FLORAL SURVEY OF KUFENA INSELBERG IN THE ZARIA AREA: AN ECOLOGICAL MODEL FOR SECONDARY SCHOOLS

BY

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A Thesis submitted to the Postgraduate School, Ahmadu Bello University, in partial fulfilment of the requirements for the degree of

MASTER OF SCIENCE IN EDUCATIONAL BIOLOGY

Faculty of Science

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OCTOBER, 1990

DECLARATION

I declare that this work is wholly my own and has not been part of any presentation for any other qualification.

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APPROVAL PAGE

This thesis entitled "Floral Survey of Kufena Inselberg in the Zaria Area: An Ecological Model for Secondary Schools" by SALIHU, Yusuf Aggie has been read and approved as meeting the requirements governing the award of the degree of MASTER OF SCIENCE of Ahmadu Bello University and is approved for its contribution to literary and scientific knowledge.

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DEDICATION

To my parents and family.

ACKNOWLEDGEMENTS

All praise and gratitude be to Allah, most Gracious, most Merciful for seeing me through the successful completion of the study.

I am most grateful to my major supervisor, Professor B.J. Harris, who in view of the tight time schedule in his hand, offered invaluable assistance and encouragement from the proposal stage of this work up to its completion. I wish him happy retirement and success in his future endeavours. I am also grateful to my co-supervisor, Dr. S. Ebele for finding time to attend to this work.

My sincere thanks go to Mr. A.O. Ohaeri, the Herbarium Curator, Biological Sciences Department for his great help and encouragement. My gratitude also goes to Mall. K. Ibrahim, Mall. I. Saidu, Alh. S.A. Kasimu, Alh. S.Y. Kasimu, Mall. D.B. Dangora, Dr. R.W. Bako-Anyam, Mr. T.T. Ubagu (the typist), my colleagues and all those who in one way or the other contributed to the success of this work.

ABSTRACT

The floral survey of Kufena inselberg in the Zaria area was carried out between January and September 1989. The study was intended as a contribution to the ecological data-bank on the area for use by educational institutions in and around Zaria.

The plotless method was used in the study. On-the-spot identification of the plant species was carried out in 14, sampled study areas. 167 species representing 65 families were recorded during the study. Specimens were collected for an ecological herbarium on the area. The frequency of the species was recorded, based on the Braun-Blanquet 5-point abundance scale. Phenological characters and the height of the angiosperms were recorded to compliment the description of the species.

It was observed that before the rains, except for a few species like Bombax costatum which was in full bloom, most of the other species were dormant, and some apparently absent. During the rains, the angiosperms were more frequent than the pteridophytes, bryophytes and the thallophytes. The cryptogams were found in both shady and open areas which were damp or wet, the phenerogams in both the dry and wet areas.

The list of references is by no means exhausitive but it is hoped that the references will provide a key to the literature for those who may wish to take up the subject further.

The appendix provides a list of 258 plant species representing 74 families recorded from Kufena between 1963 and 1989 (including previous collections, in the department's herbarium).

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CHAPTER ONE

1.0 INTRODUCTION

Ecology is a subject which seems to have given rise to more controversy, as to its place in our educational system, than any other branch of biology. It is sometimes referred to as "a luxury subject" indulging in a taste for outdoor work. As such, consensus is hardly reached as to the most suitable time for its introduction in the educational system. Events have however shown that today the ecological knowledge acquired over centuries, is being used to solve many of the environmental and related problems of man.

There are probably no areas in the world that are entirely free from the influence of man. This is as a result of the several and varied attempts by him to satisfy his essential needs of life. Ecology, an interdisciplinary study that links the natural and social sciences together and which can be approached at several levels is invaluable. Through it, a better insight into the man-environment complexities can be accomplished.

This study emphasises the general interest in an aspect of the life and vegetation of Kufena inselberg, with less emphasis on the individual plants. Once interest is aroused about the generalization, the specifics should be easy to absorb. It is hoped therefore that not too many ecologists and biologists, the students alike, will be offended when they find that their favourite field of ecology is omitted or only briefly mentioned.

1.1 OBJECTIVE OF THE STUDY

The objective of this study is to build an integral picture of the plant community of Kufena inselberg. It is expected that, at the end, the study will provide an additional source of ecological information on Kufena for the schools in and around the locality. This will partly be in the form of an ecological herbarium assembled from field collections.

1.2 JUSTIFICATION FOR THE STUDY

The availability of suitable working areas is for many biology teachers the most serious obstacle to be surmounted, but the problem may in fact be more imaginary than real. There is no doubt that it is an advantage to have favourable working sites close at hand. Though it must be admitted that many schools which are fortunately placed do not take sufficient advantage of their opportunities.

Part of the trouble is that we have grown accustomed to selecting especially attractive areas for field study purposes and have largely neglected the possibilities of more restricted, but, from the point of biology teaching, often more rewarding localities. This arises from the erroneous assumption that very little will be achieved, because similar areas somewhere else have been studied before. Secondly, there is the traditional attachment to the older ecological areas. Consequently, to change

becomes more or less difficult. Thirdly, there are often problems concerned with transport to the site and also interaction with local people at the site (who may initially be suspicious).

These attitudes, unavoidable to some extent, do make the acquisition of scientific knowledge of such areas, which are at our door-steps, a rare achievement.

Common observations have however shown that each environment has its restricted and often much specialised characteristics. The Kufena inselberg should not be an exception.

This investigative study is intended as a contribution to the ecological data-bank on Kufena inselberg for schools in and around Zaria. This is in consonance with the view of Chapman (1976), that any vegetation survey or record of plant species in a particular environment is potentially a natural history document. A documentary record is essential to biology teachers for the success of any ecological study. According to Green (1965), this provides a challenge, an incentive to effort, because any information obtained may prove to be a new contribution to knowledge.

In addition, the locality will also provide an alternative ecological study area for schools in view of the scarcity of virgin land because of the intensive need for food production and shelter, as a result of human population pressure.

Finally, based on Nigeria's current National Policy on Education, there is the need to expose students to some aspects of field work in biology. This is because, through such ventures, the much preached acquisition, appreciation and utilization of scientific knowledge and the adoption of scientific attitudes will be fully realised.

1.3 LIMITATIONS OF THE STUDY

The ecological equilibrium is dynamic within each plant community. This coupled with the annual and seasonal variations of the environmental factors, it is not possible to have an absolute record of plants in Kufena.

All the possible routes to the project site may prove difficult, especially during the rainy season.

Accessibility to the interior of the site may be difficult during the rainy season because of the rapid growth of the vegetation.

1.4 DESCRIPTION OF THE PROJECT SITE

Kufena, where the Kufena inselberg complex is located is one of the two ancient walled settlements so far identified on the plains of Zaria. The other is Turunku, 34km south of Zaria. Kufena used to be an ancient seat of power for the Zaria kings. The relics of the famous wall still remain (Smith, 1970).

Kufena inselberg is the largest inselberg complex in Wusasa ward in the Zaria area (Figure 1). It lies adjacent to the Zaria-Birnin Gwari road, 5km away, west of Zaria (Zaria Field Society, 1978; Buckle, 1979). It is located on latitude 11°05'30" North and longitude 07°39'30" East (the Gazetter of Nigeria, 1963). Its highest point is 820m above sea level. It gives an excellent view of the surrounding countryside on a clear day (Figure 1).

Kufena inselberg is composed of hard older granite of the Basement Complex (Wright and McCurry, 1970; Buckle, 1979). It consists of three elongated and asymetrical main domes, each made up of several half domes. The main domes are separated by deep joint fissures choked with boulder scree, (Thorp, 1970; Buckle, 1979). The east face is precipetous and the opposite end rises in a series of huge convex swells, (Buckle, 1979). A line of standing stones at the north-east corner of the inselberg comparable to the features found on Dumbi and Hange hills was reported by Thorp (1970). Rock caves are found in the rock jumbles, (Zaria Field Society, 1978).

The inselberg is surrounded by the lower domes, barely breaking the surface and sometimes topped by groups of rounded conestones. It also exhibits low whale-back features usually longer than broad or high sometimes surmounted by a few rounded boulders. The lower slopes are marked by broken rocks (scree).

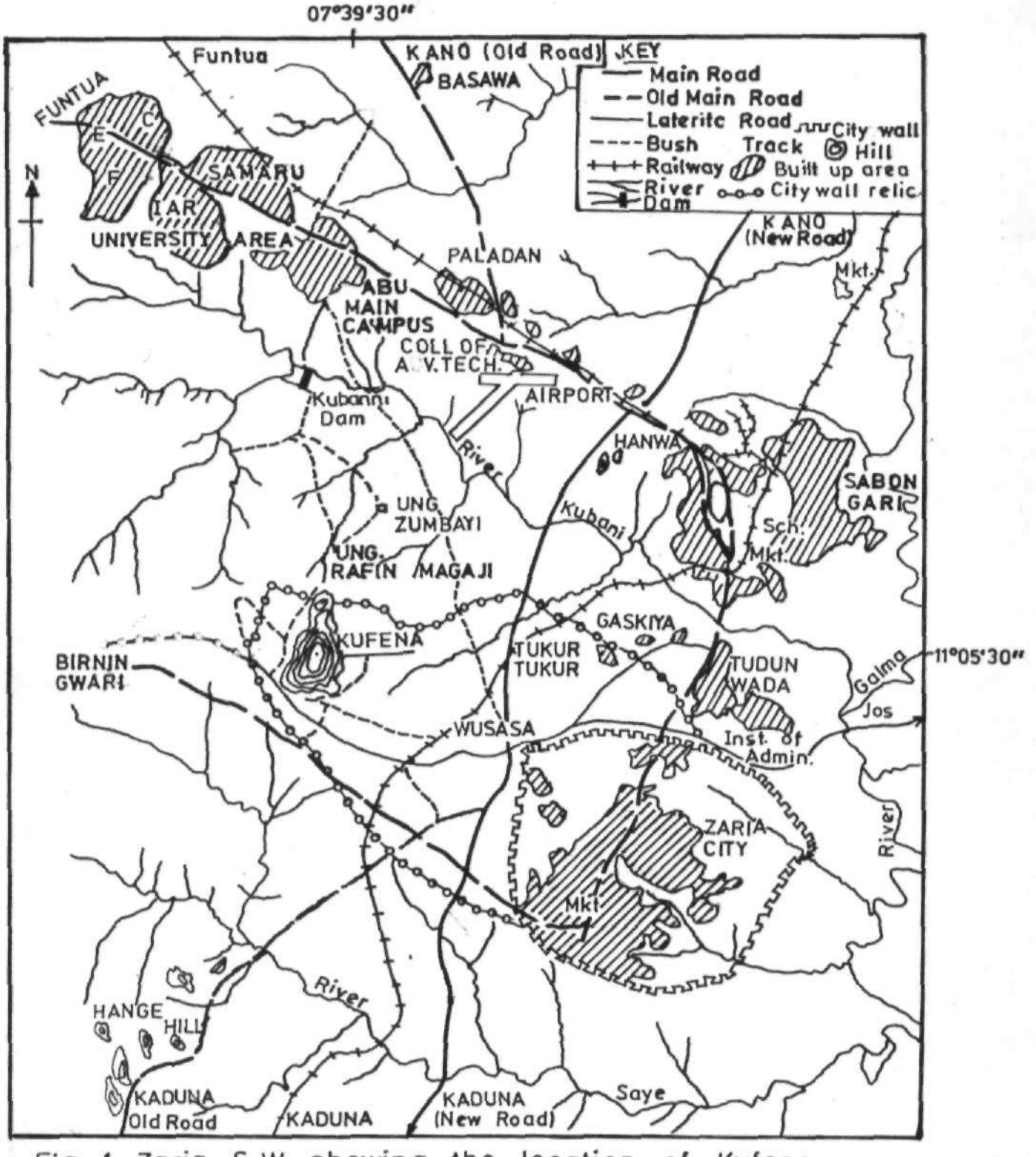


Fig. 1 Zaria S.W. showing the location of Kufena

0 1 2 3 4 5 KM.

Two main trials lead up the inselberg to the summit. One from the south west corner, the other from the west. On its top, there are depressions, cracks and pockets in which soil often accumulates. Here annual grasses, sedges, shrubs and some trees can be found, (Jackson, 1967; Zaria Field Society, 1978). Also, Thorp (1970) reported strange features, armchair hollows (weather pits) on the main dome of the inselberg. He called these hollows "natural flower pots" because they have vegetation growing in them.

Pronounced small shallow hollows are found on horizontal gentle sloping granite surfaces in large numbers. These hollows are believed to have originated from the grinding activities of the natives, (Jackson, 1967; Zaria Field Society, 1978). The hollows according to Jackson (1967) measure 50-55cm in length, 30-32cm broad and 18cm deep. These grinding hollows form water puddles during the rains but dry up during the dry season leaving dead organic matter often with stones. Jackson (1967) reported that the present nearby villages denied using these hollows nowadays, and also their use in the past. He, however reported seeing some of the small hollows on the lower slopes being used for grinding leaves particularly of Bombax costatum, an infusion of which is used as an emollient. The writer was informed that the water in the grinding hollows is used for domestic purposes. The hollows are usually cleaned at the advent of the first rains to obtain usable water.

Jackson (1967) reported an interesting games board, a series of twelve (12) smaller rounded depressions in a rough circle with one, shallower and wider, located at the centre of the circle. The board is cut in the flat rock surface of the inselberg. This board is shaded by a nearby perched boulder and is believed to have been used for playing "ayo". A similar game is still found and played in the Eastern part of Nigeria, (Jackson, 1967).

In addition, there are large depressions on the inselberg. These depressions usually form permanent pools during the rains, but gradually dry up at the advent of the dry season leaving stones and dead organic matter substrata, (Thorp, 1970). The nearby villages use the water in the pools for domestic purposes. Seasonal ponds are also found at the northeast end of the inselberg on the lower slopes, (Thorp, 1970).

The lower slopes are being progressively modified through the numerous and varied activities, such as farming and domestication of animals. Quarrying activities are also noticeably being carried out at the various points of the small hill southwest of the main hill, (Thorp, 1970).

The base of the inselberg is surrounded by cultivated parkland with vegetation typical of the northern guinea Savanna zone. Acacia albida, Parkia clappertoniana, Tamarindus indica and Anona senegalensis are some of the common scattered trees. Bombax sp. dominates the upper zones of the inselberg. The common grasses include many species of the Andropogoneae sub-family, (Jackson, 1968).

The climate of Kufena generally, like that of Zaria is mild in July-August. The maximum screen temperature may rise to 35°C and the minimum be as low as 13°C in December. The temperature may be as high as 38°C in April and as low as freezing point, especially during the harmattan, November to February (Horpe, 1970). The first shower of rains usually comes in a thunderstorm around March-April, reaches its peak in August and ceases around October. The dry season is practically rain free. Relative Humidity ranges between 12-20% in the dry season and 50-55% in the wet season, (Hore, 1970). The area experiences the Saharan dry air mass from the north and the moist cool equatorial maritime from the south (Hore, 1970).

Generally, except for a few monkeys, rock hyraxes, lizards and numerous birds, the wildlife is not obvious. This is because the area is adjacent to villages and has been heavily hunted.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 ECOLOGY

ORIGIN, MEANING, DEVELOPMENT AND FUNCTIONS

The term ecology originated from the Greek words oikos and logos which Haeckel in 1864 referred to as Oecology, meaning "study of a house", (Park, 1971; Owen, 1980).

Haeckel was the first to define the term as "the body of knowledge concerning the economy of nature (Park, 1971).

Several attempts had been made as far back as 1859 to define the term ecology. St. Hilaire coined the word "ethology" to describe the relationships between the organisms, family, society and the community. Mivart proposed "hexicology" to define the study of the relationships between organisms and the environment. In 1913 Shelford defined ecology as "the science of the community". In 1926 Elton called it "Scientific natural history" concerned with the "Sociology and economics of animals", (Kormondy, 1965). According to Odum (1975) it is "the study of the structure and functions of the communities".

The ambiguity of the subject area of inquiry and its objectives, according to Kormondy (1965) are some of the predicaments that confront ecologists. Chapman (1976) opined that it should still be viable to recognise the term in its widest possible meaning. Its original

biological meaning as "the study of organisms and their relationships with other individuals and their environment" is therefore retained.

