"ECOLOGICAL STUDY OF HERPETOFAUNA IN THE ARABUKO-SOKOKE AND GEDE COASTAL FORESTS OF KENYA"

BY

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DECLARATION

This thesis is my original work and has not been presented for any other degree to the best of my knowledge.

Chira R. M. 02/04/92

Date

This thesis has been submitted for examination with my approval as University supervisor.

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Date

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

The herpetofauna of the two coastal forests (Arabuko-Sokoke and Gede) of Kenya, were sampled using three methods namely: Quadrat, Time constraint and Opportunistic methods. During the study, 2,201 individuals were recorded comprising 49 species. The reptiles were represented by 14 families, 33 genera, 41 species and the amphibians by 4 families, 6 genera and 8 species. Snakes followed by lizards were the most diverse and abundant accounting for 24 and 16 species respectively. One species was testudine. Among the amphibian species, the Ranidae and Bufonidae were the most diverse with 4 species each followed by the Rhachopholidae and the Microhylidae with 1 species each.

The forest differed in different vegetation types with a slight decrease in species richness from November to July. For each vegetation type, there was dominance of one or two lizard species, (e.g. *Heliobolus spekii* was found in *Brachystegia* woodland only).

There was diurnal variation in abundance and activity of herpetofauna in various vegetation types, with maximum activity falling between 9.00am and 12.00 noon, for all vegetation types.

Diversity was least in *Cynometra* vegetation type for both time constraint and quadrat samples. Significant changes were registered in diversity over time for both samples. *Brachystegia* woodland and *Cynometra* vegetation types emerged as the most similar compared to the rest of

the vegetation types. Population changes occurred over the sampling period with peaks in March-April in most of the vegetation types. Significant changes in species composition were recorded in *Afzelia*, Lowland rain forest and Gede forests. The highest species densities were observed in *Brachystegia* for *H. spekii* in January-February and the lowest for *Mabuya brevicollis* in *Afzelia* and Gede in November-December.

Seasonal variations occurred and there was an increase in number of individuals during the dry season, especially the species which are specialists of a particular vegetation type (e.g. *H. spekii*). This could be due to improved visibility or more favourable conditions during the dry season than in the wet season.

CHAPTER 1

INTRODUCTION AND LITERATURE REVIEW

1:1 Introduction

In response to the continual destruction of forests, which form major ecosystems with indigenous fauna and flora of realised and potential usefulness, there has been increased awareness of the need to conserve these areas. Through the concerted efforts of the government, non-governmental organisations (NGO´S) and the press, people have now started realising the importance of conserving such vital areas by stopping indiscriminate cutting down of trees.

One of the largest remaining lowland forests on the East African coast is the Arabuko-Sokoke forest, between Kilifi and Malindi, covering an area of about 400 sq. km.. Before 1950, European timber companies exploited it for its commercially valuable timber trees such as *Afzelia quanzensis,* Welw. *Manilkara sansibarensis* (Engl) and *Brachystegia speciformis* Benth.. Near it on the eastern side is a coral rag forest harbouring the famous Gede ruins, also with tree species of commercial importance such as *Sterculia appediculata* K. Sch..

The main Sokoke forest is characterised by distinct vegetation zones related to changes in soil types and rainfall distribution as one moves inland. The forest is divided into five regions depending on the tree species which is most dominant (Zimmerman and Briton, 1979). These are: *Brachystegia* woodland, *Cynometra* thicket, white soil *Cynometra-Afzelia* forest, lowland rain forest, *Afzelia* forest and *Cynometra-Manilkara-Brachystegia* forest.

The international importance of this forest lies in the presence of endemic and near-endemic bird species. These include the Sokoke Scops owl found mainly in the *Cynometra-Manilkara* forest, the endemic Clarke´s weaver bird (mainly in the open *Brachystegia* woodland) and also the Amani sunbird, reported from only one other site, the eastern Usambaras in Tanzania. The Sokoke pipit, also recorded in Pugu Hills in Tanzania, is widely distributed in the forest in shady undergrowth. The other important bird species is the migratory spotted ground thrush which spends most of its non-breeding period in East Africa, preferring the same habitats as the Sokoke pipit (Kelsey and Langton, 1983).

The coastal forests also have different species of herpetofauna, adding to the biodiversity of these communities. The main aim of this project is to explore the contribution of the herpetofauna to the biodiversity of Arabuko-Sokoke and Gede forests. The other aim is to compare the habitat types within the forests in terms of herpetofauna abundance and diversity, seasonality, and other factors influencing changes in a community.

1:2. Literature review

1:2:1. Lizards

There have been a number of studies on living lizards, but most of them have been concerned with temperate zone species. There was inadequate literature available to me on lizards in the tropical areas in spite of the fact that tropical lizards represent the richest part of the world lizard fauna. The few exceptions include Evans (1951), Hirth (1963) and Harris (1964). Most of these investigations have tended to concentrate on the members of the family Iguanidae, from the New World, except for the detailed investigation by Harris (1964) on the rainbow lizard. Contributions to the knowledge of the related family of the Old World, the Agamidae have been scanty. Most of the published material is in form of checklists of reptiles and amphibians of East Africa by Loveridge (1957), Spawls (1978), Broadley and Howell (1991).

The Agamidae is an exclusively Old World family with a continuous distribution throughout Africa (excluding Madagascar), southern Asia, the East Indian Islands and Australia, with a few species entering into southern Europe. They are more abundant in the tropics. The family complements that of the new world, the Iguanidae and where one lives, the other is absent (Harris, 1964). *Agama* is wide-spread over the old world with many species reported in East Africa coming from the Usambara highlands but widely distributed in Africa (Loveridge, 1957).

Some species of gekkonid lizards, which occur throughout the Old and New World, have been reported as being closely associated with human activities (Oliver and Shaw, 1953). Some *Hemidactylus* (which are abundant in our coastal forests) and *Lepidodactylus* can be considered strongly homophilic species similar to the house mouse, roof rat and the other human commensals. With the exception of *Hemidactylus frenatus*, relatively few reports have dealt with the life history, habitat preference or behaviour of these common lizards (Oliver and Shaw, 1953).

Hemidactylus is widely distributed with many species in East Africa (including the coastal region), South-eastern Africa, (Broadley, 1977b) Arabia, Indian Ocean Islands, West Indies and South America. They seem to be very well adapted to tropical and sub-tropical zones and appear to have recently increased their range; for example the genus was not observed in the Hawaiian Islands until 1951 (Hunsaker, 1966; Mackeown, 1978) having presumably reached there through passive transport in ship cargos.

Lygodactylus another gekkonid lizard, ranges from East Africa, south to Natal and Cape Town (South Africa), and west to Zaire, but most species in Africa are well represented in East Africa (Gunther, 1894 cited in Loveridge, 1957 and Loveridge, 1936, 1942). Other genera found in East Africa of the family Gekkonidae are *Phyllodactylus*, reported only in Tanzania (Gray, 1828; Tarnier, 1900 cited in Loveridge 1957), *Ebenavia*, reported in Pemba Island only (Boettger, 1878 cited in Loveridge 1957), *Homopholis*, in Kenya and Tanzania (Boulenger, 1885 cited in Loveridge 1957), *Pachydactylus* (Wiegmann, 1884 cited in Loveridge 1957), and *Holodactylus* (Drewes, 1971) among others.

The family Scincidae is well represented in East Africa with various genera, such as *Mabuya* and *Lygosoma*. Many of the latter species were formerly considered as belonging to the genus *Riopa* (Greer, 1977). *Lygosoma* has most species in Kenya, although some have a distribution ranging from Ethiopia and Uganda to South Africa (Gray, 1839 cited in Loveridge, 1957 and Loveridge, 1935).*Lygosoma* is a representative genus of various virgin forests of East African countries (Hardwick and Gray, 1827 cited in Loveridge 1957). *Cryptoblepharus*, (previosly called *Ablepharus* (Greer, 1974)), the snake-eyed skink, is found mostly along the coastal strip in Eastern Africa with *Afroablepharis wahlbergi* (previously *Ablepharis* (Greer, 1974)) having a wider distribution that ranges from East Africa to South Africa and Zaire (Smith, 1849, Boulenger, 1894 and Angel, 1924, all cited in Loveridge 1957). *Scelotes* has most species reported from Tanzania (Fitzinger, 1826, cited in Loveridge 1957) and *Scolecoseps*, *Acontias* and *Feylinia* have been reported from the Kenyan and Tanzanian coasts (Loveridge, 1957). The other family common in East Africa is Cordylidae, with two genera, the *Gerrhosaurus* (Broadley, 1987) and *Cordylus* (Loveridge, 1957).

The genus *Heliobolus* in the family Lacertidae is very common along the Kenya coast with very few species reported elsewhere (Gunther, 1872 and Tarnier, 1905, both cited in Loveridge 1957).

Chamaeleo in the family Chameleonidae has been observed in East Africa, South Africa and Congo, mostly associated with mountain forests and even lowland forests in East Africa (Loveridge, 1937; Klaver and Bohme, 1986, 1988). Most of the species reported are from the Usambara region of Tanzania highlands. Another chameleonid genus, *Rhampholeon* is well represented in Kenya and Tanzania but a few species are observed from Uganda. These chameleons were formerly included in *Brookesia*, but the latter is now considered as restricted to Madagascar (Klaver and Bohme, 1986).

1:2:2 Snakes

More has been done on snakes especially in Southern Africa (Broadley, 1959, 1966a,b, 1968, 1977a,b and 1978). Considerable taxonomic work has been done on the genera *Atractaspis*, *Psammophis* and *Dendroaspis*. *Atractaspis* comprises 14 species and 31 forms. They are extensively distributed in sub-saharan African, with isolated populations outside Africa in the Jordan valley. They were long considered as members of the Viperidae. Their taxonomic status has recently been subject of investigations (Bourgeosis, 1965, Kochva *et al.*, 1977 and Minton, 1968 cited in Branch, 1981), suggesting that they lie with the aparallactine colubrids.

Broadley (1966b) has reviewed the genus *Psammophis* in Africa with particular reference to the *P. sibilans* complex. He points to the considerable taxonomic confusion surrounding the various species and subspecies in this complex and suggests that it will take some time to determine their variation and distribution.

In Kenya we have three species of the genus *Dendroaspis*. Jameson's mamba, *Dendroaspis jamesoni kaimosae* Loveridge, is a large elapid, native to East Africa in the northern forest west of Rift Valley. It differs superficially from the common green mamba, *D. angusticeps* Smith, which occurs in Eastern Africa from the Njumbeni Hills in Kenya to the Cape, in that *D. jamesoni* has a velvety black tail while *D. angusticeps* has a bright green colouration unchanged throughout the head and body (Ashe, 1979). References to envenomation by *D. jamesoni* are few but, according to Christenson and Anderson (1967) cited in Ashe (1979), the dominant toxins of *D. jamesoni* and *D. polylepis* have partial but not complete identity with *D. angusticeps* venom.

The distribution of the different races and species of cobras has been well studied. For example, *Naja haje haje* is widely distributed in Africa whereas the other two, subspecies *N. h. annulifera* and *N. h. anchietae* range from Tropical to Southern Africa. The former's northern limits are unclear but the latter reaches its north eastern limit near Lake Bangwelu (Schmith, 1923; Parker, 1949; Witte, 1953, Cendamin, 1958, all cited in Broadley, 1968).

The other species of *Naja, N. nivea* and *N. nigricollis* are reported to prefer dry and moist savannas respectively whilst *N. melanoleuca* is widespread in forested or formerly forested areas of Africa. The subspecies of *N. mossambica* also seem to prefer different regions in Africa with *N. m. mossambica* extending from Tropical to Southern Africa as opposed to *N. m. pallida* which extends from Northern to Tropical Africa with its western limit remaining uncertain. *N. m. katiensis* is confined to Tropical Africa, while *N. m. nigricinta* is limited to northern half of

Southwest Africa and Southwest Angola, but *N. m. woodi* is only confined to Southern African region (Corkhill, 1935; Loveridge, 1936, 1957; Cansdale, 1961; Eisett, 1962, and Frinkeldey, 1964, both cited in Broadley, 1968).

From Kenya a new viper of the genus *Atheris* was discovered near Mount Kenya, a form coming from the eastern area of Rift Valley in Kenya where no representatives of this genus have been previously recorded. It differs sufficiently from other forms to merit recognition as a separate species (Ashe, 1968). It is nearest to *A. chloroechis* Schlegel from Western Africa with which it agrees in having short heavily keeled scales. All vipers of this genus came from the west of Rift Valley. According to the local people (Nyambeni Hills, area of collection) they prefer tree tops in dense forests. They have nasty venom and are very aggressive. They feed on frogs, *Ptychadena*, and occasionally on birds. Males are bluish black under the tail and females are green and yellow underneath. The species *A. desaixi* is endemic to this area only.

The genus *Dasypeltis* is known for its procryptic characteristics, that is showing colour resemblance, counter shading and disruptive colouration (Cott, 1940, cited in Carl, 1961). All species possess a warning reaction and some evidence shows that at least one of the species, *D. scabra* mimics the local colour pattern and threat display of various small vipers inhabiting parts of its range. Colour resemblance is shown by the correlation of dorsal colour and habitat (Lonnberg, 1922, cited in Carl,1961). The clearest case is that of *D. medici medici* individuals of which are pink and reddish in colour, and resemble closely the colour of the lateritic soil of coastal east Africa where they are found (Loveridge, 1942). Other forms inhabit grasslands or savannah with sparse vegetation (e. g. *D. palmarum* in Congo, *D. scabra* from Arabia to the Cape and west to Liberia, *D. inanata* in Natal), and are all light brown to tan dorsally.

1:2:3. Amphibians

Duff-Mackay (1980) has reviewed the amphibians of species in coastal Kenya and also attempted to begin to asses the risks they face and to compare their distribution with that of other faunal groups. Coast habitats of various types support a high percentage of Kenya's amphibians which are an important element in coastal forest conservation. The species and subspecies reported as occurring on the coastal plain (or in Taita Hills) represent 43% of the total (there are 97 recognised taxa inclusive of sub-species). Duff-Mackay writes that they are hardy, but that like many less obvious fauna, little account has been paid to their conservation.

Duff-Mackay (1980) argues that out of the 88 species (97 species and subspecies) in Kenya, 4 (4.5%) are endangered: *Leptopelis modestus* Werner, *Afrixalus sylvaticus* Schiotz, *Hyperolius rubrovermiculatus* Schiotz and *H. lateralis* Laurent. The last of these species is however not endangered in Uganda (Drewes, pers. comm.) Two of these species (2.25%) are endemic to Kenya. These are *A. sylvaticus* and *H. rubrovermiculatus* Schiozt, and are therefore facing possible total extinction. There are also a number of species whose present status is unknown and it is quite possible that several species may have already disappeared from Kenya (although no evidence has surfaced) (Duff-Mackay, 1980).

In a recent review of endemic African amphibians, Stubbs lists 20 endemic species for Kenya, 14 of which are country endemics, while three are shared with Tanzania, two with Somalia and one with Ethiopia (Stubbs, 1987). Of the endemics, seven are coastal and include two of the species which Duff-Mackay (1980) lists as endangered, the pygmy reed frog *A. sylvaticus* and the sedge frog *H. rubrovermiculatus*. The former is only known from Shimba Hills, the latter from its type locality at Kwale, close to the Shimba Hills.

Out of the endemic species of Kenya, five more are found along the coast region. They are *Schistometopum gregorii* Boulenger (known from Witu, and Tana river delta, and Kwale), *Afrocaecilia changamwensis* Loveridge (recorded from Changamwe near Mombasa), *Afrocaecilia taitana* Schiotz,(an endangered species found in Kwale only), *Hyperolius sheldricki* Duff-Mackay and Schiotz (near Kakoneni south of Galana river), and *Hemisus marmoratus loveridgei* Laurent (recorded from Malindi where Loveridge collected two juveniles).

Other endemic amphibian species and subspecies found in Kenya are: *Afrixalus pygymaeus septentrionalis* Schiotz; *Hyperolius montanus* Angel; *H. cystocandicans* Richards and Schiotz; *H. viridiflavus glandicolor* Peters; *H. v. ferniquei* Mocquard; *H. v. pantherinus* Steindachner; *H. v. ssp.*; *Rana* *wittei* (Angel); *Arthroleptides dutoiti* Loveridge; *Phrynobatrachus kinangopensis* Angel, *P. keniensis* Barbour and Loveridge; *P. sp. A* (NMK series A/629) and *P. sp. B* (NMK series 1203) (Duff-Mackay, 1980).

1:2:4. Coastal Herpetofauna

The coastal forests of Kenya have an interesting herpetofauna. Table 1 shows the species reported from the coastal forests and their environments.

From table 1, only 25 species are reported in Arabuko-Sokoke and Gede forests. The rest come from other areas along the coast. The families represented are 21 out of which 6 are snakes, 7 lizards, 7 amphibians and 1 tortoise. There are 58 genera in all, where 27 are snakes, 12 lizards 17 amphibians, and 2 tortoises. All species are 109 of which 50 are snakes, 21 lizards, 36 amphibians and 2 tortoise. Most of the snake genera are well represented in tropical and Southern Africa. Some genera extend to Northern and Southern Africa with a few extending to Arabia (Pitman, 1938, 1974). The lizards are widely distributed in and outside Africa as reported under the section on lizards (Loveridge, 1936, 1957). Most of the frog species reported in Table 1 are coast representatives of Tropical and Southern Africa (Stewart, 1967).

