TRADITIONAL
EARTH COLOURS
AND VEGETABLE DYES
IN KENYA

"TRADITIONAL EARTH COLOURS AND VEGETABLE DYES IN KENYA"

BY

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D E C L A R A T I O N

This Thesis is my original
work and has not been presented for
a degree in any other University.

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TABLE OF CONTENTS

TABLE OF CONTENTS (CONTD.)

TABLE OF CONTENTS (CONTD.)

PAG

PAG

PAG

PAGE

PAG

CHAPTER VI

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ABSTRACT

"Traditional Earth Colours and Vegetable Dyes in Kenya" is a study conducted in two areas referred to in this thesis as 'sub-research areas,' that is: the Lake Basin and the Coastal Region of Kenya.

The hypothesis on which choice of the sub-research areas is based is articulated in terms of the diversity of physical and vegetational milieu characterizing the areas under study.

The chapter organization is initially introductory and deals primarily with general professional design pre-requisites and ushers in the historical background to production of dye from natural sources as experienced abroad. This introductory aspect is considered a requisite springboard from which the Kenyan experience has been appreciated.

The study objectives, scope and assumptions including the justification of the study areas have been clearly outlined.

The historical account of the Kenyan dyeing techniques has been elucidated in terms of Lorna Hindmarsh's experiments including experiences of local women's organizations.

The model for methodology is clear and simple. It entails Reconnaissance Survey of the sub-research

areas, collection of materials and identification of the study specimens collected. The collection and identification of the specimens involve multi-disciplinary needs. In this connection, the Department of Botany has been useful in helping with the botanical identification and listing of flora specimens, the Department of Geology with the identification of soil specimens and the Department of Chemistry with the screening of the specimens including the laboratory tests with dye-producing parts of plants.

Two textile materials, wool and cotton and their physical characteristics have been studied in detail and wool specifically used at this stage of research for dyeing experiments considering its easier administration and its instant receptivity of dye.

Mordanting processes and mordants and their value in dyeing techniques are included as essential pre-requisisites to application tests on textile material.

Experiments and discussion of results have been done and conclusions upon which recommendations have been drawn are recorded to seal this first phase of the research.

Drawings and plates have been done in outline and colour respectively. A painstaking attempt has been made to record as nearly similar as possible the outline structure of the plant specimens as well as the local colour of the hues of dyes absorbed by wool.

The appreciation of this study in terms of difficulties encountered, shortcomings, potentialities and possibilities has been presented in the form of conclusions and recommendations.

Conclusions drawn from these findings confirm the potential, in Kenya, of dyes and earth colours from local plant and earth sources respectively. The research has revealed the value of various Kenyan plants species in the production of natural vegetable dyes which give a wide array of beautiful colours. It has also underscored the threat of extinction of certain rare plant dye sources vastly imminent with the indiscriminate clearing of large tracts of natural vegetation cover in the quest either for extended human habitation or charcoal burning. Another threat equally manifest is that of the wisdom, knowledge and traditional lore of some of the oldest Kenyans disappearing without trace in the absence of sustained documentation efforts.

It has been recommended in view of the foregoing facts that all plants with potential dye-pigments should not be left untapped and that the rare dye-producing plants are overdue to be declared endangered species. It has also been noted, in the general interest of environmental protection, that leaves, rather than bark or roots of dye-producing plants should be reaped inorder to avoid affecting plant life. Research on the possibility that plants that have been used for medicinal, paper-making, fuel, ornamental, cash and food purposes can be screened for dye-stuffs has been strongly suggested. The dual advantage would thus exist in the simultaneous exploitation of the plants' consumer potential. The farmers' enemies, in the form of useless weeds like Bidens pilosa 'Black jack' and Tagetes minuta 'Mexican marigold' have been found to be good dye-producers and could be utilized more profitably than has hitherto been the practice.

The foregoing conclusions and recommendations point towards the second phase of the research which proposes the urgent need for further research based on current findings. It is my strong view, therefore, that this next phase, which is certainly beyond the scope of this thesis, takes over and develops a statistical critique and data base on which a locally established scientific and technological approach could be a possible solution to the strain on the foreign exchange earnings through continued importation of dye-stuffs into Kenya.

CHAPTER I

BACKGROUND

INTRODUCTION

The Department of Design at the University of Nairobi provides courses which, among others, includes Materials. The students of Design are exposed to exploring, handling and understanding the materials with which they work in their creative activities. They are also disposed to learning about these materials in terms of their origins, formations, processes, application techniques, physical characteristics and their limitations. For instance, the physical characteristics of wood, its grain, strength, durability for a specific job; the surface characteristics of paper and its quality in terms of grade, weight, texture, gloss, making it suitable for drawing, printing and painting in water colour, oil, gouache, spray or wash; the physical characteristics and properties of high quality paint making a whole difference in a selection range; the physical characteristics and properties of textile materials suggesting suitability for painting, printing, dyeing and weaving and the physical characteristics and properties of dyes, dyeing techniques, processes and preservation of dyes and dyed materials all embodying a desirable facet of a designer's course.