Long before the Greek words came to light, man had been aware of the mutual bond between himself and the organisms and the physical environment which gave him sustenance, (Etherington, 1974 and Morton, 1981). This awareness was through the hunting life which later metamorphosed into primitive agriculture. This was in addition to the sudden ecological catastrophes of fire, flood, erosion, drought and the regrowth of plants. Thus, from unspoken beginnings the subject developed and can be traced to the origin of scientific knowledge as far back as Aristotle, (Park, 1971). In 1916 Clements cited Petrus de Crescentius as the first writer in 1305 to appreciate the existence of plant competition, and Kings as the first in 1685 to describe the concept of succession, (Weaver and Clements, 1938; Etherington, 1974). Both competition and succession are some of the vital aspects of ecology.

Ecology however is of recent origin as an organised science. It was established at about the time the science of genetics was recognised, (Boughey, 1968; Park, 1971).

The work of Darwin in the middle of the 19th century stimulated interest in the diversity of inter-relationships of biological material, (Boughey, 1968). His theory of natural selection used an ecological entity, the environment, as an agent of evolution, (Park, 1971).

The subject was placed on a modern basis by several workers including F.A. Forel in Switzerland in 1892, J.E.B. Warning in Denmark in 1895 and the Americans, E.A. Brige, H.C. Cowles and F.E. Clements between 1891 and 1905, (Park, 1971).

Thereafter ecology became wider in scope and its interactions with other aspects of science became more apparent, (Park, 1971). It grew from being a minor branch of biology to an interdisciplinary study which the American ecologist Odum (1975) called "links between the natural and social sciences". According to Chapman (1976), the subject has developed to a stage of complexity and diversity that it is now difficult to find a group of ecologists who could agree upon the limits.

Ecology is an applied science, finding applications in forestry, agriculture, erosion and flood controls, desertification, drought, etc, (Pandeya et al., 1968). Owen (1980) added pollution, conservation of rare species, industrial growth and general economic development. In Australia, there has been a gradual economic awakening since 1964 on how to utilise natural resources, (Gare, 1974). The knowledge of ecology, especially on the relationships between vegetation and soil according to Poore (1974), may give better insight about the agricultural and land resource potentials, their planning and utilization.

The ability of the industrialised nations according to Surmarlin (1974) to realise and demonstrate the ecological effects of development on man, has helped to promote the subject. The demand for ecologists and ecological information according to Oosting (1956) therefore exceeded the supply.

ECOLOGY IN SECONDARY SCHOOLS

Green (1965) emphasised the importance of ecology as a preamble to the understanding of a wide range of biological principles. According to him, it provides school biology with the often difficult link between pure and applied biology.

Plant ecology though it may be devoid of fieldwork, tends to be stressed in schools because the plants are more static, (Green, 1953; 1965). The absence of fieldwork is not unconnected with the non-recognition of the subject as an entity, consequently failure to give it a place on the time table.

Green (1953) suggested the study of structure, habits and physiology of organisms; the physical and chemical aspects of the environment and the synthesis of the knowledge gained by fieldwork. He also recommended an ecological herbarium which in his opinion would aid acquisition of new knowledge and revision, and ensure acquaintance of the students with the plant species.

Despite obvious difficulties such as lack of staff, facilities, time, variations in local opportunities and syllabus problems, Green (1953; 1965) strongly suggested

an adequate place for ecology in schools. This, according to him would help overcome the scarcity of ecological talents and knowledge.

2.2 INSELBERGS

MEANING, ORIGIN, TYPES, FEATURES AND IMPORTANCE

Inselberg is a German word for "Island Mountain". The word was first used by B.W. Bornhardt in 1900 to describe the remarkable dome shaped rocky hills he saw in Tanganika (Tanzania), (Buckle, 1979 and Nwajide, 1989). Later in 1928, Passagre used it to describe the special residual hills in South West Africa (Namibia), (Buckle, 1979). In Nigeria, Falconer was the first in 1911 to use the word inselberg to describe the landscape scenery in the Kabba area, (Nwajide, 1989). Geologists restrict its use to such hills formed under tropical and sub-tropical conditions (Pugh, 1971). Today it is simply defined as "an isolated hill standing above all developed plains", (Twidale, 1969; Pugh, 1971; Buckle, 1979; Adeleke and Leong, 1979).

In savanna regions, inselbergs are believed to evolve from deep weathering coupled with stripping of the weathered layer and the continuous scarp retreat. This resulted in the formation of bornhardt variety initially, but broken down into castle kopjesby weathering attacking the joint planes, (Buckle, 1979).

Inselbergs are found in all the climatic zones of Africa. They vary in size and shape from small hillocks of less than 100 metres high to for example, the Branberg

of Namibia, rising more than 1800 metres above the plain, (Buckle, 1979).

Twidale (1969), Buckle (1979) and Nwajide (1989) reported the angular, castellate, mesa, butte, tor, ruware, whaleback, kopje and bornhardt structural forms of inselberg. Buckle identified more with the kopje and bornhardt because according to him all others originated from them. He also combined castellate and kopje structural forms and called them castle kopje, which he described as steep sided pile of massive crystalline boulders. Castle kopjes exhibit castle profile hence their name. In many African countries castle kopjes are called "tors". Any type of isolated hill in South Africa is called kopje in the Afrikaan language (Buckle, 1979). In Nigeria, castle kopjes are found on Jos Plateau and along Kaduna-Doka road, (Nwajide, 1989).

Bornhardt inselbergs named after B.W. Bornhardt are described as massive crystalline steep sided dome-shaped rocks of granite. They exhibit less whaleback features. Examples include the Namuli Mountains in Mozambique and in Nigeria there are Kufena in Zaria, Zuma rocks near Abuja, Kotarkoshi (Sokoto State), Kusheriki (Niger State) and along Kaduna-Kujama road (Kaduna State), (Buckle, 1979; Nwajide, 1989).

In Nigeria according to Buckle (1979), two main plan ation surfaces, the African High plains and Gondwana were identified in the north.

The African High plains lie about 450 metres to 750 metres above sea level and cover a large part of northern Nigeria. They extend from Bauchi in the east to Sokoto in the west. Meandering streams such as Galma in the Zaria area flow in broad shallow valleys across them. In certain areas, the surface is divided by a low scarp or zone of broken country into two levels. The upper altitude lies above 600 metres, (Adeleke and Leong, 1979; Buckle, 1979).

The Gondwana is one of the remnants of the plan ation surface on the African continent, north of equator. It is preserved at about 1400 metres on the Jos Plateau. It owes its existence largely due to the resistance of the younger granite complexes.

The African Hi h plains end abruptly at the scarp surrounding the Jos Plateau. Inselbergs some of the largest of which are those found near Kusheriki, Kotarkoshi and Abuja interrupt at intervals the surfaces of both plantations. Kufena dominates the landscape west of Zaria, (Mortimore, 1970; Zaria Field Society, 1978; Buckle, 1979).

Inselberg features such as boulders, gnammas, rock slabs and caves beneath the boulders are common, (Twidale, 1969; Nwajide, 1989). Gnammas also referred to as Armchair hollows are elliptical or circular weather pits. They are believed to have originated from the decaying and disintegrating activities of lichens and mosses in water medium, (Twidale, 1969). Jackson (1967) called these pits "natural flower pots".

Inselbergs are sites for artifacts. In 1969, Legett reported the find of a group of terra cotta figurines from the foot of an inselberg near Hanwwa, Zaria, (Jackson, 1967). B.J. Harris (oral communication) informed the author that in 1978 (approximately), Birkelbach collected terra cotta figurines from the Kufena inselberg. Grinding hollows and occasionally "ayo" game board at Dumbi and Kufena, Zaria were reported by Jackson (1967).

The defensive value of hills is a universal factor. Some were used as refugees in times of war. Inselbergs sometimes have ritual significance. In several cultures, they personify one god or another. In Nigeria, Olumo rock at Abeokuta and Zuma Rock at Suleja are still treated as such by the natives, (Smith, 1970; Nwajide, 1989).

Geologists consider bornhardt inselbergs as windows into the earth, because they give clues to the nature of rocks deep down in the Plutonic realm. They provide a field laboratory for the study of mechanical and chemical weathering; stability of slopes and erosion. The imposing and awesome appearance of these inselbergs attract recreations such as mountaineering and camping to the tourists. The more easily climbed ones provide spots from which to gaze across the surrounding landscape, (Nwajide, 1989).

According to Mortimore (1970), the large well jointed granite masses of an inselberg could store a substantial volume of rainwater through percolation. This water may

gradually be released through the springs at the base of the prominent hills. Ganawuri hills on Jos Plateau is an excellent example of this. When the water table is nearer the surface at the base of the inselberg, as it occasionally does, it provides sufficient soil moisture which can support dry season crops. Many localities around Zaria utilize this advantage to cultivate onions, (Mortimore, 1970). Sometimes natural pools fill the rock hollows, -- which were believed to be of great advantage to the occupants of the inselbergs, (Jackson, 1967). Today, the water in these hollows is used for domestic purposes by the surrounding villages. Animals also drink from them.

2.3 VEGETATION

MEANING, ORIGIN, DEVELOPMENT AND TYPES

Vegetation is an assemblage of plants growing together in a particular location as a result of the interactions of numerous factors, sometimes over hundreds of years. It is usually characterised by either its component species such as pine forest, Isoberlinia woodland, Acacia-Balanites savanna, etc or by the combination of structural and functional characters like mangrove forest, rainforest, savanna grassland etc. (Weaver and Clements, 1938; Walter, 1971; Chapman, 1976).

Vegetation arises from the living together of individual plants which have survived the environmental and related hardships. Its origin may be observed in a fallow field, shallow ponds, dried lakes, sand dunes,

exposed rock ledges, mountain ranges of naked rock and indeed all bare areas. Vegetation originated with the appearance of the landmass it covers. The common factors influencing the formation of vegetation are soil, water, light, temperature, repeated burning, and grazing (Weaver and Clements, 1938; Walter, 1971; Chapman, 1976; Madany and West, 1983).

Development of vegetation consists of the closely related processes: migration, aggregation, competition, reaction and stabilisation, (Weaver and Clements, 1938).

The pioneering plants migrate from their area of occurrence to the bare areas. Under favourable condition they grow to maturity and establish themselves. A process called ecesis. Through propagation, the established migrants tend to become aggregated. This is followed by competition for resources. The reaction of the individual plant to the available resources determines its survival. All these processes coupled with environmental modifications may result in a shift in the plant population. Shrubs may replace the herbs and trees may start under the shelter of the herbs. The final arbiter is however the climatic factor, (Weaver and Clements, 1938; Chapman, 1976; Billings, 1978).

At a stage according to Weaver and Clements (1938), an equilibrium is reached between the developing vegetation and the climate, and the vegetation becomes stabilised. Vegetation is differentiated into large natural units - forest, savanna, desert, montane vegetation, etc. Each unit results in plant formation, subdivided into associations.

It also exhibits dominance, resulting in layers. Where the zonation is disrupted by an abrupt change in conditions, the vegetation exhibits alternes. The adjustment of the plant species to seasonal changes results in aspects, (Weaver and Clements, 1938).

McNaughton (1983) noted that it is traditional in vegetation ecology to refer to study areas as homogeneous. Naturalists, however, have observed that in the tropics the vegetation was characterised by pronounced spatial variation, (McNaughton, 1983).

Natural savanna is understood to mean a homogeneous plant community in which woody plants are scattered on a grassy background. A peculiar illusion is presented by the landscape where the distance between the woody plants is 5 to 10 times their height, especially with trees, (Walter, 1971).

Savanna as defined by Walter (1971) occurs in Africa in areas with rainfall of more than 600mm. It covers the greater part of West Africa south of the Sahara, (Lawson, 1966). Wide range of temperature is not associated with it and rain is the most influential environmental factor affecting the vegetation, (Billings, 1978).

Two plant life forms occur in savanna. The woody plants and the grasses. The woody plants regulate transpiration by closing their stomata. Some shed their leaves. The evergreen species have sclerophyllous foliage which is usually armed with thorns and has fewer and smaller leaves or leaflets. All these help to reduce the total surface area exposed for transpiration. Trees measure up to 15m-18m tall with

branches not touching. The shrubs have extensive root systems with which they explore the soil, particularly stony soils held among the rocks. In the face of competition, the shrubs maintain a foothold among the grasses. Here, there is more moisture in the soil during the dry season than is used up by the grasses (Walter, 1971).

The grasses transpire very actively but are known to survive the dry spells before the rains, (Walter, 1971). Many grasses flower toward the end of the rains.

In savanna some trees produce new leaves before the rains. Plants such as the orchid - Eulophia sp. and aroid Armophophallus dracontioides with underground storage parts also produce flowers during this time, (Lawson, 1966).

Like all tropical vegetation, the savanna flora is usually rich. Grasses and legumes tend to be well represented, (Billings, 1978).

A French botanist Aubreville, in 1950, believed that savanna originated from dense dry forest with little grass. According to him, this was due to the varied influence of man, fire plays the most prominent role. The resistant plant species persist, (Lawson, 1966).

In 1933, Chevalier another French botanist classified West African savanna into Guinea, sudan and sahel zones, (Lawson, 1966).

The Guinea zone according to Senior (1979) is the most southerly, and relatively the most moist type of these savannas. It has an annual rainfall of more than 900mm and a dry season of at least 4 months. Trees are mainly

deciduous, 6-15 metres tall. According to Lawson (1966), trees are mostly broad leaved forming an almost closed canopy of branches in some places. Calotropis procera, Lophira lanceolata, Afzelia africana, Anogeissus leiocarpus, Borassus aethiopum, Parkia clappertoniana, Daniellia oliveri, Butyrospermum paradoxum and Isoberlina doka are some of the common woody plants. Butyrospermum paradoxum, and Parkia clappertoniana are protected because of their economic value. In some areas, because of intensive farming, Adansonia digitata is frequent. Local variations however exist. Most of the woody plants have thick bark and are fire resistant.

The grasses are tall, 1.5-3 metres high, tussocky and mostly fire resistant. Andropogon, Hyparrhenia and Penninsetum are the common genera, (Lawson, 1966).

The Sudan zone replaces Guinea to the north. It has an annual rainfall of 600mm-900mm and dry season of 7 months. Trees are usually not in clumps and grasses are 1-1.5 metres tall, (Senior, 1979). Acacia albida, Hyphaene thebica, Parkia clappertoniana and Diospyros mespiliformis are common trees on the intensive farming areas. Anogeissus leiocarpus and Combretum sp. are found in poor soils. Guierra senegalensis, Piliostigma reticulata and Dichrostachys glomerata develop into fallow shrub savanna. Grasses such as Eragrostis tremule, Cenchrus biflorus and Penninsetum pedicellatum are common. Mitragyna inermis is found on wet soil in the bottom of the valleys. Damp loving plants like Echinochloa colonum, Oryza barthii, Cyperus dives and Ipomea aquatica are also present, (Lawson, 1966).

Senior (1979) described Sahel of the west African savannas as the most northerly. It has an annual rainfall of 250-600mm and 8 month dry season. The vegetation is mainly thorny bushes with several species of Acacia. The grasses form a discontinuous cover and are rarely 1 metre tall. The common woody plants according to Lawson (1966) are Acacia senegal, Acacia raddiana, Leptadenia pyrotechnica, Salvadora persica, Acacia seyal and Grewia sp. Species of Aristida and Chloris are the common grasses.

2.4 INSELBERG VEGETATION

Inselbergs are often associated with plant species preferring a wetter habitat, than that normally found in the northern guinea savanna zone away from the rivers. Ensete gilletti found near abandoned settlement sites at Dumbi, Zaria testifies to this, (Jackson, 1970). Murdock (1960) reported that Ensete gilletti is associated with the cultivation of Digitaria exilis in Northern Nigeria, (Mortimore, 1970). Pachystela brevipes is frequent along the drainages. Rotala stagnina in association with Dopatrium longidens are common rock pool plants, (Jackson, 1970; Walter, 1971). Lowe and Stanfield (1974) reported the common occurrence of Cyperus tenniculmis, Cyperus digitatus and other various Cyperus spp. in the wet flushes on rocks and at the edge of rock pools.

Plants of drier affinities, Bombax costatum and Ficus abutilifolia are typical of inselbergs around Zaria, (Jackson, 1970). Allsworth-Jones et al. (1986) reported

the presence of Bombax costatum and Ficus glumosa on the western slopes of Kariya-wuro inselberg in Bauchi State, Nigeria. According to Jackson (1970), Albizia coriaria, Acacia ataxacantha, Saba florida and Dioscorea sp. are often found at the foot of inselbergs around Zaria and Anchomanes difformis is common in the undergrowth. Dioscorea paraehensilis is found on Kariya-wuro inselberg in Bauchi State (Allsworth-Jones et al., 1986). The trees Pterocarpus erinaceous, Lannea schimperi and Boswellio dalzielli are found in cracks and crevices on the bare rock surfaces. The perennial grass Loudetia arundinacea is found in narrow cracks and the sedge Afrotrilepis pilosa in small cracks. Afrotrilepis pilosa once established in these cracks, it forms round mats over the surface of the rock by means of persistent stolons which are covered with the fibrous remains of leaf sheaths. Shrubs of Commiphora africana is common invader of Afrotrilepis pilosa mats, rooting in the mat and not necessarily into rock cracks. The mat is not rooted into rock surface. Whole mats including shrub and sedge can be lifted from the rock surface. These rounded mats are common characteristic of most Nigerian inselbergs.

