FRAMEWORK OF THE GORONGOSA ECOSYSTEM

K. L. TINLEY

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by

KENNETH LOCHNER TINLEY

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To the peoples of Mocambique
and to Lynne -- she knows why

". . . we emerged on the vast plain bordering the Urema – Zangue marsh, over which we toiled for hour after hour in the intense heat, sighting a few wildebeest, zebra and waterbuck in the distance, looking like dancing motes in a sunbeam as they stood in the heat–haze. The plain seemed waterless, and shade there was none, for the track took us fully three miles from the nearest belt of palm trees, and such a track ! Over hard, sun-baked mud, cracked into gaping fissures at every few yards, its surface irregularities made more painfully rough by yawning holes, which represented the old spoor of the herds of game which visit these plains in the summer."

F. VAUGHAN KIRBY
Hunter-naturalist
1894

". . . this sojourn by the Sungue (Urema Plains) will remain one of the most vivid of my memories. The thousands of animals, scattered over the arid plains, the flocks of wading, web-footed, and many other kinds of birds which fly over at sunrise to feed; the peaceful, solemn, yet imposing landscape, bounded on the blue horizon by the mountains of Gorongosa and Chiringoma; all these things will remain graven on my memory".

W. VASSE
Hunter-naturalist
1904

Frontis: GORONGOSA AMBIENT

The Urema Rift Valley floodplains with Gorongosa Mountain and the three Bunga Inselbergs in the background. A herd of 2 000 buffalo with attendant flock of cattle egret in the foreground.

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Promoter: Professor F.C. Eloff
Head, Department of Zoology
University of Pretoria
Pretoria

ABSTRACT

A holistic evolutionary approach is used in the Gorongosa thesis in which emphasis is on the salient reciprocal relations and kinetic succession of land surfaces and biotic communities, influenced by landscape processes and prime mover components.

As correlations of these relations and processes require both a total interacting framework and the details of its prime components, the thesis is divided into three main parts: (1) synopsis of the essence of the Gorongosa ecosystem and the approach used in field ecology (Perspective); (2) correlation of the physical and living components of the ecosystem; and (3) synthesis. The study attempts to relate the salient features of processes and correlations into a coevolutionary whole, caught at that particular stage in space and time by the study.

The chapter titled ***Process and Response*** is the central pivot of the thesis combining the kinetic aspects of geomorphological landscape changes with coevolutionary sequences of biotic communities which change (expand, contract, and recombine) kaleidoscopically in space and time, in appearance and content.

The prime movers in ecosystem change are on the physical side, nickpoint headward eroding sequences and edaphic change in soil moisture balance, and on the biotic side, the frugivores and large ungulate components which affect geomorphic and habitat modification are central.

Of these, soil moisture appears to be the master factor. All climatic influences too, appear to be expressed through the edaphic controls which change in-situ, or with each geomorphic surface replacement sequence. This factor seems to orchestrate the opportunities and constraints from below on the possible community evolution possible in a particular time and place.

From this, a template of salient factors of the Gorongosa ecosystem is provided for management, based on causes and trends in the kinetic evolution of the various ecosystems. To maintain a diversity of ecosystems in Gorongosa, the fundamental management action is to reinforce or reinstate the natural local base level sills which cause ponding of floodwaters responsible for the mosaic of grasslands and slack marshes of high primary productivity and ungulate carrying capacity. Concomittantly reductions of certain overpopulated ungulate species, chiefly hippo, are required so that management is effective.

As natural processes are dynamic, it is necessary to identify and evaluate those salient factors operating at a particular time, as these key controls are altered and replaced by others through natural kinetic succession of landscapes and biotic communities. The salient factors governing the dynamics of an ecosystem or community thus require to be mapped at intervals, to provide templates of the trends and changing importance of key and master factors, in order to anticipate or predict what will result from their influences. With these data valid evaluation can be made with the other correlated information for meaningful management action.

SAMEVATTING

Die holisties-evolusionêre uitgangspunt is as basis in hierdie tesis oor Gorongosa gebruik. Die klem val op die invloed van die landskapprosesse en bewegingskragte op die sleutel- en terugwerkende verwantskappe en die kinetiese suksessie van landoppervlaktes en biotiese gemeenskappe.