A well-equipped designer is expected by both employer and client to have accomplished sufficient mastery of skills required in handling his materials and knowledge and proficiency so gained going hand in glove. Paper has two sides to it: the textured and the smooth side. To a designer, this is not just the usual general fact; it is knowledge of intrinsic value. This knowledge is as crucial as the awareness of which of the two sides takes the pen, pencil, or brush better than the other.

In using this knowledge and the appropriate tools, a designer's proficiency appears effortless yet it is an extremely essential ingredient of a complex body of knowladge which a painstaking design course eventually provides. Sometimes students of design raise complaints to the effect that a large part of Materials Course in Design tends to over-emphasize the technical jargon and academic bias only relevant to Geology as a discipline. This may be true perhaps either because of the handling of the subject as a service course or the personal approach to it from the ever-changing service lecturers from the discipline. External examiners' reports have also invariably pointed out that the bias is unnecessary and unfair to students who do not pursue academic and practical studies in Geology. This concern has consequently posed the question of content relevance and raised the need for appropriate departmental research programme suitable for a Materials Course in Design. It is in this light that this study, together with others before and after it, strives to partially provide the basis towards eventual departmental solution. Being a largely new area of study it has been considered necessary to research and document useful background information on dyeing processes existing before World War I. This backdrop, it is hoped, should shed light onto dyeing practices obtaining both before and after this period in the continent of Africa in general. The quest for similar practices and the availability of dye-producing flora in Kenya is, in particular, a prime object of this research.

HISTORICAL ACCOUNT ABROAD

Dyeing was carried out by all the early Mediterranean civilizations. Of these, the Egyptians were probably more skillful than the Babylonians. Much more is certainly known about Egyptian civilization except the real knowledge of the methods actually in use. It is possible that the third great Mediterranean civilization, the Minoans of Crete, surpassed both the Egyptians and the Babylonians. An examination of what is left of the frescoes and other coloured remains of the people of Crete gives the impression that they delighted in colours in quite a different way than the Egyptians or the Babylonians. Unfortunately, even less is known about their dyeing methods than is known of those of the other two early civilizations.

It is impossible to say which were the favoured dyes of the Egyptians. As far as historical information goes they seem to have been particularly fond of safflower which grew abundantly in the Nile Valley and it was possible to obtain both a red and a yellow dye from it.[1] Neither shade was particularly fast, certainly not as good as indigo, woad, madder and kermes, all of which were known to Egyptian dyers. Indigo was known in Egypt as early as the 22nd. Dynasty but it had to be brought from abroad and never became widely used. Woad, which was grown locally, was naturally used in its place for it yielded the same colour. For reds the Egyptians had both madder and kermes, so they were all equipped. It should be remembered, however, that the most common fibre was flax, which is notoriously difficult to dye and is really more attractive in its white, that is, bleached form.

The Egyptian dyers, when they first come into historical view, have already advanced a long way towards acquiring a good knowledge of dyeing methods. Dyes which can be divided into three groups are the first being those soluble in water and which could be transferred to the material without any major problems; the second those that were soluble in water but could only be satisfactorily transferred to material that had been treated, that is, mordanted with chemical.

Finally, the third group included the dyes that were not soluble in water and had to undergo some treatment before dyeing could begin.

Very few dyes of the first group known to the Egyptians gave colours with any permanence and most of the important dyes came in the second group. Here they had madder and kermes and almost all the great dyes known except, of course, woad, indigo and purple which were insoluble in water, and came in the third group. With the dyes of the second group a mordant was needed, in many cases to get any colour at all, and in all cases to get the most permanent results. The Egyptian success in applying mordant dyes satisfactorily shows the technical skill possessed by the dyers.

A renowned Roman writer Pliny, remarked of the Egyptian practice of mordanting: "They employ a very remarkable process for the colouring of tissues. After pressing the material, which is white at first, they saturate it, not with colour but with mordants calculated to absorb the colour. This done, tissues still unchanged in appearance are plunged into a cauldron of boiling dye and removed fully coloured."

Contrary to this attainment of high standard for Egyptian dyeing is an interesting episode of backwardness in English dyers. The Classic statement of the backwardness of English dyers in early modern times is contained in Richard Hackluyt's instructions to

Morgan Hubblethorpe, dyer, who was sent to Persia by the City of London in 1579 to gather information about dyeing methods. He was given very precise and careful instructions:

> "You must use means to learn all the orders of the dyeing, which are so dyed that neither rain, wine nor yet vinegar can stain. If any dyers of China, or of the East part of the World be found in Persia, acquaint yourself with them and learn what you may. In some little pot in your lodgings I wish you to make daily trials in your art, as you shall from time to time learn aught amongst them. Set down in writing whatsoever you shall learn from day to day, lest you should forget, or lest God should call you to him, and by each return I wish you to send in writing whatsoever you have learnt, or at least keep the same safe in your coffer, that come death or life your country may enjoy the thing that you go for and not lose the charge and travel bestowed in this case."[2]

Anyone at that time travelling in Persia and taking such voluminous notes and then experimenting with a pot in his room was very likely to come to an unfortunate end.