Sarcostemma viminale, Aloe barteri and the annual Cyanotis lanato are typical inselberg xerophytes. The latter is found in shallow gravel pockets around the Afrotrilepis mats, (Jackson, 1970). The small annual grasses, Michrochloa indica, and the Tripogon minimus are found in very shallow soils as pure stands or at the edge of larger vegetation mats. The brittle stemmed annuals

Euclasta condylotricha and Heteropogon contortus are found in deeper soils, (Jackson, 1970). Mascus dubius was reported by Lowe and Stanfield (1974) as characteristic of soil pockets on inselbergs and Lipocarpha sphacelata in damp areas and soil pockets on rocks. Andropogon gayanus was reported on top of the Kariya-wuro inselberg, Bauchi State by Allsworth Jones et al. (1986).

Blue green algae and bacteria are common first colonisers of weathered rough surfaces of the exposed rock. They are usually blackish purple in colour. They later change to grey and then to brown. Lichens are in abundance. They are regarded as second colonisers. They are found in tightly oppressed crustose forms on open rocks. Their foliose forms are found in sheltered areas, (Jackson, 1970; Nwajide, 1989).

2.5 VEGETATION AND MAN

Plants constitute a fundamental part in our continual existence. Man depends directly or indirectly on plants either for food or for raw materials, (Salisbury, 1938; Sinnott, 1955). Their innumerable forms of life inspired poets and confronted philosophers with some of their most profound problems, (Sinnott, 1955).

Vegetation cover regulates temperature and promotes the atmospheric moisture, consequently improving precipitation thereby controlling drought and desertification.

Huntington stated that man does best under medium temperature. He gave 18°C in moist air as most favourable to man, (Salisbury, 1938).

It is generally recognised that plants especially a close turf of grass, play a vital role in controlling erosion, (Booth, 1941; Jackson, 1970). Several species of algae and lichens in addition to being pioneers in plant succession, also form complete layers on eroded areas thereby protecting these areas against subsequent erosion, (Salisbury,1938; Booth, 1941). The humus from the decayed and decomposed components of the plants help to improve the fertility and moisture retention status of the soil. This also helps to control run-off and subsequently flood during the rains, (Salisbury, 1938).

Vegetation serves as wind breaks, and specifically checks wind movement near the soil. This role coupled with shade, lowers and stabilises the temperature and makes the air more humid. This favours the growth of seedlings, (Weaver and Clements, 1938).

Various types of vegetation provide the main source of forage for domesticated animals to graze or browse. According to the Food and Agricultural Organization world estimate in 1970, the larger portion of the 75% of the forage needs of domestic livestock which comes from extensive grazing resources, is located in savanna, (Simmons, 1974). Grazing utilizes primary productivity, from lichens to desert halophytes, which would have otherwise been uncropped by man, (Simmons, 1974). According to Madany and West (1983), grazing results

in an ecological shift in the vegetation structure and this reduces inflammability. In 1934, Pearson suggested livestock grazing for the regeneration of the vegetation in Arizona, (Madany and West, 1983). Recent publications showed that grazing by the insect of the genus Trirhabda (phytophagous insects) are possible contributors to plant succession in the old field community of South East Ontario, (McBrien et al., 1983).

The place of plants in food and medicine especially, is invaluable. In Nigeria there is widespread utilization of uncultivated plants for the treatment of ailments in domestic animals. For example, Abrus precatoriaus and Balanites aegyptiaca are used to treat bloat in ruminants and worm infection in horses, respectively. Diospyros mespiliformis and Dichrostachys glomerata are used for the treatment of wounds and bruises in livestock, (Dalziel, 1937; Nwude and Ibrahim, 1980).

Man, has had a tremendous impact on the savanna vegetation. This has been through grazing, agriculture, hunting, fire, etc which have led to desertification, erosion, floods, extinction of rare plant species, etc. (Billings, 1978).

Research has shown in some parts of the world that livestock grazing has been responsible for reducing herbaceous coverage and encouraging the proliferation of woody species. This has hastened the shift from savanna to forest status, (Madany and West, 1983).

According to Simmons (1974) grazing reduces the frequency of seedlings or completely eliminates them. Mature trees are often debarked by grazing animals. Goats can reduce woodlands to scrub or completely open land without any woody vegetation. Sheep are slower in action and cattle are much less dangerous in this respect, (Simmons, 1974).

According to Smith (1940) much of the top soil was being removed by excessive grazing. In Oklohoma, efforts are being made to cultivate all arable lands and to limit livestock grazing to only rough, wooded or rocky areas.

Zedler et al. (1983) considered fire as an extreme annual event responsible for sudden changes in the vegetation. It is known to start naturally by lightening, or through the breaking and falling of hard granite rocks, subsequently producing sparks when they strike other rocks on the ground (Walter, 1971).

In savanna, as a result of fire, trees become twisted, distorted and stunted. The resistant ones develop thick fissured corky barks for example Pterocarpus angolensis in East Africa reported by Booler in 1966, and Butyrospermum paradoxum by Lawson (1966) and Jackson (1968). Thorn scrub vegetation, (for example the genus of Acacia) and shrub thicket may invade the burnt areas, render them useless for grazing and so pose a threat to the livelihood of farmers, (Walter, 1971). Fire destroys both grasses and sedges. The badly damaged sedges are often washed away in the rains. Evidence from Idanre in South Western Nigeria showed that without fires, the Afrotrilepis mats will fuse

and form closed communities which can be invaded by larger life forms (Jackson, 1970).

Fire, however, according to Lawson (1966) favours the rapid regeneration of the perennial grasses with underground stems. Adams (1980), reported that early burning protects and encourages tree and shrub production and regeneration, and that late burning prevents forest encroachment, suppresses regeneration and encourages grassland production. Both early and late burning lead to the improvement of the fertility of the top soil, (Adams, 1980). According to White (1983), prescribed burning restores and maintains a plant community to its pre-suppressed origin.

2.6 DESCRIPTION OF VEGETATION

Before any serious or detailed ecological work can commence on an area, it is necessary to know the species present there, their distribution and degree of abundance, (Kershaw, 1973). Chapman (1976) reported that plant ecologists generally prefer an approach based upon floristic composition, if working in an unfamiliar area, especially.

Floristic composition, a simple list of species, is a necessity to all ecological work. It is an aspect which will continue to dominate the subject, (Kershaw, 1973). According to Chapman (1976), vegetation description is an integral part of much of any resources survey.

The simplest and most rapid way of describing vegetation according to Kershaw (1973) is to list the species present within a sample area and attach to each species a subjective assessment of its abundance. He further reported that this method of approach has been used by numerous workers and that several convenient classes of plant abundance have been employed.

Kuchler (1967) and Kershaw (1973) reported that the more elaborate and better defined approach was that proposed by Braun-Blanquet in 1927. The approach was based on two 5-point scales. One combining the abundance and cover of a species, and the other giving a measure of the grouping or sociability designated SOC 1 - SOC 5.

Abundance-cover scale:

+ sparsely present, cover very small

1 plentiful, cover small

2 numerous, cover 1/20 of the area

3 individuals covering $\frac{1}{4}$ - $\frac{1}{2}$ of the area

4 individuals covering $\frac{1}{2}$ - $\frac{3}{4}$ of the area

5 individuals covering more than $\frac{3}{4}$ of the area

Grouping (sociability) scale:

SOC 1 growing singly, isolated

SOC 2 grouped or tufted

SOC 3 in small patches or cushions

SOC 4 small colonies, extensive patches, carpets

SOC 5 pure population

2.7 HISTORY OF BOTANICAL COLLECTIONS IN NIGERIA

From the scientific point of view, in terms of botanical collection, Tropical Africa was practically unknown in 1753 when Linneaus published his Species Plantarum.

In West Africa, the story of botanical collection in the early days is closely linked with the history of explorations. It started as early as 1697 by Rev. John Smith of the Royal African Company in the Gold Coast (Ghana). The collection by Michael Adanson, a French botanist was however the first recorded; he was collecting in Africa when Linneaus published his 1753 Species Plantarum. Adanson collected in Senegal and Gambia, 1749 - 1754. Linneaus named the Baobab tree Adansonia digitata to commemorate him. Some of the other collectors were an English man Henry Smeathmann in Sierra Leone 1771-72, a German-born doctor Paul Isert in Guinea 1783-87 and a Swedish botanist Adam Afzelius in Freetown, Sierra Leone, 1792. Afzelius is remembered by the genus Afzelia. Mungo Park, the explorer also collected botanical specimens 1795-97. The genus of the locust bean tree, Parkia, and the sheanut tree species (Butyrospermum parkii) were named after him by Robert Brown and by Kotschy, (Keay et al., 1960).

In Nigeria, Kirkwood, a surgeon made some collections in Old Calabar in 1698. A Frenchman Palisot de Beauvois was recorded the first botanist to visit the country.

He collected in Warri and Benin 1783-87. Reichenback named a genus Palisota in his honour, He is also remembered for collecting Raphia spp. Spathodea spp. Cola acuminata and Bombax bounopozense (Hutchinson and Dalziel, 1954; Keay et al., 1960). E.G. Irving a British Naval surgeon collected a few botanical specimens in Abeokuta, 1854-55. He is remembered by the well known tree Irvingia, (Keay et al., 1960). Rev. Hugh Goldie is noted for the discovery of Pararistolochia goldieana which he collected in Calabar district in 1888, (Hutchinson and Dalziel, 1954).

In Northern Nigeria, 1822-24, Captain H. Clapperton, Major Denham and Dr. Oudney recorded 77 collections from Bornu and 16 from Eastern Hausaland. A Northern Nigeria tree dorowa Parkia clappertoniana was named after Clapperton (Hutchinson and Dalziel, 1954; Keay et al., 1960). Some of the other prominent collectors were Dalziel 1904-05 and Keay 1944-50, (Hutchingson and Dalziel, 1954).

In the Zaria Area, especially Kufena 1963 to date, K.A. Kershaw, T.C.N. Baker, Clayton, B.J. Harris, A.O. Ohaeri, M. Dyer and S.O. Oyewole have been prominent collectors, (Ahmadu Bello University Herbarium).

2.8 ECOLOGICAL HERBARIUM

Botanical collections are better kept in the Herbarium. This is a general plant data bank systematically arranged and stored in cupboards (Fosberg and Sachet, 1965). It is

either in a Botanic Garden or a related establishment. The herbaria at Royal Botanic Garden, Kew at Edinburgh, National Herbarium Melbourne, Australia are a few examples of systematic herbaria, (Arber, 1953; Turill, 1959; Jain and Rao, 1976). Others include Forestry Department Herbarium, Ibadan and Biological Sciences Department Herbarium, Ahmadu Bello University.

An Ecological Herbarium according to Mclean and Cook (1946) is a collection of the commoner plants in a particular locality. This is one aspect directly related to field ecology. The collection includes plants showing flowers, fruits, and those at their juvenile stage. Mosses, lichens, liverworts and fungi are represented. The collection is used mainly to familiarize students with plants in the locality.

Maclean and Cook (1946) gave a specimen of an Ecological Herbarium sheet lebel:

ECOLOGICAL HERBARIUM SHEET LABEL
NAME ----------
ASSOCIATION ----------
SOCIETY ----------
LOCALITY ----------
DATE ----------ABUNDANCE ---------%
COLLECTOR ----------

The initial art of Herbarium making is credited to Luca Ghini (1409-1556), an Italian Professor of Botany (Alber, 1953; Morton, 1981). Plants collected from the

field are pressed, dried, laid on cardboard sheets, appropriately labelled and systematically stored for teaching, research, reference, etc. (Jain and Rao, 1976).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 APPARATUS

The basic apparatus used in this study are:

Field notebook, pencil and thread

Plant press and old newspapers

Herbarium sheets, labels and folders

Polythene bags, specimen bottles and plastic plates

Handlens and stereomicroscope

Abney hand level and 30 meter measuring tape

Pocket knife, hand trowel and pipette

Map of the study site.

3.2 PROCEDURES

(a) SURVEY

A general survey of the study site, Kufena inselberg was carried out and specific study areas were designated. The designated study areas were selected mostly in the lower levels and to some extent the middle levels of the inselberg. Fewer study areas were chosen in the summit area because of its being less easily accessible.

The preliminary survey of the vegetation of the site was adopted, in harmony with the views of plant ecologists reported by Neal (1958); Goldsmith and Harrison (1976). This may be termed the floristic approach. Odu (1985), Allsworth-Jones *et al.* (1986),

Ghazanfar and Hussain (1986), King (1987), Amotobi et al. (1988) and Isawumi (1989) also employed this approach in their various works on plant composition of specific environments.

The plotless method of assessment was used because of the practical difficulties of using quadrats and the corner pegs. This was in conformity with the opinions reported by Kellman (1975); Goldsmith and Harrison (1976). In addition, they reported that this method is non-destructive, fairly accurate, easy to adopt and time-saving. It was therefore viewed as an appropriate ecological method for the secondary schools to adopt.

(b) THE STUDY AREAS

Fourteen sample study areas were used in the study. The areas were selected based on their unique physical features. The location of the study areas 1-14 are indicated on the map, (Fig. 2).

(c) RECORDING AND COLLECTION

The study areas were visited twice every month for a period of nine months, from January 1989 to September 1989. During such visits, the areas were visited in sequence and the plants present in each were recorded. Some plant specimens were collected when they bore either flowers or fruits.

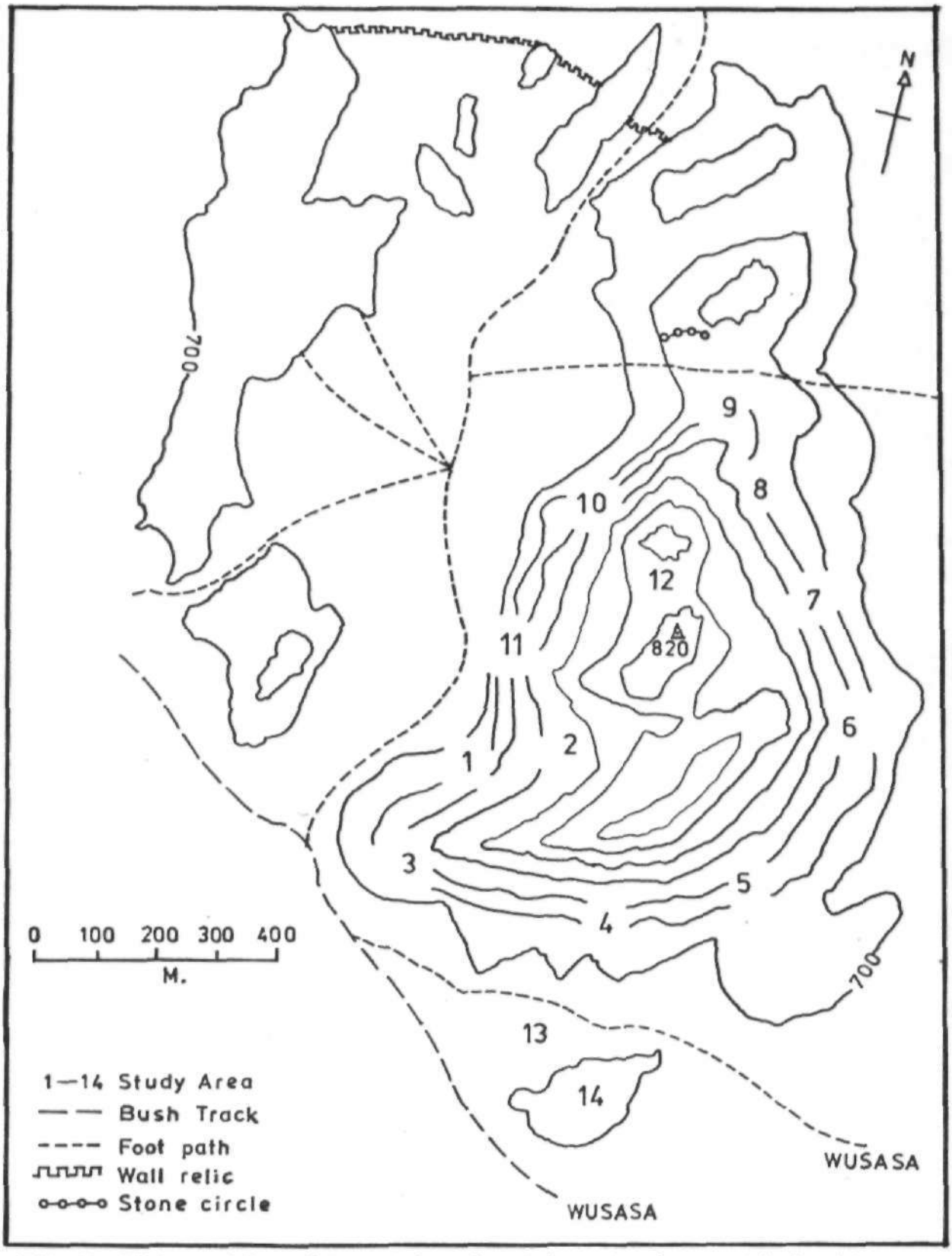


Fig. 2 Kufena inselberg showing the study area

The required parts of the woody plants were cut with the pocket knife and kept in the polythene bag. The trowel was used to scoop out or uproot some of the herbs; the lilies, orchids, grasses and the sedges. These specimens were usually kept in separate polythene bags. The knife and the trowel were used to remove cryptogams from their habitats onto the plastic plates. The pipette was used to take water samples from the puddles and pools into the specimen bottles. The thread was used to tie identification marks onto the field collections. A big polythene bag was used to carry all the field collections to the laboratory at the end of each visit.

