SOME FACTORS AFFECTING THE FEEDING ECOLOGY AND SOCIO-BIOLOGY OF THE SAMANGO MONKEY, *Cercopithecus albogularis schwarzi* ROBERTS, 1931

by

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ABSTRACT:

In an attempt to explain why forest monkeys have a one-male group type of social structure in an environment of apparently rich food supply, the food resources, feeding behaviour and ranging behaviour of the samango monkey was studied in forest on the Eastern Transvaal Escarpment.

The taxonomy of the samango monkey in southern africa is discussed, as well as it's relationship to other forest Cercopithecines. The adaptations and limitations of the animal's intrinsic characteristics in a forest environment are discussed.

By a detailed analysis of climatic, microclimatic, phytosociological and phenological data the nature of the habitat as a whole was enumerated. Climatic parameters of the study area were compared to other areas inhabited by close relations of the samango monkey and the study area was found to be highly unstable in comparison to them. The forest itself was found to exercise a buffering effect on all meteors examined, thus modulating this instability to a degree. The forest areas used by the monkeys were of mixed dominance and could be divided by qualitative methods into distinct vegetational zones. Phenologically the trees were found to be highly irregular in time, duration and amount of production of a given phytophase. Almost all identified species in the study area were found to be used by the monkeys as a source of food. Several samango food items were weighed and measured and their food values determined. The effect of palatability and ease of obtaining and preparing food items is discussed. From this enumeration of the forest as a habitat it was found that contrary to popular belief forest is in fact a highly irregular and variable provider of food, indicating that the monkeys may indeed suffer from a form of food stress, albeit not in the same way that a gelada baboon does.

In the last section the response of the monkeys in their social structure, ranging behaviour and activity patterns is discussed. Aspects of all of these were seen to show adaptations to this variable and uncertain environment.

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CHAPTER FOURTEEN

CHAPTER FIFTEEN

SECTION A

INTRODUCTION - THE SAMANGO MONKEY IN CONTEXT

CHAPTER ONE

THE SOCIO-BIOLOGY OF PRIMATES AND THE ROLE OF ECOLOGY IN SOCIAL ETHOLOGY

In the past ten years the study of animal behaviour, especially social behaviour has received progressively more attention from psychologists and zoologists alike. Indeed many would now consider this field to be a "subject" in its own right as is population ecology or cell biology. The field which studies the social behaviour of animals has become known as social ethology (Crook & Goss-Custard 1972) or socio-biology (Wilson 1975). However the field is still young and the content ill-defined. As with many young subjects therefore, it is perhaps better to look at the subject in an historical perspective, examining the progression of ideas and their testing, to realise the present day scope of the subject.

The origin of the study of ethology itself can, with little doubt, be placed at the feet of Konrad Lorenz and Nico Tinbergen. Analysing behaviour in terms of biological and evolutionary concepts rather than in terms of physical models, as earlier used especially by comparative psychologists, provided an unforeseen impetus to all aspects of the study of behaviour.

The effects of this approach can be seen in modern studies of human behaviour (Bowlby (1969)), and in anthropology and sociology (Tiger & Fox (1966), Fox (1967), Jolly (1970), Morris (1967), etc.)

Needless to say then, social ethology itself uses biological and evolutionary concepts in the study of society. Wilson (1975) has defined Sociobiology as the " systematic study of the biological basis of all social behaviour." It is clear then that human social systems and organisation (i.e. sociology) is also a part of sociobiology. The effect of socio-biology on sociology as a subject has yet to be seen, however it is my guess that sociology, now at what Wilson (1975) calls the " natural history stage", will benefit very greatly from the introduction from socio-biology of these basic concepts.

Crook & Goss-Custard (1972) look at social ethology as follows and it is clear that their view of the field mirrors Wilson's concept " sociobiology. Crook & Goss-Custard write:-

> "Social Ethology is concerned with the description of social structures, their significance as adaptive and adaptable systems, and the relations between individuals within such systems. In addition, it sets social structure within a temporal dimension so that the nature of phase changes in structure become apparent and subject to analysis in terms of seasonal determinants acting upon individuals. Structure represents a single frame in the running film of social dynamics. Change in social structure through time consists of several laminated processes with different rates of operation. Environmental change (cold weather or food dispersion, for example) may affect social relations directly (e.g. proximate factors), while the indirect effects of longer term environmental change on learned traditions of social interaction come about more slowly. Genetic selection within a society comes about more slowly still under the influences of selective pressures or "ultimate factors".

For a young science to have had such a clear and balanced statement of what the science is about at such an early stage was fortunate indeed, and social ethologists are still exploring the ramifications of this statement and will, I feel, still be doing so for a long time to come. In the past, the behaviour of 'real' animals living in their "normal" state in the wild has been largely ignored. Scientists were interested in other things, (e.g. morphology, or taxonomy,) or they did'nt have the time or money, or perhaps even the expertise to approach this highly complex aspect of natural science.

Social Ethology began, as did most other branches of science, with an inductive observation. Strangely enough, it was two sociologists who first made this observation. However, largely due to political constraints the observation was never followed up. Petrucci (1906) a sociologist at the Institut Solvay in Brussels studied social structure per se (that is spatial dispersion, numbers in groups, group composition etc.). He noted that there were few correlations between a taxonomy of social structures and the classification of species. Indeed, in contrast he noted that there was rather, a marked tendency for similar societies to emerge in parallel adaptation to similar conditions (Crook 1970a and 1970b). He concluded that social structure was directly responsive to the environment and that ecological factors were active in determining the shape of the society produced. This is the core and the starting point of modern social ethology. Indeed if we look back to Crook's formulation, ecological factors are the proximate factors affecting social structure. One must note, however, that ecology alone was never considered by Crook to be the sole determinant of social structure. Petrucci, however, did, and he developed his thesis as follows. He concluded that because, in his belief, societies were determined by extrinsic factors alone, societies could not be compared in the same way that biologists compare morphology. It naturally followed that the social evolution of man could not be explained in Darwinian Terms.

While Petrucci's information of social ethology pre-dated any other such information, it was unknown to modern science until "discovered" and revealed by Crook in 1970a and 1970b. Crook's own thinking, however, did not miss the evolutionary base and while the idea that social structures evolve and a genetic base was involved, it was this relation between social structure and ecology and the advantages for individual survival within a given social structure (socio-ecology) which were first investigated. It was only later that the question of reproductive advantage and mating and rearing strategies and hence the true evolutionary base to the subject was investigated, although this was covertly included in Crook's 1972 synthesis. Most field studies to date have been concerned with socio-ecology. In 1966 Crook and Gartlan in their paper, "Evolution of Primate Societies", attempted, albeit with fragmentary evidence, to classify all primates into five evolutionary grades of social behaviour, searching for partial correlates in the habitat and diet of the species concerned with social structure. Some authors have criticised the paper because of the fragmentary evidence, even saying that they forced the issue (Wilson 1975). Certainly there were deficiencies and both Crook (1970a, 1971) and Denham (1971) attempted to clear these up as more data became known. However, while the 'grade' idea, already heuristically applied in birds, was found to be lacking for primates, there was more in these papers than this. Crook showed that a particular social structure could be explained in terms of survival value, and that this structure had adaptive significance in a given ecological situation. His development of these ideas for the terrestrial catarrhines - the baboon, the vervet, the gelada, the Hamadryas baboon and the Patas monkey - illustrated this. In this case he noted that in the baboons (_Papio_ spp.) and the vervets (_C. aethiops_) the typical social organisation was a multi-male troop. This consisted of a troop consisting of females and offspring and several adult males as well as juveniles etc. The males were usually organised in a strict dominance hierarchy and groups of 'surplus' males being unknown. On the other hand with various variations the other three species showed harem-group structures with 'male' only groups distinct from the reproductive unit. Without going into detail Crook showed that these contrasting social structures, in the ecological situation in which they were found, bestowed advantage on the members of the group as far as individual survival was concerned. The structure had selective advantage in that, where relevant, it gave maximal predator protection and allowed effective utilisation of food resources.

Another area where confirmation of the basic hypothesis could be obtained was the comparison of species which lived in a wide range of habitats, (e.g. langurs, and vervets). Here one could safely say there were no great genetic differences and hence that differences in social structure might be attributed to variations in habitat. Indeed, the social structures found in different habitats did vary, especially in Langurs where both one-male groups with monosexual male groups and multi-male groups were observed.

There were however, aspects where the 'grade' system did'nt work. One big blank was the position of the forest monkeys. Aldrich-Blake's work on the blue monkey (1970), suggested the presence of one-male groups with solitary males. The one-male reproductive units were territorial and there was minimal overlap between units. The groups were relatively small, (ten to twelve individuals). As stated earlier, the work on the terrestrial primates indicated that the harem group was an adaptation to a seasonal or unreliable food source with predation serving to accentuate it. But most forest monkeys live in tropical forest, a highly productive area, while predation was considered to be of minimal importance. Crook was unable to explain this anomaly, and this problem is the subject matter of this thesis. I will return to it later in chapter three when enumerating my objectives.

Wilson (1975) discusses the weaknesses of the 'Crook-Gartlan format'. He points out that the correlations are weak and uncertain and that when new data were added (e.g. Ceboids and forest monkeys), the correlation largely collapsed. Secondly, and this is certainly true, while Crook would be the first to realise the fallacy of this, it led primatologists to consider that ecology and not phylogeny controls social structure. Lastly, Wilson criticises the format because "... it lacks a true dependent variable. It is constructed in the spirit of multiple regression analysis yet does not follow the correct procedure".

Eisenberg et al (1972) largely corrected the methodological flaws. The grade of multi-male groups was made more elastic and based on amount of "male tolerance" in groups. However, the correlations remained weak.

Work has however continued in this field. This has shown, especially with respect to forest species, not so much that the initial hypothesis was wrong, but that in the words of Clutton-Brock (1974) : "Attempts to relate interspecific differences in social organisation among primates to gross differences in habitat or diet type have been largely unsuccessful... partly because distantly related species have adapted to similar ecological situations in different ways and partly because much finer ecological differences are important". This latter is the main topic of discussion of this thesis, i.e. that the gross differences in ecology used in correlations were too gross and that the animals in the groups respond to relatively minor ecological variations which are difficult to quantify and highly interdependent. This will be discussed in chapter three.

It is however, clear that the initial formulations by Crook for social ethology were rich and inclusive. Crook (1970a) summarised how he visualised social ethology in three points :

i) that social structure is a dynamic system expressing interactions of a number of factors (genetic and learned), both within the ecological and social milieux, that influence the spatial dispersion and grouping tendencies of populations within a range of lability allowed by the behavioural tolerance of the species.

ii) Change in social structure over time consists of several "laminated and interacting processes with different rates of operation". The most proximate of these being ecological, then the indirect effects of learned traditions of social interactions and thirdly, and slowest, the ultimate factors - genetic selection.

iii) That the major form of genetic selection will be social and this, primarily sexual.

He also points out that the social structure observed at a given moment in time will be the resultant of the interactions of the behaviour of individuals making up a group.

A more recent development in social ethology has been the consideration of mate selection, rearing strategies and other individual traits in the social systems observed and how the given social system might favour reproductive success in individuals in a given ecological situation.

CHAPTER TWO

THE SAMANGO MONKEY - TAXONOMIC RELATIONSHIPS, MORPHOLOGY & DISTRIBUTION.

Introduction

There are special reasons for discussing taxonomic aspects here. These are as follows :-

(a) The power of socio-ecology and social ethology lies in comparison either within one species in different locations or between species of various degrees of "relatedness". In the first case distribution or geographic location of populations studied is of importance, giving an idea of the differences of habitat, climate, seasonality, etc. of the populations being compared. In the second place both geographic situation and the degree of "relatedness" genetically is of great importance. While, at best taxonomic measures of "relatedness" are imperfect for various reasons, such information at least gives a baseline of some solidity upon which to base comparisons of a more plastic nature (i.e. social organisation, etc.).

(b) Although descriptions of the animal under study are rarely included many anatomical features do have relevance when discussing an animals adaptation to a particular environment. Further when comparing different species living in similar or different environments it is important to be aware of the structural differences in the animals concerned which at a very basic level might affect the observed differences in behaviour, socio-biology, etc.

(c) So far as the southern african forms of C. mitis are concerned the taxonomy, as published, is very confused and their distribution is incompletely summarised.

Taxonomy and the Order Primates

The taxonomic position and status of most primate forms is confused. Even now taxonomists are including new taxa in an attempt to more accurately describe the relationships among the described forms (e.g. Hill (1974) includes the taxa Tribe Cercocebini, Papionini and Theropithecini, to describe better the relations between these three groups). With every newly published review we find species or subspecies deleted or reassigned to new taxa. Especially in Cercopithecus one finds extensive use of the category superspecies to indicate relationships.

There are good reasons for this confusion :-

(a) The precise geographical origin of specimens was often not known (the type specimen of Sykes monkey was purchased in Bombay and assumed to have come from Madagascar!).

(b) There were not enough recognised taxa to describe the relationships thought to exist - hence the use of superspecies or sub-genus and Tribe.

(c) At the subspecies level, many were originally assigned the status of species for various reasons - (e.g. lack of data, etc.), ... while really no such division existed, the described animal merely being a natural variant.

(d) Many primate groups are classified at the subspecies level, by variations in pelage colour. This character can be a very variable one. Hill (1966) notes that the occurence of melanistic (black), erythristic (red), flavistic (yellow) and even albinistic mutants in a given population is possible. One can easily see what might be the effect of this when animals are being classified with few specimens often of uncertain geographic origin. Schwarz (1927) noted that animals tend to get darker with age. Pocock (1907) was amazed at how many times the three colours, red, black and white were interchangeable even within the lifetime of one individual (e.g. the nose spot of C. erythrogaster changes from black to white with age). Further it has been noted by Sanderson (1940) that it is possible for vegetable stains, encountered in life, or holocrine secretions or even the mode of preparation of a skin to alter its colour either in part or as a whole.

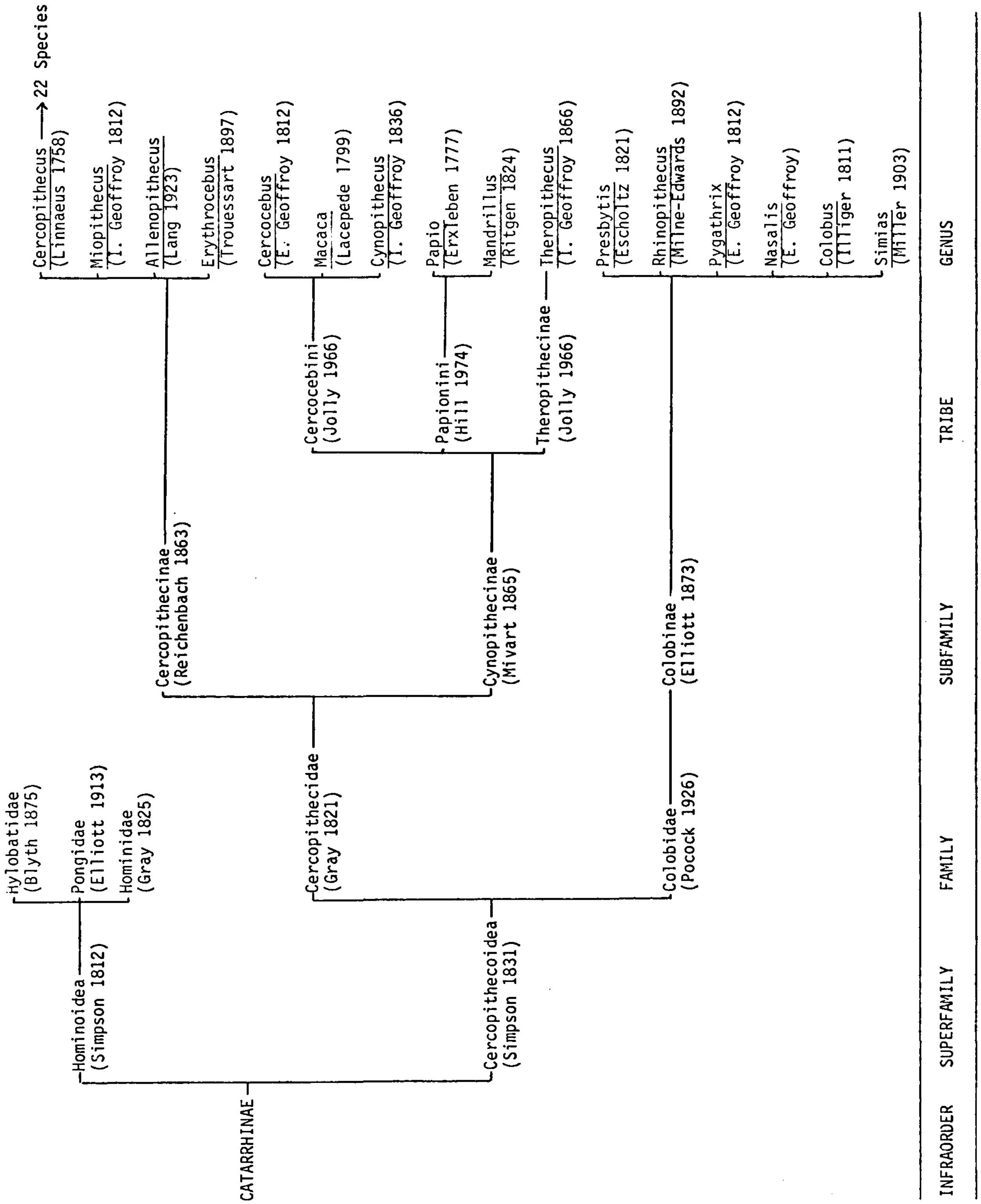
Considering this one can readily understand why there is confusion and one has a real reason to doubt the uniqueness of some of the described species and subspecies of the Order Primates.

The Taxonomic Position of Cercopithecus

Figure 1. illustrates the taxonomic position of the genus Cercopithecus so far as present day authors are concerned. Not all primate taxonomists agree with the arrangement of the taxa. However here we are concerned with relationships and not the purity of the taxonomy. The following should be noted :-

(a) Hill's (1974) inclusion of three Tribes within the Cynopithecinae has been followed because it does show the relationship between the Mangabeys,

Figure 1: A Classification of the Old World Catarrhines.



the Baboons and the Geladas. The Subfamily taxa, Cercopithecinae and Cynopithecinae separate the smaller more gracile guenons from the larger simians. In the Cynopithecinae the representatives range from the arboreal and gracile Cercocebus to the more stocky terrestrial baboons. The only member of the genus Cercopithecus to approach Cercocebus is Allenopithecus. The new subcategory of Tribe was introduced by Hill on the basis of palaeontological evidence indicating that baboon-like adaptive radiation has cropped up several times in phylogeny (Jolly 1966).

(b) The Colobidae have been put at family level, contrary to Dandelot's (1968) classification. Hill (1966) has endorsed Blyth's (1875) separation of the Superfamily Cercopithecoidea into two Families, Colobidae and Cercopithecidae on the basis of recent serological, haematological and cytological data as well as the craniological evidence of Verheyen (1959).

(c) Dandelot (1968) places Miopithecus, Allenopithecus and Erythrocebus as subgenera of Cercopithecus rather than as genera in their own right as shown here. The definition of Cercopithecus as a unique genus, including only the gracile forest guenons and the C. aethiops formenkreis is not only convenient for the purposes of this thesis, but also taxonomically sound. For example :-

Allenopithecus is more baboon or macaque-like than the other three genera, while however retaining some guenon-like characters. It inhabits swamp forest exclusively and is arboreal. It shows little or no catamenial swelling.

The Talapoin (Miopithecus) is on the other hand very small and looks like a guenon. It also inhabits swamp forest and other "wet" vegetation. However the females exhibit a high degree of catamenial swelling and in the male the testes and scrotum are relatively large as compared to the true guenons.

Erythrocebus is easier to ascribe to generic status, being a large guenon-like animal differing from the true guenons in having proportionately longer, more slender limbs with short thickly padded hands and feet bearing short digits.

Adaptive Features of the Primates : Vision and Arboreality

The Primates as an order are described as being unguiculate, implying that most of the original eutherian mammal characteristics have been retained. (five digits on limbs, clavicle, arboreality, etc.). In addition, certain features have been developed which are important to arboreal living in larger animals. Where animals are terrestrial this is almost certainly a secondary adaptation (Jolly 1966).

One might suppose that an arboreal existence differs from most terrestrial ways of life in emphasising the need for quick reaction to changing stimuli due to the unstable nature of the substrate. The result of this can indeed be seen in the Primates where characters which would tend to ensure an animals safety and survival have been specially developed.

We can consider these developments at two levels. First the physical apparatus both in co-ordination and mechanical apparatus, to be able to cope with an unstable substrate and second, the behavioural apparatus required to be able to cope with among other things, and often unstable food supply. Indeed both factors may have played a key role in directing the development of forest monkeys as we know them today.

The following generalised adaptations are common to most primates and illustrate this :-

(a) Increased Sensory Acuity and Concomitant Increase in Integrative Ability

Vision is increased and the sense of smell reduced. All Primates are microsmatic, with the turbinals and snout reduced. Due to this reduction the eyes face forward and binocular vision is possible.

(b) Increased Brain Capacity

Concomitant with these changes in sense organs, changes in brain capacity must have ensued to cope with the increased sensory complexity and resolution. The cerebral hemispheres became important and highly differentiated. The olfactory bulbs became small.

(c) Skeleto-Muscular System

The bones and muscles are arranged to allow jumping, swinging and grasping. The pentadactyl plan is retained. The pollux and hallux are adapted in many forms to allow adduction. The clavicle is very mobile

(d) Dentition

The teeth are unspecialised and the molars are quadritubercular.

(e) Reproduction

The uterus is single chambered. Usually only one offspring is produced. Placentation is very complex and leads to efficient haemochorial placentation being possible. Gestation is long and the foetus is born well developed. This is followed by a long period of parental care.

Perhaps the most important feature of Primate adaptation is the changes in senses and brain. These appear to have allowed the development of complex social structures posessing high protocultural components and in man culture and language.

Characteristics of the Genus Cercopithecus

They are largely arboreal [1], medium-sized guenons [2] of slender build. Their general form shows their adaptation to arboreal life and this is fairly generalised throughout the genus. Without the skin one Cercopithecus looks much the same as any other. These features include : (a) the pelvic limbs are longer than the pectoral limbs, (b) the tail is long, exceeding body length and well haired, never being prehensile, (c) the hands and feet are generalised.

For more detail, let us consider each part individually:-

1) PELAGE: The variation in colour and patterning of the pelage is perhaps the most important area of variation among the Cercophithici and is the key feature separating forms taxonomically. Colour variation is achieved through the presence of bands of pigmentation in the hairs especially of the dorsal pelage and face. In addition to the presence of 'agouti' hairs, colour variation is achieved through variation in the intensity of pigmentation. For instance in the Vervet or

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[1] - only C. aethiops is to any extent terrestrial.

[2] - from the french - "grimacing" introduced by Buffon.

Grivet monkeys the characteristic green tinge of the pelage is achieved by the presence of yellow, darker orange, brown and even black bands, or zones of these contrasting colours along the length of each hair shaft.

Schwarz (1927) has studied this aspect with the aim of being able to distinguish species and subspecies. He noted that in the melanised bands of the hair shafts there were two forms of melanin pigment - eumelanin (a dark-brown granular type) and phaeomelanin (a more diffused paler, yellowish type). Further these were often found to be mixed within bands, especially in dark-coated animals, and in the darker regions of hairs.

The two types of melanin are inherited independently and laid down independently. Black or dark-brown pigment develops later in development than the yellowish phaeomelanin. Animals therefore tend to become darker with age.

Erythrism is the effect which results when the eumelanin (darker) pigment is low in concentration and at very low concentrations flavism is the result. Thus young animals tend to be erythristic or even flavistic while even in some adults inhibition of eumelanin production results in adult erythristic or flavistic forms. Only complete inhibition of hair pigmentation results in albinism and this only at an individual level, while erythrism, flavism and melanism (darker forms) appear to be seen only at the population level. It is thus clear to see how taxonomic confusion has arisen.

2) HAIR TRACTS

Another characteristic of the Cercopithici is the length and orientation of the hairs of the pelage. Within the Cercopithici as a whole there are two types of hair - coarse and fine.

In most species there is a region above the eyes where the hairs are longer coarser and directed forward giving the impression of very bushy eyebrows. There is also a thickening of the cranium here further accentuating this. The remaining part of the forehead has hairs directed backwards. The eyes themselves are framed by hairs and these are usually white, thus accentuating the eyes, which are closely surrounded by bare, black pigmented skin. The eyelashes are well developed, sometimes with two rows being present. The former feature almost certainly enhances the signalling efficiency of the eyes, while the latter, unusual among simians, may be an adaptation to protecting the eyes in forest, from bark-dust, and cobwebs, etc., which in my experience is a very real hazard.

Another very characteristic feature of the pelage is the presence, especially among the forest species of long hair laterally under the chin and ears and stretching down to the shoulders. These areas of longer hair effectively obscure the demarcation between head and body when the animal is ventrally or dorsally viewed and are more marked in males than in females. Opponents grab these thick hairs in male-male fights.

3) CUTANEOUS PIGMENTATION

Skin pigmentation is not restricted to the epidermis, but is also found in the dermis in the form of contractile pigment cells (melanocytes). The presence of these dermal pigment cells results in the skin taking on a bluish tinge by an optical phenomenon. White light is refracted on passing through the translucent epidermis, and is reflected by the melanocytes having varying degrees of contraction, which may result in a blue, or blue-green skin colour rather than a black or grey colour.

This colouration is especially noticeable on the ventral areas, where the hair is thinner, e.g. on the chest, abdomen and in the genital regions. In some species it is also found on the face.

In most Cercopithici the scrotum is of a blue colour and in some species it is a remarkable turquoise blue (Vervets). This colour can vary within species and subspecies and in some cases even with individuals apparently as a result of relative dominance. The control of the blueness appears to be a function of vascular and haemodynamic factors as well as the dermal melanocytes and the organisation of the superficial dermal collagen fibres (Hill 1966). The regular organisation of the latter causes interference comparable to Multiple Thin Film Diffraction. The dermal melanocytes, here in higher concentration, again act as a reflective layer.

On the face, hands and feet the black pigmentation is due to epidermal melanocytes. The rest of the body, apart from the face, feet, hands, genital regions and ventral regions, the skin is white.

There is an area of whiterskin around the eyes, especially on the eyelids.

4. CUTANEOUS GLANDS

The hair follicles secrete sebum and there are sweat glands, though these are most localised on the palmar surfaces of the hands and feet.

No specialised or aggregate cutaneous glands have been described, however, some type of cutaneous secretory glands must exist. Most species of Cercopithici have a distinct garlic-like odour and an orange or brownish deposit of waxy granules is often present in the fur of the pubic and inguinal regions. It has been suggested that these may be of the hypertrophied holocrine type. In the Redtail C. ascanius a yellow brown scurf is common on the chest and in this species the garlic odour appears to emanate from the front of the animal.

In the vervet C. pygerythrus callidus modified apocrine and holocrine glands have been reported in the deep dermis (in Hill 1966).

5) MENSTRUATION

There is no catamenial swelling, though there may be a slight but regular puffiness of the vulva (C.albogularis erythrarchus) associated with menstrual flow. This puffiness is restricted to the labia. The period of menstruation is of medium length (31 days in C. aethiops) and the duration of flow is short (not more than three days in C.albogularis).

6) SKULL

Medium-sized with a rounded or ovoid brain case and the face truncated and rather broad. There is not a well demarcated snout.

7) POST-CRANIAL AXIAL SKELETON

There are seven cervical, nineteen thoraco-lumbar, three sacral and a variable number of caudal vertebrae, usually between twenty and twenty-eight.

8) APPENDICULAR SKELETON

The pectoral girdle is highly mobile with the scapula broad compared to sagittal length.

In the pelvis the gluteal aspect is highly excavated, an adaptation apparently highly correlated with the faculty of upright sitting (Waterman 1929).

9) PEDAL SKELETON

Both hands and feet are generalised, elongated and relatively narrow compared to *Macaca* or *Papio*, this is an adaptation to arboral life.

10) DENTITION

The adult dental formula is :-

$$1\,\frac{2}{2};\quad C\,\frac{1}{1};\quad PM\,\frac{2}{2};\quad M\,\frac{3}{3}\quad = 32.$$

Sexual differences in size are less than in *Cercocebus*, *Macaca* or *Papio*. The incisors are peg-like not chisel-like.

11) ALIMENTARY CANAL

The stomach is a simple sac-like structure with no sacculations.

12) RESPIRATORY TRACT

Larynx. Little has been published on this organ. Negus (1949) discussed that of a specimen of *C. aethiops* and of a 'Mozambique guenon' *C. albogularis erythrarchus*. The most remarkable feature in this genus is the presence of median air-sacs opening from the vestibule of the larynx, and located at the base of the epiglottis. The sac itself is variable in size and is a thin walled diverticulum of the laryngeal mucosa occupying the concave dorsal aspect of the hyoid cartilage, and caudally between the sterno-hyoid muscles. In males of *C. mitis stuhlmanni* and females of *C. albogularis* and *C. neglectus*, the sac is large and bilobed with processes extending cranio-laterally deep into the angular region of the mandible as well as caudo-laterally beneath the sternomastoids.

In the samango the presence of air sacs is only noticeable from the outside in the male. The skin below the chin and around the throat appears loose and moves like a double chin as the animal locomotes. On dissection it is found that this region has these air sacs. The sacs can be seen to be inflated just before the animal gives a "boom call" and is suddenly deflated with the call. The "boom call" is a sudden low pitched booming call, performed only by males. The females also give calls which are sudden sharp exhalations through the vocal chords, but they are high pitched and of much shorter duration. In the female the median airsacs are smaller and extend less than in the males.

The Taxonomy of Cercopithecus

The genus *Cercopithecus* consists of approximately twenty-two species depending on the reviewer (Hill (1966) - 22; Dandelot (1968) - 19). Hill (1966) puts all twenty-two he described into two higher taxa - superspecies. Other authors do not consider the superspecies to be a true taxon. Mayr (1963) concurs with this though considers it to be a useful descriptive tool. He considers a superspecies to be a monophyletic group of entirely or essentially allopatric species that are morphologically too different to be included in a single species. Dandelot (1968) follows Mayr's useage in only defining superspecies where there is a group of species which follows this definition. When there is a group of species which are clearly related he calls them, implicitly, a "species group" (e.g. *C. ascanius* sensu lato, which includes *C. ascanius*, *C. petaurista* and *C. erythrogaster*.) Hill (1966) groups these together as Superspecies *Cercopithecus petaurista*). However, while Dandelot (1968) is more correct it leads to a messy and unclear description of relationships. Hill (1966) indicates the following Superspecies :-

(a) *Cercopithecus mitis* - three species.
(b) *Cercopithecus l'hoesti* - two species.
(c) *Cercopithecus mona* - three species.
(d) *Cercopithecus petaurista* - four species.
(e) *Cercopithecus cephus* - monotypic.
(f) *Cercopithecus neglectus* - monotypic.
(g) *Cercopithecus diana* - monotypic.
(h) *Cercopithecus aethiops* - three species.
(i) *Cercopithecus hamlyni* - monotypic.
(j) Incertae sedis (*C. asnoti*) - monotypic.

Few of the members of these superspecies have been studied, most of them representing skins in museums and a few sight records.

Perhaps the best studied are the Superspecies *C. mitis* and *C. aethiops*. The latter includes the Vervet, Grivet and Green monkeys, all of them "semi-terrestrial". This leaves the Blue and Sykes monkeys (*C.(mitis) mitis* and *C.(mitis) albogularis*.) The Samango is a form of Sykes monkey and hence we can go straight on to a discussion of their taxonomy.

Taxonomy of the C. Mitis Group (Superspecies C. Mitis)

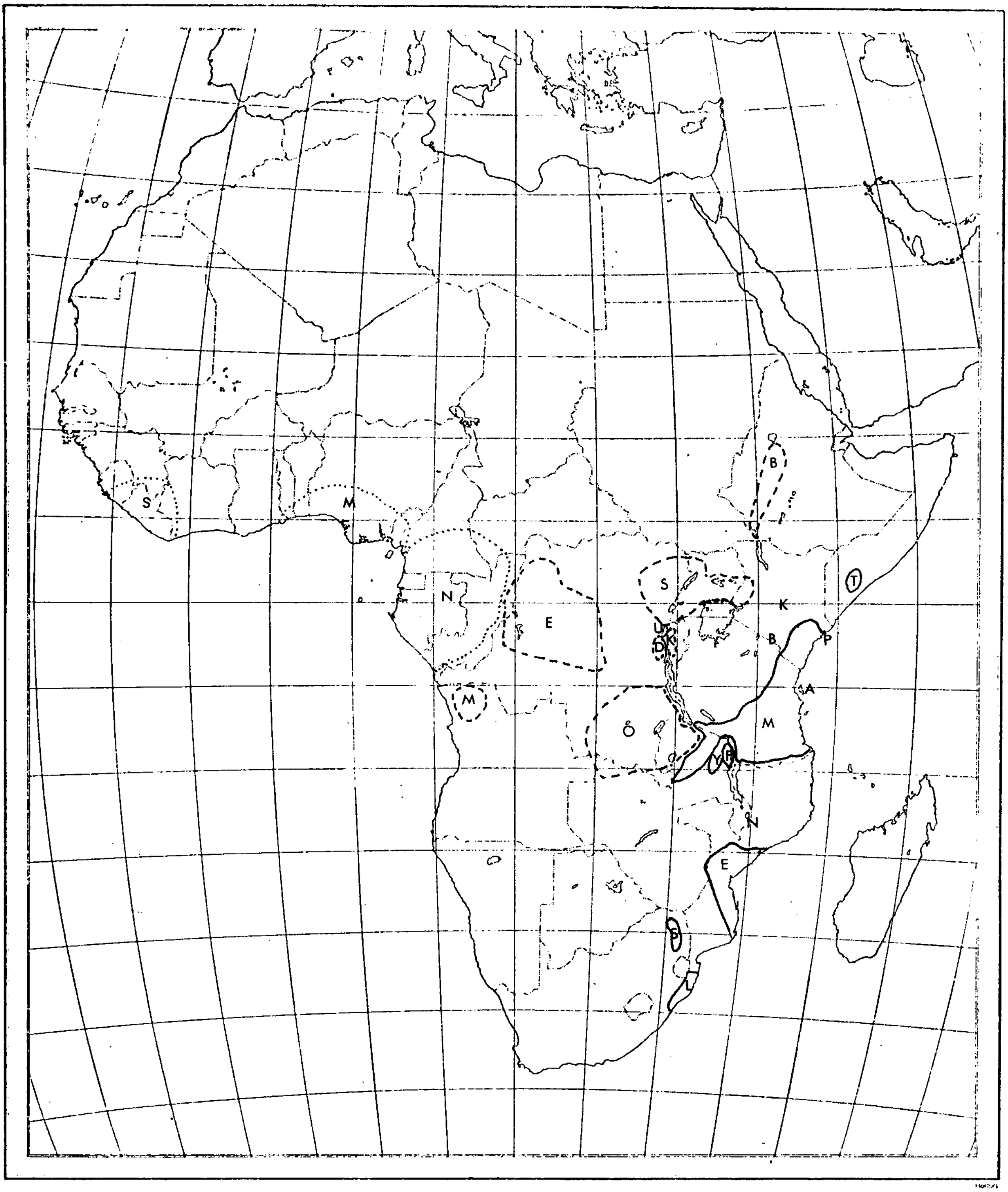
Both Hill (1966) and Dandelot (1968) include three species in the superspecies - C. (mitis) mitis, C. (mitis) albogularis and C. (mitis) nictitans. Rahm (1970) adopts a different stance and following Schwarz (1928) and Allen (1939), puts the former two into one inclusive species C. mitis with several subspecies. C. (mitis) nictitans he excludes on the basis that C. (mitis) mitis maesi and C. (mitis) nictitans nictitans are sympatric in the Budjala region of the Congo in the Congo-Oubangui District.

The mitis group is represented in forested areas of West Africa by C. (mitis) nictitans whilst C. (mitis) mitis and C.(mitis) albogularis are predominantly eastern in range. Plotting the localities of the recognisable forms one can see three north-south clines. From east to west the first, from the coast to the Great Rift Valley is the C. (mitis) albogularis group. The second is the C. (mitis) mitis group, on the west of the Great Rift Valley extending into Zaire, and third, largely separated from C. (mitis) mitis is C. (mitis) nictitans in the west. (Figure 2.) The Blue monkeys (C. (mitis) mitis) tend to have a variable pelage. However, most species have a pure black cap and shoulders and sometimes a black ventral surface. The dorsal pelage is mainly iron-grey to olive-green. They live exclusively in Forest from 1000 to 3000 metres and sometimes in gallery forest. They are very widespread in forest west of the Great Rift Valley being found in Ethiopia, Southern Sudan, Uganda, Kenya, Congo(K), Zambia and Angola.

The "White-nosed" monkeys, "hocheurs" or "Putty-nosed" monkeys (C. (mitis) nictitans) look much the same as the Blue and White-throated monkeys, but with a white or yellowish nasal spot. This is a West African species occupying the Guinean and Congolese Forest Blocs, above the River Congo.

The "White-throated" monkeys (C. (mitis) albogularis) or in Southern Africa, the samango monkey, have no black cap (c.f. C. mitis and C. nictitans) and have a white throat and always a white ventral surface. They are restricted to areas west of the Rift Valley, ranging over the whole area in suitable forest between the Rift Valley and the Coast. The latitudinal range extends from north of the Juba River as far South as the Eastern Cape

Figure 2 : The Distribution of the Subspecies of the Superspecies *C. mitis*



Drawn after Hill (1966)

For key - see opposite page.

Province. The altitudinal range extends from the coastal plain and neighbouring islands to forest at 3000 metres or more.

Figure 2 shows the ranges of the various subspecies of the three species according to Hill (1966) (i.e. using Hill's classification). Figure 3 shows the various subspecies described - first after Hill (1966) and in brackets afterwards the differences between this classification and Dandelot's (1968) and Rahm's (1970).

Factors Affecting the Present Day Distribution of the Superspecies C. Mitis

In considering the distribution of the Superspecies *C. mitis* Aldrich-Blake (1970) points out that it is the only species of *Cercopithecus*, which extends so far east and so far south excepting *C. aethiops* which is a savannah monkey. In the majority of cases members are only found in high forest and rarely in riverine forest or woodland savannah. In addition he notes that most other *Cercopithecus* are concentrated in the great forests of the Congo and West Africa and that within their ranges the distribution is very discontinuous.

After examining data and evidence from many sources, geological, climatic, palynological, etc., Moreau (1966), concluded that the reason for the discontinuity of distribution could largely be explained by climatic factors. Apart from the Congolese and West African forest blocs and the dune forests, forest occurs in isolated highland areas in the south and east of the continent, in between open lowland areas. He argues that in cooler times these forests had a much greater and continuous extent allowing wide colonisation. Later as the temperature rose the lower limit of the forested areas became higher and the forest thus discontinuous.

To explain the absence of other *Cercopithecus* spp. from the greater parts of the *mitis* group's range Tappen (1960) suggests that its major extension must have taken place during an early spread of montane forest, prior to the main *Cercopithecus* radiation. The *mitis* group would thus re-

Figure 3: Hill's (1966) classification of C. mitis with Dandelot's (1968) & Rahm's (1970) equivalents.

RAHM (1970)
All subspecies as HILL (1966) except that C. (m) mitis and C. (m) albogularis are put together as one species
= C. (m).a. zammaronoi de BEAUX 1924 and C. (m).a. albotorquatus POUSARGUES 1896
= C. m. albogularis
= C. m. monoides
= C. m. phylax
= C. m. kibonotensis
= C. m. kolbi
= C. m. moloneyi
= C. m. francescae THOMAS 1902
= C. m. nyasae
= C. m. erythrarcus and C. m. Stevensoni ROBERTS 1948
= C. m. schwarzi
= C. m. labiatus
Not included in Superspecies C. mitis

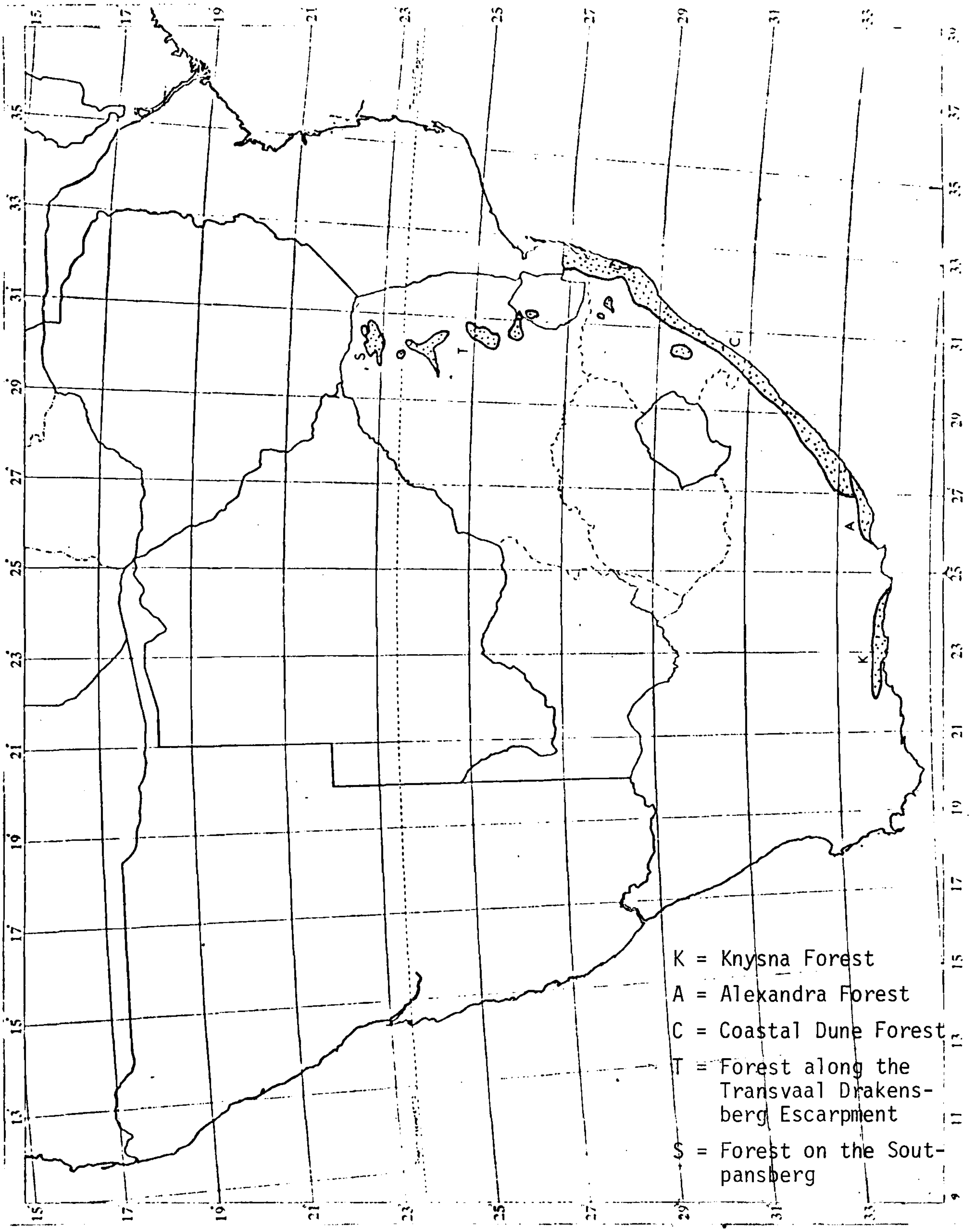
present ancestral Cercopithecus stock, whereas the other members of the genus would be of more recent origin.

The apparent greater degree of differentiation found in the other Cercopithecus might be explained by the fact that the Congo and Guinea forest belts were probably fragmented to an enormous extent forty to ten thousand years ago allowing frequent isolation of the monkey populations. (Booth 1955) (Moreau 1969). In contrast the various races of C. mitis may never have been separated for sufficiently long at a stretch for genetic and behavioural isolation to develop. If this is correct it follows that most of the modern races of C. mitis are of recent origin after the last glacial era, ten thousand years ago. The island of Zanzibar became separated from the mainland only ten thousand years ago as the ice-caps melted. (Moreau 1966). The island form is smaller and paler (C. (mitis) a. albogularis) than the mainland or (C. (mitis) a. monoides). The island of Mafia, however separated later and there is no such divergence.

The Samango Monkeys - Southern African C. (mitis) - Taxonomy

The Samango monkeys include all the subspecies of C. (mitis) albogularis occuring in Rhodesia, Mozambique and South Africa (including Transkei). As elsewhere their distribution is patchy, occurring in locations where forest (montane or dune) is found. This can be seen by comparing the maps showing the distribution of the forest and of the samango monkeys. (Figure 4 and Figure 5). Examination of the last map also shows that there are five loci where samangos are found and it is perhaps not surprising that these correspond to the taxonomic divisions which have been used by various reviewers. Again we find considerable confusion, with differences between authors. Figure 6 reviews the organisations of various reviewers of these five populations. Apart from the geographic separation of specimens and sight records there seem to be slight differences between the subspecies based mostly on pelage differences. As mentioned earlier

Figure 4 : The Distribution of Indigenous Forest in South Africa



K = Knysna Forest

A = Alexandra Forest

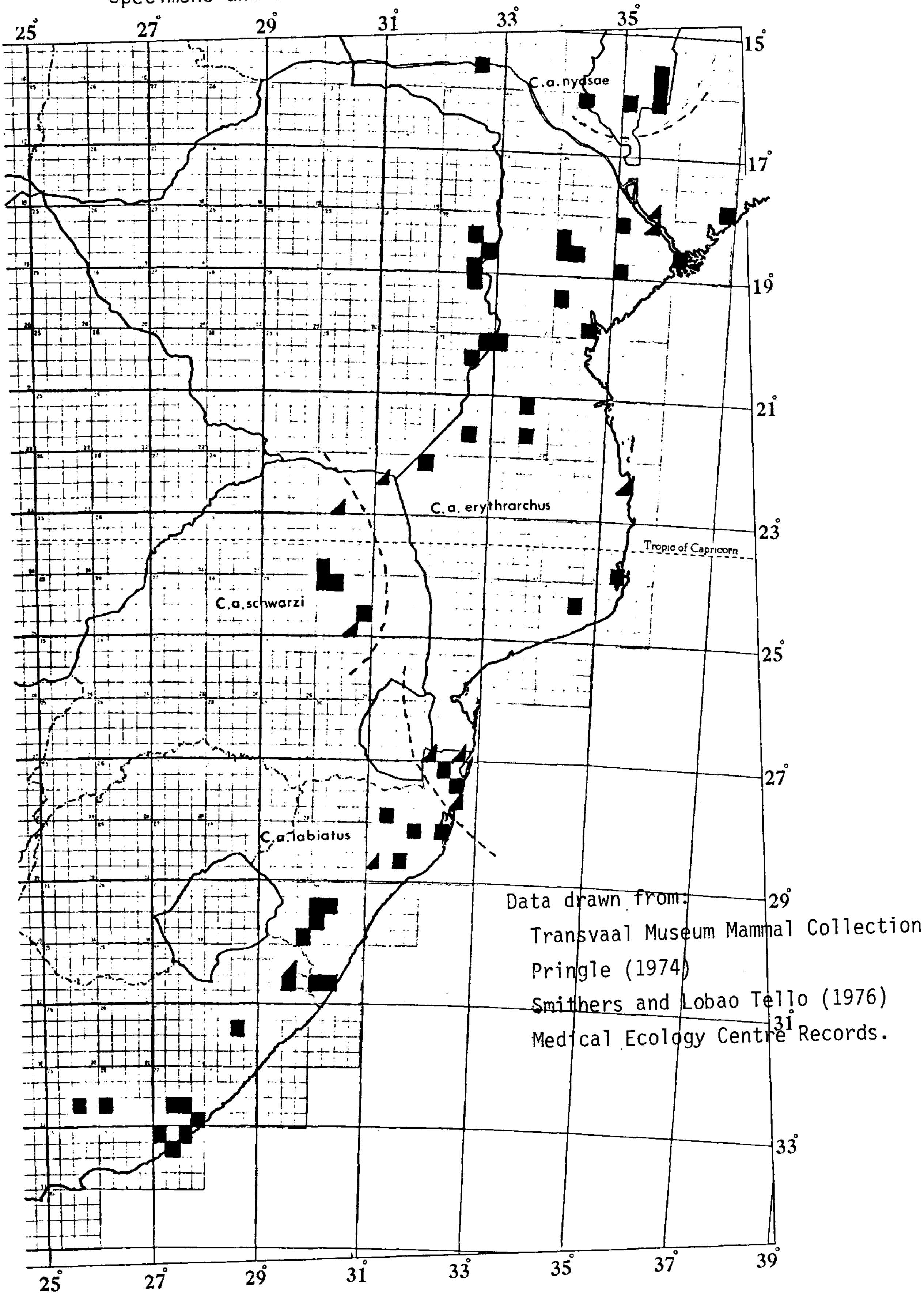
C = Coastal Dune Forest

T = Forest along the Transvaal Drakensberg Escarpment

S = Forest on the Soutpansberg

After Acocks (1953)

Figure 5: The Distribution of Southern African C.(m.) albogularis subspecies - Specimens and Site Records.



Data drawn from:
Transvaal Museum Mammal Collection
Pringle (1974)
Smithers and Lobao Tello (1976)
Medical Ecology Centre Records.

■ = Museum Specimen
◢ = Site Record

Figure 6: The various Classifications of the southern african C. (m.) albogularis.

	ROBERTS (1951)	HILL (1966)	RAHM (1970)	DANDELOT (1970)
(1) Mozambiquan Population (Dune Forest)	C. mitis erythrarchus	C. (m) albogularis erythrarchus	C. m. erythrarchus	C. (m) a. erythrarchus
(2) Rhodesian Population (Vumba Mtns)	C. mitis stevensoni	C. (m) a. erythrarchus (differences between) C. (m) a. erythrarchus and C. (m) a. stevensoni slight (Ansell 1960)	C.m. stevensoni notes Ansell's (1960) observation.	C. (m) a. erythrarchus
(3) Soutpansberg and Transvaal Drakensberg (Montane)	C. mitis schwarzi (does not include Soutpansberg population and Woodbush specimens said to be different)	C. (m) a. schwarzi	C. m. schwarzi	C. (m) a. erythrarchus
(4) Zululand (Dune forest)	C. mitis labiatus	C. mitis labiatus	C. m. labiatus	C. (m) a. labiatus
(5) Eastern Cape and S. Natal	C. mitis labiatus	C. mitis labiatus	C. m. labiatus	C. (m) a. labiatus

this type of separation may be dubious due to colour mutants, storage and preparation, and artificial coloration during life. The subspecies are as follows :-

1. C. (mitis) a. erythrarchus PETERS (1852) is by all authors different from the other subspecies which they use, by having long red hairs in the ischial region extending down the tail proximally and sometimes laterally.
2. C. (mitis) a. stevensoni ROBERTS (1948) is excluded by some authors (Hill 1966, Dandelot 1970) because of its similarity to C. (mitis) a. erythrarchus. Roberts (1951) describes the difference as being first that the ventral hairs are not pure white as in C. (m) a. erythrarchus but banded with grey and second that the dark rufous (red) ischial hairs do not extend over the base of the tail above.
3. C. (mitis) a. schwarzi ROBERTS (1931) is considered by Dandelot to be synonymous with C. (m) a. erythrarchus and Roberts (1949) notes that red hairs are not as pronounced in the southern part of the population. Roberts also notes that the tail is black for more than two-thirds of its length separating it from the southerly C. (mitis) a. labiatus. Hill (1966) describes yellowish hairs at the base of the tail.
4. C. (mitis) a. labiatus I. GEOFFROY (1842) (Synonym : C. (mitis) a. samango Ahlberg (1844)), has according to all authors quoted so far a white base to the tail, separating it from the other described subspecies.

Hill (1966) and Roberts (1951) go into considerable detail concerning description. It does however, seem that the main character in separating subspecies has been the degree and colour of the ischial and ventral tail hairs.

In observing monkeys in the wild, one does get the chance occasionally to observe this character. In monkeys from the Transvaal this appears to be variable - some having whitish "tail hairs" others more red. Further it does appear to vary from season to season.

The problem of which name to assign the various described populations is difficult. Firstly there are remarkably few actual specimens (Figure 5) and many of these are old and of dubious origin and various preparation.

To clear the problem up would require a systematic collecting expedition. Until this can be done, I shall call them just Samango monkeys.

The Distribution of Samango Monkeys

Figure 5 shows the distribution of all specimens and sight records known to the author. This has been put together using the records of the Transvaal Museum, Pringle (1974) and the records of the Medical Ecology Centre compiled by D.H.S. Davis as well as my own sight records.

These records give an idea of the places where samangos may be found. However, within the general areas indicated, the distribution is again very discontinuous, with samangos being found only where suitable forest is available, be it dune forest or montane forest.

Looking at Acocks' (1953) summaries of the distribution of forest in 1400, 1950 and 2050 gives one little hope for the survival of the species in South Africa, with true forest being almost non-existant in 2050.

SECTION B

AIMS & OBJECTIVES

CHAPTER THREE

AIMS & OBJECTIVES

Main Objectives

It is by now surely clear that the explanatory power of socio-ecology lies in the comparative approach. To date this comparison has largely rested with the comparing of the behaviour ofgroups of monkeys and how they adapt to a given habitat. Different methods, at a social level,have been described by which different types of monkeys cope in different or similar habitats. Two variables only however have been considered in any detail - the social organisations concernedand the taxonomic relationshipsbetween animals exhibiting those social structures. A third and key variable, habitat, has often been considered only at a sketchy level, though in recent studies more attention has been payed to this aspect, especially in forest monkey studies.

The germinal studies of social behaviour of Crook (1966, 1970), Hall (1962a & b, 1963, 1965a, b & c), Hall & DeVore (1965), Carpenter (1940,1942) and others, were primarily of terrestrial animals living in grasslands. It was sufficient for explanatory purposes to merely broadly classify habitats physiognomically. Seasonality of food supply for instance could be considered in an ordinal way and no more quantitative approach was necessary. In addition predation in open living animals is perhaps of greater importance to the moulding of social structure.

Until the studies of forest monkeys became available this type of enumeration appeared adequate - all known studies fitted into the explanatory scheme. However, when in 1970 Aldrich-Blake revealed that forest monkeys (C. mitis) also exhibited a basic harem-type organisation similar to that found in hamadryas baboons and geladas, there were problems. Here,on the face of it, was the "same" organisation being exhibited by animals living in harsh almost desert conditionsand by animals living in the most highly productive terrestrial environment there is - tropical forest. This was indeed a paradox and it was this paradox which prompted me to approach this problem almost from the other end - the habitat end.

Other workers have included quantitative vegetational analyses in their research in an attempt to come to grips with this problem (Struhsaker (1974), Rudran (in litt), Marsh (in litt), Clutton-Brock (1972). However, perhaps due to the fact that there were no well-established methods for doing this, as well as a desire to concentrate more on the monkeys than on the habitat, no adequate enumeration was achieved.

Hladik and Hladik (1972) came closest to a true correlation between habitat and social organisation and their research is certainly the most comprehensive to date. They, however, concentrated on habitat alone, the behavioural data being derived from co-workers.

Having observed wild samango monkeys for some months and having noted the habitat, it seemed to me that in the location concerned the animals did indeed suffer from food stress - though of a different nature to that experienced by hamadryas and gelada baboons. First, while it appeared that at a glance, plenty of food was available such as fruit on trees, young leaves, etc., did this reflect its actual availability to the monkeys? Observing monkeys feeding, showed them to be particular as to the fruit (their primary diet) which they ate - only almost or fully ripe fruit were taken and leaves were eaten only when young. Further observations were that only a small percentage of fruit was actually ripe at one time on a given tree, that not all trees produced fruit in one year and that some species had short sharp fruiting seasons while others were less synchronised in their production. It could therefore be that forest monkeys may experience food stress through their food supply being almost continually changing and unstable.

If this was the case then one would expect to find a correlation between ranging patterns during the year and the distribution of food during the year. These parameters should be and are quantifiable. However, at that time there was a distinct lack of a methodology for quantifying the latter.

My basic hypothesis then is that the one-male group organisation found in forest monkeys, later found to also be the case in samangos, is a result of food stress as it is partly in the terrestrial primates which exhibit it. The food stress is caused by the seasonality of food production and the dispersed nature of the food supply in space and time.

To attempt to test these hypotheses a very intensive study of the food supply in all its aspects was necessary.

Thus the two main objectives of this thesis are :-

i) to test the hypotheses as stated, quantitatively or qualitatively, to solve the paradox mentioned earlier.

ii) to develop quantitative methods which can be used by primatologists to adequately describe the habitat of a species under study.

Other Objectives

The objectives enumerated previously are clearly academic and as a result, of limited use in themselves alone. I hope however that this work will not merely be of academic use. As mentioned in chapter two, the samango is, if not, an endangered species, low in numbers and does live in a habitat apparently on the wane.

As a study species the samango has been almost completely neglected and any information about them will be useful to those involved in its conservation or management. Recently the Forestry Department has had problems with damage done to forestry plantations in the Soutpansberg due to samangos. Hopefully, on the basis of this work, at least some guidelines as to how to prevent this without exterminating the population should be possible.

As a vegetation type little work has been devoted to the study of forest, most of the work having been devoted to the bushveld and grasslands. While this is nominally a zoological thesis, carried out by a zoologist the botanical work may serve to supplement the work of Van Der Schijff and Schoonraad (1971) and Scheepers (1966) on forest from a purely botanical aspect rather than with respect to testing the efficiency of sampling methods and other botanical problems.

Perhaps the largest single section of this thesis is devoted to phenology, the study of the production of phytophases. Hall-Martin (1972) in his thesis on the Ecology 6f Lengwe in Malawi considered this aspect and my methods were based on this, aiming to show what an extremely variable aspect of plant life this is. It is I beleive, a character which should be given more accent in ecological studies.

To sum up one can say that an underlying theme in this thesis has been to develop and try out new methods for the enumeration of habitat and to identify those aspects of habitat which contribute to the complexity of a given habitat, in this case forest, as well as to test a basic hypothesis concerning monkey socio-ecology.

SECTION C

THE GEOGRAPHICAL & CLIMATIC CONTEXT OF THE STUDY AREA

CHAPTER FOUR

THE STUDY AREA

Introduction

Field studies extended over twenty months from November 1973 to June 1975, with intermittent breaks totalling two to three months. The particular study area was selected for several reasons. First it was known that a reasonable population of samango monkeys was present in the area. Second, the vegetation was not too dense as to preclude observation of the monkeys and movement by the observer. There were several well used paths which allowed rapid access to the various parts of the study area. Third, the monkeys appeared not to have been disturbed and the African population of the area seemed to take little or no notice of them. Moreover, the forest was not used for grazing except in the upper part on top of the escarpment. Foraging for food by Africans was never observed except in the lower part by the bridge where a grove of mulberries grew. Collection of firewood by the natives was restricted to areas close to paths and only on two occasions, was evidence found of small shrubs having been cut down for firewood.

At the beginning of the study the monkeys were very shy and preferred the rocky, inaccessible parts of the study area, rarely venturing into the main parts of the forest where observation and following of them was easier. For this reason it was decided to concentrate on the possible factors which might affect the feeding ecology of the monkeys, e.g. tree distribution, phenology and productivity. Later when the monkeys were less shy and therefore more frequently observed in more accessible areas, it was possible to observe their response to these factors.

Location and Physical Features

The study took place on the farm Cyprus (68 KT) in the Letaba District of the Transvaal. The centre of the site was situated at 24^{o} 11' 15" S and 30° 16' 45" E. Figure 7 shows it's position in the Transvaal. The nearest village was Ofcolaco, some 20 km away by road and track. Figure 7 shows the position of the study area with respect to the mountainous areas of the Transvaal illustrating it's location at the foot of the Drakensberg Escarpment.