Aangesien die korrelasies van hierdie verwantskappe en prosesse beide 'n totale wisselwerkende raamwerk, asook detail-kennis van die oorspronklike bewegingskragte benodig, word die tesis in drie hoofgedeeltes verdeel:

(1) Die samevatting van die sleutelfaktore in die Gorongosa-ekosisteem en die uitgangspunt wat in die veldekologie gebruik is;

(2) Die korrelasies tussen die fisiese en lewende komponente van die ekosisteem;

(3) Die sintese.

Hierdie studie poog om die verwantskappe tussen die sleutelfaktore van die verskillende prosesse en die korrelasie tot 'n evolusionêre geheel, soos dit op die spesifieke vlak en tyd van die studie bestaan het, vas te stel.

Die hoofstuk "Process and Response" vorm die spil waarom die tesis draai. Dit verbind die kinetiese aspekte van geomorfologiese landskapveranderings met die evolusionêre opeenvolging van biotiese gemeenskappe wat, beide in voorkoms en inhoud, met ruimte en tyd verander.

Die hoofbewegingskragte in ekosisteemverandering geskied aan die een kant fisies deur middel van stroom-op beweging van knakpunte en veranderings in grondvogbalans en aan die biotiese kant deur die invloed van vrugtevreters en groot hoefdiere op geomorfologie en habitat wat verandering veroorsaak.

Van die bogenoemde faktore skyn dit of grondvog die oorheersende faktor is. Al die klimatologiese invloede word deur middel van hierdie edafiese kontrole uitgedruk. Dié faktor rangskik die geleenthede en beperkinge van onder en beïnvloed die moontlike gemeenskap-evolusie oor 'n spesifieke tyd en ruimte.

Uit bogenoemde word 'n raamwerk van sleutelfaktore van die Gorongosa-ekosisteem vir bestuur voorberei. Dit word gebaseer op invloede en rigtings in die kinetiese evolusie van die verskillende ekosisteme. Om die diversiteit van die ekosisteme in stand te hou, is die fundamentele bestuursaksie die herstel en versterking van die

natuurlike plaaslike erosievlakke. Hierdie vlakke en knakpunte veroorsaak die opdamming van vloedwaters wat die mosaïek van grasland en moerasse met hul hoë primêre produktiwiteit en biomassa-drakrag veroorsaak. Saam met hierdie faktor moet, vir die doel van effektiewe bestuur, die verwydering van sekere hoefdiersoorte, veral seekoeie, as noodsaaklik beskou word.

Aangesien die natuurlike prosesse dinamies van aard is, is dit noodsaaklik om hierdie kernfaktore, soos hulle binne 'n spesifieke plek en tyd opereer, te identifiseer en te evalueer. Hierdie sleutelkontroles word geaffekteer en deur ander faktore vervang wanneer die natuurlike kinetiese suksessie van 'n landskap en biotiese gemeenskappe plaasvind. Dus is die sleutelfaktore die oorheersende faktore wat die ekosisteemdinamika affekteer. Dié faktore moet dus op verskillende tye gekarteer word om die rigtings en veranderings van die verskillende sleutelfaktore waar te neem.

Met hierdie inligting kan korrekte gevolgtrekkings gemaak word wat, tesame met die ander verwante inligting, tot suksesvolle bestuursaksie kan lei.

ACKNOWLEDGEMENTS

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My wife and I are particularly appreciative of the great hospitality of Mr and Mrs John Wright and later of Mr and Mrs Geoff Harrison in the only cool haven in the region, at the ranch on the slopes of Gorongosa Mountain. Special thanks goes to my two field assistants from the local Chegorongosa Tribe, Signet and Vasco Matondo. Vasco, especially, is a man of many parts, hunter-naturalist, philosopher, companion and malimba musician whose playing made light of many oppressive mosquito-infested nights.

Dr Donald Broadley of the Umtali Museum, Rhodesia, helped with materials for small mammal collections, and trained one of my field assistants to produce fine study skins.