(d) IDENTIFICATION

Some of the plants were identified in the field by the clan head of the settlement adjacent to study area 1, and by the herbarium curator. The curator gave the botanical names. The clan head gave the Hausa names, and their botanical equivalents were later checked up in Hutchinson and Dalziel (1954-72), Keay et al. (1960) and Morton (1961). This was similar to the technique employed by Allsworth-Jones et al. (1986). Other specimens were brought to the laboratory and were later identified by the herbarium curator and the major supervisor of this study.

(e) PRESERVATION

Some of the specimens were pressed using a plant press and old newspapers and sun dried. A few of these specimens were mounted on herbarium sheets with appropriate labels (Figs. 3 and 4). The specimens were sprayed with poison, Mercuric chloride. This poison was used for this study because it is a pesticide and also a long term preservative. It saves time, and labour. It ensures the intactness of the plant parts. The sheets were marked "P" for poisoning and arranged in folders ready for use as an ecological herbarium for the study site.

3.3. FLORISTIC ASSESSMENT

Cover abundance index was used to measure the quantity of the plant growth recorded from the study site. This assessment was based on one of two 5-point scales first used by Braun-Blanquet and Pavillard in 1928, (Maclean and Cook, 1946; Gates, 1949; Oosting, 1956; Kuchler, 1967; Harrison, 1976).

The cover abundance scale reads:

5 - constantly present/very abundant species covers more than $\frac{3}{4}$ of the area

4 - mostly present/abundant species. Cover $\frac{1}{4}$ to $\frac{3}{4}$ of the area.

3 - infrequent/not very abundant species. Cover $\frac{1}{4}$ to $\frac{1}{2}$ of the area.

3 - seldon/rare species. Cover 1/20 of the area

1 - rare/very rare species. Cover less than 1/20 of the area.

Family: Mimosaceae

Name: Dichrostachys glomerata (Forsk.) Chiov.

Vernac.Name: Dundu

Det. A.O. Ohaeri

Locality: Kufena inselberg

Habitat: Scrub land

Description:
A small tree with axillary spines. Bisexual flowers, upper yellow, lower pink. Leaves pinnate Fruits curved, shining crowded on a head.

Coll. Y.A. Salihu

Coll.No. 003 Date: 15/5/'89

Date: 29/9/'89 Coll.No.097

Family: Xyridaceae

Name: Xyxis straminea Nilss.

Vernac. Name:

Det. B.J. Harris

Locality: Kufena inselberg

Habitat: Seasonal wet flushes on rock outcrops

Description:
A slender annual. Yellow flowers, transparent bracts

Coll. Y.A. Salihu

Fig. 3: Samples of herbarium labels.

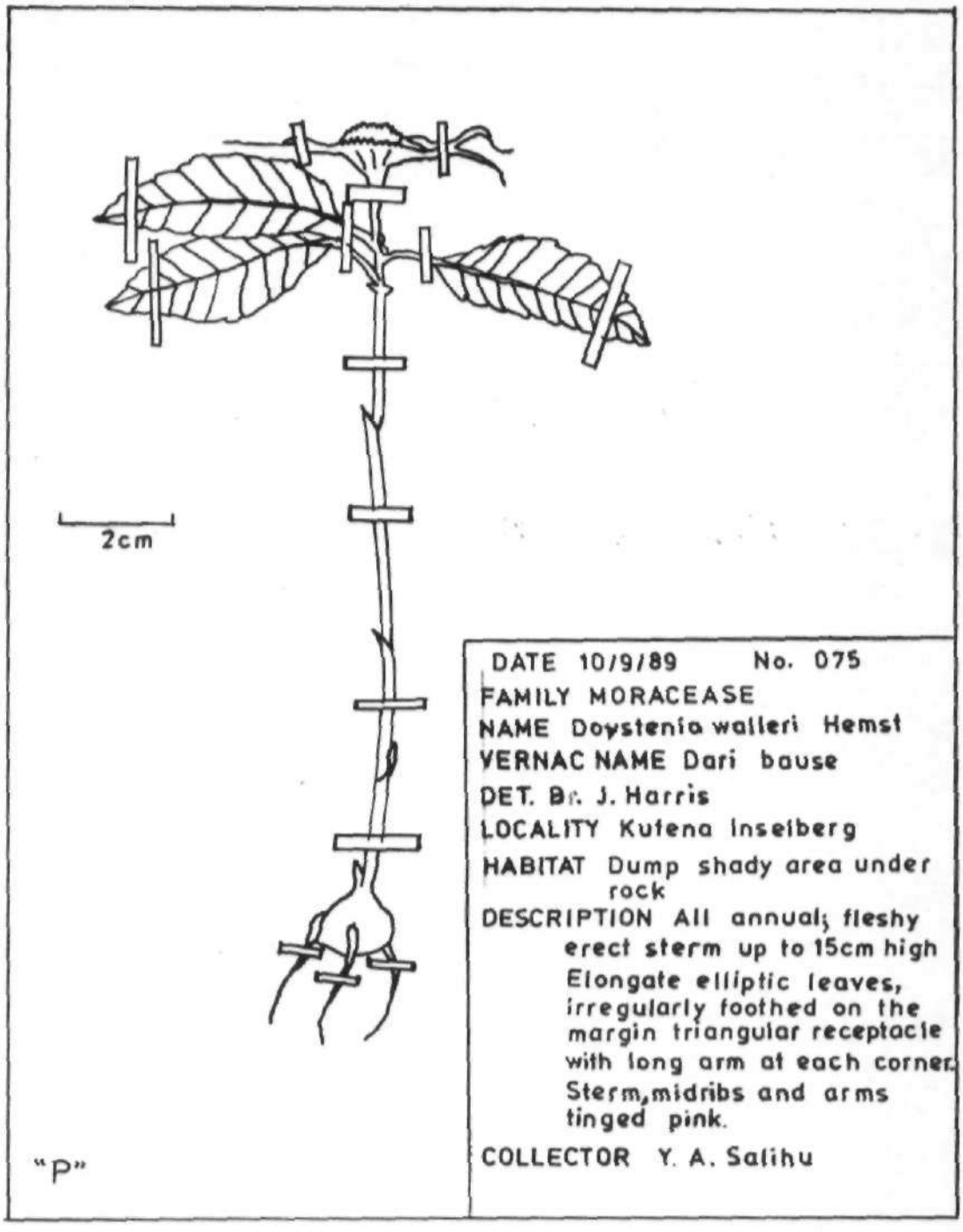


Fig. 4 Herbarium specimen mounted on herbarium sheet with paper straps. Herbarium Label is on the right. The mark "P" on the lower left corner signifies poisoned

Kuchler (1967) reported the use of the signs (+) for very rare species and (r) for recording the only one specimen which might be present in the area. These signs were however not used in this study.

The cover abundance scale was used to serve as a model for schools to adopt. It was thought that the scale would be easy to apply, quick to execute and could be used for rapid inventory (Goldsmith and Harrison, 1976).

Phenological records were made of the flowering and fruiting status of the plant species recorded, at the time the study was carried out, (Neal, 1958).

The Abney hand level was used to estimate the height of some woody plants. To achieve this, the observer stood at distance D, (Fig. 5). The tip of the plant was sighted through the telescopic tube. When the cross wire bisected the spirit level bubble at the centre, the angle of inclination was read on the protractor scale, (Garner et al., 1976). The height was worked out as illustrated below:

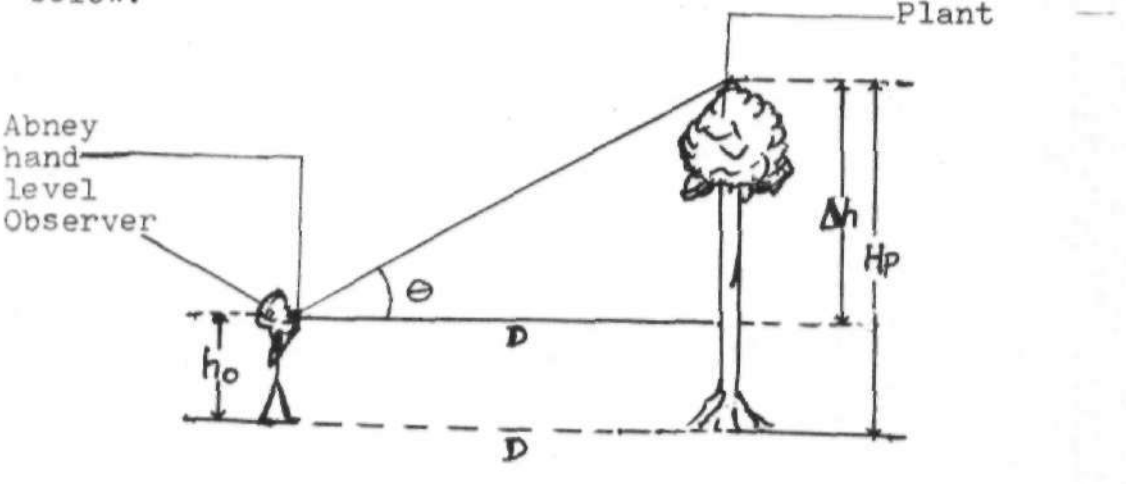


Fig. 5: Estimating the height of a plant using Abney hand level.

θ - angle of inclination

D - distance between observer and plant in meters

Δh - height of plant at eye level in meters

h_o - height at eye level in meters

Hp - Total height of plant in meters

$$\Delta h = D \tan \theta \text{ meters}$$

$$Hp = \Delta h + h_o \text{ meters}$$

Gates (1949) and Kuchler (1967) reported the use of a draftsman's triangle as an alternative to the use of the Abney hand level to estimate the height of plants, especially trees and shrubs.

CHAPTER FOUR

R E S U L T S

The results are presented in a summary form, Table 1, Table 2, in a frequency table (Table 3), in a phenological table (Table 4) and in a height table (Table 5).

One hundred and sixty seven (1967) plant species representing sixty five (65) families were identified during the survey.

The frequencies of the individual species are based on plot to plot analysis. However, the frequencies of the algae, liverworts, ferns and a few of the angiospermmae are recorded in relation to their unique habitats. These habitats were the rock pools, damp shady areas, wet flushes of the rock and the ponds.

Table 1: Summary of the families and the number of species of plants identified during the survey.

	Number of Families	Number of species
THALLOPHYTA		
Algae	6	9
Fungi	2	2
BRYOPHYTA		
Hepaticae	2	2
PTERIDOPHYTA		
Filicinae	2	2
SPERMATOPHYTA		
Angiospermmae	53	152
T O T A L	65	167

Table 2: List of 167 plant species (from the study area) under 5 groups and 65 families identified during the study.

ALGAE

BACILLARIOPHYCEAE

Navicula sp.

CHLOROPHYCEAE

Ankistrodesmus sp.

CYANOPHYCEAE

Nostoc sp.

Oscillatoria sp.

EUGLENOPHYCEAE

Phacus sp.

OEDOGONIOPHYCEAE

Oedogonium sp.

ZYGNEMAPHYCEAE

Closterium sp.

Cosmarium sp.

FUNGI

AGARICACEAE

Agaricus sp.

COPRINACEAE

Coprinus sp.

HEPATICAE

MARCHANTIACEAE

Marchantia sp.

RICCIACEAE

Riccia sp.

FILICINAE

ADIANTACEAE

Adiantum philippense L.

SELAGINELLACEAE

Selaginella tenerrima A.Br. ex. Kuhn

ANGIOSPERMAE

AMPELIDACEAE

Cissus flavicans (Bak.) Planch.

Cissus grantii (Bak.) Planch.

Cissus ibuensis Hook.f.

Cissus quadrangularis L.

ANNONACEAE

Annona senegalensis Pers.

Uvaria chamae P.Beauv.

APOCYNACEAE

Carissa edulis Vahl.

Halarrhena floribunda (G.Don.) Dur. & Schinz.

Landolphia owariensis P.Beauv.

ARACEAE

Amorphophallus abyssinicus (A.Rich.) N.E.Br.

ASCLEPIADACEAE

Calotropis procera (Ait.) Ait.f.

Pergularia daemia (Forsk.) Chiov.

Sarcostemma viminale (L.) R.Br.

BIGNONIACEAE

Jacaranda mimosifolia D.Don.

BOMBACACEAE

Adansonia digitata L.

Bombax costatum Pellegr. & Vuillet

Ceiba pentandra (L.) Gaertn.

BURSERACEAE

Commiphora africana (A.Rich.) Engl.

CAESALPINIACEAE

Cassia mimosoides L.

Cassia rotundifolia Pers.

Piliostigma thonningii (Schum.) Milne-Redhead

Tamarindus indica L.

CAPPARIDACEAE

Cleome monophylla L.

Maerua angolensis DC.

COMBRETACEAE

Anogeissus leiocarpus (DC.) Guill. & Perr.

Guiera senegalensis J.F. Gmel.

COMMELINACEAE

Aneilema lanceolatum Benth.

Commelina diffusa Burm.f.

Cyanotis sp.

COMPOSITAE

Acanthospermum hispidum DC.

Aspilia africana (Pers.) C.D. Adams

Coreopsis barteri Oliv. & Hiern

Conyza sp.

Gutenbergia nigritana (Benth.) Oliv.

Tridax procumbens L.

Vernonia pauciflora (Willd.) Less.

Vernonia sp.

CONNARACEAE

Byrsocarpus coccineus Schum. & Thonn.

CONVOLVULACEAE

Ipomea nil Rottb.

Ipomea pes-nigridis L.

CYPERACEAE

Afrotrilepis pilosa (Boeck.) J. Raynal

Cyperus cuspidatus Kunth

Cyperus difformis L.

Cyperus digitatus Roxb.

Cyperus imbricatus Retz.

Cyperus pastulatus Vahl.

Cyperus tenuiculmis Boeck.

Cyperus tuberosus Roteb.

Fimbristylis debilis Steud.

Fimbristylis ferruginea (L.) Vahl.

Kyllinga erecta Hooper

Kyllinga nigritana C.B. Cl.

DIOSCOREACEAE

Dioscorea abyssinica Hochst. ex Kunth

Dioscorea quartiniana A.Rich.

DROSERACEAE

Drosera indica L.

EBENACEAE

Diospyros mespiliformis Hochst.

EUPHORBIACEAE

Antidesma venosum Tul.

Bridelia micrantha (Hochst.) Baill. (Fig. 10)

Euphorbia heterophylla L.

Euphorbia hirta L.

Securinega virosa (Roxb.ex.Willd.) Baill.

GRAMINAE

Acroceros zizanoides (Kunth) Dandy

Aristida sp.

Brachiaria brizantha (Hochst.ex.A.Rich.) Stapf

Brachiaria distichophylla (Trin.) Stapf

Chloris pilosa Schumach.

Dactyloctenium aegyptium (L.) P.Beauv.

Echinochloa colona (L.) Link

Eleusine coracana (L.) Gaertn.

Eleusine indica (L.) Gaertn.

Elionurus hirtefolius Hack.

Eragrostis aspera (Jacq.) Nees.