Table 1: Herpetofauna reported in Kenyan coastal forests and their environs.

Tortoises

Family: Testudinidae

Genus	Species	Subspecies	Location
Kinixy	*K. belliana*	*K. b. zombensis*	Sokoke-Forest
Malacochercus	*M. tornieri*		Malindi

Snakes

Family: Typhlopidae

Genus	Species	Subspecies	Location
Typhlops	*T. braminus*		Mombasa
	T. lubriciformis		Sokoke Forest
	T. pallidus		Ngatana
	T. schlegelii	*R. s. dinga*	Sokoke F.
	T. unitaeniatus		Malindi

Family: Leptotyphlopidae

Genus	Species	Subspecies	Location
Leptotyphlops	*L. boulengeri*		Lamu
	L. conjunctus	*L. c. conjunctus*	Jilore F.
	L. longicaudus		Vipingo

Family: Boidae

Genus	Species	Subspecies	Location
Python	*Python sebae*		Malindi

Family: Colubridae

Genus	Species	Subspecies	Location
Lamprophis[1]	*L. fuliginosus*	*B. f. fuliginosus*	Malindi
Lycophidion	*L. depressirostre*		Lamu
	L. capense	*L. c. loveridgei*	Jilore F.
Mehelya	*M. capensis*	*M. c. savorgnani*	Kilifi
Meizodon	*M. semiornatus*		Malindi
	M. coronatus		Ngatana
Philothamnus	*P. irregularis*	*P. i. battersbyi*	Witu
	P. semivariegatus	*P. s. semivariegatus*	Jilore F.
Scaphiophis	*S. albopunctatus*	*S. a. albopunctatus*	Gede
Prosymna	*P. ambigua*	*P. a. stuhlmanni*	Witu
Telescopus	*T. dhara*	*T. d. somalica*	Malindi
	T. semiannulatus	*T. s. semiannulatus*	Malindi
Crotaphopeltis	*C. hotamboeia*		Kilifi
Dipsadoboa[2]	*D. aulicus*	*D. a. aulicus*	Watamu
Dispholidus	*D. typus*		Watamu
Thelotornis	*T. kirtlandii*	*T. k. kirtlandii*	Gede
Hemirhagerrhis	*H. kelleri*		Mombasa
	H. nototaenia	*H. n. nototaenia*	Kilifi
Rhamphiophis	*R. oxyrhynchus*	*R. o. rostratus*	Malindi
	R. rubropunctatus		Kilifi
Psammophis	*P. sibilans*	*P. s. sibilans*	Sokoke F.
	P. biseriatus		Watamu
	P. subtaeniatus	*P. s. sudanensis*	Malindi
Aparallactus	*A. guentheri*		Ngatana
	A. turneri		Sokoke F.
Amblyodipsas	*A. polylepis*	*A. p. hildebrantii*	Mombasa
Dasypeltis	*D. scabra*		Witu

	D. medici	*D. m. medici*	Tiwi
	D. medici	*D. m. lamuensis*	Malindi

Family: Elapidae

Genus	Species	Subspecies	Location
Naja	*N. nigricollis*	*N. n. nigricollis*	Malindi
	N. mossambica	*N. m. pallida*	Galana
	N. melanoleuca		Gede
Dendroaspis	*D. angusticeps*		Malindi
	D. polylepis	*D. p. polylepis*	Gede
Pelamis	*P. platurus*		Malindi

Family: Viperidae

Genus	Species	Subspecies	Location
Atractaspis	*A. microlepidota*	*A. m. microlepidota*	Kilifi
	A. bibronii	*A. b. rostrata*	Ngatana
Causus	*C. rhombeatus*		Jilore F.
	C. defilippii		Gede
	C. resimus		Jilore F.
Bitis	*B. arietans*	*B. a. arietans*	Malindi

Lizards

Family: Gekkonidae

Genus	Species	Subspecies	Location
Hemidactylus	*H. squamulatus*	*H. s. barbouri*	Mombasa
	H. frenatus		Lamu
	H. mabouia		Coast
Lygodactylus	*L. picturatus*		Mombasa

Family: Agamidae

Genus	Species	Subspecies	Location
Agama	*A. cynogaster*		Coastal belt

Family: Scincidae

Genus	Species	Subspecies	Location
Mabuya	*M. planifrons*		Coastal belt
	M. striata	*M. s. striata*	Coastal belt
Lygosoma[3]	*L. mabuiiformis*		Ngatana
	L. tanae		Tana delta
	L. pembanum		Coastal belt

Family: Chamaeleonidae

Genus	Species	Subspecies	Location
Chamaeleo	*C. dilepis*	*C. d. dilepis*	Sokoke-Forest
Rhampholeon[4]	*R. kersternii*	*R. k. kersternii*	Coastal Belt

Family: Cordylidae

Genus	Species	Subspecies	Location
Cordylus	*C. cordylus*	*C. c. tropidosternum*	Malindi
Gerrhosaurus	*G. major*	*G. m. major*	Coast
	G. flavigularis	*G. f. fitzsimonsi*	Coast

Family: Lacertidae

Genus	Species	Subspecies	Location
Latastia	*L. longicaudata*	*L. l. revoili*	Coastal belt
Heliobolus[5]	*H. spekii*	*H. s. spekii*	Ngatana
	H. smithi		Tana delta

	H. striata		Tana river

Family: Varanidae

Genus	Species	Subspecies	Location
Varanus	*V. niloticus*	*V. n. niloticus*	Coastal belt
	V. exanthematicus		Coastal belt

Amphibians

Family: Caeciliidae

Genus	Species	Subspecies	Location
Schistometopum	*S. gregorii*		Tana river
Afrocaecilia	*A. changamwensis*		Changamwe
	A. sylvaticus		Kwale

Family: Pipidae

Genus	Species	Subspecies	Location
Xenopus	*X. leavis*		below 6000ft
	X. muelleri		Sokoke F.

Family: Bufonidae

Genus	Species	Subspecies	Location
Bufo	*B. gutturalis*		below 6000ft
	B. steindachneri		Malindi
	B. taitanus		Taita Hill
Genus			
Merterorphyre	*M. micronotis*		Gede Forest

Family: Hyperoliidae

Genus	Species	Subspecies	Location
Kassina	*K. senegalensis*	*K. s. somalica*	Kakuyuni
	K. senegalensis	*K. s. argyreivittis*	Tiwi
	K. maculata		Malindi
Leptopelis	*L. flavomaculatus*		Sokoke Forest
	L. argenteus	*L. a. concolour*	Witu
Afrixalus	*A. brachycnemis*		Witu
	A. fornasini		Kaloleni
	A. pygmaeus	*A. p. pygmaeus*	Coast
Hyperolius	*H. argus*		Malindi
	H. tuberilingius		Kaloleni
	H. punticulatus		Malindi
	H. parkeri		Tiwi
	H. sheldricki		Kaloleni
	H. mariae		Tiwi
	H. viridiflavus	*H. v.rubripes*	Malindi
	H. viridiflavus	*H. v. glandicolor*	Taita
	H. pusillus		Sokoke F.

Family: Ranidae

Ptychadena	*P. oxyrhynchus*		Tiwi
	P. mascareniensis		Coastal belt
	P. floweri		Galana
	P. mossambica		Tiwi
Pyxicephalus	*P. adspersus*		Gede
	P. flavigula		Lamu
Hylarana	*H. bravana*		Malindi
Arthroleptis	*A. stenodactylus*		Gede

Phrynobatrachus	*P. acridoides*		Coast
Hemisus	*H. marmoratus*	*H. m. marmoratus*	Coast
	H. marmoratus	*H. m. loveridgei*	Malindi
Chiromantis	*C. xerampelina*		Coast

Family: Microhylidae

Genus	Species	Subspecies	Location
Phrynomerus	*P. bifasciatus*		Coast

This distribution has been reported in Loveridge, 1936, 1957; Stewart, 1967; and Spawls, 1978.

Notes to Table

1. Formerly known as *Boaedon* (Broadley, 1991)
2. Formerly known as *Chamaetortus* (Rasmussen, 1989)
3. Formerly known as *Riopa* (Greer, 1977)
4. Formerly known as *Brookesia* (Klaver and Bohme, 1986)
5. Formerly known as *Eremias* (Broadley and Howell, 1991)

CHAPTER 2

STUDY AREA, MATERIALS AND METHODS

2:1 Description of study area

The Arabuko-Sokoke forest is one of the largest remaining lowland forests in East African coast and is situated between Kilifi and Malindi town along the Malindi and Mombasa highway, in the Kilifi District in Coast Province of Kenya (Figure 1), covering an area of just under 400 sq. Km.

The coastal forests have been a source of timber for many centuries. In the first half of this century, European timber companies removed most of the commercially valuable timber from Sokoke forest. Saw mills were set up and forest work camps constructed. These saw mills processed timber for building materials, logging out trees such as *Afzelia quanzensis*, *Manilkara sansibarensis* and *Brachystegia speciformis* (Kelsey and Langton, 1983).

By the beginning of 1950s, most of the saw mills had closed down, mainly because most of the more valuable timber had been removed. Subsequently a large part of the forest was declared a forest reserve (Figure 2), and much forest outside the reserve boundaries was given to settlement areas and cleared for crops and villages. Today, the forest covers only about half the area that it used to 30 years ago (Kelsey and Langton, 1983).

To the east we have lowland rain forest on coral rag comprised of patches (for example Gede forest reserve) on

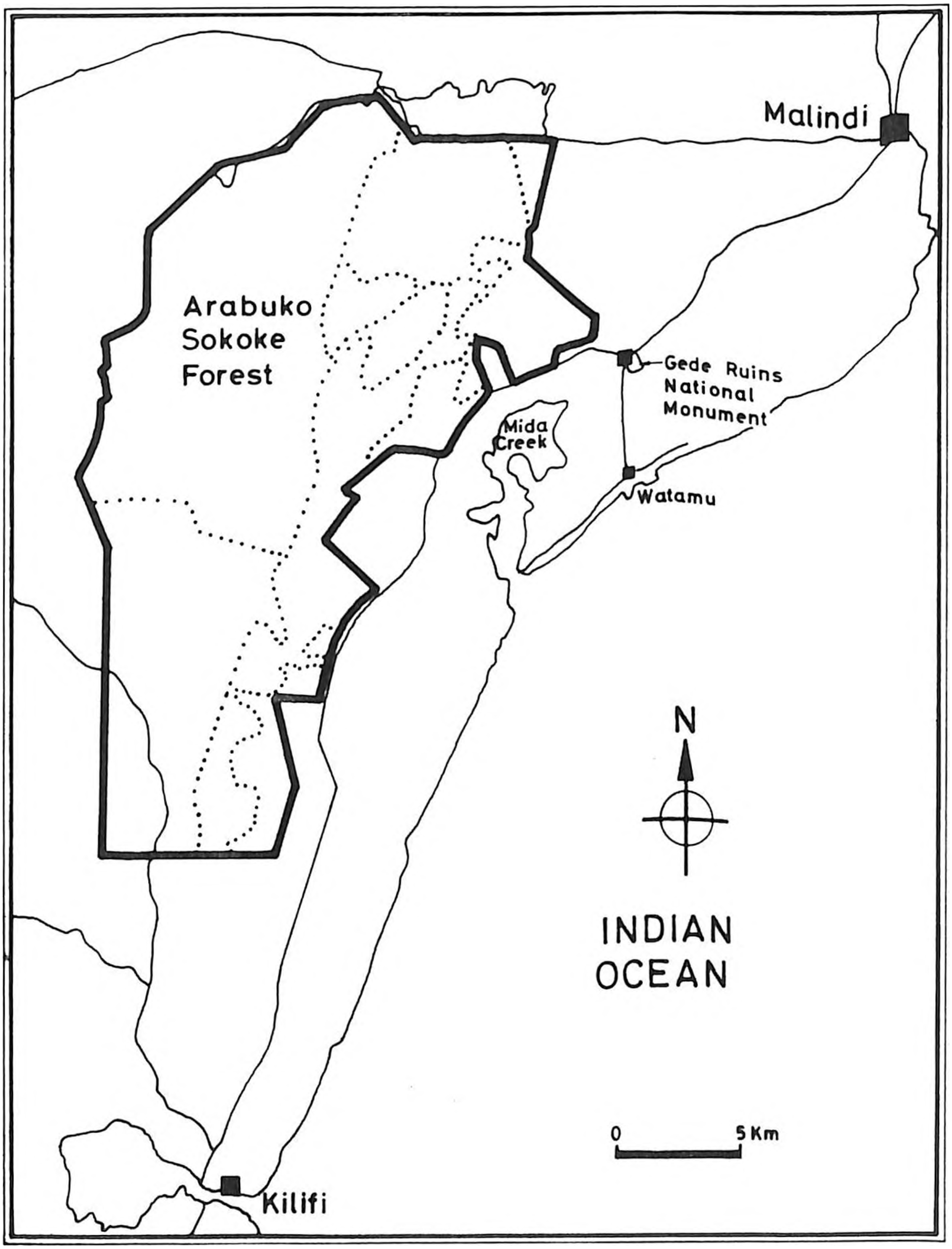


Fig. 1 Arabuko-Sokoke Forest and Gede National Monument

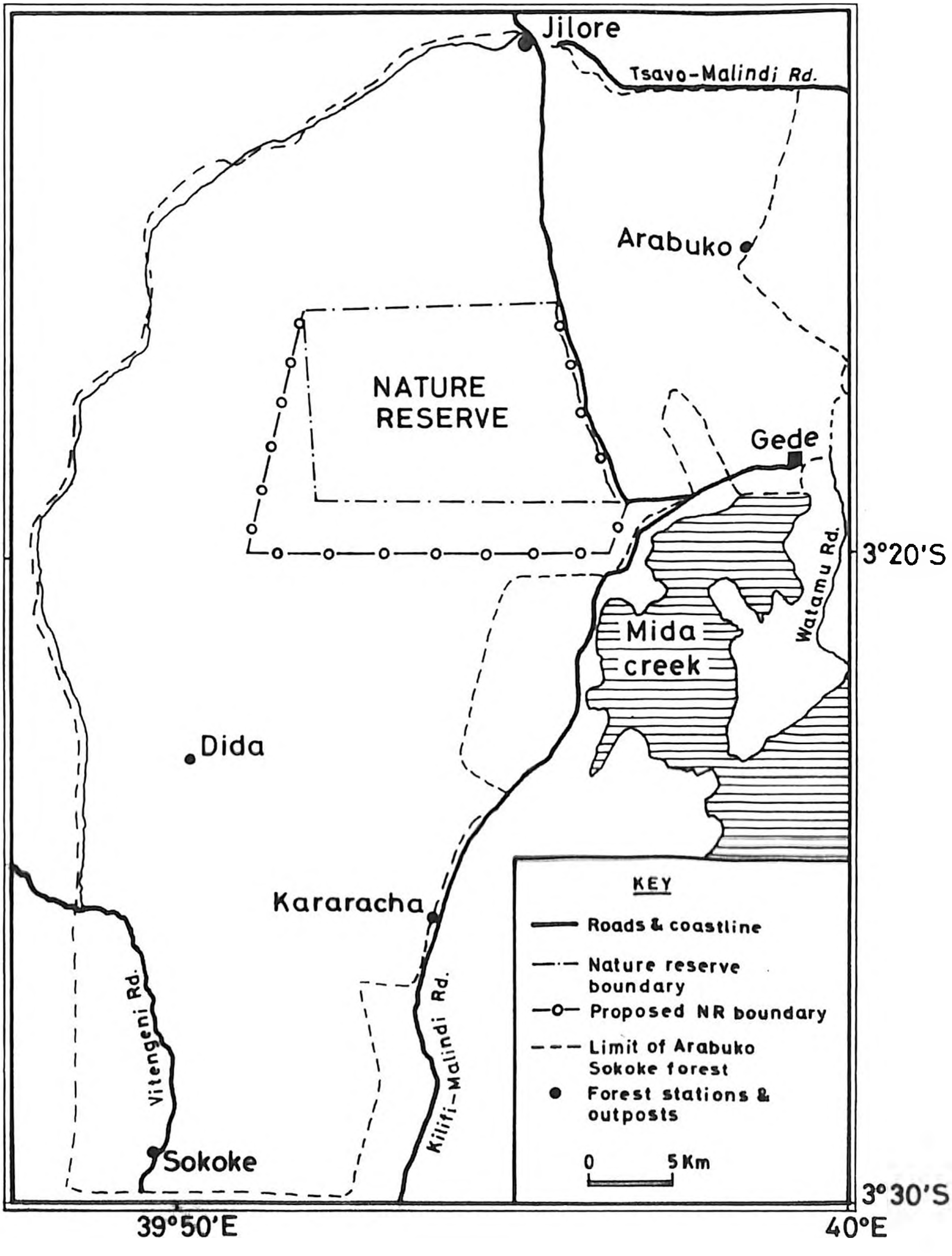


Fig. 2 Arabuko-Sokoke Forest showing the nature reserve

shallow soils, maintained by higher rainfall and characterised by *Gyrocarpus* and *Sterculia appendiculata*, a commercially valuable tree species. The forest patch at Gede is less than 1 sq. km. in area (Figure 1).