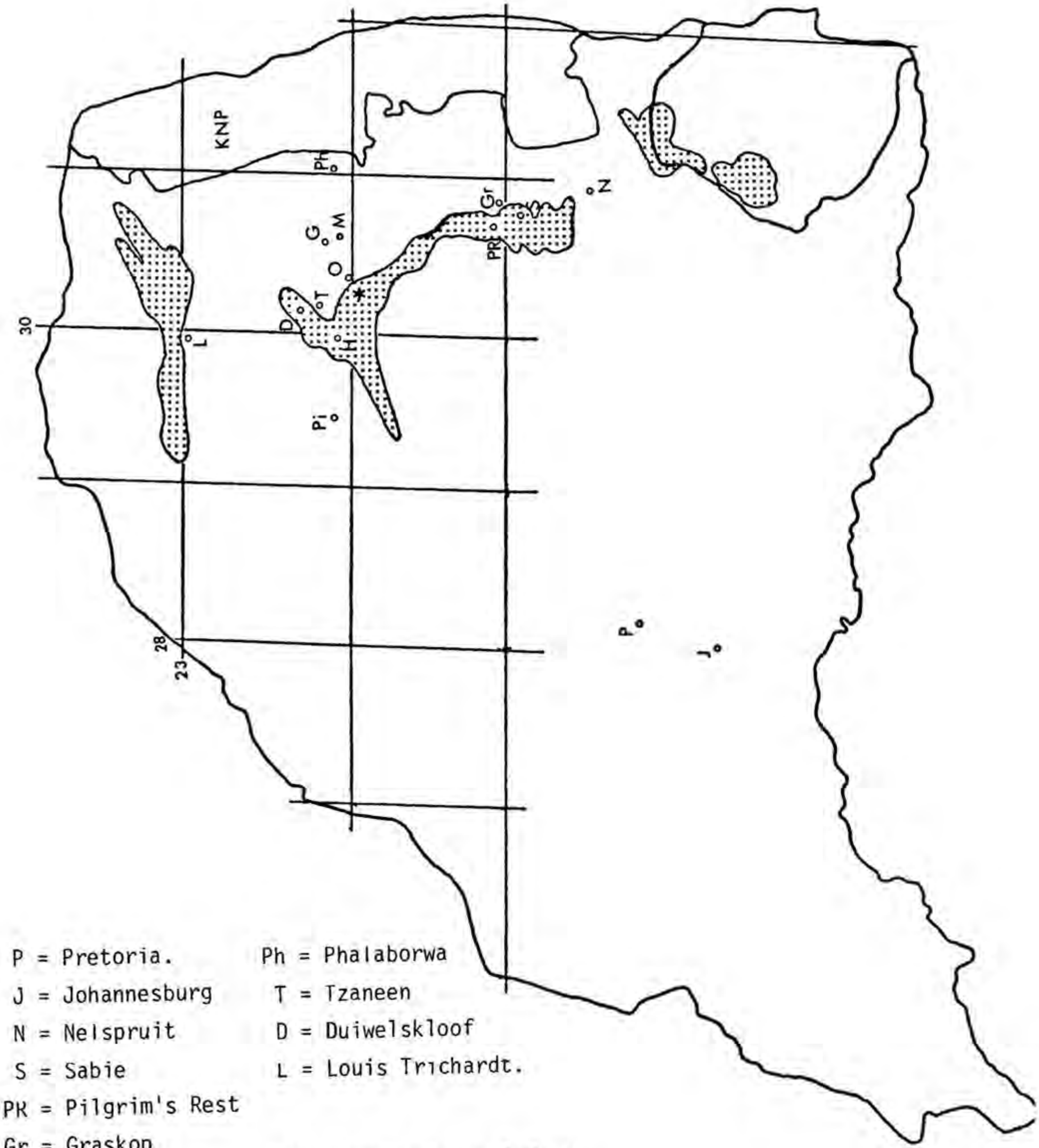
Figure 8 illustrates the relief features of the study area. Being on the escarpment, the altitude over the study area varied considerably. At the bottom of the valley, furthest from the escarpment and at the lowest part where samangos were seen the altitude was 883 metres, while at the highest parts of the forest, again where samangos were seen, and on the escarpment, the altitude was 1 341 metres. This represents a difference in altitude of 458 metres within a space of 2,2 kilometres. The top of the escarpment rises higher than this, with the highest point above the study area being 1 593 metres. In places the cliffs of the escarpment tower 150m sheer above the forest.

The main drainage of the study area is the Wolf Spruit which arises on top of the escarpment, flows through a poort in the escarpment, and receiving seasonal streams from valleys around eventually reaches the Selāti River. It flows throughout the year, and in summer after heavy rain is subject to considerable flooding. Flood waters have been known to rise as much as 3,5 metres above the dam across it at point A (Figure 8). The course of the Wolf Spruit is marked on figure 8.

Geology

The dominant geological feature of the farm is the escarpment. Rocks of the basal part of the Transvaal Supergroup outcrop on the farm and have an average dip of about 20° to the South-West. The older Wolkberg Group consist mainly of a thick layer of shale with interbedded quartzite layers and an overlying layer of quartzite. An extrusion of basic lava with associated tuff, agglomerate and shale deposits caps this group. The Black Reef Quartzite Formation is a succession of sandstone, quartzite and conglomerate beds with

Figure 7: The Position of the Farm Cyprus(68KT) in the Transvaal.

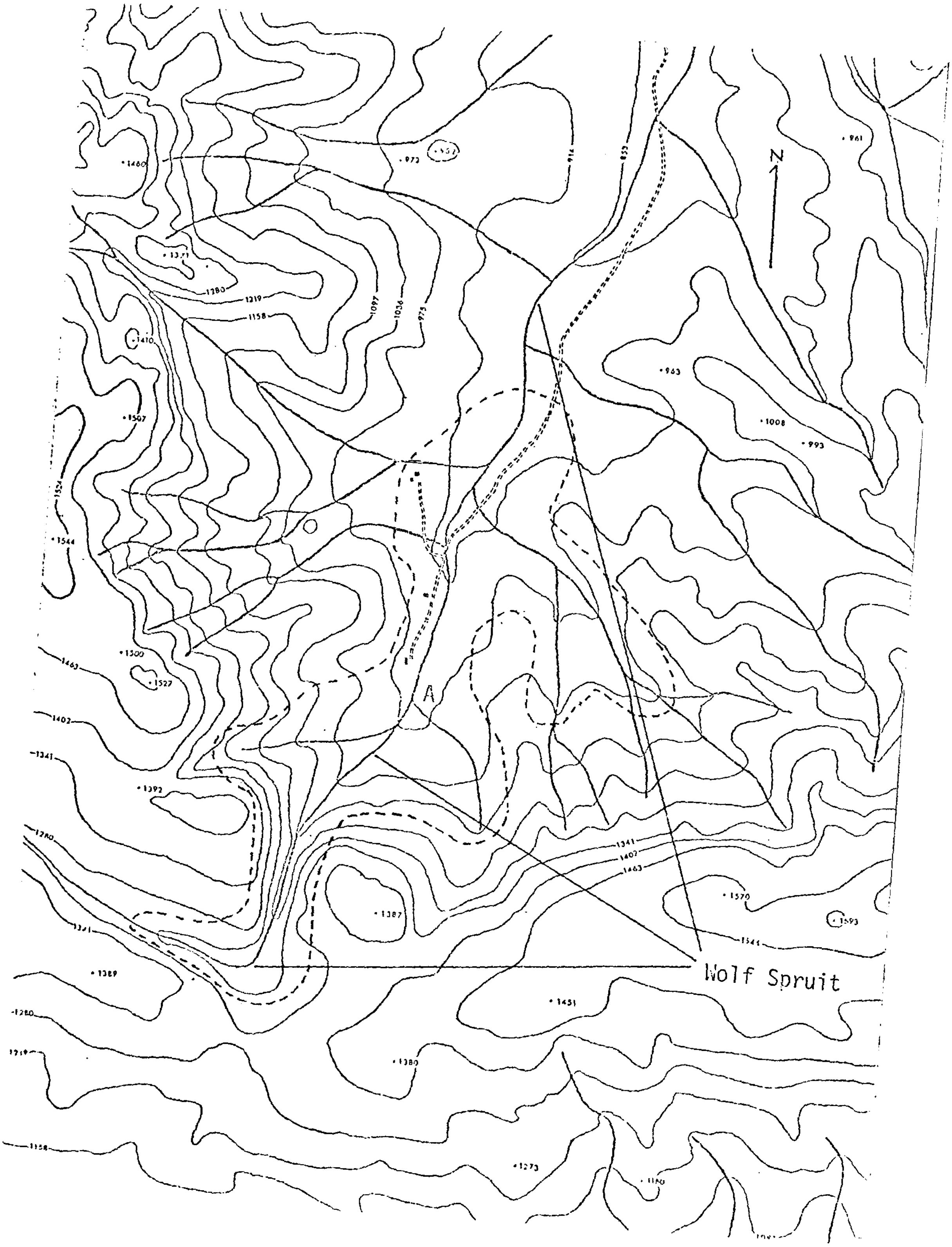


P = Pretoria.
J = Johannesburg
N = Nelspruit
S = Sabie
PR = Pilgrim's Rest
Gr = Graskop
Pi = Pietersberg
H = Haenertsberg
O = Ofcolaco
M = Mica
G = Gravelotte

Ph = Phalaborwa
T = Tzaneen
D = Duiwelskloof
L = Louis Trichardt.

KNP= Kruger National Park

Figure 8: Relief Map of the Study Area at Cyprus (68 KT).



⬚ = Area actively studied

1cm = 182m

A = Site of dam

some interlayered shale as well as dolomite bands near the top.

It is these formations which have resulted in the occurrence of the escarpment due to their resistance to weathering and erosion. They are mostly under lain by granite and chemical weathering of this is most effective, where it reaches the surface, in the hot humid conditions.

The upper quartzite layer of the Wolkberg Group crowns the escarpment. The dip slopes of the quartzite layers are steep which results in the Black Reef and basal Chuniespoort sediments being located much lower down topographically on the slopes of the escarpment. The Selati River's tributaries, the Wolf Spruit being one, arise behind the escarpment and have cut through the different quartzite bands to form deep poorts in the escarpment.

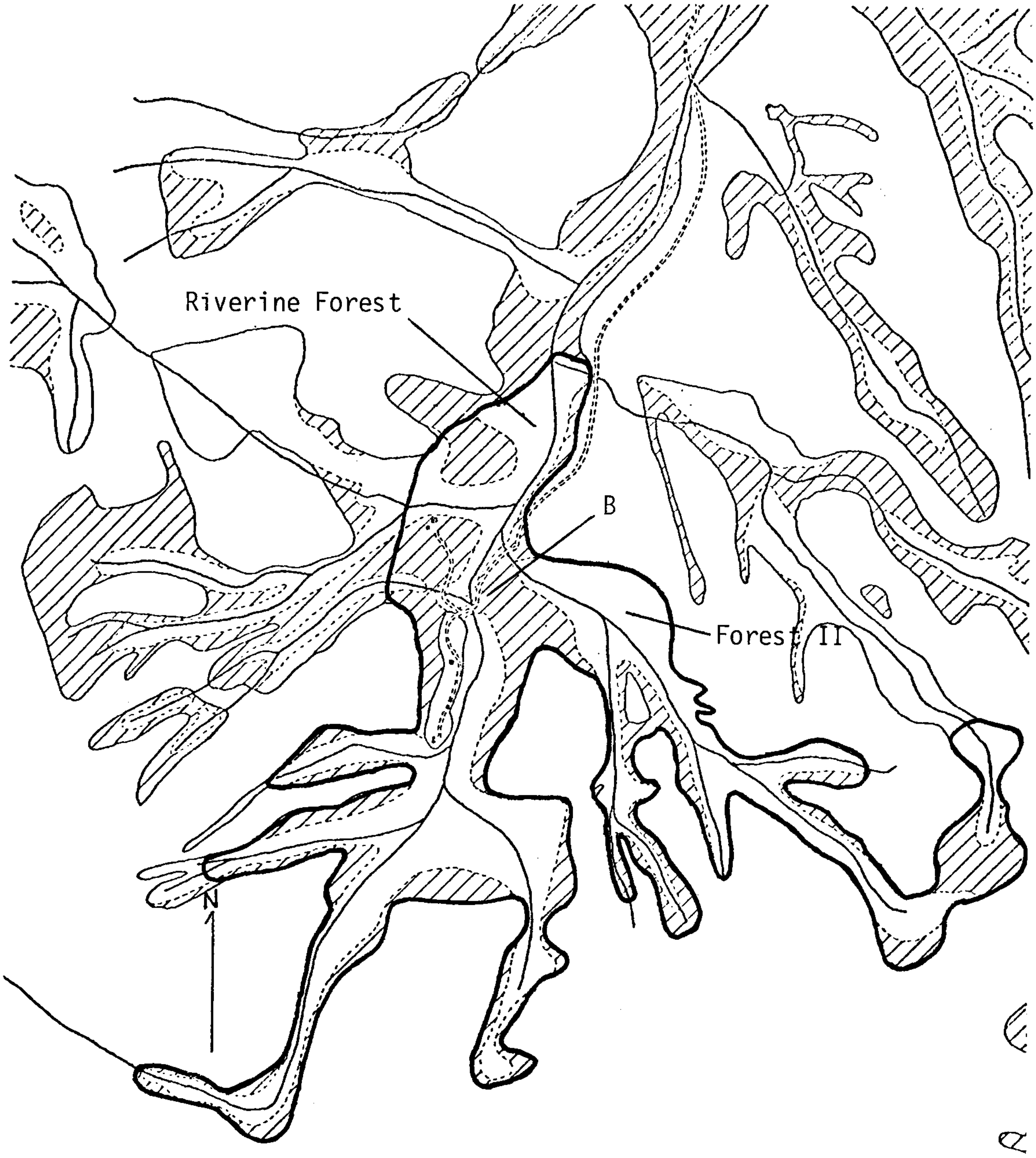
Vegetation

While the vegetation will be discussed in more detail later, a short description will be included here. The area covered by forest and forest fringe is illustrated in Figure 9. The area of forest which was considered to be the "study area" is that within the coloured shading. The scale is identical to that of Figure 8 so that comparison of the relief to the extent of vegetation can easily be made.

Apart from the areas marked on the map as forest and forest fringe, three vegetation types could be discerned. On the slopes below the escarpment and on the escarpment itself were grasslands with scattered Protea spp. and other woody species. These grasslands, as will be seen from the maps were effectively dissected by small tracts of forest along drainage lines.

As the streams moved into flatter land the vegetation along them changed to a more Riverine Bush type of vegetation. Away from the streams, the grasslands gave way to a more typical Lowveld bush veld, though this was often interrupted by intense cultivation.

Figure 9: Map of the Forested Areas of Cyprus



Scale : 1cm = 182m.

Hached Areas = Forest Fringe

● = Dwellings

— = Rivers and Streams

⋯ = Roads

◯ = Area of Study (Forested).

General Physiognomic Characters of the Vegetation

From initial observations five vegetation types could be physiognomically distinguished. These distinctions were based on such parameters as floristic compositions, stature, canopy layers and ground features such as slope, wetness and aspect. They were :

i) Riverine Forest or Bush. The area below the bridge (B on Figure 9) has a type of vegetation which differed from that found elsewhere in the main areas of the forest. The vegetation close to the stream however, was markedly similar to that found close to the stream in the main forested areas. Many "true" forest species were absent and bush veld species such as *Acacia karoo*, *Dichrostachys cinerea* and *Sclerocarya caffra* were found to be present. Some species found in the forest fringe areas were also present (e.g. *Acacia ataxacantha*). The slopes away from the stream were gentle and the cover was patchy with marshy grassland dissecting it. The canopy was largely unstratified with creepers and shrubs reaching the upper levels causing a tangled mass of vegetation from ground layer to canopy. The stature rarely exceeded 10-12 metres.

ii) Forest II - (See Figure 9) This piece of forest was a mixture between "true" forest and forest fringe. While forest trees were dominant, forest fringe trees were also represented (e.g. *Acacia ataxacantha* and *Antidesma venosum*). The forest trees present were usually of low stature and the infestation with creepers was very heavy. The ground was largely flat with a gentle slope and there were again patches of open grassland inside the forest. Stratification was again absent and the stature of the forest never exceeded 10-12 metres.

iii) Vegetation along Stream Beds. Along all drainage lines a distinct, high stature (up to 30 metres), highly stratified community existed. This was usually dominated by Breonadia microcephala, whose individuals reached extremely large sizes. Where the stream had excavated, deep clefts in the forest floor, these trees were highest, reaching the canopy level of the rest of the forest. Exceeding this species in number were Syzigium cordatum and Syzigium guineense forming a subcanopy storey beneath the crowns of the Breonadia microcephala. Creeper infestation was minimal. This type of vegetation was found all along the Wolf Spruit and its tributaries except in the Poort and behind the escarpment.

iv) Forest Fringe. At the edges of the forest which were much drier than the floor of the forest a quite different vegetational area was discernable. This had a woodland appearance rather than that of forest. Species typically present, and to the exclusion of the major forest species, were Acacia ataxacantha, Peltophorum africanum, Combretum molle, etc.

v) Forest. The major part of the study area was covered in "true" forest. This was mixed dominance semi-deciduous forest of a sub-tropical nature. Typical dominants included Drypetes gerrardii, Trichilia emetica, Cussonia spicata, Celtis africana, Protorhus longifolia, Mimusops zeyheri and others.

It was of variable stature with 15 metres being about the minimum. Creeper infestation was heavy where the canopy was broken and the canopy showed stratification.

Artificial Features of the Study Area

Figure 10 shows three sets of dwellings in the study area and areas of cultivation are also marked.

Three sets of dwellings were present in the study area each with an access road (Figure 10 - 1,2, & 3).

The first (No. 1) called The Shack, consisted of an extensive main dwelling on the side of the kloof with a garden and grassy parking area in front of it. To the south-east and north-east was forest beneath which were nurseries, where the ground cover had been removed. The Wolf Spruit had been dammed just below the house. South of the house on each side of the road were lands and on the opposite side of the road opposite the house were two rondavels for the use of servants. This house was only occupied for the latter half of the study.

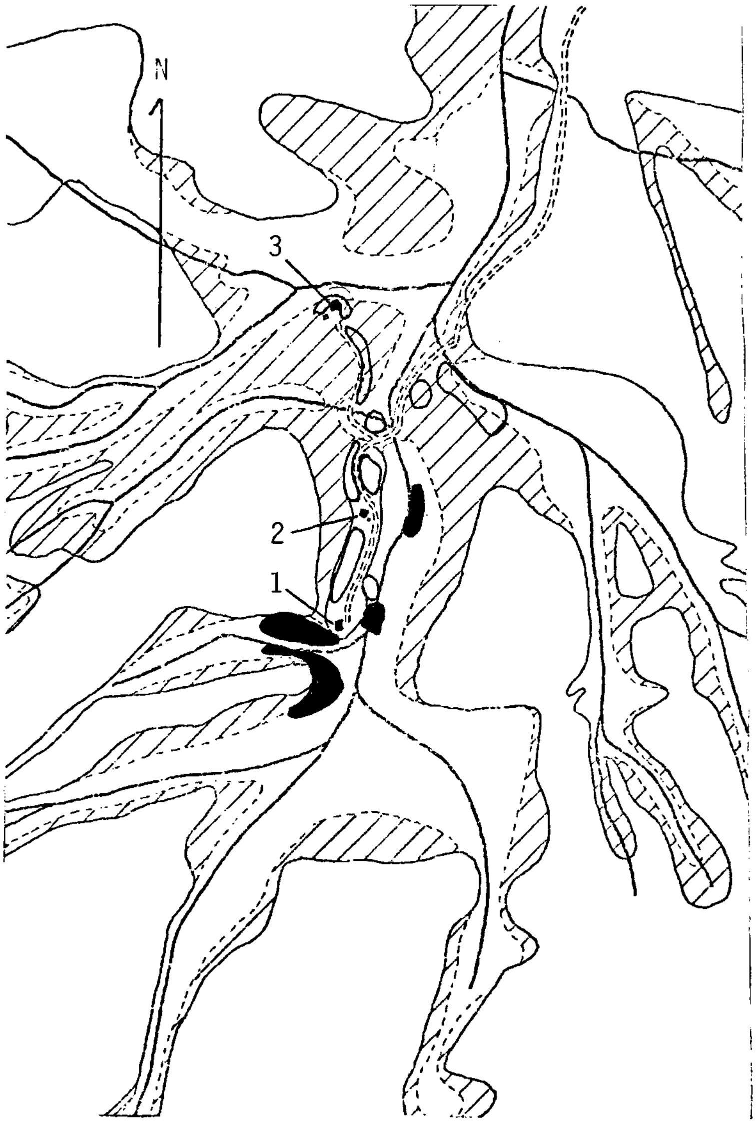
Two hundred metres down the road to the south was another group of dwellings consisting of a main house, a guest rondavel and servants quarters and outhouses. This was surrounded by extensive gardens and lands. Adjacent to the lands on all sides was forest and samangos were frequently observed along the edges. They only rarely ventured into the lands.

The third set of dwellings consisted of a house, gardens, outhouses and a native store. This was the only store available to the natives living in the valley and behind the escarpment. The latter had to walk through the forest to obtain provisions at the store. However they caused little disturbance in spite of the apparently heavy traffic. The weekends were the busiest time and on one Saturday morning sixty-five natives of all ages and sexes passed through the forest either to or from the store. In addition to the store there were extensive lands around the dwellings. Several dogs owned by natives were resident at the store. They caused disturbance to the monkeys, often "treeing" them.

Other Species

i) Mammals. In addition to the samango monkeys, four other

Figure 10: Artificial Features of the Study Area



Scale : 1cm = 135,5m.

☐ = Cultivated Areas.

■ = Terraces where Ground Cover had been removed beneath the Forest Canopy for a Nursery.

species of primates were represented in the area, though only samangos were represented in forest. On the rocky escarpment and in the grasslands, baboons (Papio ursinus) were found. Vervet monkeys (C. aethiops) were found in the lower part of the valley using the Riverine Forest there as a base. At certain times of the year, they were observed as far up the valley as point B on Figure 9. These, however, were always solitary animals.

Two species of prosimian were found in the Cyprus Valley. The thick-tailed galago (Galago crassicaudatus) was often observed at night, while making meteorological observations, in the forest fringe type habitat around the second set of dwellings. They were also seen in the forest on occasions. The lesser galago (Galago senegalensis) was never seen near the study area but was observed lower down the valley.

Genets (Genetta sp.) were also often seen though never for long enough to distinguish the species.

Duiker were rarely seen, though in summer their spoor were often found.

Bushpig (Pomatochoerus porcus), though never seen completely were occasionally encountered running away. Rubbing marks were found on tree trunks as well as diggings.

Leopard (Panthera pardus) were present in the past (G. McNeil, pers comm), however no evidence of leopards was found during the study.

ii) Birds. Bird-life was plentiful though no systematic list was drawn up. However the following larger birds were seen :-

Knysna Loeries (Tauraco corythaix)

BataleurEagles (Terathopius ecaudatus)

Jackal Buzzards (Butes rufofuscens)

Parrots were seen flying overhead.

CHAPTER FIVE

CLIMATE

Introduction

It is readily noticeable that plants and animals are responsive to various aspects of the climate of their habitat. This may occur at two levels, though this is an artifical demarcation; the two almost certainly interact to some degree. First they may respond at a physiological level, (eg. plant response to sunlight, the effect of rainfall on reproduction in prairie voles (Orr 1970)). Second at a behavioural level animals respond to the weather, either by seeking an optimal climate condition or by altering their activity levels.

However, it is far from easy to demonstrate the dependence of an animal on the climatic quantitatively and still less easy to determine which climatic factors may be limiting.

The reasons for this difficulty are various and interacting in most cases. The first reason is inherent in the study of meteorology itself. In measuring climate one usually divides the climate into several categories, usually dependent on the instruments which have been devised for measuring climate. Thus the meteorologist looks at such features as air temperature, humidity, wind, precipitation, sunshine, evaporation, visibility, cloudiness, air pressures, etc. While all these meteors are studied as separate entities they in fact interact to produce a given climate in the given place where their measurement has taken place. In addition a meteor so measured is meaningless unless one is able to compare the measurements obtained with those obtained elsewhere. This then brings in the problem of standardisation of instruments, for unless the measurements taken at all localities being compared, are equivalent, there can be no base for comparison. These problems are inherent in any type of meteorological investigation, but then these are further compounded by the nature of the measurements gained. Nearly all meteors are in terms of figures - the amount of rain which fell during a certain day, the temperature at a certain time, etc. These figures, to have any meaning must be put together in the form of averages or other statistics to produce another figure which hopefully has more meaning.

National and other types of Meteorological Bureaux have now standardised their measurement and treatment of data obtained so that for their purposes a reasonable picture of the weather can be obtained and used for weather prediction, their main function.

For the biometeorologist the problem goes further than this. In studying the weather an ecologist or biometeorologist has two aims. First, he wishes to describe and categorise the climate of the area in which the plants, animals or the community he is studying live so as to give other ecologists working in different areas a baseline in terms of climate upon which to base comparisons. In this respect, the problem is essentially the same as that of the meteorologist, though the statistical treatment of meteors may be different, the ecologist perhaps presenting daily ranges of temperature or rates of fall of rain rather than monthly maximum, minimum and mean temperatures, or monthly rainfall.

Second the ecologist wishes to correlate the behaviour and physiology of the animal or plant under study with the climatic conditions under which they live. Here again the main problem lies with instrumentation. A weather station set up under standard conditions is rarely relevant to the animals in their environment. In addition to this there is the question of whether the meteors being measured are of importance to animals. If we consider for the time being one meteor, say air temperature, we can with safety say that it is unlikely that the animal will respond to the actual ordinal temperature on a Celsius scale, though in some species, for instance some reptiles, there may be an almost linear relationship between activity levels and temperature. It is more likely that animals respond to changes in temperature in a manner following Helson's Adaptation Level Theory (Helson 1964) or that they respond to the average temperature. It is however, not easy to convert ordinal statistics into statistics which express an idea of the changeability of a meteor.

There is also great danger in considering only one meteor at a time. Animals, as are human beings, are more than likely to respond to a combination of meteors. This leads to problems of interpretation again imposed by the way in which climate is measured, i.e. by single meteors.

Methodology

The climate was measured bearing these problems in mind and with the following aims :-

(a) In order to facilitate climatic comparison with other regions where studies of a similar nature have been conducted and to define the climate with respect to other vegetational zones. The vicinity of the study area has a marked local climate which is clearly of importance when considering aspects of the flora and fauna of the area.

(b) To compare the climate during the course of the study with that of past years.

(c) To facilitate comparisons between the forest climate and that outside the forest. The climatic data will act as a baseline for all comparative data obtained in the forest.

To do this climatic data have been presented from three sources:-

(a) Data collected at the site both during the study and during previous years, using standard techniques.

(b) Data collected within the forest for use in microclimatic comparisons. (see chapter six).

(c) Data from local Weather Bureau Stations.

Instrumentation

Temperature - The daily maximum and minimum temperatures (recorded at 08h00) and the daily course of temperature (from a Theis Thermohydrograph) were recorded. The maximum and minimum thermometers and the Thermohydrograph were housed in a Stevenson Radiation Screen, with the base of the screen 125 cm from the ground and the door south-facing. The screen was placed in as open a location as convenience and the terrain would allow.

Humidity - Relative Humidity was computed from Wet and Dry Bulb Thermometer readings taken three times daily at 08h00, 14h00 and 20h00. The Wet Bulb was fanned till a steady reading was obtained, using a battery-powered fan moving air at 5 m/sec. The daily march of humidity was recorded on the thermohydrograph. The daily range data was corrected using the instantaneous ambient values obtained from the Wet and Dry Bulb Hygrometer at 08h00, 14h00 and 20h00. The Wet Bulb depression gave the ambient humidity and the Dry Bulb value the ambient temperature. The errors in the daily range records were found to be due mainly to the slow response of the instrument to humidity and temperature changes. Errors found are therefore dependent mainly on the rate of change in humidity and temperature experienced, there being few errors when humidity and temperature are relatively constant (e.g. at 20h00) and large errors when they are in a state of flux. Further when humidity approached 100%, the instrument tended to underestimate humidity, during periods when change in humidity was slight.

Sunshine - A Campbell-Stokes sunshine recorder was used to measure the number of hours of sunshine daily.

Precipitation - When rainfall occurred the daily fall was measured in tenths of a millimetre using a standard 10,16 cm diameter gauge. The times and rate of fall of precipitation during the day was recorded using a Theis Pluviograph (4011-689).

Wind - The speed and direction of the wind were recorded three times daily at 08h15, 14h15 and 20h15. Wind speed was measured using a three-cup direct reading anemometer. Wind direction to the nearest principle compass point (N, NNE, NE, ENE, E etc.) were recorded using a burgee. The burgee and anemometer were mounted on a fixed and stayed four metre pole in open ground. Readings on the anemometer were taken using binoculars from just outside the closest focussing range of the binoculars. Instantaneous records of speed and direction were taken at ½ minute intervals over a ten minute period (21 records in all). From this data the mean wind speed ($\bar{x}$) was computed and the wind direction data was summarised as vectors.

A speed-direction vector was also computed from the data. As a measure of gustiness the following relationship was used :

$$\text{gustiness} = \sqrt{\sum (x_i - \bar{x})^2 / N}$$

where x_i is the ith wind speed record and $\bar{x}$ is the mean wind speed. N in all cases was 21.

In addition to ground wind parameters, the movement of upper air was noted from the direction of movement of clouds. This was not always possible (e.g. if there was no cloud or at night).

Qualitative notes on the weather at and during the sample period were made, including whether the anemometer was in sun or not.

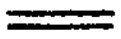
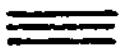
Qualitative Weather Records - Qualitative weather records were made using standard symbols at 08h00, 14h00 and 20h00. Changes in the weather between these times were noted along with the time of the change. Figure 11 shows the key to the symbols used including those of my own design to denote weather features of importance to the local climate.

Climatic and microclimatic data were collected together and as this took some time standardised procedures were devised to control errors due to time lag in making these readings. These were likely to have been large when meteors were in a state of rapid flux (e.g. at 08h00 and 14h00). These are described under procedures used to record meteors .

Instrument Calibration

As the differences in temperature and humidity recorded inside and outside the forest were expected to be small, it was considered essential

Figure 11 : Symbols used to record Qualitative Weather Records.

Symbol	Description
	No Cloud
	Quarter to half of sky cloud covered
	Half to three quarters of sky cloud covered
	Three quarters of sky covered to overcast
	Rain
	Drizzle
	Showers of Rain
	Hail
	Dew
	Thunderstorm; whenever thunder heard
	Thunder only
	Haze
	Shallow fog - sky clear
	Mist - not low cloud
	Fog - not low cloud
	Heavy winds - bars indicate degree
	+ intensity indicated by 0, 1, 2, 3, as suffix e.g.

Local Conditions Symbols

	Low cloud obscures mountains - 3/4 to overcast sky
	Low cloud obscures mountains - 1/2 to 3/4 sky
	Low cloud obscures mountains - 1/4 to 1/2 sky
	Low cloud envelopes 'Mashela' & whole study area
	Gusty winds - in conjunction with / symbol

that all temperature and humidity readings be accurate and comparable. All the thermometers used were seen to be inaccurate with respect to one another over a range of temperatures. Thus all the thermometers comprising the hygrometers were calibrated against a single thermometer chosen as a standard. While this thermometer was not known to be absolutely accurate, calibrating in this way would ensure that all the readings taken at the study site were comparable. This would also be true for the readings as these were obtained from the wet and dry bulb hygrometers. The thermometer chosen as the standard was a Casella - (ref 2842/66 NF 15969). Each thermometer - sixteen in all - was calibrated against the standard in a water-bath over a temperature range 2,0°C to 40,0°C. From this data calibration curves were plotted and a correction table for each drawn up from the curves.

The corrected values for temperature and humidity were used to correct the value of temperature and humidity on the daily march charts from the thermo-hydrograph. The Maximum and Minimum readings were corrected using the reset temperatures and comparing these with the ambient temperatures at the time of reset.

In this way all temperature and humidity readings were rendered comparable to the nearest tenth of a degree Celcius.

Procedure used to Record Meteors (including Microclimatic[1])

All the instruments were visited three times daily. To visit all the screen sites (three in all) and the trunk zone hygrograph took fifteen minutes. It was noted that considerable changes could take place during that fifteen minute period especially at 08h00 and 14h00. Thus the order of visiting was reversed on alternate days. Thus any time affect it was hoped would be nullified.

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[1] - For details of Microclimatic Data Collection see chapter six

The procedure for taking readings at each screen was as follows :

08h00 (i) Wet and dry bulb hygrometer - wet bulb read after being fanned using a small battery operated fan producing an airflow of 5,0 m/sec. The Wet bulb reservoir was topped up prior to each reading.

(ii) Thermohydrograph read after the instrument had been lightly tapped. Time mark on temperature chart made.

(iii) Maximum and Minimum temperatures read - reset - and reset temperatures read.

14h00 (i) Wet and Dry bulb hygrometer read as above.

(ii) Thermohydrograph read as above.

(iii) Minimum temperature since 08h00 read, reset, reset temperature recorded. Maximum at 14h00 read (not reset).

20h00 (i) Wet and Dry bulb hygrometer read as above.

(ii) Thermohydrograph read as above.

The trunk zone hygrometer was read at 08h00, 14h00 and 20h00 in a similar way to the others.

Forest rain gauges were visited as soon as precipitation had occurred to minimise possible loss due to evaporation.

The standard rain gauge was read after the temperature and humidity readings had been taken.

Wind readings were taken at 08h15, 14h15 and 20h15 daily.

The cards for the sunshine recorder are replaced after sunset daily.

The charts for the thermohydrographs were changed on Mondays - the main station charts at 08h00 and the forest charts at 11h00. The hair of the hygrometers were cleaned weekly at 11h00 on Tuesdays, with boiled, cooled, pure water, applied with a grease-free camel hair brush.

In the case of a set of readings not being taken, the relevant data were extracted from the thermohydrograph charts. This happened rarely - 2 per cent of all readings.

During periods when it was not possible to take readings (i.e. when the five-day follow was conducted) the only reading taken was that at 20h00, Maximum and Minimum temperatures being taken then rather than at 08h00.

Results

i) Preamble

As mentioned in the introduction to this chapter, one often has problems when interpreting meteorological data, because of the discontinuous way such data are collected. Often one finds such data published merely as a block of figures relating to various parameters. This is the way in which a weather bureau publishes data and is done to allow others to draw conclusions from them. In this case data have been collected to answer specific questions and thus the data are presented in such a way as to allow comparisons to be made and possible conclusions to be drawn from these data. One possible draw-back to such an approach may be that a certain loss of objectivity may be incurred. However, where it was felt that data selection or a lack of comparability might jeopardise the usefulness of comparisons, this has been noted.

The data will be presented at three levels :-

i) Comparisons of individual meteors at the study site during the study period with those at other stations during the study period.

ii) Comparisons of meteors at the study site and at other stations in years previous to the study period.

iii) A consideration of the way in which the observed meteors might have an immediate effect on the forest habitat as a whole.

The first two levels of comparison have relevance to the problem of placing the study area meteorologically and answering such questions as "how seasonal?"...,"how wet?"...,"how hot?"... "how variable?" etc was the climate with respect to other stations, both close by and in Africa as a whole.

In all tables Cyprus refers to the station at the study site. Data for other stations have been drawn from Lebedev (1968) - The Climate of Africa - and the monthly and annual weather reports of the Weather Bureau, Pretoria.

The stations used for comparisons were chosen in areas where other large areas of forest exist - i.e. in Liberia, Zaire, Congo (Brazzaville), Uganda, Zambia. It was not always found that complete sets of data were available and in these cases places close by were used for comparison.

For the periods during the study no data were available for non South African stations. Rainfall comparisons were made between Schelm, Pietersberg, Levubu, Letaba and Cyprus (Fleur de Lys had no data available for this period).

Temperature data from representative stations at all latitudes were available and are presented.

Relative humidity, wind velocity and sunshine data were only available for stations in South Africa during the study.

Individual meteors will first be discussed and then the total climatic effect of all meteors considered. Figure 12 and Figure 13 show the positions of the stations whose data is quoted in the text, while Figure 14 lists certain biographical data about these stations such as their position altitude and the periods over which such quoted data runs.

ii) Precipitation

During the Study

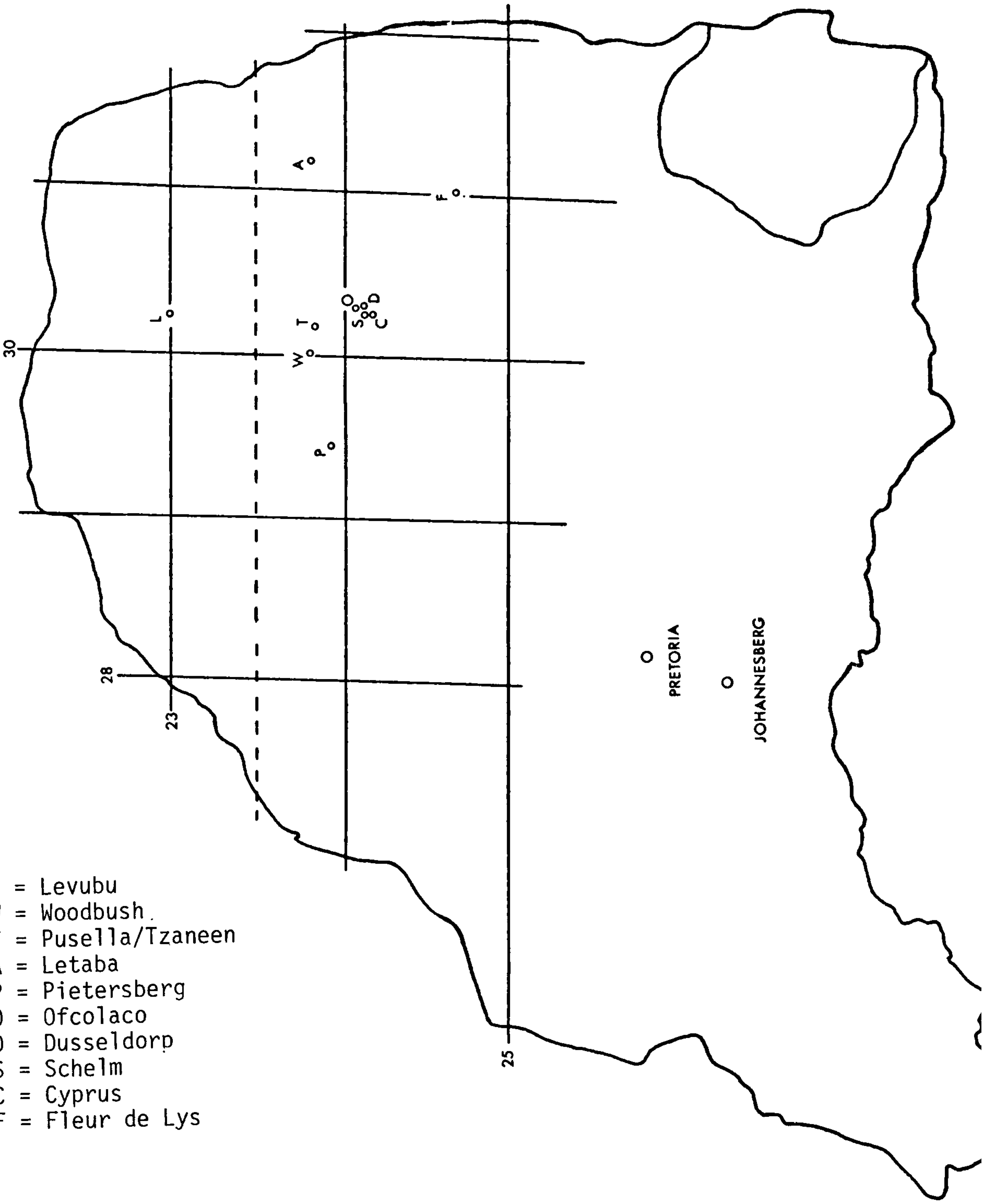
Figure 15 shows the precipitation which occurred at Cyprus during the study as well as the same data for other South African stations. Figure 16 shows the number of days with rain at the various stations during the study site.

Examination of the latter table shows that all the stations closely related to mountainous areas (Cyprus, Schelm, Pusella/Tzaneen and Levubu,) had a high rainfall (1 000 mm+) while the stations in flatter, more open country had almost half the amount. Pietersberg, in spite of its high altitude, had a low rainfall during the study, compared to the stations with high relief.

All stations appear to exhibit a marked seasonality of rainfall with annual monthly maxima of rainfall appearing during January or December. Letaba appears to be an exception to this with this maximum appearing in February.

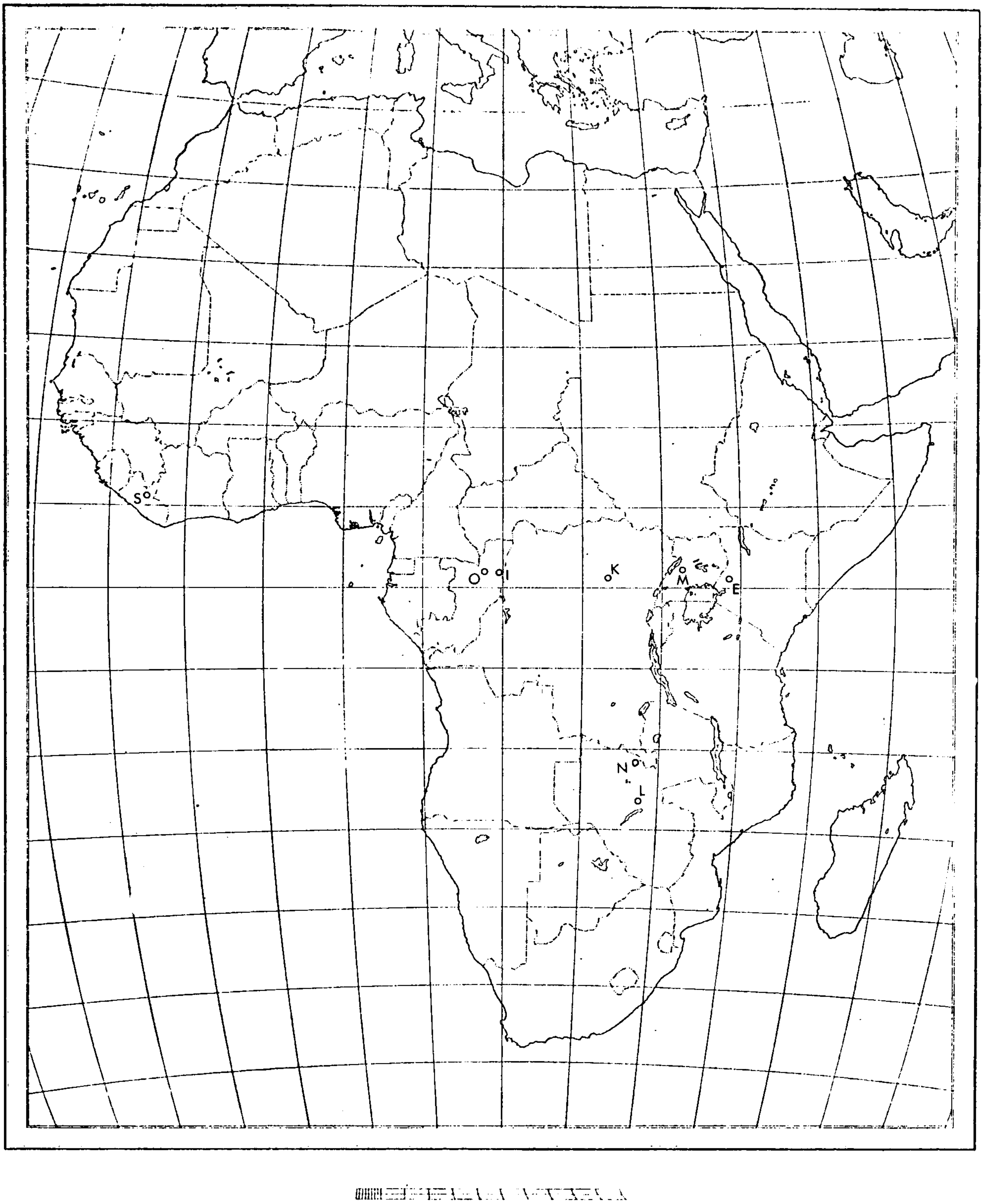
The detailed rainfall data for Cyprus reveals that not only are there more days upon which rain fell during summer but also that the actual amount of rain falling in one day is greater than in winter. Further during the midwinter months of June and July the falls were usually small (less than 2 mm) and in most cases these small falls were associated with a low mist which frequently occurs along the escarpment of the Transvaal Drakensberg and which has led to the name Wolkberge (Cloud Mountains) being given to them. Only in one instance during the study was there a heavy fall during

Figure 12: Positions of the South African Stations Quoted in the Text.



L = Levubu
W = Woodbush
T = Pusella/Tzaneen
A = Letaba
P = Pietersberg
O = Ofcolaco
D = Dusseldorp
S = Schelm
C = Cyprus
F = Fleur de Lys

Figure 13 : Position of stations quoted in the Text (excepting South African)



KEY :

S - Saklape
O - Ouessa
I - Impfondo
K - Kisangani
M - Masindi
E - Eldoret

N - Ndola
L - Lusaka

Figure 15: Precipitation at Cyprus and other stations during the Study

PRECIPITATION (mm)

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOT
1974	CYPRUS	341,8	238,9	206,7	53,1	13,5	0,0	58,1	8,0	60,7	63,9	73,2	156,2	1274,1
	SCHELM	681,5	292,4	257,2	26,2	6,1	0,0	125,0	20,0	92,5	26,5	98,3	164,8	1568,4
	LEVUBU	134,7	325,2	81,8	61,9	36,6	1,4	12,8	11,7	73,4	44,3	144,7	181,9	1110,4
	LETABA	82,3	181,6	52,9	5,1	8,0	0,0	15,5	1,5	32,0	8,8	156,3	71,0	515,0
	PUSELLA/TZANEEN	299,7	483,8	120,6	58,4	14,9	2,1	26,9	14,7	84,2	20,8	136,6	197,3	1460,0
	PIETERSBERG	85,3	27,6	13,6	26,7	14,8	0,0	11,5	4,3	49,4	7,8	75,8	50,6	367,4
1975	CYPRUS	251	201,2	61,0	37,3	33,9	7,2	0,1	8,4	6,8	6,8	79,8	308,1	1002,9
	SCHELM	261,8	261,3	55,5	14,5	0,0	0,0	0,0	0,0	0,0	0,0	101,5	367,7	1062,3
	LEVUBU	223	337,6	119,9	141,8	31,5	17,4	0,8	9,5	34,0	29,6	63,8	374,2	1383,1
	LETABA	75,8	147,0	27,8	29,4	27,5	7,2	0,0	0,0	0,0	0,3	61,7	52,9	429,6
	PUSELLA/TZANEEN	253,8	197,2	101,3	62,6	23,5	0,2	0,2	3,0	7,8	17,7	120,6	361,8	1149,7
	PIETERSBERG	158,6	81,5	43,4	49,2	46,7	3,6	0,0	0,3	0,1	0,4	45,5	146,5	574,9

Figure 16 : Number of days with rain at Cyprus and other South African Stations.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOT
1974													
CYPRUS	25	22	14	1	4	-	3	3	5	9	13	21	130
SCHELM	26	20	11	5	3	-	1	3	2	1	10	12	95
LEVUBU	19	18	14	9	4	1	2	3	5	9	16	11	112
LETABA	12	10	3	1	1	-	1	1	3	2	7	18	59
PUSELLA/TZANEEN	19	22	16	10	3	1	3	5	4	8	15	4	110
PIETERSBERG	10	12	7	10	4	-	4	2	3	4	10	10	74
1975													
CYPRUS	20	22	19	10	6	6	1	3	5	6	11	21	130
SCHELM	19	20	6	8	-	-	-	-	-	-	9	18	80
LEVUBU	14	13	15	10	8	4	1	3	4	5	11	17	105
LETABA	9	11	3	4	2	2	-	-	-	1	4	11	47
PUSELLA/TZANEEN	20	17	14	9	4	3	1	1	3	5	10	18	105
PIETERSBERG	13	16	9	5	6	2	-	1	1	2	8	18	81

these months (on the night of July 1st 1974).

In contrast, during the summer months of December and January, small falls are rare with large falls of 50mm or more being more common and usually associated with thunder.

Another notable feature of the rainfall at Cyprus during summer was the tendency for a rainless period to be followed on the first day when rain occurred by a high fall of rain and then on subsequent days for the falls to be progressively less.

The intervening months show transition between these states. The number of days of rain decreases as winter approached and the daily falls also decrease. As spring approached the same takes place but in reverse, the number of days with rain increasing, (e.g. June - Nov. 1974 0,3,3,5,9, 13 days, etc.) and the average daily fall increasing more or less steadily with a few exceptions.

These conclusions from two years data cannot be expected to be absolute, but the data do show these trends.

Another interesting comparison to make is that between Schelm and Cyprus. The station at Cyprus was situated right at the foot of the escarpment while Schelm was five km south in the valley below. In both 1974 and 1975 Schelm had a higher total rainfall, indicating that the escarpment in some way causes some rain shadow. On the other hand the number of days with rain at Cyprus is greater by between 30-55 days in these two years. Examination of the monthly figures shows that the summer figures for both stations are much the same, while in winter Schelm has far fewer days with rain, with no rain falling between May and October in 1975. This would indicate that a short distance from the escarpment the falls are far heavier than close to the escarpment - the total rainfall being greater in a shorter period of time. However, that the mountainous relief clearly plays a role in producing this high rainfall can be seen if one compares Letaba and Schelm, although Schelm is considerably higher than Letaba. This will also be clear from the long-term precipitation data.

Prior to the study

While the rainfall data taken during the study give a rough indication of the rainfall pattern and its seasonal shifts, data from previous years are more useful in that the variations from year to year can be identified and means can be computed to give an idea of what the usual rainfall pattern is. For instance, examination of Figures 17 and 18 shows that the rainfall experienced during 1974 and 1975 at Cyprus and Schelm was quite exceptional. The pattern of rainfall at Schelm is illustrated in Figure 19. These three tables alone reveal that the rainfall in one year can vary by incredible amounts. The standard deviation of annual rainfall at Schelm around the mean of 990,8mm is no less than 360,1mm, with a variation between 479,9mm and 2257,4mm. For Cyprus with a shorter period the mean rainfall was 983,4mm ± 318,9 and varying between 482,0mm and 1630,4mm.

It is interesting to note that while during the study Schelm had appreciably more rain than Cyprus. The two means and standard deviations are remarkably similar. During years of low or average rainfall however (1 000mm and below) it would seem that Cyprus receives marginally more rain. While the data are hopelessly inadequate to prove this it would seem to explain to some extent the fact that the means are so similar but that in years of above average rainfall Schelm gets more rain.

Figure 19 illustrates visually the variation in rainfall at Schelm and this I think could safely be applied to Cyprus - the absolute amounts only differing.

Visually the graph shows peaks of rainfall at regular intervals, these being in 1925, 1939, 1955 and 1972 respectively, indicating intervals between peaks of rainfall of 14, 16 and 16 years respectively (See Figure 20).

While the data do not provide evidence for cyclical peaks in rainfall - an approximately fifteen year cycle would certainly seem to be indicated.

Figure 17 : Annual and Seasonal Rainfall at Cyprus [2] 1964 - 1975.

	Rainfall mm		
	Seasonal [1]	Annual	
1965	-	657,6	
1966	654,7	758,4	
1967	1026,8	912,2	
1968	731,8	796,7	
1969	825,0	979,3	
1970	682,7	482,0	
1971	1107,8	1168,8	
1972	1546,5	1630,4	
1973	805,2	1109,4	
1974	1644,2	1298,3	
1975		1024,4	
		$\bar{X} = 983{,}4$ mm	$\sigma = 318{,}9$

[1] The amount of rain falling the year previous to the year cited.

[2] Figures courtesy of A.T. Renny, Mashela, P.O. Ofcolaco.

Figure 18 : Annual and Seasonal Rainfall at Schelm[2] 1951 - 1975.

	Rainfall mm		
	Seasonal[1]	Annual	
1951		652,6	
1952	559,1	706,0	
1953	1505,9	1352,1	
1954	696,5	752,1	
1955	1579,3	1754,4	
1956	1570,0	1339,9	
1957	743,2	862,2	
1958	1328,6	1372,8	
1959	829,9	762,5	
1960	309,5	1183,7	
1961	1333,2	912,8	
1962	509,7	664,8	
1963	625,2	574,7	
1964	634,1	839,6	
1965	793,1	481,2	
1966	638,5	903,5	
1967	1118,6	918,3	
1968	705,2	862,5	
1969	807,6	873,0	
1970	659,0	479,9	
1971	1540,2	1607,9	
1972	1928,6	2257,4	
1973	1094,2	1413,7	
1974	2266,8	1790,5	
1975	1120,2	1062,3	
		$\bar{X}$ = 990,8	σ = 360,1 mm

1 - Seasonal Figures calculated as for Figure 19

2 - Courtesy of Selati Estates (Pty) Ltd., P.O. Ofcolaco.

Figure 20: Interval (years) between Precipitation Maxima at Schelm.

Year of Maxima	Interval (Years)
1925	
	14
1939	
	16
1955	
	16
1972	

The remaining tables presented detail an African Tour of the rainfall patterns of forested areas. All but the following rainfall stations are in or close to forest - Eldoret, Ndola, Lusaka, Fleur de Lys and Pietersberg. Eldoret is an area, now under intense agriculture, but which in the recent past was an area of montane forest. Lusaka and Ndola have been included as representative of the transition between "non-seasonal" tropical rainfall and seasonal rainfall as found in South Africa. Fleur de Lys and Pietersberg were included for comparative purposes - Fleur de Lys being Lowveld and Pietersberg Highveld, at a comparable latitude.

The data presented are means over different periods of time. As already noted rainfall varies considerably and in an apparently cyclical manner thus the data are not absolutely comparable. To illustrate this see table Figure 21 for means over different periods for Fleur de Lys and Pietersberg. The mean annual rainfall can vary by up 12 per cent depending upon which span of years one looks at. Thus Pietersberg's mean annual rainfall is 521 mm if measured over the period 1904-1950 while when measured from 1904 to 1976 it is 456mm. Similarly Fleur de Lys shows figures of 789 and 883 when computed over two different periods. Figure 22 shows the mean monthly and annual rainfall for various stations. The first noticeable feature is that the mean annual rainfall for all the equatorial stations is higher than the other stations. Looking at the three Congo Forest block stations, Ouessa, Impfondo and Kisangani we see a different distribution of rain from that found in the southerly stations. In April and May there is a small peak in rainfall and this is followed by a second larger peak in September or October. This contrasts with the marked peaks in rainfall found in January and December in the South African stations. December and January are usually months where equatorial stations experience the least rain. The two Zambian stations also show a marked seasonal rainfall, similar to that in South Africa. Their winter rainfall however is much smaller, Ndola having a mean monthly rainfall of 0mm for four months. Eldoret and Masindi, further east than the three Congo Forest Block Stations, but also equatorial,

Figure 21 : Comparison of Precipitation at Pietersberg and Fleur de Lys over different periods

1. PIETERSBERG

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOT
1904 - 1950	98	77	68	29	11	3	6	4	11	42	80	92	521
1904 - 1976	68	70	38	30	10	11	2	2	12	36	73	106	456

2. FLEUR DE LYS

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOT
1916 - 1960	139	129	105	46	15	9	9	7	23	50	121	132	789
1926 - 1938 1940 - 1943 1945 - 1958	161	130	122	50	21	14	15	19	38	67	107	139	883

Figure 22 : Mean monthly and annual precipitation at various African Stations.

PRECIPITATION (mm)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOT
SAKLAPÉ	36	86	140	163	150	282	302	241	391	279	102	33	2210
OUESSA	62	74	123	132	168	121	88	140	225	201	135	84	1553
IMPFONDO	73	72	149	147	116	144	137	163	181	202	151	86	1681
KISANGANI	68	109	162	184	152	119	118	157	176	227	176	103	1751
MASINDI	28	61	104	160	150	104	104	135	140	145	122	43	1296
ELDORET	18	48	58	114	122	107	185	190	79	30	48	28	1027
NDOLA	297	236	172	31	2	0	0	0	0	16	114	278	1146
LUSAKA	231	190	142	18	3	< 2	< 2	0	< 2	10	91	150	835
WOODBUSH	352	307	280	95	44	20	29	28	49	109	189	266	1786
SCHELM	180	188	145	65	18	10	11	8	26	54	110	155	971
FLEUR DE LYS	161	130	122	50	21	14	15	19	38	67	107	139	883
PIETERSBERG	98	77	68	29	11	3	6	4	11	42	80	92	521
CYPRUS	209	146	138	80	18	8	8	5	20	88	110	153	983

show a similar equatorial distribution but the absolutes are smaller. Eldoret receives less rain than Masindi but is further east and of higher altitude.

Another noticeable feature of the distribution of rainfall during the year is that the rainfall varies less from month to month in the equatorial areas than in the more temperate regions. The rainfall in any one month at Impfondo has never been lower than 16mm, while in South Africa it is a frequent occurrence for there to be zero rainfall in a given month. On the other hand if we look through and see which station has the highest mean monthly rainfall we find that it is a South African Station which has the highest rainfall (Woodbush - Jan. 352mm - mean).

This variability in the rainfall of more temperature regions is also reflected in other parameters. In Figure 23 is illustrated the values of the mean maximum amount of rain which fell during one day for a given month. For the equatorial stations the amounts are all much the same for any month if we compare them with South African stations. The highest value for the equatorial stations was September in Saklape, where we must not forget the mean annual rainfall is over 2 000mm per year. This station also showed the smallest maximum daily falls (23mm). In contrast, Woodbush shows values of 292mm and 362mm for February and March.

Figure 24 shows the mean number of days with rain for the various months for the various stations. These figures reflect the points already made. Thus there is a tendency for there to be a higher number of days with rain if the rainfall is higher.

Summary

While rainfall is but one factor in the total climatic picture it is certainly one of the most important. This is not only because the amount of rain which falls has a direct effect on the type and growth of vegetation of an area, but also because it is perhaps the best documented of climatic parameters. Rainfall measurements in most cases span many decades and the measurements themselves are relatively easy thus making them all the more comparable and meaningful.

Figure 23 : Mean Diurnal Maximum Precipitation for African Stations

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN.MAX
SAKLAPE	23	53	51	74	66	91	56	61	163	61	36	25	163
OUESSA	74	70	76	47	51	56	35	74	54	72	48	49	76
IMPFONDO	96	64	103	94	116	84	76	101	105	78	93	82	116
KINSANGANI	82	86	136	101	127	88	116	128	100	121	121	100	136
MASINDI	33	89	89	69	76	66	69	74	66	64	53	46	89
ELDORET	51	79	96	117	190	142	142	145	53	36	53	23	190
NDOLA	74	89	66	43	13	0	0	0	5	15	61	96	96
LUSAKA	74	71	56	33	5	8	2	0	5	20	56	68	74
WOODBUSH	150	292	362	90	72	66	32	52	53	99	107	105	362
SCHELM	60	64	53	33	11	8	8	3	14	19	38	50	112
FLEUR DE LYS	59	62	47	31	21	3	3	5	12	22	43	49	62
PIETERSBERG	65	50	57	122	57	28	14	3	33	43	77	59	122

Figure 24 : Number of days with rain - Africa Stations.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
SAKLAPÈ	5	5	10	17	21	26	24	20	26	22	19	22	207
OUESSA	3	5	6	8	8	7	5	8	12	11	9	6	88
IMPFONDO	5	4	9	10	12	10	8	11	12	14	12	6	113
KISANGANI	6	9	11	10	10	9	10	11	13	14	15	10	128
MASINDI	5	6	9	14	16	11	10	15	13	14	13	6	132
ELDORET	5	5	7	12	15	14	18	19	10	6	6	4	119
NDOLA	22	19	17	5	0,5	0	0	0	0,1	3	13	19	98
LUSAKA	21	17	15	3	0,9	0,4	0,1	0	0,4	3	11	17	89
WOODBUSH	19	17	18	12	6	4	6	7	8	13	16	18	144
SCHELM	12	11	11	6	3	2	2	1	4	7	10	12	81
FLEUR DE LYS	12	11	11	7	3	2	2	2	4	7	11	12	84
PIETERSBERG	10	8	8	5	2	1	0,8	0,5	2	5	9	10	61

Rainfall, however, reveals itself to be a highly variable and unpredictable feature of climate, even in the most climatically stable areas (i.e. on the equator). In spite of this inherent variability, however, we can see that in the rainfall of the area under study when compared to that the equatorial areas has certain important features :-

i) It is seasonal (i.e. there is a marked wet and dry season).

ii) The rainfall is more unpredictable with an apparent cyclical occurrence of years with high rainfall.

iii) When compared to equatorial areas the falls of rain occurring on a single day are more variable and have a greater range.