Eragrostis tremula Hochst. ex. Steud.

Eragrostis turgida (Schumach.) De Wild.

Eragrostis sp.

Eucalysta condylotricha (Hochst. ex. Steud.) Stapf

Heteropogon contortus (L.) P.Beauv. ex Roem & Schult.

Michrochloa indica (L.f.) P.Beauv.

Panicum sp.

Paspalum orbiculare Forst.

Pennisetum pedicellatum Trin.

Phytachne triaristata (Steud.) Stapf

Sacciolepis africana C.E. Hubbard & Snowden

Setaria barbata (L.) Kunth

Setraria pallide-fusca (Schumach.) Stapf & C.E. Hubbard

Sporobolus festivus Hochst.ex. A.Rich.

LABIATAE

Leocus membranaceus J.K. Morton

Platostoma africanum P.Beauv.

LENTIBULARIACEAE

Utricularia sp.

LILACEAE

Aloe buettneri A. Berger

Asparagus africanus Lam.

Gloriosa superba L.

Scilla sudanica A. Chev.

Uriginea altissima (L.) Bak.

LORANTHACEAE

Tapinanthus globiferus (A.Rich.) Van Tiegh.

LYTHRACEAE

Lawsonia inermis L.

Rotala stagnina Hiern

MALVACEAE

Hibiscus cannabinus L.

Sida acuta Burm.

Sida alba L.

MIMOSACEAE

Acacia albida Del.

Acacia ataxacantha DC.

Acacia senegal (L.) Willd.

Acacia sieberiana DC.

Dichrostachys glomerata (Forsk.) Chiov.

Parkia clappertoniana Keay

MORACEAE

Dorstenia walleri Hemsl.

Ficus abutilifolia (Miq.) Miq.

Ficus exasperata Vahl

MYRTACEAE

Eucalyptus sp.

NYMPHAEACEAE

Nymphaea lotus L.

OLACACEAE

Olax subscorpioides Oliv.

ONAGRACEAE

Ludwigia octovalvis L.

OXALIDACEAE

Biophytum petersianum Klotzch

PALMAE

Borassus aethiopum Mart.

PAPILIONACEAE

Abrus precatorius L.

Aeschynomene indica L.

Crotalaria naragutensis Hutch.

Crotalaria retusa L.

Desmodium volutinum (Willd.) DC.

Indigofera numulariifolia (L.) Livera ex Alston

Sesbania sesban (L.) Merrill

Tephrosia linearis (Willd.) Pers.

Tephrosia pedicellata Bak.

PERIPLOCACEAE

Tacazea apiculata Oliv.

POLYGONACEAE

Polygonum salicifolium Brouss.ex Willd.

PORTULACACEAE

Portulaca oleracea L.

RHAMNACEAE

Ziziphus mauritiana Lam.

Ziziphus spina-christi (L.) Desf.

RUBIACEAE

Borreria chaetocephala (DC.) Hepper

Borreria octodon Hepper

Borreria starchydea Hutch. & Dalz.

Feretia apodanthera Del.

Microsphyra longistyla (DC.) Hiern

SAPINDACEAE

Paullinia pinnata L. (Fig. 10)

SAPOTACEAE

Butyrospermum paradoxum Hepper

SCROPHULARIACEAE

Dopatrium longidens Skan.

Rhamphicarpa fistulosa (Hochst.) Benth.

Scoparia dulcis L.

Striga hermontheca (Del.) Benth.

STERCULIACEAE

Waltheria indica L.

TILIACEAE

Corchorus tridens L.

Grewia mollis Juss.

Triumfetta rhomboidea Ja.

UMBELLIFERAE

Steganotaenia aralicea Hochst.

Table 3: The frequency of plant species based on the Braun-Blanquet 5-point abundance scale.

5 - very abundant; 4 - abundant; 3 - infrequent; 2 - rare; 1 - very rare

	STUDY AREA													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Abrus precatorius								1						
Acacia albida				4	4	4	3	3						
Acacia ataxacantha				3	3	3	2	3	2	3	2			
Acacia senegal				4	4	4	3	3	2	3				
Acacia sieberiana				3	3	3	2	2	3	3	2			
Acanthospermum hispidum	2			3	3					3	2	3		
Acroceros zizanoides	2			3									2	
Adansonia digitata	1		1							1	1			
Adiantum philippense+	1		2	2	2	2		2	3	2				
Aeschynomene indica	4		4	3	3	2	2							
Afrotrilepis pilosa		3							3			3		
Agaricus sp.	1						1							
Aloe buettneri	2	1												
Amorphophallus abyssinicus			1											
Aneilema lanceolatum	2	1	2	1				1						
Ankistrodesmus sp.*	2												1	
Anogeissus leiocarpus				3	3	3	2	2	2	3	3			
Annona senegalensis	1									2				
Antidesma venosum				2	2									
Aristida adescensions	3	3												
Aristida sp.	3	3												

\+ Fern in damp shady areas
* Algae in rock pools.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Asparagus africanus	2	2	1	2	2	1	1	1	1	1				
Aspilia africana		1	2	3	3	3	2	2	2	1				
Balanites aegyptiaca				3	3	2	2	1						
Biophytum petersianum				1	1					2	1			
Bombax costatum	3	3	4	4	4	3	3	2	2	3	2			
Borassus aethiopum			1	1	1						1			
Borreria choetocephala														
Borreria octodon	2			3	3	3			2					
Borreria starchydea	2			2	2									
Brachiaria brizantha				4	3									2
Brachiaria distochophylla				3										2
Bridelia micrantha										1				
Butyrospermum paradoxum			1	1							1			
Byrsocarpus occineus	2	2	3	3	3	2	2	3	3	2	2			
Calotropis procera	2								1	1				
Coreopsis barteri	3	3								3	3			3
Carissa edulis			2	4	4	3	2	2	2	1				
Cassia mimosoides	3	3	2	3	3	2	2			3	2			
Cassia rotundifolia	1		3	4	4	3	3			3	2			
Ceiba pentandra			1		1									
Chloris pilosa	3		3	3						3	3			
Cissus flavicans										1				
Cissus ibuensis	2		2	1	1									
Cissus grantii	2		2	1										

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Cissus quadrangularis				1	1									
Clerodendrum aculeatum	3		3	2						3				
Cloeme monophylla	2													
Closterium sp.*	4								1					
Cochorus tridens	3									3	3			
Commelina diffusa										1	1			
Commiphora africana			3	2	2	2			1	1				
Conyza sp.	1													
Coprinus sp.	1			1							1			
Cosmarium sp.	4								1					1
Costus spectabilis					1			2						
Crotalaria naragutensis	2													
Crotalaria retusa	2		2	2						3	3			
Cyanotis sp.	3	3		2										3
Cyperus cuspidatus														
Cyperus diformis									2					3
Cyperus digitatus	4			3	3					4	4			
Cyperus imbricatus	3			2	2				3		2			
Cyperus pastulatus	2			1										
Cyperus tenuiculmis														
Cyperus tuberosus									2					3
Dactyloctenium aegyptium	3	3		4	4					3			4	
Desmodium volutinum														
Dichrostachys glomerata			3	3	2				2	3	3			
Dioscorea abyssinica									2	2				
Dioscorea quartiniana	1	2	3	2	2	2	3	2	2	1				

* Algae in rock pools

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Diospyros mespiliformis	2								2		2			
Dopatrium longidens /	2								3					
Dorstenia walleri					1									
Drosera indica	2								2					
Echinochloa colona														2
Eleusine coracana											1			
Eleusine indica		1		2	1						2			
Elionurus hirtefolius	1													1
Eragrostis aspera				4	3								4	
Eragrostis tremula					3									
Eragrostis turgida	3			3	3								3	
Eragrostis sp.				4	3								4	
Eucalyptus sp.											1			
Eucalysta condylotricha	2													
Euphorbia heterophylla				2	2									
Euphorbia hirta	2		1		2		2							
Feretia apodanthera				3	2									
Ficus abutilifolia	2	3	3	3	3	3	3	2	2	2	2			
Ficus exasperata										1	1			
Fimbristylis debilis	3	2												3
Fimbristylis ferruginea	3		2											3
Gloriosa superba			1	1	1	1								
Gmelina arborea										1	1			
Grewia mollis										3	3			
Guiera senegalensis	2	3		3	3	2								
Gutenbergia nigritana			2	4	4	3	2	1	2	3	3			

/ Angiospermmae in rock pools

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Heteropogon contortus			3	3	3	3	3	3		2	3			
Hibiscus cannabinus	2		3	3	3	2	3	2	2	3	3		2	
Holarrhena floribunda				1	1									
Indigofera numulariifolia				3	3								3	
Ipomea nil											2	2		
Ipomea pes-nigridis										2	1			
Jacaranda mimosifolia	1													
Kaempferia nigerica				3	3	2	2	1						
Kyllinga erecta				4	3							3	3	
Kyllinga nigritana	3			3	3									3
Landolphia owariensis												1		
Lawsonia inermis	1													
Leocus membranaceus	2									2	2			
Lippia chevalieri				1	1	1								
Ludwigia octovalvis	1								1					
Marchantia sp. (x)														
Maerua angolensis				1										
Michrochloa indica	1			3	3	1	1					3		
Microsphyra longistyla														
Navicula sp.*	3													1
Nostoc sp.*	2													
Nymphaea lotus _/										4				
Oedogonium sp.*	3													2
Oscillatoria sp.*	2													

(x) Liverworts in damp shady areas
* Algae in rock pools
_/ Angiospermmae in ponds

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Olax subscorpioides				3	2									
Panicum sp.														
Parkia clappertoniana		3		3					3	3	3			
Paspalum orbiculare			3	3										4
Paulinia pinnata			3	2	2									
Penninsetum pedicellatum	2		2		2					3	3			
Pergularia damae	2				2									
Phacus sp.*	3													1
Phytachne triaristata									2					
Piliostigma thonningii				1	3	3	2	2	3	2	1		3	
Platostoma africanum	3				2	2				1	1			
Polygonium salicifolium	3													
Portulaca oleracea	2													
Rhamphicarpa fistulosa	1								1					
Riccia sp. (x)				1					3					
Rotala stagnina	1								2					
Sacciolepis africana _/									3					
Sarcostemma viminale		3							3			3		
Scilla sudanica	2	2												
Scoparia dulcis														
Securinega virosa				2	3	3	2							
Sesbania sesban	3		3							3	3			
Selaginella tenerrima+			1	1					2					
Setaria barbata	3													
Setaria pallide-fusca	3			3	3					3	3	3		
Sida acuta	3		3	3	3	3	3	3		3	3		3	
Steganotaenia araliacea														

\+ Fern ally in damp shady areas
(x) Liverworts in damp shady areas
_/ Angiospermmae in ponds

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Stephanodiscus sp.*	2								3					
Striga hermontheca			2			2			2	3	3			
Sporobolus festivus	3			3	3					3	2			
Tacazzea apiculata				2	1									
Tamarindus indica			3	3	3	3			2	3	3		3	
Tapinanthus globiferus			3		3				3	3	3			
Tephrosia linearis	3									2	2			
Tephrosia pedicellatum	3	3	3	2						3	3			
Tridax procumbens	2		3	2	2		3	3		3	3			
Triumfetta rhomboidea														
Uriginea altissima	1													
Utricularia sp.	1								1					
Uvaria chamae				3	3	3	3	3	2	2	3			
Vernonia pauciflora										2	3			
Vernonia sp.														2
Waltheria indica				3	3	3	3	2		3	3			
Xyris straminea	1								2					
Ziziphus mauritiana			1	2	2	2	2	3	2	3	3			
Ziziphus spina-christis				1						1				

Table 4: Periods of flowering and fruiting of the angiospermmae.
fl - flowering. fr - fruiting

PLANT SPECIES	MONTH								
	J	F	M	A	M	J	J	A	S
Abrus precatorius							fr		
Acacia albida	fl	fr	fr	fr	fr				
Acacia ataxacantha						fl	fl		
Acacia senegal				fl	fl	fl	fr.fl	fl.fr	
Acacia sieberiana	fl	fl.fr	fl.fr	fl.fr					
Acanthospermum hispidum									
Acroceros zizanoides								fl	
Adansonia digitata	fr	fr	fr		fl	fl	fl		
Aeschynomene indica							fr		
Afrotrilepis pilosa								fr	fr
Aloe buettneri								fl	fl
Amorphophallus abyssinicus									
Aneilema lanceolatum					fl				
Anogeissus leiocarpus	fr						fl	fl.fr	fr
Annona senegalensis									fr
Antidesma venosum									
Aristida adescensions									
Aristida sp.									
Asparagus africanus				fl	fl.fr	fr		fr	fr
Aspilia africana									
Balanites aegyptiaca			fr	fr	fl.fr	fl.fr	fr	fr	
Biophytum petersianum								fl fr	fr

	J	F	M	A	M	J	J	A	S
Bombax costatum	fl	fl.fr	fr	fr	fr	fr			
Borassus aethiopum									
Borreria chaetocephala								fl	fl
Borreria octodon								fl	fl
Borreria starchydea								fl	fl
Brachiaria brizantha								fl	fl
Brachiaria distochophylla								fl	fl
Bridelia micrantha							fl.fr	fl.fr	fr
Butyrospermum paradoxum	fl	fl			fr	fr	fr		
Byrsocarpus coccineus								fr	
Calotropis procera									
Coreopsis barteri								fl	fl
Carissa edulis			fl	fl	fr	fr	fr	fr	
Cassia mimosoides									
Cassia rotundifolia									
Ceiba pentandra	fl		fl						
Chloris pilosa								fl	fl.fr
Cissus flavicans									fr
Cissus grantii						fl			
Cissus ibuensis						fl	fl	fl.fr	
Cissus quadrangularis								fr	
Clerodendrum aculeatum									
Cleome monophylla				fl	fl	fr	fr		
Cochorus tridens									
Commelina diffusa							fl		
Commiphora africana	fl	fl	fl	fl	fr				

	J	F	M	A	M	J	J	A	S
Conyza sp.									
Costus spectabilis							fl	fl	
Crotalaria naragutensis							fl	fl	fl.fr
Crotalaria retusa							fl	fl.fr	fl.fr
Cyanotis sp.									
Cyperus cuspidatus							fl	fl	fl.fr
Cyperus difformis							fl	fl	fl.fr
Cyperus digitatus							fl	fl	fl.fr
Cyperus imbricatus							fl	fl	fl.fr
Cyperus pastulatus							fl	fl	fl.fr
Cyperus tenuiculmis					fl	fl	fl	fl	fl.fr
Cyperus tuberosus							fl	fl	fl.fr
Dactyloctenium aegyptium							fl	fl	fr
Desmodium volutinum									
Dichrostachys glomerata	fr	fl	fl	fl	fl.fr		fl		
Dioscorea abyssinica								fl	
Dioscorea quartiniana								fl	
Diospyros mespiliformis	fl	fl	fl	fl	fl	fl		fr	
Dopatrium longidens						fl	fl	fl	
Dorstenia walleri									fl
Drosera indica									fl
Echinochloa colona							fl	fl	
Fleusine coracana							fl	fl	fl
Fleusine indica							fl	fl	fl
Flionurus hirtefolius				fl	fl		fl	fl	
Frogrostis aspera							fl	fl	
Fragrostis tremula							fl	fl	
Fragrostis turgida							fl	fl	

	J	F	M	A	M	J	J	A	S
Eragrostis sp.							fl	fl	
Eucalyptus sp.								fl	fl
Eucalysta condylotricha									
Euphorbia heterophylla									
Euphorbia hirta									
Feretia apodanthera						fr	fr		
Ficus abutilifolia	fl	fl.fr	fl.fr	fl.fr					
Ficus exaseperata									
Fimbristylis debilis							fl	fl	
Fimbristylis ferruginea							fl	fl	
Gloriosa superba			fl	fl			fl		
Gmelina arborea									
Grewia mollis									
Guiera senegalensis							fl	fl.fr	fr
Gutenbergia nigritana							fl	fl	
Heteropogon contortus								fl.fr	fr
Hibiscus cannabinus								fl	fl
Holarrhena floribunda		fl	fl	fl	fl	fl.fr	fl.fr	fr	
Indigofera numulariifolia									
Ipomea nil									fr
Ipomea pes-nigridis								fr.fr	fr
Jacaranda mimosifolia		fl	fl	fl					
Kaempferia nigerica									
Kyllinga erecta							fl	fl	
Kyllinga nigritana							fl	fl	
Landolphia owariensis									
Lawsonia inermis									
Leocus membranaceus									

	J	F	M	A	M	J	J	A	S
Lippia chevalieri								fl.fr	fr
Ludwigia octovalvis	fl	fl	fl.fr	fl.fr	fr			fl	fl
Maerua angolensis							fl	fl	
Michrochloa indica					fl	fr	fr		
Microsphyra longistyla									fl
Nymphaea lotus									
Olax subscorpioides									
Panicum sp.									
Parkia clappertoniana	fl	fl.fr	fl.fr	fr	fr	fr	fr		
Paspalum orbiculare							fl	fl	
Paullinia pinnata	fr	fr	fl.fr	fl	fl			fr	
Penninsetum pedicellatum							fl	fl	
Pergularia damae							fl	fl.fr	
Phytachne triaristata							fl	fl.fr	
Piliostigma thonningii	fl	fl	fl	fl.fr	fr				
Platostoma africanum					fl				
Polygonium salicifolium									
Portulaca oleracea									
Rhamphicarpa fistulosa									fl
Rotala stagnina									fl
Sacciolepis africana									
Sarcostemma viminale									
Scilla sudanica						fl			
Scoparia dulcis									
Securinega virosa							fr		
Sesbania sesban									
Setaria barbata									

	J	F	M	A	M	J	J	A	S
Setaria pallide-fusca									
Sida acuta									
Sida alba									
Steganotaenia araliacea									
Striga hermontheca									
Sporobolus festivus							fl	fl.fr	fr
Tacazzea apiculata									
Tamarindus indica	fr			fl	fl	fl	fl	fl	
Tapinanthus globiferus							fl	fl	fl
Tephrosia linearis									
Tephrosia pedicellatum									
Tridax procumbens							fl	fl	fl
Triumfetta rhomboidea									
Uriginea altissima					fr	fr			
Utricularia sp.									fl
Uvaria chamae								fl	
Vernonia pauciflora									
Vernonia sp.									
Waltheria indica							fl	fl	
Xyris straminea									fl
Ziziphus mauritiana	fl,	fl	fl	fl			fl	fl.fr	fr
Ziziphus spina-christi									

Table 5: Estimated maximum height (in meters) of some trees and shrubs using the abney hand level.