2:1:1 Climate

The forest receives a mean total rainfall of 1053 mm per year (calculated from monthly mean rainfall over a period of 10 years) (Figure 3), with an average of about 88 mm per month. The rain is not well distributed over the year, with the area receiving the minimum rainfall between January and March. From April to June, the area receives the highest rainfall, during the long rains period. There is a decrease from July to September, after which the rainfall increases in the minor rainy season up to December, before the dry spell sets in. The least rainfall is received in February whilst the highest is in May.

There are also temperature fluctuations from January to December, with February and March having the highest mean maximum temperature of about 32.5^{o}C. The lowest mean maximum temperature per month is 28^{o}C between June and August. The temperature rises again from September to December and all the way to March (Figure 4). The highest minimum temperatures are in March and April and in September. The climate is generally hot and humid throughout the year.

2:1:2 Topography and Soils

The study area is generally flat with the land rising gradually from the coastline to inland. On the coastal side

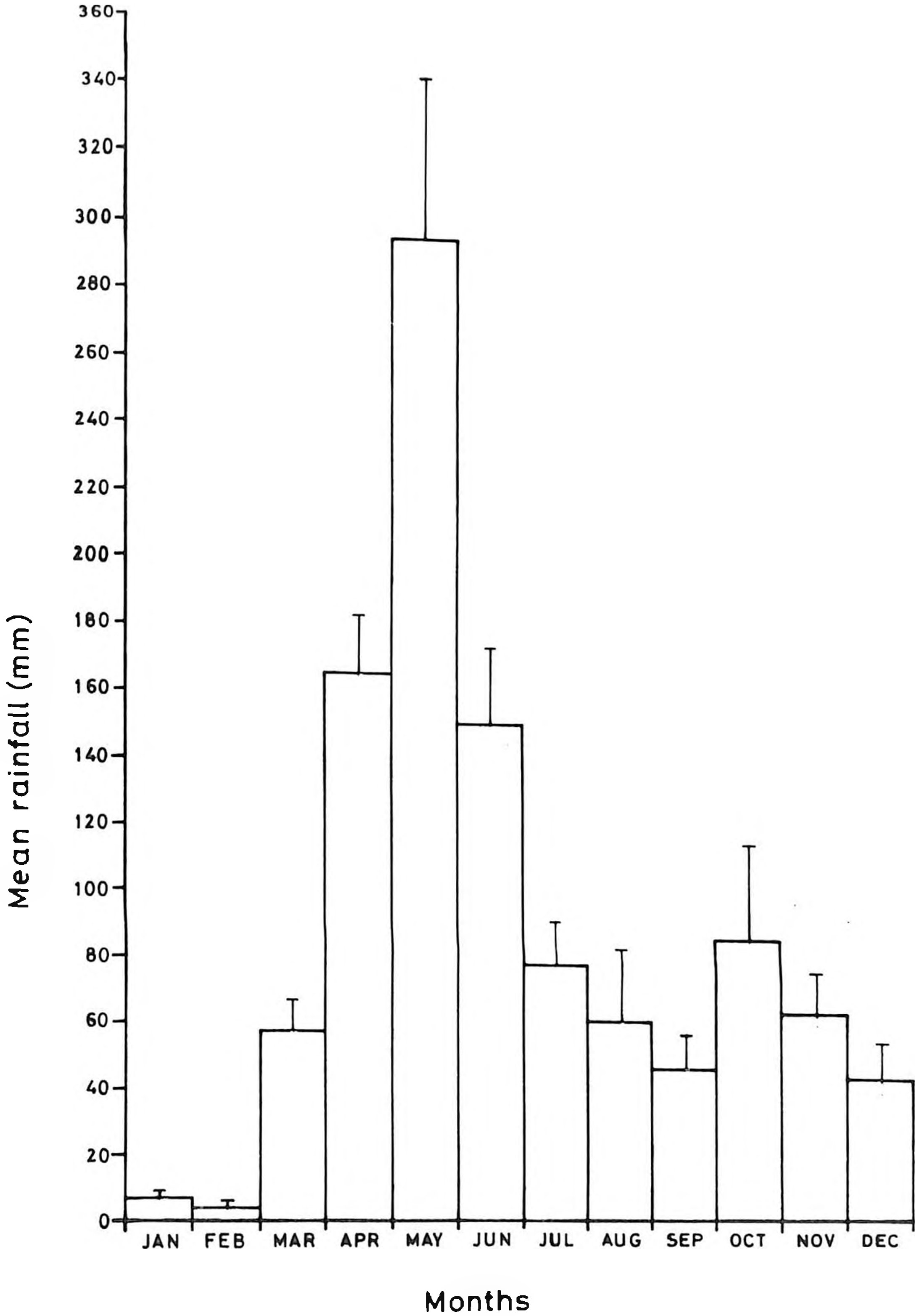


Fig. 3 The mean monthly rainfall (mm) at the Gede Forest Station (1980-1990)

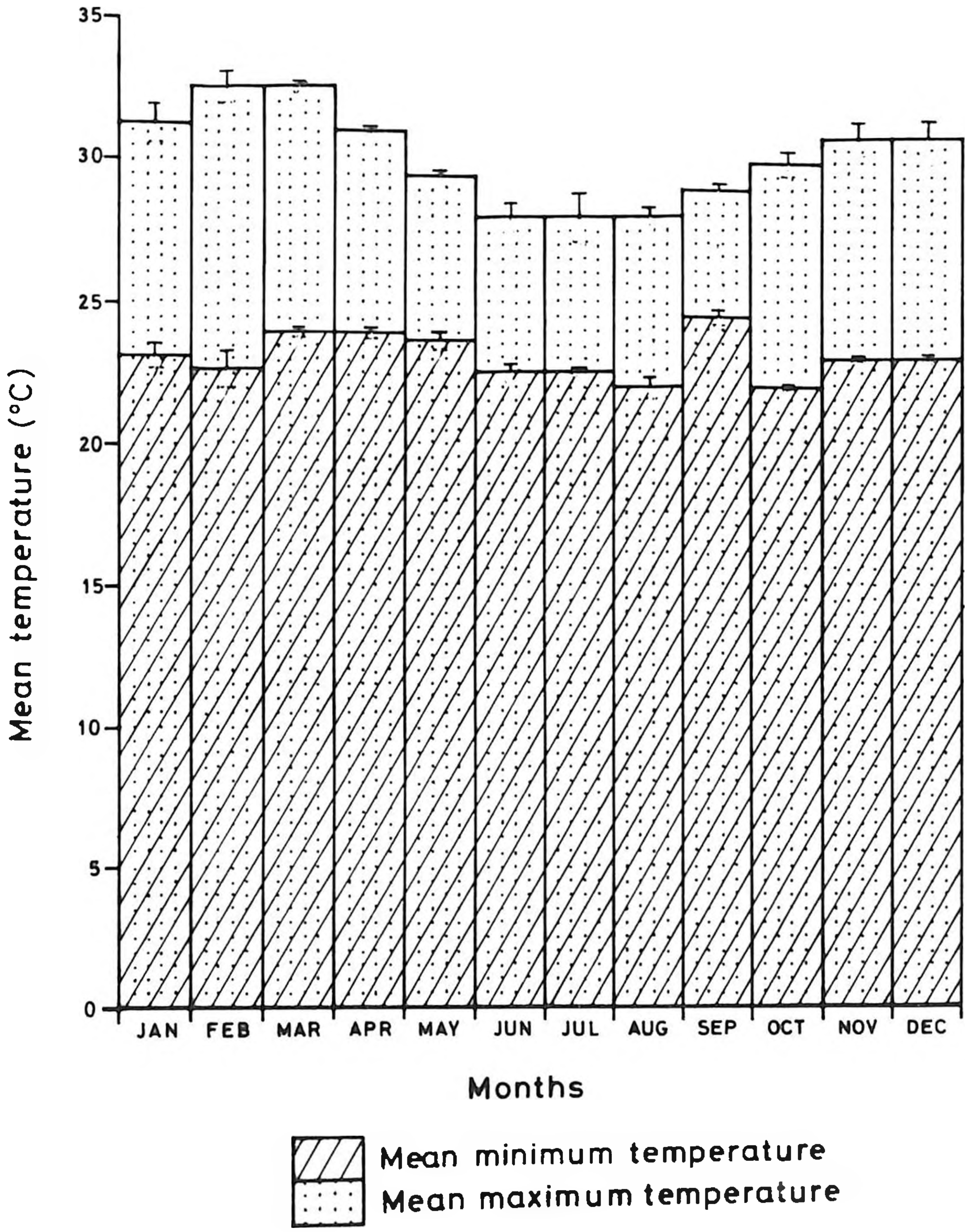


Fig. 4 Mean monthly temperature (°C) at K.A.R.I. Malindi (1978-1991)

there are buffish soils while next to it on west there are light white soils. Further inland to the west of the forest, there are the reddish lateritic soils that are characteristic of most of coastal East Africa. The red soils are poorly drained and wet under foot. Also along the coast we have the coral rag soil type which supports forest patches maintained by higher rainfall, as at Gede.

2:1:3 Vegetation

The forest is divided up into various vegetation types (Zimmerman and Britton, 1979) (Figure 5) related to various factors such as soil type and rainfall distribution which change as one moves inland. Lowland rain forest replaces *Afzelia* forest in areas of higher rainfall (more than 1000 mm per annum) on compact buff-grey sands. The small area (less than 20 km^2) of this vegetation type is close to Gede forest station, and is referred to as the Mida-Gede forest by Moomaw (1960). Apart from a higher canopy and a less tangled understory, it is structurally similar to *Afzelia* forest. The characteristic trees are *Combretum schumannii* Engl., *Sorindeia obtusifoliolata* Engl., *Lannea stuhlmanii* (Engl.), *Lecaniodiscus fraxinifolius* Bak,. and species of *Diosypros*.

The *Afzelia* forest is a more dense and generally evergreen forest characterised by *Afzelia quanzensis*, *Trachylobium verrucosum* Gaentn. and *Julbernardia magnistipulata* (Harms.). The nearly continuous canopy of trees is as low as 10 - 12 m with a tangled understory of shrubs and small trees, and moderate leaf litter. This

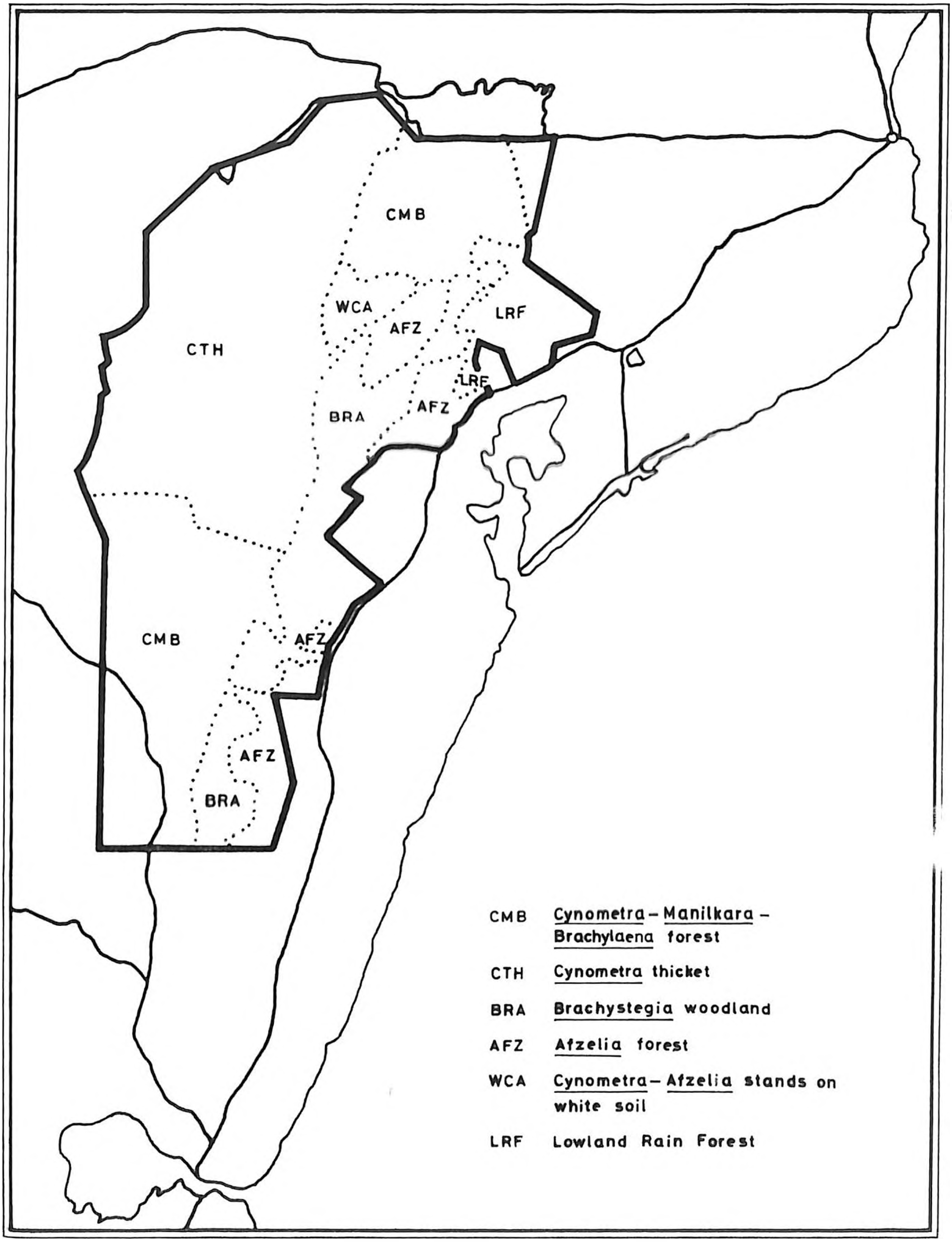


Fig. 5 Vegetation types in Arabuko-Sokoke Forest
(After Zimmerman and Briton, 1979)

distinct vegetation type occupies areas of less than 1000 mm of rainfall.

Brachystegia woodland occurs on deep, loose, light grey to buff, medium to coarse sands according to Moomaw (1960). These soils are about as poor a prospect for agriculture development as any on the coast. Rainfall ranges from 600 to 1000 mm per annum. The vegetation has over 70 per cent of the trees of the same species, *Brachystegia speciformis*.

The *Cynometra-Manilkara* zone, a closed canopy evergreen forest occupies the biggest area of the Arabuko-Sokoke forest on infertile dark red loams (Moomaw, 1960). Over a distance of less than 20 km, this habitat changes from rich forest over 15 m high in the south, to impoverished thicket (4 m or lower) in the comparatively arid north west. *Cynometra webberi* Bak. f., *Manilkara sulcata* (Engl.) and *Brachylaena hutchinsii* Hutch. are dominant throughout. Others are *Pavetta*, *Cremaspora*, *Canthium* species and *Encephalartus hildebrandtii* A. Br and Bouche.

2:1:4 Fauna

The forests have a number of different forms of fauna all contributing to a high biodiversity. There are two endemic bird species, the Sokoke Scops owl (*Otus ireneae*) and Clarke's weaver (*Ploceus golandii*). Others are the Amani sunbird (*Anthreptes pallidigaster*), and the Sokoke pipit (*Anthus sokokensis*). The other important bird is the spotted ground thrush (*Turdus fischeri*). Its density is quite high in the coral rag forest in Gede ruins National Monument

(Kelsey and Langton, 1983).

In addition to the endemic bird species, Sokoke forest is of importance for other wildlife. It is the only known locality for the rare Ader's Duiker *(Cephalopus aders)*. The frog *Leptopelis flavomaculatus* is only known elsewhere in the Shimba Hills. Two butterflies, *Charaxes lasti* and *C. protocles azota* are endemic. Other fauna found in the forest include leopards, (*Panthera pardus* (Linneaus)) baboons, (*Papio cynocephalus* (Linneaus)), white-throated monkey (*Cercopithecus albogularis* (Linnaeus)), buffalo (*Syncerus caffer* (Sparrman)), elephants (*Loxodonta africana* (Blumenbach)), elephant shrew (*Rycnchocyon cirnei* (Peters)), and giant Gambian rats (*Criscetomys gambianus* (Waterhouse)). Other butterflies found are *Papilio dardanus, P. constantinus, Graphium colonna, Hypolimnas missipus* and *H. deceptor*. The herpetofauna comes in many colours, forms and sizes making the forest one of the major areas necessary to conserve for its high biodiversity.

2:2 Materials and Methods

2:2:1. Determination of optimal sampling time

To determine the optimal sampling time, I sampled four plots in each of the closed canopy (*Afzelia*, Gede, *Cynometra*, and Lowland rainforest), and open canopy (*Brachystegia*) vegetation types. This was done over a period of ten days. Each plot was searched for between 30-40 minutes at different hours of the day that is between 6-7, 9-10 am and 12-1, 3-4 pm.

2:2:2 Quadrat search-and-seize

I sampled four plots (size 25x25m) in each vegetation type in Sokoke and Gede forest reserve. A plot was sampled five times on different days per two-month period from November 1990 to July 1991. The sampling took place between 9 am and 1 pm in the afternoon. Counting or sampling a plot more than once a day was avoided. Each plot was searched for between 30-40 minutes by visually examining trees, ground cover, shrubs, leaf litter and turning over logs and replacing them. Where possible animals were identified without capture and if impossible, they were caught, identified and released, or retained for identification later.