While rain is unlikely to be a factor directly affecting the ecology of monkeys except at a day to day level, the indirect effect via the vegetation, its growth cycles and the way it produces food must be important, though it was beyond the scope of this study to be able to give direct proof of this.

iii) Temperature

While precipitation is a highly variable parameter of climate, temperature is relatively constant at any given location and is a good indicator of the type of climate experienced. On the other hand, however, temperature often suffers as a measure because the measurements are more complex, thermometers are never completely accurate, however calibrated, and the data span is often short or interrupted.

In this description mean temperatures are quoted. These were computed on the basis of Pretoria Weather Bureau information that the statistic, "maximum daily temperature plus minimum daily temperature divided by two" is within 1 per cent of the true mean temperature as determined by examining daily range data. This has been found to be the case for all South African stations. However, the validity of this cannot be verified for other African Stations.

Temperatures during the Study

The amount of data available for stations during the study was limited.

Data were available for only four stations, all in South Africa, and indeed even these were not totally complete.

Examining the temperatures experienced at Cyprus during the study (Figure 25) we may note first of all that there is a seasonal variation in temperature with the winters being approximately 7°C cooler than the summers. The data for the individual years show a less smooth run of mean, and absolute temperatures during the year than the average of the two years. During winter and early spring the range, between mean maxima and minima is greatest, slowly falling until in late summer and autumn this range is at its minimum (1974/1975 - April - 8,28°C). If we remember that more rain fell in 1974, than 1975 at Cyprus we can also see that 1974 was also warmer with a mean yearly temperature of 19,16°C as opposed to 18,75°C. The figures also illustrate this. The summer months of 1974 are all warmer than those in 1975, while the winter months are more or less the same.

To compare the observed temperatures at Cyprus with those over the same period at other stations, we may see that Tzaneen and Levubu (Figure 25) experience much the same temperature regime as at Cyprus, the ranges being slightly greater and the temperatures being slightly higher.

However, looking at Pietersberg (Figure 25), we see that although the maxima are more or less the same as at Cyprus there is a considerable reduction in the minima which produces a corresponding reduction in the mean, especially during the winter months. It is also interesting to note that the summer maxima at Pietersberg are 3-4°C higher than at Cyprus. One might conclude from this that either the close proximity of the Cyprus station to the forest or the mountain results in an insulating effect on the temperature preventing cooling at night and heating up during the day.

Temperatures prior to the study

Using so far as possible the same stations as used for the precipitation comparisons we can now examine more closely the temperatures of various stations in Africa.

Figure 25: Temperatures experienced at Cyprus, Levubu, Tzaneen and Pietersberg during the Study.

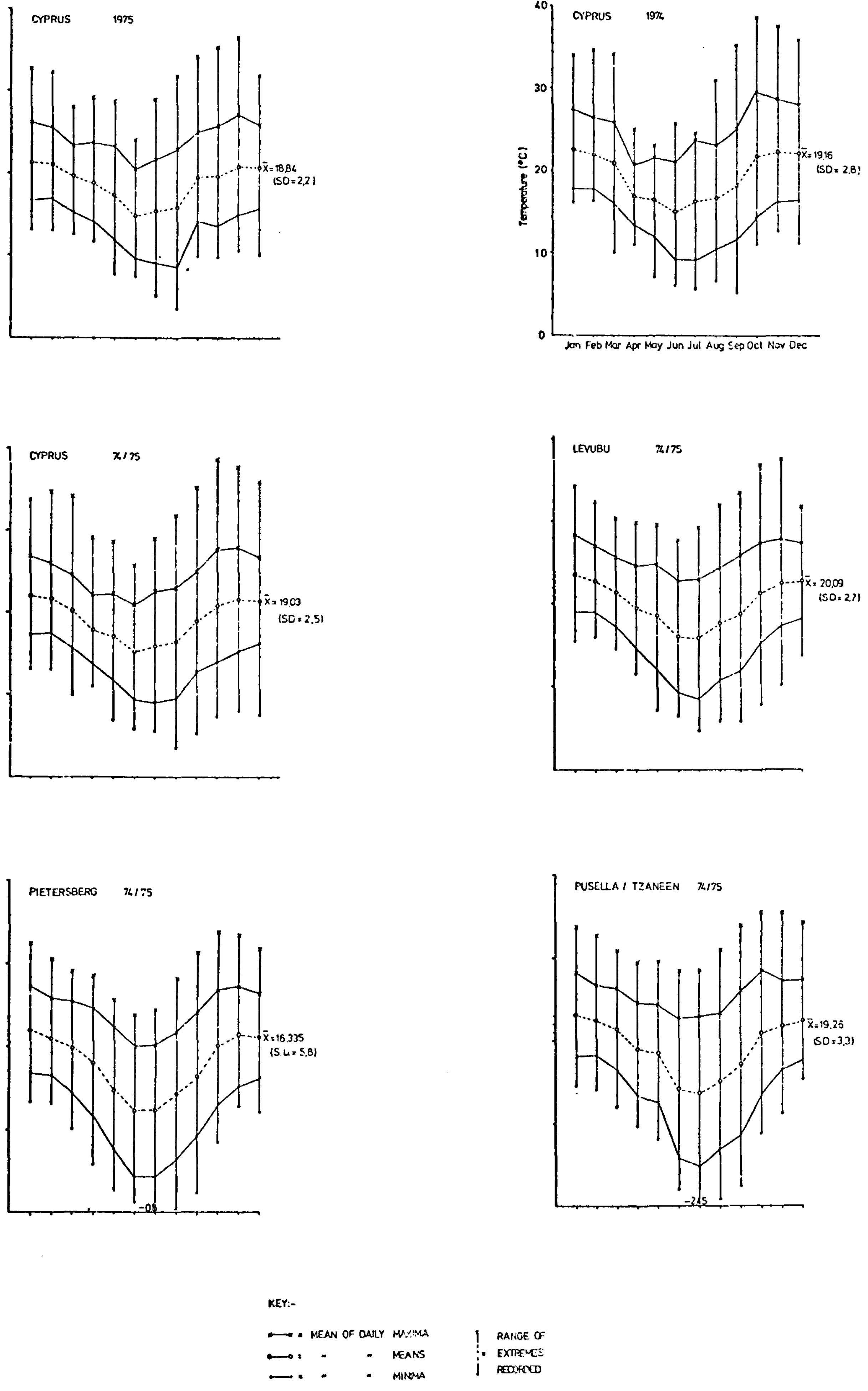


Figure 26 gives the mean monthly temperatures as well as the amount of variation in mean temperature during the year. The equatorial stations, Ouessa, Impfondo, Kisangani and Masindi show high temperatures with a progressive reduction in annual mean from west to east. Eldoret, although equatorial has a mean annual temperature lower even than Pietersberg's and this one must attribute to its high altitude.

In comparison to this the subtropical stations Lusaka and Ndola (not related to forest or high relief) show a seasonal march of temperature during the year with mean temperatures similar to those at South African stations.

For South African stations the data shows two groups of stations, the Lowveld and Highveld stations, Pietersberg, Dusseldorp and Fleur de Lys and the stations related either to relief or to relief and forest. The former all show a high seasonality - (Standard Deviations of 3,9; 4,1 and 2,7 respectively.) The higher altitude stations being cooler than the low altitude stations. Ofcolaco, though a Lowveld station, is higher than Fleur de Lys yet shows a higher mean annual temperature, with a similar amount of variation. This could be due to the fact that this station was just below a large koppie and in its lee. The farms in this area were well known in the district for producing ripe fruit earlier than other farms away from the koppie. Cyprus on the other hand shows a lower mean temperature as well as a marginally smaller variation in monthly temperatures. When considering Cyprus's temperatures we must not forget that the data concerned were collected in two years of exceptionally high rainfall indicating that the temperatures may be an underestimation. Similarly all the other stations' data are for periods of at least five years, thus the Standard deviations may be an overestimation. Again, however, it would appear that the location of the site has a buffering effect in temperatures as mentioned earlier.

Summary

Figure 25 shows the temperature regimes in force during the study. Comparisons with other stations shows that the sites proximity to forest and heavy relief appears to have a buffering effect on the variations in temperature. The temperature varies in a seasonal manner with greater variability in winter than in summer. In contrast to precipitation, however, temperature is relatively constant from year to year and would appear to be a good indicator of general climate.

Again, as with precipitation, there is more variation among the South African Stations in all monthly temperature statistics, with the stations close to forest or close to mountain showing less variation, except where the station was very highly elevated and almost alpine (e.g. Eldoret).

iv) Humidity

Humidity data were even more scarce than those for temperature, incomplete data for three stations including Cyprus being presented (Figure 27).

Levubu is a station in a similar location to that of Cyprus being in close proximity to a mountain range - the Soutpansberg.

For each month two figures are presented - the mean humidity at 08h00 and at 14h00.

One of the drawbacks of the measurement relative humidity should be mentioned here - it is actually a measure of two parameters - the amount of water in the air and the temperature. The amount of water which can evaporate into the air is clearly proportional to the temperature. However, relative humidity does give a rough idea of the "dampness" of the climate, which as we all know can have a marked influence on ones behaviour. If both humidity and temperature are high then the ability to lose heat by evaporation is impaired leading to lassitude.

The first noticeable feature is that this parameter is highly variable from day to day. Figure 28 shows the day to day data for January and April 1975. The summer 08h00 humidities are less variable than those at late autumn. The 14h00 data are more variable than the morning data. However, one must remember that the absolute amount of water present in the air as vapour, may be the same for a given day - the relative humidity may drop

Figure 27: Mean Monthly Relative Humidities for three stations as recorded at 08h00 and 14h00.

	JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE	
	0800	1400	0800	1400	0800	1400	0800	1400	0800	1400	0800	1400
Pietersberg	78 (4,9)	54 (6,8)	81 (5,6)	54 (5,1)	85 (3,4)	54 (5,4)	88 (2,5)	50 (1,6)	85 (3,2)	42 (2,3)	82 (2,8)	37 (4,1)
Levubu	88 (5,4)	60 (9,5)	90 (3,7)	67 (6,1)	92 (2,4)	67 (4,5)	90 (1,7)	60 (2,4)	83 (2,7)	51 (4,6)	81 (3,8)	43 (4,0)
Cyprus	92 (4,9)	74 (4,9)	93 (1,4)	74 (4,2)	94 (0,7)	71 (5,6)	93 (3,5)	69 (8,4)	86 (0,7)	52 (9,1)	82 (3,5)	48 (4,2)

	JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
	0800	1400	0800	1400	0800	1400	0800	1400	0800	1400	0800	1400
Pietersberg	79 (3,7)	35 (3,7)	73 (1,7)	33 (0,8)	69 (2,3)	34 (4,7)	69 (6,2)	42 (7,9)	73 (4,2)	49 (5,4)	73 (7,2)	54 (10,8)
Levubu	77 (3,8)	43 (4,0)	77 (3,6)	43 (4,3)	74 (4,0)	43 (5,5)	78 (3,1)	50 (4,5)	83 (3,9)	61 (8,6)	83 (7,0)	56 (6,8)
Cyprus	86 (0,0)	50 (2,8)	81 (2,1)	50 (2,8)	79 (0,7)	46 (9,1)	79 (6,3)	52 (4,2)	86 (4,2)	66 (12,0)	89 (5,6)	74 (5,6)

Figures in brackets indicate the Standard Deviation of the Raw Data.

Figure 28 : Daily Humidity at Cyprus for January and April, 1975

1975

	JANUARY		APRIL	
	0800	1400	0800	1400
1.	87	69	93	54
2.	91	72	95	72
3.	78	80	96	97
4.	79	63	97	96
5.	77	59	96	92
6.	91	57	97	92
7.	92	78	95	38
8.	96	66	94	43
9.	89	60	94	55
10.	82	57	96	68
11.	82	51	75	71
12.	92	71	91	65
13.	96	79	92	93
14.	89	73	97	94
15.	91	73	97	86
16.	90	82	97	86
17.	93	72	96	81
18.	95	71	89	67
19.	86	91	89	49
20.	92	68	89	48
21.	82	57	92	55
22.	92	59	94	66
23.	85	67	98	45
24.	97	97	71	28
25.	95	70	94	50
26.	70	49	96	32
27.	94	76	89	35
28.	97	91	72	40
29.	97	97	65	41
30.	98	97	98	59
31.	97	71		
$\bar{X}$	89,4	71,7	91,2	63,3
σ	7,05	13,1	8,68	21,58

purely as a result of the increase in temperature from morning to afternoon.

This absolute amount could have been determined if the temperature, relative humidity and barometric pressure were available. A barometer, however, was not available for the study.

So far as the other stations are concerned, few useful conclusions can be drawn from the data except that Cyprus appears to be the most humid of the three and the least variable perhaps again implying that the forest and mountain acts as a climatic buffer against flux in climatic parameters (Figure 28).

Humidity would appear from these data to be a fairly useless tool in describing climate for various areas.

v) Wind

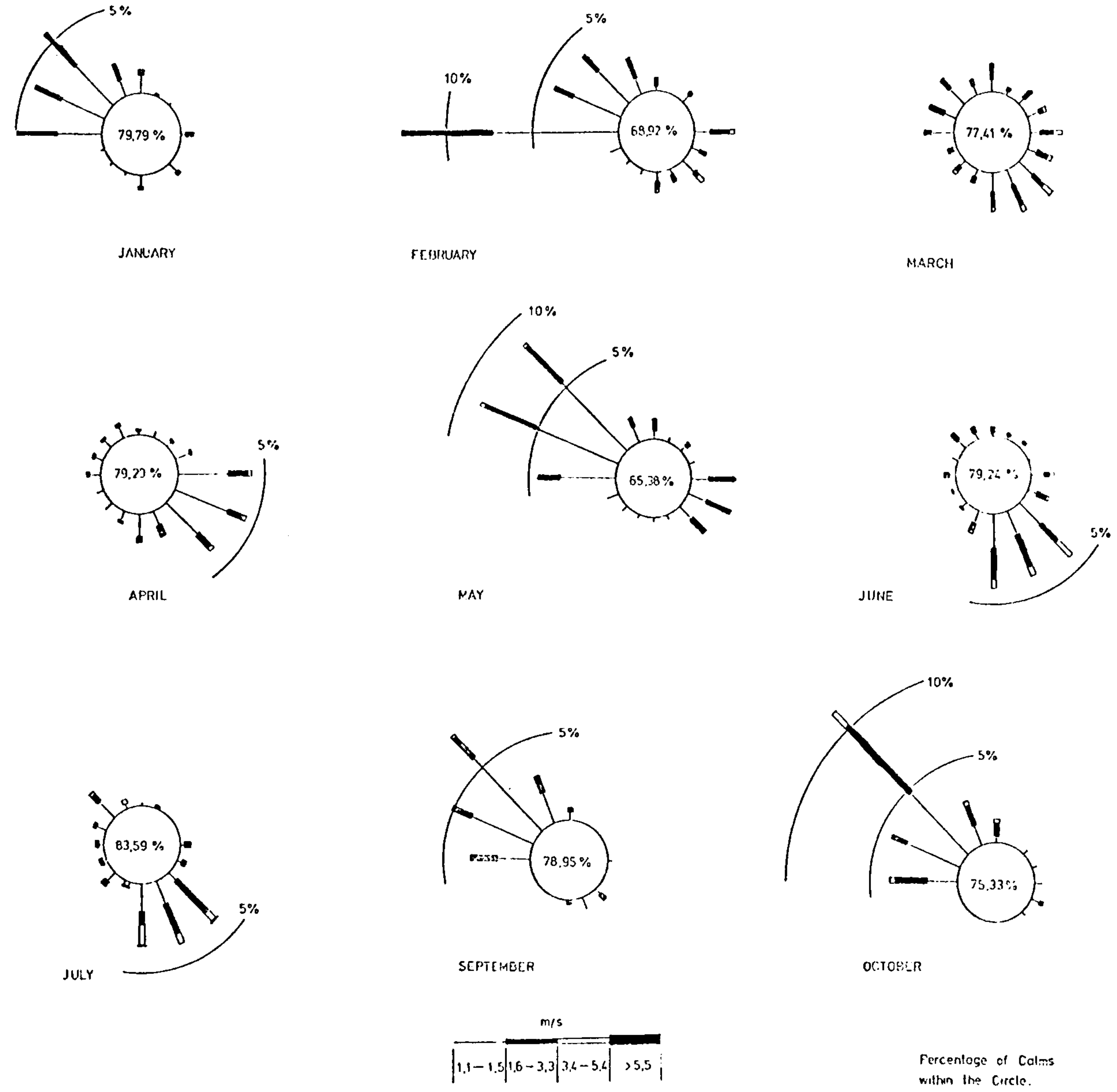
The data on wind collected at Cyprus are rudimentary to say the least. The wind roses (Figure 29) shows the wind direction frequencies as a percentage of all observations. Figure 30 shows the upper air wind directions for these months and the gustiness of the wind. Noticeable features are the high percentage of calms and the relatively low wind speeds in comparison to Pietersberg, where 12 to 15 per cent of the winds recorded were greater than 5,5 m/sec in speed.

These facts are hardly surprising considering the sheltered position of the Cyprus site and the relatively low height of the gauge above the ground.

Looking at the wind through the year we can see that the second half of the year experiences heavier winds than the first half but that the first half of the year has more observations in which wind actually occurred.

As far as the actual direction of the wind is concerned, it may not be valid to draw conclusions from the data presented because of the situation of the windvane and the nature of the relief. It was found that the direction of the wind was very variable and that there were considerable eddies in the valley. While the burgee might indicate one direction for the wind at a given moment, a tree 20m away might show that the wind was flowing in a completely opposite direction. This too was to be expected.

Figure 29 : Percentage of Winds of Various Speeds by Directions for Cyprus and Pietersberg (1975)



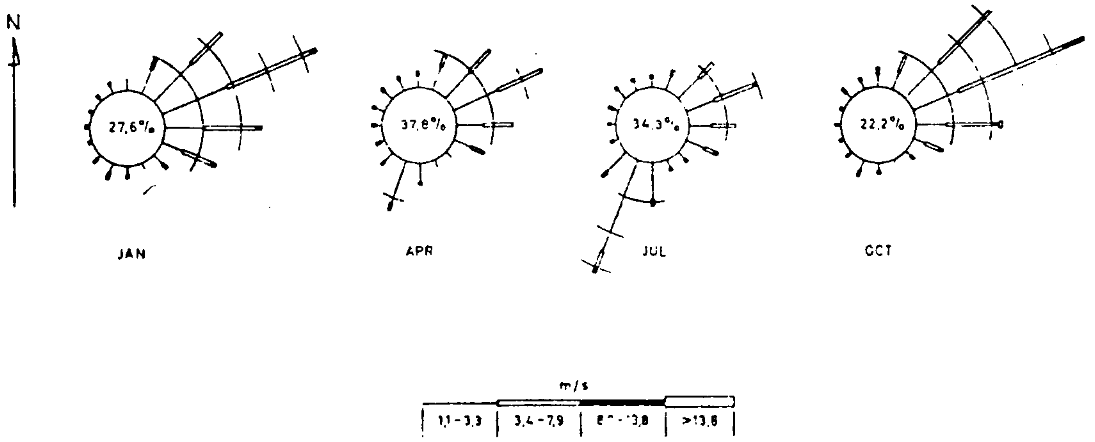


Figure 30 : Upper Air Wind Directions and Wind Gustiness at Cyprus

1975

Frequencies by month in each Direction

MONTH	ND	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOT
JANUARY	18	5	10	17	13	6	1	2	1	1	4	0	0	0	0	0	0	78
FEBRUARY	9	1	4	4	4	1	0	1	0	0	3	4	0	0	1	3	2	36
MARCH	15	2	4	6	5	0	0	0	0	0	3	3	1	0	0	2	0	41
APRIL	22	2	0	2	3	0	0	3	2	2	0	3	0	2	0	0	0	42
MAY	53	1	0	5	4	5	1	0	0	0	2	1	0	3	1	0	0	75
JUNE	55	1	1	1	0	2	0	2	0	0	0	0	1	0	0	0	0	63
JULY	29	3	2	4	2	0	0	0	0	0	3	0	0	1	0	1	0	45
SEPTEMBER	8	2	4	4	1	0	1	0	0	1	0	0	0	0	0	0	0	21
OCTOBER	6	1	2	3	5	0	0	0	0	0	1	0	0	0	0	0	0	20
TOTAL	215	18	27	47	38	14	3	8	3	4	16	11	2	6	2	6	2	421

1975

MONTH	GUSTINESS	N	MONTH	GUSTINESS	N
JANUARY	0,13	22	JUNE	0,21	29
FEBRUARY	0,14	11	JULY	0,25	16
MARCH	0,12	15	SEPTEMBER	0,14	10
APRIL	0,13	14	OCTOBER	0,15	9
MAY	0,17	27			

The upper air wind directions were on average for the year in a north easterly direction. This contrasts with the ground directions where no real prevailing direction can be discerned.

The gustiness of the wind was greatest in June and July, and this may be of ecological significance as these types of winds may affect the rate of leaf fall.

As far as the total climate of the site is concerned the wind is probably of minor importance, though ecologically it may be of more importance especially when it becomes destructive.

vi) Sunshine

Again the data are totally incomplete for any really important comparisons to be made (Figure 31). One important fact which appears is that Cyprus has far fewer sunshine hours than either Pietersberg or Levubu. This is certainly due to the fact that the mountains around the site allowed less sun to reach the site as well as the fact that morning mists already described and which were a local phenomenon caused reduction of sunshine in the early morning and late afternoon. Indeed in winter when the sun's zenith is at its lowest the sun "went down" behind the mountains at about 14h00.

It is also noticeable that the months with least rain - in spite of this effect had the most sun and vice versa.

Conclusions

In considering the climate of Cyprus as a whole and comparing the recorded meteors with those of other regions perhaps the most notable feature is its extreme variability. While the mean rainfall and temperature is lower than equatorial stations the variability in these meteors is greater. The implications of this are difficult to assess, however according to Helson's Adaptation level theory and present ideas of the nature of stress this would seem to point towards this environment being more unpredictable and requiring a higher degree of behavioural adaptability than the equatorial environment. This in turn should indicate, if the human analogy is valid,

Figure 31 : Hours of Sunshine at Cyprus, Levubu and Pietersberg (1974 - 1976)

1974	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	σ
CYPRUS			5,0	5,3	5,8	6,6	6,3	5,8	6,7	6,2	3,4	3,7	5,5	1,1
1975														
PIETERSBERG	7,8	5,5	7,2	7,3	8,7	8,4	9,6	9,2	-	8,8	8,6	6,7	8,0	1,2
LEVUBU	7,3	5,6	5,9	6,9	8,1	7,9	9,0	8,2	-	6,6	7,4	5,4	7,1	1,2
CYPRUS	4,0	3,6	4,3	4,7	5,4	5,6	6,7	6,8	5,0	5,0			5,1	1,0
1976														
PIETERSBERG	6,9	8,4	6,9	7,3	7,6	8,9	9,2	9,3	9,3	8,7	7,5	8,3	8,1	0,9
LEVUBU	6,0	6,8	5,8	7,4	6,4	7,3	8,1	8,1	8,5	6,6	6,8	7,5	7,1	0,8

to the more temperate Cyprus situation being a more stressful and hence more difficult environment in which to live.

These concepts are highly subjective and thus very open to question. The important one so far as this thesis is concerned is the idea that a more variable environment requires a higher level of behavioural adaptability. This in turn may have implications as to the nature of the social organisation adopted by the monkeys under study.

SECTION D

THE FOREST AS A HABITAT

CHAPTER SIX

MICROCLIMATE

Introduction

In the last chapter the climatic context of the study area, so far as the usual climatic measures are concerned, was discussed. Here it was illustrated that the environment of the study area was extremely seasonal, a situation not found in the majority of the areas where forest monkeys are found. It was further mentioned that while the total climate, as measured by standard weather bureau methods, allows comparison of one area with another, this may not be the climatic regime experienced by the animals under study. Indeed this is not the situation, as most parameters are measured in Stevenson Screens, one metre above the ground.

The monkeys were found to be completely relient upon and to live wholly within "the forest". It is a straightforward observation to note that the forest has a different climatic regime from that "outside the forest" (i.e. as measured by standard techniques). Further it is highly probably that in the different strata, and in different locations within the forest, various different climatic regimes will be in operation. For the purpose of this chapter this will collectively be described as the "microclimate" of the forest in the study area.

As in any climatic discussion the meteors may have little or no directly observable influence on the faunal or even floral components of the habitat. However, as stated earlier, these monkeys under study can be considered to be at or close to the limit of their range climatically and if climate is a limiting factor so far as range is concerned, then any modulation of the climatic regime by the habitat is clearly of some importance.

Geiger (1966) presents work by several authors which indicates that forest does have such a modulating influence on climate, with respect to temperature, humidity, rainfall, and wind. Most of the work which he quotes is, however, for temperate forests of the northern hemisphere, primarily coniferous.

Richards (1952) also discusses the modulating influence of tropical forest on the climate experienced within it. The mixed dominance, semi-deciduous forest, as encountered at Cyprus, has, however, never been studied in this context, and hence this present investigation. While it was certainly expected that modulating effects on climate would be observed, the most interesting feature which I tried to investigate, was the magnitude of this modulation.

How does the forest modulate the climate within it? Geiger (1966) points out that microclimatologically a forest habitat presents certain unique features. In the trunk zone there exists a more or less enclosed air space, whose climate must be expected to be intermediate between that of the open air above and that of the forest floor.

Richards (1952) notes that the forest crown will impede lateral air movements, resulting in stillness on the forest floor.

In addition due to the insulating effect of the foliage layer changes in temperature may be buffered, resulting in lower maxima and higher minima which will be reached later than those outside the forest. Moreover, because the canopy impedes lateral air movement and mixing of air inside and outside one can expect to find a decrease in the range of humidity inside and outside the forest.

Both Geiger (1966) and Richards (1952) discuss the effect of the forest foliage on the pattern of rainfall or snowfall within the forest. Rain only begins to fall some time after a shower has begun, and the time lag between onset of rain inside and outside is dependent on the intensity of the rain itself.

As with the climatic data one must ask how does this affect the feeding ecology of the monkeys? In the last chapter data were presented indicating how the climatic regime influenced the monkeys via the habitat which supports them foodwise, and in terms of substrate, however, was clearly indicated that such a standardised meteorological climate is not in fact a measure of the parameters directly affecting either the monkeys or the substrate. As a result, the next question must be "What is the climate of the habitat in which they live?" and "How much does this differ from the meteorologists climate?"

Methods

The following meteors were studied with the forest at various levels and compared with the climatic data already discussed and presented in chapter five - Temperature, Relative Humidity and Rainfall. The instrumentation used follows in the next section, however, one or two notes concerning the methods used are appropriate here.

First the amount of detail which was possible was limited because the instrumentation available and the time necessary to service the instruments had they been available, was lacking. Hence, the experimental situation was beyond doubt far too primitive to draw unequivocal conclusions.

Second, in spite of these deficiencies, wherever possible, all procedures used and data collected were standardised.

Instrumentation

i) Temperature

Maximum and minimum thermometers were placed in the canopy in a Breonadia microcephala at a height of 13m and on the forest floor at a height of 1,25m from the forest floor. Both were housed in identical radiation screens. The tree carrying the canopy instrumentation was 13,5m high and had a canopy depth of 6m. The thermometers were all calibrated against a standard thermometer as were the thermometers used outside. Access to the canopy was by a chain ladder. Thermohydrographs were placed in both the screens already mentioned.

ii) Humidity

Apart from the thermohydrographs, wet and dry bulb thermometers were placed in the canopy screen, the forest floor screen and in a single instrument radiation screen suspended 6,5 metres below the canopy screen. All these thermometers were calibrated and the humidity and temperature readings from them used to correct the readings obtained from the thermohydrographs.

iii) Rainfall

The studies of rainfall in forest to date (reviewed by Geiger (1966)) indicate that the foliage modifies the pattern of rainfall producing two separate components. When rain begins to fall it is initially intercepted by the foliage itself, wetting the surfaces of the leaves and to a lesser extent those of the branches and the trunk. It is this which results in the delay in rain falling on the floor of the forest. Once the foliage has been "wetted", the water can then begin to drip from the leaves to the floor of the forest, or, depending on the physical structure of the trees concerned, it may be directed along the branches to the trunk producing a so-called "Trunk Flow". The two components are therefore Drip Fall and Trunk Flow.

Earlier work has indicated that there is a discrepancy in the total amount of rain reaching the forest floor by Drip Fall and Trunk Flow and the amount of rain which actually fell. This discrepancy has been called the Carrying Capacity or the Interception of the foliage layer and has been attributed to the water retained in the foliage to wet the leaves and evaporated during and after the fall. The amount of this interception as a percentage of the total fall is considered to be a function of the rate of fall of the rain.

The question of interest here is, "How much of the rain is intercepted?"

The study of rainfall within the forest was divided into two main experiments. The first studies the extent of the Trunk Flow and the second the interception of rain as a function of fall rate.

Trunk Flow

A trough of plastic sheeting was constructed around the trunk of a Rauvolfia caffra, whose canopy area was calculated to be 38,5m^2. The trough consisted of a wire frame secured to the tree with strips of rubber inner tube and covered with sheets of industrial plastic sheeting. The amount of water collected was measured. If 1,0mm of rain falls on an area of 1,0m^2, the amount of water collected would be 1,0 litre. Thus every 1,0 litre of water collected represents a fall of 0,026mm of rain.

Interception

To study the interception five bath-like troughs were constructed to collect the water dripping from the trees. The troughs consisted of a wooden frame covered with plastic-sheeting. The collecting area of each was 1,0m^2. Four of these troughs were placed under four different individuals of different species of trees in the forest as follows :-

I - Cryptocarya liebertiana
II - Harpephyllum caffrum
III - Rauvolfia caffra
1V - Celtis Africana

The fifth was placed in the open as control.

The amount of rain falling in each was recorded as soon after a fall had ceased as possible. Being 1,0m^2 in surface area 1,0 litre of water collected represented a fall of 1,0mm.

The rate of fall was computed from a Theis Pluviograph.

Results

i) Temperature

Figure 32 illustrates the mean monthly temperatures for the three zones studied and Figure 33 the daily march in temperature for the three zones in summer and winter respectively. The daily fluctuations were

Figure 32: A Comparison of the Mean Monthly Temperatures in the Three Forest Zones for 1975.

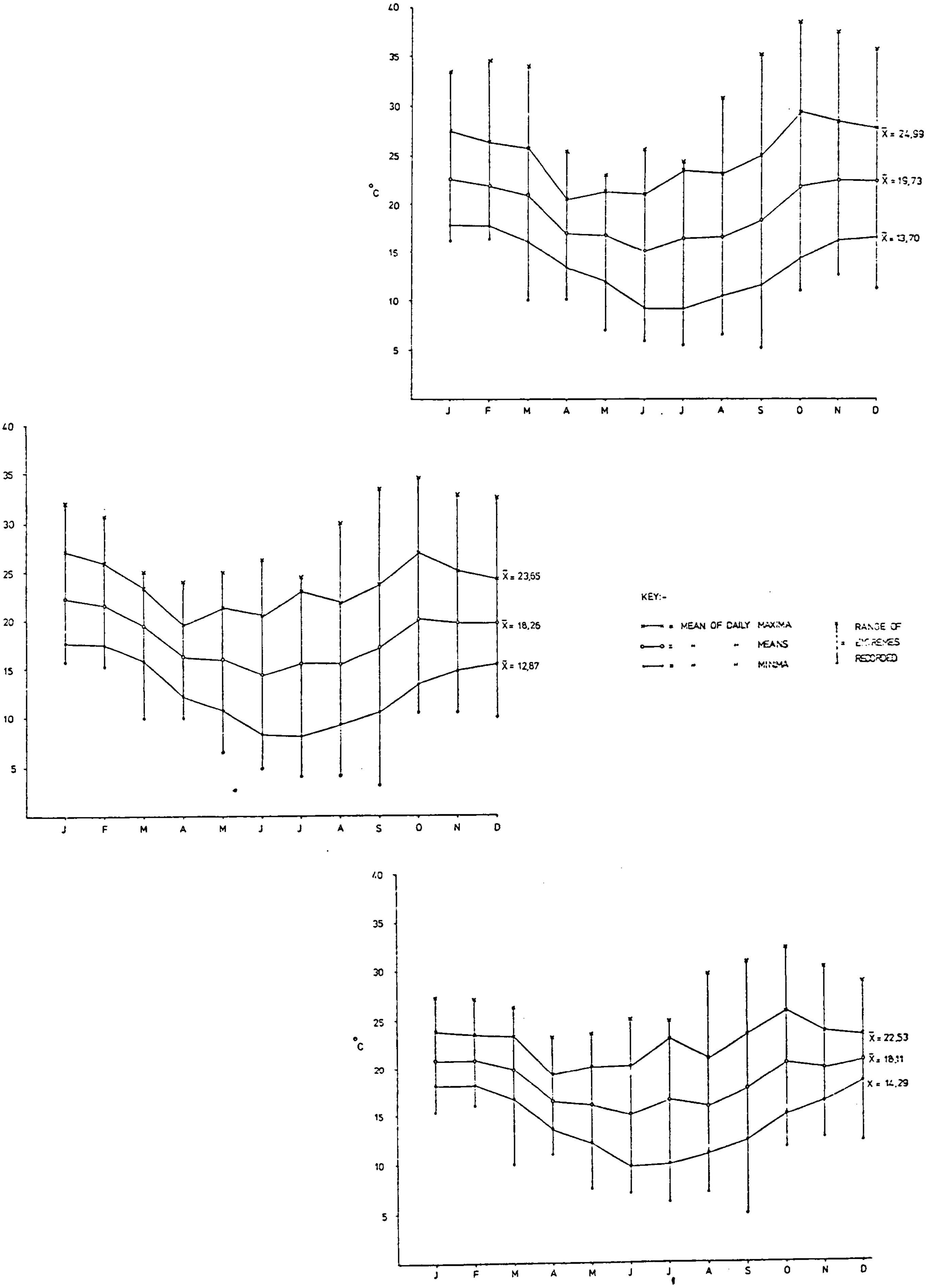
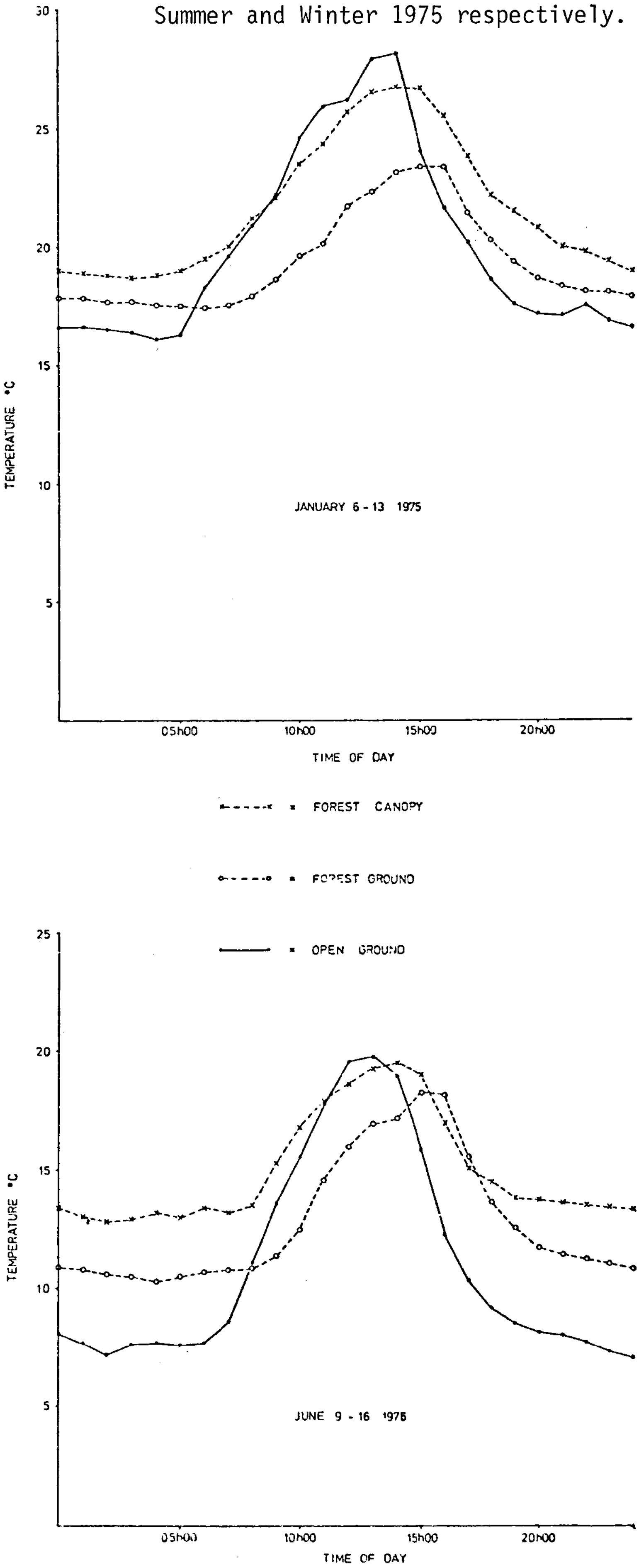


Figure 33: The Daily March of Temperature in the Three Forest Zones for Summer and Winter 1975 respectively.



derived by taking the mean temperature for a given time of day over a full week in summer and winter.

ii) Humidity

Figure 34 shows the mean Relative Humidity for 08h00, 14h00 and 20h00, for 1975 in each of four zones and Figure 35 the daily march (as for temperature) in summer and winter.

iii) Rainfall

Trunk fall

The device constructed to study this was unfortunately not of a sturdy enough construction to get a large number of quantitative results. On most occasions where there was an appreciable trunk fall, considerable leaking took place. Only one result could be considered to be reliable. During a fall, measured outside the forest to be 58,5mm, 6,5 litres of water were collected. This then means that the amount of rain reaching the forest floor via the trunk of this particular tree would have been only 0,16mm. Thus 0,27 per cent of the fall was trunk fall.

Drip Fall

The data concerning Interception is presented on Figures 36 and 37 for summer and winter respectively.

In the first column of each are the dates of the falls under consideration. The second column (ΣR) is the total amount of rain which fell outside the forest. The columns marked I, II, III, IV are the equivalent amounts of rain which fell in troughs I, II, III and IV respectively. The seventh column (V) denotes the equivalent amount of rain which fell in the fifth trough outside the forest - the control. $\overline{\Sigma R}_f$ is the mean fall in the forest. $\%R_f$ is the Mean Forest Fall as a percentage of the outside fall. %I is the percentage interception ($\%I = 100 - \%R_f$)

The columns of the right of %I and marked (08. - 10) to (06 - 08) indicate the amounts of rain which fell outside the forest during twelve two hour intervals during the day concerned. ΣR is again the total outside

Figure 34 : Mean Relative Humidity in the various zones at different times for 1975

	OPEN	FOREST FL	TRUNK	CANOPY
0800	87,86	92,28	88,64	85,38
1400	68,8	80,93	78,31	72,61
2000	90,53	93,75	94,59	95,48

Figure 35: The Daily March of Humidity in the Three Forest Zones for Summer and Winter respectively.

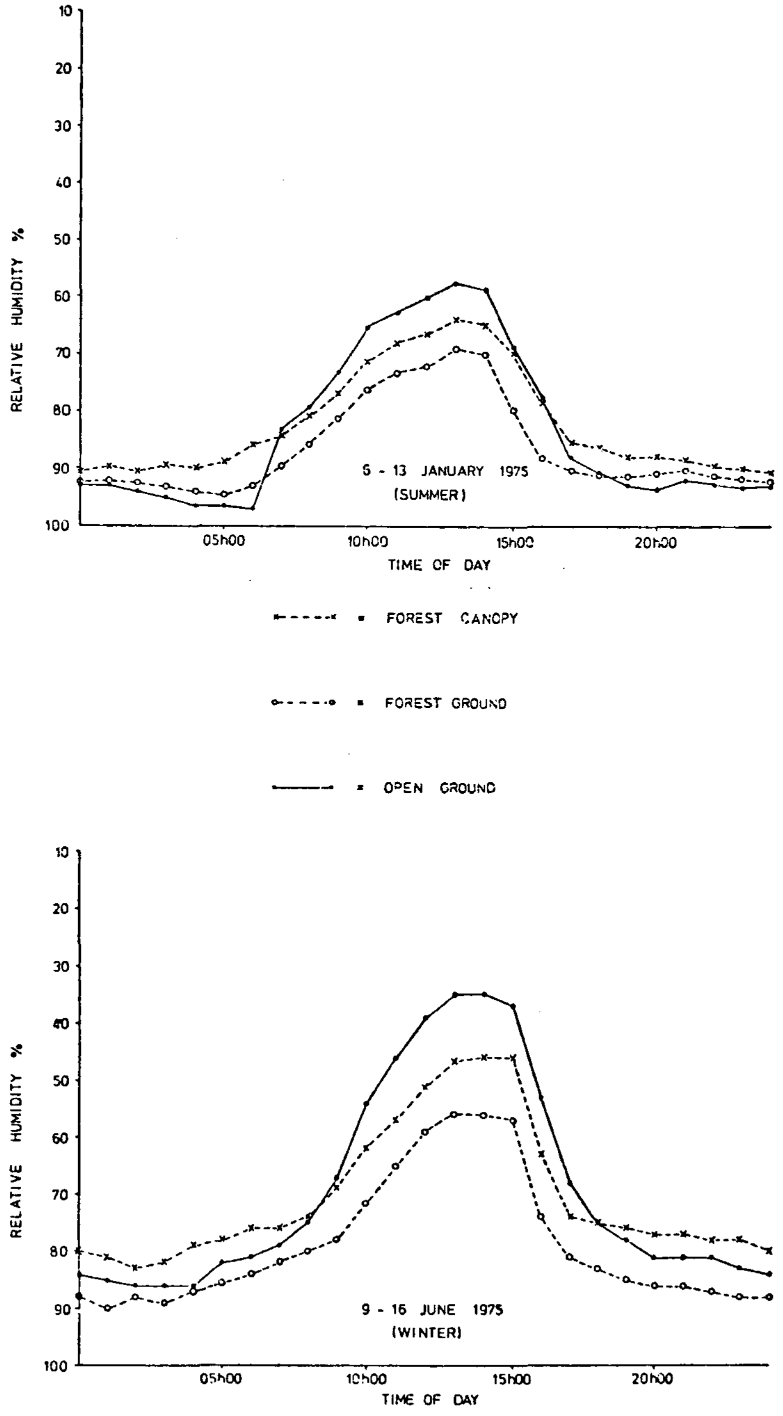


Figure 36: Data concerning Rainfall intercepted by the Forest (Summer).

DATE	ΣR	I	II	III	IV	V	$\overline{\Sigma R}_f$	$\%R_f$	% I	08 - 10	10 - 12	12 - 14	14 - 16	16 - 18	18 - 20	20 - 22	22 - 24	24 - 02	02 - 04	04 - 06	06 - 08	ΣR	f	$\frac{\Sigma R}{hr}$
1/1/75	53,2	39,880	31,500	48,190	49,870	53,8	42,36	79,50	20,50				10,0	36,0	5,2	1,5						53,2	8	6,65
2/1/75	5,7	3,860	3,430	3,600	4,500	5,31	3,849	72,50	27,50					5,0	0,5							5,5	4	1,37
3/1/75	0,2	0,010	0,000	0,000	0,015	0,18	0,0063	3,50	96,50		0,2											0,2	2	0,1
8/1/75	10,3	7,355	6,370	8,335	7,880	9,89	7,486	75,70	24,30				4,0	6,0								10,0	4	2,5
10/1/75	1,0	0,280	0,190	0,335	0,510	0,99	0,329	33,25	66,25			0,4	0,6									1,0	4	0,25
11/1/75	0,2	0,025	0,000	0,020	0,045	0,25	0,0225	9,00	91,00												0,2	0,2	2	0,1
12/1/75	5,0	3,390	2,880	4,125	3,835	5,18	3,557	67,80	32,20										1,0	3,2	0,8	5,0	6	0,83
13/1/75	0,2	0,010	0,000	0,035	0,020	0,20	0,0162	4,00	96,00			0,2										0,2	2	0,1
14/1/75	1,2	0,435	0,350	0,515	0,605	1,22	0,475	39,00	61,00					0,6	0,6							1,2	4	0,3
15/1/75	2,4	1,110	0,910	1,470	1,530	2,38	1,250	52,50	47,50					1,4		0,5	0,9					2,8	6	0,46
17/1/75	0,9	0,190	0,160	0,315	0,325	0,93	0,246	26,50	73,50								0,4		0,5			0,9	4	0,225
18/1/75	5,0	3,510	2,940	3,540	3,805	4,84	3,450	71,20	28,80									3,6	1,4			5,0	4	1,25
19/1/75	11,9	7,450	7,205	9,180	8,520	11,90	8,806	74,00	26,00						6,1	1,5	0,1	4,3				12,0	8	1,50
24/1/75	58,5	47,390	31,790	46,690	52,440	58,50	44,57	76,20	23,80	13,2	13,4	3,2	2,6	9,2	0,3	3,7	7,7		2,0	2,8	0,4	58,5	22	2,65
27/1/75	9,6	6,180	5,835	8,140	7,900	9,6	7,18	74,80	25,20								0,5		0,2	1,0	8,0	9,7	8	2,42
28/1/75	47,4	36,240	31,280	39,380	40,010	47,4	36,730	77,50	22,50	6,8						34,8	5,0			0,2	0,6	47,4	8	5,92
29/1/75	29,6	20,580	19,690	24,740	25,330	29,71	22,580	76,00	24,00	8,1	18,9	1,6						1,0				29,6	8	3,7
30/1/75	8,2	5,710	5,120	6,000	6,350	8,21	5,79	70,50	29,50	3,8	3,6	0,4									0,4	8,2	8	1,02
31/1/75	0,8	0,170	0,090	0,250	0,230	0,91	0,184	20,50	79,50									0,1	0,6	0,1		0,8	6	0,13
$\Sigma\Sigma R$ $\overline{\Sigma R}$	24,68 12,99					251,40 13,23			$\frac{\Sigma R}{f}$	31,9 8	36,1 8	5,4 8	3,0 4	25,8 12	54,0 12	46,7 12	16,1 14	9,0 8	5,7 12	7,3 10	10,4 12			
									$\frac{\Sigma R}{hr}$	3,98	4,5	0,67	0,75	2,15	4,5	3,89	1,15	1,12	0,47	0,73	0,87			

Figure 37: Data concerning Rainfall Intercepted by the Forest (Winter).

DATE	ΣR	I	II	III	IV	V	$(\overline{\Sigma R})_f$	% R_f	% I	08-10	10-12	12-14	14-16	16-18	18-20	20-22	22-24	24-02	02-04	04-06	06-08	ΣR	f	$\frac{\Sigma R}{hr}$
10/4/75	2,9	2,005	2,025	2,005	1,995	2,900	2,015	69,5	30,5				2,3		0,1	0,4	0,1					2,9	8	0,36
13/4/75	20,0	14,000	15,860	17,500	17,250	20,190	16,152	80,0	20,0			1,4	10,6	2,0	1,6	0,6			2,7	1,4		20,0	14	1,42
14/4/75	1,5	0,810	0,960	1,005	1,015	1,510	0,948	62,8	37,2			0,9	0,2	0,4								1,5	6	0,25
15/4/75	1,7	1,270	0,950	0,980	1,200	1,720	1,100	46,0	36,0								0,1			0,2	1,4	1,7	6	0,28
17/4/75	1,2	0,780	0,795	0,925	0,365	1,190	0,842	70,8	29,2					0,9								0,9	2	0,45
20/4/75	0,2	0,030	0,040	0,120	0,030	0,200	0,05	27,5	72,5												0,2	0,2	2	0,1
1/5/75	0,7	0,290	0,300	0,360	0,470	0,700	0,35	50,0	50,0											0,4	0,2	0,6	4	0,15
4/5/75	9,6	9,100	8,700	8,900	8,200	10,500	3,70	83,2	16,8						8,7	0,9						9,6	4	2,4
7/5/75	0,1	0,005	-	0,020	0,010	0,150	0,009	5,8	94,2											0,1		0,1	2	0,05
8/5/75	9,9	7,620	7,420	8,430	7,710	9,900	7,79	78,75	21,25				2,8				3,6	3,1	0,2	0,2		9,9	10	0,99
9/5/75	0,9	0,410	0,300	0,735	0,615	0,900	0,520	58,3	41,7											0,2	0,7	0,9	4	0,22
13/5/75	12,8	11,500	12,520	12,380	13,600	13,700	12,5	92,0	8,0		12,8											12,8	2	6,4
4/6/75	1,3	0,770	0,670	0,820	0,800	1,280	7,65	59,76	40,24								0,1	0,6	0,3	0,3		1,3	8	0,16
5/6/75	1,9	1,260	1,250	1,520	1,415	2,010	1,362	67,8	32,2									0,7	0,1	1,1		1,9	6	0,32
7/6/75	0,2	0,015	0,020	0,040	0,035	0,200	0,0275	13,75	86,25											0,1	0,1	0,2	4	0,05
26/6/75	2,8	1,900	2,005	2,320	1,840	2,820	2,016	71,5	28,50						1,2	0,4	1,2					2,8	6	0,47
29/6/75	0,2	0,010	0,005	0,090	0,010	0,250	0,030	11,5	88,50										0,1	0,1		0,2	4	0,05
30/6/75	0,8	0,345	0,360	0,510	0,532	0,840	0,436	52,0	48,0								0,3		0,1	0,2		0,8	6	0,13
									ΣR		12,8	2,3	15,9	3,3	10,4	2,3	5,4	4,4	3,6	4,3	2,6			
									f		2	4	8	6	6	8	12	6	12	22	10			
									$\frac{\Sigma R}{hr}$		6,4	0,57	1,98	0,55	1,73	0,28	0,45	0,73	0,3	0,9	0,26			

rainfall. 'f' is the number of hours during which rain fell, based on two hour intervals and ΣR/hr is the rate of fall.

Figure 38 illustrates the relationship between Interception and rate of fall, for falls during summer and winter.

Discussion

i) Temperature

Looking at the mean temperatures in the canopy, outside the forest and on the forest floor, it is on average warmer during the year outside the forest than on the forest floor, with the canopy being intermediate. This is mirrored in the mean daily maxima and the absolute monthly maxima.

Looking at the minimum temperatures, however, we see a slightly different pattern with the lowest mean daily minimum being in the canopy, rather than outside the forest as one might expect. To explain this effect one might implicate dew and the evaporation of dew leading to cooling. In the canopy with a greater density of foliage than the outside and hence a greater surface area one might expect more dew to be deposited than outside the forest. As the dew evaporates at daybreak one then might expect greater cooling in the forest canopy than outside. The forest floor, one might expect to receive less dew, due to the shelter of the canopy and thus less cooling due to evaporation of dew than either of the other situations.

The absolute minimum temperature recorded for the Open and the Forest Floor was 6,0°C and 5,0°C respectively while that for the canopy was as low as 3,2°C. This observation might serve to support this hypothesis as the Forest Floor absolute minimum is closer to that outside the forest than that within the canopy. This hypothesis would have to be tested by making dew fall measurements and somehow determining the amount of dew falling in each situation.

The data concerning the daily march of temperature, for summer and winter show no inexplicable phenomena.

Winter is clearly cooler than summer. In both summer and winter the range in temperature is greater outside the forest than on the forest floor, with the canopy being intermediate. This last observation is also illustrated in Figure 32. This data then support the hypothesis that the foliage layer of the forest acts as an insulator, modulating the increase and decrease of temperature within the forest and, as far as temperature is concerned, creating a "more equable" climate within the forest.

One very noticeable feature of Figure 33 is that there is a delay in the attainment of daily maximum within the forest as compared to that outside. Again the canopy is intermediate in this.

There are two possible explanations for this or it may be a combination of the two. First the canopy station was higher than the outside station and due to the nature of the terrain received the direct sun longer than the outside station, which became shaded as the sun descended, by the mountains around.

Second, while the outside station received direct radiation from the sun, the canopy station was at all times mostly shaded, the leaves receiving the radiation. The leaves themselves would then warm up and, as the amount of radiation produced by a body is proportional to the temperature difference between the radiator and the body receiving radiation to the fourth power, would tend to only lose their radiation (i.e. start to cool), after the sun stops shining on them, and thus heating the air. On the outside however, there is less foliage and freer convection, which must result in the air here cooling quicker.

Thus the following may serve to explain the delay to maximum phenomenon. As the sun ceases to radiate directly on the outside station, heat is rapidly lost resulting in rapid lowering of temperature, due to convection and a relative lack of re-radiation from absorbing surfaces. While the station in the canopy reaches a lower maximum because the radiation on the station was not direct, the heat absorbed into the leaves will begin to be re-radiated. This combined with the convection leads to a later achievement of maximum temperature, along with a later cessation of direct radiation from the sun.

The forest floor on the other hand reaches its peak later, because foliage re-radiation causes a slight increase or at least allows the "heat content" of the air to be maintained and because almost complete lack of convection, and the insulation of the foliage layer, prevents loss of heat from the lower strata of the forest..

ii) Relative Humidity

In discussing the Relative Humidity data, we must remember that Relative Humidity is also a function of temperature. This renders all the data presented on humidity almost meaningless, because one cannot determine whether an observed change, or difference in humidity is due to a real change in the water content of the atmosphere, or merely due to a change in temperature.

However, drawing general conclusions from the data we can say that the forest is "damper" than the open ground which is hardly surprising, though, again it does illustrate the insulating properties of the foliage layer preventing water loss from the forest.

The daily march of humidity in the various zones presents aspects which may serve to strengthen the dew-hypothesis with regard to temperature.

In winter, the drier part of the year, the night time humidities are lower in the canopy than in the open. As previously mentioned the canopy presents a greater surface area than the open site. Thus when dew is able to form (i.e. when moisture leaves the atmosphere) more dew will fall in the canopy than in the open and hence the humidity - the atmospheric water would be expected to be less in the canopy than in the open.

iii) Rainfall

Trunk Fall

The data presented, i.e. that the amount of rain which reaches the forest floor via the trunk amounts to only 0,27 per cent even in a relatively heavy fall would seem to indicate that in this forest with trees the shape they are (i.e. not acting as channels for water), trunk flow accounts for so small a percentage of the throughfall that it can be safely ignored.

Drip Fall

Examination of Figures 35 - 37 indicate different species of trees or perhaps only differently constructed trees produce different drip fall patterns and allow through different amounts of rain.

The graph shows a quite definite relationship between the percentage Interception and the rate of fall.

First from the shape of the graph we may suppose that at low rates of fall, almost all of the rain is intercepted or used to wet the leaves and later evaporated, never reaching the forest floor. As the rate of fall increases and more and more of the foliage becomes completely wetted the percentage of the fall intercepted tends to become constant implying that after a certain amount of rain has fallen all the foliage is wetted and all or most of the incident rain reached the floor.

That the foliage density is important in this relationship is shown by the fact that during winter when the foliage density of all trees is lower more of the incident rain penetrates the canopy and the carrying capacity of the foliage is less.

CONCLUSIONS

The hypothesis that the forest itself modulates the environment experienced within a forest of this type was confirmed. Temperatures tend to be reduced in their range and humidity to be maintained in general higher than in the open.

The actual rainfall which reaches the forest floor and which can thus be used by forest trees situated away from standing water is reduced. This in turn may affect the production capacity and even survival of trees away from the water.

So far as the monkeys are concerned, it is extremely difficult to say how this affects them. One fact, however, the significance of which cannot be ignored is that forest presents several climatic profiles at once. Thus if the regime in one part becomes too hot, too cold, too wet or whatever, the monkeys will be able to find a situation which is more equable.

CHAPTER SEVEN

THE VEGETATION OF THE STUDY AREA

Introduction

As stated earlier one of the main aims of this study has been to study the food supply of the monkeys concerned and in doing so to try to offer possible solutions to questions concerning the socio-biology of forest monkeys.

The first question we must ask then is, "What comprises the food supply of the monkeys in the study area?" Initial observations showed that the monkeys relied mainly on plant food of many different types. Fruits, pods and leaves of many different tree, creeper and shrub species as well as some herbs were observed to be eaten. It appeared that some or other part of almost all major plant species were potentially utilisable. Holcroft (1970) reports that samangos also eat the blossoms of certain species and this was confirmed at Cyprus. The Forestry Department (pers comm) report that samangos strip bark from pine trees either to obtain young vascular tissue or sap. Gum exudate from *Acacia karroo* has been observed to be eaten at the study site (Bearder (pers comm) reports this as one of the main food sources of *Galago senegalensis*).

While plant food is certainly the primary source for samangos, animal sources are utilised. Oatley (1970) reports that samangos raid birds nests to obtain the eggs. Captive samangos relish hens eggs, breaking the shells with their canines and licking up the contents. Butterfly and moth caterpillars were observed being eaten. On occasions samangos were observed foraging in dead trees, peeling off the bark and picking out objects from under the bark and eating them. Flying insects were often seen to be "plucked" from the air and if caught, eaten. It is possible that many forms of insects and maybe even lizards are eaten by samangos, however plant food did appear to be the main source of food. The samango's diet will be discussed in more detail later.

Forest, while having a clear unitary structure, being composed of readily identifiable trees and shrubs, which are well spaced and unique, has a highly structured composition and shows, as a food source, several levels of complexity in time and space. This complexity must affect their ranging behaviour and feeding strategies.

Considering forest as a food source provides us with three basic levels of complexity - a phytosociological level, a phenological level and a productivity level. All three of these interact together to produce at any one time a given food supply picture.

(i) The Phytosociological Level

This complexity stems from the observed phenomenon that the units making up the forest are not evenly distributed and belong to one of several different species. Further on the basis of membership and density the forest may be divided up into two or more subdivisions of forest. The type of forest encountered close to water courses may be quite different to that in another area. In addition the total numbers of individuals of a different species may vary and the size and stage of growth can vary.

Thus the parameters which are of interest at this level are:

(i) What species are present?

(ii) What is their abundance and density in the forest as a whole?

(iii) What is the degree to which their numbers vary within the forest? (i.e. How localised is their distribution?)

(iv) How far, on the basis of these, can the forest be divided into subunits of different types?

(v) What is the age structure of the forest?

These are the questions which we will attempt to answer in this present chapter. Clearly this is the basic level of complexity of a forest and it will clearly have a dramatic effect on the feeding patterns and ranging behaviour of the animals using the forest as a substrate. If a given species of tree or other food producing plant is not present in a given area of the forest then the monkeys will be unable to feed upon it. It is an old maxim of ecology that animals tend to congregate in those areas in their living area or space where there is the highest concentration of available food, except of course where other factors affecting survival or reproduction militate against it (e.g. predation). Thus the distribution of potential food sources is of key importance to the understanding of an animal's ecology, in that this may be of key importance in moulding the strategies which it may adopt in obtaining food, as well as the pattern of ranging which it adopts, to exploit the food source optimally.