Another part of these instructions contained:

> "Forasmuch as it is reported that the woollen cloth dyed in Turkey be most excellently dyed you shall send home into this realm certain pieces to be shown partly to remove out of their (that is the dyers') heads the too great opinion that they have conceived of their own cunning and partly to move them for shame to learn more knowledge to the honour of their country England and to the universal benefit of the realm."

This early example of industrial espionage is interesting both for general economic history and for the history of dyeing. Everything is there; the dyer today will delight in the little pot in the house at night where the information learnt during the day is to be tested.[3]

Whether as a result of these efforts or not, English dyeing certainly improved during the seventeenth century and by the eighteenth it was the equal of any in Europe. Many pattern books remain from this period and consequently the high level of craftsmanship can be appreciated. All dyes were of natural origin and tests made on a pattern book of a West of England firm of around 1779 show the following colours as being used: blue and navy were dyed with indigo, red with madder on an alum mordant. Light brown was dyed with a natural product, probably fustic, with an iron mordant. The dark maroon appeared to be coloured with one of the insoluble redwoods, possibly barwood with the addition of one of the soluble redwood, such as peachwood, and the mordant appeared to consist of iron, probably with a trace of copper.

When the use of imported dyes had become general in Great Britain, owing chiefly to French and Flemish influences, the native dyes were gradually given up in favour of the new foreign dyes. The exception to this rule was the important class of lichens and mosses. Lichens have always been extensively used and still are to some extent, by northern peasantry. In an interesting little book called 'SCOTTISH CLANS AND THEIR TARTANS' many of the colours listed in the different Highland tartans were obtained from lichens: brown, crimson, dark crimson, purple, two kinds of red, scarlet and yellow. In Norway, Sweden, Iceland, the Shetlands, Orkney, Skye and Western Ireland, Lichens are still used for dyeing woollens. Harris, Donegall and Shetland tweeds owe their characteristic smell to the boiling lichen. There are between forty and fifty kinds of lichen which give a dye. The lichens are substantive dyes, that is, they need no mordant, though it is that a little acetic acid brings out the colour. Lichens growing on stones give, on the whole, a better colour than the same lichens growing on trees.

Two dyeing methods have been described:[4]

A:

The lichen is put into a large pot which is filled up to the top with cold water. About 1 lb. lichen to 1 lb. wool is required. This is brought up to the boil very slowly, allowed to simmer for two or three hours before being allowed to get cold. Next day, the wool, which is thoroughly wetted first is put into the pot and boiled all up together until the required depth of colour is obtained. The wool is not taken out until it is cold. It is then washed. The loose lichen shakes off the wool quite easily.

B:

A layer of lichen is placed at the bottom of the pot, then a layer of wool, another layer of lichen, and so on until the pot is nearly full. The pot is filled up with cold water and put on the fire to simmer for some hours, till the required depth of colour is reached. It could be taken off at night and then put on again next day. The colour is very fast. The wool is then washed well and allowed to dry.

INDIGO AND OTHER DYES

Wool and cotton yarn, raphia and, in Madagascar, (See Fig. 1.0) bast fibres are frequently dyed before they are woven: and by far the most extensively used dye in Traditional Africa is indigo. It is obtained from several plants of the genus _Indigofera_, which are both wild and cultivated, and from _Lonchocarpus cyanescens_, the indigo vine or Yoruba wild indigo which is regarded by Yoruba dyers as giving the more permanent dye. All these plants contain indican, a sugar and indigo compound, fermentation of which releases indoxyl and this, on exposure to air, becomes a mixture of indigo red and indigo blue. The first colour is obtained by slow oxidation in an acid medium, the second by rapid oxidation in an alkaline medium.

The dye indigo is prepared in two parts:

A:

Breaking up the plant structure to facilitate the fermentation process.

B:

Preparation of the alkaline medium, which, in addition to encouraging the release of the indigo-blue, also acts as a mordant serving to fix the dye colour in the yarn or cloth, as the case may be.