During the period spent in analysing and writing up the Gorongosa data in Pretoria, the following organizations and people have provided valuable assistance: Farrell & Van Riet, Landscape Architects & Ecological Planners; the Council for Scientific and Industrial Research (CSIR); the South African Nature Foundation (affiliated with the World Wildlife Fund); the Wildlife Society of South Africa; the Okovango Wildlife Society; Ted and Liz Reilly of Swaziland; Francis I. Morrison of White River; Clem Haagner, and Dr D.M. Joubert. Mrs Joyce van Schalkwyk, Mrs Sandra Good, and especially Ingrid Vis helped with the typing. Many of the figures were redrawn by Lindsay Miller and in particular by Mike Isakov – a master draughtsman.

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I am particularly grateful to Mr R.B. Drummond, head of the Rhodesian National Herbarium, Salisbury, for the large job he did of naming my plant collections from Mocambique. Mrs K.E. Bennett at the same institute kindly identified the grasses. At the Botanical Research Institute in Pretoria. Miss Elizabeth Retief in particular helped follow up name changes and resolved some botanical problems. From Dr Jeff Morris at the same Institute I obtained guidance on quantitative analysis. Mr Robin Barnard of the Soil Faculty of the University of Pretoria gave creative criticism of the chapter on soils.

Special mention must go to Willem van Riet, a landscape planner who sees things in the round, and my wife Lynne, for their enthusiastic role as sounding boards against whom ideas were tested. To my promoter Professor Fritz Eloff, great thanks for his forebearance and encouragement at all times.

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KLT
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PREVIOUS STUDIES

The collection of plant and animal specimens from the Gorongosa region and surrounding parts of Central Mocambique is a rich story still to be told, involving some of southern Africa's most famous names in natural history — Frade, Grant, Haagner, Kirk, Livingstone, Peters, Roberts (on the north side of the Zambeze Delta in 1908), Selous, Serpa Pinto, Sheppard, Swynnerton, Vaughan-Kirby, Vasse and others. The background noted here relates to actual field studies as opposed to collections of which only two are mentioned. These are by the famous hunter-naturalists Vaughan-Kirby (1899) and Vasse (1909) whose books, now valuable Africana, deal specifically with the Gorongosa region. Both these men recorded many observations of ecological importance as well as valuable proof of such species as tsessebe and roan which are extinct in the park today. The locality of the Gorongosa-Cheringoma area is depicted in Fig 1.1.

Kirby arrived at Chinde at the Zambeze mouth in 1894 and travelled upriver to near the Chire junction before exploring inland on the Cheringoma Plateau. Passing south of Inhaminga he describes the deep ravines of the Riftward drainage and then descending to the floor of the Rift, camped near the Muaredzi stream. He traversed the Urema plains to the NW of Gorongosa Mountain (Báruè area) and returned to hunt elephant extensively on the Cheringoma Plateau. Thereafter he explored the Zambezia district, hunting chiefly in the area between the Chiperoni and Namuli mountains.

Vasse, a Frenchman, spent almost all of three years hunting and collecting in what is defined above as the Gorongosa ecosystem. His book, though biased to the hunt, is a remarkable record of conditions as they were in the first part of the 1900's. In addition he explored and mapped the area, including an ascent to the highest summit area of Gorongosa Mountain. His collections sent back to the Pasteur Institute and Paris Museum comprised 53 ungulates, 118 birds, 18 000 insects, 500 plants, 63 reptiles and amphibians, mollusca, worms etc., and 250 minerological specimens (Vasse 1909: 157).

In the early 1900's detailed geological exploration of the region was made by various geologists including Teale & Wilson (1915), Teale (1924) and Abrard (1928) amongst others, and is summarised in a major work on the geology of the Mocambique sector of the Zambeze Basin (Real 1966). Mouta (1957) published a short account of the Urema Trough.

After Vasse, more than fifty years elapsed before a biological study was made by the ornithologist Rosa Pinto (1959). In 1965 a photographic and written record of wildlife in Gorongosa was published by João August Silva, who had for many years been Administrator at Vila Paiva (now Vila Gorongosa) on the Midlands between Gorongosa Mountain and the Rift Valley.