2:2:3 Time constraint sampling

Searching was done intensively in each vegetation zone as described above and no partial boundaries were set other than staying within the habitat. The time limit for each search period was four hours. Double-counting of animals was avoided by not searching the areas twice. This also involved recording of species identity for each specimen captured or observed and any other biological information of interest (Bell, 1986).

2:2:4 Species collection, preservation and identification

Most of the species collected were caught by hand especially the lizards and amphibians although for amphibians, a scoop net was quite helpful. Non-dangerous snakes were pressed down with a stick by the head and then held behind the neck and put into a container and subsequently immersed in formalin. Dangerous snakes were killed by hitting the head with the stick.

Before putting the specimens in preservative, field data was collected by labelling the specimen indicating locality, date and other additional observations. This was followed by fixing in formalin, which proved to be the most effective all-round fixative. Fixative was introduced into the body cavity to ensure complete preservation, injecting by syringe. Injections were also used on the head and limbs of large specimens for lizards, frogs and toads. For snakes, the head and various points along the rest of the body were injected. The specimens were initially stored in formalin and later in alcohol (75% for the reptiles and 60% for amphibians).

Before preservation and storage of the specimens they were first identified as far as possible and the species was indicated on the label. Keys for identification were used (Broadley, 1970 and Branch, 1988) and consultation with herpetologists helped much in identification. In particular, I received valuable assistance from James Ashe in the field and Alex Duff-Mackay and Damaris Rotich of the herpetology department of the National Museums of Kenya.

CHAPTER 3

RESULTS

3:1 Species recorded during the study period

Table 2 shows the total number of species captured during the study period, the taxa they belong to, the various vegetation types in which they were collected, and also including the number of individuals per species recorded. Very few individuals per species were collected in the order Salienta, but quite a number in the sub-order Lacertilia. However, more species were recorded in sub-order Serpentes than in sub-order Lacertilia and order Salienta.

Table 3 shows that the reptilian fauna is composed of 41 species and the amphibian fauna of 8 species. The reptiles are represented by 14 families, 33 genera, 41 species and the amphibians by 4 families, 6 genera and 8 species. The ratio of reptilian species to genera is 1.24:1 whereas that of genera to families is 2.36:1. The amphibian species to genera ratio is 1.33:1 whereas that of genera to families is 1.50:1.

Table 3 also shows the taxonomic profile of the reptilian communities in coastal forests of Kenya. Snakes followed by lizards are the most diverse and abundant, accounting for 24 (58.5%) and 16 (39.0%) species, respectively. One species is testudine accounting for 2.5%. Amongst the amphibian species the Ranidae and Bufonidae are the most diverse with 3 species each (37.5%), followed by the Rhachopholidae and the Microhylidae with 1 species each (12.5%).

Table 2. The herpetofauna captured during the study period in Arabuko-Sokoke and Gede forests

Higher taxa	Families	Species	Veg. Type	No. rec.
Class: Reptilia				
Order: Squamata				
Sub-order: Serpentes				
	Typhlopidae	*Typhlops schlegelli*	Gede	1
	Leptotyphlopidae	*Leptotyphlops Sp.*	LRF	1
	Boidae	*Python sebae*	Gede	1*
	Colubridae	*Lycophidion capense*	Gede	1
		Lamprophis fuliginosus	LRF	7*
		Lamprophis lineatus	LRF	1*
		Philothamnus semivariegatus	LRF	2
		Scaphiophis albopunctatus	Afz	4
		Telescopus semiannulatus	Brac	1*
		Crotaphopeltis hotamboeia	Brac	1*
		Disphlidus typus	LRF	2*
		Thelotornis kirtlandii	Gede/LRF	6
		Hermirrhagerrhis nototania	LRF/Brac	2*
		Rhamphiophis oxyrhynchus	LRF	3 *
		Psammophis sibilans	LRF	2
		Psammophis biseriatus	LRF/Gede Afz	7*
		Psammophis subtaeniatus	Afz/LRF Brac	6*
		Aparallactus capense	Cyno	3*
		Atractaspis microlepidota	LRF	1*
		Dasypeltis medici	LRF	1*

	Elapidae	*Naja nigricollis*	LRF	2
		Dendroaspis polylepis	LRF	3*
		Dendroaspis agusticeps	LRF/Afz	4*
	Viperidae	*Bitis arietans*	LRF	1*

Higher taxa	Families	Species	Veg. type	No. rec.
Sub-order: Lacertilia				
	Gekkonidae	*Hemidactylus mabouia*	All	23*
		Lygodactylus picturatus	All	36*
	Agama	*Agama sp.*	Gede	1*
		Agama cyanogaster	Gede	1*
	Varanidae	*Varanus exanthematicus*	Gede	1*
		Varanus niloticus	Afz/LRF	2*
	Lacertidae	*Latastia longicaudatus*	Brac	2*
		Heliobolus spekii	Brac	7*
	Gerrhosauridae	*Gerrhosaurus major*	Gede/LRF	21*
		G. flavigularis	Brac/LRF	11*
		Cordylus cordylus	Brac/Cyno	2*
	Scincidae	*Mabuya planifrons*	Not Afz	12*
		Mabuya brevicollis	All	9*
		Lygosoma sp. s/1976 NMK	LRF	3*
	Chamaeleontidae	*Chamaeleon dilepis*	Afz/LRF	14*
		Rhampholeon sp.	Brac/Afz LRF	8*
Order: Testudine				
	Testudinidae	*Kinixys belliana*	LRF	10*
Class: Amphibia				
Order: Salienta				

Bufonidae	*Bufo maculatus*	Brac	6*
	Bufo gutteralis	Gede	1*
	Merterorphyre micronotis	LRF	1
Ranidae	*Ptychadena mossambica*	LRF	3*
	Ptychadena anchieta	LRF	4*
	Pyxicephalus adspersus	LRF	1
Microhylidae	*Phrynomerus bifasciatus*	LRF	1*
Rhacophoridae	*Chiromantis xerampelina*	LRF	1*

* - species which I documented to occur in Arabuko-Sokoke and Gede forests. They were previously recorded as occurring along the coastal belt in the literature.

Table 3. Taxonomic profile of herpetofauna in Arabuko-Sokoke and Gede forests

	Families	Genera	Species
Order : Testudine	1	1	1
Order : Squamata:			
Suborder: Lacertilia	7	12	16
Suborder: Serpentes	6	20	24
Order: Salienta	4	6	8
Total	17	38	49

3:2. Relative species abundance

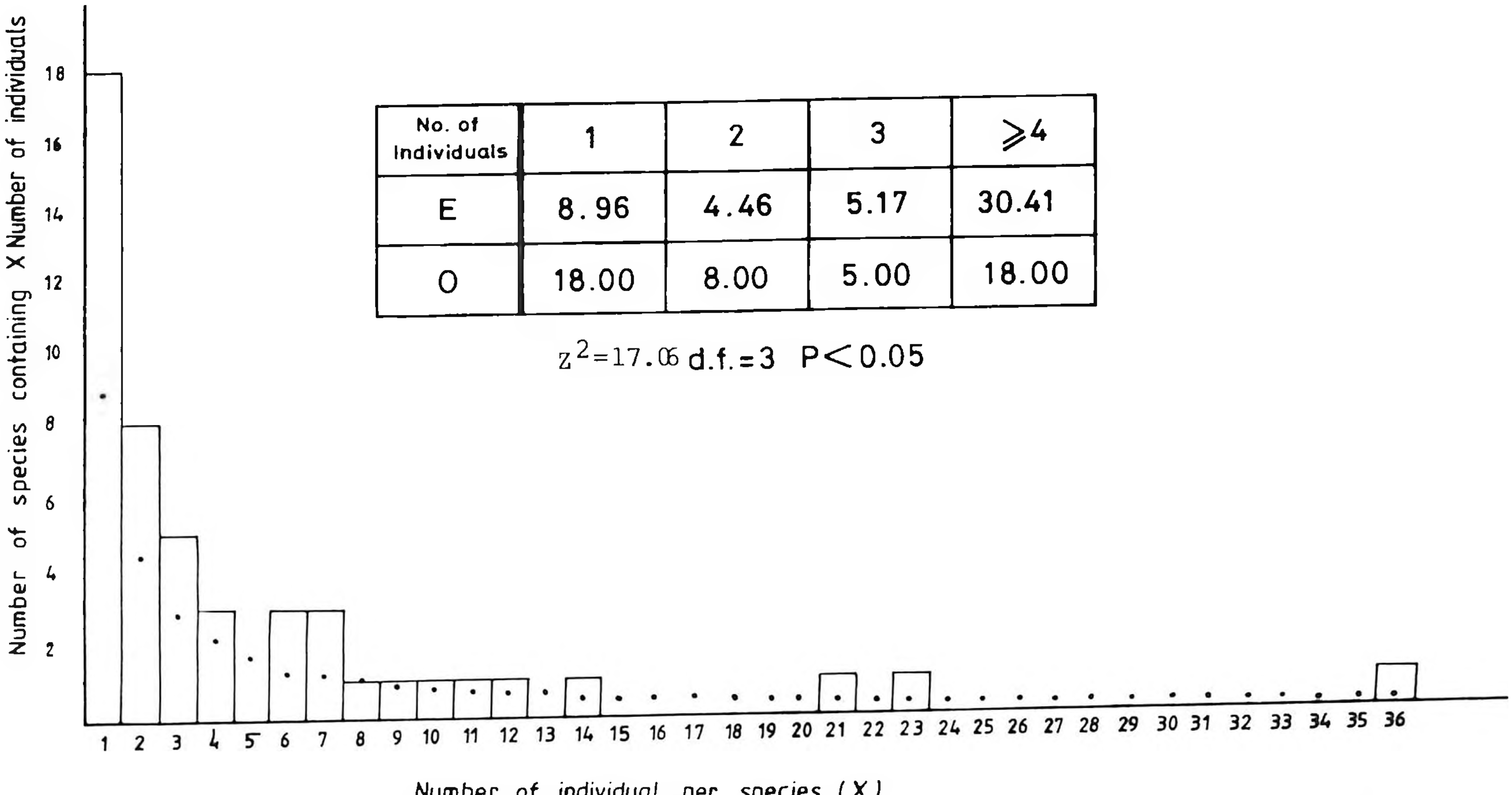
Figure 6 shows the relative species abundance in Arabuko-Sokoke and Gede forests. There emerges a common trend where rare species are represented by few individuals and the most common by many individuals. The dots show the expected number of species calculated in a logarithmic series (Lewis and Taylor, 1966). The X^2-test shows that the observed numbers do not conform to logarithmic series.

3:3 Patterns in space

The following results describe patterns in space in the herpetological communities with respect to species composition in different vegetation types, species diversities, similarity coefficients, and specific associations.

3:3:1. Herpetological communities and vegetation zones

Table 4 shows the total numbers of individuals of 5 common lizard species recorded during the study period in various vegetation zones of Arabuko-Sokoke and Gede forests. Other species were also recorded (Table 2) but the numbers of individuals were too few for analysis. The proportions of the five lizard species are significantly different in the vegetation types ($x^2_{[16]} = 1634.92$, $P < 0.001$). *Heliobolus spekii* is extremely abundant in *Brachystegia* woodland but was not recorded in any other vegetation type. *Lygodactylus picturatus*, is common in all vegetation types but is especially abundant in the *Cynometra* zone and least common in the *Brachystegia* zone. *H. mabouia* is moderately common in



No. of Individuals	1	2	3	≥4
E	8.96	4.46	5.17	30.41
O	18.00	8.00	5.00	18.00

$Z^2 = 17.06$ d.f. = 3 $P < 0.05$

Fig. 6 Relative species abundance of herpetofauna collected in Arabuko-Sokoke and Gede forests (1991–1992)

Table 4. Total numbers of individuals of five common lizard species in different vegetation types.

	Brachy.	Afz.	LRF.	Cyno.	Gede	Total
H. spekii	407 (124.98)	0 (63.82)	0 (50.31)	0 (88.18)	0 (79.71)	407
L. picturatus	53 (195.31)	73 (99.72)	67 (78.63)	295 (137.79)	148 (124.55)	636
H. mabouia	2 (129.89)	152 (66.33)	117 (52.29)	22 (91.65)	130 (82.84)	423
M. planifrons	6 (3.69)	0 (1.88)	3 (1.48)	2 (2.60)	1 (2.35)	12
M. brevicollis	4 (18.13)	16 (9.25)	3 (7.29)	14 (12.78)	22 (11.55)	59
Total	472	241	190	333	301	1537

$X^2_{[16]} = 1634.82, P < 0.001$

Note. The numbers in parentheses are the expected values all vegetation types except for the *Cynometra* and *Brachystegia* zone where it is rare. The other lizard species, *Mabuya brevicollis* and *Mabuya planifrons*, are rare in all vegetation types, and the latter species was not recorded at all in the *Afzelia* zone.

3:3:2. Diversity indices in different vegetation types

Table 5 shows the total numbers of individuals and total numbers of herpetofauna species recorded (for both quadrat and time constraint methods and opportunistic collections) in the different vegetation types for the entire study period. Most of the species collected or recorded in quadrat and time constraint methods are represented in the opportunistic collection. This involved encounters by chance during routine activities in the area. The total number of individuals recorded was 2,201 and the total number of species was 49. Lowland rain forest (LRF) emerges with the most species collected and *Cynometra* with the least.

When the composition of the community is described simply in terms of the number of species present, important information concerning their relative abundance is left out. The simplest measure of the character of a community that takes into account both the abundance patterns and the species richness is the Diversity Index. The index used here is the Shannon diversity index calculated from the formula:

$$H = \quad P_i \log P_i$$

Table 6 shows diversity indices for quadrat and time

Table 5. Total numbers of individuals and species (reptiles and amphibians) recorded in different vegetation types

	Brachy.		Afz.		LRF.		Cyno.		Gede f.	
	N.	S.	N.	S.	N.	S.	N.	S.	N.	S.
Quad. Samp.	474	7	241	4	193	7	334	5	305	7
Time Con.	111	6	52	8	63	4	49	3	126	5
Opp. Col.	42	14	26	9	113	33	21	4	51	13
Tot.	627	15	319	9	369	33	404	5	482	13

Quad. - Quadrat samples

Time con. _ Time constraint samples

Opp. coll. _ opportunistic samples

Table 6. Diversity indices for both time constraint and quadrat methods in different vegetation types

	Brachy.	Afz.	LRF.	Cyno.	Gede
Quadrat method	0.2648	0.3724	0.3756	0.2040	0.4254
Time constraint	0.4299	0.6108	0.3012	0.2402	0.4565
t	3.447*	4.816*	1.317	0.626	1.054
d.f	(176)	(70)	(92)	(69)	(235)

* - indicates significantly different diversity indices (P<0.01 t - value at Bonferroni corrected significant level)

constraint samples in different vegetation types. Opportunistic records are not included because they were not collected in a systematic manner. For both sampling methods *Cynometra* emerges as the least diverse. However the two methods give quite different results for the other four zones. For the quadrat method the diversity indices are ranked in the order Gede, Lowland rain forest, *Afzelia* and *Brachystegia*, while for the time constraint sample the order is *Afzelia*, Gede, *Brachystegia* and Lowland rain forest. Although the ranking is not significantly different (r_s = 0.5, P>0.20) there are significant differences in the diversity indices for the two methods for *Brachystegia* and *Afzelia* (Table 6).

Table 7a tests for differences in diversities between vegetation types for the quadrat method. *Afzelia* and Lowland rain forest vegetation types have significantly higher diversities than *Brachystegia* (Table 6). The other significant differences are registered between *Cynometra* and *Afzelia*, Lowland rain forest, *Brachystegia*, and Gede forest where the diversity is lower in *Cynnometra* than in all the other vegetation types (Table 6).

Table 7b tests for differences between the diversity indices for the time constraint method. *Brachystegia*, Lowland rain forest, *Cynometra*, and Gede forest all have significantly lower diversities than *Afzelia* (Table 6). The other difference is evident between *Cynometra* and Gede forest reserve with Gede having the higher diversity.

Table 7. Differences between diversity indices for different vegetation types

a. Quadrat method

	Brachy.	Afz.	LRF	Cyno.
Afzelia	3.698* (360)			
LRF	3.369* (392)	0.105 (293)		
Cyno.	3.430* (541)	5.632* (398)	5.107* (425)	
Gede	2.195 (489)	2.129 (318)	1.705 (332)	7.768* (547)

b. Time constraint method

	Brachy.	Afz.	LRF.	Cyno.
Afz.	2.899* (75)			
LRF.	1.941 (140)	4.513* (114)		
Cyno.	2.798 (112)	5.294* (98)	0.830 (108)	
Gede	0.543 (180)	2.967* (83)	2.744 (91)	3.710* (71)

Numbers in parathensis indicate degrees of freedom

* - (P<0.005 t - value at Bonferroni corrected level)

3:3:3 Similarity between vegetation types

From the available data on species distribution, similarity coefficients for pair-wise comparisons between vegetation types have been calculated, using th formula

$$S = \frac{2\ C}{A + B}$$

where A equals the number of species in sample A, and B equals the number of species in sample B, and C equals the number of species common to both samples (Odum, 1971).

