precipitating however only in localized showers and thunderstorms which may have largely missed the Karibib rain-gauge during January, but which individually were quite sufficient to stimulate local termite flights of considerable proportions. After the first few heavy rains of February however, the termite flights tailed off and the raptor flocks moved on.

Finally, in view of personal experiences with "white-headed falcons" and other strange, but non-new, raptors, it seems necessary to comment on a number of highly doubtful records claimed by Button and Clancey (1972) on the basis of the former's observations supported by inadequate photographs, from the extreme northern Cape Province. Mr. Clancey kindly sent me duplicates of the critical slides involved in the cases of the Red Kite *Milvus milvus,* the Saker *Falco cherrug* and the Barbary Falcon *F. (peregrinus) pelegrinoides.* Although these slides are considerably better than the printed reproductions, careful examination, and comparison with my own slide collection and with photographs, paintings and descriptions in the literature failed to convince me of their acceptability. Further correspondence with Clancey yielded no additional supporting evidence. It seems unnecessary to go into details regarding the reasons for rejecting these re-

Figure 1. A probably adult Steppe Eagle. The bill is noticeably slender in the field when compared with a Tawny Eagle's. White tail-base does not show in this pose.

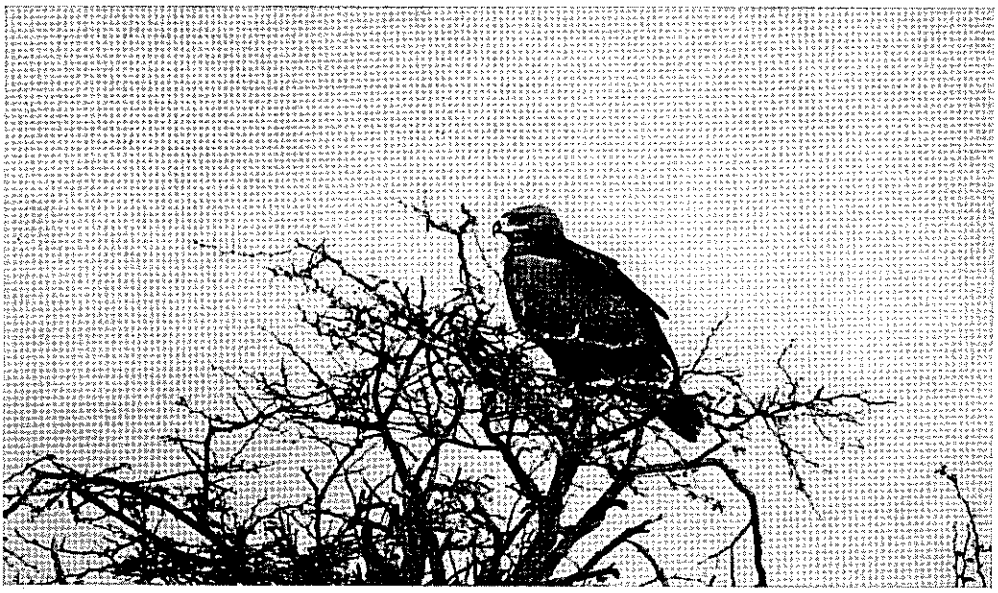

Figure 2. A sub-adult Steppe Eagle, probably in the 3rd-4th year. White lines of wing-coverts (partly obscured by twigs) are not as pronounced as in juveniles, and the bird is darker.

Figure 3. A Steppe Eagle probably in its first year. Typically these birds are *"cafe au lait"* in general colour, but darker than juvenile Tawny Eagles, with diagnostic white wing-bands. Pale wing-window also shows in near wing.

cords. It may be noted that neither in the paper (*op. cit.*) nor in correspondence was any indication given of how the kites and falcons were identified as non-Black Kites and non-Lanners except by the most subjective criteria. While the case for *Milvus milvus* is perhaps the least weak, it appears that the *Falcos* must be ascribed to immature Lanners which are quite variable and often very "white-headed" by mid-summer in the western arid regions. Under the circumstances, while none of the claimed records is impossible, one must urge both more precise work and more caution in the study of these fascinating migrant raptor congregations.

## V. ACKNOWLEDGEMENTS

I am endebted to the Director of Nature Conservation and Tourism for special permission to collect the specimens, to the landowners concerned, and to J. Lenssen and O. P. M. Prozesky for the actual collecting. W. Ferguson assisted with skin preparation, pellet analysis and observations, M. Odendaal with photographic printing. Dr. W. G. H. Coaton identified termite remains. Karibib rainfall figures were provided by the Weather Bureau's Windhoek Office. P. A. Clancey extended full co-operation, R. K. Brooke, M. K. Rowan and P. Steyn commented on the manuscript and R. Liversidge kindly commented on both the manuscript and the kite-falcon correspondence with Mr. Clancey.

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