In Nigeria, (See Fig. 1.O) the Yoruba Method of preparing indigo dye is described as follows:

> "Fresh green leaves of whichever indigo plant is available are pounded in a mortar and the pulp moulded into balls. These are allowed to dry in the sun for two or three days during which time fermentation begins. Preparation for potash for the alkaline medium is more complicated. The basic apparatus is a kiln built of mud about four feet high and four feet wide. (See Diagram 1.O)

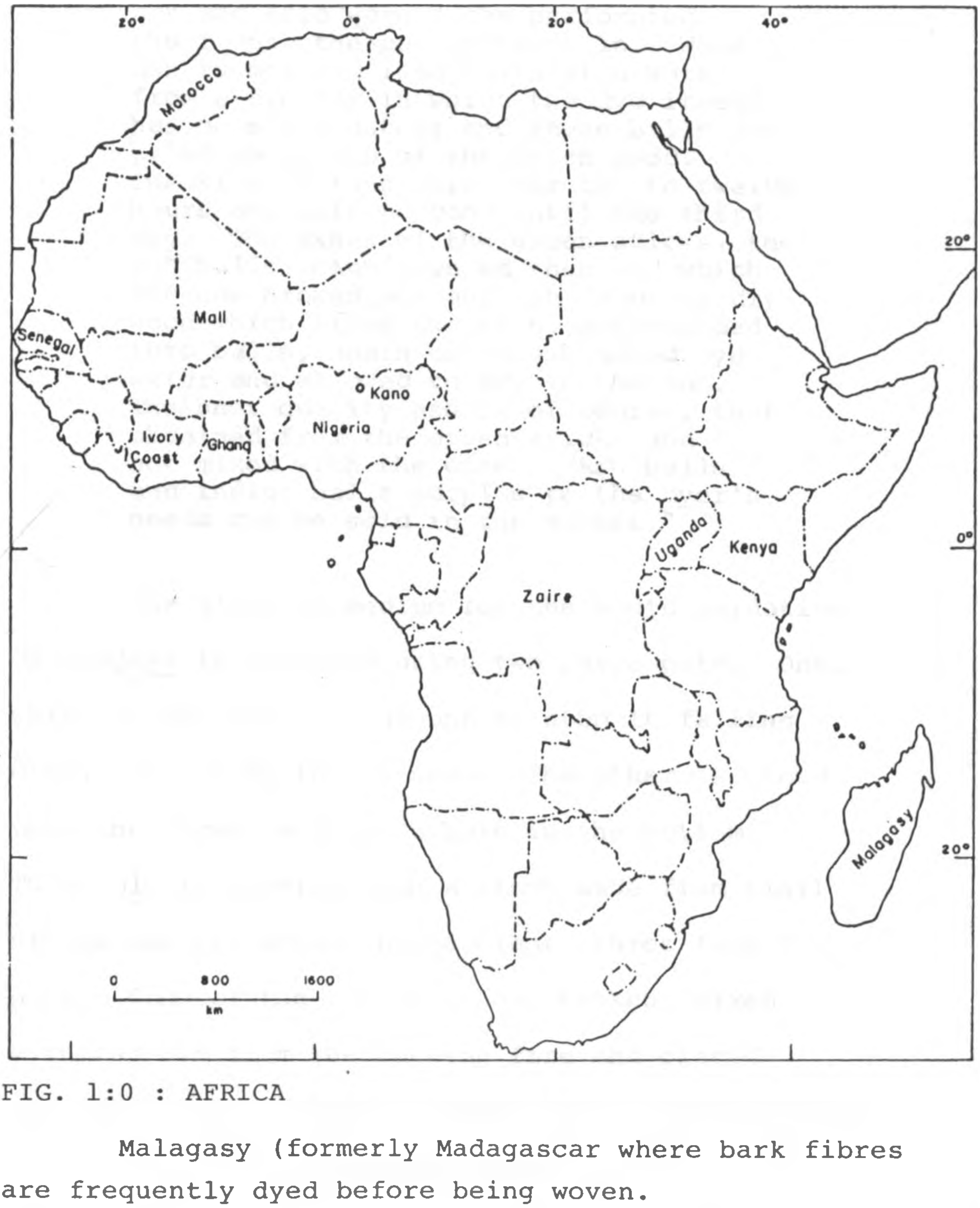
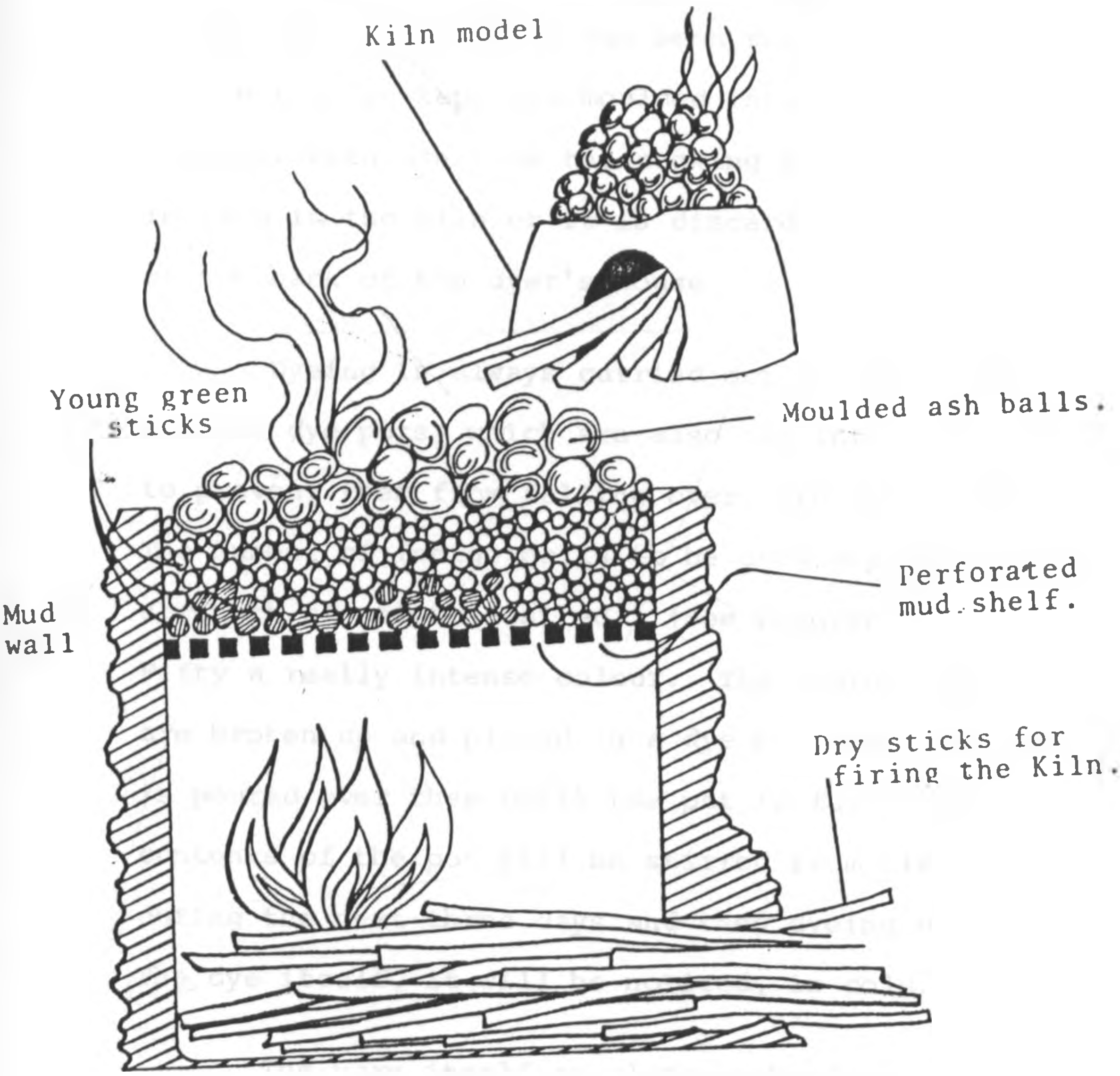