PLANT SPECIES	ESTIMATED MAXIMUM HEIGHT IN METERS
Acacia senegal	6
Adansonia digitata	15
Anogeissus leiocarpus	12
Annona senegalensis	5
Balanites aegyptiaca	8
Bombax costatum	10
Butryospermum paradoxum	9
Ceiba pendandra	24
Commiphora africana	5
Dichrostachys glomerata	7
Diospyros mespiliformis	11
Ficus abuntilifolia	12
Holarrhena floribunda	8
Maerua angolensis	6
Olax subscorpioides*	6
Parkia clappertoniana	14
Paullinia pinnata *	7
Piliostigma thonningii	6
Tamarindus indica	10
Ziziphus mauritiana	8

* Climbing shrub

CHAPTER FIVE

D I S C U S S I O N

Basically, ecology is natural history. It is one of the youngest sciences though it means different phenomena to different people. Ecology is essentially a quantitative science but most of its early approaches consisted of purely descriptive studies. Many methods have been used to carry out ecological studies. A preliminary survey study using a plotless technique is one of these methods; it was used in this case to undertake the flora survey of Kufena inselberg.

In nature, floristic differences exist between localities. Also the ratios of population mixtures of plant species vary from locality to locality, because some plants are more successful than others in a particular habitat or locality. Many similarities do exist too. Kufena inselberg provided the opportunity to survey these variations and similarities within one inselberg. Kufena inselberg was selected for study because although it has been affected by man, it still shows many features of inselbergs. Furthermore, it is easily accessible to students and visitors, and is well placed for educational visits from schools, colleges and universities in the area.

The fundamental task of any ecologist in such an unfamiliar and seemingly stable vegetation is to carry out a survey study and provide foundations for subsequent studies and investigations.

OBSERVATIONS BEFORE THE RAINS

At the onset of the project in January 1989, except for Bombax costatum, Dichrostachys glomerata and Diospyros mespiliformis, (Fig. 6) which were in flower or fruit, most of the other angiosperms were dormant. The deciduous plants had shed their leaves. Even Bombax costatum, which was in full bloom, was leafless. The writer learned that some of the trees were cut for firewood and roofing. The grasses and a few of the herbs and shrubs were cut for feeding livestock and for roofing.

Plants such as Sarcostemma viminale and dried mats of Afrotrilepis pilosa were prevalent on the surfaces of the rock, particularly the higher parts. Lilies and orchids were apparently absent. Fresh specimens of thallophytes, bryophytes and pteridophytes were not present.

The rock pools and puddles were dried up. There were no springs. Dried green patches of algae were noticed in the dried substrata of the sites of previous pools and puddles. Some of the laterite surfaces, rock and rock outcrop surfaces showed traces of dried lichens and mosses. Grazing by goats was restricted to the higher parts of the inselberg. This was because the lower parts were already devoid of palatable forage for the animals.

On 23 March, 1989, the whole inselberg was swept by fire. Except for the fire-resistant plants like Bombax costatum and Butyrospermum paradoxum, the majority of

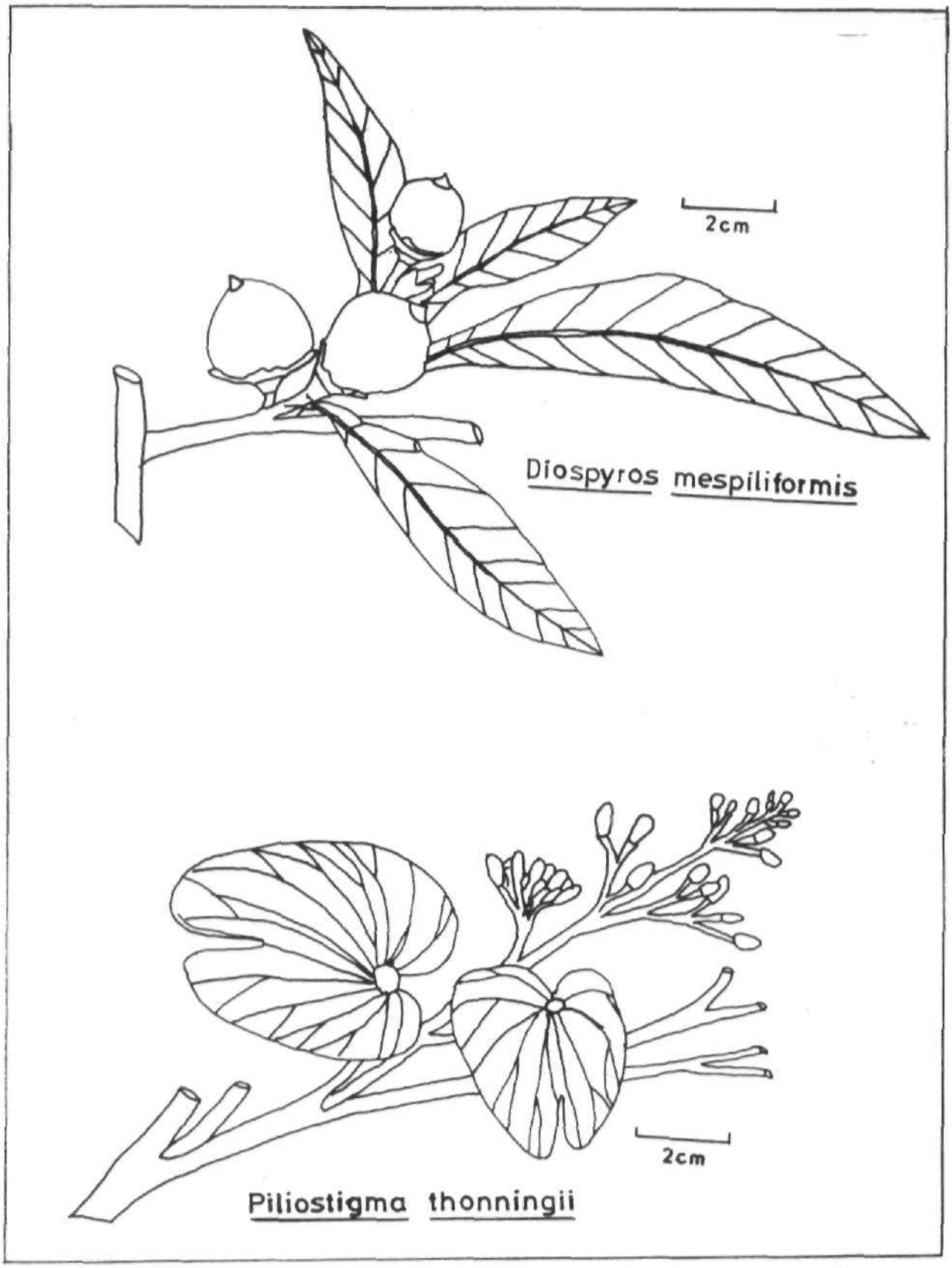


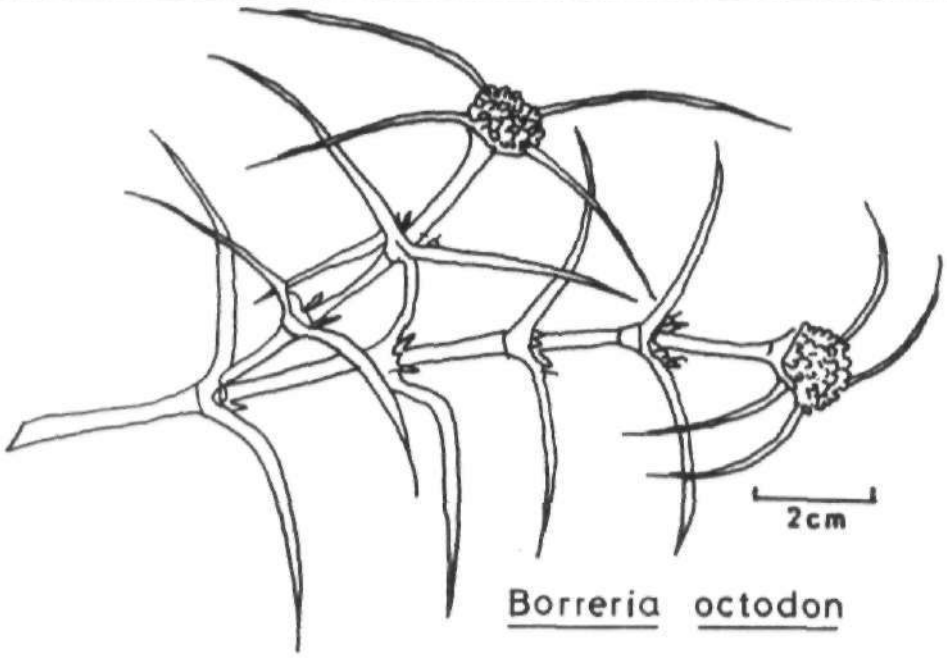
FIG. 6 Diospyros mespiliformis and Piliostigma thonningii

the other plants suffered the effects of burning to varying degrees. For instance, the grasses and sedges in some areas were completely burnt. This made the plant life in the site at first to be more dull, but subsequently more interesting; after the fire and before the first rain on 17 April, 1989, grasses had started sprouting. This phenomennn had already been commented upon by Lawson, (1966) and Jackson (1968).

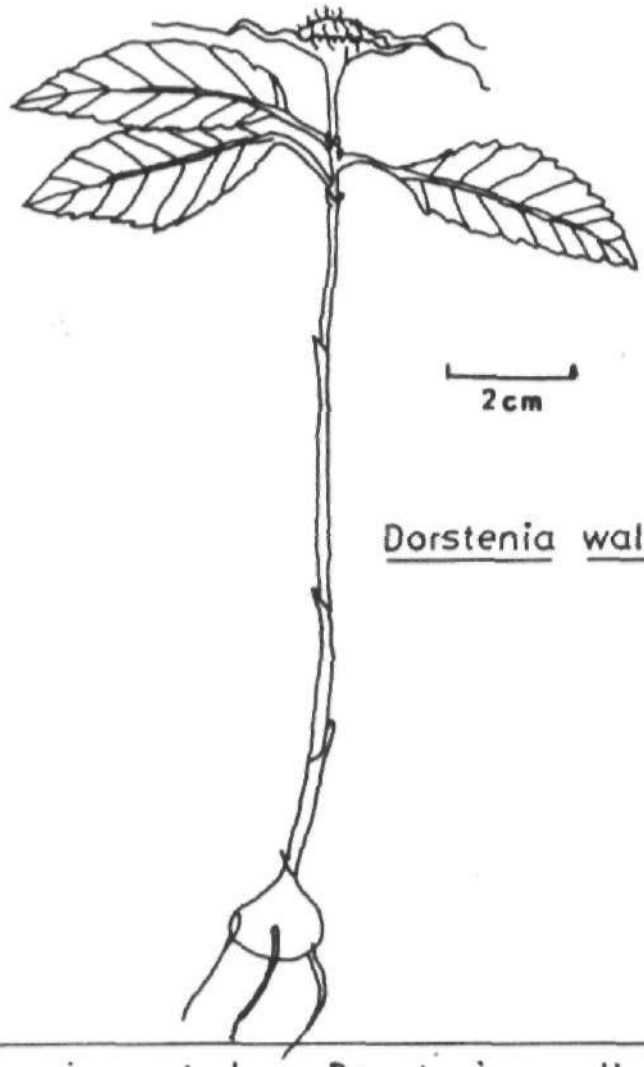
OBSERVATIONS DURING THE RAINS

The vegetation of the site became more active with the coming of the rains. Grasses like Heteropogon contortus continued to sprout and grow. Similarly, herbs such as Coreopsis barteri (Compositae) started growing particularly in the study areas 1, 2 and 3. Most of the wet laterite surfaces and wet flushes of the rock outcrop were invaded by blue green algae, (Fig. 8), lichens and subsequently mosses. This sequence was an example of succession on bare surfaces. Mosses and ferns were observed in the damp shady areas particularly in between the rock boulders. The plant Dorstenia Walleri (Moraceae), (Fig. 7), was interestingly found in one of the damp places among rocks during the rains too.

The rock pools and puddles were filled up during the rains with fairly green coloured water. This signified the presence of a particular green algae. The green algae Closterium sp., Cosmarium sp., Oedogonium sp.,