Mendes da Rocha Faria (1966) published the first attempt at describing the climate of the region by using statistics collected at stations on the higher ground on either side of the Rift (Vila Paiva and Inhaminga), and as the Chitengo station was only initiated in 1966, used Vila Machado as a Rift example (40 km to the SW of the park on the Beira-Rhodesia main road). The present study has benefitted from 10 years of climate statistics recorded at Chitengo (in the centre of the Rift Floor), and on a ranch halfway up the southern slope of Gorongosa Mountain. The latter records were kept first by Mr & Mrs John Wright (1963—1969) and later by Mr & Mrs Geof Harrison (1970—1973).

The botanist José Aguiar de Macedo (1966) made the first botanical survey of the region, but unfortunately this work remained incomplete as most of his collections were unnamed. He later published two works on the flora of Gorongosa Mountain (Macedo 1970a, 1970b) and as so many specimens had still not been named by this time, was forced to list the majority with his collection numbers, as reference. The present author made extensive plant collections in the process of analysing the various ecosystems and communities and was fortunate to have these named by the Salisbury Herbarium.

Plant collections were made in the region by many Portuguese botanists including A. Rocha da Torre, F.A. Mendonça, J. Simão, Pedro and Pedrogão, A.Gomes e Sousa (1966), J. Gomes Pedro, L.A. Grandvaux Barbosa. These last two authors were responsible for the first comprehensive vegetation map of Mocambique (Pedro & Barbosa 1955). Important plant collections were also made by expeditions and members of the Rhodesian Herbarium. In addition to Rosa Pinto, collections of birds were made by the Durban Museum and bird, reptile and small mammal collections by the Rhodesian Museums.

A soil survey of the region was made by the pedologist Fernandes (1968a, 1968b), who compiled maps of both the mountain area and the park by airphoto interpretation as determined from samples at intervals along roads.

This sums the totality of studies made of the region, and apart from Vasse (1909), they were all single disciplinary thus leaving an unlimited field for original ecological research.