Figure 7 is a dendrogram showing the patterns of similarity in the various vegetation types and Gede forest for the quadrat and time constraint samples. This was obtained by taking the pair with the highest similarity and joining them with a horizontal line at the level of their similarity coefficient on the vertical axis. The pair then is treated as a single sample and compared with the rest of the vegetation types. The highest emerging similarity index shows where the incoming vegetation type connects with the first pair. The triple vegetation types are again treated as a single pair and compared with the rest of the remaining vegetation types and so on until we exhaust the comparisons.

Figure 7a shows the result from the quadrat samples where *Brachystegia* and *Cynometra* have the highest similarity, and are more similar to both Lowland rain forest and Gede forest than *Afzelia* forest. In the time constraint samples (Figure 7b), *Brachystegia, Afzelia,* and *Cynometra* forest are most similar and all more similar to

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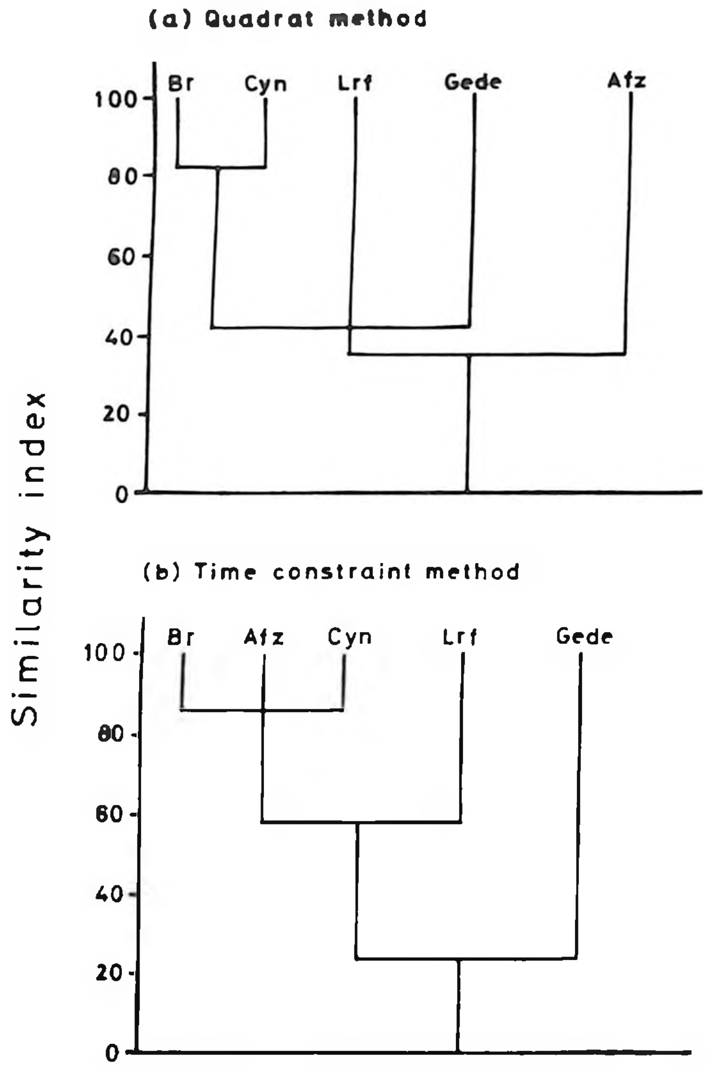


Br - Brachystegia woodland
Cyn-Cynometra
Lrf-Lowland rain forest
Afz-Afzelia

Fig. 7 Dendrogram showing the patterns of similarity in various vegetaion types and Gede Forest

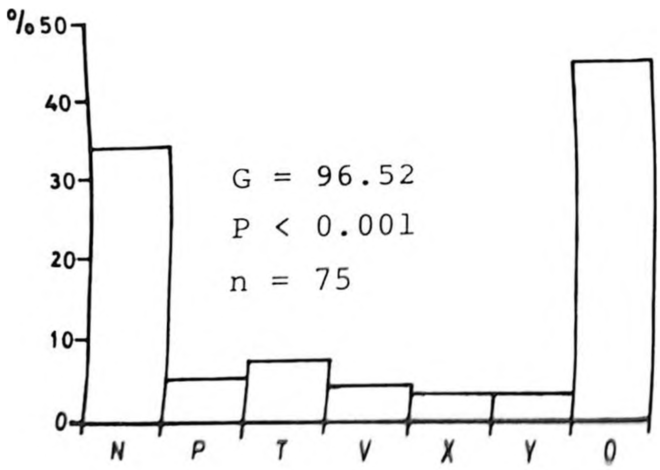
Lowland rain forest than Gede forest. The two methods seem to give different results as they did with the diversity indices.

3:3:4 Resting sites (trees) for two lizard species

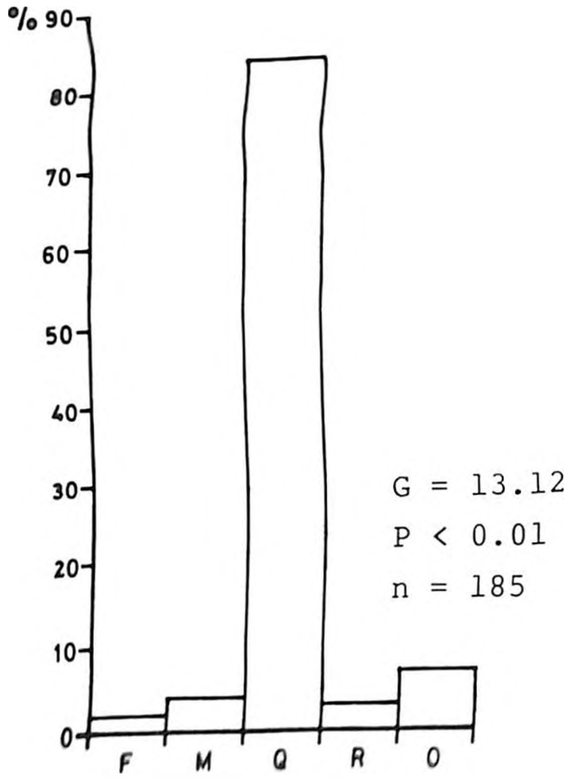
Figures 8 and 9 show the proportions of different tree species on which *L. picturatus* and *H. mabouia* were observed in different vegetation types. In Gede forest *L. picturatus* 34% of the individuals were found on *Combretum schumanii* (Figure 8). This species was often on *Cynometra webberi* (84%) in *Cynometra vegetation* type, and on *Trachylobium verrucosum* (40%) in lowland rain forest. The latter species was also commonly used in the *Afzelia* vegetation type. The lizard was also common on *Brachystegia speciformis* in the *Brachystegia* woodland.

For *H. mabouia* (Figure 9), 75% of the individuals were registered on *Cynometra webberi* in *Cynometra* vegetation type. In Gede forest reserve, 29% were found on *Sterculia appediculata*, and in *Brachystegia* woodland, 50% were found on *Brachystegia speciformis*. In *Afzelia* and Lowland rain forest 34% and 54% of the individuals were found on *Trachylobium verrucosum* respectively. A significant difference was registered in all vegetation types indicating that one or both lizard species show preference on resting sites (Figure 8 and 9).

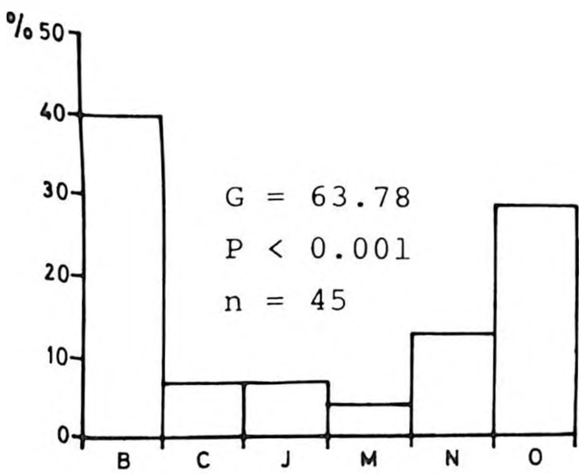
Some of the tree species listed above are of commercial importance (e.g. *S. appediculatus*, *A. quanensis*). However it is worth commenting that the lizard species frequency on one tree species also could depend on the dominance of a



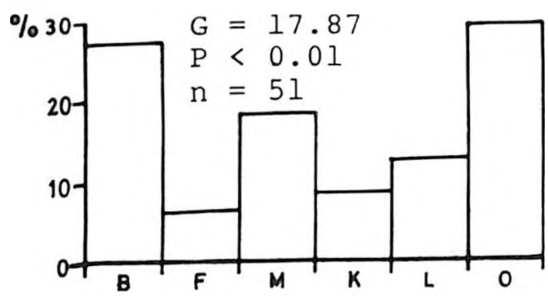
Gede forest



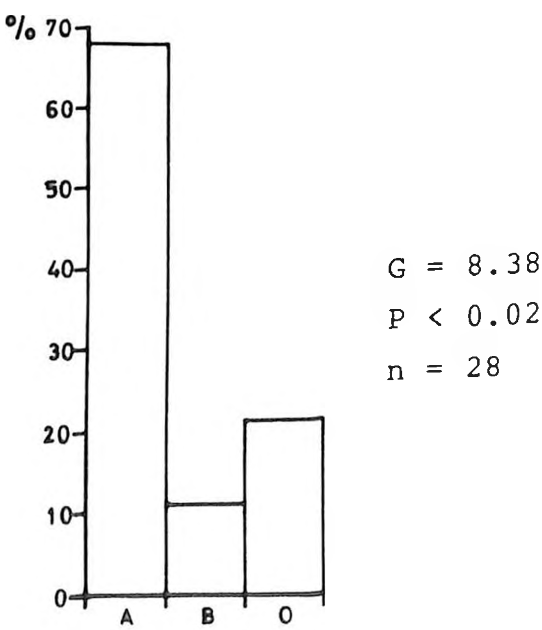
Cynometra



Lowland rain forest



Afzelia



Brachystegia

Figure 8. Proportions of *L. picturatus* on various trees in Arabuko-Sokoke and Gede forests

Key :-

A -*Brachystegia speciformis*
B -*Trachylobium verrucosum*
C -*Afzelia quanzensis*
F -*Barranities wilsoniana*
H -*Drypetes reticulatus*
J -*Manilkara sansibarensis*
K -*Terminalia bovinii*e
L -*Polysphaeria parrifolia*
M -*Manilkara sulcata*

N -*Combretum schumanii*
P -*Grewia plagiophylla*
Q -*Cynometra webberi*
R -*Stryvhnos sp.*
T -*Tamarindus indica*
V -*Hyphaene coriacea*
X - *Lonchocarpus sp.*
Y - *Markhania zanzibarica*

OTHERS (0)

Haplocoelum inopleum
Ximenia caffra
Pleurostylia africana
Encephalatus hildebranditii
Lanea stuhimanii
Flacourtia indica

Ozoroa obovata
Memecylon sansibaricum
Brachylaena hutchinsii
Ficus sansibarica
Gyrocarpus americanus
Leaf litter

G - test values compare the distribution of the two lizard species in the same quadrat samples.

Figure 8. Proportions of *H. mabouia* on various trees in Arabuko-Sokoke and Gede Forests

Key:-

B - Trachylobium verrucosum

C - Afzelia quanzensis

F - Barranities wilsoniana

H - Drypetes reticulatus

L - Polysphaeria parrifolia

M - Manilkara sulcata

N - Combretum schumanii

Q - Cynometra webberi

S - Sterculia appediculata

T - Tamarindus indica

U - Terminalia spinosa

X - *Loncocarpus* sp.

Others

Haplocoelum inopleum

Pleurostylia africana

Lanea stuhimanii

Vitex obovara

Memecylon sasibaricum

Ficus sasibarica

Ximenia caffra

Encephalatus hildebranditii

Flacourtia indica

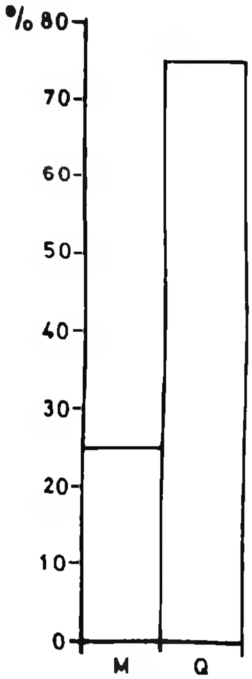
Ozoroa obovara

Brachylaena hutchinsii

Gyrocarpus americanus

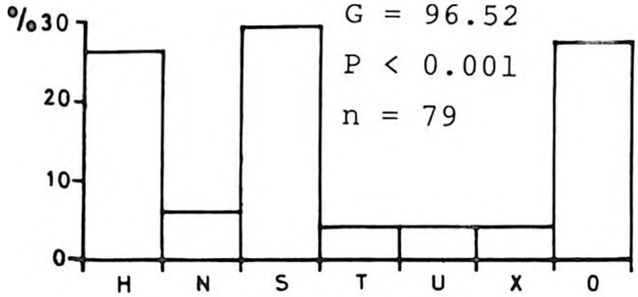
Leaf litter

G - test values compare the distribution of the two lizard species in the same quadrat samples.



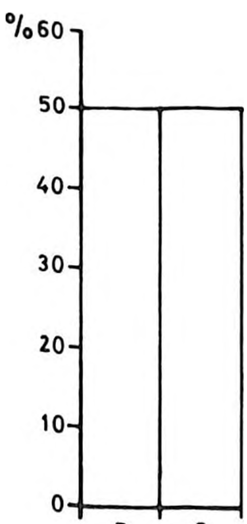
G = 13.12
P < 0.01
n = 20

Cynometra



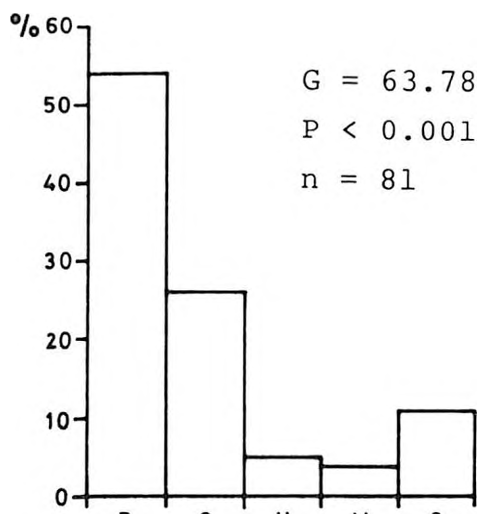
G = 96.52
P < 0.001
n = 79

Gede forest



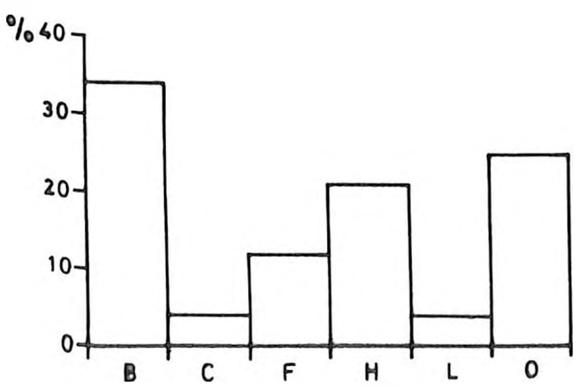
G = 8.38
P < 0.02
n = 4

Brachystegia



G = 63.78
P < 0.001
n = 81

Lowland rain forest



G = 17.87
P < 0.01
n = 108

Afzelia

particular tree within a vegetation type. The two lizard species on various trees showed colour resemblance with the bark reflecting possible crypsis.

3:4 Patterns in time

Most of the individuals and species were recorded during the dry period between January and April, with the rest of the months showing lower numbers.

The behaviour and activity levels of species vary with time of the day giving a diurnal pattern and also vary with time of the year giving an annual pattern. This reflects changes in temperature and insolation during the day and seasonal changes especially in rainfall throughout the year.

3:4:1 Diurnal activity patterns of selected species

Sampling time was determined by selecting the time when most of the common species were active and abundant in a certain vegetation type. Two vegetation types were taken into consideration categorising them by their canopies. The two categories were open *Brachystegia* vegetation type and closed canopy, *Afzelia*, *Cynometra*, lowland rain forest and Gede forest reserve.

The best sampling time was determined by sampling throughout the day for 10 days at intervals of 2 hours from 6.00 am to 4 pm. Figure 10 shows the total numbers of sightings per hour of three common lizard species in different vegetation types at different times of the day.