FIG. 1:0 : AFRICA

Malagasy (formerly Madagascar where bark fibres are frequently dyed before being woven.

> The top of the kiln is open and about a foot below the top, across the inside, is a perforated mud shelf. At ground level there is a hole in the side through which the kiln is fired. Dry Wood is collected for the firing. Short lengths of very green wood are cut and laid across the perforated shelf upto the top of the kiln. Wood ash is moulded into balls with water from a dye pot in which the dye itself has been exhausted; and these balls are piled up on top of the green wood. The kiln is then fired for ten to twelve hours and left to cool until the third day. The ashes of the green sticks, the ash balls which covered them and which are now broken up, and ash from the dry wood which fired the kiln, are moulded into balls, again using exhausted dye water and allowed to dry in the sun. The best quality ash is of course, that obtained from the green sticks and not mixed with the other. Ash balls and indigo balls surplus to the dyer's needs can be sold in the market."

The alkaline medium for the rapid oxidation of indoxyl is prepared using two large pots. One, which is dug into the ground to stop it falling over, has a hole in its side. The other is stood upon the first, and has a hole in the bottom. This hole is covered with a sieve made from small sticks and discarded indigo plant fibres from dye pots. Some of the ash balls are broken, mixed with the ash from the cooking fire and placed upon the sieve. Water is added which drips through to the pot below taking the potash with it. As the water filters through it is scooped out via the hole in the side and transferred to a dye pot.



The Yoruba Kiln in profile.

Diagram 1.0

When it has all filtered through the ash is removed and replaced, and filtering begins again. This procedure continues until enough ash water is obtained. Ash which has been used in this way will either be kept and moulded into balls together with ash from the cooking fire, to be refired in the kiln or it is discarded in a heap at the back of the dyer's house.