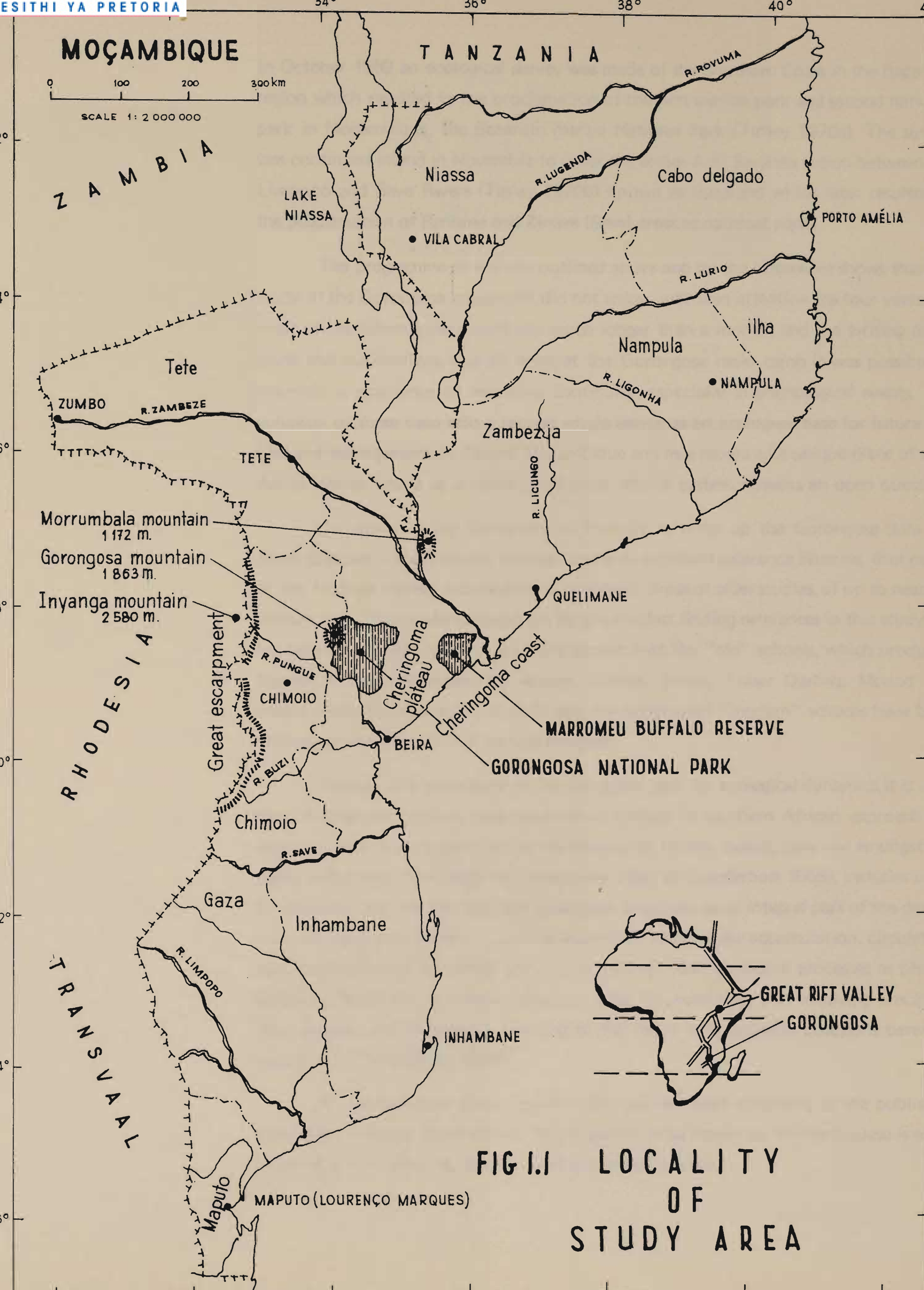

FIG 1.1 LOCALITY OF STUDY AREA

AMBIENT OF PRESENT STUDY

In August 1968 on arrival at Gorongosa, which was to be my base for the next four years, I was faced with the task of determining the ecological limits of the national park. All previous boundary limits had been arbitary or political, ie. straight lines, roads or rivers, and the authorities were concerned about the space requirements for seasonal wildlife migrations, the sufficiency of wildlife habitats, and the constant pressure by companies and tribal cultivators for park land. The report of this first major study was presented to the Mocambique Government in August 1969 (Tinley 1969b). After this base work was completed, it was clear that the highest conservation priority in Mocambique was not the further detailed study of Gorongosa wildlife alone as no indepth study could alter the fundamental importance of the salient factors, but the urgent need was to define the unique ecosystems throughout the territory which still required proclamation as national park areas. As the only wildlife ecologist in the territory it was important therefore for me to work on a priority basis covering as much of the territory as possible as well as keeping the study of Gorongosa as the main ongoing theme (see References). In the fifth year I moved to head office in Lourenco Marques, and left Mocambique in April 1974. Wildlife conservation and national parks was then and remains the responsibility of the Fauna Section of the Veterinary Department.

A prerequisite for meaningful ecological research is the use of a light aircraft for studying geomorphology, seasonal changes in habitats, and for air census of the larger wildlife species. To prove its efficacy to the Mocambique authorities, I arranged with Paul Dutton (then Ranger-in-charge of the Ndumu Game Reserve in Zululand) who has his own highwing Piper aircraft, to initiate the air studies in November 1968. As Mocambique at this time of the year is covered by a dense pall of smoke from veld fires, Paul and Ann Dutton flying in from Zululand were only able to find the park's main camp by navigating at tree-top level up the Pungue River from the coast! In this way the first air count of wildlife in Mocambique was made. The report emanating from this air survey also highlighted the crucial part played by Gorongosa Mountain in providing the perennial surface water which traversed the heart of the park system (Tinley *et. al.* 1968). This historic air survey and the resulting report had the desired effect of enthusing the authorities to provide a light aircraft for all ensuing research in the territory, and twice a year for air census of Gorongosa and the Marromeu Buffalo Reserve in the Zambeze Delta. An agreement was made by the Veterinary authorities with the Chimoio Airclub for the use of a highwing Cessna monoplane which could be called on even at short notice. Soon after, the first air count of the legendary buffalo herds of Marromeu in the Zambeze Delta was made in December 1968 (Tinley 1969a).

In October 1969 an ecological survey was made of the Southern Coast in the Bazaruto region which resulted in the proclamation of the first marine park and second national park in Mocambique, the Bazaruto marine National Park (Tinley 1970a). The survey was continued inland in November to cover the entire Arid Savanna region between the Limpopo and Save Rivers (Tinley 1970b) known as Gazaland which later resulted in the proclamation of Banhine and Zinave (Save) areas as national parks.