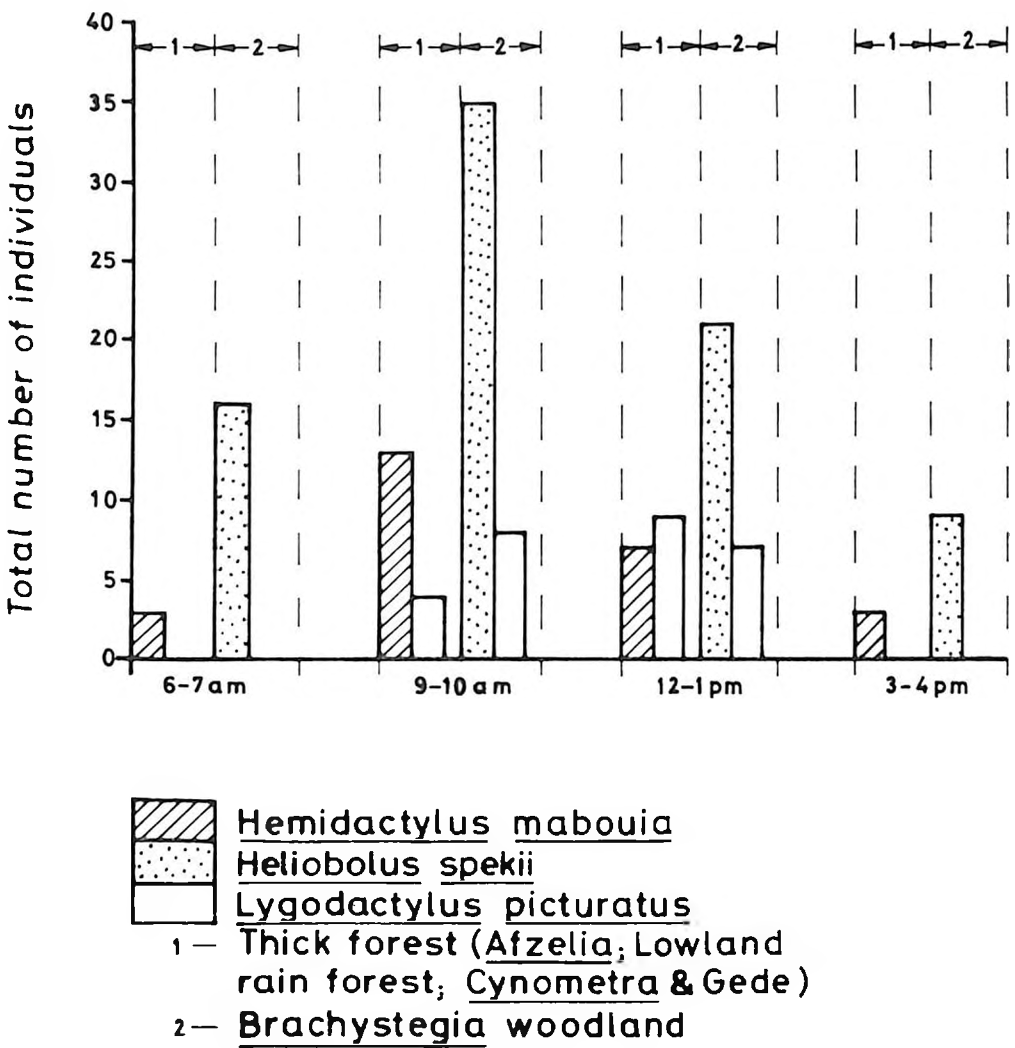


Fig. 10 Total number of individuals of three common lizard species recorded at different hours of the day

Table 8. Numbers of individuals and species recorded in different vegetation types in successive two-monthly periods (Nov. 1990 - July 1991)

	Vegetation types											
	Brachy.		Afzel.		LRF		Cyno.		Gede		Tot.	
	N.	S.	N.	S.	N.	S.	N.	S.	N.	S.	N.	S.
Nov-Dec.	106	3	39	4	38	3	39	3	51	5	273	11
Jan-Feb.	179	4	55	8	60	3	100	3	149	5	543	9
Mar-Apr.	169	5	122	3	109	6	152	3	148	3	700	8
May-Juy.	131	6	77	3	49	3	92	3	83	3	432	9

Key:-

N - number of individuals

S - number of species

Brachy.- *Brachystegia* woodland

Afzel. - *Afzelia* zone

LRF. - Lowland rain forest

Cyno. - *Cynometra* zone

Gede - Gede forest reserve

From 6-7 am there was only *H. mabouia* in thick forest and *H. spekii* in *Brachystegia* woodland. Their peak was reached between 9-10 am when three common lizard species were recorded. The numbers started to fall again between 12-1 pm. for both *H. mabouia* and *H. spekii* but those of *Lygodactylus picturatus* were stable. Very few individuals of *H. spekii* and *H. mabouia* were found between 3-4 pm. and no *L. picturatus* were counted at this time of the day. The activity period of *L. picturatus* appears to be shorter than that of the other species as it was also not seen in the early morning.

3:4:2 Seasonal changes

There are noticeable changes in numbers and composition of species in different vegetation types from November to July. This period covers the short rains period from November to December, the dry season from January to March and the long rains period from April to June.

3:4:2:1 Seasonal changes in diversity

Table 8 shows the numbers of individuals and species recorded in different vegetation types during successive two monthly periods. The highest total number of individuals was recorded in March-April (700) and the lowest in November-December (273). Numbers of species show the reverse pattern with the highest numbers in November-December (11) and the lowest in March-April (8). For each vegetation type considered separately, the number of individuals showed a similar pattern to that for the totals. However for number

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Figures 11 and 12 show seasonal changes in diversity indices in various vegetation types in Arabuko-Sokoke and Gede forest for the quadrat and time constraint samples respectively. For the quadrat samples (Figure 11) the overall trend in diversity was a decline from November-December to January-February followed by stable trends in Gede and *Cynometra*, increases to March-April in lowland rain forest and *Brachystegia* and a decrease in *Afzelia*. Subsequent trends in diversity were stable except in Lowland rain forest which declined in May-July.

In time constraint samples (Figure 12) a decrease is evident in Lowland rain forest, Gede forest, and *Brachystegia* woodland from November-December to January-February. Diversity in *Brachystegia* and Gede forest subsequently rises, while that in the Lowland rain forest declines further. *Afzelia* and *Cynometra* vegetation types had an increase in diversity from November-December to January-February, followed by a decrease in March-April thereafter increasing in May-July.

Table 9 tests the diversity indices (using the Bonferroni correction) from November to July in all vegetation types to determine whether there are significant differences between consecutive two-month periods of

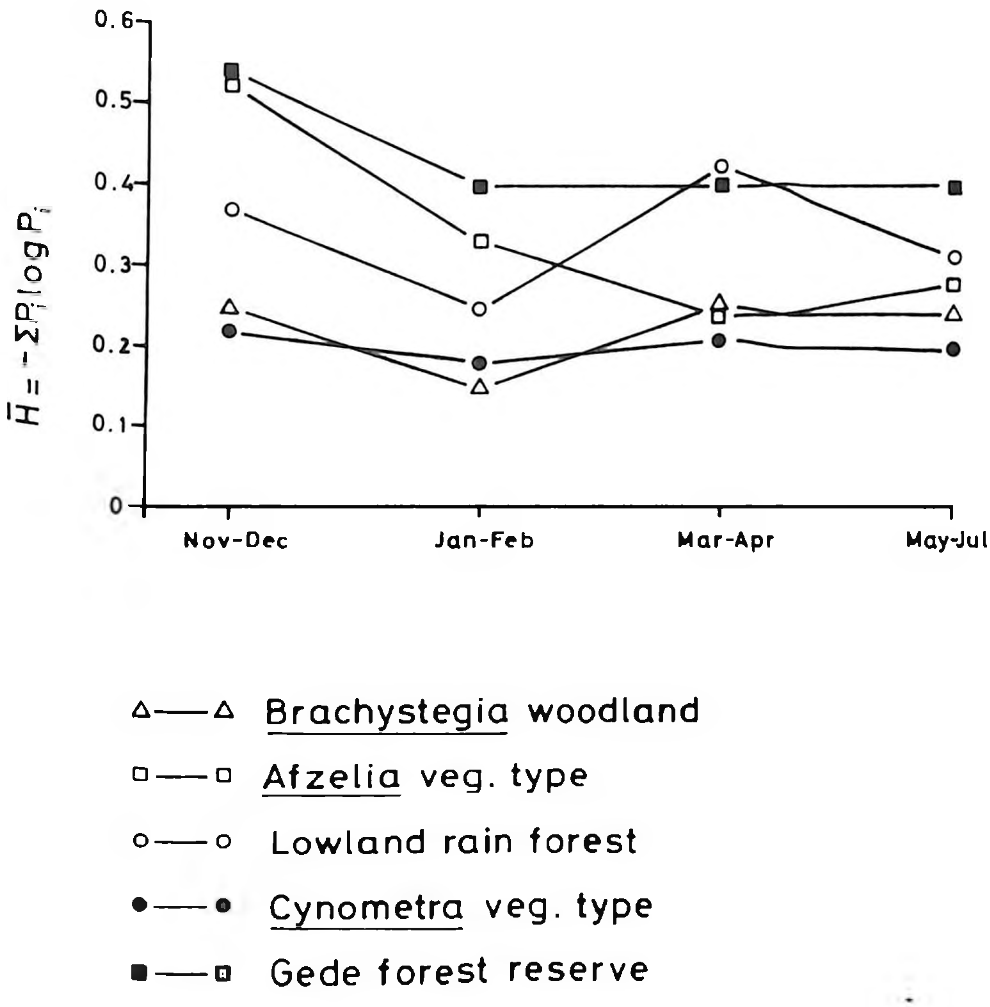


Fig. 11 Changes in diversity indices with months in various vegetation types (quadrat samples)

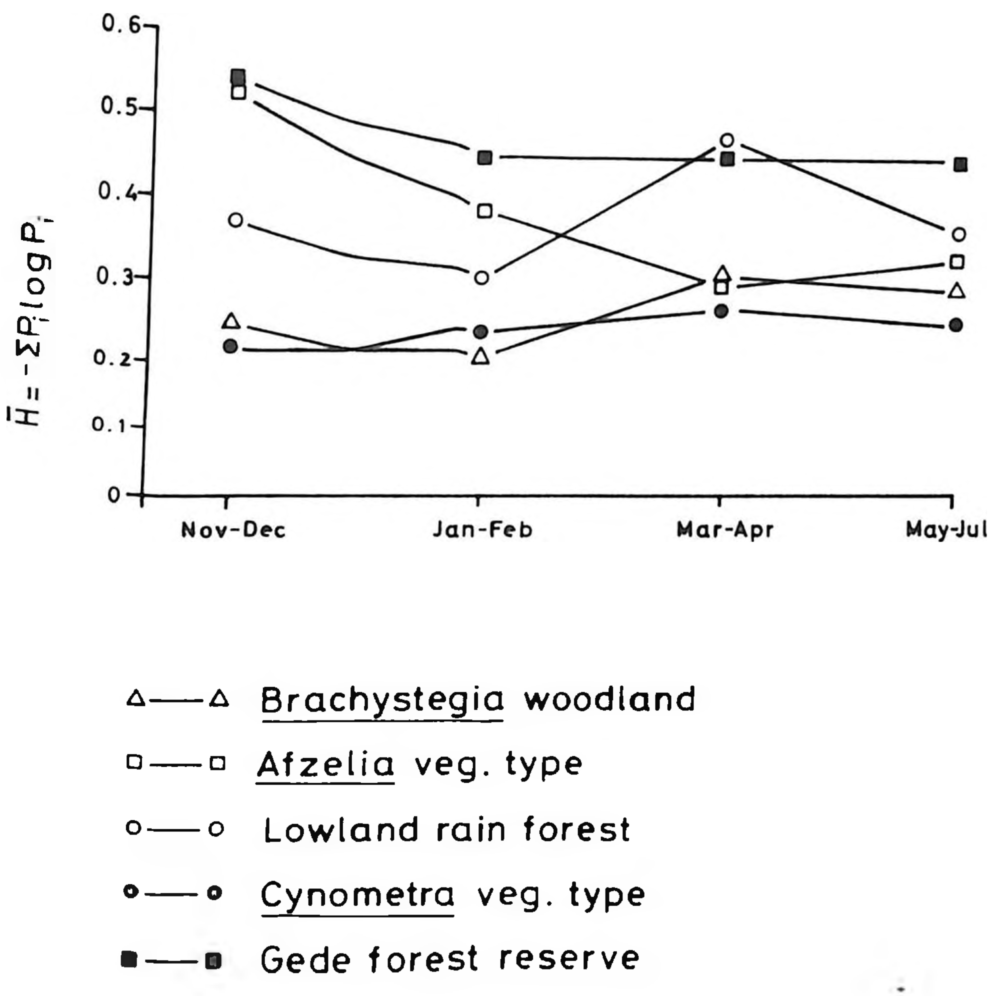


Fig. 11 Changes in diversity indices with months in various vegetation types (quadrat samples)

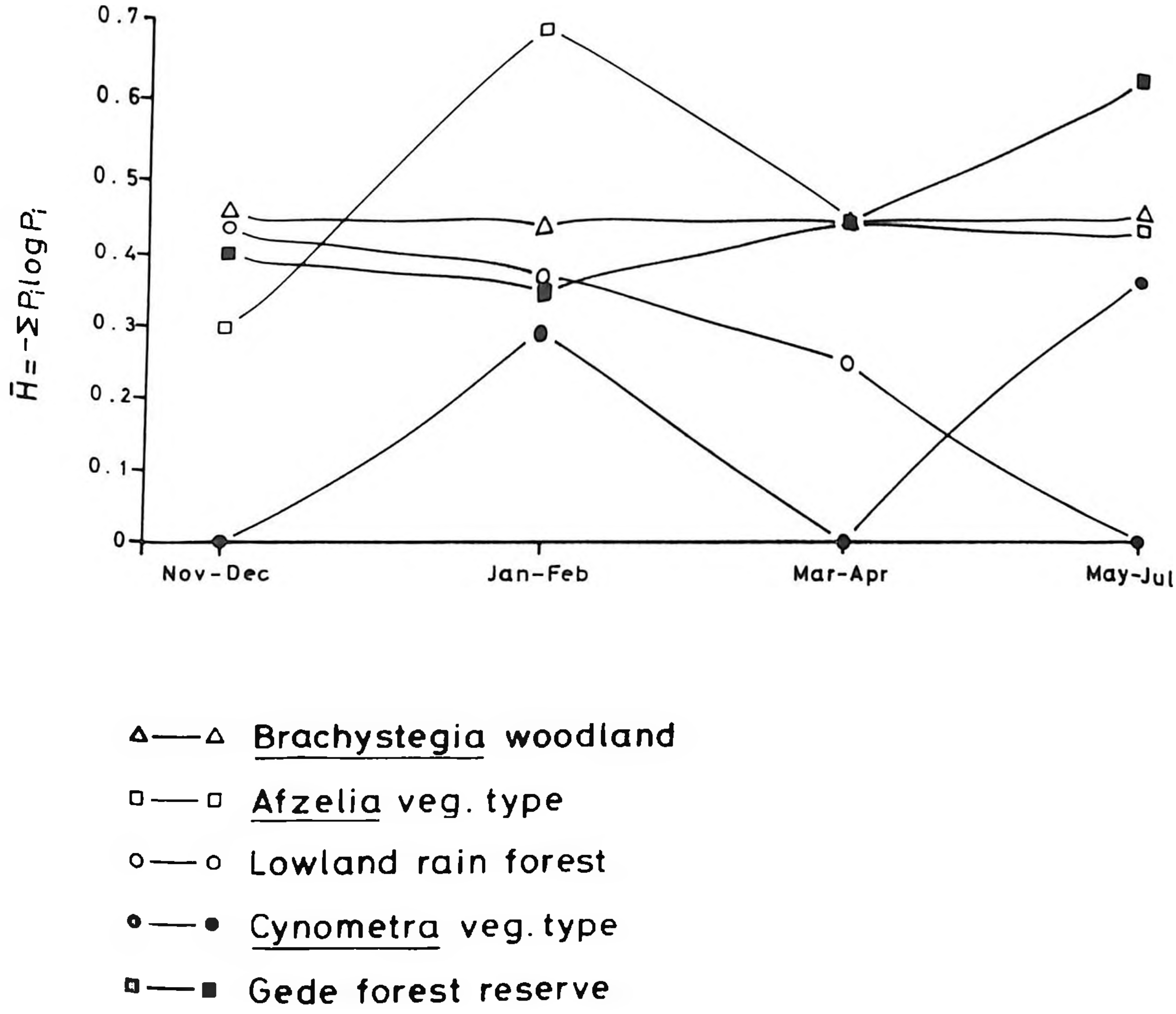


Fig. 12 Changes in diversity indices with months in various vegetation types (Time constraint samples)

Table 9. t - test for differences between diversity indices for different months

a. Quadrat samples

Veg. type	Nov-Feb	Jan-Apr	Mar-Jul
Brachy.	2.271 (189)	2.329 (249)	0.376 (234)
Afz.	1.197 (70)	0.291 (56)	1.275 (134)
LRF	2.451 (44)	3.373* (105)	2.266 (81)
Cyno.	0.147 (70)	0.195 (136)	0.226 (173)
Gede	1.906 (49)	0.190 (161)	0.307 (106)

b. Time constraint

Veg. types	Nov-Feb	Jan-Apr	Mar-Jul
Brachy.	1.437 (43)	0.208 (67)	0.978 (601)
Afz.	3.848* (21)	2.485 (36)	1.038 (27)
LRF	1.868 (39)	0.783 (28)	2.705 (11)
Cyno.	1.622 (22)	2.644 (22)	5.420* (14)
Gede	0.271 (55)	0.353 (53)	3.928* (33)

* - Indicates significantly different diversity indices ($P<0.002$ t - value at Bonferroni corrected significant level)