Dyeing is always carried out in the shade and the dye-pots, which are also dug into the earth to prevent them from falling over, are kept covered. The number of indigo balls to be used depends on the strength of colour desired. (See Diagram 1.1). Fifty a really intense colour. The indigo balls are broken up and placed in a dye pot, and ash water is poured over them until the pot is full. The contents of the pot will be stirred from time to time during the next three days and then dyeing commences. The dye itself, it will be noticed, is cold.

The yarn itself or cloth to be dyed is immersed for 2 minutes or so and then lifted out, dripping onto a board which drains back into the dye pot. It will be dipped like this three or four times and then put to dry in the sun. This will be repeated until the desired colour is produced.

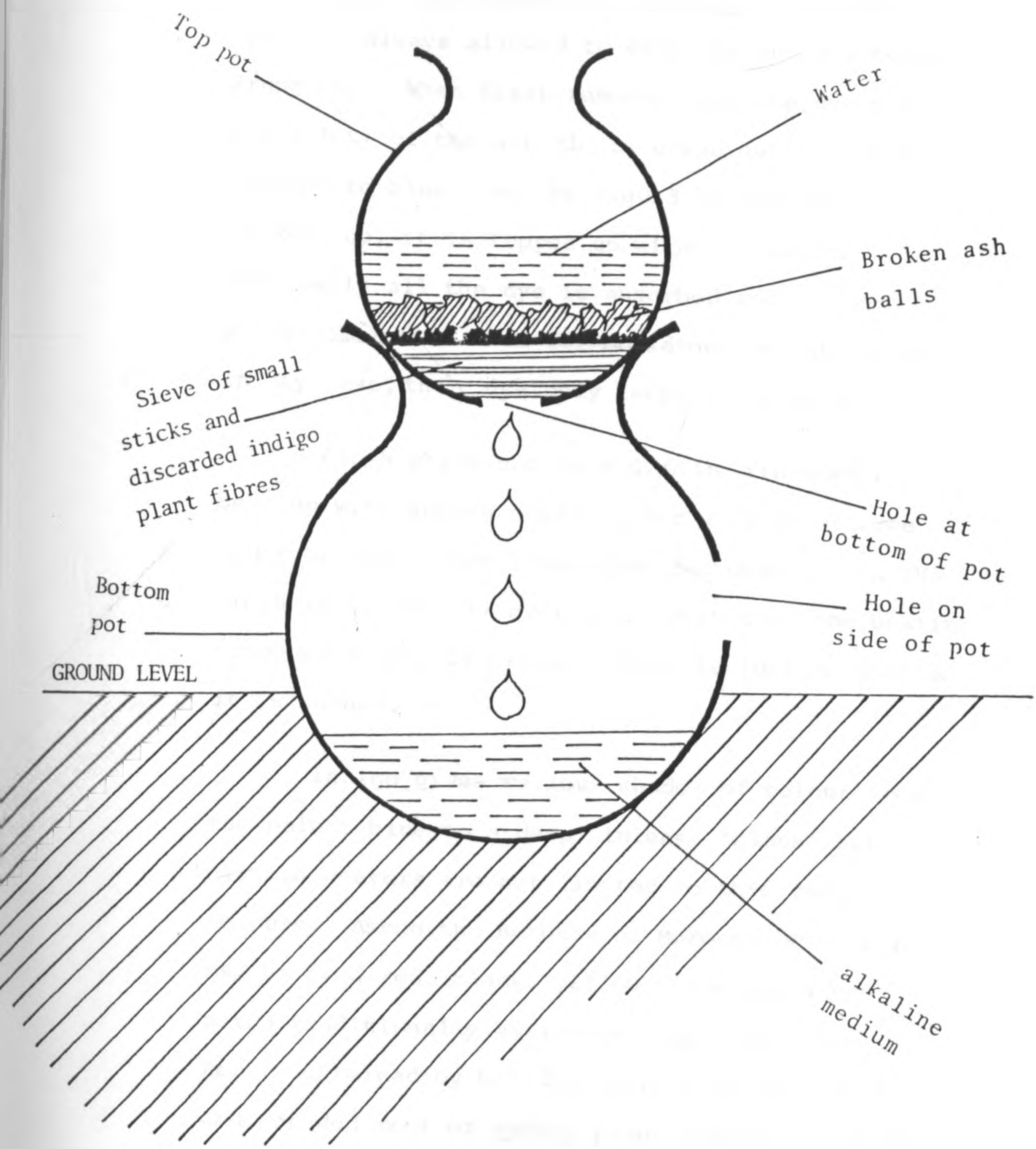


Diagram 1.1: Preparation of alkaline medium for rapid oxidation of indoxyl.

For the best quality of colour, fresh dye will be used for each series of dippings. The objects dyed are always allowed to drip dry and are never wrung out. When first removed from the dye pot the colour of the article is green but this soon deepens to blue. As the liquid in the pot is soaked up, it is topped up with ash water. Eventually all the dye is absorbed and the water which remains is used for moulding the ash balls. In any case, the dye only keeps for 5 days.