The programme of activity outlined above and by the references shows that the study of the Gorongosa ecosystem did not enjoy unbroken attention for four years. As most of the interruptions were not much longer than a month, and the writing of reports and publications was all done at the Gorongosa main camp it was possible to maintain a semblance of recording continuity, especially in phenological events. The collation of these data into a related whole serves as an ecological base for future studies and management in Central Mocambique and as a record of a unique piece of wild Africa whose future as a viable productive natural system remains an open question.

On arrival at the University of Pretoria to write up the Gorongosa data for thesis puposes, I soon found, through access to excellent reference libraries, that many of my findings merely substantiate or elaborate those of older studies, of up to nearly a century ago. Thus readers should not be surprised at finding references in this study going back to the last century. It would appear that the "old" schools, which produced Darwin, Wallace, Woodworth, Adams, Cowles, Smuts, Fraser Darling, Monod and others, were integrative and holistic and the subsequent "modern" schools have been divisive, or merological, and compartmented.

Though it is superflous to use the prefix geo- for ecological dynamics, it is used here in emphasis because most students of ecology in southern African approach the subject purely from a plant or animal viewpoint. In this regard, only one amongst the many definitions of ecology and ecosystems (that of Dyksterhuis 1958), includes energy relations, and the climatic and geological processes as an integral part of the definition. His definition reads: ".........the ecosystem involves the accumulation, circulation and transformation of energy and matter through such biological processes as photosynthesis, herbivory and decomposition, with the non-living part involving precipitation, erosion and deposition, reacting to the living part and with coactions between organisms" (Dyksterhuis 1958).

All Mocambique place names in the text are spelt according to the published Portuguese maps of the territory. The ***h*** used in tribal names by the Portuguese is equivalent to ***y*** in English, eg. Banhine is pronounced Banyine,