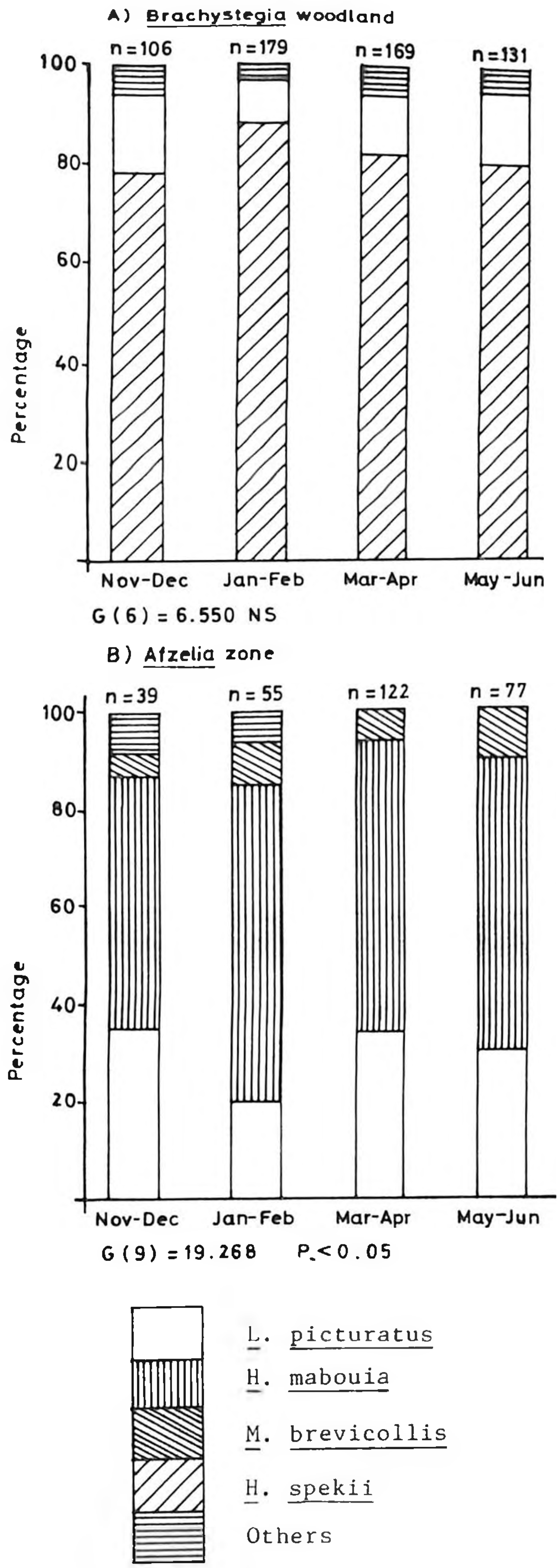
sampling, for both quadrat and time constraint samples. In the quadrat samples, a significant difference is registered only once in Lowland rain forest between the January-February (0.26) and March-April (0.42) samples (Table 9a).

For the time constraint samples *Afzelia* diversity registers a significant increase between the November-December and January-February samples, while *Cynometra* and Gede forest both increase significantly between March-April and May-July (Table 9b).

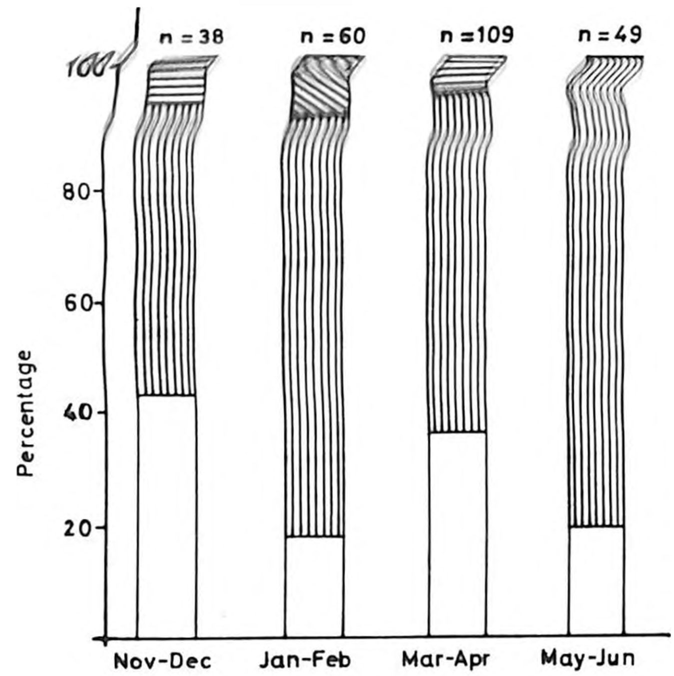
3:4:2:2 Change in species composition with time

Figure 13 shows changes in species composition in various vegetation types in Arabuko-Sokoke and Gede forests for both quadrat and time constraint samples. No significant changes were noted in *Brachystegia* or *Cynometra* vegetation types. However there were significant changes in the rest of the vegetation types (Figure 13B, C and E).

In the *Afzelia* zone other species were recorded in the first two periods and there was a significant increase in the proportion of *H. mabouia* during the dry months of January-February together with a drop in that of *L. picturatus*. The same trends were registered in lowland rain forest but not in Gede. Other species were abundant in Gede forest in November-December but were absent in other months. There was also a steady increase in the proportions of *M. brevicollis*.

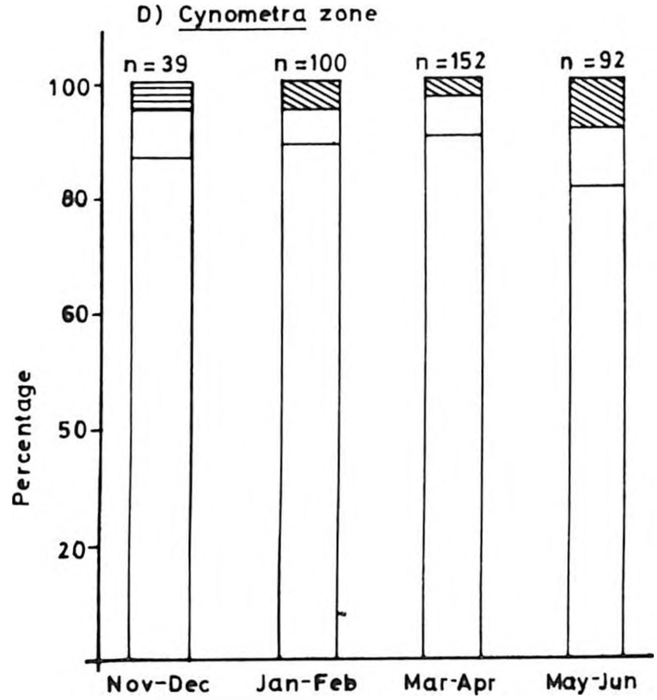

A) Brachystegia woodland
n = 106
n = 179
n = 169
n = 131
Percentage
100
80
60
40
20
Nov-Dec
Jan-Feb
Mar-Apr
May-Jun
G (6) = 6.550 NS
B) Afzelia zone
n = 39
n = 55
n = 122
n = 77
Percentage
100
80
60
40
20
Nov-Dec
Jan-Feb
Mar-Apr
May-Jun
G (9) = 19.268 P < 0.05
L. picturatus
H. mabouia
M. brevicollis
H. spekii
Others

C) Lowland rain forest

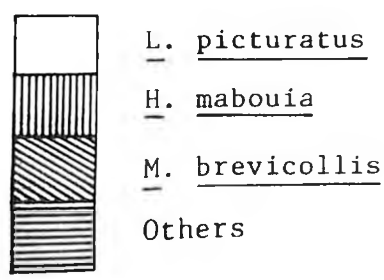


G (9) = 34.815 P $<$ 0.05

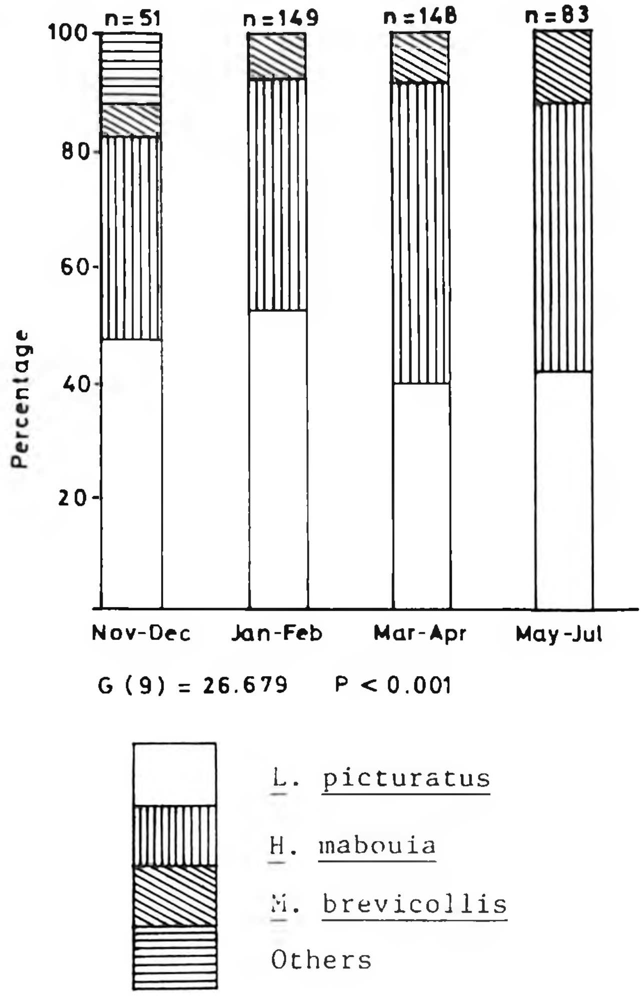
D) Cynometra zone



G (9) = 16.871 NS



E) Gede forest reserve



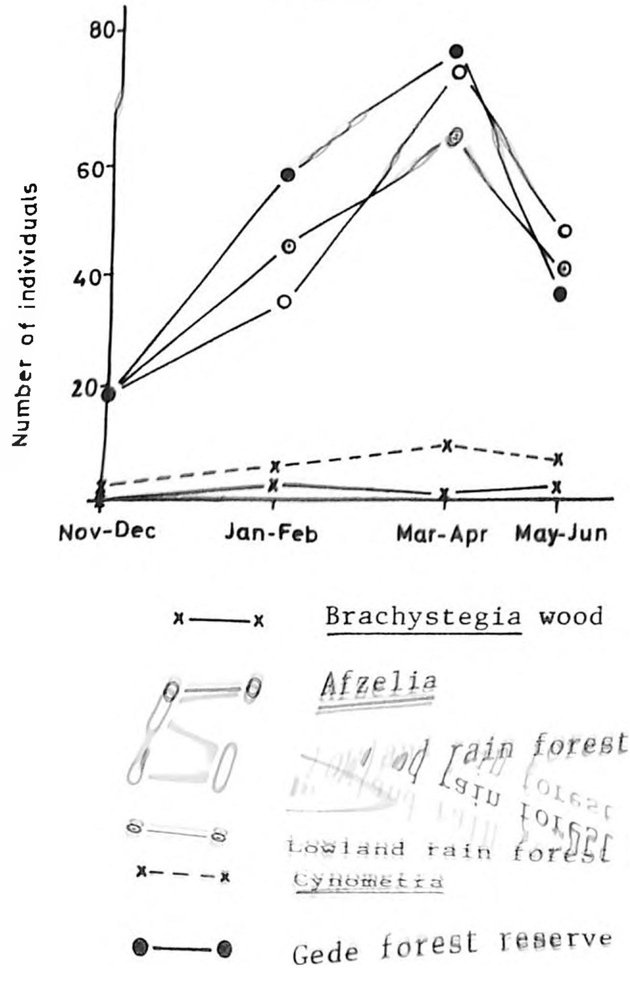
3:4:2:3 Population changes of selected species

Population changes occurred over the sampling period from November to July. Figure 14 shows changes in the numbers of individuals recorded of four common lizard species with data combined for both sampling methods. Numbers generally peaked in March-April.

L. picturatus increased from November-February in *Cynometra* and Gede forests but dropped in Gede forest from January to July (Figure 14a). However in *Cynometra*, it increased to reach a peak in March-April and then dropped. For the rest of the vegetation types, a slight decrease in numbers was recorded between November to February, increasing there after to reach a peak in March-April before dropping. The largest population changes were recorded in *Cynometra* followed by Gede forest and the least in *Brachystegia* woodland.

The *H. mabouia* population increased from November to reach a peak in March-April in Lowland rain forest, *Afzelia*, and Gede forest. In *Cynometra* and *Brachystegia* woodland the populations remained almost constant although a small peak for the former was recorded in March-April. *H. spekii* increased rapidly from November-December to January-February before subsequently decreasing. *M. brevicollis* increased to a peak in March-April before dropping in Gede and *Brachystegia* woodland. Its population increased in *Cynometra* and Lowland rain forest from November to February and dropped thereafter in Lowland rain forest but remained constant in *Cynometra* from January to April before

14b. *H. mabouia*



14a. L. picturatus

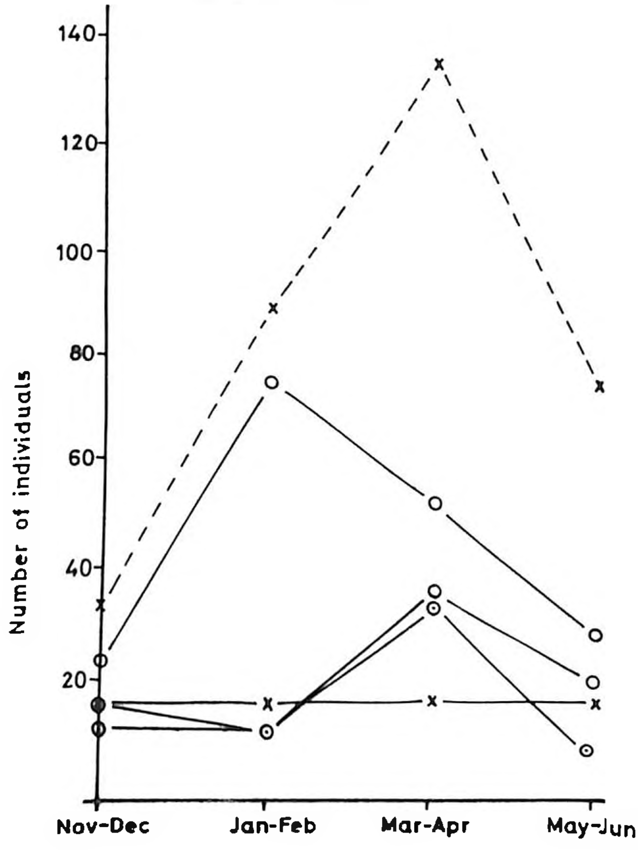
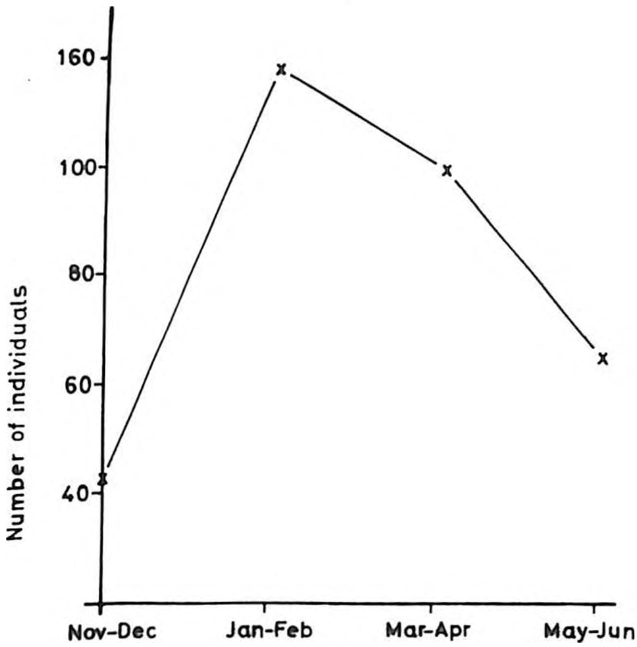
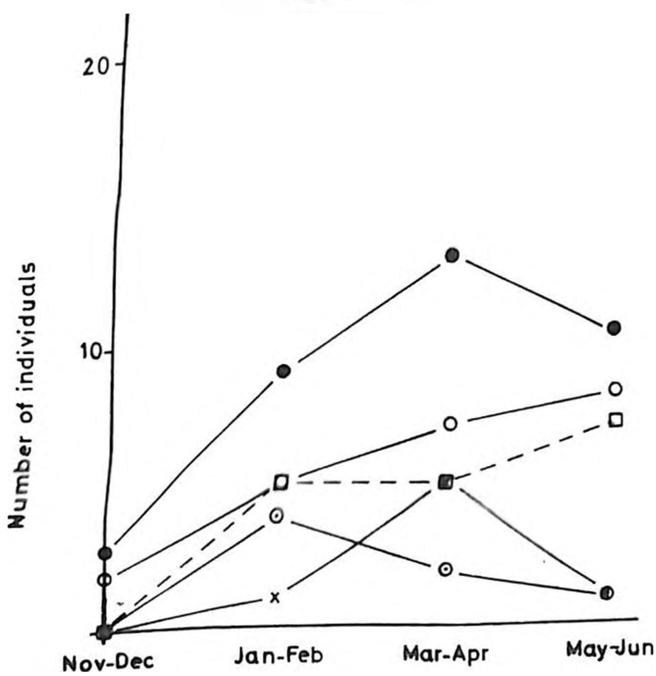


Figure 14. Changes in species populations with time in Arabuko-Sokoke and Gede forests

14c. H.spekii



14d. M. brevicollis



x——x Brachystegia woodland

o——o Afzelia

⊙——⊙ Lowland rain forest

□- - -□ Cynometra

●——● Gede forest reserve

increasing again. In *Afzelia* vegetation type, the population increased throughout the period.