Borreria octodon



Dorstenia walleri

Fig. 7 Borreria octodon Dorstenia walleri

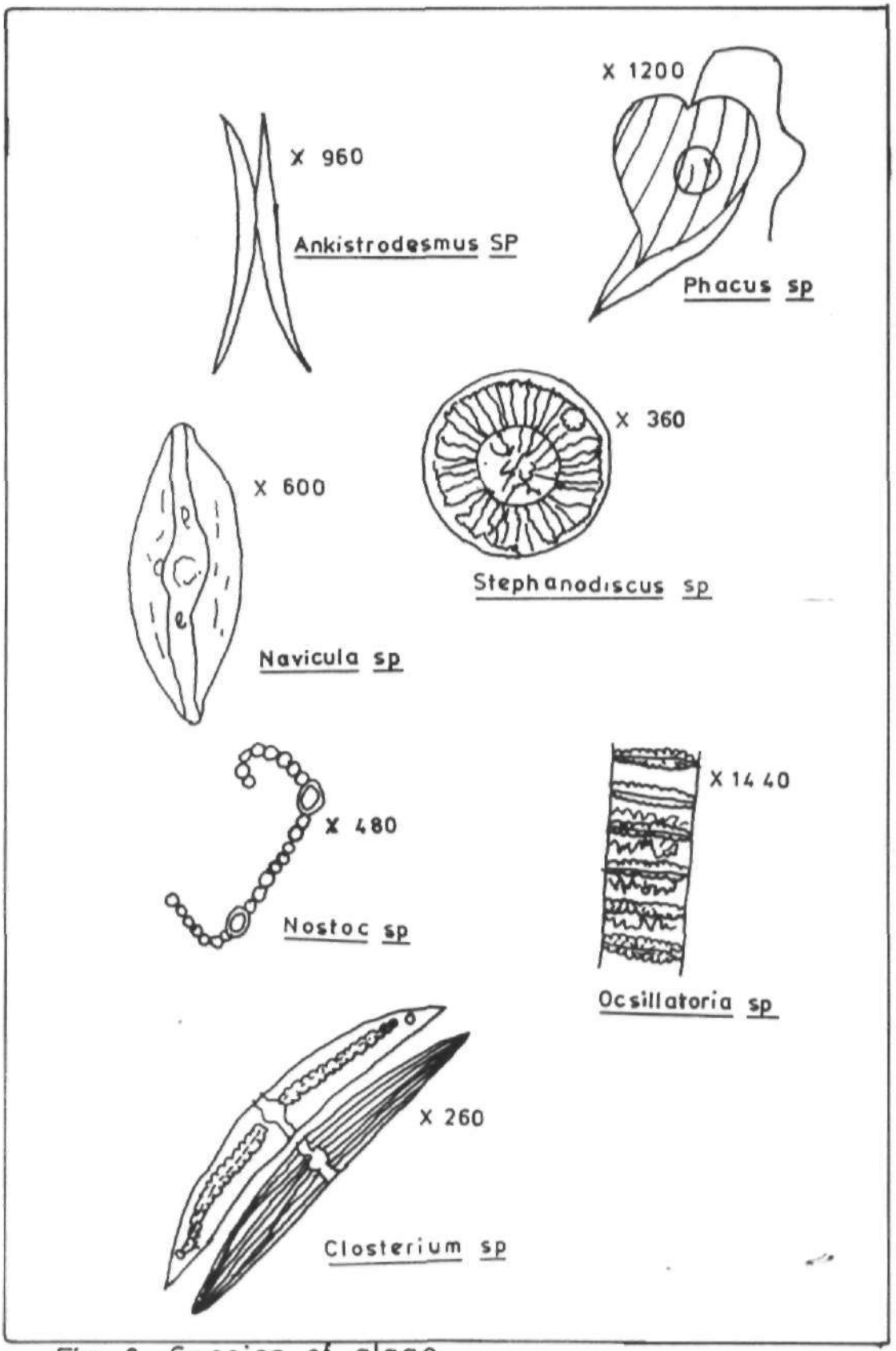


Fig. 8 Species of algae

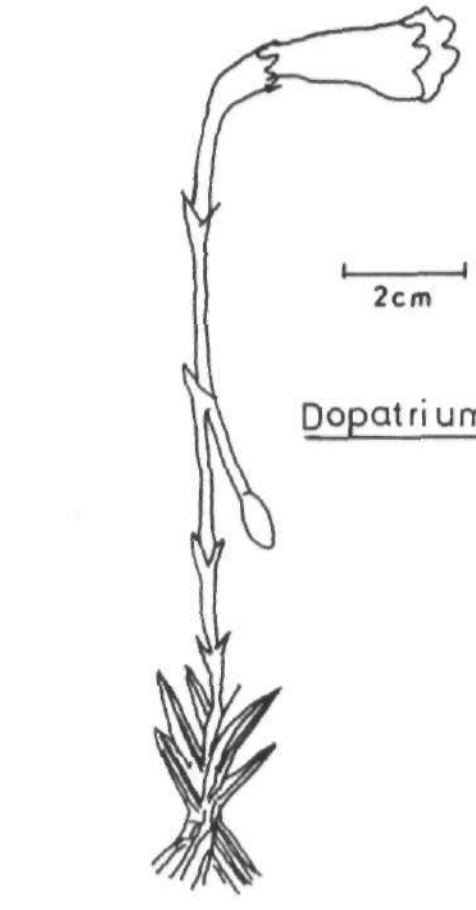
and the blue green algae Nostoc sp., and Oscillatoria sp., (Fig. 8) were found in these puddles and pools especially in study areas 1 and 14, (Table 3). Lilies like Scilla sudanica, ginger lilies like Kaempferia nigerica (Fig.8) and sedges mostly of the genus Cyperus, and Afrotrilepis pilosa became pronounced. They produced new leaves and some, new leaves and inflorescences. A lot of the trees and shrubs were producing new leaves.

It was, however, observed that during the rains, the grasses and herbs in some sections of study areas 4 and 5 were slow to sprout and grow. This was because of the padding nature of the soil there coupled with the consistent grazing by cows, sheep and goats.

Of interest here is that during the rains with continuous plant growth, and development of the vegetation, grazing activities shifted back to the lower slopes of the inselberg. This was because palatable forage became abundant on these slopes and accessibility to the higher slopes became more difficult.

GENERAL OBSERVATIONS

It is pertinent to mention that angiosperms were more frequent than the pteridophytes, and the thallophytes. Dicotyledonous plants, especially the trees and shrubs appeared more frequently than the monocotyledons. In some parts, grasses appear more abundant. From a distance, during the wet season, Kufena inselberg presents the appearance of a forest. For example, the insects Mylabris trifasciata (Meloidae) were observed devouring the flowers of Crotolaria sp. Though these herbs are known



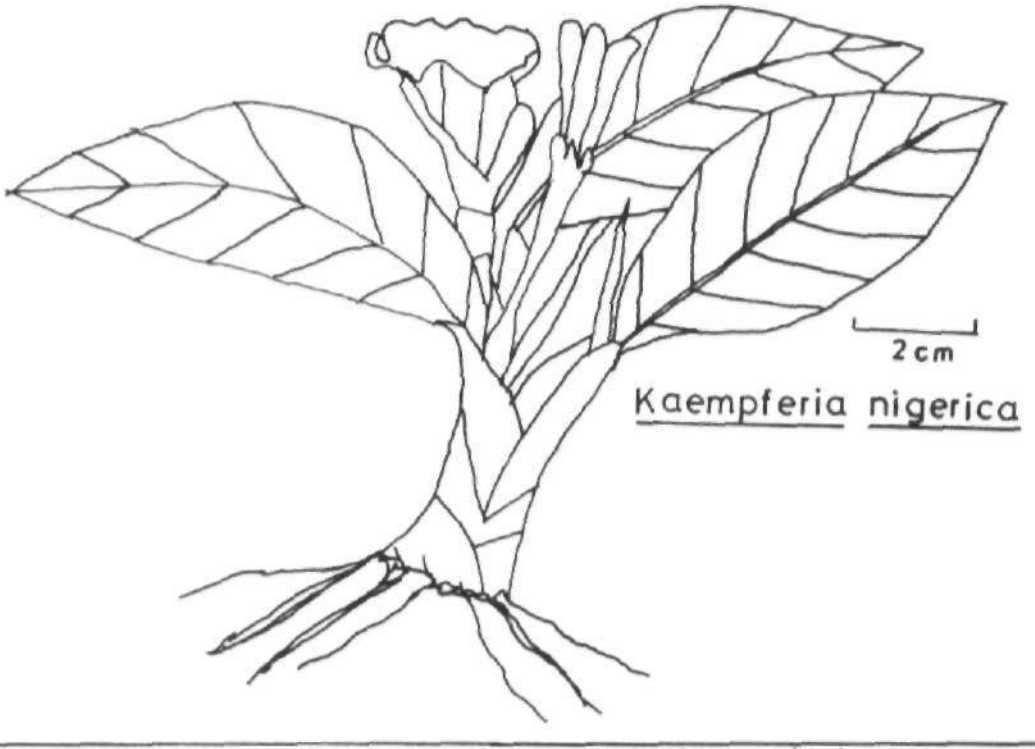


Fig. 9 Dopatrium longidens and Kaempferia nigerica

to produce a lot of fruits and seed, the continuous activities of these insects will with time tend to reduce their abundance to the advantage of the shrubs and trees. Though this was not assessed.

Pteridophytes (like Adiontum philipense and Selaginella tenerrima); bryophytes (like Riccia sp. and Marchantia sp.) and thallophytes were found only in the damp shady areas and wet flushes in the wet season. Sometimes algae were found in the pools and puddles. On the other hand, the angiosperms were found in a greater range of situations on the inselberg not just in the wet places. While some like Drosera indica, Xyris straminea and Utricularia sp. were found in damp places and wet flushes, Dopatrium longigens and Cyperus digitatus were found in rock pools and puddles. The plant Piliostigma thonningii, (Fig. 6) was found in both the dry and moist areas.

Thorn scrub vegetation and shrub thickets were prevalent in study areas 4, 5, 6, 7, 8, and 10. Acacia sp. and Dichrostachys glomerata were abundant in these areas most especially at the foot of the inselberg. The agricultural activities were limited in these areas.

Furthermore, as a result of the increasing demand for food, more areas of the lower parts of the inselberg are being cleared for farming. This was observed particularly in study ares 4, 5, and 6. Quarrying

activities especially on study area 14 are also on the increase to meet the demand for the construction of houses and other related projects for man's welfare.

All the agricultural and quarrying activities coupled with livestock grazing and the effects of fire put stress on the natural vegetation of Kufena inselberg. The existense of rare species such as Dorstenia walleri and Marchantia sp. which have not been frequently found in the Zaria area is threatened.

VEGETATION ANALYSIS

It is noteworthy to emphasize that the term abundance is often an indication of frequency, but the concept is broader than that of frequency alone. Abundance figures were used to bring out the considerable variations in the different study areas.

The difficulty with this method was how to deal with seasonal influence. For instance most of the plants were obvious in the rainy season but much less so in the dry season. This explained the abundance of the cryptogamic plants, the Graminae, Cyperaceae, Compositae and Papilionaceae plant families in the rainy season. While these plants were vartually absent from the record in the dry season.

Seasonal influences and variations were also observed between study areas. Some plant species such

as Bysocarpus coccineus, Carissa edulis and Guiera senegalensis showed obvious differences in frequency in the various study areas. Cassia rotundifolia was found to be rare in study areas 3, 6 and 7 but better represented in areas 4 and 5 (Table 3).

The writer is of the view that for a comprehensive analytical picture of any vegetation, there is the need to collect and analyse the relevant data over a greater time span of years.

FLOWERING AND FRUITING

Observations made on the periods of flowering and fruiting should ideally be compiled from data collected over many years. The periods recorded were for a short term project such as in this study.

There are usually dry and wet seasons in the tropics. Depending upon the year, weather and the locality, these seasons may vary. It is interesting to note that some plants both flower and fruit within one season (for example Annona senegalensis that flowers and fruits within the dry season) but others flower in one season and fruit in the other (for example Commiphora africana, Maerua angolensis and Piliostigma thornningii, (Fig.6 &10) all flower in the dry season but do not fruit until the wet season (Table 4).

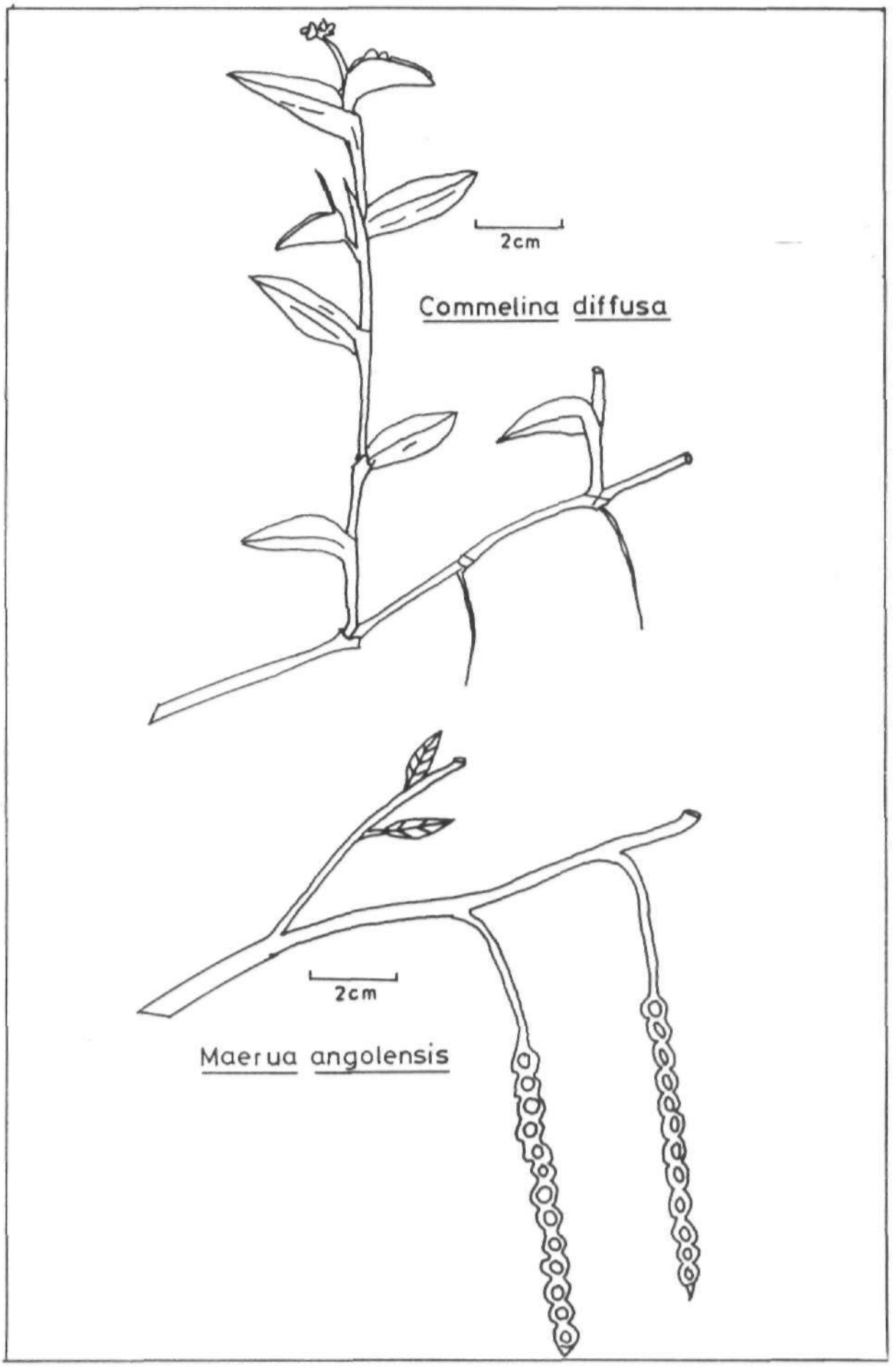


Fig. 10 Commelina diffusa and Maerua angolensis

ESTIMATED MAXIMUM HEIGHT

Most of the trees and shrubs measured had their height range from 1-14 meters. A few of the species like Ceiba pentandra measured above 14 meters. The heights of the climbing shrubs were measured when they were still in their infancy. Their heights depend upon what they climbed and could be more than what was recorded in this study (Table 5).

Having obtained a rought indication of the frequency of the plant species and a fair knowledge of their periods of flowering and fruiting at Kufena, future studies can concentrate on more detailed investigations of their ecology.

APPLICATION OF THE STUDY TO SECONDARY SCHOOL ECOLOGY

Environmental science has such a significant relevance to man that it should be recognised and taught in our schools and colleges. Exposing the students to the basic ecological principles will enable them to demonstrate skills in vegetation description and analysis, and in the utilisation of plants and in land planning. The development and use of such skills will help to unravel the problems of location and life history of the plants for use by man.