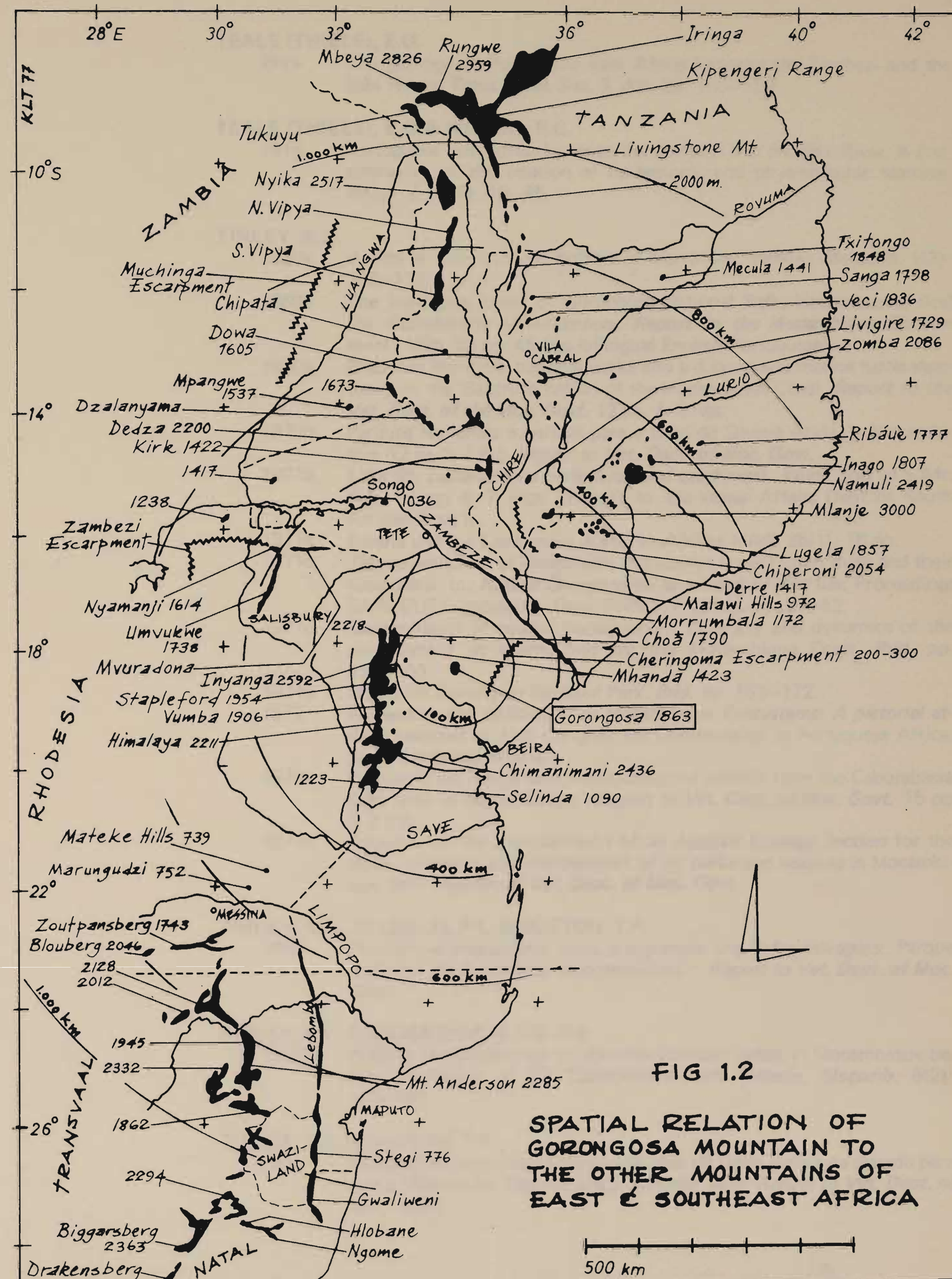

FIG 1.2

SPATIAL RELATION OF GORONGOSA MOUNTAIN TO THE OTHER MOUNTAINS OF EAST & SOUTHEAST AFRICA

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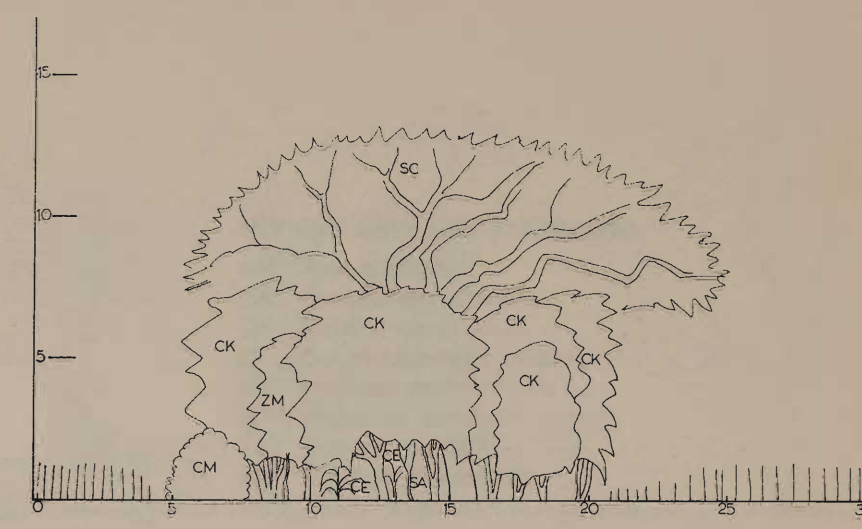
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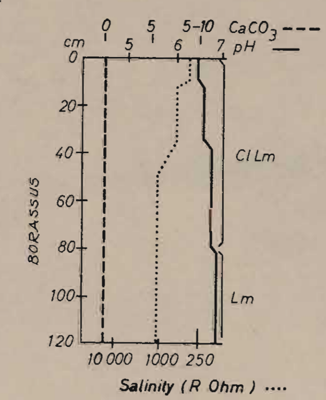