(ii) The Phenological Level

While the phytosociological structure is one factor which may affect the food supply of the monkeys, the physical presence of an individual of a given species of food producing plant does not necessarily mean that that individual will actually be producing palatable food at a given moment of time. Indeed Struhsaker (1974) attempted to find a correlation between ranging behaviour and the floristic composition and did not find one, more than likely because the phenological aspect was not taken into account. In order to get a complete picture of food availability we must also consider that the trees and all plants for that matter, produce phytophases periodically or in some cases they may never produce a given phytophase. This aspect is discussed in chapter eight.

(iii) The Productivity Level

In addition to the levels of complexity already discussed we must also consider the fact that the trees do not produce phytophases in equal amounts. Trees producing regular large crops are more likely to be exploited than trees producing sparse crops. There are several other factors which may affect the availability of food or its attractiveness to the monkeys. These, along with productivity will be discussed in chapter nine. These include the problem of the food value of the foods utilised, the size and manageability of the food items, and the palatability and the accessibility of food items.

All these factors together act to produce a food supply picture to which the monkeys must react through their ranging behaviour and social feeding strategies. As previously suggested it may also be that this affects the social organisation of the animal concerned. It is however only when all these factors are considered as a whole that such correlations will become meaningful. Several workers have attempted similar analyses, but have failed to show direct correlations between social organisation and feeding requirements (Clutton-Brock (1974), Struhsaker (1974)).

Clutton-Brock (1974) sums up the position well in saying:

"Attempts to relate interspecific differences in social organisation among primates to gross differences in habitat or diet type have been largely unsuccessful. This is probably partly because distantly related species have adapted to similar ecological situations in different ways and partly because much finer ecological differences are important."

In the following three chapters the behaviour of the forest as a producer of food will be described. In following chapters the response of the monkeys to this supply will be described.

THE DISTRIBUTION OF FOOD PLANTS

The accurate description and classification of vegetation has been the life's work of many botanists and it still presents modern botanists with problems. The methods used by workers are almost as legion as the number of workers attempting such work and the choice of a method for this enumeration was made difficult by the vast array of methods available. In reviewing the present status of the field, Shimwell (1971) points out that the study of the phytosociology of vegetation can be either extensive or intensive and that the methods used in these two often overlapping approaches are different. He also points out that the aims in classifying and describing vegetation are often different and that the methods employed in the past may depend on whether the worker concerned believes that types of vegetation are mutually exclusive elements or whether they represent a continuum each plant community blending into another in both time and space. This latter approach has led to the use of ordination techniques and sophisticated computer analysis of data (Gittins (1969)). Indeed one may almost say that phytosociology and the description and classification of vegetation is to botany what the nature-nurture question or drive theory is to psychology and this is certainly not the place to discuss the relative merits and disadvantages of the various techniques.

In selecting a method it was necessary to find methods that would yield the type of data required for the study in hand. As the methods from which they were to be selected are botanical it is necessary to briefly discuss what botanists are trying to do in describing and classifying vegetation.

Firstly, what is vegetation? Shimwell gives a spiral type of definition. He describes vegetation as "all the different types of plant community within a region." A plant community he describes as "not merely a random aggregation (of plants) but an organised complex (of plants) with a typical floristic composition and morphological structure, which has resulted from the interaction of species populations through time." He points out that the species population is the fundamental vegetational characteristic and that it is the constant response of this unit to various ecological factors - climatic, etcetera, which makes the vegetation and the plant communities so complex and which results in their uniqueness.

From these definitions the botanist's starting point and aim in description and classification become clear, at least at a superficial level. It is not so much to ask "What plants grow where?" or "What is this community?", but rather "Why does this community exist here?"

It will immediately be seen that this is a quite different starting point from that of the zoologist looking at possible causes for particular ranging patterns in a given population of monkeys in a restricted piece of vegetation. His ideal would be to have every single tree individually mapped along with various parameters of each unit which might be of relevance to the question in hand. This was the technique used by Hladik and Hladik (1972) at Polonnaruwa in Sri Lanka. They used a low-level aerial photograph which allowed each tree to be identified and thus an accurate map of the trees and their crown areas could be drawn. This approach was precluded in the present study due to the lack of a suitable aerial photograph, lack of manpower, the very hilly terrain and the larger area of the study. When making comparisons with other areas the vegetational descriptions were made using transects or physiognomic observation, though the exact methods were not described. Struhsaker (1974) used a technique of "strip enumeration" to determine the distribution of food species. This was in effect a type of transect and all trees 2,5 metres from existing footpaths and over 10 metres in height were identified. From this data the densities of the various tree species was computed. The area covered in this way was 1,43 hectares or 3 - 4 percent of the area of the home range of the group under study. Whether density alone is an adequate measure of species dispersion is debatable and will be discussed later. Waser and Floody (1974) enumerated the trees in their study area in circular quadrats of 10 metre radius (area: $314m^2$ = 0,3 hectare), the quadrats being at 50m intervals also along paths. In total 36 quadrats were sampled and the number of each species of tree over 10m in height in each quadrat computed. Clutton-Brock (1975) also enumerated the abundance of various species in his study areas at Gombe and at Kibale. He used five quadrats with dimensions of 100m by 100m (one hectare). Trees with a diameter at breast height greater than 4 inches were counted at Gombe. The results were expressed as a percentage frequency by species in each quadrat.

These studies represent some of the methods used by workers to solve the problem of enumerating forest habitats so as to be able to test whether ranging habits are in any way related to the physical structure of the forest. Clearly they have followed Shimwell's axiom of the "best method". Replying to the question,"What is the best method to a particular problem?", Shimwell answers "that from a phytosociological point of view, the best method may be taken to be that one which enables the maximum comprehension of the structural complexity of the vegetation relative to the background environmental variables, this in turn relative to the amount of time input."

It is also worth noting what the constraints on methods of forest enumeration are from a zoological point of view. First, while the divisions may be artificial, it is necessary to have an idea as to what associations of plants or floristically different entities exist within the study area or areas where the monkeys are or are likely to be found and not just in the mapped home ranges of given groups. Secondly, if it is not possible to map individual trees because of time constraints or other constraints, the different communities must be mapped to show their extent and positions. Forest is floristically a highly complex entity and to merely take a strip transect or even random quadrats and then lump the results as most of the East African workers have done is clearly not adequate, because what one wants to know is where the trees are or,another way, if a monkey is at point A what are the chances of it encountering tree species B. Thirdly the data collected must be compatible with all the other data. The botanical data collected by the zoologist is collected for one of two reasons and in both cases the data doesn't stand as an entity on its own as does the data collected by a botanist. Firstly it may be collected so that other workers can compare their study area to that of the observer and secondly it may be collected for correlation with other data (e.g. phenology, productivity, animal movements, etcetera). In the latter case it is clearly of little consequence collecting highly quantitative, intensive data if the data to be compared with them are of a qualitative nature.

METHODS

Two methods were used to describe and classify the forest, both an extensive, physiognomic method and an intensive plotless sampling method. Later analysis of other data, e.g. the phenological and ranging data, proved these to be unsuitable for direct comparison at a quantitative level with the intensively obtained data and hence these data have not been presented. A description of the method is however included in the appendix as it has several advantages over methods previously used by zoologists for this type of work.

The extensive method was a physiognomic one based on presence and absence of various species in various parts of the forest and with weighting of the samples by subjective methods to determine the relative abundance of the species. (N.B. Here "relative abundance" is not being used in the quantative botanical sense).

This survey was initially started to act as a basis upon which the marking of trees for the phenological survey could be based. Clearly some idea of what trees grew where and in what numbers was required for this so that representative samples of the different species present could be marked and observed for phenology.

After an initial period of field work all the major tree species could be identified, this with the aid of a local naturalist [1] and the identifications being done at the study site.

At this stage a subjective idea of the division of the forest into floristically unique areas was already possible merely on the basis of presence and absence of various species. These subjective ideas were now systematised. Using non-vegetational landmarks (i.e. streams, paths, relief, etcetera) the presence or absence of various species as well as an indication of their abundance in note form (not on a scale) was recorded with reference to the points.

From this information it was noted that over the majority of the forest no individual species was exclusively dominant and that while certain communities could be distinguished as being physiognomically different, they could not be defined sufficiently to enable an initial dividsion of the forest into distinct communities except for a basic division between vegetation fringing the forest and the forest itself. This distinction could also be clearly seen on an aerial photograph - the lighter grey areas of forested parts being fringe. Figure 39 was drawn from the aerial photograph and the areas confirmed as fringe on the ground. Further confirmation that these were floristically distinct was obtained in later physiognomic surveys on the basis of floristic compositions (see Results).

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[1] Mr A. T. Renny, Mashela, P.O. Ofcoloco, 0854
North Eastern Transvaal, South Africa

Figure 39: Map showing the Extent of Forest and Forest Fringe at Cyprus.

Drawn from Aerial Photographs

Scale: 1cm = 137,13m.

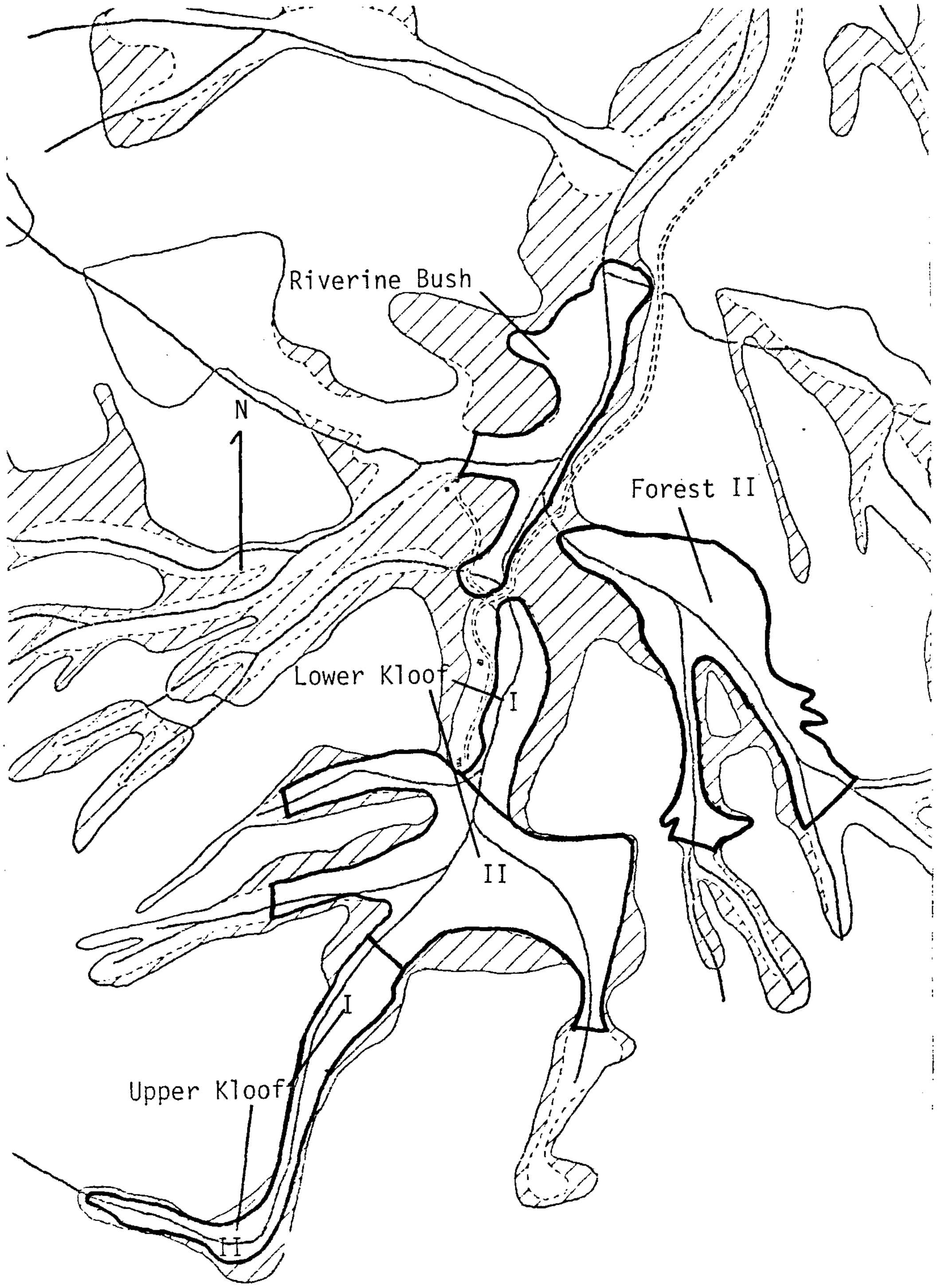
Forest Fringe = Hatched Areas.

In order to continue sampling of floristic composition and abundance the forest was now divided into three zones, one of them a real vegetational zone and the other two artificial. Figure 40 illustrates how this was done. Additional sampling was carried out in Forest II and the Riverine Bush included within the hached outlines. During the survey the areas were further divided as illustrated into upper and lower Kloof I and II. These zones were originally designed to represent areas which could be visited in a morning or an afternoon for the phenology survey. It was estimated that approximately two hundred and fifty trees could be visited in a morning or afternoon, and hence the areas at the top of the study area are smaller so as to allow time to reach the area. As more trees were marked later it became necessary to further subdivide the areas.

Within each area (i.e. Lower Kloof I etcetera) the vegetation was sampled as follows. Points within each area were chosen and a stake placed at that point. The observer then stood at the point and using a range-finder all trees within a five metre radius were recorded as being present in that sample area. Again notes were made as to the abundance of each species. The location of each sample was noted, its distance from rivers, etcetera, its slopes, exposure and the direction it faced. The points sampled in this was were spread evenly about the areas demarcated. The number of points in each area so sampled were as follows:

FRINGE	:	29
UPPER KLOOF I	:	33
UPPER KLOOF II	:	31
LOWER KLOOF I	:	36
UPPER KLOOF II	:	45
		174

Figure 40: Map showing the Divisions used to Sample the Study Area for Tree Distribution.



Scale: 1cm = 137,13m.

It took four days for the observer and an assistant to sample these one hundred and seventy-four plots. The other two areas, Forest II and Riverine Bush took an additional day and involved sampling in eighteen and twenty-two plots respectively. Abundance measures for each species were then computed for each zone using a six-point abundance scale (Figure 41). These data were then used to compile the results.

RESULTS

Figure 42 is a list by families of all the major species of plant encountered in study area. The first section deals with trees, shrubs and woody creepers, while the second section deals with exotic and cultivated plants as well as some herbs which were noted as present. The table also, notes for reference the authority, life form and forest level of the species concerned. The abundance section refers to the abundance of the species as a whole over the study area on a weighted five-point scale which has nothing in common with that used later.

The rest of the columns refer to whether the species was marked for the phenological survey or whether it was so-called "unmarked species". Unmarked species did not have individual trees marked for the survey but were observed as a species during phenological observation periods. For some species the fruit was weighed and measured and this is noted in the second column, while the third notes whether the fruit, flowers and leaves, etcetera, were sent for biochemical analysis. The fourth column records whether any part of the species concerned was eaten by the samangos at Cyprus.

Figure 43 is a list of the abundances of the various species as encountered in the sample plots. The abundance figures refer to the scale as previously quoted and the number of sample plots making up the sample are quoted at the end of the table. The table records the abundances obtained in the seven arbitary zones as well as the abundance in the hypothesised floristic communities which were demarcated both by subjective analysis and plotting the results of

Figure 41 : Abundance Scale used to categorise the abundance of trees and shrubs at Cyprus.

0 - Absent in all Sample Plots

1 - Absent in less than 20% of Sample Plots

2 - Present in 21 - 40% of Sample Plots

3 - Present in 41 - 60% of Sample Plots

4 - Present in 61 - 80% of Sample Plots

5 - Present in 81 - 100% of Sample Plots

I – TREES, SHRUBS & WOODY CREEPERS

Figure 42: Species of Tree, Shrub and Creeper Recorded at Cyprus with Biographical Data included.

SPECIES[1]	S.A. TREE LIST NO.	AUTHORITY	LIFE FORM	FOREST LEVEL	ABUNDANCE	MARKED FOR PHENOLOGY	FRUIT WEIGHED	FRUIT ANALYSED	EATEN BY SAMANGO	COMMON NAME
Cyathaceae										
Alsophila dregei (= *Cyathea dregei)*	1	(Kunze) Tryon.	Tree Fern <3m	Shrub	Local 2	X	X	X	X	Common Tree Fern
Zamiaceae										
Encephalartos transvenosus	13	Stapf. & Burtt Davy	Small Cycad > 2m in height	Shrub	Rare 1	X	X	X	X	Modjadji Cycad
Podocarpaceae										
Podocarpus falcatus	16	(Thunb.) R. Br. ex Mirb.	Tree	Canopy	Present 2	√	X	X	X	Outenqua Yellowwood (C.K. Brain Reports Fruit eaten by Samango at Mt. Sheba. N.R)
Podocarpus latifolius	18	(Thunb.) R.Br. ex Mirb.	Tree	Sub-Canopy	Local 2	√	X	X	X	Real Yellowwood
Liliaceae										
Dracaena hookerana (= *hookeriana)*	30,9	C. Koch.	Shrub→ Small Tree	Shrub	Local 2	X	√	√	N.O.[2]	Large Leaved Dragon Tree
Ulmaceae										
Celtis africana	39	N.L. Burm.	Tree	Canopy	Common 4	√	X	X	√	White Stinkwood
Trema orientalis	42	(L.). Blume.	Tree	Shrub/Sub-Canopy	Local 2	√	√	√	√	Pigeonwood
Chaetachme aristata	43	Planchon.	Tree → Shrub	Shrub/Sub-Canopy	Local 2	√	√	X	No	Thorny Elm
Moraceae										
Ficus capensis	50	Thunb.	Tree	Canopy/Sub-Canopy	Common 4	√	√	√ + Leaves	√ + Leaves	Cape Fig.
Ficus ingens	55	(Miq.) Miq.	Tree	Forest Fringe	Local 2	√	X	√	No	Red-Leaved Rock Fig.
Ficus natalensis [= *F. burkei, F. petersii, F. rhodesiaca F. thonningsii*]	57	Hochst.	Tree Single or Rock splitter or Strangler	Canopy/Sub-Canopy	Local 2	√	√	X	No	Common Wild Fig
Proteaceae										
Faurea saligna	75	Harvey.	Tree	Forest Fringe	Local 2	√	X	X	X	Transvaal Boekenhout
Faurea speciosa	76	(Welw.) Welw.	Tree	Fringe	Rare 1	√	X	X	X	Broad Leaved Boekenhout
Olacaceae										
Ximenia caffra	103	Sonder.	Shrub	Fringe	Rare 1	X	X	X	√	Large Sour Plum
Annonaceae										
Annona senegalensis	105	Pers.	Shrub	Fringe	Local 2	√	X	X	NO	Wild Custard Apple
Xylopia odoratissima	110	Welw. ex Oliver.	Tree	Fringe	Local 2	√	X	X	NO	Small Bitterwood
Monimiaceae (=Trimeniaceae)										
Xymalos monospora	111	(Harvey.) Baill.	Tree	Canopy/Sub-Canopy	Present 3	√	X	X	√	Lemonwood
Lauraceae										
Cryptocarya liebertiana	114	Engl.	Tree	Canopy	Common 4	√	X	X	√	Wild Quince
Pittosporaceae										
Pittosporum viridiflorum	139	Sims.	Tree	Fringe	Local 2	√	X	X	√	Pittosporum
Rosaceae										
Parinari curatellifolia	146	Planch. ex Benth.	Tree	Fring	Local 2	√	X	X	NO	Mobola Plum
Leguminosae										
Mimosoideae (=Mimosaceae)										
Acacia ataxacantha	160	D.C.	Tree →Shrub	Fringe	Local 2	√	√	√	√	Flame Acacia

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[1] NAMES AND AUTHORITIES AS IN PALGRAVE (1977)

[2] NO =NOT OBSERVED AT CYPRUS

SPECIES	S.A. TREE LIST No.	AUTHORITY	LIFE FORM	FOREST LEVEL	ABUNDANCE	MARKED FOR PHENOLOGY	FRUIT WEIGHED	FRUIT ANALYSED	EATEN BY SAMANGO	COMMON NAME
Acacia karoo	172	Hayne.	Tree	Gallery Forest	Local 2	X	X	X	√	Sweet Thorn
Dichrostachys cinerea	190	Wight & Arn.	Shrub	Gallery Forest	Local 2	X	X	X	X	Sickle Bush
Caesalpinioideae (=Caesalpineae)										
Bauhinia galpinii	208,2	N.E. Brown	Shrub	Fringe	Local 2	√	√	√	√	Pride-of-de Kaap
Peltophorum africanum	215	Sonder.	Tree	Fringe	Local 2	√	X	X	X	Weeping Wattle
Papilionoideae (= Papilionaceae)										
Dalbergia armata	231	E. Mey.	Creeper	All Levels	Common 4	X	X	√Leaves	√	Thorny rope
Dalbergia sp. (? = melanoxylon)			Tree	Fringe	Local 2	√	X	X	NO	(Zebrawood ?)
Erythrina lysistemon	245	E. Mey.	Tree	Fringe	Rare 1	X	X	X	X	Transvaal Kaffirboom
Erythroxylaceae										
Erythroxylum emarginatum	249	Thorn.	Shrub	Shrub Level	Local 2	√	X	X	X	Common Coca Tree
Rutaceae										
Fagara capensis	253	Thunb.	Small Tree	Sub-Canopy	Rare 1	√	X	X	X	Small Knobwood
Calodendrum capense	256	(L.f.) Thunb.	Tree	Canopy	Present 3	√	X	X	√	Cape Chestnut
Oricia bachmannii	257	(Engl.) Verdoorn.	Tree	Sub-Canopy	Present 3	√	X	X	√	Twinberry Tree
Teclea natalensis	264	(Sonder) Engl.	Tree	Sub-Canopy	Present 3	√	X	X	√	Natal Tellea
Clausena anisata	265	(Willd.) J.D. Hook ex Benth.	Shrub	Fringe	Present 3	√	X	X	√	Horsewood
Meliaceae										
Ekebergia capensis	298	Sparrm.	Tree	Canopy	Present 3	√	X	X	√	Cape Ash, Dog Plum
Ekebergia pterophylla	299	(C. D.C.).Hofmeyr.	Small Tree	Fringe	Rare 1	√	√	X	√	Rock Ash
Trichilia emetica	301	Vahl.	Tree	Canopy	Common 4	√	√	√	√	Natal Mahogany
Euphorbiaceae										
Andrachme ovalis	305	Muell. Arg.	Woody Herb	Shrub	Common 4	X	√	X	NO	Bastard Lightning Bush
Drypetes gerrardii	314	Hutch.	Tree	Canopy	Common 4	√	X	X	√	Bastard White Ironwood
Antidesma venosum	318	E. Meyer ex Tul.	Small tree → Shrub	Fringe/Sub-Canopy	Local 2	√	√	√	√	Tassel Berry
Bridelia micrantha	324	(Hochst) Baillon.	Tree	Canopy	Common 4	√	√	X	√	Mitzeerie
Croton sylvaticus	330	Hochst.	Tree	Canopy	Present 3	√	X	X	√	Forest Croton
Euphorbia ingens	351	E. Mey. ex Boiss	Small Tree	Shrub	Rare 1	X	X	X	X	Naboom
Anacardiaceae										
Sclerocarya caffra	360	Hochst.	Tree	Fringe	Local 2	X	X	X	√	Marula
Harpephyllum caffrum	361	Bernh.	Tree	Canopy	Common 4	√	√	√	√	Wild Plum ; Kaffir Plum
Lannea discolor	362	(Sonder.) Engl.	Tree	Fringe	Rare 1	√	X	X	√	Live-Long
Protorhus longifolia	364	(Bernh.) Engl.	Tree	Canopy	Common 4	√	X	X	√	Red Beech, Currant
Rhus chirendensis	380	E.G. Baker	Tree	Canopy	Present 3	√	X	X	√	Bostaaibos
Aquifoliaceae										
Ilex mitis	397	(L.) Radlk.	Tree	Canopy	Present 3	√	X	X	√	African Holly
Celastraceae										
Maytenus heterophylla	399	(Eckl. & Zeyh.) N. Robson	Small tree	Sub-Canopy Shrub	Present 3	√	X	X	X	Common Spike-Thorn

SPECIES	S.A. TREE LIST No.	AUTHORITY	LIFE FORM	FOREST LEVEL	ABUNDANCE	MARKED FOR PHENOLOGY	FRUIT WEIGHED	FRUIT ANALYSED	EATEN BY SAMANGO	COMMON NAME
Catha edulis	404	(Vahl.) Forsk. ex Endl.	Small Tree	Sub-Canopy	Local 2	✓	X	X	X	Bushman's Tea
Apodytes dimidiata	422	E. Meyer. ex Arn.	Tree	Canopy/Sub-Canopy	Local 2	✓	X	X	✓	White Pear
Sapindaceae										
Allophylus africanus	423,1	Beauv.	Shrub	Fringe	Rare 1	X	X	X	X	African Allophylus
Pappea capensis	433	Ecklon & Zeyher	Shrub → Small Tree	Fringe	Local 2	X	X	X	✓	Doppruim
Ptaeroxylaceae										
ptaeroxycon obliquum	292	(Thunb.) Radlk.	Tree	Canopy	Rare 1	✓	X	X	X	Sneezewood
Melianthaceae										
Bersama transvaalensis	442	Turrill	Tree	Canopy/Sub-	Local 2	✓	X	X	NO	Transvaal Bersama
Rhamnaceae										
Ziziphus mucronata	447	Willd.	Shrub → Tree	Sub-Canopy	Rare 1	✓	X	X	✓	Buffalo Thorn
Vitaceae										
Rhoicissus rhomboidea	456,4	(L.f.) Wild. & R.B. Drumm	Creeper	All Levels	Present 3	X	✓	X	✓	Bastard Forest Grape
Rhoicissus tomentosa	456,5	(Lam.) Wild. & R.B. Drumm	Creeper	All Levels	Abundant 5	X	X	X	✓	Common Forest Grape
Rhoicissus tridentata	456,6	(L.f.) Wild & R.B. Drumm	Creeper	All Levels	Local 2	X	X	X	✓	Bitter Grape
Tiliaceae										
Grewia occidentalis	463	L.	Shrub	Fringe	Rare 1	X	X	X	X	Cross Berry
Sterculiaceae										
Dombeya burgessiae	468,1	Ger. ex Harvey	Shrub	Fringe	Rare 1	X	X	X	X	Pink Dombeya
Dombeya rotundifolia	471	(Hochst) Planchon	Small Tree	Fringe	Local 2	✓	X	X	X	Wild Pear
Ochnaceae										
Ochna arborea var. o'connorii	482	(Phillips) Du Toit	Small Tree	Fringe	Local 2	✓	X	X	NO	Cape Plane
Ochna holstii	480	Engl.	Tree	Canopy	Present 3	✓	X	X	NO	Red Ironwood
Flacourtiaceae										
Rawsonia lucida	491	Harvey & Sonder	Tree	Sub-Canopy	Common 4	✓	✓	X	✓	Rawsonia
Kiggeleria africana	494	L.	Tree	Canopy	Local 2	✓			✓	Wild Peach
Scolopia zeyheri	498	(Nees.) Harvey	Shrub	Shrub	Rare 1	X	X	X	✓	Thorn Pear
Trimeria grandifolia	503	(Hochst.) Warb.	Small tree	Sub-canopy	Rare 1	✓	X	X	X	Wild Mulberry
Thymelaeaceae										
Peddiea africana (= *fischeri* [*Palgrave (1977)*])	517	Harvey.	Shrub → Woody Herb	Shrub	Common 4	X	X	X	✓	Green Flower Tree
Combretaceae										
Combretum molle	537	R.Br. ex G. Don.	Tree	Fringe	Local 2	✓	✓	X	✓	Velvet Bush Willow
Combretum kraussii	540	Hochst.	Tree	Canopy	Present 3	✓	X	X	✓	Forest Bush Willow
Combretum sp.			Creeper	All Levels	Present 3	X	X	X	✓	Creeping Combretum
Myrtaceae										
Eugenia capensis subsp. natalitia (= *natalitia*)	553,2	(Sonder) F. White	Small tree	Sub-Can/Shrub	Local 2	✓	✓	X	✓	Natal Myrtle
Eugenia sp.			Small Tree	Sub-Canopy	Local 3	✓	✓	X	✓	

SPECIES	S.A. TREE LIST No.	AUTHORITY	LIFE FORM	FOREST LEVEL	ABUNDANCE	MARKED FOR PHENOLOGY	FRUIT WEIGHED	FRUIT ANALYSED	EATEN BY SAMANGO	COMMON NAME
Syzigium cordatum	555	Hochst	Tree	Canopy	Present 3	✓	X	X	✓	Waterbessie
Syzigium guineense subsp. gerrardii = (S. gerrardii)	557	(Willd.) D.C.	Tree	Canopy	Common 4	✓	✓	X	✓	Forest Water Berry
Heteropyxis natalensis	455	Harvey	Tree	Fringe	Local 2	✓	X	X	X	Lavender tree
Araliaceae										
Cussonia spicata	564	Thunb.	Tree	Canopy	Present 3	✓	X	X	✓	Cabbage Tree
Schefflera umbellifera	566	(Sonder) Baillon.	Tree	Canopy	Present 3	✓	✓	X	✓	Bastard Cabbage Tree
Cornaceae										
Curtisia dentata	570	(N.L. Burm.) C.A. Smith	Tree	Canopy	Present 3	✓	✓	X	✓	Assegai
Myrsinaceae										
Maesa lanceolata	577	Forsk.	Tree	Fringe	Local 2	✓	✓	✓	✓	Maesa
Rapanea melanophloeos	588	(L. Mez.)	Tree	Fringe	Local 2	✓	X	X	✓	Cape Beech
Sapotaceae										
Bequaertidendron magalismontanum	581	(Sonder) Heine & J.H. Hemsley	Tree	Sub-canopy	Common 4	✓	✓	X	✓	Stamvrug
Mimusops obovata	584	Sonder.	Tree	Canopy	Present 3	✓	✓	✓	✓	Red Milk-Wood
Mimusops zeyheri	585	Sonder.	Tree	Canopy	Common 4	✓	✓	✓	✓	Transvaal Red Milkwood
Ebenaceae										
Euclea natalensis	597	A. D.C.	Tree	Can/Sub-Canopy	Local 2	✓	✓	X	✓	Large Leaved Guarri
Diospyros whyteana	611	(Hiern.) F. White	Shrub	Shrub Layer	Local 2	X	✓	X	✓	Bladder-nut
Loganiaceae										
Strychnos henningsii	625	Gilg.	Tree	Canopy	Present 3	✓	✓	X	✓	Coffee Bean Strychnos
Strychnos madagascariensis	626	Poir	Shrub	Fringe	Rare 1	✓	X	X	X	Black Monkey Orange
Strychnos usambarensis	631	Gilg.	Small Tree	Shrub	Local 2	✓	X	X	NO	Stipe Fruited Strychnos
Anthocleista grandiflora	632	Gilg.	Tree	Canopy	Present 3	✓	X	X	X	Forest Fever Tree
Nuxia congesta	633	R. Br. ex Fresen.	Shrub	Fringe	Rare 1	X	X	X	X	Broshout
Nuxia floribunda	634	Benth.	Small Tree	Fringe	Rare 1	X	X	X	X	Forest Nuxia
Apocynaceae										
Carissa bispinosa var acuminata	640,2	(E. Mey.) Codd.	Shrub	Shrub	Local 2	X	✓	X	✓	Num-Num
Carissa edulis	640,5	Vahl.	Shrub	Sub-Canopy	Local 2	X	X	X	✓	Simple spined Num-Num
Rauvolfia caffra	647	Sonder	Tree	Canopy	Local 2	✓	X	X	✓	Quinine Tree
Verbenaceae										
Clerodendrum glabrum	667	E. Meyer	Tree	Canopy	Local 2	✓	X	X	✓	White's Cat's Whiskers
Lamiaceae										
Iboza riparia	-	(Hochst) N.E. Brown	Shrub	Fringe	Local 2	X	X	X	NO	Ginger Bush
Scrophularaceae										
Halleria lucida	670	L.	Shrub→ Small Tree	Sub-Canopy	Present 3	✓	X	X	✓	Tree Fuschia
Acanthaceae										
Mackaya bella	681,1	Harvey	Woody Herb	Shrub	Present 3	X	X	X	X	Mackaya

Figure 42: Continued

SPECIES	S.A. TREE LIST No.	AUTHORITY	LIFE FORM	FOREST LEVEL	ABUNDANCE		MARKED FOR PHENOLOGY	FRUIT WEIGHED	FRUIT ANALYSED	EATEN BY SAMANGO	COMMON NAME
Rubiaceae											
Cephalanthus natalensis	685	Oliver	Shrub	Fringe	Rare	1	X	X	X	✓	Tree Strawberry
Gardenia amoena	690	Sims	Shrub	Shrub	Local	2	✓	✓	X	✓	Spiny Gardenia
Rothmannia capensis	693	Thumb	Tree	Sub Canopy	Local	2	✓	✓	X	✓	Common Rothmannia
Oxyanthus speciosus *(= gerrardii)*	696	D.C.	Small Tree	Sub Canopy	Present	3	✓	✓	X	NO	Wild Loquat
Breonadia microcephala *(= Adina microcephala var galpinii)*	684	(Delile) Ridsd	Tree	Canopy	Local	2	✓	X	X	X	Matumi, Mingerhout
Trycalysia lanceolata *(= Neorosia andongensis)*	699	(Sonder) Burtt. Davy	Shrub	Sub-Canopy	Rare	1	✓	X	X	✓	Common Trycalysia
Vangueria infausta	702	Burch.	Shrub	Fringe	Rare	1	✓	X	X	✓	Wild Medlar
Tapiphyllum parvifolium	703	(Sonder) Robyns	Shrub	Fringe	Rare	1	X	X	X	✓	Bergmispel
Canthium ciliatum	705,1	(Klotzch) Kuntze	Shrub	Fringe → Sub-canopy in forest	Rare	1	✓	X	X	✓	Dwarf Turkey Berry
Canthium gueinzii	705,2	Sonder	Creeper	All Levels	Present	3	X	X	X	✓	Climbing Canthium
Canthium inerme *= (C. ventosum)*	708	(L.f.) Kuntze	Small tree	Sub-Canopy	Local	2	✓	X	X	✓	Turkey Berry
Canthium mundianum	710	Cham & Schlecht	Shrub	Fringe	Rare	1	X	X	X	X	Rock Alder
Pavetta lanceolata	718	Ecklon	Small Tree	Sub-Canopy	Local	2	✓	X	X	✓	Forest Bride's Bush
Psychotria capensis	723	(Ecklon) Sonder	Small tree	Sub-Canopy	Local	2	✓	X	X	✓	Cream Psychotria
Compositae											
Brachylaena discolor *= (B. Transvaalensis)*	724	D.C.	Tree	Canopy	Present	3	✓	X	✓	✓	Wild Silver Oak

II – EXOTIC, AND CULTIVATED PLANTS AND HERBS

Figure 42: Continued

SPECIES	LIFE FORM	SITUATION	ABUNDANCE		MARKED	FRUIT WEIGHED	FRUIT ANALYSED	EATEN BY SAMANGO	COMMON NAME
Ensete sp.	Tree	In Forest-Sub Canopy	Local	2	X	X	X	√	Cultivated Banana
Morus sp.	Shrub →Tree	In Forest Sub Canopy	Local	2	X	X	X	√	Mulberry
Mangifera indica	Tree	In Lands Adjacent to forest	Local	2	X	X	X	√	Mango
Opuntia sp.	Succulent	Close to Forest	Rare	1	X	X	X	X	Prickly Pear
Psidium sp.	Tree	In and close to Forest	Local	2	X	X	X	√	Guava
Jacaranda mimosifolia	Tree	In and close to Forest	Rare	1	X	X	X	X	Jacaranda
Solanum mauritianum	Shrub	In Lands	Rare	1	X	√	X	X	Bug tree
Haemanthus sp.	Herb	In Forest	Present	3	X	√	√	√	
Asparagus asparagoides	Creeper	In Forest	Local	2	X	√	X	√	
Asparagus sp.	Herb	In Forest	Local	2	X	X	X	X	
Clivea mineata	Herb	In Forest	Local	2	X	√	X	√	
Clivea sp.	Herb	In Forest	Local	2	X	√	X	√	
Lantana sp.	Herb	Around lands	Local	2	X	X	X	X	
Passiflorum sp.	Creeper	In Forest & Cultivated	Local	2	X	X	X	√	Grenadilla
Smilax mitis	Creeper	In Forest	Local	2	X	√	X	√	
Toddalia asiatica	Creeper	In Forest	Present	3	X	X	X	√	
Adenium gummifera	Creeper	In Forest	Present	3	X	X	X	X	
Cassia sp.	Shrub	Fringe	Rare	1	X	X	X	X	
(Avocado Pear)	Tree	In Orchards	Local	2	X	X	X	X	Avocado
(Paw-paw)	Tree	On Lands	Local	2	X	X	X	NO	Paw-Paw
Quisqualis parviflora	Creeper	In Forest	Local	2	X	X	X	NO	
Indigophera sp.	Scrambling Herb	Fringe	Local	2	X	X	X	X	

Figure 43: Table of Abundances of Species of Tree and Shrub encountered at Cyprus

SPECIES	Tree List No.	ABUNDANCE – SAMPLING AREAS							ABUNDANCE – VEGATATIONAL ZONES											NOTES
		LK I	LK II	UK I	UK II	FR	F II	RB	UKS	UKF	PF	MF	DMF	SB	T	FF	F II	FR	RB	
Podocarpus falcatus	16	1	3	0	1	0	0	0	0	1	0	3	1	1	2	0	1	0	0	
Podocarpus latifolius	18	0	0	2	3	0	0	0	3	1	1	0	0	0	0	0	0	0	0	
Celtis africana	39	3	1	1	2	1	1	1	1	2	1	2	1	1	1	2	1	1	1	
Trema orientalis	42	1	0	1	1	2	2	1	0	1	1	0	0	0	0	0	2	2	1	
Chaetachme aristata	43	1	1	1	0	0	1	1	0	0	1	2	0	0	1	1	1	0	1	
Ficus capensis	50	3	2	2	2	0	2	1	3	1	2	1	0	3	0	3	2	0	1	
Ficus ingens	55	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	
Ficus natelensis	57	0	1	3	1	0	0	1	2	1	3	1	0	1	0	0	0	0	1	
Faurea saligna	75	0	0	0	0	2	1	1	0	0	0	0	0	0	0	0	1	2	1	
Faurea speciosa	76	0	0	0	1	2	1	1	0	1	0	0	0	0	0	0	1	2	1	
Ximenia caffra	103	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	2	0	2	
Annona senegalensis	105	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	1	
Xylopia odoratissima	110	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	3	0	
Xymalos monospora	111	0	2	2	1	0	1	1	0	1	2	1	0	0	3	0	1	0	1	
Cryptocarya liebertiana	114	3	2	1	1	0	2	0	0	1	1	3	1	2	1	1	2	0	0	
Pittosporum viridiflorum	139	0	0	0	1	2	2	2	0	1	0	0	0	0	0	0	2	2	2	
Parinari curatellifolia	146	1	0	0	0	2	0	1	0	0	0	1	0	0	0	0	0	2	1	
Acacia ataxacantha	160	0	0	0	0	3	2	2	0	0	0	0	0	0	0	0	2	3	2	
Acacia karoo	172	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	3	
Dichrostachys cinerea	190	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	
Bauhinia galpinii	208,2	0	0	0	0	2	1	1	0	0	0	0	0	0	0	0	1	2	1	
Peltophorum africanum	215	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	3	0	
Dalbergia armata	231	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	Creeper
Dalbergia sp.	-	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	
Erythrina lysistemon	245	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	
Fagara capensis	249	1	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	
Calodendrum capense	256	1	2	0	0	0	0	0	0	0	0	1	0	0	3	0	0	0	0	
Oricia bachmannii	257	0	1	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	
Teclea natalensis	264	0	0	1	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	
Clausena anisata	265	0	1	0	1	1	1	1	0	1	0	0	1	0	0	0	1	1	1	
Ekebergia capensis	298	1	2	1	2	1	2	1	0	2	1	0	2	0	1	0	2	1	1	

See Figure 45 for Key to Areas

Figure 43: Continued

SPECIES	Tree List No.	ABUNDANCE – SAMPLING AREAS							ABUNDANCE – VEGATATIONAL ZONES											NOTES
		LK I	LK II	UK I	UK II	FR	F II	RB	UKS	UKF	PF	MF	DMF	SB	T	FF	F II	FR	RB	
Ekebergia pterophylla	299	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	
Trichilia emetica	301	3	4	2	1	0	2	1	0	1	2	4	1	0	2	0	2	0	1	
Drypetes gerrardii	314	1	4	2	2	1	1	0	0	2	4	4	1	0	2	0	1	1	0	
Antidesma venosum	318	1	0	0	0	2	1	1	0	0	0	1	0	0	0	0	1	2	1	
Bridelia micrantha	324	3	2	0	0	0	2	1	0	0	0	3	1	0	2	2	2	0	1	
Croton sylvaticus	330	2	3	1	0	0	1	0	0	0	0	3	1	0	0	0	1	0	0	
Euphorbia ingens	351	0	1	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	
Sclerocarya caffra	360	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	
Harpephyllum caffrum	361	2	3	1	1	0	0	0	0	1	1	3	2	0	2	0	1	0	1	
Lannea discolor	362	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	
Protorhus longifolia	364	1	3	1	2	0	1	1	0	2	1	3	1	0	2	0	1	0	1	
Rhus chirendensis	380	2	1	2	0	1	1	0	0	0	1	2	1	1	0	1	0	1	0	
Ilex mitis	397	1	0	3	4	0	-	0	2	4	3	0	0	1	0	0	0	0	0	
Maytenus heterophylla	399	0	3	0	0	0	0	0	0	0	0	2	3	0	1	0	0	0	0	
Catha edulis	404	0	0	0	0	3	2	2	0	0	0	0	0	0	0	0	2	3	2	
Apodytes dimidiata	422	2	0	0	0	3	2	1	0	0	0	1	0	0	0	0	2	3	1	
Pappea capensis	433	0	0	0	2	0	0	0	0	2	0	0	0	0	0	0	0	0	0	
Bersama Transvaalensis	442	1	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	1	
Ziziphus mucronata	447	1	0	0	0	0	2	2	0	0	0	1	0	0	0	0	2	0	2	
Rhoicissus rhomboidea	456,4	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	Creeper
Rhoicissus tomentosa	456,5	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	Creeper
Rhoicissus tridentata	456,6	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	Creeper
Dombeya rotundifolia	471	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	
Ochna arborea	482	0	0	1	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	
Ochna holstii	480	2	3	1	1	0	1	1	0	1	1	3	4	0	1	0	1	0	1	
Rawsonia lucida	491	0	3	21	0	0	0	0	0	1	1	3	3	0	2	0	0	0	0	
Kiggeleria africana	494	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	
Combretum molle	537	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	3	0	
Combretum kraussii	540	1	0	0	3	0	0	0	0	4	0	1	0	0	0	0	0	0	0	
Combretum sp.	-	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	Creeper
Eugenia capensis	553,2	2	0	0	2	0	0	0	0	3	0	0	0	1	0	1	0	0	0	
Eugenia sp.	-	-	2	2	0	2	0	0	0	0	3	0	2	0	1	0	1	0	0	
Sizigium cordatum	555	3	3	3	3	0	3	3	4	1	3	0	0	4	0	3	2	0	1	
Syzigium guineense	557	2	2	0	2	0	2	1	0	3	3	2	2	0	0	0	2	0	1	
Heteropyxis natalensis	455	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	3	0	

See Figure 45 for Key to Areas

Figure 43: Continued

SPECIES	Tree List No.	ABUNDANCE – SAMPLING AREAS							ABUNDANCE – VEGATATIONAL ZONES											NOTES
		LK I	LK II	UK I	UK II	FR	F II	RB	UKS	UKF	PF	MF	DMF	SB	T	FF	F II	FR	RB	
Ekebergia pterophylla	299	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	
Trichilia emetica	301	3	4	2	1	0	2	1	0	1	2	4	1	0	2	0	2	0	1	
Drypetes gerrardii	314	1	4	2	2	1	1	0	0	2	4	4	1	0	2	0	1	1	0	
Antidesma venosum	318	1	0	0	0	2	1	1	0	0	0	1	0	0	0	0	1	2	1	
Bridelia micrantha	324	3	2	0	0	0	2	1	0	0	0	3	1	0	2	2	2	0	1	
Croton sylvaticus	330	2	3	1	0	0	1	0	0	0	0	3	1	0	0	0	1	0	0	
Euphorbia ingens	351	0	1	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	
Sclerocarya caffra	360	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	
Harpephyllum caffrum	361	2	3	1	1	0	0	0	0	1	1	3	2	0	2	0	1	0	1	
Lannea discolor	362	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	
Protorhus longifolia	364	1	3	1	2	0	1	1	0	2	1	3	1	0	2	0	1	0	1	
Rhus chirendensis	380	2	1	2	0	1	1	0	0	0	1	2	1	1	0	1	0	1	0	
Ilex mitis	397	1	0	3	4	0	-	0	2	4	3	0	0	1	0	0	0	0	0	
Maytenus heterophylla	399	0	3	0	0	0	0	0	0	0	0	2	3	0	1	0	0	0	0	
Catha edulis	404	0	0	0	0	3	2	2	0	0	0	0	0	0	0	0	2	3	2	
Apodytes dimidiata	422	2	0	0	0	3	2	1	0	0	0	1	0	0	0	0	2	3	1	
Pappea capensis	433	0	0	0	2	0	0	0	0	2	0	0	0	0	0	0	0	0	0	
Bersama Transvaalensis	442	1	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	1	
Ziziphus mucronata	447	1	0	0	0	0	2	2	0	0	0	1	0	0	0	0	2	0	2	
Rhoicissus rhomboidea	456,4	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	Creeper
Rhoicissus tomentosa	456,5	c	c	c	c	c	c	c	c	c	c	c	c	c	c.	c	c	c	c	Creeper
Rhoicissus tridentata	456,6	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	Creeper
Dombeya rotundifolia	471	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	
Ochna arborea	482	0	0	1	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	
Ochna holstii	480	2	3	1	1	0	1	1	0	1	1	3	4	0	1	0	1	0	1	
Rawsonia lucida	491	0	3	21	0	0	0	0	0	1	1	3	3	0	2	0	0	0	0	
Kiggeleria africana	494	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	
Combretum molle	537	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	3	0	
Combretum kraussii	540	1	0	0	3	0	0	0	0	4	0	1	0	0	0	0	0	0	0	
Combretum sp.	-	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	Creeper
Eugenia capensis	553,2	2	0	0	2	0	0	0	0	3	0	0	0	1	0	1	0	0	0	
Eugenia sp.	-	-	2	2	0	2	0	0	0	0	3	0	2	0	1	0	1	0	0	
Sizigium cordatum	555	3	3	3	3	0	3	3	4	1	3	0	0	4	0	3	2	0	1	
Syzigium guineense	557	2	2	0	2	0	2	1	0	3	3	2	2	0	0	0	2	0	1	
Heteropyxis natalensis	455	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	3	0	

See Figure 45 for Key to Areas

the survey on a large map of the study area. It should be noted that these communities are not considered as unique separate entities and they certainly do grade into one another.

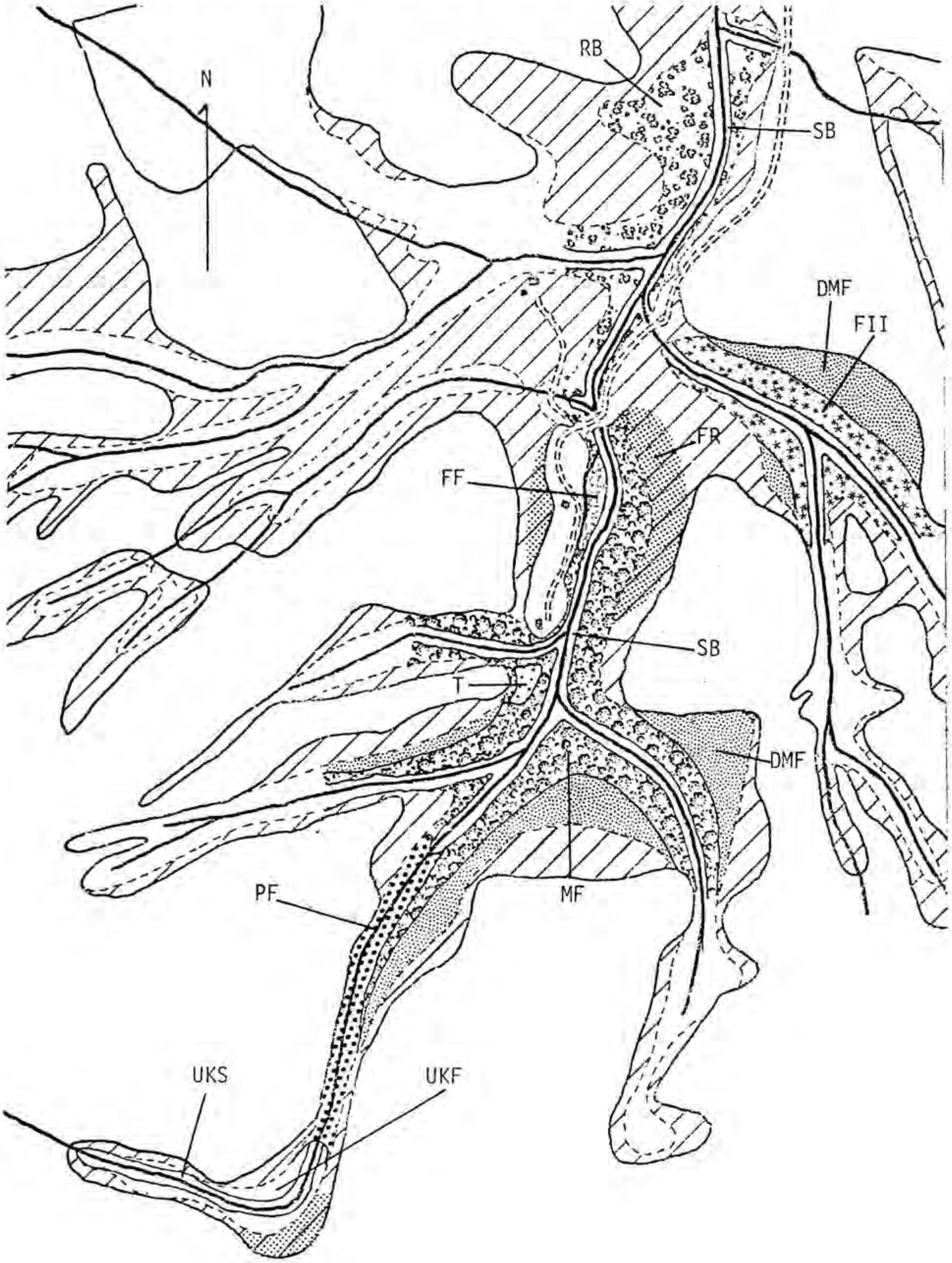
Figure 44 shows the approximate positions of the various vegetation zones or communities encountered and discerned using qualitative methods. The borders are not meant to have been drawn accurately - the sampling did not permit this. However, it does give a good idea of the vegetational complexity of the study area.

Figure 45 is a further treatment of the data presented in Figure 43. For each of the communities the species present are listed in order of abundance. Where more than one species appears under a given abundance rating it should be noted that they have been listed in S. A. Tree List order and the species must be considered as being of equal abundance.

DISCUSSION

While most botanists might be horrified by the methods employed to describe the vegetation of the study area, so far as this study was concerned, the results are adequate and the aims of undertaking such a survey have been largely acheived. The methods were rapid and it was possible from the data to produce a map which at least tells one what sort of vegetation grows where. Thus it is possible to say with reasonable certainty that a monkey in a given part of the habitat will be encountering a piece of vegetation of a certain type. The efficacy of this approach is perhaps amplified by comparing the type of data obtained, with those which would have been obtained had transect or classical quadrat methods been used. First, the survey would have taken far longer. Second, as illustrated by the work of Struhsaker (1974), a transect from which density data have been extracted, and which has been placed through representative communities gives only the average floristic composition of the forest. It ignores the fact that it is to individual trees or even to communities

Figure 44: Map showing Vegetation Zones present at Cyprus as determined by Extensive Qualitative Sampling Methods.



for key see facing page

Scale: 1cm = 94,1m.

Figure 45 Species Composition by Abundance at Cyprus for the Eleven Vegetational Zones

MAIN FOREST - MF		DRY MAIN FOREST-DMF		FOREST II		FRINGE		RIVERINE BUSH		FLOOD FOREST	
SPECIES	AB	SPECIES	AB	SPECIES	AB	SPECIES	AB	SPECIES	AB	SPECIES	AB
Trichilia emetica	4	*Ochna holstii*	4	*Cussonia spicata*	3	*Xylopia odoratissima*	4	*Acacia karoo*	3	*Rauvolfia caffra*	5
Drypetes gerrardii		*Maytenus heterophylla*	3	*Bequaertidendron mag.*		*Acacia ataxacantha*		*Schefflera umbellifera*		*Ficus capensis*	3
Podocarpus falcatus	3	*Rawsonia lucida*		*Trema orientalis*	2	*Peltophorum africanum*		*Nuxia floribunda*		*Syzigium cordatum*	
Cryptocarya liebertiana		*Bequaertidendron mag.*		*Ficus capensis*		*Catha edulis*		*Ximenia caffra*	2	*Halleria lucida*	
Bridelia micrantha		*Gardenia amoena*		*Ximenia caffra*		*Apodytes dimidiata*		*Pittosporum viridiflorum*		*Celtis africana*	
Croton sylvaticus		*Rothmannia capensis*		*Cryptocarya liebertiana*		*Combretum molle*		*Acacia ataxacantha*		*Bridelia micrantha*	2
Harpephyllum caffrum		*Ekebergia capensis*	2	*Pittosporum viridiflorum*		*Heteropyxis natalensis*		*Catha edulis*		*Cussonia spicata*	
Protorhus longifolia		*Harpephyllum caffrum*		*Acacia ataxacatha*		*Bequaertidendron mag.*		*Ziziphus mucronata*		*Bequaertidendron mag.*	
Ochna holstii		*Syzigium guineense*		*Ekebergia capensis*		*Trema orientalis*	2	*Rapanea melanophloeos*		*Mimusops zeyheri*	
Rawsonia lucida		*Schefflera umbellifera*		*Trichicia emetica*		*Faurea saligna*		*Bequaertidendron mag.*		*Anthocleista grandifolia*	
Cussonia spicata		*Rapanea melanophloeos*		*Bridelia micrantha*		*Faurea speciosa*		*Mimusops zeyheri*		*Chaetachme aristata*	1
Bequaertdendron mag.		*Mimusops zeyheri*		*Apodytes dimidiata*		*Pittosporum viridiflorum*		*Nuxia congesta*		*Cryptocarya liebertiana*	
Mimusops zeyheri		*Strychnos henningsii*		*Catha edulis*		*Parinari curatellifolia*		*Brachylaena discolor*		*Rhus chirendensis*	
Celtis africana	2	*Strychnos usambarensis*		*Ziziphus mucronata*		*Bauhinia galpinii*		*Celtis africana*	1	*Eugenia capensis*	
Chaetachme aristata		*Oxyanthus speciosa*		*Syzigium cordatum*		*Dalbergia sp.*		*Trema orientalis*		*Eugenia sp*	
Rhus chirendensis		*Brachlaena discolor*		*Syzigium guineense*		*Antidesma venosum*		*Ficus capensis*		*Oxyanthus speciosus*	
Maytenus heterophylla		*Podocarpus falcatus*	1	*Scheflera umbellifera*		*Dombeya rotundifolia*		*Chaetachme aristata*		*Brachylaena discolor*	
Eugenia sp		*Celtis africana*		*Rapanea melanophloeos*		*Rapanea melanophloeos*		*Ficus natalensis*		17 SPECIES	
Syzygium guineense		*Cryptocarya liebertiana*		*Mimusops zeyheri*		*Brachylaena discolor*		*Faurea saligna*			
Schefflera umbellifera		*Oricia bachmannii*		*Anthocleista grandiflora*		*Celtis africana*	1	*Faurea speciosa*			
Oxyanthus speciosus		*Teclea natalensis*		*Brachylaena discolor*		*Ficus ingens*		*Annona senegalensis*			
Brachylaena discolor		*Clausena anisata*		*Podocarpus falcatus*	1	*Annona senegalensis*		*Xymalos monospora*			
Ficus capensis	1	*Trichilia emetica*		*Celtis africana*		*Clausena anisata*		*Parinari curatellifolia*			
Ficus natalensis		*Drypetes gerrardii*		*Chaetachme aristata*		*Ekebergia capensis*		*Dichrostachys cinerea*			
Xymalos monospora		*Bridelia micrantha*		*Faurea saligna*		*Drypetes gerrardii*		*Bauhinia galpinii*			
Parinari curatellifolia		*Croton sylvaticus*		*Faurea speciosa*		*Lannea discolor*		*Erythrina lysistemon*			
Fagara capensis		*Protohus longifolia*		*Xymalos monospora*		*Rhus chirendensis*		*Clausena anisata*			
Calodendrum capense		*Rhus chirendensis*		*Bauhinia galpinii*		*Mimusops zeyheri*		*Ekebergia capensis*			
Oricia bachmannii		*Cussonia spicata*		*Clausena anisata*		*Strychnos madagascariensis*		*Trichicia emetica*			
Teclea natalensis		*Mimusops obovata*		*Drypetes gerrardii*		*Carissa bispinosa*		*Antidesma venosum*			
Antidesma venosum		30 SPECIES		*Antidesma venosum*		*Gardenia amoena*		*Bridelia micrantha*			
Euphorbia ingens				*Croton sylvaticus*		31 SPECIES		*Sclerocarya caffra*			
Apodytes dimidiata				*Harpephyllum caffrum*				*Harpephyllum caffrum*			
Ziziphus mucronata				*Rhus chirendensis*				*Protorhus longifolia*			
Kiggeleria africana				*Ochna holstii*				*Apodytes dimidiata*			
Combretum kraussii				*Maesa lanceolata*				*Bersama transvaalensis*			
Curtisia dentata				*Carissa bispinosa*				*Ochna holstii*			
Mimusops obovata				*Oxyanthus speciosus*				*Syzigium cordatum*			
Euclea natalensis				*Canthium inerme*				*Syzigium guineense*			
Strychnos henningsii				39 SPECIES				*Cussonia spicata*			
Strychnos usambarensis								*Anthocleista grandiflora*			
Anthocleista grandiflora								*Carissa bispinosa*			
Clerodendrum glabrum								*Carissa edulis*			
Gardenia amoena								*Canthium inerme*			
Rothmannia capensis								43 SPECIES			
Canthium inerme											
46 SPECIES											

NOTE: AB = Abundance

NOTE: Bequaertidendron mag. = Bequaertidendron magalismontanum

Figure 45: Continued

TERRACES		STREAMBED		UPPER KLOOF STREAM		UPPER KLOOF FOREST		POORT	
SPECIES	AB	SPECIES	AB	SPECIES	AB	SPECIES	AB	SPECIES	AB
Xymalos monospora	3	*Syzigium cordatum*	4	*Syzigium cordatum*	4	*Ilex mitis*	4	*Mimusops obovata*	4
Calodendrum capense		*Ficus capensis*	3	*Podocarpus latifolius*	3	*Combretum kraussii*		*Ficus natalensis*	3
Podocarpus falcatus		*Anthocleista grandiflora*		*Ficus capensis*		*Curtisia dentata*		*Ilex mitis*	
Trichilia emetica	2	*Breonadia microcephala*		*Breonadia microcephala*		*Eugenia capensis*	3	*Syzigium cordatum*	
Drypetes gerrardii		*Cryptocarya liebertiana*	2	*Ficus natalensis*	2	*Eugenia sp.*		*Syzigium guineense*	
Bridelia micrantha		*Ilex mitis*		*Ilex mitis*		*Syzigium guineense*		*Bequaertidendron mag.*	
Harpephyllum caffrum		*Bequaertidendron mag.*		*Maesa lanceolata*		*Cussonia spicata*		*Strychnos henningsii*	
Protorhus longifolia		*Podocarpus falcatus*	1	*Celtis africana*	1	*Schefflera umbellifera*		*Ficus capensis*	2
Rawsonia lucida		*Celtis africana*		*Bersama transvaalensis*		*Rapanea melanophloeos*		*Xymalos monospora*	
Bequaertidendron mag.		*Ficus natalensis*		*Bequaertidendron mag.*		*Bequaertidendron mag.*		*Trichicia Emetica*	
Mimusops zeyheri		*Rhus chirendensis*				*Psychotria capensis*		*Drypetes gerrardii*	
Euclea natalensis		*Eugenia capensis*				*Ficus capensis*	2	*Schefflera umbellifera*	
Celtis africana		*Eugenia sp.*				*Xymalos monospora*		*Clerodendrum glabrum*	
Chaetachme aristata						*Trichilia emetica*		*Rothmannia capensis*	
Cryptocarya liebertiana						*Drypetes gerrardii*		*Oxyanthus speciosus*	
Oricia bachmannii						*Protorhus longifolia*		*Podocarpus latifolius*	1
Ekebergia capensis						*Pappea capensis*		*Celtis africana*	
Maytenus heterophylla						*Mimusops obovata*		*Trema orientalis*	
Ochna holstii						*Diospyros whyteana*		*Chaetachma anisata*	
Cussonia spicata						*Halleria lucida*		*Cryptocarya lieberitiana*	
Schefflera umbellifera						*Brachylaena discolor*		*Teclea natalensis*	
Rapanea melanophloeos						*Podocarpus falcatus*	1	*Ekebergia capensis*	
						Podocarpus latifolius		*Euphorbia ingens*	
						Trema orientalis		*Harpephyllum caffrum*	
						Ficus capensis		*Protorhus longifolia*	
						Ficus natalensis		*Rhus chirendensis*	
						Faurea speciosa		*Ochna arborea*	
						Xymalos monospora		*Ochna holstii*	
						Cryptocarya liebertiana		*Rawsonia lucida*	
						Pittosporum viridiflorum		*Cussonia spicata*	
						Fagara capensis		*Rapanea melanophloeos*	
						Clausena anisata		*Mimusops zeyheri*	
						Ekebergia pterophylla		*Strychnos usambarensis*	
						Harpephyllum caffra		*Breonadia microcephala*	
						Ochna arborea		*Canthium inerme*	
						Ochna holstii		*Pavetta lanceolata*	
						Rawsonia lucida			
						Syzigium cordatum			
						Mimusops zeyheri			
						Rothmannia capensis			
						Canthium inerme			
22 SPECIES		13 SPECIES		10 SPECIES		41 SPECIES		37 SPECIES	

that the animals are responding and not to elegant looking density figures. It is thus essential not to ignore the fact that individuals of a species of food plant are not homogenously distributed throughout a home range and that in certain cases it may be possible to discern distinct communities which have floristic and physiognomic characters of their own.