Cloth which has been dyed is finished by beating with wooden mallets over a piece of tree trunk or some other rounded wooden object. As the cloth is invariably overloaded with dye, the beating produces a metallic sheen. This is lost as soon as it is washed.

Indigo gives various shades of colour from the palest blue to a deep, intense 'black' but African weavers are not limited to this range of colours. Among the Berbers of Morocco, weft yarn may be dyed red, black, yellow, blue and green, using traditionally available vegetable dyes. Red is obtained by boilding yarn with the dried and pounded root of madder plant together with the juice of a bitter variety of pomegranate, which is the mordant. There are three sources of colour black; naturally black wool; pomegranate skin, or evergreen oak bark, either of which dye the yarn yellow and this is turned black (saddened) with iron sulphate. The root of a plant gives yellow and a second dyeing with indigo gives green.

In West Africa many shades of red, yellow, blue, green, brown and black are available from traditional vegetable and mineral sources. An account has been given of the dyes used by Fulani of the inland Niger delta region of Mali.[6]

> "To dye yarn black it is first boiled with the leaves of two trees, Anogeissus and Combretum which turn it yellow. The yarn is then totally immersed for several days in a pot containing mud, which turns it black. Yellow can be obtained using the first half of the method just described but a more stable colour is produced by boiling the yarn with sheep's dung and a wild mushroom which has been dried and powdered. The best red is obtained by boiling already yellow yarn with the flowers of Hibiscus cannabinus, the hemp-leaved hibiscus (the stem of which yields a bast fibre widely used for cordage)."

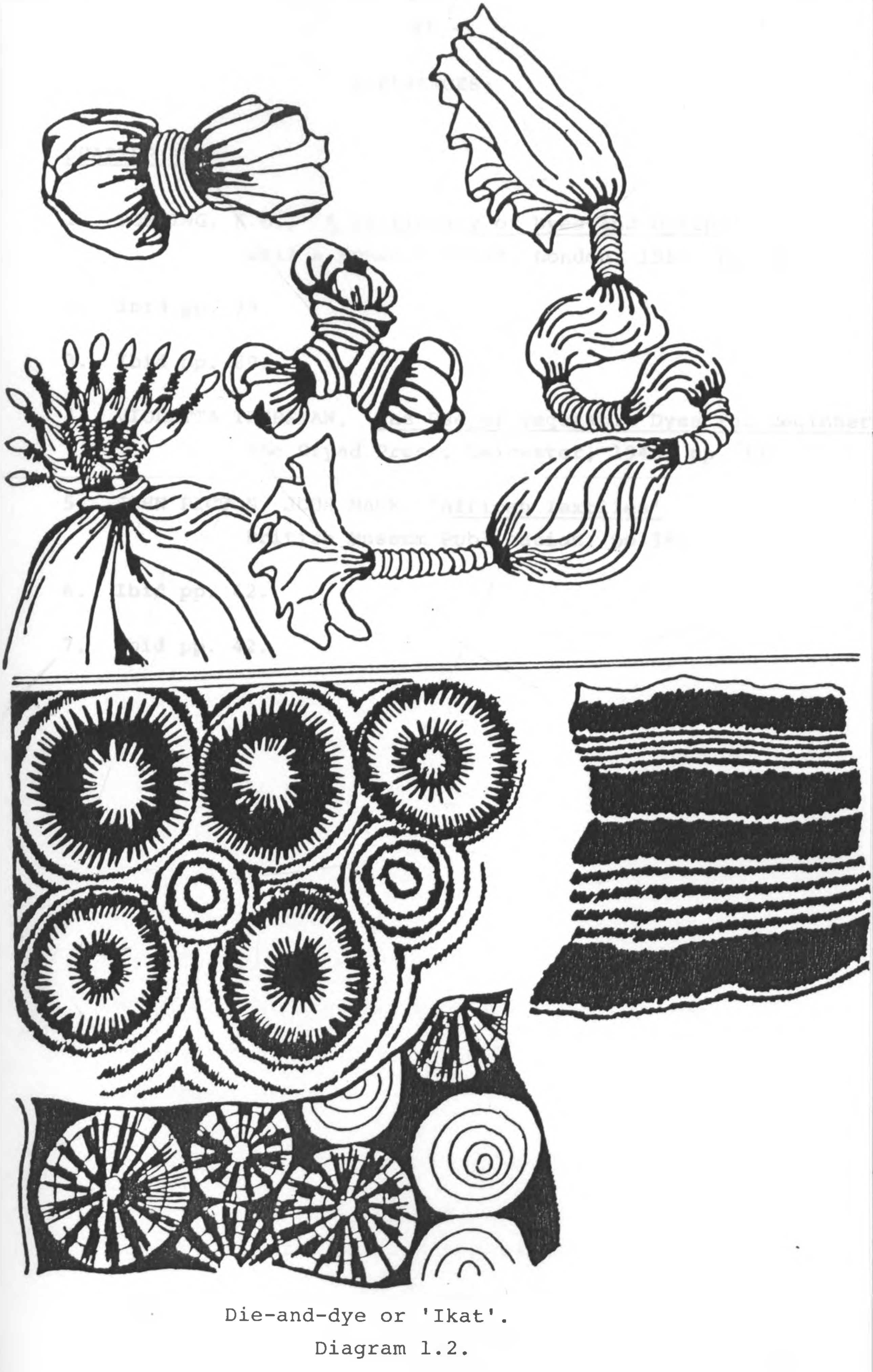
It would be impossible to list all the sources of dyes used in West Africa in addition to indigo. However, the following is a broad selection: turmeric, kola nuts and a yellow flowering plant, Cochlospermum tinctorium, gives different shades of yellow; a species of guinea corn cultivated only for its dye content, Sorghum caudatum, as well as Henna and the camwood trees Baphia and Pterocarpus give reds; Sorghum caudatum if immersed in forest mud gives a black dye; the bark of various trees such as Parkia (the locust bean), Acacia and Anogeissus gives browns, in addition to the naturally brown cotton; and green can be obtained by dyeing yarn yellow first and then with indigo.