In a developing country like Nigeria where emphasis is placed on the exploration and use of locally available resources, the need for the knowledge on the plant environment is paramount. Ecology is one of the few

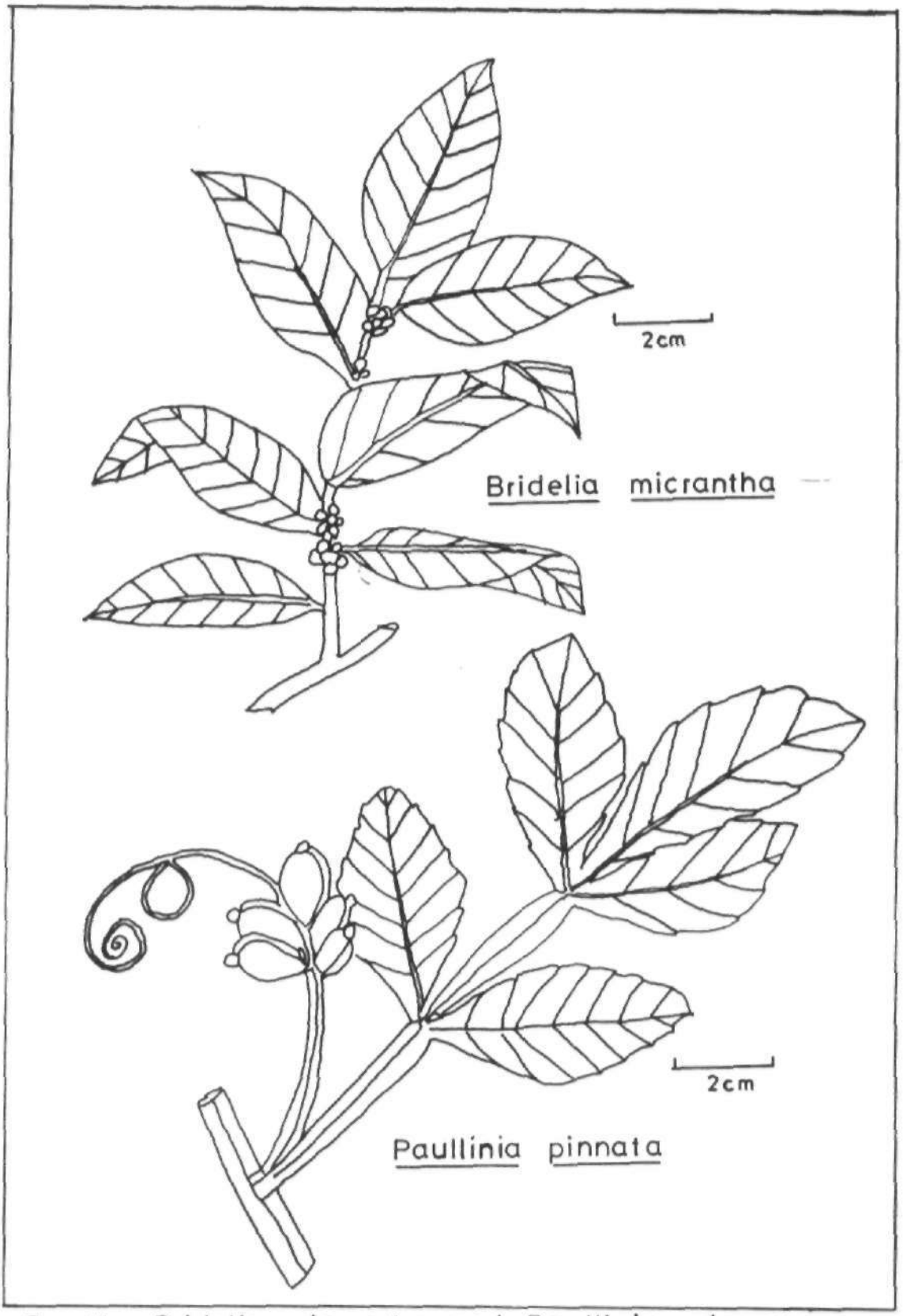


Fig. 11 Bridelia micrantha and Paullinia pinnata

sciences in which even the amateur can make new significant discoveries.

5.2 CONCLUSION

Each environment has its unique ecological characteristics. Specific habitats or localities are pontential ecological information sources to biology teachers in particular and researchers in general.

In spite of the seasonal influences on the method of observation, this study has provided the framework on which to build up a picture of the locality, Kufena. It also helped to show gaps in the knowledge of the locality.

Ecology has today developed so much that it is now difficult to define its limits. In an ecological study such as this, limits and artificial divisions had to be made and a compromise had to be reached to ease adoption by schools.

Although difficulties abound in terms of manpower, facilities and variation in local opportunities, there is the need to make ecology a fundamental school science subject. This will ensure that ecological inputs play their roles in the planning and use of our environmental resources, considering the haphazard exploitative nature of these resources in the past. There is therefore the need for a more detailed vegetation study of Kufena inselberg.

5.3 RECOMMENDATIONS

Ecology should be given a better place in schools and its practical aspects in the field should not be limited to only the familiar and less challenging localities. This is because the results from such myopic studies tended to limit the scope, opportunities and materials for teaching and research.

Results of ecological work should be properly documented and made accessible. This will stimulate further studies on the locality concerned.

Biology teachers should be exposed to and kept abreast with the fundamental principles of ecology and environmental sciences. This can be achieved through in-service training, workshops, seminars and conferences. In addition, the biology teachers involved in ecological work should enjoy for instance, some hazard or field allowance as a form of incentive.

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APPENDIX

258 PLANT SPECIES REPRESENTING 74 FAMILIES RECORDED FROM KUFENA

ALGAE

BACILLARIOPHYCEAE

Navicula sp.

Stephanodiscus sp.

CHLOROPHYCEAE

Ankistrodesmus sp.

CYANOPHYCEAE

Nostoc sp.

Oscillatoria sp.

EUGLENOPHYCEAE

Phacus sp.

OEDOGONIOPHYCEAE

Oedogonium sp.

ZYGNEMAPHYCEAE

Closterium sp.

Cosmarium sp.

FUNGI

AGARICACEAE

Agaricus sp.

COPRINACEAE

Coprinus sp.

HEPATICAE

MARCHANTIACEAE

Marchantia sp.

RICCIACEAE

Riccia sp.

FILICINAE

ADIANTACEAE

Adiantum philippense L.

Aspidotis schimperi (Kunze) Pic. ser. H

Cheilanthes farinosa (Forsk) Kaulf H

Nephrolepis undulata (Afzel. ex. SW) J. Sm. H

Pellaea doniana Hook H

OPHIOGLOSSACEAE

Ophioglossum costatum R.Br. H

Ophioglossum sp. H

SELAGINELLACEAE

Selaginella tenerrima A.Br. ex Kuhn

ANGIOSPERMAE

ALISMATACEAE

Sagittaria guayanensis subsp. lapputa (D.Don) Bogin H

AMPELIDACEAE

Cissus cymosa Schum & Thonn. H

Cissus flavicans (Bak.) Planch.

Cissus grantii (Bak.) Planch

Cissus ibuensis Hook. f.

Cissus quadrangularis L.

H - not seen, but previously recorded (specimen in the department herbarium)

Cissus rubiginosa (Welw. ex.Bak.) Planch H

Cissus rufescens Guill. & Perr. H

ANNONACEAE

Annona senegalensis Pers.

Uvaria chamae P. Beauv.

APOCYNACEAE

Carissa edulis Vahl

Holarrhena floribunda (G.Don.) Dur. & Schinz.

Landolphia owariensis P.Beauv.

Saba florida (Benth.) Bullock H

ARACEAE

Amorphophallus abyssinica (A.Rich.) N.E.Br.

Pistia stratiotes L. H

Stylochiton lancifolius Kotschy & Peyr H

ASCLEPIADACEAE

Calotropis procera (Ait.) Ait.f.

Cerapegia rhynchanta Schltr. H

Pergularia daemia (Forsk.) Chiov.

Pergularia tomentosa L.

Sarcostemma viminale (L) R.Br.

BIGNONIACEAE

Jacaranda mimosifolia D.Don

Stereospermum Kunthianum Cham. H

BOMBACACEAE

Adansonia digitata L.

Bombax costatum Pellegr. & Vuillet

Ceiba pentandra (L.) Gaertn.

BURSERACEAE

Commiphora africana (A. Rich.) Engl.

CAESALPINIACEAE

Cassia absus H

Cassia mimosoides L.

Cassia rotundifolia Pers.

Piliostigma thonningii (Schum.) Milne-Redhead

Swartzia madagascariensis Desv. H

Tamarindus indica L.

CAPPARIDACEAE

Cleome monophylla L.

Gynandropsis gynandra (L.) Brig. H

Maerua angolensis DC.

COMBRETACEAE

Anogeissus leiocarpus (DC) Guill. & Perr.

Guiera senegalensis J.F. Gmel.

COMMELINACEAE

Aneilema lanceolatum Benth.

Aneilemma sp. H

Commelina diffusa Burm. f.

Commelina erecta L. H

Commelina subulata Roth. H

Cyanotis lanata Benth. H

Cyanotis sp.

COMPOSITAE

Acanthospermum hispidum DC.

Aspilia africana (Pers) C.D. Adams

Coreopsis barteri Oliv. & Hiern.

Conyza sp.

Coreopsis setigera Sch. Bip. H

Guizotia scabra (Vis.) Chiov. H

Gutenbergia nigritana (Benth.) Oliv. & Hiern.

Kleinia cliffordiana (Hutch.) C.D. Adams H

Sclerocarpus africanus Jacq. H

Tridax procumbens L.

Vernonia macrocynus O. Hoffn. H

Vernonia pauciflora (Willd.) Less

Vernonia sp.

CONNARACEAE

Byrsocarpus coccineus Schum. & Thonn.

CONVOLVULACEAE

Ipomea asarifolia (Desr.) Roem & Schult H

Ipomea nil Rottb.

Ipomea pea-nigridis L.

Ipomea pyrophila A. Chev. H

CYPERACEAE

Afrotrilepis pilosa (Boeck) J. Raynal

Ascolepsis protea Welw. H

Bulbostylis coleotricha (A. Rich) C.B. Cl. H

Bulbostylis congolensis De Wild H

Bulbostylis filamentosa (Vahl) C.B. Cl. H

Bulbostylis pusilla (A. Rich) C. B. Cl H

Cyperus cuspidatus Kunth

Cyperus difformis L.

Cyperus digitatus Roxb.

Cyperus imbricatus Retz.

Cyperus nudicaulis H

Cyperus rastulatus Vahl.

Cyperus tenuiculmis Boeck

Cyperus tuberosus Rottb.

Fimbristylis debilis Steud.

Fimbristylis ferruginea (L.) Vahl

Fimbristylis hispidula (Vahl) Kunth H

Fuirema stricta H
Fuirema umbellata H
Kyllinga erecta Hooper

Kyllinga nigritana C. B. Cl.

Kyllinga odorata Vahl. H

Lipocarpha albiceps Ridl.

Lipocarpha sphacelata (Vahl) Kunth

Lipocarpha sp.

Pycerus capillifolius (A. Rich.) C. B. Cl H

Pycreus flavescens (L.) Reichenb H

Pycreus lanceolatus (Poir.) C. B. Cl. H

Pycreus macrostachyos (Lam.) J. Raynal. H

Pycreus pauper (A. Rich.) C. B. Cl. H

Pycreus pumilus (L.) Nees H

Scirpus jacabii C. E. C. Fishes H

Scirpus oxyjules Hooper H

DIOSCOREACEAE

Dioscorea abyssinica Hochst. ex. Kunth

Dioscorea quartiniana A. Rich.

DROSERACEAE

Drosera indica L.

EBENACEAE

Diospyros mespiliformis Hotchst.

EUPHORBIACEAE

Antidesma venosum Tul.

Bridelia ferruginea Benth. H

Euphorbia heterophylla L.

Euphorbia hirta L.

Securinega virosa (Roxb. ex Willd.) Baill.

FICOIDACEAE

Trianthema portulacastrum L. H

GENTIANACEAE

Sebaea grandis (E. Mey) Steud. H

GRAMINAE

Acroceros zizanoides (Kunth) Dandy

Aristida adescensions L.

Aristida sp.

Brachiara brizantha (Hochst. ex. A. Rich) Stapf

Brachiara deflexa (Schumach) C. E. Hubbard ex. Robyns H

Brachiara xantholeuca (Hack ex Schniz.) Stapf H

Chloris pilosa Schumach.

Dactyloctenium aegyptium (L.) Beauv.

Echinochloa colona (L.) Link

Eleusine coracana (L.) Gaertn.

Elionurus hirtefolius Hack.

Eragrostis aspera (Jacq) Nees

Eragrostis tremula Hochst. ex. Steud.

Eragrostis turgida (Schumach.) De Wild

Eragrostis sp.

Eucalysta condylotricha (Hochst.ex.Steud.) Stapf

Heteropogon contortus (L.) P.Beauv. ex. Roem & Schult.

Loudetia togoensis (Pilger) C.E. Hubbard

Michrochloa indica (L.f.) P.Beauv

Panicum sp.

Paspalum orbiculare Forst.

Pennisetum pedicellatum Trin.

Phytachne triaristata (Steud.) Stapf

Sacciolepis africana C.E. Hubbard & Snowden

Setaria barbata (L.) Kunth

Setaria pallide-fusca (Schumach.) Stapf & C.E. Hubbard

Sporobolus festivus Hochst.ex.A.Rich.

IRIDACEAE

Gladiolus unguiculatus Bak. H

LABIATAE

Hostundia opposita Vahl. H

Leocus membranaceus J.K. Morton

Leonotis nepetifolia var africana (P.Beauv.) J.K. Morton H

Plastostoma africanum P.Beauv.

LENTIBULARIACEAE

Utricularia pubescens Sm. H

Ultricularia sp.

LILIACEAE

Aloe buettneri A. Berger

Asparagus africana Lam.

Chlorophytum blepharaphyllum Schweinf. ex. Baks H

Chlorophytum laxum R.Br. H

Dipcadi tacazzeanum (Hochst. ex. A. Rich.) Bak H

Drimiopsis barteri Bak. H

Gloriosa simplex L. H

Gloriosa superba L.

Scilla sudanica A. Chev.

Uriginea altissima (L.) Bak.

LORANTHACEAE

Agelanthus brunneus (Engl) van. Tiegh H

Tapinanthus globiferus (A. Rich.) van Tiegh

LYTHRACEAE

Lawsonia inermis L.

Rotala stagnina Hiern.

MALVACEAE

Hibiscus cannabinus L.

Sida acuta Burm.

Sida alba L.

Wissadula amplissima var. rostra (Schum. & Thonn.) R.E. Fries H

MENISPERMACEAE

Cissampelos mucronata A. Rich. H

MIMOSACEAE

Acacia albida Del.

Acacia ataxacantha DC.

Acacia senegal (L.) Willd.

Acacia sieberiana DC.

Dichrostachys glomerata (Forsk.) Chiov.

Parkia clappertoniana Keay

MORACEAE

Dorstenia walleri Hemsl.

Ficus abutilifolia (Miq.) Miq.

Ficus exaseparata Vahl

Ficus glumosa Del. var. glaberrima Martelli H

Ficus glumosa var glomusa Del. H

Ficus iteophylla Miq. H

Ficus lecardii Warb. H

MYRTACEAE

Eucalyptus sp.

NYCTAGINACEAE

Boerhavia coccinea Mill. H

Boerhavia repens L. H

NYMPHAEACEAE

Nymphaea lotus L.

OLACACEAE

Olax subscorpioides Oliv.

ONAGRACEAE

Ludwigia octovalvis L.

ORCHIDACEAE

Eulophia cucullata (SW) Steud. H

Habenaria longirostris Summerhays H

OXALIDACEAE

Biophytum petersianum Klotzsch.

PALMAE

Borrassus aethiopum Mart.

PAPAVERACEAE

Argemone mexicana L. H

PAPILIONACEAE

Abrus precatorius L.

Aeschynomena indica L.

Crotalaria naragutensis Hutch.

Crotalaria retusa L.

Desmodium volutinum (Willd.) DC.

Erythrina sigmoidea Hua H

Indigofera numulariifolia (L.) Livera ex. Alston

Sesbania sesban (L.) Merrill

Teptrosia linearis (Willd.) Pers.

Tephrosia pedicellata Bak.

PERIPLOCACEAE

Tacazea apiculata Oliv.

POLYGONACEAE

Polygonum lanigerum R.Br. H

Polygonum salicifolium Brouss.ex Willd.

PORTULACACEAE

Portulaca oleracea L.

RANUNCULACEAE

Clematis hirsuta Guill. & Perr. H

RHAMNACEAE

Ziziphus mauritiana Lam.

Ziziphus spina-christi (L.) Desf.

RUBIACEAE

Borreria chaetocephala (DC) Hepper

Borreria octodon Hepper

Borreria starchydea Hutch. & Dalz.

Feretia apodanthera Del.

Michrosphyra longistyla (DC) Hiern

Polysphaeria arbuscula K. Schun H

SANTALACEAE

Thesium tenvissimum Hook f. H

SAPINDACEAE

Dodonea viscasa Jasq. H

Eriocoelum kerstingii Gilg.ex. Engl. H

Paullinia pinnata L.

SAPOTACEAE

Butyrospermum paradoxum Hepper

Pachystela brevipes (Bak.) Baill.ex. Engl. H

SCROPHULARIACEAE

Dopatrium longidens Skan.

Rhamphicarpa fistulosa (Hochst) Benth.

Scoparia dulcis L.

Striga asiatica (L.) O.Ktze. H

Striga bilabiata Subsp. rowlandii (Engl.) Hepper H

Striga gesnerioides (Willd) Vatke H

Striga hermontheca (Del.) Benth.

STERCULIACEAE

Waltheria indica L.

TILIACEAE

Corchorus tridens L.

Grewia mollis Juss.

Triumfetta rhomboidea Ja

ULMACEAE

Celtis integrifolia Lam. H

UMBELLIFERAE

Steganotaenia aralicea Hochst.

VERBENACEAE

Clerodendrum aculeatum (L.) Griseb.

Clerodendrum sp.

Lippia chevalieri Moldenka

Gmelina arborea Roxb.

XYRIDACEAE

Xyris straminea Nilss.

ZINGIBERACEAE

Costus spectabilis (Fenzl) K. Schum

Kaempferia nigerica Hutch. ex Hepper

ZYGOPHYLLACEAE

Balanites aegyptiaca (L.) Del.