Using the methods outlined here, eleven distinct communities have been described. In three cases, Flood Forest, Stream Bed and Upper Kloof Stream Bed, these appear to be typified by very few species. However, the reason for this soon becomes clear when the number of sample plots examined is noted (i.e. eight, seven and seven sample plots respectively). More plots should have been sampled retrospectively to check this.

One thing which must be noted about these data is that they give no indication of the dominant species found in a community. Dominants are botanically those species which contribute proportionately the most to the total biomass of the vegetation. Thus we get statements such as "the forest is of mixed dominance" and so on. From the point of view of this study it is not certain that such an enumeration is useful, especially if the monkeys respond to the trees as individuals, which, as will be discussed later, is a good possibility. However, discussing the communities only in terms of abundance does lead to apparent discrepancies. For instance, in the Stream Bed Community, Breonadia microcephala is physiognomically the most striking species but in terms of abundance it takes second place to Syzigium cordatum and appears as equally abundant with Ficus capensis and Anthocleista grandiflora.

The communities thus defined confirm the subdivisions suggested by initial physiognomic survey and which were described in chapter four.

In addition to Riverine Bush, Forest II, Stream Beds, Forest Fringe and Forest, the survey suggests that the community "Forest" can be further subdivided into the following zones;

(i) Drier parts of the Main Forest.

(ii) Main Forest.

(iii) Flood Forest.

(iv) Terrace Forest on the West Side of the Study Area

(v) Upper Kloof Forest.

(vi) Upper Kloof Stream Bed Forest.

(vii) Poort Forest.

The description here implies that one reason why correlations between forest compositions and monkey ranging have not been found may be due to a lack of detailed analysis of the supposition that average composition data reflects those characteristics of the forest to which the monkeys are responding.

CHAPTER EIGHT

THE PHENOLOGY OF FOOD PRODUCING PLANTS - THE SEASONALITY OF FOOD PRODUCTION

Introduction

In chapter seven the levels at which the forest varies as a food producer was discussed. The second of these was the phenological level, which recognises that while potentially food producing plants may be present in an area this does not guarantee that a particular plant will be producing palatable food at a given point in time. Thus, the study of the seasonality of food production and the production of phytophases is a highly legitimate one in a study such as this.

While phenology has been a relatively recent study to primatologists and primate ethologists, to plant ecologists, agrononomists and autecologists, it is far from new. Linnaeus (1751) outlined methods for compiling annual plant calendars of leaf opening, flowering, fruiting and leaf fall along with climatological observations "so as to show how areas differ". It was, however, Morren (1853) who first proposed that the name phenology be given to this field. In recent years the word has achieved a more general flavour as ecologists have taken up the study. Leith (1970) suggests the following definition "Phenology is generally described as the art of observing life cycle phases or activities of plants and animals in their temporal occurance throughout the year". In 1972 the US/IBP published the conclusions of an International Phenology Congress which gave the following as their definition of phenology. "Phenology is the study of recurring biological events, the causes of their timing with regard to biotic and abiotic forces and the interrelation among phases of the same or different species".

Thus, again, we have the situation that to different disciplines the field under study takes on different connotations. To the botanists, the field is one whereby vegetation can be classified and described or as information to be included in floras. To the agronomists phenology of crop species is a test to be used in prediction of when a certain crop should be sown in various places. To the ecologist it forms an important aspect of autecological studies in different areas so that they can be compared. The latter has become a huge field, with computer modelling and many sophisticated techniques involved, requiring co-ordination at a global level.

To the primate ethologist the aim of studying phenology of food producing species lies within that of the ecologist and at an intensive level. Having recognised that food source production is variable at a temporal, as well as, spatial level this must be studied as part of the description of the animal's habitat and if possible correlates between this and observable behaviour must be attempted.

Struhsaker (1974) in looking for variables affecting feeding behaviour ignored phenology, though recognised that this was an important variable. Waser & Floody (1974) also did not report having considered phenology of food plants in their description of mangabey ranging patterns. Clutton-Brock (1975) did not make a detailed description of the phenology of the tree species present at Gombe Stream, though he recognises that this would have been desirable "to interpret seasonal changes in the animal's feeding behaviour". He reports marked qualitative differences in the phenology of different species, some producing entire crops in a single month, while others had a spread production. He also reports that some species varied in time of production at different sites in the study area. While a detailed phenological description was not made a "visual estimate" of the proportion of thirty common species of tree which carried the various parts in a given month was made. The following criteria were used for this estimate. If more than 20% of a species individuals were estimated to be carrying a given part then that species was recorded as carrying that part. Species were recorded as "out of leaf" if more than 50% of trees did not carry leaves.

Hladik and Hladik (1972) record whether the food plants used by the three primate species under study carried fruit, flowers, leaves or flush during a given month. How this was achieved was not mentioned however.

Hall-Martin (1972) includes a description of the seasonality of availability of leaves, flowers and fruits at the Lengwe National Park based on methods used by Huntley (1970). He monitored at least twelve individuals of twenty species representative of four communities in the park, at weekly intervals. The presence of flowers (or buds), fruit and leaves was recorded. Dead and falling leaves were recorded as lost. Depending on the number of trees which exhibited a phytophase, a species was classified for abundance of the phytophase present. The classes used were 0 - 25%, 26 - 50%, 51 - 75%, and 76 - 100%.

Methods

(i) Introduction

In order to study the phenomenon of seasonality it was decided to select a number of individuals of important species and to visit them at fixed intervals noting the presence or absence of phytophases as well as in the case of fruit, the relative amounts produced, making comparisons within species.

Several constraints affected the choice of these individuals.

(a) There were several qualitatively distinct communities present in the areas inhabited by the monkeys (e.g. Forest Fringe, Stream Bed etc.) and individuals of each species had to be sampled in each community where they occurred.

(b) Individuals of the same species occupied localities of markedly different altitude. Clearly trees of the same species at differing altitudes had to be sampled, those at higher altitudes being expected to flower and fruit later.

(c) At the time of the study being set up, no data was available as to the distribution of species nor of the size structure of the populations in different areas. It was thus initially difficult to make sampling representative. Where more of a given species was present more individuals would have the same age structure as the population at large of that species. Without adequate distribution data to hand and with time at a premium (in order to be meaningful the study had to run as long as possible), trees were selected on the basis of the qualitative distribution data available at that time and described in chapter seven.

(d) In order to obtain as high a resolution of phytophase progression as possible so that the synchronicity of production could be determined and so that observer errors due to not observing leaf or flower buds etc., it was decided to sample the marked trees weekly. This meant that only a limited number of trees could be marked.

(e) A very large number of individual species were either present in large numbers and would therefore have to be sampled or though present in small numbers, were seen, from the literature to produce food items likely to have been palatable to the monkeys. The result of this was that over eighty species out of nearly one hundred and twenty qualified to be observed resulting in the fact that fewer individuals than would have been the ideal could be marked. The eventual total of trees marked was seven hundred and two and twenty-six species were eventually not marked but observed as populations in the same way that Clutton-Brock observed his trees.

(f) A number of species were found to be dioecious (e.g. Podocarpus spp. and Protorhus longifolia) and these it was decided to should be more intensively sampled as only 50% of individuals would, theoretically produce fruit.

(g) Fruits appeared to be the most preferred food source and so accent has been placed on trees and other plants producing drupes or other fleshy fruits.

(ii) Selection of individuals

The study area was divided into five zones which have been described and illustrated previously. Within each zone five individuals of each species were marked where present. Where there was more than one community within a zone, individuals were marked within all of these communities. In Lower Kloof I, Upper Kloof I and II individuals were marked in all parts of the zone. In Lower Kloof II and Fringe, the two largest, certain areas were not sampled due to inaccessibility.

Each tree marked was measured and the following parameters recorded:- Height; Height of first branch; Canopy Depth; Canopy Diameter along contour; Canopy Diameter normal to contour; Canopy Type and Leaf Form; Girth at Chest Height; Location; Exposure; Slope; Creeper infestation (species and percentage infestation)

In this way seven hundred and two trees of eighty-five species were marked with metal tags, bearing a number. The numbers of trees marked in each zone were as follows:-

LOWER KLOOF I	-	149
LOWER KLOOF II	-	174
UPPER KLOOF I	-	112
UPPER KLOOF II	-	150
FRINGE	-	117

In addition to the species for which individuals were specifically marked twenty-seven species were observed, but not marked individually. Observations were made by the same method as used by Clutton-Brock (1975) and the results have been presented separately. This group included species which were impossible to mark (e.g. Creepers, Herbs and Small Shrubs).

(iii) Observation procedures

Individual trees were scored for the presence or absence of the following phytophases and conditions:- Mature Leaves; New Leaves; Leaf Buds; Turning and Falling Leaves; Flower Buds; Open Flowers; Moribund Flowers; Setting Fruit; Unripe fruit; Ripe fruit; Unripened Fruit; Caterpillar Damage.

Figure 46: Scale used to Score Fruiting Trees for Crop Productivity.

1	ONE OR TWO FRUIT SEEN
2	INDIVIDUAL OR SMALL BUNCHES OF FRUIT SEEN ON SEPARATE ADAPTIVE UNITS
3	SOME FRUIT SEEN - INDIVIDUAL FRUIT OR SMALL BUNCHES SEEN ON MORE THAN TEN ADAPTIVE UNITS
4	ABUNDANT - TREE WELL STOCKED WITH FRUIT
5	HEAVY CROP - BRANCHES OF THE TREE WEIGHED DOWN WITH FRUIT ON ALL ADAPTIVE UNITS.

The unmarked species were similarly scored, but if 20% of the population of a species were estimated to bear a given phytophase in a given zone then the phytophase was scored.

Each individual was scanned for approximately one minute using 7 x 50 binoculars. The scanning was done where possible from a distance to one side of the tree so that the top of the canopy, where most phytophases occured, could be seen.

The trees were visited weekly. The survey usually took two days and the survey was done during the week when suitable weather became available. When there was low cloud over the study area the survey was not attempted until it cleared as the visibility was extremely poor under these conditons in the forest.

On certain occasions surveys were missed and in these circumstances a survey was made immediately on return and the survey missed made up by extrapolation.

Additional data on crop abundance for fruit was collected where fruit was present. Figure 46 illustrates the scale used to describe the abundance.

Results

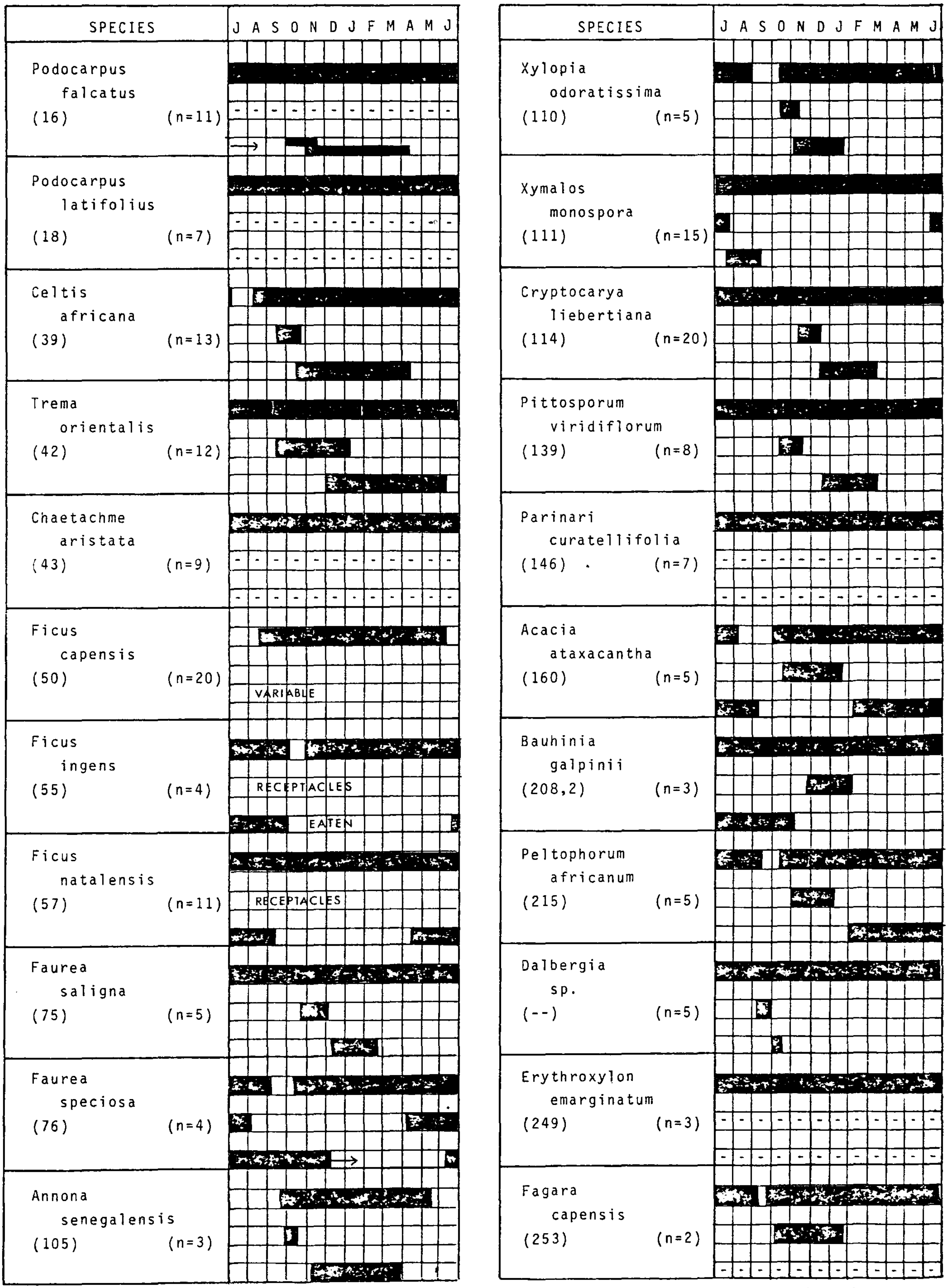
Figure 47 is a species by species summary of phenological events taken from a much larger table, which was impossible to publish here. Figure 48 shows what percentage of marked species were in fruit, flower or leaf during two weekly periods during the course of one year. Figure 49 examines the degree of synchronicity of phytophase production. The degree of synchronicity is expressed in terms of the time within which all the individuals producing a given phytophase actually produced them. In cases where less than five individuals produced a given phytophase in the sample synchronicity was not determined.

Discussion

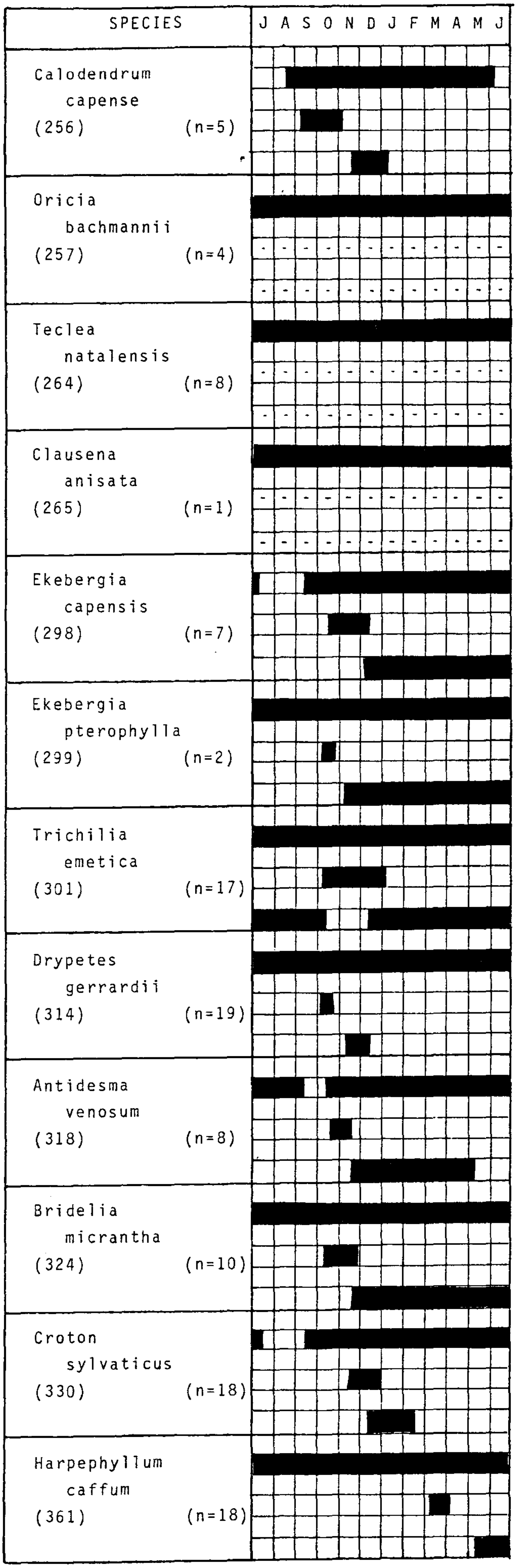
As suggested earlier at an individual level considerable variability in phytophase production was discovered. It was, however, a pity that the study

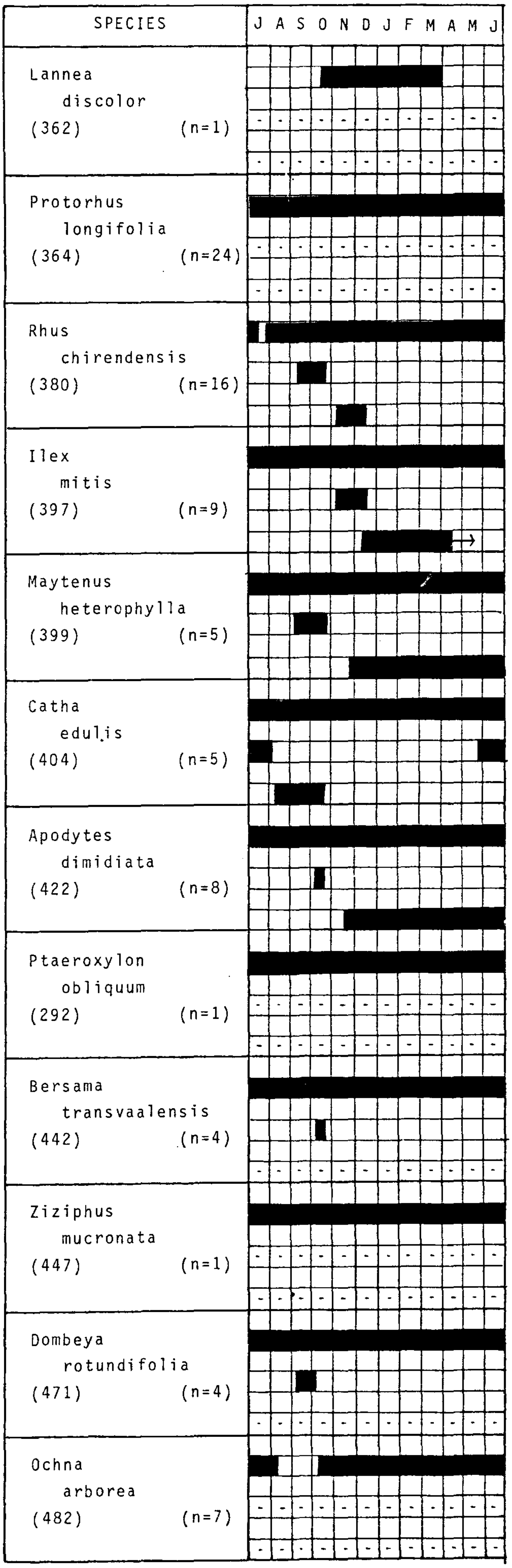
Figure 47: Phenology Summary for Marked and Unmarked Species.

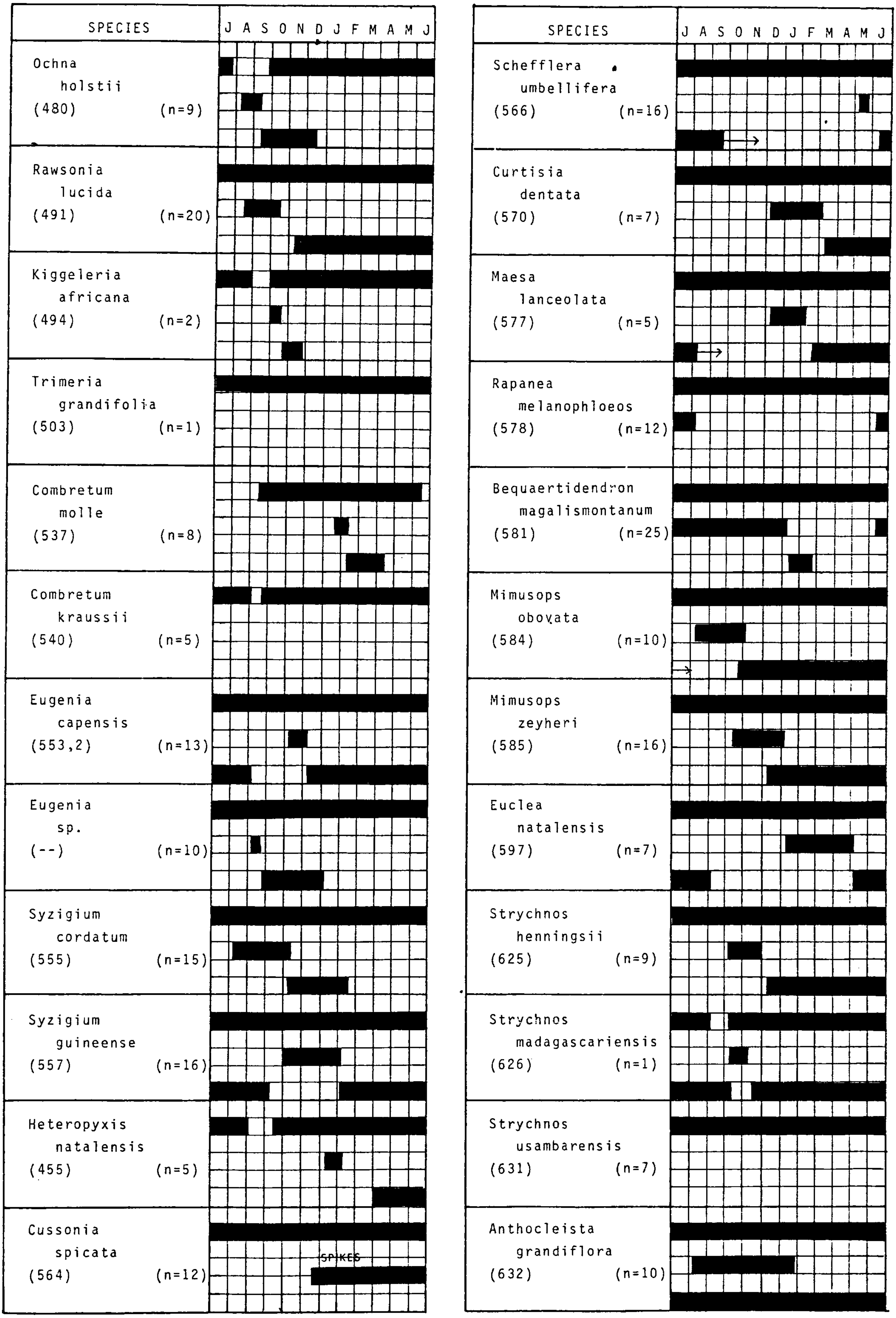
A: MARKED SPECIES

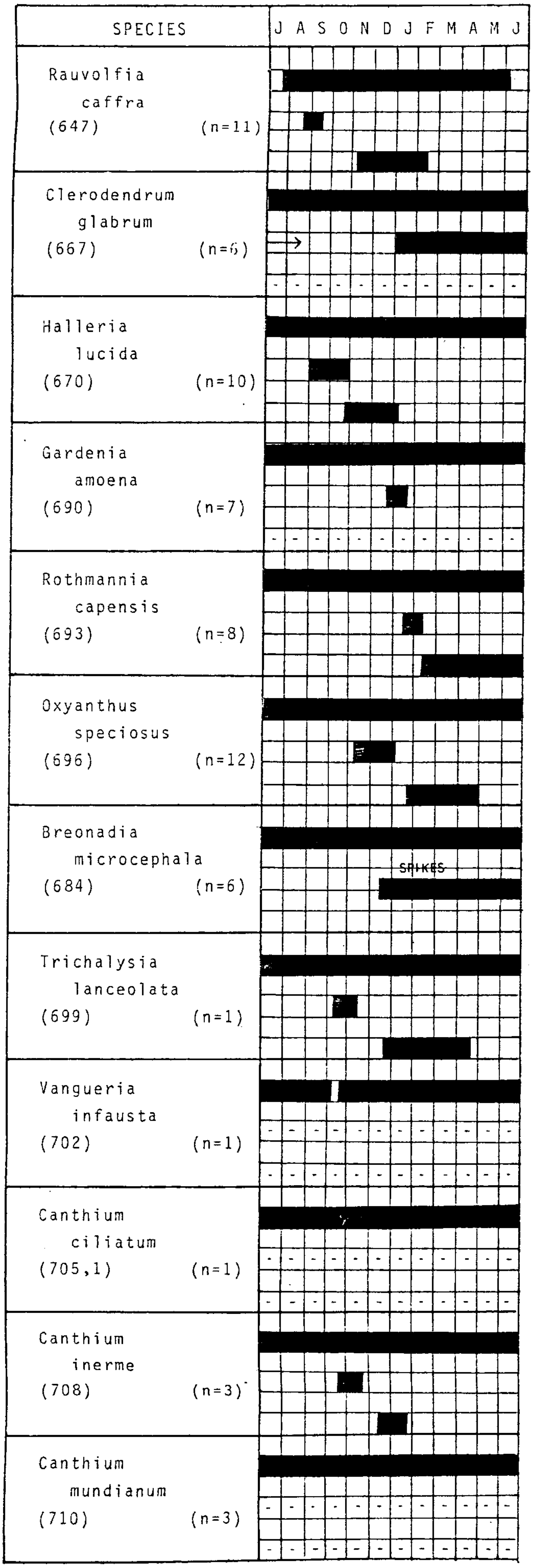


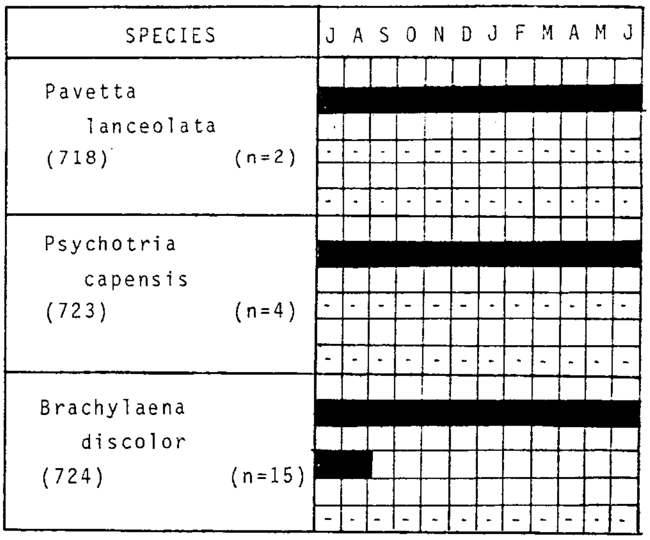
KEY: Row 1 = Presence of Leaves; Row 2 = Presence of Flowers; Row 3 = Presence of Fruit


SPECIES
J A S O N D J F M A M J
Calodendrum capense (256) (n=5)
Oricia bachmannii (257) (n=4)
Teclea natalensis (264) (n=8)
Clausena anisata (265) (n=1)
Ekebergia capensis (298) (n=7)
Ekebergia pterophylla (299) (n=2)
Trichilia emetica (301) (n=17)
Drypetes gerrardii (314) (n=19)
Antidesma venosum (318) (n=8)
Bridelia micrantha (324) (n=10)
Croton sylvaticus (330) (n=18)
Harpephyllum caffum (361) (n=18)

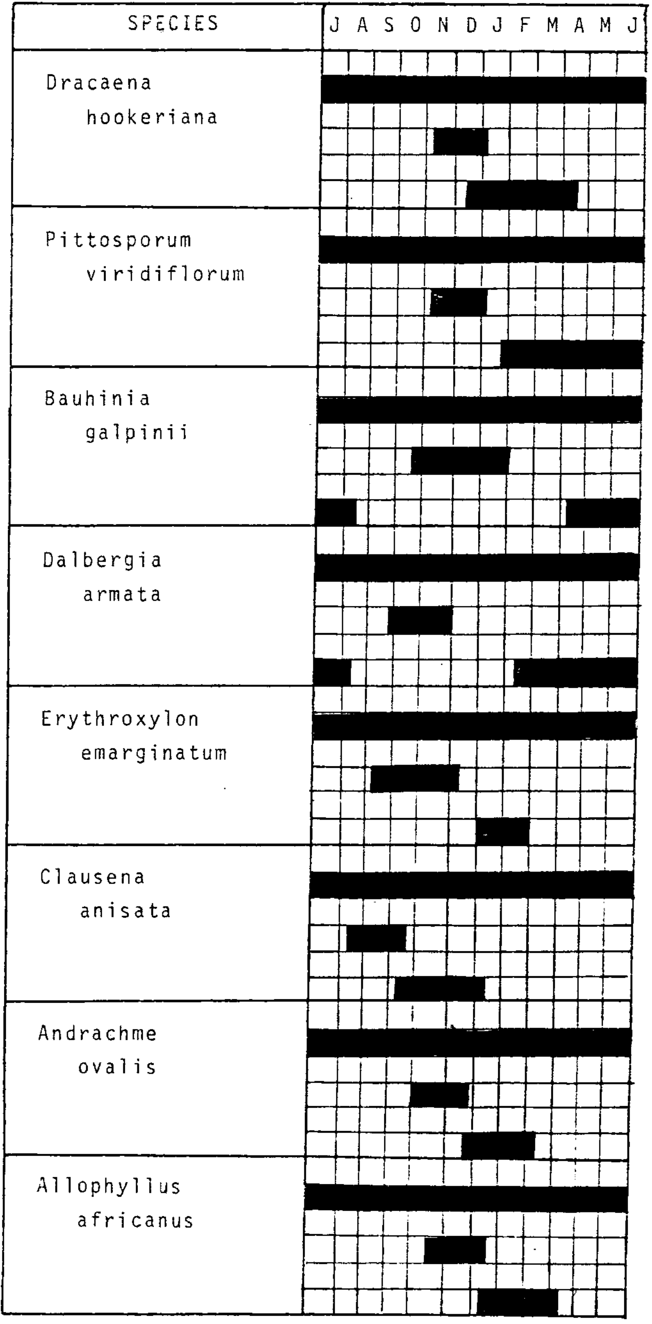

SPECIES
J A S O N D J F M A M J
Lannea discolor (362) (n=1)
Protorhus longifolia (364) (n=24)
Rhus chirendensis (380) (n=16)
Ilex mitis (397) (n=9)
Maytenus heterophylla (399) (n=5)
Catha edulis (404) (n=5)
Apodytes dimidiata (422) (n=8)
Ptaeroxylon obliquum (292) (n=1)
Bersama transvaalensis (442) (n=4)
Ziziphus mucronata (447) (n=1)
Dombeya rotundifolia (471) (n=4)
Ochna arborea (482) (n=7)

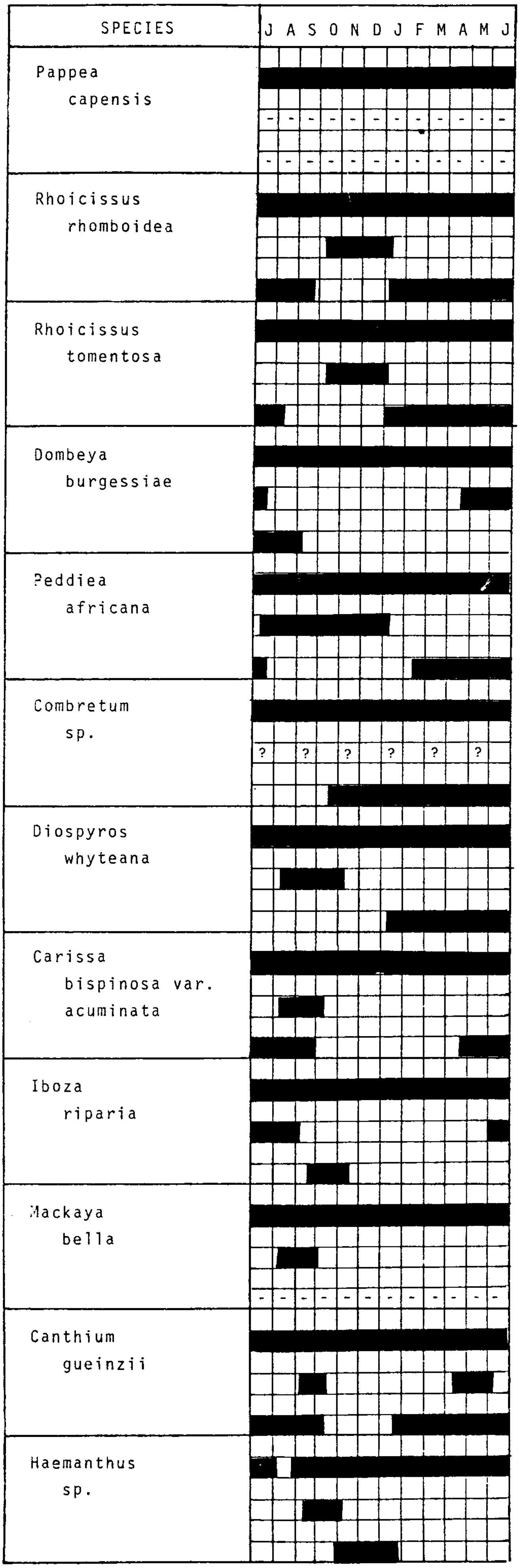

SPECIES
J A S O N D J F M A M J
Ochna holstii (480) (n=9)
Rawsonia lucida (491) (n=20)
Kiggeleria africana (494) (n=2)
Trimeria grandifolia (503) (n=1)
Combretum molle (537) (n=8)
Combretum kraussii (540) (n=5)
Eugenia capensis (553,2) (n=13)
Eugenia sp. (--) (n=10)
Syzigium cordatum (555) (n=15)
Syzigium guineense (557) (n=16)
Heteropyxis natalensis (455) (n=5)
Cussonia spicata (564) (n=12)
SPIKES
SPECIES
J A S O N D J F M A M J
Schefflera umbellifera (566) (n=16)
Curtisia dentata (570) (n=7)
Maesa lanceolata (577) (n=5)
Rapanea melanophloeos (578) (n=12)
Bequaertidendron magalismontanum (581) (n=25)
Mimusops obovata (584) (n=10)
Mimusops zeyheri (585) (n=16)
Euclea natalensis (597) (n=7)
Strychnos henningsii (625) (n=9)
Strychnos madagascariensis (626) (n=1)
Strychnos usambarensis (631) (n=7)
Anthocleista grandiflora (632) (n=10)





B: UNMARKED SPECIES




SPECIES
J A S O N D J F M A M J
Pappea capensis
Rhoicissus rhomboidea
Rhoicissus tomentosa
Dombeya burgessiae
Peddiea africana
Combretum sp.
? ? ? ? ? ?
Diospyros whyteana
Carissa bispinosa var. acuminata
Iboza riparia
Mackaya bella
Canthium gueinzii
Haemanthus sp.

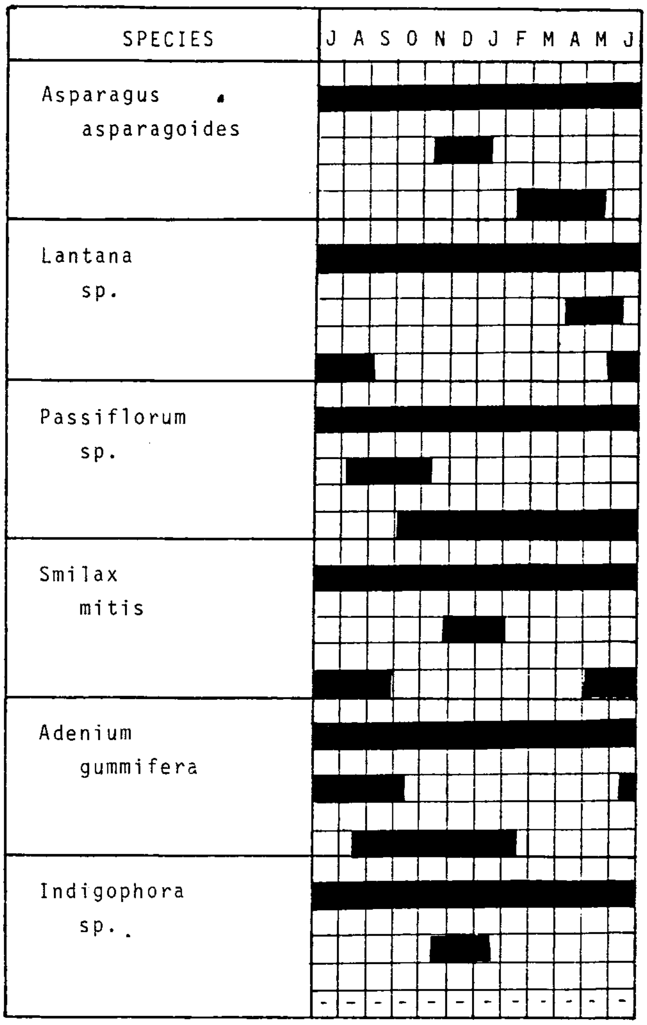

SPECIES
J A S O N D J F M A M J
Asparagus asparagoides
Lantana sp.
Passiflorum sp.
Smilax mitis
Adenium gummifera
Indigophora sp.

Figure 48: Percentage of Marked Species' Individuals in Fruit, Flower and Leaf for Given Periods.

PERIOD	% OF MARKED SPECIES		
	IN LEAF	FLOWERING	IN FRUIT
JUL 1 - JUL 15	79/85 = 93%	5/85 = 6%	12/85 = 14%
JUL 16 - JUL 31	75/85 = 88%	4/85 = 5%	13/85 = 15%
AUG 1 - AUG 15	75/85 = 88%	3/85 = 3%	14/85 = 16%
AUG 16 - AUG 31	77/85 = 90%	8/85 = 9%	14/85 = 16%
SEP 1 - SEP 15	70/85 = 82%	11/85 = 13%	14/85 = 16%
SEP 16 - SEP 30	74/85 = 87%	14/85 = 16%	10/85 = 8,5%
OCT 1 - OCT 15	77/85 = 90%	22/85 = 26%	11/85 = 13%
OCT 16 - OCT 31	84/85 = 98%	25/85 = 29%	11/85 = 13%
NOV 1 - NOV 15	85/85 = 100%	23/85 = 27%	16/85 = 19%
NOV 16 - NOV 30	85/85 = 100%	20/85 = 23%	19/85 = 22%
DEC 1 - DEC 15	85/85 = 100%	15/85 = 18%	23/85 = 27%
DEC 16 - DEC 31	85/85 = 100%	14/85 = 16%	30/85 = 35%
JAN 1 - JAN 15	85/85 = 100%	13/85 = 15%	28/85 = 33%
JAN 16 - JAN 31	85/85 = 100%	12/85 = 14%	27/85 = 32%
FEB 1 - FEB 14	85/85 = 100%	10/85 = 8%	31/85 = 36%
FEB 15 - FEB 28	85/85 = 100%	4/85 = 5%	31/85 = 36%
MAR 1 - MAR 15	85/85 = 100%	6/85 = 7%	29/85 = 34%
MAR 16 - MAR 31	85/85 = 100%	6/85 = 7%	28/85 = 33%
APR 1 - APR 15	84/85 = 98%	6/85 = 7%	27/85 = 32%
APR 16 - APR 30	84/85 = 98%	4/85 = 5%	19/85 = 22%
MAY 1 - MAY 15	84/85 = 98%	5/85 = 6%	22/85 = 26%
MAY 16 - MAY 31	83/85 = 97%	5/85 = 6%	21/85 = 25%
JUN 1 - JUN 15	82/85 = 96%	4/85 = 6%	21/85 = 25%
JUN 16 - JUN 31	80/85 = 94%	7/85 = 8%	22/85 = 26%

21/85 = 24% did not flower during the study
27/85 = 32% did not produce fruit during the study

Figure 49: Synchronicity of Phytophase Production by Species

SPECIES	No. Marked	No Producing New Leaves	No Producing Flowers	No Producing Fruit	Degree of Synchronicity Leaves						Degree of Synchronicity Flowers						Degree of Synchronicity Fruit						NOTES
					1 wk	2 wk	3 wk	4 wk	5 wk	5 wk +	1 wk	2 wk	3 wk	4 wk	5 wk	5 wk +	1 wk	2 wk	3 wk	4 wk	5 wk	5 wk +	
Podocarpus falcatus (16)	11 (♀ = 6 ; ♂=4)	11	♂ = 3 ♀ = 6	♂ = 0 ♀ = ?	5	6	9	11			♂ = 3/4 ♀ = 0						♂ = 0 ♀ = ?						♂ - 3/4 Produced catkins within 1 week - one did not produce ♀ - Flowers not observed Fruit:- more variable - Dependent on visibility and producivity - higher produtivity indivs noted earlier
Podocarpus latifolius (18)	7	7	0	0	3	5	6	6	7		-	-	-	-	-	-	-	-	-	-	-	-	No individuals were seen to produce fruit or flowers
Celtis africana (39)	13	13	13	13	4	7	9	10	10	13 (8 wk)	4	8	11	12	13	-	9	12	13				10 Indivis produced new leaves within 4 wk of each other. Of remaining 3 - 2 were in the Fringe & UK respectively // Fruit onset =presence of green fruit - 2 mm in size
Trema orientalis (42)	12	12	12	10	12 (8 wk)						3	6	8	9	10	12 (8 wk)	2	3	3	4	5	10 (16 wk)	All indivs appeared to produce new leaves at all times Onset of fruit v. irregular (from Oct 23 - Sept 5). Both fringe trees early (30 Oct). 2 Trees did not fruit.
Chaetachme aristata (43)	9	9	0	0	3	3	3	3	4	9 (13 wk)	-	-	-	-	-	-	-	-	-	-	-	-	All trees in UK produced new leaves approx 1 month before those in LK. No flowers or fruit produced during study.
Ficus capensis (50)	20	20*	- 13	13	6	7	8	10	12	31 (25 wk)	Flowers =Fruit (Receptacles)						Variable/ Sept. & Apr. - Drainage apparently affecting onset - the wetter the earlier - 7 Did not fruit	-	-	-	-	13 (29 wk)	* 11 Produced new leaves twice - UK & LK populations produced new leaves separately - The LK Pop'n 7 weeks before the UK Pop'n. 7 Trees with roots in water in LK produced new leaves and receptacles before those in drier areas - No trees in Uk had roots in water (See text)
Ficus ingens (55)	4	4	- (3)	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Insufficient individuals marked (None produced fruit)
Ficus natalensis (57)	11	11*	- (3)	3	3	5	6	6	8	13 (31 wk)	Flowers = Fruit (Receptacles)						-	-	-	-	-	-	*2 Produced new leaves twice during study // 3 Lower Kloof trees produced figs - U.K. specimens did not // One indiv. produced new leaves on Jan 1 - Hence wide spread.
Faurea saligna (75)	5	5	4	4	2	3	4	4	4	5)	-	-	-	-	-	-	-	-	-	-	-	-	4 individuals produced 3 lots of new leaves during the year - the other only 2.
Faurea speciosa (76)	4	4	4	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Insufficient individuals marked
Annona senegalensis (105)	3	3	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Insufficient individuals marked
Xylopia odoratissima (110)	5	5	5	5	3	4	5	-	-	-	3	5	-	-	-	-	-	-	-	-	-	-	
Xymalos monospora (111)	15	15	5	5	1 3	2 4	3 6	3 8	3 9	4 11 (10 wk)	- 2	- 2	- 3	- 4	- 4	- 5 (6 wk)	- 2	- 4	- 4	- 5	- -	- a) - b)	a) = 4 Trees at top of Kloof - exposed b) = Sub canopy unexposed in Main Kloof & Lower Kloof - 11 Indivs. // 'a' Trees produced new leaves thro' winter cf 'b' in Spring // 'a' Trees produced no fruit
Cryptocarya liebertiana (114)	20	20	15	15	7	13	14	15	16	20 (11 wk)	4	7	8	10	11	15 (12 wk)	4	7	9	10	10	15 (13 wk)	Modal date of NL Produced in UK =2 Oct cf 16 in LK. – Flower Production in UK also 5 wk ahead of LK LK flowered within 5 Weeks of each other - UK within 7 weeks of each other. LK (9 indivs) fruit within 3 wks of each other and 8 wks behind the UK trees (6) which produced over 9 wks.
Pittosporim viridiflrum (139)	8	8	3	3	4	6	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Parinari curatellifolia (146)	7	5	0	0	3	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	No individuals produced fruit or flowers
Acacia ataxacantha (160)	5	5	4	4	4	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Insufficient individuals marked
Bauhinia galpinii (208,2)	3	3	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

UK = Upper Kloof
LK = Lower Kloof
NL = New Leaves

Figure 49: Continued

SPECIES	No. Marked	No Producing New Leaves	No Producing Flowers	No Producing Fruit	Degree of Synchronicity Leaves						Degree of Synchronicity Flowers						Degree of Synchronicity Fruit						NOTES
					1 wk	2 wk	3 wk	4 wk	5 wk	5 wk +	1 wk	2 wk	3 wk	4 wk	5 wk	5 wk+	1 wk	2 wk	3 wk	4 wk	5 wk	5 wk +	
Peltophorum africanum (215)	5	5	2	2	3	4	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Dalbergia sp. (-)	5	5	5	5	3	3	5	-	-	-	3	5	-	-	-	-	4	5	-	-	-	-	
Erythroxylon emarginatum (249)	3	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Insufficient individuals marked
Fagara capensis (253)	2	2	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Insufficient individuals marked
Calodendrum capense (256)	5	5	5	4	2	3	3	3	3	5 (14 wk)	2	2	3	4	4	5 (6 wk)	-	-	-	-	-	-	
Oricia bachmannii (257)	4	3	1	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Insufficient individuals marked
Kiggeleria africana (494)	2	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Insufficient individuals marked
Trimeria grandifolia (503)	1	1	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Insufficient individuals marked
Combretum molle (537)	8	8	3	3	4	4	5	5	6	8 (6 wk)	-	-	-	-	-	-	-	-	-	-	-	-	
Combretum kraussii (540)	5	5	0	0	2	2	3	3	3	5 (9 wk)	-	-	-	-	-	-	-	-	-	-	-	-	
Eugenia capensis (553,2)	13	11	2	2	5	8	9	9	10	11 (7 wk)	-	-	-	-	-	-	-	-	-	-	-	-	
Eugenia sp. (-)	10	19	2	2	3	5	6	9	9	10	-	-	-	-	-	-	-	-	-	-	-	-	
Syzigium cordatum (555)	*15*	*15*	UK =7 *T* = 11 UK =4	9	-	-	-	-	-	-	3 3 2	4 4 3	5 5 3	6 6 3	6 6 3	7 (9 wk) 11 (11 wk) 4 (6 wk)	3	5	6	7	7	9 (7 wk)	13/15 had NL before beginning of study UK flowered 4 weeks before LK
Syzigium guineense (557)	16	16	7	7	-	-	-	-	-	-	2	3	4	5	5	7 (9 wk)	2	3	4	5	6	7 (11 wk)	16 All had NL at beginning of study
Heteropyxis natalensis (455)	5	5	2	2	2	3	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Cussonia spicata (564)	12	12	3	3	3	6	9	10	11	12 (7 wk)	-	-	-	-	-	-	-	-	-	-	-	-	
Schefflera umbellifera (566)	16	9	4	4	2	3	4	5	7	9 (9 wk)	-	-	-	-	-	-	-	-	-	-	-	-	6 Had NL at the beginning of the study

Figure 49: Continued

SPECIES	No. Marked	No Producing New Leaves	No Producing Flowers	No Producing Fruit	Degree of Synchronicity Leaves						Degree of Synchronicity Flowers						Degree of Synchronicity Fruit						NOTES
					1 wk	2 wk	3 wk	4 wk	5 wk	5 wk +	1 wk	2 wk	3 wk	4 wk	5 wk	5 wk +	1 wk	2 wk	3 wk	4 wk	5 wk	5 wk +	
Curtisia dentata (572)	7	7	5	5	1	2	3	4	4	7	1	1	1	2	2	5 (12 wk)	2	3	3	3	3	5 (9 wk)	2 Had NL at the beginning of the study
Teclea natalensis (264)	8	UK 3 8 LK 5	0	0	UK - 1 LK - 2 All - 2	1 3 3	2 4 4	2 5 5	3 - 6	- - 8 (9 wk)	-	-	-	-	-	-	-	-	-	-	-	-	6 Individuals produced 3 lots of new leaves
Clausena anisata (265)	1	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Insufficient individuals marked
Ekebergia capensis (298)	7	7	4	4	1	2	3	4	6	7 (8 wk)	-	-	-	-	-	-	-	-	-	-	-	-	
Ekebergia pterophylla (299)	2	2	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Insufficient individuals marked
Trichilia Emetila (301)	17	17	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14 Had new leaves at the beginning of the study
Drypetes gerrardii (314)	19	17	3	3	6	8	12	14	15	17 (15 wk)	-	-	-	-	-	-	-	-	-	-	-	-	1 Individuals produced new leaves 10 weeks after the rest
Antidesma venosum (318)	8	8	7	7	4	6	8	-	-	-	6	6	6	7	-	-	5	6	6	6	7	-	
Bridelia micrantha (324)	10	10	9	6	6	8	10	-	-	-	8	9	-	-	-	-	2	3	4	6	-	-	
Croton sylvaticus (330)	18	10	3	2	2	3	4	7	8	10 (7 wk)	-	-	-	-	-	-	-	-	-	-	-	-	
Harpephyllim caffrum (361)	18	18	UK - 9 FR - 2 UK - 4 } 15	9 2 4 } 15	2	5	8	13	15	18 (12 wk)	3 1 1	5 1 2	7 1 3	8 1 4	8 1 -	9 (6 wk) 2 -	4 1 3	5 1 1	6 1 -	9 1 -	- 1 -	- 2 (14 wk) -	3 - 4 Weeks later than the rest // LK flowered in March and April while Uk & Fringe from Septem December // Fruiting similar - can have production of phytophases at almost any time.
Lannea discolor (362)	1	1	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Insufficient individuals marked
Protorhus longifolia (364)	24	24	0	0	5	7	10	13	19	24 (11 wk)	-	-	-	-	-	-	-	-	-	-	-	-	
Rhus chirendensis (380)	16	15	7	2	6	7	9	12	14	15 (6 wk)	2	4	6	7	-	-	-	-	-	-	-	-	
Ilex mitis (397)	9	9	3	3	2	3	4	6	8	9 (6 wk)	-	-	-	-	-	-	-	-	-	-	-	-	
Maytenus heterophylla (399)	5	4	4	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	All had new leaves when marked
Catha edulis (404)	5	5	4	4	LK - 2 T - 1 FR - 2	3 3 -	- 3 -	- 3 -	- 3 -	- 5 (8 wk) -	-	-	-	-	-	-	-	-	-	-	-	-	LK trees produced NL 6 weeks before the Fringe trees
Apodytes dimidiata (422)	8	8	6	6	4	5	5	7	7	8 (9 wk)	5	6	-	-	-	-	4	6	-	-	-	-	
Ptaeroxylon obliquum (292)	1	1	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Insufficient individuals marked

T = Terrace FR = Fringe

Figure 49: Continued

SPECIES	No. Marked	No Producing New Leaves	No Producing Flowers	No Producing Fruit	Degree of Synchronicity Leaves						Degree of Synchronicity Flowers						Degree of Synchronicity Fruit						NOTES
					1 wk	2 wk	3 wk	4 wk	5 wk	5 wk +	1 wk	2 wk	3 wk	4 wk	5 wk	5 wk +	1 wk	2 wk	3 wk	4 wk	5 wk	5 wk +	
Bersama transvaalensis (442)	4	4	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Insufficient individuals marked
Ziziphus mucronata (447)	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Insufficient individuals marked
Dombeya rotundifolia (471)	4	4	4	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Insufficient individuals marked
Ochna arborea (482)	7	7	1	0	2	3	4	4	4	7 (10 wk)	-	-	-	-	-	-	-	-	-	-	-	-	
Ochna holstii (480)	9	9	9	9	4	5	6	9	-	-	2	4	6	8	8	9 (7 wk)	3	4	4	6	7	9 (11 wk)	
Rawsonia lucida (491)	20	20	17	16	4	7	9	12	13	20 (12 wk)	5	8	9	12	16	17 (6 wk)	4	8	10	11	12	17 (9 wk)	
Maesa lanceolata (577)	5	5	5	5	2	3	4	5	-	-	3	4	5	-	-	-	3	4	5	-	-	-	
Rapanea melanophloeos (578)	12	12	2	0	3	4	4	4	4	9 (6 wk)	-	-	-	-	-	-	-	-	-	-	-	-	3 In Fringe had NL before the rest when study began 3 In LK had NL 5 weeks before UK trees
Bequaertiodendron magalismontanum (581)	25	23	15	7	6	9	14	15	16	23	7	9	10	11	12	15	3	3	5	5	6	7	
Mimusops obovata (584)	10	10	9	6	-	-	-	-	-	-	3	5	7	9	-	-	2	3	5	6	-	-	8 With NL at beginning of study
Mimusops zeyheri (585)	16	16	12	10	3	5	-	-	-	-	3	4	6	9	9	12	3	5	6	7	9	10	11 With NL at beginning of study
Euclea natalensis (597)	7	6	2	1	1	2	3	4	5	6 (6 wk)	-	-	-	-	-	-	-	-	-	-	-	-	
Strychnos henningsii (625)	9	9	6	6	3	4	4	5	5	9 (14 wk)	3	5	6	-	-	-	3	4	4	5	5	6 (7 wk)	
Strychnos madagascariensis (626)	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Insufficient individuals marked
Strychnos usambarensis (631)	7	7	0	0	2	4	6	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Anthocleista grandiflora (632)	10	10	10	10	-	-	-	-	-	-	2	4	5	6	9	10							NL produced all thro the year Bore fruit at all times

Figure 49: Continued

SPECIES	No. Marked	No Producing New Leaves	No Producing Flowers	No Producing Fruit	Degree of Synchronicity Leaves						Degree of Synchronicity Flowers						Degree of Synchronicity Fruit						NOTES
					1 wk	2 wk	3wk	4 wk	5wk	5 wk +	1 wk	2 wk	3 wk	4 wk	5wk	5 wk +	1wk	2 wk	3 wk	4 wk	5 wk	5 wk +	
Rauvolfia caffra (647)	11	11	10	9	6	7	9	9	10	11 (9 Wk)	8	8	9	10	-	-	5	8	9	-	-	-	
Clerodendrum glabrum (667)	6	6	3	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	All had NL at the beginning of the study
Halleria lucida (670)	10	10	UK 4 9 UK 5	9	2	2	3	4	4	5 (6 wk)	3 3 2	4 4 3	- 4 4	- 4 4	- 4 5	- 9 (10 wk) -	2	3	3	4	6	9 (9 wk)	5 Trees had new leaves at the beginning of the study UK trees (4 individuals fruited and flowered 6 weeks after LK
Gardenia amoena (690)	7	7	0	0	1	2	3	3	4	7	-	-	-	-	-	-	-	-	-	-	-	-	
Rothmannia capensis (693)	8	8	0	0	2	4	6	7	8	-	-	-	-	-	-	-	-	-	-	-	-	-	
Oxyanthus speciosus (696)	12	12	12	7	5	7	10	11	12	-	3	5	7	7	9	12	4	5	6	6	7	-	
Breonadia microcephala (684)	6		6		-	-	-	-	-	-	2	3	4	4	4	6 (9 wk)	-	-	-	-	-	-	New leaves not recorded Fruit indistinguishable from flower pom pom
Trycalysia lanceolata (699)	1	1	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Insufficient individuals marked
Vangueria infausta (702)	1	1	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Insufficient individuals marked
Canthium ciliatum (705,1)	1	1	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Insufficient individuals marked
Canthium mundianum (710)	3	3	2	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	Insufficient individuals marked
Pavetta lanceolata (718)	2	2	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Insufficient individuals marked
Psychotria capensis (723)	4	4	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Insufficient individuals marked
Brachylaena discolor (724)	15	15	-	-	4	5	6	7	8	15 (15 wk)	-	-	-	-	-	-	-	-	-	-	-	-	Flower and fruit not noted
Canthium inerme (708)	3	3	1	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

could not have lasted for a longer period. With more data and over a longer period it may have been possible to find reasons for this variability and why certain species either did not produce fruit and flowers or why a given individual produced fruit or flowers later than other individuals.