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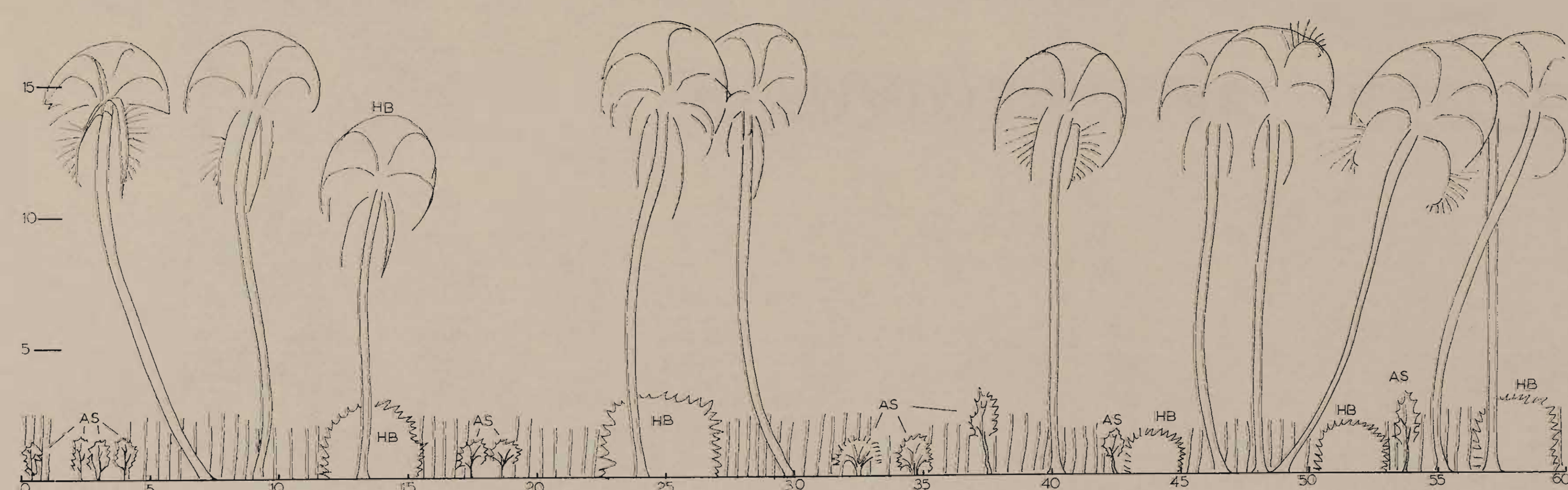
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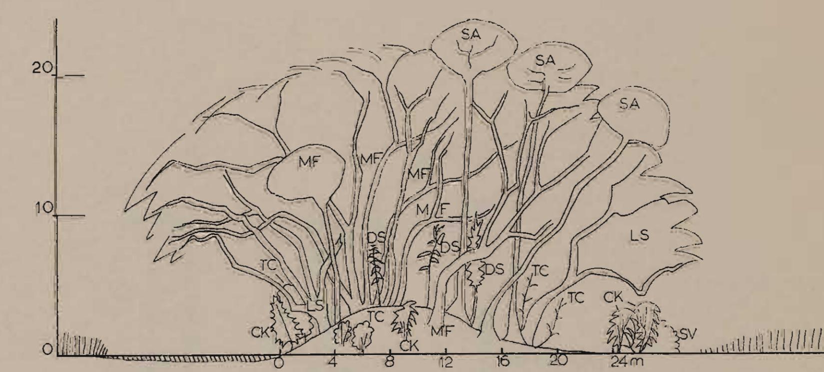
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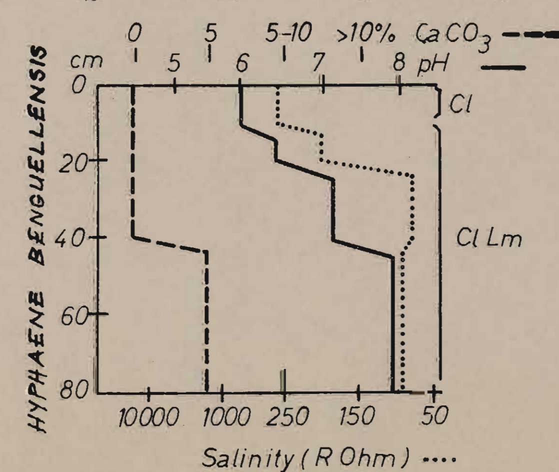
24m


$CaCO_3$
pH
cm
Cl
Cl Lm
HYPHAENE BENGUELLENSIS
Salinity (R Ohm)