Table 10 shows the densities (numbers per hectare) of these lizard species for the four sampling periods in each of the vegetation types. These data were based on quadrat samples alone. The highest densities were observed in *Brachystegia* for *H. spekii* in January-February (532), and for *H. mabouia* in *Afzelia* in March-April (268) and for *L. picturatus* in *Cynometra* in March-April (508). The lowest densities were observed for *M. brevicollis* in the first two periods in *Afzelia* (8) and in Gede in November-December (12).

Table 10. Changes in species density (numbers/hectare) with time in various vegetation types

	Nov-Dec	Jan-Feb	Mar-Apr	May-Jul
Brachystegia zone				
H. spekii	316	532	452	328
L. picturatus	52	48	52	60
Afzelia zone				
L. picturatus	52	36	124	80
H. mabouia	76	96	268	164
M. brevicollis	8	8	24	24
Lowland rain forest				
L. picturatus	48	36	148	36
H. mabouia	52	92	216	108
Cynometra zone				
L. picturatus	120	280	508	272
H. mabouia	12	16	40	20
M. brevicollis	--	16	20	20
Gede forest reserve				
L. picturatus	32	248	208	100
H. mabouia	48	128	232	112
M. brevicollis	12	20	40	16

CHAPTER 4

DISCUSSION

This herpetofaunal survey has been conducted using different methods of sampling, namely the time constraint and quadrat methods in addition to opportunistic sampling. The results obtained from the two formal methods often do not agree. For example, we get significant differences in diversity indices between vegetation types in the quadrat method that are not obtained using the time constraint method, and *vice-versa* (Table 7). Furthermore the two methods give significantly different estimates of diversity for the same vegetation types in two of the five cases (Table 6). The two methods also do not agree with respect to similarity between vegetation types (Figure 7).

However, an overall picture of the trends in the diversity and similarity of the herpetofaunal communities does emerge. Diversity is clearly lowest in the *Cynometra* zone. This agrees with the results obtained in a survey of the butterfly fauna of Arabuko-Sokoke forest (Bagine, *et al.*, 1991). Diversity also appears to be relatively high in *Afzelia* and in Gede forest reserve. In similarity indices, the overall picture we get is that *Brachystegia* woodland and *Cynometra* vegetation types are more similar and less similar to Gede forest reserve. However, the patterns of similarity of these vegetation types to Lowland rain forest and *Afzelia* vegetation types are contradictory (Figure 7).

These discrepancies show that no one particular method can be considered the best in herpetofauna sampling. In the quadrat method bias arises due to selection of quadrat site and limits of the boundaries set, and the limited number of quadrats that can be realistically sampled. In view of this, the quadrat method is best suited for use in a relatively homogenous habitat. A further disadvantage of the quadrat method is that shy reptiles especially snakes, can move out of the quadrat as soon as it is approached and may not be counted. However the quadrat method is the only one employed to get densities.

The time constraint method is less restrictive, enabling sampling in many different habitat patches and the recording of all the animals sighted, but does not give the density estimates. It may be more useful than the quadrat method in heterogenous habitats and may also provide a more comprehensive survey of herpetofauna. In general the more the methods applied, the better the picture we get of herpetofauna species composition in an area.

During the study, I recorded 49 species accounting for 48% of the species recorded to occur in our coastal region (Table 1). 19 of the species have previously been recorded in the two forests. The other 30 species are recorded as coastal species in the literature but have not been specifically recorded from Arabuko-Sokoke and Gede forests (e.g. *Psammophis subtaeniatus*, *Dasypeltis medici*, and *Varanus niloticus* among others).

The presence of 49 species suggests high diversity but I lack enough information of this kind from other African forests to compare it with. Nature conservation organisations are preoccupied with large mammal research to the neglect of other groups leading to a lack of natural history information on reptiles and amphibians. To the best of my knowledge there have been no published ecological studies comparable to mine for any other forest in Africa. There is need for further quantitative studies of this kind in order to have comparisons for different ecological areas. This is also important to establish the conservation status of herpetofauna in Africa.

Diversity varies from one vegetation type to another. Each vegetation type boasts of its own species of herpetofauna. For example *H. spekii* is only found in *Brachystegia* woodland. In order to keep and preserve this diversity, it is necessary to retain the different vegetation types by designing the best management plan.

From a management policy perspective, it is clear from diversity indices and graphs that Gede, *Afzelia* and Lowland rain forest are very important. These areas receive the highest rainfall and their vegetation structure is complex compared to *Brachystegia* woodland and *Cynometra* zone. Except in Gede forest reserve, timber harvesting is evident in all other vegetation types (although to a lesser extent in *Brachystegia* woodland) and the likely impact on herpetofauna and other animal species resident to the forest is destruction and modification of their habitats. This probably has already taken place since the diversity of Gede forest reserve is higher than that of *Cynometra* and Lowland rain forest, where timber extraction is taking place illegally. Gede forest has the highest diversity possibly because it is the most well protected area. (Gede forest reserve is protected by the National Museums of Kenya).

High diversity in areas of high rainfall is expected to give adequate food supplies and more microhabitats allowing species of the same genera to occur giving high diversity of herpetofauna. Spatial heterogeneity can also explain why some communities are richer in species than others. Spatially heterogeneous environments are expected to accommodate extra species due to greater variety of microhabitats, a greater range of microclimates, more types of places to hide from predator, and so on. This increases the resource spectrum. This may be why we get a lower number of species in *Brachystegia* woodland where 70% of the vegetation is composed of one species, *B. speciformis* (Moomaw, 1960). The *Brachystegia* woodland also has lower rainfall and grass with open areas and no ground litter, offering few microhabitats and probably less food resources. Likewise in *Cynometra* vegetation type, we have much of the area under *Cynometra webberi* resulting in less complex vegetation structure and fewer microhabitats. Also there is virtually no ground litter and the soils are relatively poor (Moomaw, 1960) which probably results in low productivity.

On changes of diversity from one time of the year to another, in all vegetation types, coastal forests are in an area of predictable seasonal changes. In a predictable seasonally changing environment, different species may be suited to conditions at different times of the year. More species might therefore be expected to co-exist in a seasonal environment than in a completely constant one (Begon, *et al.* 1986). This could probably explain the fluctuation in diversity over the sampling period in all the vegetation types where we have different combinations of different species in a particular time of the year. However, the data may have been affected by differences in detectability of the various species in different seasons. Detectability was probably lower during the wet season when there was more vegetation cover.

The highest diversities of animals are observed in vegetation types receiving higher rainfall (*Afzelia* and Lowland rain forest) in Arabuko-Sokoke forest. It is an area which has received extreme modifications for a long time through exploitation for its valuable tree species. Kelsey and Langton (1983) indicate that the forest was highly exploited in the 50s and 60s due to its commercially valuable timber namely the *Chlorophora, Sterculia, Brachylaena* but the yield declined resulting in extraction of only *Brachylaena* and *Brachystegia*. The latter being a poor quality timber, attention turned to *Afzelia* which is still exploited. Therefore special management attention needs to be given to these vegetation types to ensure there is no more exploitation going on.

The other area of concern is *Cynometra* vegetation type exploited largely for local wood supplies. This needs to be well managed by the forest authorities in order for the resources to be utilized sustainably. Areas should be licensed for given periods of time depending on rates of vegetation regeneration. However, strict measures ought to be taken not to interfere with the tree species which are already threated in this area for instance *Brachylaena*, whose stumps are evidence of past exploitation. In order to achieve this, there is need to protect some of the exploited areas especially to the west of the forest under the nature reserve where no exploitation will take place. Presently, there is very little of the *Cynometra* vegetation type protected under the now nature reserve comparing it with the vast area of the forest covered by this vegetation type. This forest zone is important in reference to various animals for example golden -rumped elephant shrew, bushpig, elephants and reptiles.

Although *Brachystegia* woodland might be mistaken for its low diversity of reptiles as an area of less importance, it has the highest diversity of birds (Zimmerman and Britton, 1979). It is therefore of potential importance for tourism if only conservationists can address themselves to ways of improving it. On the western boundary of the woodland lie seasonal pools. The pools are important as watering points for forest animals especially the elephants which spread havoc by straying into settled areas during the dry season of the year in search of permanent water points. Also the ponds can be important areas for water birds, reptiles, amphibians and many invertebrates. Further research on these pools is necessary for the management of the forest.

Whatever measures should be taken to conserve the forest, attention should be paid to the needs of the local people. They are particularly concerned with elephant damage to the crops. They dread the idea of protecting the forest if it all sums up to protecting the elephants which they view as their enemy number one. Therefore conservationists and especially KWS and non- governmental organisations need to address themselves to this elephant problem in view to abating this widely felt effect. A method of deterring elephants from reaching the farms should be developed. This way the locals will have benefited and will help in conserving the forest after realizing what has been done towards this problem.

Local people depend very much on trapping to provide themselves dietary protein. This endangers some of the species in the forest which also are a source of food for some reptiles, for example the elephant shrew. The extent of this should be well assessed to eliminate any possible over-exploitation. They should at the same time be encouraged to keep domestic animals as a substitute for hunting and trapping. Economically valuable tree species continue to dwindle even after banning indiscriminate cutting of trees and closure of saw mills, which is quite evident as one takes a stroll in lowland rain forest and *Afzelia* forest types. The affected species are mostly *Afzelia quanzensis* and *Pleurostylia africana*. Others although not heavily logged are *Trachylobium verricosum*, *Manilkara sansibarensis* and *Combretum sp.*.

Therefore, since this logging is encouraged by economic problems, for valuable tree species and domestic problems (building and possibly fire wood), the conservationists need to draw a plan on how to discourage the cutting of valuable trees e. g. by encouraging the planting of *Casuarina sp.* which they can sell and get money and also use as building material. Also, in order to protect the number of indigenous species in the forest, indigenous plantations should also be initiated within sections of the already cleared forest areas and locals should also be encouraged to grow them.

Ultimately the herpetofauna community depends on the continued existence of the forest and its proper management. With increasing human populations management problems will be more acute. Therefore the management plan to be drawn should totally involve the local people to minimize their dependence on the forest resources as well as making sure that problems resulting from wildlife are resolved. The central area (Nature reserve) should be well marked with no exploitation taking place but the locals should be allowed to utilize the rest of the forest in a sustainable manner.

With specific reference to herpetology the following studies are recommended. First we need to study the zoogeography of Kenyan herpetofauna. Second, the behaviour and habitat ecology of different species of herpetofauna in various forests and National parks of Kenya should be investigated. Third we need research on herpetofauna biodiversity in various forests and conserved areas.

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APPENDIX 1

Common names for herpetofauna reported to occur along the coastal Kenya

scientific names	**common names**
Testunidae	Tortoises
Kinixy belliana	Bell's Eastern Hinged-Tortoise
Malacochacus tornieri	Pan-Cake Tortoise
Family: Typhlopidae	Blind Snakes
Typhlops braminus	Braminy or Flower pot snake
T. lubriciformis	Wormlike Blind snake
T. pallidus	Zanzibar Blind snake
Family: Leptotyhlopidae	Worm Snakes
Leptotyhlops boulengeri	Manda Flesh pink Worm snake
L. conjunctus	All black Worm snake
L. longicaudus	Long-tailed Flesh-pink worm snake
Family: Colubridae	Colubrids
Lamprophis fuliginosus	Common House snake
Lycophidion capense	Coastal Wolf-snake
L. depressirostre	Flat-snouted Wolf-snake
Mehelya capensis	North-Western File snake
Meizodon semiornatus	Semiornate Snake
M. coronatus	Crowned snake
Philothamnus irregularies	Green Water-snake
P. semivariegatus semivariegatus	Spotted Bush-snake
Scaphiophis albopuntatus	Hook-nosed Snake
Prosymna ambigua stuhlmanii	East African Shovel-snout snake

Telescopus dhara somalica	Southern Large-eyed snake
T. semiannulatus	Eastern Tiger-snake
Crotaphopeltis hotamboeia	White lipped snake
Dipsadoboa aulicus aulicus	Cross-barred Tree-snake
Dispholidus typus	Boomslang
Therotonis kirtlandii kartlandii	Vine snake
Hemirhagerrhis kelleri	Stripped Bark-snake
H. nototaenia nototaenia	Bark snake
Rhamphiophis oxyrhynchus rostrus	Rufous Beaked-snake
R. rubropunctatus	Red-spotted Beaked-snake
Psammophis sibilans sibilans	Hissing sand snake
P. biseriatus	Link-marked Sand-snake
P. subtaeniatus sudanensis	Northen stripe-bellied sand-snake
Aparallactus guentheri	Guenther's Centipede-eater
A. turneri	Malindi Centipede-eater
Amblyodipsas polylepis	Hildebrant's purple-gloss snake
Dasypeltis scabra	Common Egg-eater
D. medici medici	Rufous Egg-eater
D. m. lamuensis	Lamu Egg-eater
Family: Elapidae	Elapids
Naja nigricollis nigricollis	Spitting Cobra
N. mossabica pallida	Red Spitting Cobra
N. melanoleuca	Forest Cobra
Dendroaspis angusticeps	Green Mamba
D. polylepis polylepis	Black Mamba
Pelamis platurus	Yellow-bellied Sea-snake

Family: Viperidae	Vipers
Atractaspis microlepidota	Black Borrowing viper
A. bibronii rostrata	Zanzibar Borrowing viper
Causus rhombeatus	Rhombic Night-adder
C. deffilipii	Snouted Night-adder
Causus resimus	Velvety-green Night-adder
Bitis arietans arietans	Puff-adder

Lizards

Family: Gekkonidae	Gekkos
H. frenatus	Common House Gekko
H. mabouia	Tropical House Gekko
Lygodactylus picturatus	White-headed Dwarf Gekko

Family: Agamidae	Agamas
Agama cyanogaster	Black-necked Aboreal Agama

Family: Scincidae	Skinks
M. striata striata	Common Two-stripped Skink
Lygosoma mabuiiformis	Mabuya-like Skink
L. tanae	Tana Delta Skink
L. pembana	Pemba Island Writhing Skink

Family: Chamaeleonidae	Chamaeleons
Chamaeleo dilepis dilepis	Common Flap-necked Chamaeleon
Rhampholeon kersternii kersternii	Kenya Pigmy Chamaeleon

Family: Cordylidae	
Cordylus cordylus tropidosternum	Eastern Spiny-tailed Lizard
Gerrhosaurus major major	Zanzibar Great Plated Lizard
G. flavigularis fitzsimonsi	Kenya Yellow-throated Plated-lizard
Family: Lacertidae	
Latastia longicaudatus revoili	Southern Long-tailed Lizard
Heliobolus spekii spekii	Southern Speke's Sand-lizard
H. smithi	Smith's Sand Lizard
H. striata	Peter's Sand Lizard
Family: Varanidae	Monitor Lizards
Varanus niloticus niloticus	Nile Monitor
V. exanthematicus microstictus	Eastern Savanna Monitor

Amphibians

Family: Caeciliidae, Caecilians, Legless Worm-like amphibians for example :- *Schistometopus gregilii* and *Afrocaecilia changamwensis*.

Family: Pipidae	Claw Frogs
Xenopus leavis	Upland Claw Frog
X. muelleri	African Claw Frog
Family: Bufonidae	Toads
Bufo gutturalis	Guttural Toad
B. steindachneri	Steindachner's Toad
B. taitanus	Black-chested Dwarf Toad

Family: Hyperoliidae	
Kassina senegalensis	Running Frog
K. maculata	Red-legged Pan Frog
Leptopelis flavomaculatus	Ornate Treefrog
Afrixalus brachycnemis	Short-legged Banana Frog
A. fornasini	Spiny Leaf-folding Frog
A. pygmaeus pygmaeus	Pygmy Leaf-folding Frog
Hyperolius argus	Argus Reed Frog
H. tuberilingus	Tinker Reed Frog
H. puncticulatus	Golden Sedge Frog
H. parkeri	Trilling Reed Frog
H. mariae	Coast Reed Frog
Family: Ranidae	Ranas
Ptychadena oxyrhynchus	Sharp-nosed Ridged Frog
P. mascareniensis	Mascarene Rocket Frog
P. floweri	Flower's Ridged Frog
P. mossambica	Mozambique Ridged Frog
Pyxicephalus adspersus	African Bull Frog
Hylarana bravana	Golden-backed Frog
Arthroleptis stenodactylus	Common Squeaker
Phrynobatrachus acridoides	Small Puddle Frog
Hemisus marmoratus marmoratus	Marbled Shovel-nose
Family: Rhacophoridae	Treefrogs
Chiromantis xerampelina	Foam-nest Treefrog
Family: Microhylidae	
Phlynomerus bifasciatus	Red-banded Frog