It is convenient to discuss the data under two separate headings. First, the variability in phytophase production between species will be discussed and then that within species, i.e. at an individual level.

(i) Variability between species

Figure 48 shows that there was a gradual fall off of species bearing leaves from autumn through till early spring with a rapid rise in numbers of species bearing leaves from September to November when all species bore leaves. It should be noted however, that only twenty out of the eighty-five species marked were in fact deciduous, the other sixty-five species bore leaves all the year around. This contrasts with data presented by Clutton-Brock (1975) which shows that only 40% of the thirty species he sampled were evergreen and according to his criteria bore leaves during October. At Cyprus the lowest percentage of species having leaves at one time was 82%. Twenty-four percent of the species marked were deciduous and thus the smallest percentage of species with leaves at any one time was 76% and this only if all the deciduous species were without leaves at the same time. The duration of this leafless period in the deciduous species varied from one week in the case of Vangueria infausta to just on six and a half months in the case of Lannea discolor. Most of the deciduous species were devoid of leaves for only one to two months.

In flowering the species present at Cyprus show themselves to be shy in comparison to Clutton-Brock's (1975) sample. 24% of species did not flower at all during the study. Of the remaining 76% which did flower, 8% did not set fruit from the flowers. The highest percentage of flowering species was encountered in late October when 29% of species were in flower. Clutton-Brock also records a peak at this time (50%), which coincides with the peak time of flush production in both study areas. While samangos do eat the flowers of certain species (Oatley 1970 and see later) they are of considerably less importance than fruit and leaves. Indeed it is at this time of year (early spring) when fruit production is at its lowest that feeding on leaves and flowers is at its peak. It should be remembered that in the majority of cases it is distinctly disadvantageous for the monkeys to feed on the flowers of the trees as this potentially could reduce the potental crop of fruit. On the other hand, thinning out of a particularly heavily flowering tree might increase its final yield.

While a peak in flowering occurs in early spring it appears that five to eight percent of species are in flower all during the year. In addition some species flower early in the spring and others later in late summer and autumn. For instance _Ochna holstii_ is one of the earliest trees to flower which contrasts with _Harpephyllum caffrum_ which flowered as late as March, the fruit coming ripe only in the summer by the following seasonal year. Other species (_Faurea speicosa_, _Xymalos monospora_, _Catha edulis_ and _Brachylaena discolor_) produced flowers in mid-winter.

The duration of flowering was also considerably variable. Figure 50 illustrates the number of species which flowered for specified periods, showing that while most species flowered for a relatively short period some species flowered for long periods (e.g. over four months). These included species such as _Breonadia microcephala_, _Anthocleista grandiflora_, _Clerodendrum glabrum_ and _Bequaertidendron magalismontanum_ which all produced either unpalatable fruits, no fruits or very little fruit and samangos were never seen to feed in any of these trees.

Fruit was undoubtedly the most important phytophase for the monkeys. Again a lower percentage actually produced fruit compared to Clutton-Brock's sample with a low of 8,5% compared to 25% at Gombe. The period during which a low in presence of fruit was experienced was however coincident with that at

Figure 50: The Duration of Flowering by various Trees Marked at Cyprus

		Number of Months the Individuals of a Species Flowered						
	Did Not Flower	0 - 1	1 - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7
Number of Species	21	23	19	13	4	1	3	1

Total = 85 species.

Cyprus lasting one month longer. The question of whether this winter fruit was actually available to the monkeys and whether they ate it will be discussed in the following chapter and is of great importance, for the fruit produced by the majority of these winter fruiting species was actually fruit which had failed to ripen during the season.

The peak in fruit availability by species occurred during summer and autumn, trailing off from mid-summer through to autumn with a sudden drop in mid-winter. This is the same as occurred at Gombe. It is noticeable that the percentage of species fruiting is on average higher for any one month than the percentage flowering. Clearly a species could not produce fruit unless it had flowered and this higher percentage is due to the fact that the fruit is more persistent than the flowers. Some species were observed with fruit the whole year round.

Figure 51 shows the duration of fruiting by species. The three species with incredibly short recorded fruiting periods includes _Drypetes gerrardii_, one of the more common species in the study area. The reason for this short period was not because it has a short period, but because only one individual fruited and only one produced very little fruit which for some reason disappeared within a month of appearing.

In the case of _Ficus capensis_ fruit was present all year around on one or other individuals. This will be discussed under the next heading.

(ii) Variability within species

While analysis by species shows that in the forest as a whole there is a tendency for there to be more food of different types available at different times, analysis at an individual tree level shows that this is far less constant than the average data by species indicates.

Figure 51: Duration of Fruiting by Tree Species at Cyprus

	Number of Months the Individuals of a species were in Fruit											
	Did Not Fruit	0 - 1	1 - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 - 7	7 - 8	8 - 9	9 - 10	10 - 11	11 - 12
Number of Species	27	3	5	12	7	8	7	5	4	3	1	1	2

Total = 85 species

It will be seen from examination of Figure 48 that of seven hundred and two trees marked only three hundred and fifty-nine actually produced flowers at some or other time (51%). Similarly, only three hundred and two out of seven hundred and two marked trees bore fruit in any amount (45%). On the other hand, all marked trees produced new leaves or flush at some time or another, sometimes producing two or even three crops of new leaves in a season. These facts alone indicate that the forest is perhaps less productive than at first would appear.

Clutton-Brock (1975) has noted, as have others, that some species are more synchronous in phytophase production than others and that the duration of phytophase production is also variable. This is clearly of importance to monkeys feeding in the forest and Figure 49 attempts to show the degree of synchronicity achieved by the various species. Under degree of synchronicity the figures refer to the number of individuals which had produced a given phytophase in a given period of time. Those species which had individuals which had not produced the phytophase within five weeks of the first in the sample have individuals in the column - 5 wk + - and here the time it took for all individuals in the sample to produce is indicated in weeks.

What does asynchronicity mean in terms of obtaining food or using the phytophase as a source of food. First, it means that at any given time in the season of a particular phytophase, especially at the start, there will be fewer individuals of that species exhibiting the phytophase. This is in itself another factor which could produce food stress. Second, because fewer individuals will be producing and because the probability of a phytophase being present on a given tree is further reduced even in the so-called season of the species, it will not help so far as foraging strategies are concerned to go to trees of a given species. Individual trees will have to be visited if potential food sources are to be exploited.

First, let us consider the synchronicity of the new leaf production. Twenty-three out of seven hundred and two marked trees did not produce any new leaves during the study (4%). Of the eighty-five species marked, fifty-three had sufficient individuals to be included in this synchronicity analysis. Of these fifty-three, in only eighteen did the individuals produce leaves within five weeks of each other, with the mean period till all had produced new leaves being 3,4 weeks (σ = 1,14). On the other hand those taking over five weeks for all individuals to produce a phytophase took 10,6 weeks (σ = 5,49) to achieve this. It should be noted, however, that the numbers of individuals in each species which were marked differs and indeed there is a preponderence of less marked species in the group which produced leaves within five weeks. Figure 52 illustrates this.

From this analysis it is clear that the more individuals in the sample the more asynchronons the species appears and it is worth noting that at the population level the same effect will appear.

Several species show a high degree of asynchronicity. Ficus capensis was represented in the sample by twenty individuals which took twenty-five weeks (almost six months) for all trees to have produced new leaves twice during the season and because the Upper Kloof and Lower Kloof individuals produced new leaves at different times, with the Lower Kloof population producing new leaves before the Upper Kloof population.

On the other hand Ficus natalensis, represented by eleven individuals took thirty-one weeks for all its individuals to produce new leaves, only two individuals producing new leaves twice. However, it should be noted that eight of the eleven had already produced new leaves within five weeks of each other.

These two species were the ones with very spread leaf production. All the rest produced leaves within fifteen weeks of the first individual producing leaves, and of these, in most cases the majority of the samples showed production of new leaves by most of the individuals within five weeks with only a few individuals not producing within the five week period. Figure 53 illustrates this. Thus those species of which the individuals did not all produce new leaves

<u>Figure 52</u>: Table to Illustrate the Effect of the Numbers of Trees in Samples on the Rate at which all Individuals of the Sample to Produce New Leaves.

	Number Producing New Leaves	Number Producing New Leaves Within Five Weeks
Species with More Than Ten Individuals Marked	21	4
Species with Less Than Ten Individuals Marked but More Than Five.	32	14

Figure 53: Table to Show the Synchronicity of Production of New Leaves.

	Number Marked & Producing New Leaves	Number Producing New Leaves Within Five Weeks	%
Celtis africana	13	10	76
Chaetachme aristata	9	4	44
Ficus capensis	20	12	60
Ficus natalensis	11	8	72
Cryptocarya liebertiana	20	16	80
Calodendrum capense	5	3	60
Teclea natalensis	8	6	75
Ekebergia capensis	7	6	85
Drypetes gerrardii	19	17	89
Croton sylvaticus	10	8	80
Harpephyllum caffrum	18	15	83
Protorhus longifolia	24	19	79
Rhus chirendensis	15	14	93
Ilex mitis	9	8	88
Catha edulis	5	3	60
Apodytes dimidiata	8	7	87,5
Ochna arborea	7	4	57
Rawsonia lucida	20	13	65
Combretum molle	8	6	75
Combretum kraussii	5	3	60
Eugenia capensis	11	10	90,9
Eugenia sp.	10	9	90
Cussonia spicata	12	11	91,6
Schefflera umbellifera	9	7	77,7
Curtisia dentata	7	4	57
Rapanea melanophloeos	9	4	44
Bequaertidendron magalismontanum	23	16	69
Euclea natalensis	6	5	83
Strychnos henningsii	9	5	55,5
Rauvolfia caffra	11	10	90,9
Halleria lucida	5	4	90
Brachylaena discolor	15	8	53,3

$\bar{X}$ = 73,8%

σ = 14,8%

within five weeks had produced new leaves in 73,8% of cases within that time.

We can therefore conclude that there is a large degree of synchronicity of leaf production and that where cases of asynchronicity do occur this can be ascribed to a few individuals only. In certain cases definite differences due to altitude were discerned (e.g. *Teclea natalensis*, *Xymalos monospora*, *Ficus capensis* and *Ficus natalensis*).

Sixty-five out of eighty-five species produced flowers, but only twenty-seven of these had enough individuals actually producing flowers to allow analysis. Of these three were fig species which will be discussed under fruit. Of the twenty-four remaining nine had flowered within five weeks, the remaining having flowered within twelve weeks. It is again apparent that the species containing more individuals took longer to complete flowering. One aspect of interest is that in several cases the Upper Kloof trees flowered earlier than the Lower Kloof trees (*Harpephyllum caffrum*, *Cryptocarya liebertiana* and *Syzigium cordatum*). In one case the Upper Kloof individuals did not flower at all while the Lower Kloof individuals did (*Xymalos monospora*). Several factors may have been active here. First, while the Upper Kloof is higher and one would expect later flowering, the top of the mountain received more sun. The sun rose later and set earlier in the valley than above in the escarpment due to the mountains. Second, the trees on the escarpment were more exposed and old leaves would tend to be removed by wind action earlier than in the more sheltered individuals.

However, all individuals had flowered within twelve weeks of each other with the majority flowering within an even shorter period. This indicates that flowering is relatively asynchronous.

The fruiting data are even more scant than those of the flowering data with twenty-four species, including the figs, producing fruit and being marked in sufficient numbers to allow analysis. Furthermore the data is made less accurate by the fact that the distinction between fruit and setting fruit was by necessity different in different species and the method used to define a species in fruit could not be absolute, the fruit or setting fruit only having been observed at a distance. In addition there is again the problem of unequal numbers of individuals in species marked, the more marked the longer it takes for a species individuals to all be with fruit.

However, following the previous analysis ten species all had individuals which did produce fruit, producing fruit within five weeks. Of the remaining, except Ficus capensis, fruit was produced within sixteen weeks, with a mean of ten weeks (σ = 3,14). In the case of the Cape Fig (Ficus capensis) two distinct populations were discernable in the sample and which explains the occurrence of ripe figs at almost any time of the year. Those individuals whose roots were in or around standing water had receptacles present much earlier than those in drier areas, with a season between September and April. These figs became ripe approximately four to six months after their appearance and hence two crops of ripe figs were observed - during summer and winter. This was clearly of some importance as figs were a good source which occured in some abundance and which yield a large amount of fruit for a small amount of energy.

While the time taken for an individual to produce a phytophase after the first of its species has done so is one way to measure the degree of variability in the phenology of the trees, there are other aspects which contribute to the phenological picture.

One aspect of importance is the duration for which a phytophase is borne. Clutton-Brock (1975) notes that some species bear a short-lasting crop while in others the crop is more persistent, even lasting into the following season. Figure 54 shows the duration of the fruit crop of various species by individuals. The data in this table bears out this observation. Of the twenty-six species for which complete duration data was available the mean duration of fruiting was 17,4 weeks, with a standard deviation of 6,58 weeks. The range of durations was from a low of 6,8 weeks for Xymalos monospora, 5,88 weeks for Bequaertidendron magalismontanum, 9,11 weeks for Ochna holstii to 31,05 weeks for Mimusops *obovata*, 27,16 weeks for *Mimusops zeyheri* and 26,8 weeks for *Trema orientalis*. Several other species showed a tendancy for the unripe fruit to persist. These included *Chaetachme aristata*, *Harpephyllum caffrum*, *Mimusops spp*, *Syzigium guineense*, *Anthocleista grandiflora*.

The data presented in this section show that there is a very high degree of variability at an individual level, which when averaged and summarised is easily lost, in spite of the fact that it is probably of major importance to the monkeys and the feeding strategies which they adopt. It is clear that to respond to the overall production pattern of a food species, as might appear in a summary in a paper, would be a poor strategy because of this variability within species. Thus one expects to see a feeding strategy which allows the monkeys to forage trees individually, in spite of the fact that this might seem to imply a high level of intellectual capability to remember where producing trees are present.

CHAPTER NINE

THE PRODUCTIVITY, DIMENSIONS, FOOD VALUE AND AVAILABILITY OF FRUIT OF THE VEGETATION OF THE FOREST.

Introduction

So far the variation in time and the space of food production has been discussed. In this chapter other aspects such as productivity, the size and food value of fruits and the type of fruit and their mode of bearing will be discussed and the way that these may affect the feeding and ranging behaviour of the monkeys.

Productivity

In the previous phenology discussion phytophases (fruit included) were merely scored for presence or absence. However, not all the individuals so scored produced equal amounts of fruit. All that was necessary was for an individual to be observed bearing one fruit. While this, if ripe and accessible, is potentially a source of food the chances of its being found to be eaten is small and hence the crop produced by food producing trees is of great importance in the total picture of food availability.

Methods available for the measurement of productivity vary as the information required varies. Hladik and Hladik (1972) were interested in finding the average amount of fruit produced by a species per square metre of canopy. They used two methods; first, for trees with a long fruiting season, the tree - that individual thought to have an average production - was divided up into adaptive units. The number of fruit in a number of adaptive units were counted and thus the total number of fruit was computed. The average weight of the fruit was found as well as the average weight of pulp and pip. From these data, knowing the canopy area of the tree, the weight of fresh pulp per square metre of canopy for an "average" tree could be determined. Second, for trees with a short season which lost fruit quickly, the number of fruit falling into the square metre panniers below the tree during one season was found and computed. From these data knowing the average fruit and pulp weight and the surface area of the canopy, the weight of pulp per square metre of canopy could be found.

These methods give one a good idea of the productivity of an average tree, but do not tell one much about the degree of variability of fruit production within a species population. As the levels of variability of food production and their identification was the aim of this thesis another method had to be found.

During the phenological survey all trees visited bearing fruit were simultaneously subjectively rated on a six point scale for productivity. Figure 46 shows the categories used.

This method has all the usual disadvantages of subjective enumeration, but within species at least gives an idea of the degree of variability encountered.

Figure 54 lists the highest productivity of the individuals by species as well as the duration of the fruiting period and the time till ripe fruit appeared on the tree. The duration of fruiting has already been discussed under phenology.

The percentage occurrence of the classes 1-5 is shown in Figure 55.

It must be noted that only those trees which actually did fruit are being considered here, which was only two hundred and fifty seven out of seven hundred and one trees marked. Some species show a tendency for all or most individuals observed to have a high productivity (e.g. Rauvolfia caffra, Cryptocarya liebertiana, Maytenus heterophylla, Mimusops obovata, Halleria lucida), while others show an equally consistant tendency towards low crops (Podocarpus falcatus, Bequaertidendron magalismontanum).

Figure 54: Productivity and Duration of Fruiting for all Marked Trees which Produced Fruit

SPECIES	No. Marked	No. Fruiting	Tree No.	Maximum Productivity	Duration of Fruiting	Time Till Ripening	NOTES	COMMENTS
Podocarpus falcatus (16)	11	6	74	2	26 wk	Not Determined		Mean Production =2,3 σ =0,5
			87	3	43 wk +			Mean Duration =26,8 wk σ =11,16
			150	2	17 wk			
			151	2	38 wk			
			162	2	18 wk			
			163	3	19 wk			
Podocarpus latifolius (18)	7	0	-	-	-	-		
Celtis africana (39)	13	13	4	5	21 wk			Mean Production =3,46 σ =1,05
			64	3	19 wk	-		Mean Duration =21,4 wk σ = 7,9
			236	2	10 wk	-		
			x	3	20 wk	-		
			84	4	26 wk	-		
			96	5	34 wk	-		
			106	3	12 wk	-		
			139	3	24 wk	-		
			145	4	25 wk	-		
			175	3	22 wk	-		
			268	5	35 wk	-		
			379	3	20 wk	11 wk		
			687	2	10 wk	-		
Trema orientalis (42)	12	10	63	4	32 wk	14 wk		Mean Production =3,2 σ =1,2
			65	5	38 wk	25 wk		Mean Duration =27,4 σ =11,12
			117	3	24 wk	12 wk		
			189	3	26 wk	-	DNR	
			347	4	44 wk	26 wk	10 - 20% Ripe at one time	
			349	4	43 wk	27 wk	10 - 20% Ripe at one time	
			530	2	14 wk	-	DNR	
			531	1	10 wk	-		
			561	2	14 wk	9 wk		
			673	4	25 wk			
Chaetachme aristata (43)	9	1	447	1	-	-	Residual fruit from previous year	

DNR = Did not ripen
IFBS = In Fruit at beginning of Season
IFES = In Fruit at end of Season

Figure 54: Continued

SPECIES	No. Marked	No. Fruiting	Tree No.	Maximum Productivity	Duration of Fruiting	Time Till Ripening	NOTES	COMMENTS
Ficus capensis (50)	20	14	19	2	13 wk	7 wk		Mean Production =2,47 $\sigma = 0{,}9$ Mean Duration =18,25 $\sigma = 12{,}8$ 6 Indivs out of 10 Produced fruit in UK and their duration of production was longer cf 9 indivs out of 10 in LK where indivs also tended to produce more than one crop per season.
			22	3	13 wk	8 wk		
			42	4	-	-	IFBS	
			123	3	17 wk	11 wk		
			123	2	9 wk	3 wk	Receptacles v. small	
			88	1	5 wk		DNR	
			183	3	-	-	IFBS	
			183	3	14 wk	6 wk		
			291	3	-	-	IFBS	
			291	2	18 wk	6 wk		
			292	3	23 wk	13 wk		
			292	2	12 wk	4 wk		
			226	3	14 wk	6 wk		
			226	1	17 wk		DNR	
			230	1	12 wk		DNR	
			230	1	6 wk		DNR	
			230	2	-	-	IFES	
			509	4	58 wk	50 wk	2 fruiting seasons	
			529	3	32 wk		DNR	
			564	3	29 wk	18 wk		
			685	3	-	-	IFBS	
Ficus ingens (55)	4	2	502	4	-	-	IFBS	
			503	5	-	-	IFBS	
Ficus natalensis (57)	11	5	464	4	-	-	IFBS	UK trees shyer to fruit – most UK trees were stranglers cf the LK which were rock splitters.
			464	4	-	-	IFBS	
			465	4	-	-	IFBS } LK =3/3 fruited	
			465	3	-	-	IFES	
			466	3	-	-	IFBS	
			466	2	-	-	IFES	
			547	3	-	-	IFBS } UK =2/8 fruited	
			555	2	-	-	IFBS	
Faurea saligna (75)	5	4	-	-	-	-	No production data	

Figure 54 Continued

SPECIES	No. Marked	No. Fruiting	Tree No.	Maximum Productivity	Duration of Fruiting	Time Till Ripening	NOTES	COMMENTS
Faurea speciosa (76)	4	4	-	-	-	–	No productivity data	
Annona senegalensis (105)	3	3	x_1	3	16 wk	-	Time of ripening not easy to observe - fruit is still green	Mean production = 2,66 σ=0,6 Mean duration =17 wk σ=1
			x_2	2	17 wk	..		
			x_3	3	18 wk	-		
Xylopia odoratissima (110)	5	5	-	-	-	-	No productivity data	
Xymalos monospora (111)	15	7	170	3	-		IFBS LK	Mean production = 2,5 σ = 0,5 Mean duration =6,8 σ=0,44
			171	2	-	-	IFBS	
			221	2	-	-	IFBS	
			221	2	6 wk	3 wk		
			229	3	7 wk	3 wk		
			231	3	7 wk	3 wk		
			232	3	7 wk	3 wk		
			236	2	7 wk		DNR	
Cryptocarya liebertiana (114)	20	14	24	3	12 wk	7 wk	LK	Mean duration =13,9 σ=4,8 Mean Production =3,5 σ=0,99 Mean T→R =6,35 σ= 2,09
			26	3	14 wk	8 wk		
			39	4	13 wk	6 wk		
			72	4	16 wk	9 wk		
			75	4	10 wk	4 wk		
			184	4	12 wk	7 wk		
			185	4	12 wk	5 wk		
			271	4	13 wk	6 wk		
			289	4	11 wk	4 wk		
			233	2	10 wk	6 wk		
			552	1	9 wk		DNR UK	
			557	5	16 wk	11 wk		
			591	3	14 wk	6 wk		
			596	4	15 wk	7 wk		
			711	4	30 wk	3 wk	Ripened twice	
Pittosporum viridiflorum (139)	8	3	-	-	-	-	No productivity data	

T →R = Time till Ripening.

Figure 54: Continued

SPECIES	No. Marked	No. Fruiting	Tree No.	Maximum Productivity	Duration of Fruiting	Time Till Ripening	NOTES	COMMENTS
Parinari curatellifolia (146)	7	0	-	-	-	-		
Acacia ataxacantha (160)	5	4	323 324 368 398	4 5 3 2	- - 26wk 22wk	19 wk 18 wk 16 wk 14 wk	IFES IFES	Mean Production =3,5 σ = 1,3
Bauhinia galpinii (208,2)	3	3	-	-	-	-	No productivity data	
Pelpophorum africanum (215)	5	3	-	-	-	-	No productivity data	
Dalbergia sp (–)	5	5	-	-	-	-	No productivity data	
Erythroxylon emarginatum (249)	3	0	-	-	-	-		
Fagara capensis (253)	2	0	-	-	-	-		
Calodendrum capense (256)	5	4	173 176 177 298	2 2 3 2	12wk 11wk 15wk 9wk		DNR DNR DNR DNR	Mean Production =2,25 σ =0,5 Mean Duration =11,75 σ = 2,5
Oricia bachmannii (257)	4	0	-	-	-	-		
Teclea natalensis (264)	8	0	-	-	-	-		
Clausena anisata (265)	1	0	-	-	-	-		

Figure 54: Continued

SPECIES	No. Marked	No. Fruiting	Tree No.	Maximum Productivity	Duration of Fruiting	Time Till Ripening	NOTES	COMMENTS
Ekebergia capensis (298)	7	4	107	4	17 wk	7 wk		Mean Production =3,5 $\sigma = 1$ Mean Duration =15 $\sigma = 1{,}4$ Mean T →R = 8 $\sigma = 3{,}16$
			186	2	14 wk	4 wk		
			371	4	15 wk	11 wk		
			378	4	14 wk	10 wk		
Ekebergia pterophylla (299)	2	1	675	3	34 wk	20 wk		
Trichilia emetica (301)	17	3	10	2	-	-	IFES	
			73	4	-	-	IFES	
Drypetes gerrardii (314)	19	2	242	2	5 wk		DNR	
			327	1	4 wk		DNR	
Antidesma venosum (318)	8	7	439	2	28 wk	22 wk	LK	Mean Production =3 $\sigma = 0{,}81$ Mean Duration =32,28 $\sigma = 5{,}15$ Mean T →R =14,4 $\sigma = 5{,}25$
			440	2	25 wk	22 wk		
			343	4	28 wk	13 wk	Fringe	
			388	3	25 wk	12 wk		
			390	3	25 wk	11 wk		
			394	4	16 wk	10 wk		
			396	3	16 wk	11 wk		
Bridelia micrantha (326)	10	6	17	2	18 wk	7 wk		Mean Production = 3,5 $\sigma = 0{,}83$ Mean Duration =15 $\sigma = 1{,}78$ Mean T →R = 6
			20	3	13 wk	4 wk		
			32	4	14 wk	4 wk		
			197	4	15 wk	4 wk		
			199	4	14 wk	4 wk		
			127	4	16 wk	4 wk		
Croton sylvaticus (330)	10	2	30	5	16 wk	6 wk		
			253	4	12 wk	7 wk		
Harpephyllum caffrum (361)	18		9	3	-	18 wk	IFES	Mean Production =3,07 $\sigma = 1{,}18$
			38	4	-	22 wk	IFES	
			40	4	-	17 wk	IFES	
			45	2	-	-	IFES	
			86	2	-	-	IFES	
			103	4	-	18 wk	IFES	
			112	5	-	-	IFES	

Figure 54: Continued

SPECIES	No. Marked	No. Fruiting	Tree No.	Maximum Productivity	Duration of Fruiting	Time Till Ripening	NOTES	COMMENTS
Harpephyllum caffrum (Cont.)			142	4	-	-	IFES	
			286	4	-	13 wk	IFES	
			510	2	9 wk	6 wk	UK	
			580	2	13 wk	7 wk		
			637	3	14 wk	7 wk		
			638	1	9 wk	7 wk		
Lannea discolor (362)	1	0	-	-	-	-		
Protorhus longifolia (364)	24	0	-	-	-	-		
Rhus chirendensis (380)	16	3	153	2	16 wk	11 wk		Mean Production =2,66 σ = 1,15 Mean Duration =11,33 σ = 4,04 Mean T →R =6,66 σ = 3,78
			195	2	9 wk	4 wk		
			611	4	9 wk	5 wk		
Ilex mitis (397)	9	3	535	2	13 wk	10 wk		Mean Production =3,33 σ =1,15 Mean Duration =18,33 σ =5,5 Mean T →R =13 σ = 3,6
			577	4	18 wk	12 wk		
			709	4	24 wk	17 wk		
Maytenus heterophylla (399)	5	4	318	4	31 wk	26 wk		
			451	4	-	-	IFES	
			485	4	-	-	IFES	
			486	4	37 wk	29 wk		
Catha edulis (404)	5	5	-	-	-	-	No production data	
Apodytes dimidiata (422)	8		247	4	28 wk	20 wk		Mean Production = 3 σ = 0,89 Mean Duration = 20,16 σ = 9,3 Mean T →R =11,6 σ =6,7
			351	3	25 wk	13 wk		
			352	2	26 wk	17 wk		
			356	2	4 wk	2 wk		
			374	4	24 wk	12 wk		
			410	3	14 wk	6 wk		
Ptaeroxylon obliquum (292)	1	0	-	-	-	-		
Bersama transvaalensis	4	0	-	-	-	-		

Figure 54: Continued

SPECIES	No. Marked	No. Fruiting	Tree No.	Maximum Productivity	Duration of Fruiting	Time Till Ripening	NOTES	COMMENTS
Ziziphus mucronata (450)	1	0	-	-	-	-		
Dombeya rotundifolia (471)	4	0	-	-	-	-		
Ochna arborea (482)	7	0	-	-	-	-		
Ochna holstii (480)	9	9	435	4	10 wk	8 wk		Mean Production =3,11 σ = 0,78
			462	2	12 wk	8 wk		Mean Duration =9,5 σ =1,64
			473	3	8 wk	6 wk		Mean T →R = 9,55 σ = 1,80
			476	3	8 wk	6 wk		
			478	4	12 wk	11 wk		
			645	3	8 wk	7 wk		
			647	4	11 wk	9 wk		
			663	3	9 wk	8 wk		
			590	2	9 wk	5 wk		
Rawsonia lucida (491)	20	16	132	4	32 wk		DNR	Mean Production 2,8 σ = 1,1
			144	2	29 wk		DNR	Mean Duration = 20,62 σ = 9,9
			147	2	33 wk		DNR	
			148	4	25 wk		DNR	
			165	4	24 wk		DNR	
			168	3	31 wk		DNR	
			267	2	12 wk		DNR	
			275	4	35 wk		DNR	
			280	4	21 wk		DNR	
			307	3	14 wk		DNR	
			506	1	7 wk		DNR	
			560	2	9 wk		DNR	
			586	3	17 wk		DNR } LK	
			670	1	7 wk		DNR	
			688	2	9 wk		DNR	
			214	4	25 wk		DNR	

Figure 54: Continued

SPECIES	No. Marked	No. Fruiting	Tree No.	Maximum Productivity	Duration of Fruiting	Time Till Ripening	NOTES	COMMENTS
Kiggeleria afrioana (494)	2	0	-	-	-	-		
Trimeria grandifolia (503)	1	0	-	-	-	-		
Combretum molle (537)	8	3	-	-	-	-	No Production data	
Combretum krausii (540)	5	0	-	-	-	-		
Eugenia capensis (553,2)	13	5	315	4	-	-	IFBS	
			319	4	-	-	IFBS	
							No Production data for UK	
Eugenia Sp (–)	10	2	662	4	17 wk		DNR	
			632	2	14 wk		DNR	
Syzigium cordatum (555)	15	9	2	2	8 wk		DNR	Mean Production =2,44 σ = 1,23
			34	1	5 wk		DNR	Mean Duration =12,66 σ = 5,5
			125	2	12 wk	6 wk	} LK	Mean T →R = 6,7 σ = 3,7
			154	1	7 wk	3 wk		
			246	4	13 wk	4 wk		
			576	2	19 wk	8 wk		
			617	4	22 wk	14 wk	} UK	
			629	4	13 wk	4 wk		
			692	2	15 wk	8 wk		
Syzigium guineense (557)	16		248	3	26 wk		DNR	Mean Production =2,85 σ =0,89
			249	2	25 wk		DNR	Mean Duration =2,85 σ = 87
			259	2	7 wk		DNR	
			116	4	23 wk	9 wk		
			225	4	28 wk	8 wk	(For 14 wks – fruit old and dried)	
			238	3	12 wk	7 wk		
			699	2	10 wk	6 wk		
Heteropyxis natalensis (455)	5	2	-	-	-	-	No Production data	

Figure 54: Continued

SPECIES	No. Marked	No. Fruiting	Tree No.	Maximum Productivity	Duration of Fruiting	Time Till Ripening	NOTES	COMMENTS
Cussonia spicata (564)	12	0	-	-	-	-		
Schefflera umbellifera (566)	16	5	-	-	-	-	No Production data	
Curtisia dentata (570)	7	5	314	2	18 wk	8 wk		Mean Production =3,2 σ 0,83
			565	3	19 wk	11 wk		Mean Duration =21 σ = 4,52
			572	4	19 wk	10 wk		Mean T→R = 10,5 σ = 3,9
			665	3	29 wk	17 wk		
			707	4	20 wk	7 wk		
Maesa lanceolata (577)	5	5	588	4	28 wk		DNR	Mean Production = 4 σ = 1
			589	3	19 wk		DNR	Mean Duration = 22,4 σ = 1,06
			612	5	29 wk	7 wk		Mean T→R =5,3 σ = 1,42
			660	5	27 wk	5 wk		
			695	3	9 wk	4 wk		
Rapanea melanophloeos (578)	12	0	-	-	-	-		
Bequaertidendron magalismontanum (581)	25	9	329	1	5 wk		DNR	Mean Production =1,77 σ = 0,97
			355	1	4 wk	3 wk		Mean Duration = 5,88 σ = 2,97
			360	1	2 wk		DNR	Mean T→R = 4,28 σ = 2,62
			48	1	7 wk	4 wk		
			285	1	6 wk	4 wk		
			658	2	3 wk	2 wk		
			585	3	6 wk	4 wk		
			696	3	12 wk	10 wk		
			719	3	8 wk	3 wk		
Mimusops obovata (584)	10	8	457	2	26 wk	8 wk	LK	Mean Production =3,75 σ = 0,88
			305	4	32 wk	18 wk		Mean Duration = 31, σ =4,6
			306	5	34 wk	23 wk		Mean T→R =18,66 σ = 5,6
			513	4	34 wk	15 wk	UK	
			539	4	35 wk	20 wk		
			646	4	37 wk	23 wk		
			656	4	-	25 wk		
			702	3	25 wk	13 wk	IFES	

Figure 54: Continued

SPECIES	No. Marked	No. Fruiting	Tree No.	Maximum Productivity	Duration of Fruiting	Time Till Ripening	NOTES	COMMENTS
Musops *zeyheri* (585)	16	9	68	1	29 wk	13 wk		Mean Production =2,22 σ =1,4 Mean Duration = 27,16 σ = 3,06 Mean T→ R = 15 σ = 9,6 109/136/137/140 - Ripened only in the following year
			79	4	27 wk	6 wk		
			97	4	28 wk	6 wk		
			109	2	46 wk	22 wk		
			136	1	-	23 wk	IFES - flowered twice } LK	
			137	4	31 wk	6 wk	IFES	
			140	2	-	29 wk	IFES	
			160	1	22 wk		DNR	
			172	1	26 wk		DNR	
Euclea *natalensis* (597)	7	1	494	4	17 wk	4 wk		
Strychnos *henningsii* (625)	9	6	215	2	11 wk		DNR	Mean Production = 3,16 σ = 0,75 Mean Duration =16,33 σ = 7,3
			309	3	15 wk	12 wk		
			527	3	10 wk		DNR	
			597	3	11 wk		DNR	
			610	4	25 wk	18 wk		
			683	4	26 wk	18 wk		
Strychnos *madagascariensis* (626)	1	1	365	-	-	-	No production data	
Strychnos *usambarensis* (631)	7	0	-	-	-	-		
Anthocleista *grandiflora* (632)	10	All trees marked	No data	Bore all year				
Rauvolfia *caffra* (647)	11	10	1	5	15 wk	9 wk		Mean Production =4,66 σ = 0,7 Mean Duration =13,7 σ = 2,7 Mean T→ R =10 σ =1,4
			21	5	14 wk	10 wk		
			122	5	19 wk	13 wk		
			204	5	13 wk	11 wk		
			205	5	13 wk	9 wk		
			207	5	17 wk	9 wk		
			208	3	10 wk		DNR	
			239	5	13 wk	9 wk		
			241	4	13 wk	10 wk		
			131	1	10 wk		DNR	

Figure 54: Continued

SPECIES	No. Marked	No. Fruiting	Tree No.	Maximum Productivity	Duration of Fruiting	Time Till Ripening	NOTES	COMMENTS
Clerodendrum glabrum (667)	6	0	-	-	-	-		
Halleria lucida (670)	10	9	23	3	6 wk	2 wk		Mean Production =3,54 $\sigma = 1{,}36$
			23	3	9 wk+	3 wk	IFES	Mean Duration = 9,11 $\sigma = 2{,}8$
			62	5	15 wk	10 wk		Mean T→R = 4,7 $\sigma = 2{,}5$
			152	2	7 wk	3 wk		
			155	1	7 wk	3 wk		
			245	5	11 wk	5 wk		
			245	5	12 wk+	9 wk	IFES	
			601	4	9 wk	4 wk		
			627	5	10 wk	5 wk		
			628	3	10 wk	4 wk		
			630	3	7 wk	4 wk		
Gardenia Amoena (690)	7	0	-	-	-	-		
Rothmannia capensis (693)	8	1	717	2	16 wk	-	DNR	
Oxyanthus speciosus (696)	12	2	-	-	-	-	No Production Data	
Breonadia microcephala (684)	6	6	-	-	-	-	No Production Data	
Tricalysia lanceolata (699)	1	0	-	-	-	-		
Vangueria infausta (702)	1	0	-	-	-	-		
Canthium ciliatum (705,1)	1	0	-	-	-	-		

SPECIES	No. Marked	No. Fruiting	Tree No.	Maximum Productivity	Duration of Fruiting	Time Till Ripening	NOTES	COMMENTS
Canthium inerme (708)	3	1	433 704	2 2	7 wk 21 wk		DNR DNR	
Canthium mundianum (710)	3	0	-	-	-	-		
Pavetta lanceolata (718)	1	0	-	-	-	-		
Psychotria capensis (723)	4	0	-	-	-	-		
Brachylaena discolor (724)	15	15	-	-	-	-	No Production Data	

Figure 55: The Percentage Occurence of the Various Productivity Classes for Trees which Produced Fruit.

Class	Percentage
1	9%
2	25%
3	26%
4	31%
5	9%
	100%

Mean Productivity by Species = 3,05

A relationship between the duration of the crop and the heaviness of the crop is also apparent, the heavier the crop the longer the fruit appears to persist.

Thus at this third level there is furthur variability which, taken with the previously discussed sources of variability compounds the instability in the food supply. Other factors which also must play a role will be discussed later (i.e. Ripeness, Palability, Food Value, Ease of Access etc.).

Dimensions and Food Values of Certain Fruits, Flowers and Leaves.

While the physical presence of a food source is one major factor affecting its utilisation, another major group of factors affecting the utilisation of food sources is the physical character of the food source itself and whether they are palatable to the monkeys. Figure 56 and Figure 57 tabulate measurements made in various fruits and their food values. Fruit masses were determined on an Ohaus Triple Beam Balance and lengths using a pair of Vernier Calipers. The Food Value Measurements were made on fresh fruit at the National Institute for Food Research by their standard techniques.

Unfortunately, the data are not complete. It was originally collected to form the basis of comparisons as made by Hladik and Hladik (1972). Figure 56 illustrates several interesting points which will be developed later. First, the fruits may vary quite considerably in size. For example, the average weight of a fig (*Ficus capensis*) was 11,68 grams, while the fruit of *Trema orientalis* weighed only 0,0155 grams. Second, regardless of size, the percentage of pulp on the fruit varied considerably in those species measured (i.e. Mean = 64,32% σ = 12,76% Range = 91,30% to 41,02%).

With regard to size and pulp content one would expect those fruit which are large and have a high pulp percentage to be preferred to those which are small and require higher expenditure of energy to gather per unit weight gathered and which have a low pulp percentage, giving a lower return of food in bulk. One

Figure 56: Table of the Dimensions and Weights of Certain Fruits Eaten by Samangos at Cyprus.

SPECIES		Wt.(g) Fruit	σ	Wt.(g) Pip	σ	Wt.(g) Pulp	% Pulp	Length (cm.)	σ	Width (cm.)	σ	N	NOTES
Dracaena hookerana		1,76	0,73	0,83	0,38	0,93	52,84	1,21	0,12	1,25	0,22	69	Number of seeds/fruit = 1,58 (- 0,78).
Trema orientalis		0.0155	-	-	-	-	-	0,26	0,03	0,26	0,03	1200	Weight of Pips ignored.
Chaetachme aristata		2,3	0,30	0,2	0,01	2,1	91,30	1,47	0,05	1,50	0,07	94	
Ficus natalensis		0,86	0,07	-	-	-	-	1,2	0,10	1,09	0,13	59	
Ficus capensis		11,86	2,7	-	-	-	-	2,67	0,24	3,02	0,30	74	
Acacia ataxacantha (green)	- pod	0,697	0,06	-	-	-	-	-	-	-	-	50	4,94 beans/pod.
	- bean	0,153	0,01	-	-	-	-	1,15	0,23	0,30	0.03	247	
Acacia ataxacantha (dry)	- pod	0,178	-	-	-	-	-	-	-	-	-	50	3,03 beans/pod
	- bean	0,0649	-	-	-	-	-	0,76	0,06	0,16	0,03	152	
Bauhinia galpinii (green)	- pod	2,455	-	-	-	-	-	-	-	-	-	50	3,68 beans/pod
	- bean	0,561	-	-	-	-	-	1,54	0,18	0,52	0,11	184	
Bauhinia galpinii (dry)	- pod	1,124	-	-	-	-	-	-	-	-	-	50	3,82 beans/pod
	- bean	0,207	-	-	-	-	-	1,14	0,12	0,33	0,09	191	
Dalbergia armata (dry)	- pod	0,075	-	-	-	-	-	-	-	-	-	50	4,2 beans/pod
	- bean	0,0194	-	-	-	-	-	-	-	-	-	210	
Ekebergia pterophylla		0,337	0,08	0,08	0,02	0,26	77,44	0,71	0,06	0,75	0,08	49	
Trichilia emetica	- whole	27,8	6,6	-	-	-	-	-	-	-	-	-	
	- bean	2,8	0,97	-	-	-	-	2,70	0,40	1,40	0,24	96	
Andrachme ovalis		0,272	-	-	-	-	-	-	-	-	-	103	
Antidesma venosum		0,0544	-	0,017	-	0,037	68,75	0,45	0,05	0,37	0,03	238	
Bridelia micrantha		0,175	-	0,04	-	0,137	78,57	0,84	-	0,68	-	123	
Harpephyllum caffrum		4,51	0,94	2,01	0,29	2,5	55,43	2,53	0,23	1,51	0,16	98	
Rhoicissus rhomboidea		0,72	0,12	0,23	0,09	0,49	68,05	0,99	0,07	0,97	0,06	153	
Rhoicissus tridentata		0,36	0,08	0,16	0,07	0,2	55,55	1.01	0,12	0,83	0,08	61	
Rawsonia lucida		21,8	8,08	14,56 (rind)	4,9	-	-	3,63	0,48	3,7	0,48	61	
				7,24 (pips)	4,35	-	49,72						
Combretum molle		-	-	0,152	-	-	-	-	-	-	-	73	
Eugenia sp.		1.5	0,68	0,53	0,35	0,97	64,66	1,35	0,19	1,25	0,31	122	
Eugenia capersis		0,58	0,25	0,22	0,08	0,46	67,64	1,07	0,12	0,98	0,10	86	
Syzigium guineense		1,792	1,32	0,98	0,94	0,81	45,31	1,41	0,16	1,41	0,16	58	

Figure 57: Table of Food Values for certain Plants collected at the Cyprus Study Site and Eaten by Samango Monkeys.

SPECIES & PART ANALYSED		g%						kJ	mg/100g									Vitamins mg/100g			
		Mois-ture	Ash	Pro-tein	Fat	Fibre	CHO	Energy Value	Ca	Mg	Fe	Na	K	Cu	Zn	P	B_1	B_2	B_3	C
Ficus capensis	- whole fruit	92,9	0,9	0,6	6,4	1,2	4,1	92	48,1	24,8	0,25	1,5	269	0,07	0,14	15,2	0,01	0,002	0,21	3,4
	- leaves	76,1	2,8	3,7	0,5	3,3	13,6	310	413,1	86,2	3,39	2,0	541	0,46	0,76	50,0	0,04	0,05	0,92	39,2
Ficus natalensis	- whole fruit	77,9	2,0	1,3	1,0	8,9	8,9	209	161,2	44,4	1,00	1,5	508	0,22	0,26	28,3	0,04	0,01	0,50	2,6
Ficus ingens	- whole fruit	75,4	1,6	1,4	1,3	9,6	10,7	252	167,5	57,2	1,91	3,2	510	0,35	0,34	32,0	0,03	0,01	0,44	8,3
Acacia ataxacantha	- green seed	68,9	1,5	9,4	2,7	2,3	15,2	510	113,7	67,2	1,65	4,0	317	0,26	1.52	134	0,19	0,02	0,77	24,6
	- dry seed	29,2	3,4	18,8	8,0	6,1	34,5	1183	222,6	155,4	3,00	8,1	794	0,19	2,59	250	0,28	0,01	1,33	3,7
Bauhinia galpinii	- green seed	59,0	1,3	10,2	7,6	3,6	18,3	752	41,3	109,3	1,08	9,2	355	1.10	0,80	175	0,36	-	1,11	26,3
	- dry seed	25,6	2,6	20,3	12,0	7,1	32,4	1290	152,6	216,5	2,09	13,0	732	0,90	1,69	350	0,55	0,55	1,71	1,4
Dalbergia armata	- leaves	73,9	2,4	5,9	0,5	3,9	13,4	343	264,9	105,5	3,73	3,4	564	0,70	1,13	74,8	0,08	0,27	1,54	35,7
Trichilia emetica	- seed alone	49,0	1,8	4,9	27,8	2,5	14,0	1318	101,4	113,7	1,72	15,7	617	0,82	1,16	101	0,29	0,12	2,71	18,2
	- seed & skin	46,7	1,8	5,2	28,5	3,5	14,3	1354	87,3	113,2	1,65	14,5	618	0,64	1,24	106	0,32	-	3,61	23,9
Antidesma venosum	- fruit	93,7	1,1	0,4	0,1	0,9	3,8	535	28,0	22,5	0,86	3,7	219	0,29	0,20	10,0	-	-	-	-
Harpephyllum caffrum	- green fruit	78,2	1,4	1,0	0,3	-	-	-	78,7	43,4	1,21	9,5	447	0,22	0,22	20,0	-	-	-	59,0
	- ripe fruit	87,5	0,9	0,7	0,25	1,7	9,0	170	48,9	22,5	0,51	4,3	251	0,14	0,14	15,0	0,12	-	-	70,7
Rhoicissus tomentosa	- leaves	76,1	1,8	3,6	0,3	5,1	13,4	297	220.0	75,9	3,77	2,4	413	0,44	0,52	52,0	0,03	0,02	1,60	44,0
Maesa lanceolata	- fruit	67,2	1,7	3,7	7,2	8,0	12,2	420	242,3	66,7	2,39	12,5	572	0,43	1,42	103	0,08	0,03	1,35	6,9
Mimusops obovata	- fruit	70,2	1,7	1,9	0,3	1,9	24,0	446	43,9	51,5	0,88	51,6	489	0,39	0,21	26,0	-	-	-	60,0
Mimusops zeyheri	- fruit	72,3	0,8	1,0	0,2	3,4	22,3	399	35,1	19,3	0,77	11,8	276	0,12	0,12	13,0	-	- -	-	47,0
Brachylaena discolor	- flowers	52,9	3,2	5,2	4,7	12,6	21,4	616	191,4	82,6	3,60	21,5	859	1,44	1,48	87,0	0,12	0,14	0,68	15,0

All Fruit, Flowers etc were collected on Cyprus and transported while still fresh to Pretoria on a commercial fruit truck. These trucks travelled through the night and arrived in Pretoria at 04h00. They were then picked up by the C.S.I.R. and immediately prepared for analysis using the Standard Methods of the National Food Research Institute, C.S.I.R., PRETORIA. Results are expressed on a natural basis would therefore on the basis of these criteria expect moepels (Mimusops zeyheri) to be preferred to the fruit of Euclea natalensis.

Another criteria which can be considered here are the food values. One has, however, to be careful in inputing such parameters as factors which may affect a monkey's choice because whether monkeys are able to distinguish cognitively or subconsciously, the food value of a fruit is dubious to say the least. Furthermore the discussion is complicated by the fact that one is not really sure what are the food requirements of monkeys. However, intuitively we can say that energy wise for instance Trichilia emetica , Bauhinia galpinii and Acacia ataxacantha seeds should be favoured, perhaps because of their high fat content. On the other hand with respect to vitamin C, a vitamin which if lacking or deficient in vervet monkeys in the laboratory, leads to severe lesions (De Klerk et al 1973), Harpephyllum caffrum or Mimusops obovata would be expected to be favoured fruits.

Ripeness, Palatability, Accessibility and Preparation of Food items

Ripeness is a form of variability which should fall under phenology but which it is more convenient to discuss here under monkey oriented variables, for it is the monkeys who choose to feed on fruit when it is ripe. This is an immediately observable fact, both from direct observation and by examination of debris. It was initally attempted to qualitatively estimate the percentage of fruit ripe at one time on fruiting trees but it was found to be too difficult to make such an estimate accurately, partly because in many species the ripe fruit hardly differed externally from the unripe or partially ripe fruit. In those individuals where it was possible to keep such a record (e.g. Halleria lucida) it was notable that at most 20% of the fruit was ripe at any one observation time. Clearly this reduces even further the amount of food available to the monkeys and introduces an additional aspect to the problem of finding food.

By palatability is meant the question of whether the monkeys like or can eat the fruit. Clearly even if a food source is available and ripe and has been noted by a monkey it will not be utilised by the monkeys if it has a terrible taste or causes stomach or intestinal disorders. While this is a subjective variable it is clearly of importance, although we have absolutely no information about it and only very detailed laboratory work could obtain it.

Another factor which has to be taken into account, again a "monkey orientated" variable is the accessibility and degree of preparation necessary for food items. Here, again it is difficult to assess the effect of this for the same reasons as with palatability. Subjective observation showed however that it appeared to be "easier" for drupes to be eaten because they required less preparation, while capsulated seeds (e.g. Trichilia emetica, Acacia ataxacantha Combretum molle etc.) required more time to eat because they required more extensive preparation. In additon, for instance, in the case of Acacia ataxacantha, the very dry seeds of plants had to be softened by initial chewing and storage in the cheek pouches where salivary amilase could act on the seeds. It was noted that the rejected debris underneath an Acacia bearing dried out, brown seeds was often hard and lumpy, the result of a single chewing session while after the monkeys were disturbed after a feeding session and the contents of cheek pouches was ejected and spat out, this was of a soft starchy consistency.

The characteristics of the various fruits and flowers, as well as the known occurence of certain specific butterfly leaves is listed in Palgrave (1977). In this book factors such as whether the various species bear auxillary or terminal fruits, whether the fruit is a seed or a drupe, whether the tree is monoecious or dioecious or bisexual is noted, all these being factors of importance at this level, and this will be referred to again in later chapters.

Summary

In the last three chapters the levels at which the forest provides an unstable and seasonal feeding substrate have been discussed. While previous workers have recognised that distribution and numbers of trees is an important variable which may affect feeding behaviour of monkeys, it was pointed out that an average view of a whole study area is really inadequate. What is really required is a description of how much these parameters vary within the animal's home range or within the home area of study.

So far as phenology, productivity and so-called monkey orientated variables are concerned these have been largely ignored previously, although they individually and collectively must play a highly important role in moulding the feeding strategies and ranging behaviour of a group.

In the following chapters the response of the monkeys to this habitat will be described and the extent of the role of the variables described and identified will be tested.

SECTION E

THE RESPONSE OF THE MONKEYS TO THE HABITAT

CHAPTER TEN

INTRODUCTION AND METHODS USED

In the preceding chapters many aspects of forest as a habitat have been discussed. It has been attempted to show the areas where such an enviroment exhibits a labile and unstable substrate for the monkeys in question, and the levels at which this occurs. We must now examine whether the monkeys are actually limited by this instability and, if they appear to be, to examine how they have solved this problem.

In order to do this data were collected on four major aspects of behaviour, namely their social organisation, their feeding behaviour, their ranging behaviour and other aspects of behaviour not directly relevant to the hypothesis in hand.

At the beginning of the study it was found that the collection of complete systematic data on these parameters was almost impossible. First the monkeys were rarely found in the main part of the study area, their movements being primarily concentrated in areas which were almost inaccessible to an observer. When they did move into the more accessible areas periods of continuous observation were very short and precluded the collection of systematic data. It was primarily due to this initial set-back that the study, originally directed at the collection of data on all aspects of social and individual behaviour exclusively, was changed in accent with the prime object of study being the habitat.

Initially therefore, data collection on monkey behaviour was limited to ad lib observations when and where the chance arose. As the study progressed not only did the monkeys become more habituated, not fleeing from the observer immediately contact was made, but they were also found to occupy the main parts of the forest more frequently, thus facilitating easier observation. With the other habitat parts of the study being either in hand or completed it was possible to do some systematic sampling to test the main hypotheses of the study.

There were thus two methods which were used to sample behaviour, an ad lib method and a systematic method. Each method was directed at the acquisition of different types of data. The ad lib method was used to collect data on group sizes and structure, sex ratios, species of plants eaten and the observation of inter-individual behaviour, modes of progression, and inter-specific behaviours which one might classify as general behavioural observations. In contrast the systematic sampling was directed at collecting data on home range sizes, daily distances of travel and dispersion, daily activity patterns and other such parameters where data of a quantitative nature were required.

Description of the Methods used

(1) Ad Lib. Methods

Whenever monkeys were seen or heard while occupied in other work attempts were made to collect data in the form of sight records. The location of the sighting, the number and where possible the age and sex of the individuals were recorded. The duration of the contact was noted and their direction of movement. If contact with the observer did not appear to have disturbed the activities of the monkeys then contact was maintained for as long as possible and notes taken on behaviour. Where possible notes on feeding (i.e. age - sex class of animal and item consumed) were taken according to the criteria laid down (see Systematic Method). These last data were used to compile the table in chapter seven as well as the systematically collected feeding data. The quantative data appear in chapter eighteen.

(2) Systematic Method

When more or less continuous observation was possible systematic sampling was begun. Here the accent was upon collecting specific data at regular intervals rather than recording events which at the time seemed interesting or which were most noticeable. Ad lib observations suffer from many major disadvantages which are greatly reduced if sampling is done systematically and a sampling schedule can be drawn up and adhered to without interruptions. With Ad Lib sampling there is a great danger that the data collected will only be those which the observer wants to see or which are most visible or obvious to the observer. Other, perhaps, more subtle or cryptic behaviours are very likely to be missed or ignored. The result can only be bias in the data. However, systematic sampling can only be successful if continuous observation over extended periods is possible. It should be noted that even systematic sampling is not foolproof in this regard when observing forest animals. In terrestrial primates after sufficient habituation has taken place, observation of most if not all of the group under study is possible. This can rarely be the case in forest monkeys, where the majority of individuals are usually wholly or partially obscured from the observer by foliage. In addition some individuals may be obscured more of the time than others, resulting in unequal observation of all individuals. There is however no way of telling how much this type of bias occurs. As will be noted later, the most important data collected by this method were those on ranging behaviour and this is relatively free of bias from this source. Other data collected using this method are however certainly subject to this error (i.e. feeding and activity data).

The method was as follows and was based on a method devised by Struhsaker (1974) and used by several workers in East Africa.

The Main Group (see chapter eleven) was followed from dawn till dusk over a five-day sampling period from February 4th - 8th, 1975 and from June 17th - 21st, 1975.

During each hour of the day starting on the hour data on the various previously discussed parameters were collected according to the time schedule illustrated in Figure 58.

(a) Ranging Data

On the hour and half hour a five minute period was devoted to noting the position of the study group and its dispersion. Where possible the observer moved around the group, skirting it to determine how widely dispersed the individuals were. When observations were made from above the canopy of the forest i.e. from the kloof sides, the dispersion of the group was much easier to determine than when inside the forest. Dispersion was noted in terms of known landmarks or trees and later plotted on a scale map. The dispersion of groups was of necessity a very approximate measure. Position was also recorded with respect to known fixed points in the forest.

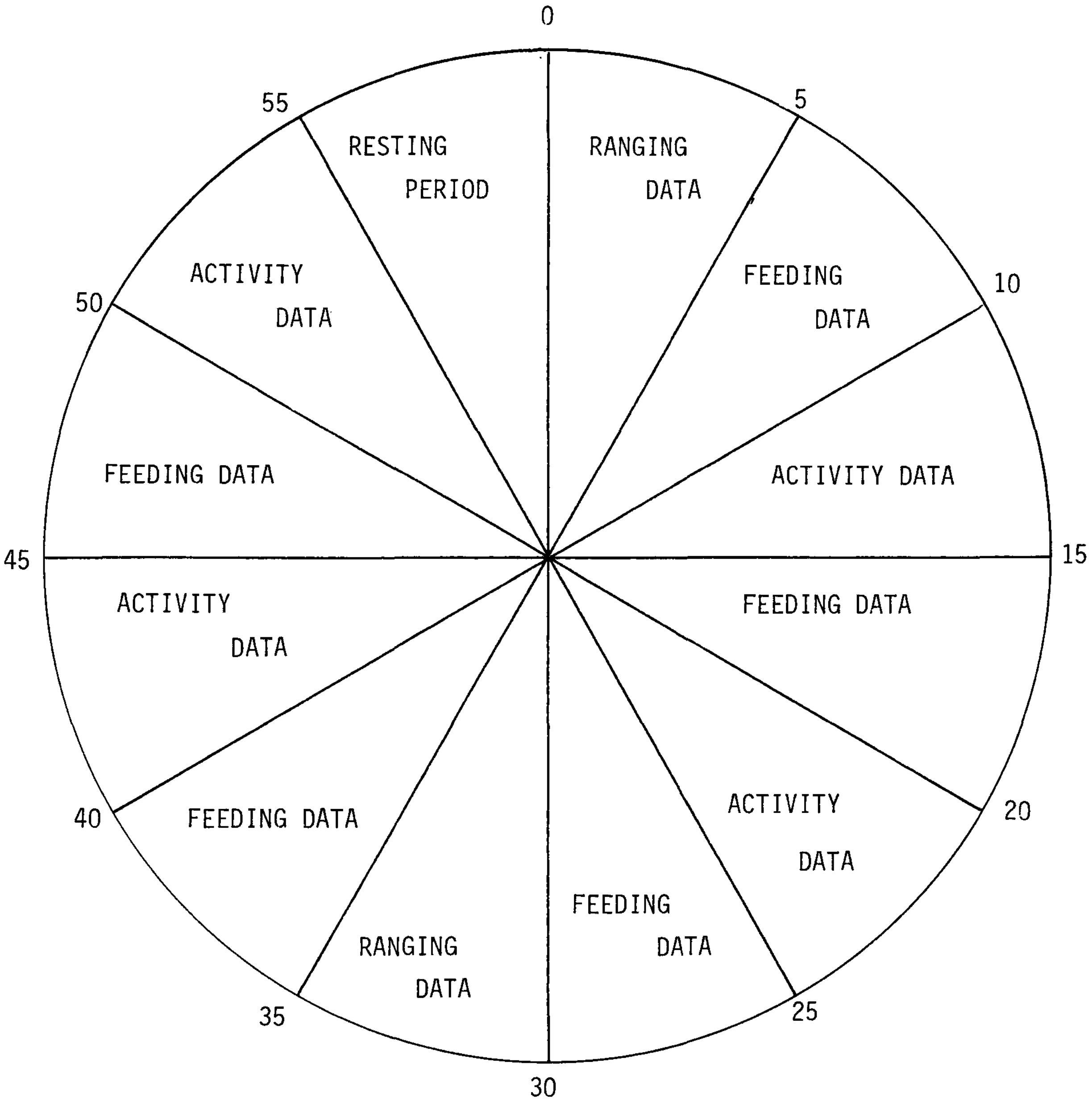
(b) Daily Activities

Data on activities were taken during five minute periods during each hour as indicated in Figure 58. The methods used will be discussed in more detail in chapter thirteen.

(iii) Feeding

This was observed Ad Lib during the whole sample period and noted on a tape recorder. Details of the methods are in chapter fourteen.

Figure 58: Hourly Time Schedule used to collect Ranging, Activity and Feeding Behaviour Data during 5 - Day Follows.



CHAPTER ELEVEN

POPULATION STRUCTURE

In chapter two it was noted that a characteristic of most primates is their tendancy to live in well-defined social groups and this is the case in most monkeys and apes which have to date been studied. Indeed the social group is such a characteristic part of the population structure of monkeys that its size and composition has become one of the most important traits used in the comparison of their societies. Further, the social group and it's composition is thought to reflect, in a broad sense, aspects of adaptation of the species concerned to environmental conditions.

There is however some disagreement as to what a "social group" constitutes. Wilson (1975) describes a group as "a set of organisms belonging to the same species that remain together for any period of time while interacting with one another to a much greater degree than with other conspecific organisms". This definition is clearly a very loose one which is useful when discussing the societies of many often totally unrelated organisms. It implies that the organisms comprising the group are organised into subsets or subgroups or hierarchically. It does not help one, however, to decide in the field, whether an observed party of animals is indeed a group.

Aldrich-Blake (1970) defines a group simply as "the basic social unit of a species", a group being mutually exclusive of a "party" which is that part of a society which is observed at any one time and which consists of either part of a group or several groups. This too is not very helpful so far as field observations are concerned. From the text of Aldrich-Blakes' thesis the apparent reluctance he shows in defining exactly what he means by "group" stems from the fact the blue monkeys which he studied did not show an immediately obvious group structure. He concluded that this forest guenon did show a group structure because certain members of parties, showed mutually exclusive ranging behaviour.

Aldrich-Blake (1970) discusses in some detail the problems of analyzing the population structure of forest monkeys, and these are equally applicable to the present study.

While in terrestrial primates such as baboons the number of individuals in different age-sex classes can readily be counted and the party assigned to the status of a group in a relatively short space of time, this is not the case in forest monkeys. On encountering forest monkeys, the parties are usually two to five in number and of inconstant membership. The fact that the parties encountered did not always consist of the same animals led Aldrich-Blake to think twice as to whether the monkeys he studied did actually have a stable group structure. He was only able to conclude that this was likely because of data gained from study of the ranging behaviour of the monkeys.

Struhsaker (1969) suggested several criteria which may be used to define a "group" and these are the criteria which most workers now accept. as being valid, though it is not possible to, in all cases, define groups in terms of all of the criteria.

These criteria are as follows:

(1) Membership in a common social network. "Individuals of the same social network.......have the majority......of their non-aggressive social interactions within this social network. A given individual does not necessarily interact with all members of its social network, but is associated with all at least indirectly." (page 83)

(2) Temporal stability of group membership.

(3) Occupancy of individuals of a common home range.

(4) The existence of distinct social roles among members of the group.

(5) Participation in synchronised progressions.

(6) Members of the group show signs of distinguishing between group and non-group conspecifics.

(7) Relative exclusiveness or closure of the group with respect to the acceptance of new members.

Waser & Floody (1974) recognise that the acceptance of a group on the basis of these criteria in toto relies on the ability of the observer to recognise individuals. In the present study it was not possible to define groups in terms of all of these criteria. Indeed only criteria two, five and six were completely fulfilled.

In the present study it was also not immediately obvious that the population was organised into groups. However, as observation times increased and it became possible to follow parties, censusing became possible and on the basis of these and from Ad Lib observations a stable group structure was indicated. Thus the aim of the chapter is to show that the population was indeed composed of discrete (after a period of months) groups as defined by Wilson (1975) and Aldrich-Blake (1970) and to give data concerning the size and group structure of the groups encountered in the study area.

METHODS

The samangos encountered at Cyprus exhibited several features which enabled an accurate idea of the population structure to be compiled.

(i) They moved much further in one day than the monkeys studied by Aldrich-Blake.

(ii) In several parts of the study area there were narrow strips of forest along which they moved (i.e. along kloofs and through the gorge to Upper Kloof, as well as places where the roads and paths separated one piece of forest from another and which could only be crossed by one or two monkeys at a time).

(iii) When the monkeys were in these kloofs they could be readily observed from above using binoculars.

A combination of systematic censuses at the crossing points already mentioned, of Ad Lib observations already described and data on the ranging behaviour was used to compile the statistics on population structure. In addition certain behavioural data concerning the interactions of animals when parties met and the protocol of progression lend support to these data.

(i) Age-Sex Classes

The following criteria were used to separate age-sex classes. The divisions are arbitrary and certainly represent a continuum rather than actual discrete categories. Because of the difficulty experienced in completely distinguishing some classes as used by other authors, they are necessarily vague. Both behavioural and morphological criteria have been used.

Adult Males

Large in size, with long very well haired tails and dorsum. The hair at the side of the neck long and thicker than in other age-sex classes. Laryngeal air-sacs visible. Produced characteristic "Pant" and "Boom" calls. Progressed with a characteristic swaggering gait using horizontal branches where possible and rarely hurrying over exposed limbs, very easy to recognise.

Adult Females

Retiring and shy - easy to confuse with sub-adult males. Identifiable close up by the possession of medially placed long pendulous nipples. In summer spring, early winter associated with infants. Distinguishable from sub-adult males which had a similar size but a more hairy and greener dorsal pelage, when close.

Sub-Adults

Difficult to distinguish but considered to be animals intermediate in size and darkness between adults and juveniles.

Juveniles

Dorsal pelage grey rather than dark olive and independent of adults in crossing hindrances.

Babies

Cape grey and smaller than juveniles with a tendency when moving independently to miss their footing. Always associated with adult females and other babies. In crossing exposed areas away from cover always "chaperoned" by females.

Infants

Black, incompletely covered in hair and always carried. Rarely seen except during progressions.

These classes are certainly far from ideal. They do not however form a basis for the analysis of behaviour but rather are a base for the description of the structure of the population itself. It is therefore permissible to use behavioural characteristics for distinguishing the classes.

(ii) Censusing

If one of the groups crossed a gap or crossing where it progressed in single file or nearly so, a census was conducted, and where possible age-sex classes determined. The censuses were graded for reliability (after Marsh 1973 - in litt.). This is illustrated in Figure 59.

Censuses were made when the groups were in the open forest and when groups were viewed from above. However, these censuses were certainly unreliable and none of these was more than a II grade census. The census data presented includes only censuses made between December 1974 and April 1975, during which period the group sizes and composition remained constant.

Results and Discussion

Figure 60 summarises the population structure of the groups encountered in the study area. All were obtained from censuses and were class IV censuses except those for groups X and H, which were class III.

Figure 59: Classes Assigned to Censuses so as to Grade them for Reliability.

I - POOR Census unreliable - a minimum estimate only

II - FAIR Total beleived to be of the right order of magnitude but some animals known to have been missed.

III - GOOD Total beleived to be correct.

IV - COMPLETE Census tallies in all respects with censuses made within a period of one month.

Figure 60: Population Structure of Groups of Samango Monkey found at Cyprus.

Group Name	Group Size	Adult Males	Adult Females	Sub-Adult	Juv-enile	Babies	Infants	No. of Censuses
M	34	3	8	1	10	6	6	5
D	6	1	2	-	2	-	1	3
B	18	2	6	1	3	4	2	4
X	4	1	1	-	1	1	-	-
H	6	1	3	-	1	1	-	1
$\bar{X}$	13,6	1,6	4	0,4	3,4	2,4	1,8	
σ	12,6	0,9	2,6	0,5	3,8	2,9	2,9	

3 Solitary Males were known to be present in the Study Area.

These data show the mean group size to be 13,6 animals with a standard deviation of 12,6. The Adult Sex Ratio was 1:2,5.

In discussing these figures we must first consider evidence which implies that they are in fact groups, or that the monkeys indeed have stable groups.

(i) The fact that on five occassions when censuses were made of the main group the group size did not alter and this being over a period of five months in itself implies a stable group structure.

(ii) While ranging data will be discussed later, this shows that the groups during the periods when ranging data were systematically collected and from Ad Lib data that groups did not come together or fuse at any time. In addition when observations were made from above the forest on kloof sides, the groups were observed to space themselves in an active manner, by moving away from each other when coming into proximity with each other. On these occassions adult males showed characteristic behaviours, climbing the highest trees they could find and looking in the direction of an approaching group. When two groups approached each other there was an increase in the frequency of pant-calls and boom-calls, both calls being very audible when above the forest.

(iii) When an obstruction to the direction of travel was encountered, i.e. a place where only one tree over-hung the road and the animals could not cross in a spread out manner, the progression was temporarily halted, the adult males would boom and pant call, the other animals would give chirrup calls and the previously well spread animals would become concentrated. Then in two's and three's the animals would cross, usually juveniles and sub-adults crossing first and the males last. On the other side of the obstruction animals would disperse rapidly into feeding trees. This behaviour will be discussed in more detail later.

This information would certainly indicate that these monkeys indeed have a stable social unit or group structure. Assuming then that these represent true groups we can compare them with similar data obtained by Aldrich-Blake (1970) for blue monkeys in Uganda (Figure 61).

The mean sizes of the groups correspond well, though it is clear that the two populations studied differ in their composition quite considerably. The Cyprus samangos are clearly a young population with the ratio of adults to young animals of 1:1,4 while that of the blue monkeys is 1:0.85. This would seem to imply that the Cyprus samango population is increasing.

Another interesting feature is that the group sizes of the Cyprus animals are incredibly variable, with one group being, at the time of study very large indeed and larger than one would have believed or predicted from the blue monkey data. It is also notable that in this group there are three adult males and the adult to young ratio is 1:2,2. These phenomena will be discussed later, but it might indicate that this group was indeed on the verge of splitting.

Population structure alone has its limitations. However, when considered along with other data such as ranging and feeding behaviour it is of considerable significance. The population structure will be discussed again later when ranging activity and other behaviour has been discussed.

Figure 61: Population Structure of the Blue Monkey Population at the Budongo Forest Study Site of Aldrich-Blake (1970)

Group Name	Group Size	Adult Males	Adult Females	Young Females	Undetermined	Adults (Total)	Juveniles	Babies	Infants
A	16	2	6	1	-	9	2	3	2
B	12	1	3	-	2	6	3	3	-
C	17	1	5	1	2	9	3	4	1
D	10	1	3	1	-	5	1	3	1
E	12	1	4	1	-	6	2	4	-
F	13	1	4	-	2	7	2	4	-
$\bar{X}$	13,3	1,1	4,16	0,6	1	7	2,16	3,3	0,6
	2,6	0,4	1,16	-	-	1,6	0,75	0,5	0,8

CHAPTER TWELVE

THE RANGING BEHAVIOUR OF SAMANGOS AT CYPRUS - 1974/5

Introduction

Where the animals under study go, how far they travel in a day and the degree of dispersion of the group under study, are parameters of primate social life which have occupied much of the time of observers. Different species studied appear, over a period of time, to occupy varying areas. The area occupied seems to depend on the number of individuals within the group and on the type of animal. Groups of the same approximate size may have different home range sizes (Waser & Floody (1974)). In past studies a certain amount of confusion has arisen as to how data should be analysed. Ranging data usually consist of plots of varying degrees of systematised collection over varying periods of time. From a map of these plots, a line is then drawn around them in either of two ways. First, a "taut-string" line or maximal convex polygon can be drawn around the sightings, or, second a line can be drawn connecting the outermost points, thus delimiting the area within which all the activity of the group took place - a minimal convex polygon. Waser and Floody (1974) note that considerable differences in home range size are obtained using these two techniques. For the mangabeys they studied the home range for the 35 days they observed the monkeys was 89 ha. for the former method and only 43 ha. using the latter. A further method was used by Altmann and Altmann (1970) for baboons which was to define the day's range by the minimal convex polygon method and then to superpose these maps of the individual day ranges. This method is less likely to include areas skirted or encircled, but not entered. Using this method Waser and Floody obtained a home range of 73 ha.

The last method attempted by Waser and Floody was to superimpose a grid 25m by 25m over the daily sighting records and then to compute the number of quadrats entered as well as the total number of sightings occuring within each such quadrat to determine home range size. This estimate of home range size gave a figure of thirty-four ha. Struhsaker (1974) used this type of information to produce an index of quadrat utilisation diversity using the Shannon-Wiener Information measure, which in one-statistic gives one an idea of the diversity of the ranging pattern, taking into account the time spent in each quadrat.

Another parameter of ranging behaviour which can shed some light on the type of ranging pattern being used is the daily distance travelled by the group, though this does not take into account the time spent by the monkeys in various locations.

The above discussion illustrates the difficulties one faces in saying the home range is 'x' ha, for instance. Not only does home range size reflect certain parameters of the biological life of the animals, the dispersion of food, the size of group etc, but also the method used to analyse the data.

So far we have only considered the home range, so far as systematic data are concerned. It will be clear that data collected in an Ad Lib manner is even less reliable and because the time base is not defined such data for comparative purposes are much less useful, the amount of time being spent in various areas being undeterminable.

The analytical problems of determining the size of the group's living space and the relative amounts of time spent in the various parts of that area are only one aspect of the problem of interpretation of ranging pattern data. A further problem lies in the interpretation by various workers as to what a "Home Range" is and what is, for the animal under study, a useful definition or empirical description of living area. The names which have been used to describe the living area or area occupied by an individual, a pair or a group of animals,are legion and have verying degrees of implication as to the social function of that area. Thus we get concepts such as "territory", implying a living area or part of a living area which is defended, or such as "Life Time Range". "Home Range" has been used to mean the area used by a group in a twenty-four hour period by some workers, while others (Mason (1968) suggest it is the area used over a longer period. Casimir and Butenandt (1973) use the word "animal home range" while Burt (1940) and Jewell (1966) suggest that an animal's "Home Range" is the area that the animal covers in it's "normal activities".

From this rather muddled picture it may be deduced that there is some confusion as to why the area occupied by an animal group is useful to determine. For the purposes of this study the actual area in hectares was considered to be of less importance to actually where in the study area the animals were at what time and in relation to the amount of food available. The sizes of the home ranges of the various groups was, however determined using the minimal convex polygon method. For 'M' Group home range was also determined using the quadrat method. Daily distance travelled was also determined for 'M' Group.

While no systematic data have been collected for 'D', 'B', 'X' and 'H' Groups, the area within which all sightings of these groups occured during the study have been included. These maps only really show where the animals were found and to call the area covered by these sightings a home range is not really 'accurate' in the sense that, that of 'M' Group is. 'M' Group's sightings are also included in this map. No information as to which areas were used more than others can be deduced from this map and hence the plots of these sightings have not been included, as a higher density of sightings in one area might imply that an area was used more than another, while this may not have been the case.

Ranging Patterns of Groups as collected by Ad Lib. Observation.

During the period January 1974 to November 1975, a total of 1428 sightings of samango monkeys were recorded during the course of work on other aspects of the study. In many cases no attempt was made to continue observation though the centre of the group's spread was determined so far as possible.

Figure 62 shows the areas where the different groups were sighted in the study area as well as the number of sightings of each group. Figure 63 shows the area in hectares covered by each such 'home range' and also indicates the number of individuals per hectare.

It will be noted that there is considerable overlap in these home

Figure 62: The 'Home Ranges' of the Groups of Samango Monkey encountered at Cyprus as determined by Ad Lib. Observations.

Scale: 1 cm = 135,5m.

▦ = 'M' Group - 51,2 ha. (876 observations)

D = 'D' Group - 11,1 ha. (136 observations)

X = 'X' Group - 4,8 ha. (34 observations)

▨ = 'B' Group - 22,1 ha. (248 observations)

H = 'H' Group - 9,3 ha. (84 observations)

Figure 63: Areas in hectares of the 'Home Ranges' of the 5 Groups encountered at Cyprus

Group	Home Range Area	Density of Animals/ha.	No. of Sightings
M	51,2	1,4	876
D	11,1	1,85	186
X	4,8	1,2	34
B	22,1	1,26	248
H	9,3	1,55	84
$\bar{X}$	19,7	1,45	

ranges and this must be a result of the fact that the data were collected over a period of almost two years. This does not mean that groups fused at any time.

While the areas of the home ranges appear to be highly variable this appears to be a function of the number of animals in each group because the densities of individuals per hectare remains fairly constant (standard deviation = 0.26).

Ranging pattern of 'M' group as obtained by five-day follows

'M' group was followed in February and June 1975 in the manner described in chapter ten. The monkeys were located late in the afternoon of February 3rd, 1975 and the 16th June, 1975. They were on both occasions relocated in the same positions they were left before dawn on the following day. The group was subsequently followed as described for the following five days (4th - 8th February and 17th - 21st June.

Conditions during the follows

February 1975

Figure 64 illustrates the climatic conditions during the follow.

This table shows that quite a lot of rain fell during the follow. The heaviest fall was however during the night. On four days out of the five low clouds enveloped the upper part of the study area.

June 1975

Figure 65 shows the climatic conditions experienced during the June follow. No rain fell during this period, while the number of hours of sunshine experienced was on average more than found in February. The temperatures are markedly less with an average mean daily temperature of 11,9°C and an average munimum at night of 4,7°C in comparison with 21,25°C and 15,2°C respectively in February.

Figure 64: The Climatic conditions Prevailing during the 5-day Follow from February 4th 1975 to February 8th 1975.

Date	Rainfall. (mm.)	Period	Sunshine (hrs)	Low Clouds Obscure Escarpment	Maximum Temperature 08h00	Minimum Temperature 08h00	Mean Temperature 08h00
4 Feb	0,3	08h00 - 10h00	6,4	Clear 14h00	27,5	14,5	21,0
5 Feb	nil		9,5	Clear 09h00	29,5	13,0	21,2
6 Feb	32,1	19h00 - 22h00	7,5		29,0	16,5	22,75
7 Feb	1,9	10h00 - 12h00	4,6	Clear 11h00	24,5	15,0	19,75
8 Feb	1,6	05h00 - 08h00	0,8	Clear 09h00	26,0	17,0	21,5
TOTAL	35,9	$\bar{X}$	5,76		27,3	15,2	21,25

Figure 65: The Climatic conditions Prevailing during the 5-day Follow from June 17th 1975 to June 21st 1975.

Date	Rainfall. (mm.)	Period	Sunshine (hrs)	Low Clouds Obscure Escarpment	Maximum Temperature 08h00	Minimum Temperature 08h00	Mean Temperature 08h00
17 Jun	nil		6,8		28,5	9,0	18,75
18 Jun	nil		5,5		16,0	5,0	10,5
19 Jun	nil		7,1		17,0	2,5	9,75
20 Jun	nil		7,0		16,0	4,0	10,0
21 Jun	nil		7,4		18,5	3,0	10,75
TOTAL	0,00	$\bar{X}$	6,76		19,2	4,7	11,95

Five-day follow - February 1975

Figures 66,67,68,69 and 70 show the daily ranging patterns for the five days of the follow. Figure 71 shows all the points for all five days plotted without the sequence shown. A minimum convex polygon has been drawn as well as the line enclosing all points. In the case of the minimum convex polygon it is noticeable that areas of grasslands and forest fringe have been included which the monkeys were never observed to enter.

The five day home ranges as determined by these methods show a similar result to that discovered by Waser & Floody (1974) using a minimum convex polygon the value was 21,4 ha which included areas of grassland while the method joining outside points yielded a home range of only 7,28 ha. By Waser and Floody (loc. sit) quadrat methods, using a 50 m x 50 m quadrat the home range was 11,25 ha while using 25m x 25m ha quadrats a five day home range of 5,5 ha was found.

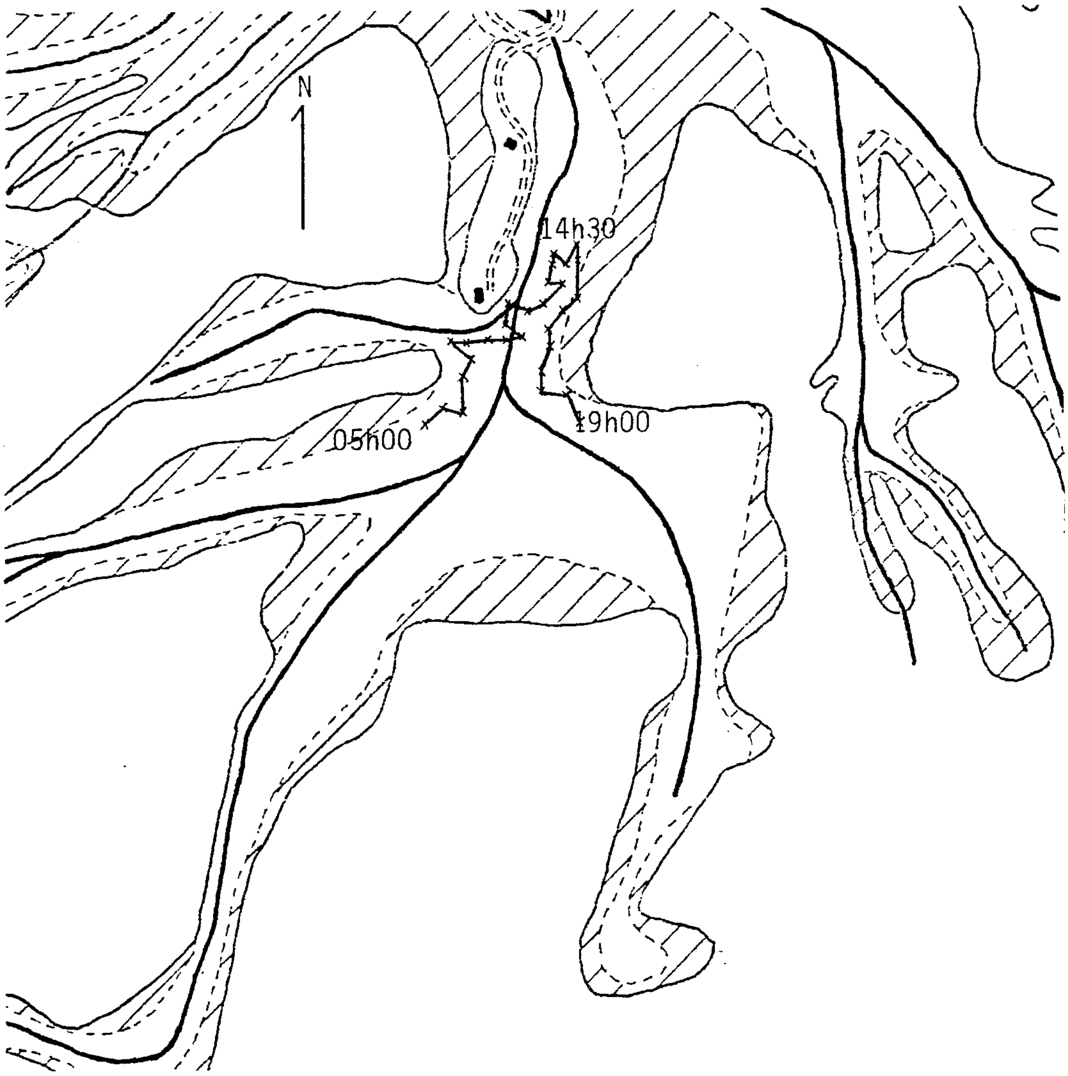
Clearly the size of the quadrat used affects the home range size obtained.

The most used areas of the home range can be discerned visually in Figure 71. These have been indicated as areas ①, ②, and ③. As in Waser & Floody's work these correspond to areas where food sources were particularly dense. At ① there was a local abundance of Celtis africana, Croton sylvaticus, Cryptocarya liebertiana and Syzigium cordatum all bearing ripe fruit. At ②, which corresponds almost exactly with the Flood Forest Community, there were several heavily bearing Rauvolfia caffra and Cryptocaya liebertiana. ③ was an area which was heavily infested with creeper (Rhoicissus spp) which also bore heavy crops of ripe fruit.

From the feeding data it was noticeable that these fruits predominated in the feeding records.

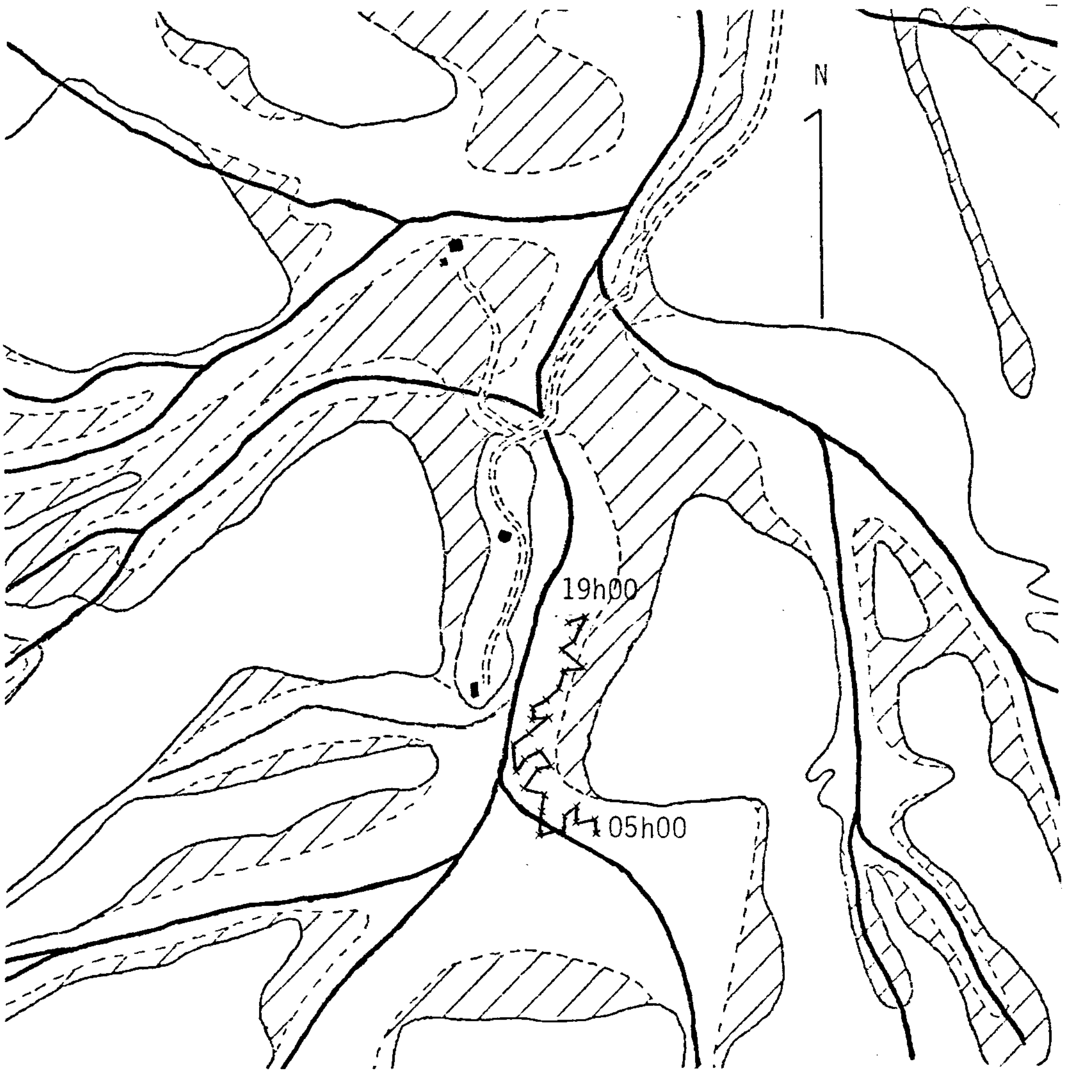
Figure 72 shows the distances travelled between sightings. The average daily distance travelled was 829m while the average distance travelled in a half hour period was 29,46m.

Figure 66: Ranging Pattern for 'M' Group - 4/2/75.



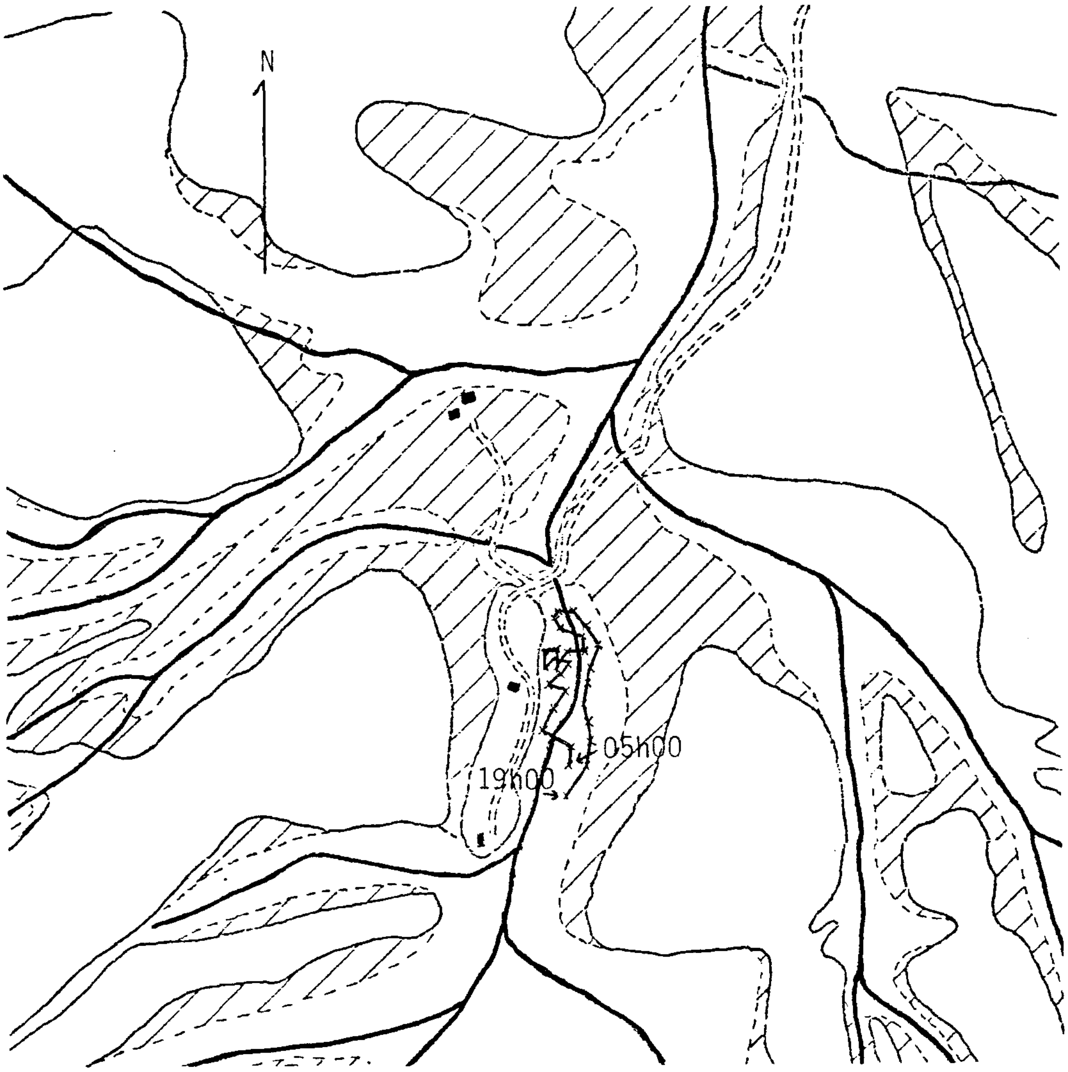
Scale 1cm = 94,1m.

Figure 67: Ranging Pattern for 'M' Group - 5/2/75.



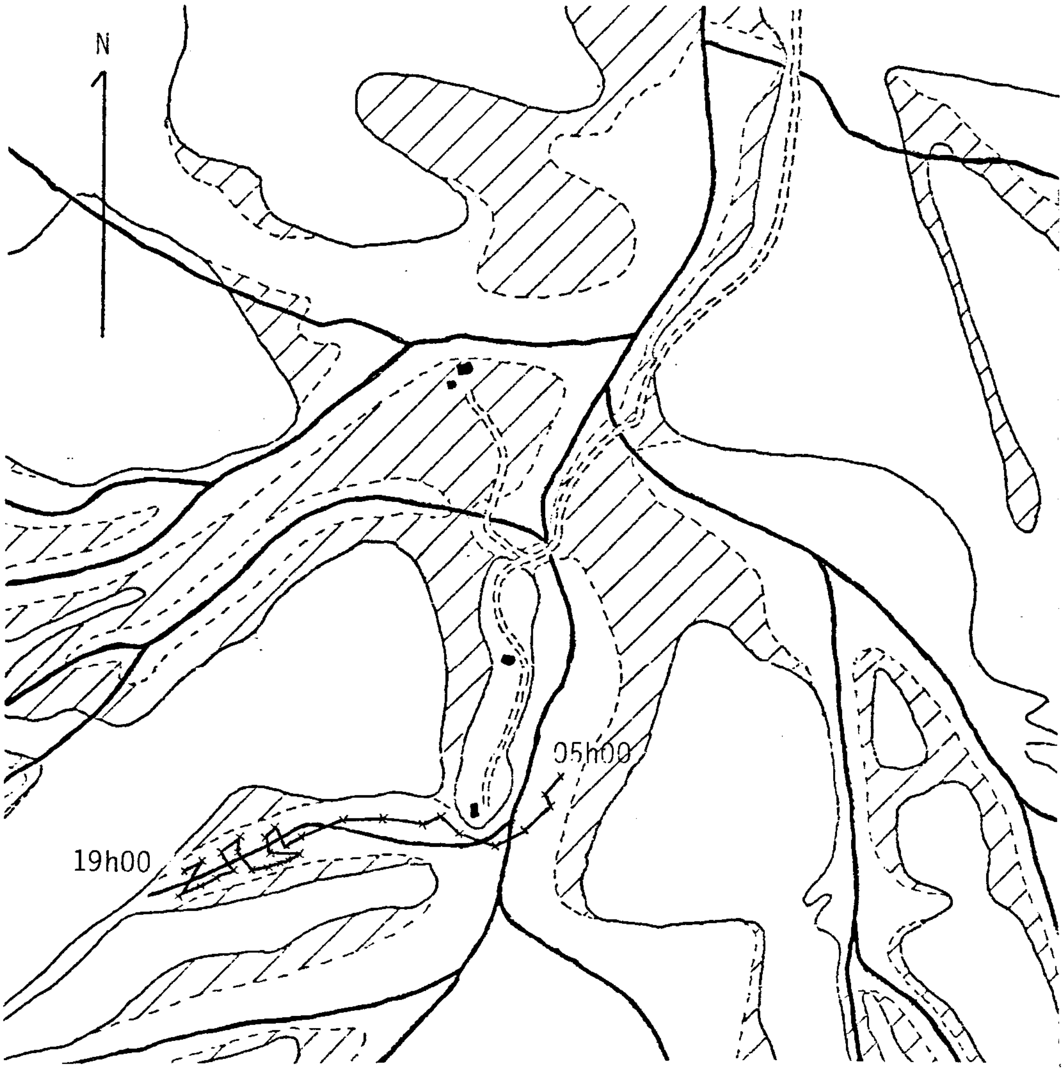
Scale 1cm = 94,1m.

Figure 68: Ranging Pattern for 'M' Group - 6/2/75



Scale 1cm = 94,1m.

Figure 69: Ranging Pattern 'M' Group - 7/2/75



Scale 1cm = 94,1m.

Figure 70: Ranging Pattern for 'M' Group - 8/2/75

Scale 1cm = 94,1m.

Figure 71: A Plot of ½-hour Fixings for the 5 Days of the Follow 4/2/75 to 8/2/75.

Scale 1cm = 94,1m.

Figure 72: The Distances Travelled between Plots for the 5-day Follow from February 4th 1975 to February 8th 1975.

Time	Feb 4	Feb 5	Feb 6	Feb 7	Feb 8	
05h30	35	20	25	30	20	
06h00	25	25	45	20	35	
06h30	40	20	30	45	80	
07h00	25	20	30	40	40	
07h30	40	20	25	50	70	
08h00	20	30	25	35	70	
08h30	25	30	20	25	45	
09h00	20	25	20	50	55	
09h30	25	30	15	55	30	
10h00	30	30	20	60	60	
10h30	30	20	10	25	25	
11h00	25	25	30	25	20	
11h30	25	20	30	20	30	
12h00	40	15	20	20	20	
12h30	20	35	20	40	30	
13h00	30	25	30	20	45	
13h30	25	35	20	10	35	
14h00	25	25	10	15	40	
14h30	35	10	20	20	35	
15h00	25	20	25	30	30	
15h30	50	25	30	20	25	
16h00	25	25	35	30	25	
16h30	30	25	20	30	50	
17h00	20	35	30	25	20	
17h30	35	20	25	20	25	
18h00	25	20	30	30	15	
18h30	35	10	35	60	50	
19h00	40	25	50	25	30	
TOTAL	825	665	725	875	1055	
AVERAGE/ ½ HOUR	29,46	23,75	25,89	31,25	37,67	$\bar{X}$ = 29,46

Average Daily Distance Travelled = 829m.

Five day follow - June 1975

Figures 73,74, 75, 76 and 77 show the ranging patterns of 'M' group for the June five day follow. Figure 78 is the combined plot of all fixes made and Figure 79 shows all the distances between plots. The home ranges were calculated as before. This yielded a five day minimal convex polygon result of 103 ha, while the joining of outside points yielded a home range of 22,8 ha. Using 50m square and 25m square quadrats yielded results of 21,25 ha and 7,06 ha respectively.

The concentrations of activity are less easy to discern. Much more of the available area was used than during the February follow. Noteworthy was the use of Forest B, and the Riverine forest. Feeding records show that in these areas the monkeys fed almost entirely on the seeds and leaves of *Acacia ataxacantha* and *Acacia Karoo*. In both these areas time appears to have been concentrated. In the Main Forest and up the kloof little time was spent concentrated in one locality except during the parts of the day when the sun was strongest and the animals sunned themselves (Upper Kloof c 12h00 - 14h00, Main Forest c 10h00 - 12h00) In the main forest it was noticeable that a wide variety of food items were used and that much leaf was eaten.

Figure 73: Ranging Pattern for 'M' Group - 17/6/75

Scale 1cm = 94,1m.

Figure 74: Ranging Pattern for 'M' Group - 18/6/75

Scale 1cm ≐ 94,1m.

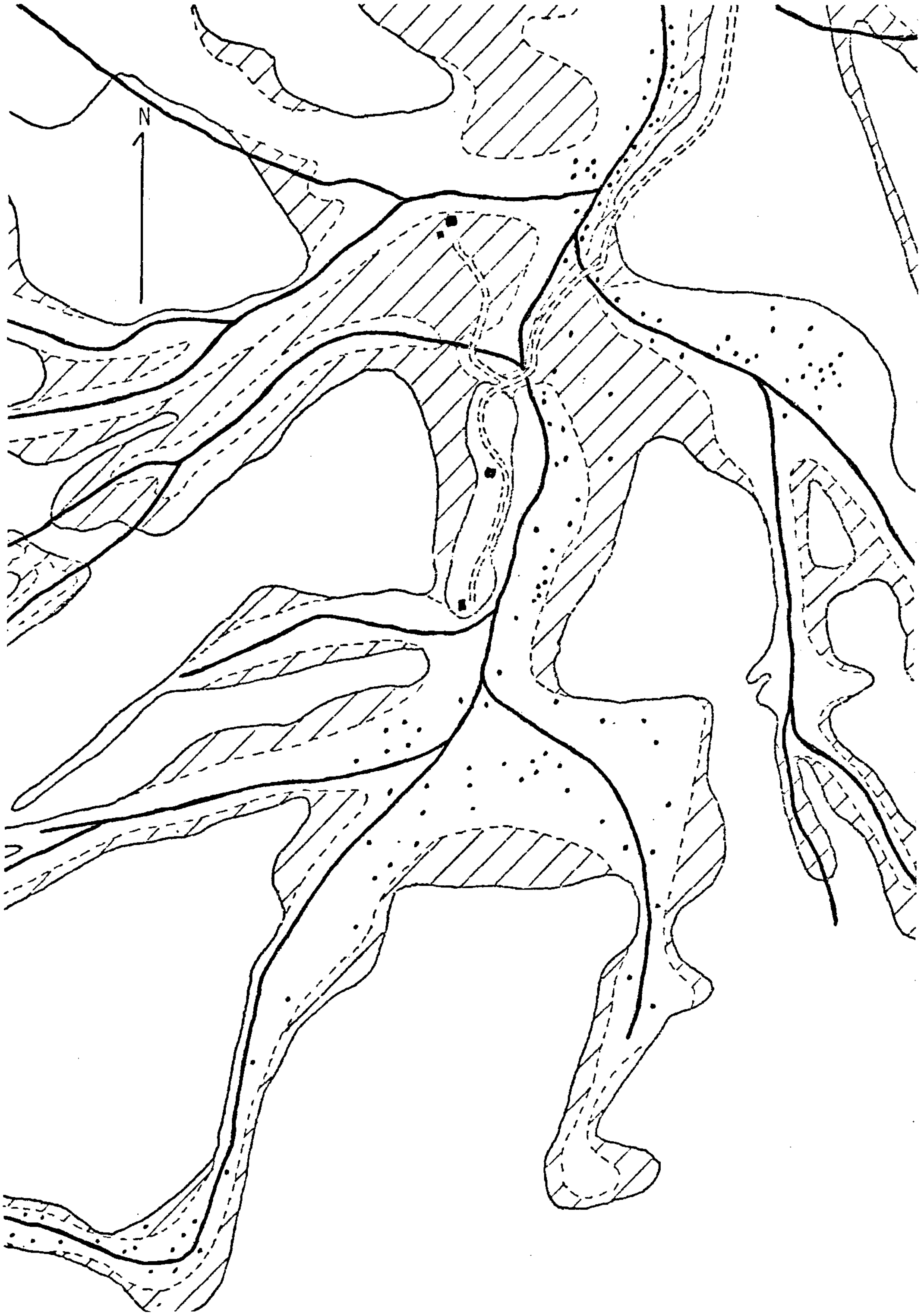
Figure 75: Ranging Pattern for 'M' Group - 19/6/75

Scale 1cm = 94,1m.

Figure 76: Ranging Pattern for 'M' Group - 20/6/75.

Scale 1cm = 94,1m.

Figure 78: A Plot of ½-hour Fixings for the 5 Days of the Follow 17/6/75 to 21/6/75



Scale 1cm = 94,1m.

Figure 79: The Distances Travelled between Plots for the 5-day Follow from June 17th 1975 to June 21st 1975.

Time	Jun 17	Jun 18	Jun 19	Jun 20	Jun 21	
05h30	45	30	35	35	25	
06h00	45	120	65	105	160	
06h30	85	70	30	125	50	
07h00	145	95	50	95	80	
07h30	130	145	55	60	170	
08h00	60	185	45	210	115	
08h30	30	115	20	30	170	
09h00	40	60	50	60	125	
09h30	160	35	30	80	140	
10h00	120	25	30	60	50	
10h30	20	35	10	40	110	
11h00	25	20	30	25	35	
11h30	35	85	30	30	180	
12h00	45	70	35	30	70	
12h30	70	85	70	50	60	
13h00	50	165	115	60	30	
13h30	50	50	70	90	40	
14h00	35	110	110	90	30	
14h30	25	80	90	180	90	
15h00	140	35	110	80	60	
15h30	205	40	100	200	40	
16h00	220	50	105	20	55	
16h30	220	65	180	30	120	
17h00	45	50	60	20	40	
17h30	25	30	50	50	30	
TOTAL	2070	1850	1575	1855	1995	
AVERAGE/ ½ Hour	82,9	74,0	63,0	74,2	79,8	$\bar{X}$ = 74,46

Average Daily Distance Travelled = 1869m.

CHAPTER THIRTEEN

ACTIVITY PATTERNS

Introduction

The proportion of time spent in various activities and the distribution during the day of these activities, especially in this case of feeding is an important aspect of an animal's ecology, for it reflects the relative importance to the animal concerned of the various major categories of activity.

In free-living primates only very few studies have attempted to study this aspect in a systematic manner. As for ranging behaviour, that the data be collecte in a systematic way is of prime importance to preclude too much bias entering the data collected.

Three groups of methods have been used and all require close contact with the animals under study. The first, and most accurate method involves selection and continuous observation of a single individual over periods of time. The secon method called scanning, involves recording the behaviour of all visible animals or a set number at fixed intervals. Clutton-Brock (1974) points out that the former method used by Yoshiba (1967) and Richard (1970) among others is less likel to have bias than scanning methods, providing that the observer's choice of animal to watch is not biased and providing that the observer, and not the animals, controls the starting and ending of observation bouts. However, it is in the latter condition that the former method becomes impracticable because animals so observed can rarely be held in view for periods greater than ten to fifteen minutes. Scanning Techniques (Chalmers 1968a & b, Crook & Aldrich-Blake 1968 Aldrich-Blake 1970; Clutton-Brock 1972) can, however, be used in situations where the whole group is not in view at once and where the animals individually are not continuously visible. The disadvantage however of scanning techniques is that they are susceptible to bias from two main sources. First, individuals showing the more dramatic and visible activities are more likely to be scored. Second, there is the possiblility that more cryptic and shy individuals will be scored less and that if they exhibit a different pattern of daily activities this will be less likely to contribute to the data collected.

The third method used in primate field studies is to treat the group of monkeys under study as single individuals and to record the proportion of time for which "predominant group activity" or the "majority" of individuals visible fell into different types of activity. This method was used by Hall (1962a) and Chivers (1969).

In this study a scanning method was chosen, not only because it was the best method available but because it enabled other data to be collected concerning ranging and feeding during the same period, only twenty minutes in the hour being devoted to the collection of activity data.

Methods

The Scanning Method used in this study was similar to that used by Aldrich-Blake (1970) in his study of blue monkeys in a forest in Uganda and that used by Clutton-Brock (1974) in his study of colobus monkeys.

Aldrich-Blake (loc sit) counted all monkeys visible at fifteen minute intervals and recorded their activity. The activities were then scored into four categories of activity -grooming, sitting, feeding and moving. Other activities such as play and copulation were not included, being too infrequent.

Clutton-Brock (loc sit) recorded the activity of all visible individuals at fifteen minute intervals, including in the scan records for that interval all individuals which came into view during the period (always < five minutes) when he moved around the troop checking its position. Three to eight animals were usually scored in this way per scanning period, though in a few cases eighteen to twenty individuals were scored during a scan. Seven kinds of activities were distinguished; Inactive, Feeding, Moving, Mutual Grooming, Playing, Self-Grooming and other activities (mounting, copulating, fighting etc.).

The method used in this study was similar to that used by Aldrich-Blake and Clutton-Brock. During five day follows activity data were collected at fifteen minute intervals according to the schedule laid down in chapter ten All animals visible were scored for activity and their age-sex class noted. The activities were scored using the same categories as used and defined by Clutton-Brock (loc sit). The height in the canopy was not scored.

During the five day follow from the 4th - 8th February, 1975, fifty-four scans were made on each day, giving a total of two hundred and seventy over the five day period. During these scans one thousand three hundred and fifty-one animals were scored for activity. For the June follow (17th - 21st June) forty-four scans were made daily and two hundred and twenty were made over the five day period. One thousand two hundred and thirteen animals were scored for activity.

To test the accuracy of the scanning the expected number of records for each age-sex class was compared with the actual number. Figure 80 shows these results. Babies and Infants have been excluded from these results. The graph shows that there is no evidence of the data being biased by differential representation.

Results

(a) Weather

Other studies have shown how important the weather is in determining activities. In chapter twelve Figures 64 and 65 summarise the rainfall, temperature sunshine etc., for the February and June follows.

The daily temperature cycle is however also of importance and Figure 81 illustrates the average daily termperature cycle for these periods as determined with the study thermograph.

Figure 82 shows the periods when the sun shone during the two 5-day follows. The long periods when no sun shone at the beginning and end of the day was due to the effect of the mountains. This reulted in a much longer 'twilight' period than normal. In fact it became light up to an hour before the astronomical sunrise and was light up to an hour after astronomical sunset due to this effect.

Figure 80: Expected and Observed Representation of Males, Females and Adolescents in Activity Records.

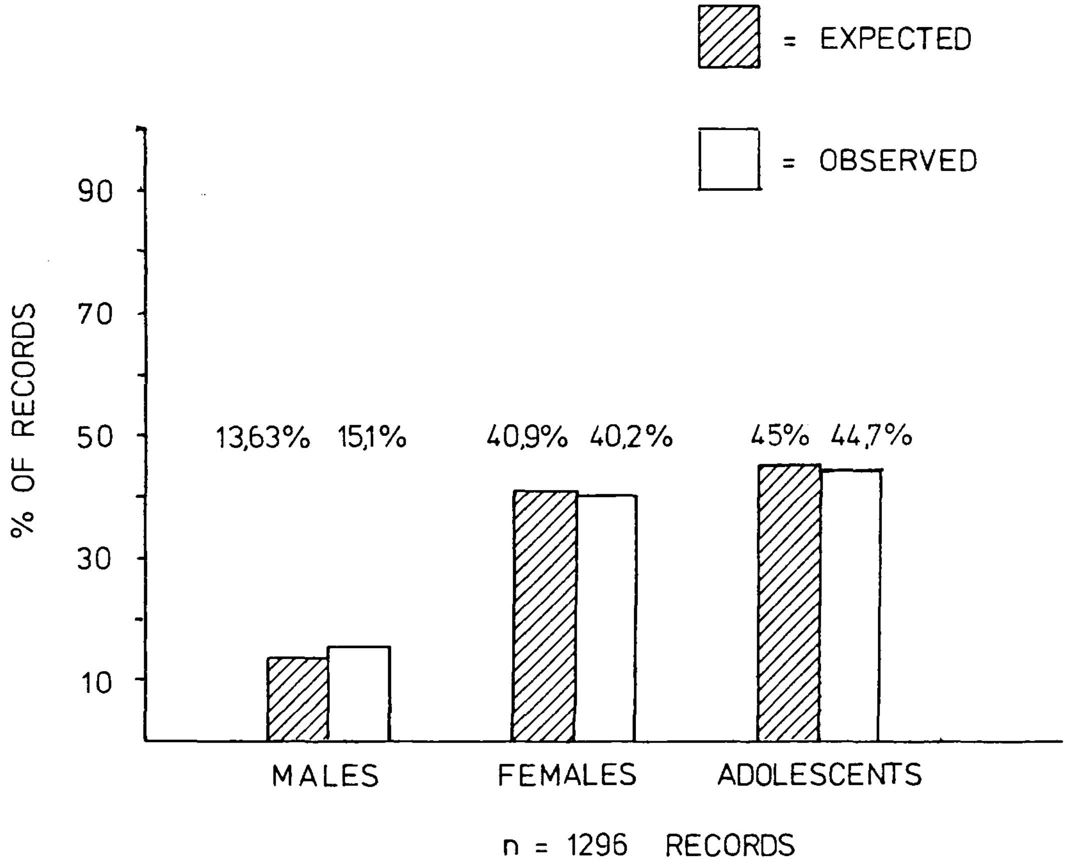


Figure 81: Mean Daily March of Temperature for February 4th - 8th 1975 and June 17th - 21st 1975 at Cyprus.

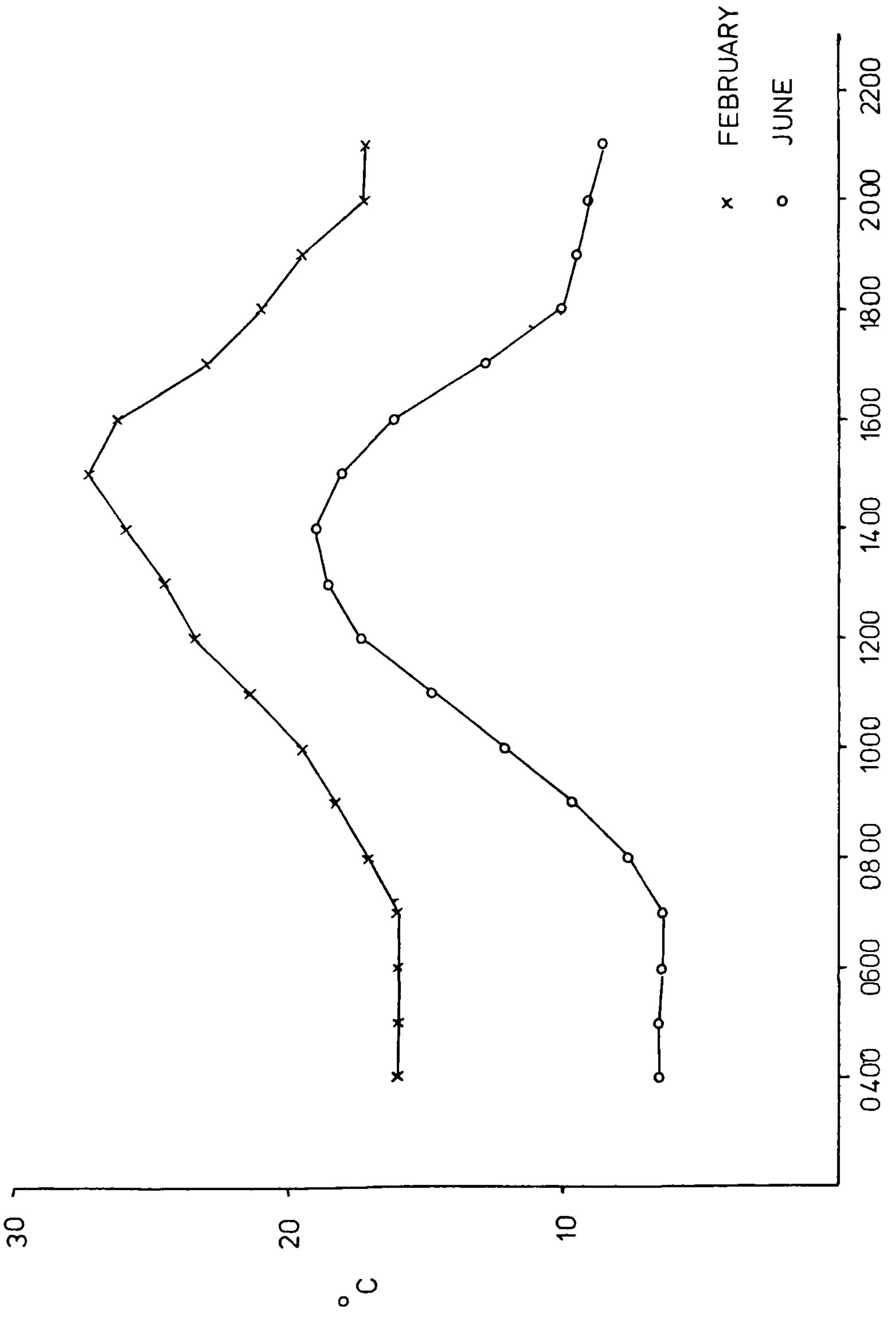
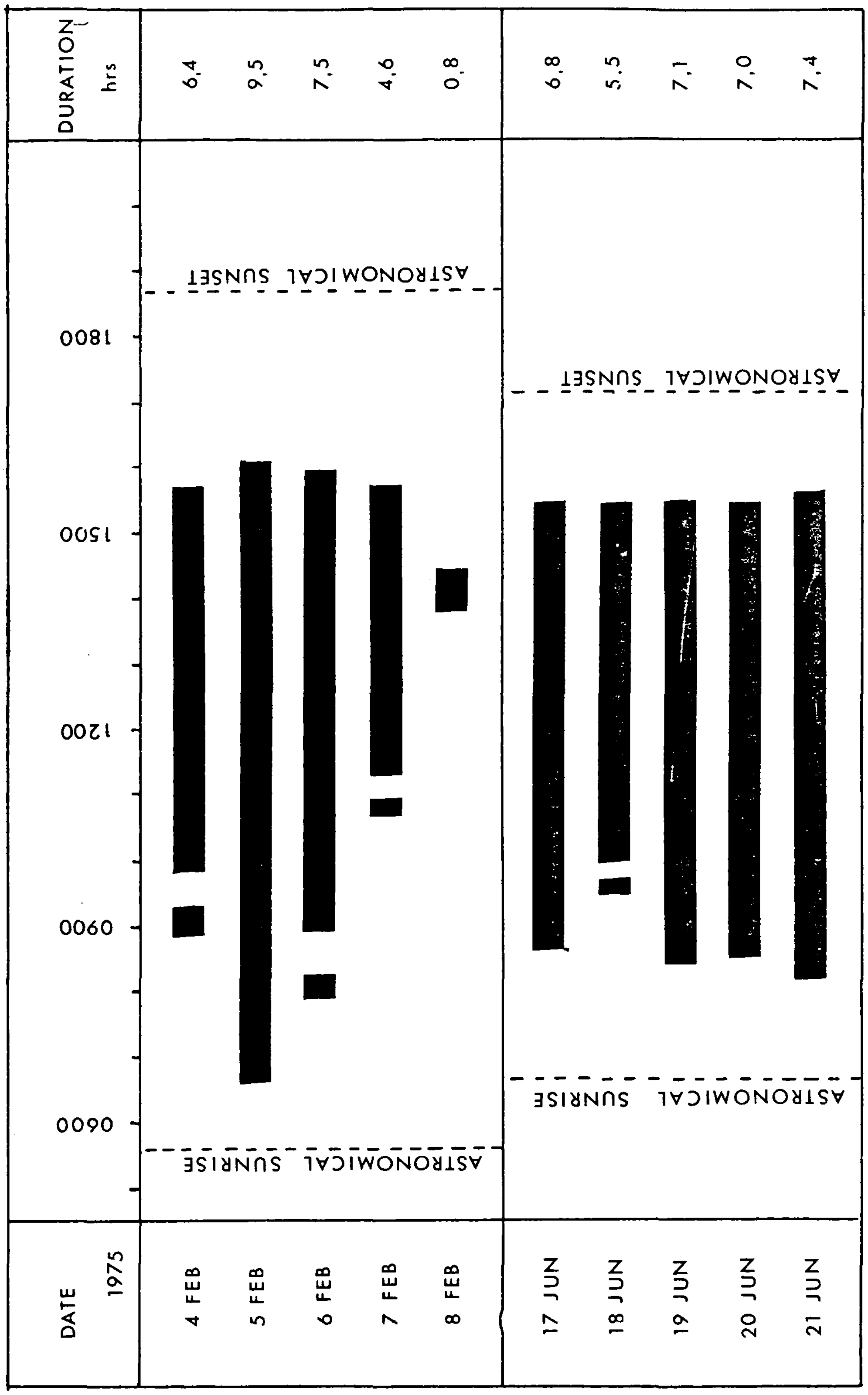


Figure 82: Periods when the Sun Shone for February 4th - 8th 1975 and June 17th - 21st 1975 at Cyprus.



The monkeys were active both before and after these times as will be seen from the ranging data, though the distances moved were small - (twenty to thirty metres on all occasions).

(b) Activity patterns

(i) Proportion of time spent in different activities

Figure 83 shows the proportion of time spent in the various activities This shows that the monkeys spent a large proportion of their time inactive. A seasonal difference in the amount of time spent inactive is clear, with 51,8% of the time spent in inactivity during the summer rainy period and only 38,6% of the time spent inactive in the colder, dry winter period. This is most likely to be related to the cold weather during this period. It is noticeable that on the hottest of the winter days the animals were most inactive (17th June, 1975) In contrast in winter the monkeys moved and fed more than in summer, a finding confirmed in the former case by the ranging data. Further one would expect that more feeding behaviour would take place in winter because food was less easily available and more spread out requiring more movement and more foraging behaviour.

Differences in the proportion of time spent in different activites by different age-sex classes was also found. Figure 84 illustrates this . It shows that babies and infants were the most inactive class followed by Adult Males. Babies which were carried were classified as being inactive even though the mother may have been in motion, which may account for this. Females fed the most and juveniles were seen to play.

The pattern of diurnal activities is shown in Figure 85. This shows that the monkeys become active at or just before sunrise. They soon become engaged in intensive feeding, not moving far from the sleeping site. This feeding period continues with peaks in intensity till noon, but with progression away from the sleeping site. As the sun increases in intensity more inactivity is found, which is noticeable in both summer and winter. The height in the canopy of this

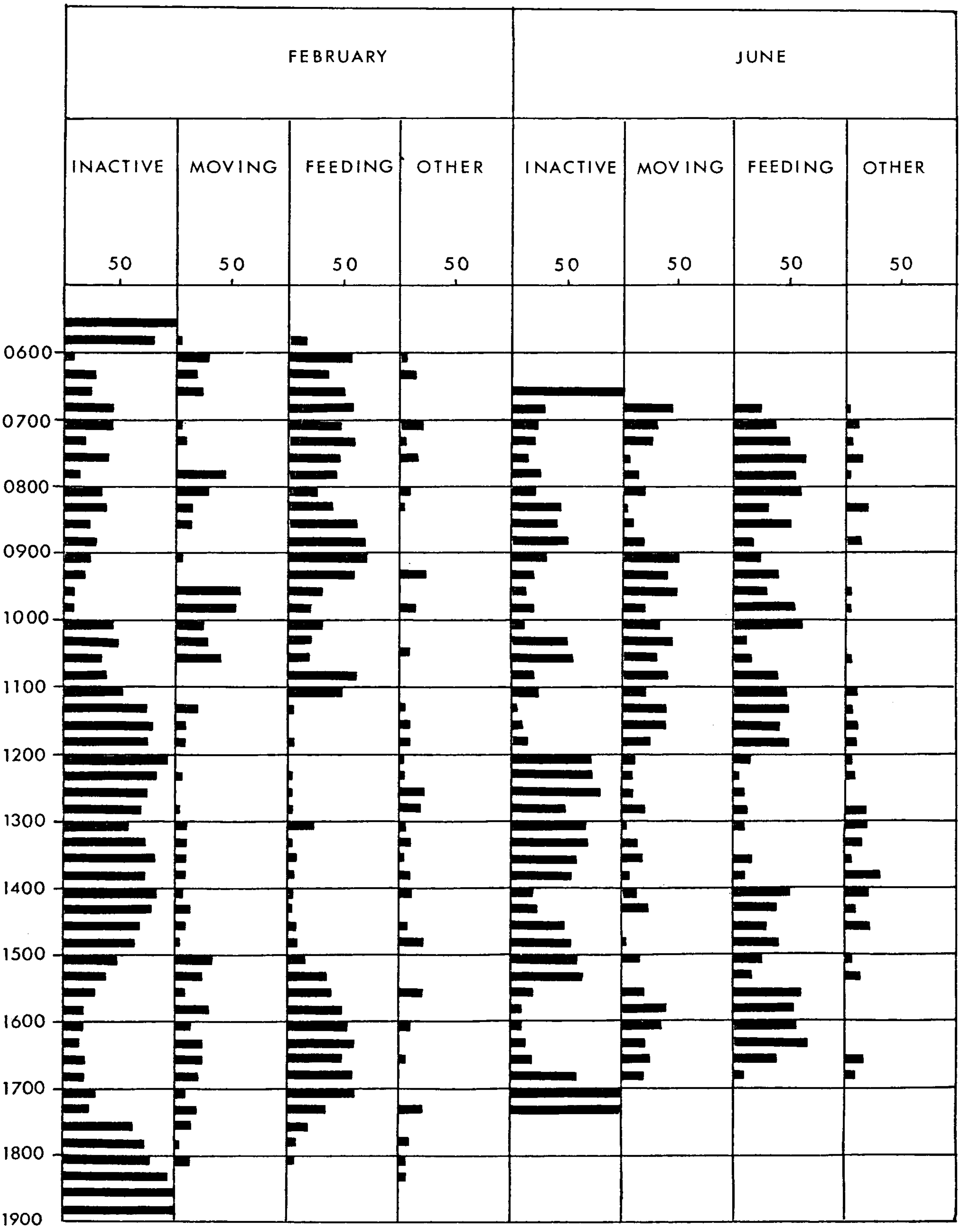
Figure 83: Percentage Time Spent in Specified Activities for the February and June Follows.

Date	No. of Scans	No. of Records	Inactive %	Feeding %	Moving %	Mutual % Grooming	Playing %	Self % Grooming	Other %	Mean Records per Scan
4/2/75	54	302	43	32	13	6	2	-	-	5,6
5/2/75	54	291	62	24	9	3	2	1	-	5,4
6/2/75	54	264	51	28	12	4	5	-	-	4,9
7/2/75	54	276	48	26	10	7	7	-	1	5,1
8/2/75	54	218	55	34	9	2	-	-	-	4,0
MEAN			51,8	28,8	10,6	4,4	3,2	0,2	0,2	
MEDIAN			51	28	10	4	2	0	0	
RANGE			43 - 62	24 - 32	9 - 13	2 - 7	0 - 7	0 - 1	0 - 1	
17/6/75	44	238	46	35	17	2	-	-	-	5,4
18/6/75	44	246	41	32	20	4	2	-	1	5,6
19/6/75	44	198	32	36	22	9	-	1	-	4,5
20/6/75	44	261	33	34	23	5	3	-	2	5,9
21/6/75	44	270	41	37	14	4	4	-	-	6,1
MEAN			38,6	34,8	19,2	4,8	1,8	0,2	0,6	
MEDIAN			41	35	20	4	2	0	1.5	
RANGE			32 - 46	32 - 37	14 - 23	2 - 9	0 - 4	0 - 1	0 - 2	

Figure 84: Proportion of Time Spent by Different Age-Sex Classes in Different Activities (February and June Data Combined).

Category of Animal	No. of Records	Inactive %	Feeding %	Moving %	Mutual % Grooming	Playing %	Self % Grooming	Other %
Adult Males	212	62	28	9	-	-	1	-
Adult Females	562	52	31	9	7	-	-	1
Juveniles	625	41	28	12	7	12	-	-
Babies and Infants	891	67	15	18	-	-	-	-
Unidentified	274	26	26	15	4	2	-	-
TOTAL	2564							

Figure 85: Diurnal Activity Patterns for the Cyprus Samangos - February and June 1975.



increase in inactivity is worth noting, most resting taking place in the canopy tops during winter and is in winter accompanied by a decrease in the frequency of feeding.

The period from noon to 16h00 is also marked by prolonged period of inactivity taking place in the deep canopy in summer and in the canopy tops or in openings in the canopy in winter. Feeding and movement decreases during this period though less in winter than summer.

After 16h00 feeding increases for an hour and the monkeys progress towards a sleeping site.

This pattern contrasts with the picture described by McMahon (1978) who describes a period of 1 - 1½ hrs after sunrise when the monkeys sun themselves, feeding little. Clearly as the sun only shone as late as 09h00 in some cases due to the mountains this was not possible for the Cyprus monkeys though as soon as the sun shone in winter they did sun themselves.

Both McMahon (1978) and Aldrich-Blake (1970) describe a reduction in activity in rain and this was confirmed in the present study.

Clutton-Brock (1974) describes the feeding of the colobus he studies as occuring in bouts. This was not quantitatively confirmed in this study, but the same qualitative observation as that made by Clutton-Brock was seen. After a period of inactivity which may have lasted ten to forty minutes, one or two individuals would move to the periphery of trees and begin to feed. Resting individuals now followed suit and within the space of minutes general feeding would be in progress with 40% - 70% of the individuals feeding and most of the rest moving. This bout could end just as quickly as it began, either with the resumption of resting or with concerted progression.

CHAPTER FOURTEEN

FEEDING BEHAVIOUR

Introduction

In chapters seven, eight and nine habitat factors which might affect the ranging and feeding behaviour of the monkeys were discussed. In chapter twelve the evidence from two five day follows seemed to indicate that the monkeys concentrated in areas where food was available. In this chapter more detailed aspects of feeding will be discussed, in particular what the monkeys fed upon - types of food eaten, species eaten, the parts of those species which were eaten and the relative amounts of various food eaten at different times of year and how this relates to the availability of those foods.

Such detailed information on feeding behaviour in other species is scarce. This has primarily been due to the difficulty in identifying what species and what part is being eaten while observing monkeys. Second there is difficulty in obtaining representative feeding records. Thus, again, the methods used in obtaining such information are particularly important.

Aldrich-Blake (1970) states that "All records were obtained by direct observation", in contrast to stomach contents or dung samples. He does not state what criteria were used in collecting information and he was unable to give quantitative information as to the relative amounts of various species which were eaten, except for a three point ranking scale as to importance. A monthly run down of species which were fed in intensively helps to give a better idea of the feeding pattern.

Clutton-Brock (1975) in his study of red, and black and white colobus in East Africa, performed a detailed and exhaustive study of feeding behaviour. He noted the feeding behaviour of animals during scans for activity data. Every quarter hour all the individuals visible were scored for activity and parts eaten were noted. In this way a reasonably representative idea of what the monkeys were feeding on was obtained. The categories used to classify food items was heavily directed towards leaves, the colobus being a "leaf-eating" species. Using this technique he was able to obtain large numbers of feeding records over a year (7,346 for red Colobus alone).

Struhsaker (1974) also made feeding observations on red colobus, but he distinguished them operationally to prevent the chance of the same monkey being scored twice eating the same plant and so on to make the sampling more representative. He used the following criteria to distinguish observations. Additional observations were scored in the same scan if:-

(i) A different individual was feeding on the same food item
(ii) The same individual fed on a different item of the same food species
(iii) The same individual fed on a different food species
(iv) The same individual fed on the same food item of the same food species at least one hour after any previous such observation

These criteria were used to collect feeding information in the present study as it was found that during feeding bouts the same animal could easily be scored three or four times. An additional criterion was included for this study. Additional observations were scored if the same individual fed on the same food item of a different individual of the same food species regardless of whether an hour had elapsed. Struhsaker's last criterion is thus modified to read:-

iv) if the same individual (monkey) fed on the same (type of) item of the same individual (tree) of the same species one hour after a previous observation.

The modification of this criterion was deemed necessary to take into account the observation that individuals when feeding in trees whose local density was high would feed in one tree and then move to another tree of the same species and then begin feeding on the same item again. It was felt that this should be scored as two feeding observations rather than one, because if concerted feeding on one species took place, it would be biased against unless the fifth criterion was included.

Methods

Two distinct methods of collecting feeding data are reported here, one systematic and the other Ad Lib. Systematic data similar to those collected Clutton-Brock (1975) and Aldrich-Blake (1970) were collected only during the two months when five day follows were performed. Individuals feeding during quarter hour activity scans were scored and the parts eaten noted. Parts eaten were only scored if the individual fitted the criteria laid down. Thus the Thus the true feeding observations could be identified in the records. In addition at other times feeding individuals were scored as before, but as the individuals came into view. Using these methods 946 feeding observations were made in February and 839 in June.

In addition to these systematic data, ad lib. data were collected when contact was made with the monkeys. These data were scanty and certainly not representative of the total diet for a month, for the contacts were short and considerable bias certainly affects the data. These data have been used to compile a list of the food species used by the samangos and descriptions of what the monkeys were eating at various times of year.

The bias which is likely to affect feeding data is as follows:-

(i) Areas where contact with monkeys is easier will be represented disproportionately in the data. These areas will be floristically different from other areas and thus species absent in areas in which observation is easier will tend to be missed if fed upon. In systematic sampling individuals are maintained in contact more or less continuously, thus the chance of missing important food plants is reduced. However, where observation is difficult there will be proportionately fewer records and so a species' importance may be underestimated.

(ii) Trees in which several individuals are feeding are more likely to be scored than where a single individual is feeding. The group feeding as a whole is more likely to be scored than single individuals.

(iii) Shy animals are less likely to be scored and the possibility exists that

Figure 86: Plants and Plant Parts Eaten by Samango at Cyprus

SPECIES	PART EATEN	IMPORTANCE RATING	MONTH OF YEAR EATEN											
			J	F	M	A	M	J	J	A	S	O	N	D
Celtis africana	Fruit	A	✓	✓	✓	✓								
	Young Leaves	A							✓	✓	✓			
	Shoots	B							✓	✓				
	Flowers	B									✓	✓		
Trema orientalis	Fruit	B	✓	✓										✓
	Shoots	C								✓	✓			
	Young Leaves	C		✓	✓			✓			✓		✓	✓
Ficus capensis	Fruit	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Young Leaves	A							✓	✓	✓			
	Shoots	B						✓						
	Mature Leaves	B			✓	✓	✓							
Ximenia caffra	Fruit	C	✓											
Xymalos monospora	Fruit	B								✓	✓	✓	✓	✓
Cyptocarya liebertiana	Fruit	A	✓	✓										
	Flowers	C												✓
Pittosporum viridiflorum	Fruit	C		✓										
Acacia ataxacantha	Young Leaves	A									✓	✓		
	Mature Leaves	C				✓	✓	✓						
	Green Pods	A			✓	✓	✓	✓	✓					
	Dry Pods	A					✓	✓	✓	✓	✓			
Acacia karoo	Mature Leaves	C			✓	✓								
	Pods	A					✓	✓						
	Resin	B									✓	✓		
Bauhinia galpinii	Flowers	C	✓											✓
	Young Leaves	C										✓		
	Dry Leaves	A						✓	✓	✓	✓			
Dalbergia armata	Young Leaves	A								✓	✓			
	Mature Leaves	A	✓			✓	✓			✓			✓	✓
	Flowers	A	✓										✓	✓
	Pods	B					✓	✓						
Calodendrum capense	Flowers	C										✓		
	Fruit	B	✓											✓
Oricia bachmannii	Young Leaves	C		✓										
	Mature Leaves	C						✓	✓					
	Flowers	C							✓	✓				
	Fruit	C				✓								
Teclea natalensis	Young Leaves	C									✓		✓	
	Mature Leaves	C					✓							
	Flowers	C										✓		
	Fruit	C												✓
Clausena anisata	Fruit	C											✓	
Ekebergia capensis	Young Leaves	A									✓	✓		
	Mature Leaves	C				✓	✓							
	Fruit	A	✓	✓										✓
	Flowers	C											✓	

SPECIES	PART EATEN	IMPORTANCE RATING	MONTH OF YEAR EATEN											
			J	F	M	A	M	J	J	A	S	O	N	D
Ekebergia pterophylla	Fruit	C		✓										
Trichillia emetica	Young Leaves	C									✓			
	Fruit	A	✓	✓	✓	✓	✓							
Drypetes gerrardii	Fruit	C												✓
	Young Leaves	C									✓			
Antidesma venosum	Fruit	B	✓	✓										
	Young Leaves	C										✓		
Bridelia micrantha	Young Leaves	B									✓	✓		
	Fruit	B	✓	✓										✓
Croton sylvaticus	Fruit	B	✓	✓										
Sclerocarya caffra	Fruit	C					✓							
Harpephyllum caffrum	Fruit	A						✓	✓	✓	✓	✓		
	Young Leaves	C				✓								
Lannea discolor	Fruit	C										✓		
Protorhus longifolia	Fruit	A										✓	✓	✓
Rhus chirendensis	Young Leaves	B							✓	✓				
	Mature Leaves	C			✓	✓	✓							
	Fruit	A											✓	✓
	Flowers	C									✓		✓	
Ilex mitis	Fruit	B			✓									
Apodytes dimidiata	Fruit	C					✓	✓						
Pappea capensis	Fruit	C				✓								
Ziziphus mucronata	Fruit	C					✓	✓						
Rhiocissus Spp.	Fruit	A	✓	✓	✓	✓	✓							
	Flowers	A										✓	✓	✓
	Young Leaves	A								✓	✓	✓	✓	
	Tendrils	B								✓	✓	✓		
	Mature Leaves	B					✓	✓	✓	✓				
	Sap	C								✓	✓			
Rawsonia lucida	Young Leaves	C										✓	✓	
	Dropped Fruit	C	✓	✓										
Kiggeleria africana	Fruit	C												✓
Scolopia zeyheri	Fruit	C									✓			
Peddeia africana	Leaves	C				✓								
Combretum molle	Young Leaves	C										✓		
	Capsules	B		✓	✓									
Combretum kraussii	Young Leaves	C									✓			
	Capsules	B				✓	✓							
Combretum sp. *(Creeper)*	Young Leaves	C										✓		
	Capsules	B					✓	✓	✓					

Figure 86: Continued

SPECIES	PART EATEN	IMPORTANCE RATING	MONTH OF YEAR EATEN											
			J	F	M	A	M	J	J	A	S	O	N	D
Eugenia capensis subsp. natalitia	Fruit	B		✓	✓									
	Young Leaves	B									✓	✓		
Eugenia sp.	Fruit	B											✓	✓
Syzigium cordatum	Flowers	A									✓	✓		
	Fruit	A	✓	✓										✓
	Young Leaves	C							✓	✓				
Syzigium guineense subs gerrardii	Fruit	A					✓	✓	✓		✓		✓	
Cussonia spicata	Fruit	B	✓										✓	✓
	Young Leaves	C									✓	✓		
Schefflera umbellifera	Fruit	B							✓	✓				
Curtisia dentata	Fruit	B				✓	✓							
Maesa lanceolata	Fruit	B			✓		✓	✓						
Rapanea melanophloeos	Fruit	C		✓										
Bequaertidendron mag.	Fruit	C	✓											
	Flowers	C							✓	✓				
Mimusops obovata	Fruit	A	✓	✓	✓	✓	✓							
	Flowers	A									✓	✓	✓	
Mimusops zeyheri	Fruit	A			✓	✓	✓	✓	✓	✓				
	Flowers	A											✓	✓
Euclea natalensis	Fruit	B							✓	✓	✓			
	Flowers	C			✓									
	Mature Leaves	C								✓				
Diospyros whyteana	Fruit	B	✓	✓	✓									
Strychnos henningsii	Fruit	B	✓	✓										✓
Carissa bispinosa var acuminata	Fruit	C						✓						
Carissa edulis	Fruit	C							✓					
Rauvolfia caffra	Fruit	A	✓	✓	✓								✓	✓
	Young Leaves	A				✓	✓							✓
Clerodendrum glabrum	Young Leaves	C						✓		✓				
Halleria lucida	Fruit	A										✓	✓	✓
	Flowers	C								✓	✓			
	Young Leaves	C								✓				
Gardenia amoena	Fruit	C			✓									
Rothmannia capensis	Fruit	C					✓							
Cephalanthus natalensis	Fruit	C				✓								
Tricalysia lanceolata	Fruit	C	✓	✓										

Figure 86: Continued

SPECIES	PART EATEN	IMPORTANCE RATING	MONTH OF YEAR EATEN											
			J	F	M	A	M	J	J	A	S	O	N	D
Vangueria infausta	Fruit	C		✓										
Tapiphyllum parvifolium	Fruit	C			✓									
Canthium ciliatum	Fruit	C				✓								
Canthium gueinzii	Fruit	B								✓	✓			
	Young Leaves	B							✓	✓	✓			
Canthium inerme	Fruit	C		✓										✓
Pavetta lanceolata	Fruit	C	✓											
Psychotria capensis	Fruit	B					✓							
Brachylaena discolor	Young Leaves	B							✓	✓	✓			
	Flowers	B								✓	✓			
	Shoots	B							✓	✓	✓	✓		
Ensete spp. (Wild & Cultivated)	Fruit	C				✓								
Morus sp.	Fruit	A									✓	✓	✓	
	Young Leaves	B								✓	✓			
Mangifera indica (mango)	Fruit	C		✓										
Psidium sp. (guava)	Fruit	C												
Haemanthus sp.	Fruit	C	✓											
Asparagus asparogoides	Fruit	C			✓									
Clivea mineata	Fruit	C			✓									
Clivea sp.	Fruit	C			✓									
Passiflorum sp. (grenadilla)	Fruit	B					✓				✓			
Smilax mitis	Fruit	C		✓										
Toddalia asiatica	Fruit	C			✓									
	Flowers	C										✓		

Figure 87: Rating Scale used to Indicate Importance of Food Plants to the Samangos at Cyprus (after Aldrich-Blake 1970).

A - Was one of the Top 5 most eaten Food Items in at Least One Month

B - Frequently Eaten

C - Occasionally Eaten - Few Records.

Blake's observation that the majority of the blue monkey's food came from less than thirty species.

Insects also were represented in the diet. Samangos were seen pulling bark from trees (Rhus chirendensis, Podocorpus falcatus) and licking or catching objects from underneath. On one occasion an animal was seen to pluck an insect from the air, The insect was caught and held between thumb and forefinger. The wings were pulled off and the insect eaten. In some cases there was a definite association between insects and trees and insect foraging occurred often in these trees. Around the figs and on the trunk and branches of Ficus capensis ants were found. These were licked from the surface. Celtis africana was often infested with caterpillars and these were picked off and eaten. Rauvolfia caffra, Rhus chirendensis and Breonadia microcephala appeared to house insects in their foliage, the leaves being carefully separated and occasionally objects being picked out and eaten.

No evidence was found for samangos eating eggs, though samangos were seen investigating birds nests. McMahon found that hen's eggs were the best lure for catching samangos in cages, while Oatley (1970) reports samangos eating bird's eggs. The captive group relished hen's eggs when these were offered.

Aldrich-Blake reports that fruit was eaten unripe. This was not confirmed in this study. When fruit was eaten it was invariably eaten ripe. In order to test this, Halleria lucida fruit was picked and given to the captive group. Only ripe black fruits were eaten, the green ones being left. The left over fruit was then kept and allowed to ripen. When these were presented again, the now ripened fruit was eaten.

McMahon reports that exotic foods were not taken by captive animals and that they were ineffective as cage lures. At Cyprus the wild monkeys found wild-living grenadillas and mulberries in the forest, which they relished. They would also raid guava, mango and banana trees in the lands. On one occasion the group started digging up sweet potatoes from the lands.

The captive group lived on a staple diet of mielie porridge rolled up into handleable balls. They ate many sub-tropical and other fruits so long as these were cut into handleable sized pieces. Mango, pawpaw, tomato, carrot, peanuts, bananas, guavas, lichis, bread and peanut butter sandwiches, green beans, peas and a hos of other foods were accepted. Typically when a new type of food was introduced it was the sub-adult male who was first to experiment Other individuals would approach and sniff his mouth while eating. They would then themselves shortly eat the food. The only food presented which they would not eat was avocado pear.

Drinking was common among the captive group. Wild samangos were seen licking leaves and stems after rain and during dry times would drink from holes and natural hollows. On one occasion a sub-adult male was seen drinking from a stream.

Techniques of feeding varied according to the type of food being eaten. Small berries were eaten by bending back the branch carrying the fruit and bringing the berries directly to the mouth, eating them off the branch. Fruit of Maesa lanceolata and Schefflera umbellifera were eaten in this way. Larger fruits were plucked individually. Preparation of fruit took place mostly in the mouth, the pips and skin being spat out if these were not eaten. Very small pips and soft skins were ingested, being found in the faeces. Pods and capsules and other fruit with a hard unplatable outside were prepared outside the mouth (Combretum spp., Acacia spp. Rothmannia sp, Peltophorum sp, Dalbergia sp, Bauhinia sp,) The skin was usually bitten through and the edible parts extracted. The species bearing pods formed a major source of food during the winter (e.g. Acacia spp).

Dung was collected in the hope that this might yield information on diet but proved an unsatisfactory method.

Systematic Sampling

Nine hundred and forty-six feeding observations were made during the five-day follow in February and eight hundred and thirty-nine in June by the method already described. Figures 88 and 89 summarise the data. The records were analysed by summing the total number of records for each food species and expressing these as percentages of the total number of feeding records collected. These proportions can be considered as representative of the proportion of time spent feeding on each food speceies. Numbers of animals seen feeding on the different parts were also recorded as a percentage of the total number of observations for a species. If percentages were less than 0,1% it is so indicated. Also indicated in this table is the abundance figure for the plant concerned in the study area as a whole.

Comparing the two tables show that fewer species were used in winter, presumably because there were fewer species providing food. In both cases five species provided over 50% of the food or if the percentages do represent the amount of time spent on a species, over 50% of the time was spent feeding on five species only. In addition these species were not the most abundant species in the study area. A similar result was obtained by Clutton-Brock (1975) and he hypothesises that this indicated that the monkeys were exercising some form of food selection and that species bearing abundant food and in large numbers were not eaten in preference to lesser perhaps more palatable foods. In this case the same selection is not clear, for the evidence from tree distribution, ranging and productivity shows that these five species in each case represent the most common species producing palatable food in the areas used by the monkeys. For June, the group's time was concentrated for two days in Forest B and the Riverine forest. Here the numbers of *Acacia ataxacantha*, *Brachylaena discolor*, *Acacia karoo* and *Mimusops zeyheri* were high and all bore high concentrations of palatable food For February, the most time was spent in the flood forest and in areas where the concentration of *Rhoicissus* was high. Flood forest has a very high local abundance of *Rauvolfia caffra*. Both these species had very high productivities of ripe fruit at this time and hence these two species account for over 20% of the records. *Cryptocarya liebertiana* and *Ficus capensis* are also highly con-

Figure 88: Percentage Representation of Various Food Species in Feeding Records for February 1975.

Species	% of Records	Abundance	Percentage of Observations for that Species					
			Fruit	Flowers	Young Leaves	Mature Leaves	Other	Unspecified
Ekebergia capensis	12,9	3	85	-	-	4	5	6
Rhoicissus sp.	11,0	5	80	-	3	-	2	15
Rauvolfia caffra	10,6	2	92	-	4	-	-	4
Cryptocarya liebertiana	9,2	4	86	-	10	-	2	2
Ficus capensis	8,3	4	91	-	-	5	-	4
Celtis africana	7,6	4	88	-	-	4	-	8
Antidesma venosum	6,8	2	68	1	-	-	-	31
Bridelia micrantha	5,0	4	79	-	-	-	-	21
Croton sylvaticus	4,8	3	84	-	-	-	-	16
Syzigium cordatum	3,8	3	72	2	12	-	-	4
Trema orientalis	3,1	2	85	-	6	-	-	9
Dalbergia armata	2,8	4	-	25	-	59	3	13
Eugenia capensis	2,4	2	80	2	-	-	-	18
Cussonia spicata	1,8	3	94	-	-	-	-	6
Strychnos henningsii	1,2	3	99	-	-	-	-	1
Combretum molle	0,7	2	60	-	20	-	-	20
Rawsonia lucida	0,7	4	94	-	2	-	-	4
Trichalysia lanceolata	0,6	1	94	-	-	-	-	6
Trichilia emetica	0,4	4	95	-	-	-	-	5
Ekebergia pterophylla	0,4	1	97	-	-	-	-	3
Mimusops zeyheri	0,3	4	90	3	-	-	-	7
Peltophorum africanum	0,2	2	-	76	-	-	-	14
Diospyros whyteana	0,1	2	86	-	-	-	-	16
Rapanea melanophloeos	0,1	2	93	-	-	-	-	7
Bequaertidendron magalismontanum	0,1	4	85	-	-	-	-	15
Calodendrum capense	< 0,1	3	96	-	-	-	-	4
Bauhinia galpinii	< 0,1	2	-	84	-	-	-	16
Oricia bachmannii	< 0,1	3	-	-	79	-	-	21
Pittosporum viridiflorum	< 0,1	2	96	-	-	-	-	4
Unidentified	4,8	-	17	-	2	-	-	81
Average % Overall			72,9	6,8	4,7	2,6	0,5	12,5

Figure 89: Percentage Representation of Various Food Species in Feeding Records for June 1975.

Species	% of Records	Abundance	Percentage of Observations for that Species					
			Fruit	Flowers	Young Leaves	Mature Leaves	Other	Unspecified
Acacia ataxacantha	19,2	2	86	-	-	9	3	2
Brachylaena discolor	12,2	3	-	6	86	-	4	4
Mimusops zeyheri	8,3	4	91	-	-	-	6	3
Euclea natalensis	7,6	2	86	-	5	-	-	9
Acacia karoo	7,2	2	81	-	-	-	13	6
Dalbergia armata	6,9	4	14	-	68	-	6	12
Harpephyllum caffrum	6,7	4	85	-	-	-	-	15
Syzigium cordatum	4,9	3	13	-	72	-	8	7
Rhoicissus sp.	4,9	5	-	-	-	95	-	5
Catha edulis	3,2	2	-	91	-	-	-	9
Bauhinia galpinii	2,8	2	92	-	-	-	-	8
Trichilia emetica	2,7	4	84	-	-	-	-	16
Syzigium guineense	2,6	4	50	-	29	-	-	21
Carissa bispinosa	2,4	2	89	-	-	-	-	11
Trema orientalis	2,2	2	-	-	86	-	-	14
Celtis africana	2,0	4	-	-	98	-	-	2
Ficus capensis	1,6	4	61	-	26	22	-	1
Oricia bachmannii	< 0,1	3	-	-	97	-	-	3
Ziziphus mucronata	< 0,1	1	91	-	-	3	-	6
Clerodendrum glabrum	< 0,1	2	-	-	60	-	39	1
Unidentified	2,4	-	-	-	37	61	-	2
Average % Overall			46,0	4,3	30,2	10,4	2,1	7,1

centrated in the area where the monkeys spent most time in this period.

The only case for selection is among Ekebergia capensis, whose distribution was not local, and whose productivity was not high.

It is noteworthy that the amount of leaf eaten was much higher in winter than summer (40% winter, 6% summer) and that 16% of the fruit eaten was in the form of pods from leguminous plants and Combretum species not always associated with forest habitats.

CHAPTER FIFTEEN

VOCALISATION, PROGRESSION AND OTHER ASPECTS OF SOCIAL AND INDIVIDUAL BEHAVIOUR

During the course of the study qualitative observations were made on various aspects of social and individual behaviour, which, though not of direct relevance to the main theme of this thesis does add to our, to date, scanty knowledge of the behaviour of these animals. Because most of the observations described occurred infrequently no attempt was made to quantify them, except cursorily in the case of vocalisations.

Vocalisations

Samangos were found to emit a variety of sounds some of which were clearly distinguishable as calls and some of which may have been grades of the same call. No systematic study of the vocalisations, though from responses to calls and the context of the calls, they obviously played an important role in the social behaviour of these animals. Indeed it is to be expected in a forest-dwelling social species that vocal communication should be important because visual communication is very limited and can only function over short distances.

Six distinct types of sound were heard to be emitted. This is not exhaustive and to describe the full repertoire of vocalisations of the samangos would require tape-recording and spectrographic analysis of the duration and relative frequencies of the calls so that adequate classification of the calls could be made. The description put forward here is subjective and completely dependent on the aural capabilities of the human ear

Three of the sounds were loud and could be heard at some distance. These calls were often the signal which gave away the position of the animals and allowed the location of them in the forest. They were indeed so much louder than the other calls that this would appear to indicate that they function either in the spacing of separate groups or in the maintainance of cohesion in a group or as an alarm or all three.

(1) Boom Calls

This is a very low pitched, booming call, like a short, low 'Ooo'. It was only emitted by adult males. It corresponds to the sound called the 'wah-sound' by McMahon(1978) for Natal samangos. It carries for long distances reverberating through the forest and unless one is listening for it or has an attuned ear it is easy to miss or mistake for the calls of baboons or distant thunder. Aldrich-Blake (1970) mistook this call (presumably similar in C. mitis stuhlmanni) for a chimpanzee call. The call was always given singly, though several were often made within the space of an hour. The most heard on one day was twenty-six. The shortest space of time between calls emitted by the same animal (visually confirmed) was 3½ minutes.

The call was observed being emitted on six occasions and on all six occasions the animal was seen sitting in an upright position, not crouched, with feet and hands gripping the branch, Prior to calling the laryngeal air sac was inflated, the animal taking deep breaths and blowing the air into the sac on expiration During this period the hands and feet were lifted from the branch and replaced hitting the branch. Both hands or feet were lifted and replaced together, hands hitting more frequently than feet. This action looked similar to that performed by human infants when sitting up - hitting their hands or feet against the floor. The call was then emitted, the mouth pursed, and the sac being partially deflated The call was followed by the animal sitting still and looking around for several minutes.

The context of the call was determined in forty-two cases. In twenty-two cases they were given during intergroup or group - caged group encounters (see Appendix). Pant calls from a nearby group were often followed by the male moving towards the call, climbing a tree and looking towards the pant calls. A boom call often followed. In group - caged group encounters, M group often had to pass the caged group and the M group male would watch the caged group while the rest of the group passed. The caged-group male and the M group male would maintain eye-contact and threaten each other and after such bouts both males would sit, looking away from each other and 'Boom' or 'Pant' call. Highest frequencies of boom calls were seen in this situation. Fifteen more cases were observed when, after a prolonged feeding session the group was well dispersed, a boom call would be given. Five other cases of boom-calling were noted in response to the alarm barking of baboons and when jackal buzzards were sighted.

The response of other monkeys to this call was in all cases chirp and chirrup calling. In the case of boom calls directed at other groups it also resulted in movement away from the call. In contrast, members of the same group as the emitter ceased ongoing activity, rested, and then moved towards the call.

This call, then, functions both as a spacing call between groups, a concentrating call in the same group and in a limited number of calls as an alarm call. Whether in the latter case it functions as an alarm or a signal indicating that the group should concentrate because there was danger is unclear, because in this context in four out of five cases it was also accompanied by pant calls.

(2) Pant Calls

These are second of the two loud calls given by samangos. They were usually given in series and individually they had a 'nyah' and 'kyuh' sound. They correspond, by description to the cough/bark of McMahon in samangos and the 'explosive call' of Aldrich-Blake in C. mitis stuhlmanni. They were the most frequently heard call. The average number of calls in a series was 16,03, with a range from two to forty-six. The series of calls were often followed by chuckle calls which appeared to grade into the pant call at the end and were only heard after a series of pant calls. Chuckle calls were only heard after longer series (number of calls greater than fifteen.) The interval between them was variable - one to four seconds .

The call was seen emitted on eighteen occasions. The call is given only by adult males, though a captive sub-adult male was seen to attempt to produce the call, though the result was hoarse and of low intensity. The animal usually (13 - 18 observations) sat crouched with the head protruding forward. The laryngeal air sac was not used, and the call was started with the mouth closed. As the call was emitted the mouth was rapidly opened wide. On five occasions a standing male emitted.

The context of the call was determined in fifty-six cases. In twenty-one cases it was emitted in response to the observer's appearance. On stumbling across monkeys, females and juveniles would chirp, the male would move toward the observer and once sighted a series of pant calls would be initiated.

In sixteen cases pant calls were initiated almost immediately after a boom call from another group or after chirrup calls in the same group.

Other situations which initiated pant calls were helicopters, passing cars, thunder, rifle shots, during inter-group encounters and after baboon alarm barks.

The response to pant calls was determined in fourteen cases. In three cases the monkeys appeared to make no response, on five, they merely looked towards the source of the call and on the balance of occasions the animals showed signs of nervousness. This picture mirrors almost exactly the situation found by Aldrich-Blake for the blue monkeys explosive call.

From this description it would appear that the pant call, though not an alarm call is an immediate response to potential danger which may put other animals on their guard.

(3) Chuckle calls

As stated earlier these followed long series of pant calls. They were also emitted in series though at a higher frequency than pant calls. At the end of a pant call the intensity of the calls tailed off and the timbre changed to an O-O-O-O-O sound emitted at a higher frequency than the pant calls, to high to count. Of two hundred and eighty-five pant calls heard and recorded eighty-six were followed by chuckle calls. The pant calls associated with the chuckle calls were typically in rapid series, with call intervals of approximately one to two seconds.

The context and response to chuckle calling could not be determined but it appeared to change the nature of the pant call accentuating it. Of those pant calls whose context and response were determined when followed by chuckle calls the danger was not potential but real. It was only emitted by adult males.

(4) Chirp, Chirrup and Twitter calls

These are high-pitched, birdlike noises with the general sound as indicated by the names. The context of them was difficult to distinguish so they are grouped together. The chirp is a single sound, the chirrup double while the twitter is longer and like a high pitched trill. All classes except adult males make these calls. They are quiet and being high pitched travel only short distances.

The calls were usually made in bouts. They were made in response to any disturbance as noted earlier. Specific instances were not determined. While making the call the animals looked around them or towards the disturbance, almost as if showing their displeasure at the disturbance. The brows were puckered, the eye-brows bought over the eyes and the eyes narrow, giving the impression of a "displeased schoolmaster".

(5) Croaks

These were quiet, low-pitched groans or grunts emitted by all classes. During feeding sessions where the animals were concentrated this was the background noise heard. They were also heard when an individual approached another, or when an individual moved off after a period of inactivity.

They were often responded to by croaks from other individuals. Croaks were only returned by individuals in visual contact with the emitter.

(6) Squeals, Chatters and Screams

These calls include a variety of calls grouped here according to their general context. These are the calls given in agonistic or accident situations. Attacked females or infants in trouble scream or squeal and the contexts and causes were the same as those described by Aldrich-Blake.

Progression

Progression or concerted group movement, when the majority of animals were moving in a given direction, showed certain characteristic features. Periods when the monkeys were quiet and there was little movement of foliage and periods when individuals were moving from feeding site to feeding site, were interspersed with periods of progression. Progression was initiated when an animal moved from rest or feeding along the direction of progression and was followed or accompanied by others. Thus the stimulus for progresion appeared to be an animal, or animals, moving out of feeding trees and then moving through the forest as if concertedly moving to a new location. If, within a few minutes (2 to 3), all the monkeys followed, progression continued until a new feeding site was found.

Once progression had been initiated the role of the male was interesting. He usually moved into a position of high visibility and sat looking and listening around him.He then moved off in the direction of the progression very rapidly, taking the lead and directing the movement direction. He then sat again and the progressing group passed him. In cases where it appeared that some feeding subgroup had lost contact with the group as a whole a 'boom' call was made. Thus the male directed progression,though the initiation of progression appeared to be by concensus.

Another interesting aspect was the place of infants in progression. Though able to walk, infants often had trouble negotiating some parts in the forest. They were typically,as a group, preceded by a female who would select an easy path and the rear was brought up by another female who would help them to negotiate difficult pieces. Where a jump was necessary, their chirrups would bring others to th "nursery group" and they would be carried ventrally across the gap.

Grooming

Grooming was not often observed, but when it was observed it appeared to follow the normal pattern found in Old World Primates. The posture soliciting grooming was typical - resting on the side on a branch or lowering the head to an animal facing. After sexual activity the female would groom the male.

Aggression

Aggression between individuals of the same group was rare, with mildly aggressive acts predominating. Intensity of aggression could be categorised with a continuum culminating in fighting and chasing. This began with the threat. Here an individual stares directly at the individual being threatened, with eyebrows raised. At low intensities the threat consists of a rapid projection of the head with eyebrows raised, and followed by return to the ongoing activity. In more intense situations, the head is continuously projected for several seconds, the eyebrows raised and the mouth closed or in more intense situations still the mouth is opened in an 'O', but the teeth are not revealed.

If these mild threats do not produce displacement, the individual may run at the other monkey, tail usually erect. This may result in a chase but not of long duration.

Contact in aggression was seen only on six occasions. Two of these conform to the grapple and bite described by Aldrich-Blake, where one individual seizes another with the hands and bites the piece closest. On three occasions one individual hit the other with open hand, but not after threats had been made.

On one occasion during a fight between two of the males in M group a unique form of fighting was seen. The incident developed from a squabble over an oestrous female. The larger male chased the intruder and the chase ended on an almost horizontal branch with both individuals facing each other threatening, heads down and thrust forward with tails in the air and mouths open. Heads

back. She got up and turned to face him,
lowering her head towards him. Sam groomed
head. Sam moved away.

The other caged group copulation followed a similar pattern and was between the same two individuals except that this time the female did not fall over and the ankle-touching did not take place. Omar and de Vos(1971) report that conception takes place between june and december for C. mitis kolbi in kenya, with a peak in october and that the conception and birth season is related to the annual distribution of rainfall. This would seem to indicate that these copulations were early and that they were preliminary copulations not resulting in conception. No semen was observed in all cases.

Birth Season

No direct observations were made of birth. Censuses over the period 1974/75 indicated that an increase in troop size occurred in late summer. Black and grey infants were not observed as late as january. After this, black and carried infants appeared in the group gradually, the group size increasing from 31 to 36 over the period january to the beginning of april.

Solitary Animals

Three solitary animals were known to live in the study area and all were males. One appeared very old, with a white muzzle and a stumpy tail. He was always seen in the rocks outside the forest at the entrance to the poort. He was seen on six occasions. Another younger male with no distinguishing marks was observed early in the study in Forest II. He disappeared later in the study and that area became occupied by 'H' Group. He was observed from the kloof sides on 26 occasions and was often seen sitting in the crook of an old dead tree. The male of 'H' Group was also noted to do this in the later part of the study and it was therefore assumed that the solitary and this male were one and the same animal. The third solitary male was observed only once and that was in a completely different place.

Predation

No known predator species were observed in the study area. The response, however, to potential predators was noted. When jackal buzzards and bataleur eagles soared low over the forest, this was greeted by chirrup calls from the females and juveniles and by 'pant' calls or 'boom' calls from males. Animals at the top of the canopy descended into the canopy.

Parasites

The pelts of captured animals were macroscopically examined for ectoparasites but none were found. Similarly dissection of the caged animals which died revealed no internal gut parasites on macroscopic inspection.

Group Interactions

Groups often came into close proximity but the actual sequence of events was usually difficult to ascertain from inside the forest. One encounter was, however, well documented because it was observed from beginning to end from above from the side of the kloof overlooking the forest. Both groups could be observed simultaneously. It occurred between 'M' and 'H' Groups on the 26/6/75 in Forest II between 09h00 and 11h55.

09h03 - Boom calls were heard from the male of 'H' Group in the south fork of Forest II sitting in a dead Breonadia microcephala, just below the peice of forest which bridges over the col separating the north and south fork of Forest II. This boom call was followed by cannonade of chirp calls from the females of 'M' Group, which was about 250m down from 'H' Group in the main part of Forest II.

09h20 - Pant calls - 26 followed by chuckle calls - from male in 'M' Group. 'M' Group females chirrup.

09h25 - Squeal calls, chirps and chirrups were heard from 'M' Group in the same location as at 09h03.

10h35 - Boom call from 'M' Group. Chirps heard from 'H' Group.

10h40 - Boom call from 'H' Group was heard.

10h42 - Boom call from 'H' Group was heard ,followed by chirps from 'M' Group.

10h45 - Male from 'M' Group moved into the fringe forest between the two forks of Forest II, and climbed into an emergent *Faurea speciosa* where he looked over towards 'H' Group in the south fork of the forest.

10h46 - 'M' Group male gave a volley of pant calls - 10 - and then a series of chuckle calls

10h47 - 'H' Group male moved off up the south fork, being before this only c.40m. from the 'M' male.

10h49 - 'M' Group male moved back towards the south fork and sat in an *Acacia ataxacantha* and a female joined him in the same tree. 'M' Group male pant called - 46 and then a series of chuckle calls - . Chirps and chirrups were heard from 'H' and 'M' Groups. 'H' Group male gave a series of pant calls - 46 -.

10h50 - 'M' Group male moved into the southern fork. The group made a general progression to follow him.

11h00 - The groups began to move away from each other slowly alternating feeding and progression

11h55 - 'M' Group male gave a boom call. Three seconds later a boom call was heard from up at the top of the southern fork. Chirrups in 'M' Group.

Other group interactions appeared to be similar in nature with boom calls and volleys of pant calls being exchanged between groups, males moving towards each other and one or the other of them giving way to the other and leading his group away from the other group.

The observations included in this chapter are not of direct relevance to the gist of the thesis, however they do serve to give the reader insight into the behaviour of the monkey under study and perhaps indicate areas of further study.

OPSOMMING

Etlike veldstudies op primate het reeds aangedui dat die sosiale struktuur wat in woud-Cercopithecinae gevind word ietwat teenstrydig is. 'n Enkel-mannetjie of harem-tipe groepstruktuur is in stremmende savanne habitatte aangetref. Die hipotese is voorgelê dat 'n enkel-mannetjie cf. 'n multi-mannetjie groepstelsel die wyfies bevoordeel om die oorlewing van nageslag te verseker. Die vraag ontstaan hoekom die samango-aap dan 'n soortgelyke groepstruktuur in een van die mees produktiewe habitatte bekend aan ons ontwikkel het.

Hierdie vraag is ondersoek deur die habitat eerder as die dier te evalueer. Nadat die habitat in sy geheel in soveel detail as moontlik beskryf is, is die ape bestudeer om te sien hoe hulle tot variasies in die habitat aangepas het. Gegewens oor die klimaat is vesamel en met die van ander stasies in Afrika vergelyk. Daar is gevind dat die klimaat meer seisoenaal is en dat groter uiterstes voorkom as by ander weerstasies. Die winter is kouer en die somer warmer. Reënval was groter en meer wisselvallig van jaar tot jaar.

Die mikroklimaat binne die woud het hierdie uiterstes tot 'n mate gemodereer. Soortgelyke parameters soos die in die klimaatstudie is in die boomtoppe sowel as die vloer van die woud waar die mees gematigde klimaat gevind is gemeet. Studies op die hoeveelheid reënval wat die vloer van die woud bereik het het aangedui dat die hoeveelheid reën wat dit bereik in verhouding was met die duur en tempo van die reën wat geval het.

Die woud self is bestudeer om die verskeidenheid in boomspesies en getal van elk te bepaal. Deur verskeie metodes te gebruik is gevind dat 11 verskillende en afgebakende gemeenskappe in die gebied deur die samango-ape gebruik, voorgekom het. 'n Beskrywing in terme van verskillende gemeenskappe eerder as 'n suiwer plantkundige een van die habitat as geheel beskou, was verskieslik want lokale konsentrasies van spesifieke boomsoorte het waarskynlik 'n groter invloed op die bewegings van die ape binne die studiegebied gehad. Ander navorsers het woude alleen deur gemiddelde floristiese samestelling geëvalueer en waarskynlik as gevolg hiervan geen korrelasie tussen tropbewegings en floristiese samestelling gevind nie.

'n Tweede vlak van variasie wat die voedings- en bewegingsgedrag mag beïnvloed en bydra tot die belangrikheid van die woud as voedingsbron is wanner en vir hoe lank die voedselproduseerders wel voedsel geproduseer het. Gemerkte indiwidue van al die vernaamste spesies van boom, bos, struik sowel as uitheemse soorte wat miskien van belang was is weekliks besoek. Hierdie studie het geweldige variasie aangedui. Die feit dat 'n sekere boomsoort in 'n sekere gebied voorgekom het was geen waarborg dat voedsel op die boomspesie beskikbaar was nie. Voedsel beskikbaar vir die ape was wisselvallig in beide kwantiteit, kwaliteit sowel as die fisiese voorkoms daarvan in die woud.

Ander vlakke van variasie is maar oppervlakkig ondersoek. Dié het ingesluit die produktiwiteit van voedselproduserende plante, hulle grootte en gewigte, voedselwaarde, die hoeveelheid ryp vrugte op 'n spesifieke stadium ens. Al hierdie faktore kon die voedsel bron meer onseker maak.

Hierdie studies het dus aangedui dat die woud glad nie die eenvoudige eenvormige omgewing is wat deur ander navorsers aanvaar is nie. Dit is hoogs wisselvallig selfs van dag tot dag wat betref voedsel beskikbaarheid. Voedsel beskikbaarheid is by woud-ape waarskynlik die primêre ekstrinsieke bepaler van sosiale struktuur en dus is die teenstrydigheid wat voortvloei uit vorige studies eintlik nie van toepassing nie.

Nadat die habitat voldoende beskryf is was dit moontlik om die reaksie van die ape self tot die habitat te bepaal. Die populasie-samestelling van die groepe teenwoordig in die studiegebied is soortgelyk as die vir blou-ape in Uganda. Verskille is hoofsaaklik te wyte aan die feit dat my studiepopulasie besig was om te groei met die gepaardgaande opbreek van troppe. Bewegings van een trop is bestudeer deur hul vir vyf dae van sonop tot sononder in somer en winter te volg. Dit het getoon dat tuisareas groter was in winter as in die somer en dat die middelpunte van aktiwiteite verskil het. Toe gegewens oor voeding, boom fenologie en boom verspreiding bestudeer is, is gevind dat hierdie verskille te wyte aan die feit is dat verskillende voedselbronne in somer as in die winter by verskillende lokaliteite beskikbaar was. Die vergroting in tuisarea is as gevolg van 'n meer verspreide en verskillend beskikbare voedselbron. Gegewens oor indiwiduele gedrag en oor dié metode van beweging het aangedui dat die ape strategieë aanvaar het om die beskikbare voedselbronne tot 'n maksimum te kan benut. Die hele bron is nie op een slag opgebruik nie en oor 'n tydsperiode is die hele studiegebied deurgesoek asof om vas te stel watter voedsel beskikbaar gaan wees, analoog aan 'n huisvrou wat haar in 'n supermark bevind waarin voedsel volop is, maar waar sy slegs kan koop wat haar beursie haar toelaat. Dit is anders as by blou-ape en bobbejane (soos by jagters-insamelaars soos die boesman) waar alles wat beskikbaar is geeet word terwyl dit nog daar is.

Die taksonomie en verspreiding van die Woud-Cercopithecinae word ook bespreek en die gevolgtrekking gemaak dat te veel subspesies tans in suider Afrika beskryf word. Drie afgebakende populasies kan uit verspreidingsrekords uitgesonder word maar of hul subspesies verteenwoordig word as onwaarskynlik beskou.

SUMMARY

Numerous primate field studies indicated that the social structure found in forest Cercopithecines was somewhat paradoxical. They were found, in common with several terrestrial species living in harsh savannah and saheal habitats, to exhibit a one-male or harem type of group structure. It had been hypothesised that the one-male structure as opposed to a multi-male group structure favoured the females so that survival of offspring could be ensured. Why then should forest Cercopithecines, like the blue monkey in Uganda and the samango monkeys studied here, exhibit a similar group structure in an environment which, by cursory examination, is one of the most productive terrestrial environments known to man?

This question was investigated by approaching the problem rather from the habitat end than the animal end. Once a description of the habitat as a whole and in as much detail as could be acheived had been completed, the monkeys were studied to see how they had adapted to the variability observed in the habitat. Climatic data were collected and compared with similar data from other stations in Africa. It was found that the climate was more seasonal and that the extremes of weather in all cases was more extreme than that found at the other stations. Winter was colder and summer was hotter. More rain fell and there was more variability in the rainfall from year to year.

The microclimate within the forest was found to modulate these extremes to some degree. Similar meteors to those monitored in the climatic study were monitored in the forest canopy and on the floor of the forest, which was found to be the most equable climate of all. Studies on the Interception of rainfall showed that the amount of rain reaching the forest floor was related to the rate and duration of falls of rain.

The forest was enumerated to find where the various species of tree were to be found and in what numbers. Using various methods it was found that 11 different and distinct communities, floristically, existed in the

area used by the samangos. A description in terms of different communities was considered superior to a purely botanical description of the study area as a whole, because the localities of high concentrations of a given tree species was probably more important in controlling the movements in the study area of the monkeys. Other workers enumerated forest only in terms of average floristic composition and probably as a result obtained no correlation between ranging and floristic composition.

A second level of variability which might affect the feeding behaviour and ranging behaviour, and have relevance to the question of the variability of the forest as a producer of food was when and for how long the food producers actually produced food. All major species of tree,shrub herb and exotic which might have been of importance to the monkeys was visited weekly, individual trees of each having been marked. This study revealed an enormous amount of variability. The fact that a certain tree was in the study area was by no means a guarantee that food would be available on that tree species. Food for the monkeys was transient and constantly changing in amount and quality as well as it's physical location in the forest.

Other levels of variability were cursorily studied. These included productivity of food producing plants, their sizes and weights, their food value, the proportion of a crop ripe at one time and so on. All these were factors which might make the food supply even more uncertain.

These studies, then, clearly showed that forest was far from the unitary, simple environment that other workers assumed it to be. It is in fact a highly variable, and, from day to day, an uncertain supplier of food. Food supply is, in forest monkeys, probably the primary extrinsic moulder of social structure and hence we can say that the apparent paradox posed by previous studies is not the paradox it was thought to be.

Having described the habitat adequately it was possible to observe how the monkeys themselves responded to this habitat. The population structure of the groups present at the study site concurred more or less with that found for blue monkeys in Uganda. Differences could be ascribed to the fact that the Cyprus population was clearly growing and that group splits were in progress or about to occur. Ranging behaviour was studied for one group by following them for five days from dawn till dusk in both winter and summer. This showed that the home range was larger in winter than in summer and that the centres of activity were different. When data on feeding, tree phenology and tree distribution was studied it was seen that this difference was due to the fact that different food sources were available for summer and winter and in different locations. The increased home range size was due to a more spread out and different available food supply. Data on individual behaviour and on the mode of progression showed that the monkeys had adopted strategies to enable them to exploit the food supply described maximally. Whole crops were not exploited at one sitting and over a period of time most parts of the study area were visited, as if to check on what foods were coming available. To make an analogy one can consider this strategy to be similar to that of a housewife shopping around at various supermarkets to get the best quality for the price. There is no actual shortage of food but there is the constraint of a budget. One can perhaps contrast this to the feeding strategy of baboons or vervets, where the idea seems to be to eat what you can while you can, corresponding more to the system adopted by hunter-gatherers like the bushman.

The taxonomy and distribution of the forest Cercopithecines is also discussed and the conclusion drawn for the south african Cercopithecines that there too many subspecies presently described. Three distinct populations can be discerned from the site records but whether they represent subspecies is considered doubtful.

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APPENDIX ONE

AN INTENSIVE PLOTLESS SAMPLING METHOD FOR DESCRIBING AND CLASSIFYING COMMUNITIES PRESENT IN SMALL STANDS OF FOREST AS TYPIFIED BY FOR INSTANCE THE HOME RANGE OF A GROUP OF FOREST MONKEYS

The method involves the use of the Point-Centered Quarter Method of Plotless sampling (Cottam and Curtis 1949). The advantages and disadvantages of this method have been discussed by Greig-Smith (1964).

The method is based on the fact that the density of a given species is inversely related to the mean distance between individuals. Thus information on the density of a species can be obtained without using time-consuming and laborious quadrat methods.

First of all the method of sampling will be described and then the procedure followed at each sample point described.

One of the aims of enumerating the habitat was to be able to distinguish what smaller communities of associated trees occurred within the forest preferably not taking into account prior subjective judgements. Botanists usually sample within stands and then compare the stands by ordination or association analysis to see if they are the same or not. Such an approach was clearly inadequate here. A system of so-called restricted random sampling was therefore developed. The field preparation for this was minimal. Landmarks were placed at approximate 100m intervals in a rough grid. Helium balloons were then flown from these points and their positions plotted on a large scale map from trig points by triangulation. The area to be sampled (Upper Kloof, Lower Kloof, Fringe forest II and Riverine Bush) was then divided into equally sized areas and within each area (twenty-six in all) thirty random points were determined using in random number tables. The bearings of the points from the nearest fixed and surveyed point was determined as well as the distance. It was found by measuring the distance along the bearing in this way an accuracy of 10 metres over 1,500 metres, taking account of height differences, could be achieved, using foresters compass and range-finder (0,66%)

This method of sampling has the following advantages. Plotless sampling can be achieved throughout the survey area in a random manner. This is not possible using transect or quadrat methods. Randomness achieves certain important requirements, the most important being that results are comparable between studies, that the area will be equally covered, that any small communities provided they are adequately sampled will appear. In addition the results can be accurately localised and points not appearing to be homogenous can be assigned to different communities, allowing different communities to be enumerated in one move. If there are any problematic areas then it is an easy matter to include more points.

Sampling at each point proceeds as follows:-

(i) from the sampling point two lines were erected at right angles to each other, one along the contour.

(ii) in each quadrant so erected the distance from the point to the nearest tree with a diameter at breast height of greater than 10 cm was measured.

(iii) the following parameters of each tree was measured.

- (a) the species
- (b) the diameter at breast height
- (c) the height
- (d) the height of the first branch
- (e) the canopy diameter at right angles to and along the contour line
- (f) the percentage infestation with creepers and the species involved

(iv) the following parameters of the point site were noted:-

- (a) slope
- (b) aspect
- (c) ground cover - dominant ground herbs in each quadrant
- (d) soil

Using these parameters and computed values such as Importance Value, associat analysis, or ordination can be used to define the communities present in the study area.

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APPENDIX TWO

THE SAMANGO MONKEY IN CAPTIVITY

Capture and Immobilisation

The best tried method of capturing samangos used to date has been using cages (McMahon 1978), Keith (pers. comm.). McMahon used cages, one metre by one metre by two metres, constructed with a frame of aluminium or wood and with a guillotine door. The frame was covered with 6,5cm fencing wire. The Transvaal Provincial Administration used standard baboon capture cages (Keith and Stoltz) McMahon reports that the only effective lure was chickens eggs. The T.P.A. used the fruit which the animals were reputed to have been raiding. After capture McMahon used Ketalar ^{R} to immobilise the animals. the T.P.A. used Sernylan^R .

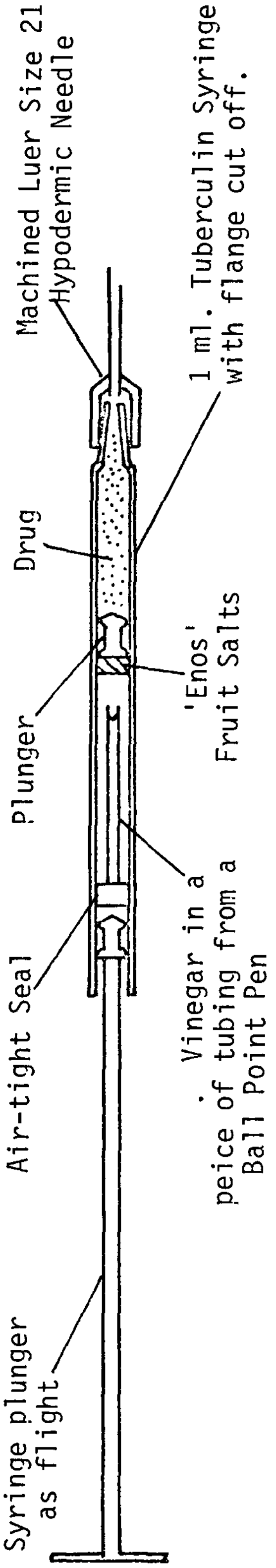
To immobilise and capture samangos in the wild and in captivity a blow-gun with a drug-filled dart was used with some success. The darts were designed after Brockelman and Kobayashi (1971). A two metre aluminium tube was used and the darts were constructed from 1cc tuberculin syringes. Figure 1 shows the construction of the syringe. The impact of the dart on the target caused the vinegar to come into contact with the Eno's. This produced CO_2 which injected the drug.

The blow gun had an effective range of about 15 metres and at 20 metres an object 30 metres high could be hit 75% of the time.

It was found ideal for immobilising captive animals but in the forest the darts were deflected too easily by foliage. Samangos were immobilised on five occasions in the cage using Sernylan (20 mg/ml) at a dose of 3-8 mg/6-7 kg of animal. Only one animal was immobilised in the wild using this method.

A more effective method which would have the same advantages of quietness and selectivity would be low-power cross-bows. One problem with cage techniques is that you catch what you get. Using a similar dart to the above as the bolt and a low-power cross-bow, good accuracy, quietness and selectivity should be obtainable.

Figure 1:(Appendix). Diagram of the Dart used to immobilise Samango monkeys



Cages

Six samango monkeys obtained from the T.P.A. Problem Animal Control Division were caged in a 7 x 7 x 3 metre enclosure, constructed of 6,5 cm fencing wire and blue gum poles. On one side a platform 7 x 2 metres was constructed with spaced 2cm diameter blue gum poles. A hutch of hard board and S.A. pine was constructed on the platform as shelter. The rest of the cage was filled with branches so that the animals could exercise. 1cm chicken wire was placed around the bottom of the cage to exclude snakes and genets etc. The aim of introducing the monkeys was to attract other wild samangos to the area where observation was easiest. In this the caged group succeeded admirably. Initially, the wild monkeys took much interest in the caged group and after the introduction sightings in the vicinity of the cage increased. After 6-7 months less interest was taken but close contact with the wild monkeys had allowed the wild monkeys to become habituated to the observer who was often at the cage when the wild group passed.

The Monkeys

Six samangos were introduced on the 23.10.73 to the cage. They had all been caught near Houtbosdorp, Transvaal, where samangos had been causing damage to grenadilla lands. The six animals were;

SAM	-	Adult male	8,2 kg
MUNGO	-	Subadult male	NOT WEIGHED
KINKO	-	FEMALE	5,0 kg
BELLA	-	FEMALE	5,4 kg
SKIMPY	-	FEMALE	NOT WEIGHED
III	-	FEMALE	5,4 kg

Diet

Described in "Feeding Behaviour" (Chapter Twelve)

Deaths

Of the six monkeys captured three died and three were released at the end of the study.

KINKO - died 12.8.74

BELLA - died 13.10.74

SAM - died 21.12.74

The cause of these deaths could not be determined in the field. No signs of disease or parasitisn was evident on dissection. Weight loss in all cases was about 25% but all organs appeared normal. Fat was still present around kidneys and in orbits.

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