The usual colours which the Bakuba of Zaire use in their textiles are red, yellow, black and white.[7] The red is obtained from camwood properly called barwood (Baphia nitida) the true camwood does not occur in the Congo Basin; yellow from brimstone tree (Morinda species); black from mud, charcoal or plant sources and white from kaolin. Various plant species give blues, orange and purple.

In Uganda, the black dye used on some Baganda barkcloth is prepared from swamp mud mixed with various vegetable substances.

The basis of the indigo-dyeing process is constant because of the chemical properties of the various substances involved in it, although there is more than one way, even with Yorubaland, of inducing fermentation and of preparing the alkaline medium (sometimes called a 'lye'). The economic basis also seems to be constant for indigo dyeing and is almost everywhere a specialist activity, unlike dyeing in other colours. The indigo-dyers in a community, certainly in West Africa, are usually women, as among the Yoruba, although in some areas, such as Hausaland, the indigo-dyers are men. The Hausa city of Kano was famous for its dye-pits in the mid-nineteenth century when it was estimated that it had some two thousand of them. (Instead of dye-pots the Hausa dig large pits in the ground and line them with the traditional cement used in building. Elesewhere in West Africa, the people particularly famous for their indigo-dyeing are the Baule of the Ivory Coast and the Soninke or Sarakole of Senegal.

Patterns are usually contrived on fabric or yarn prior to weaving by resist-dyeing methods simply known in Kenya and the entire East African region as "tie-and-dye." In West African countries, the weaving communities like the Hausa, Yoruba and northern Edo peoples of Nigeria as well as the Ewe of Ghana, the technique of resist-dyeing is called "ikat". Several lengths of yarn are tied together at intervals before being immersed in the indigo. Where the yarn is tied the dye is, of course resisted so that lengths of yarn are produced which change colour at intervals. The use of the "ikat" also occurs in Madagascar. (See Diagram 1.2).



Die-and-dye or 'Ikat'.

Diagram 1.2.

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CHAPTER II

RESEARCH

STUDY OBJECTIVES

"Traditional Earth Colours and Vegetable Dyes in Kenya" is a Materials research study leading to a Masters degree research thesis in Design. It is carried out with the objective to investigate on the one hand, the potential in Kenya, of locally available material (parts of plants) as source of vegetable dyes and on the other hand, the different parts of earth colours as source of painting material. The objectives set around this study have arisen from the need to develop a more relevant Materials Course and to partially satisfy the need to boost and diversify the content of coursework in the Department of Design at the University of Nairobi. The boost and diversification of the Materials Course is seen from the point of view of the Textile and or Graphic design student learning more about locally available and locally produced dyeing and painting materials and their application.

The historical backdrop against which this appraisal is set is inevitably crucial to a design student's experience with general reference to findings and practices abroad, in the African continent and in Kenya in particular. The application tests on textile materials and paper raise the need for basic knowledge of features, types and physical characteristics of these materials. The broad aim for general education, active participation and readership is also seen as being satisfied through dissemination of knowledge through symposia, seminars, public lectures and journals in such a way as to contributing positively to general goals for national development through relevant research.

KENYA; LOCATION AND SIZE

The Republic of Kenya is located on the eastern part of the vast continent of Africa. It shares boundaries with its East African neighbours such as the Republic of Uganda to the West, and the United Republic of Tanzania to the South, it is also bordered by the following countries:

1. Ethiopia in the North;
2. The Republic of Sudan in the North-west;
3. The Republic of Somalia in the East.

Kenya is bordered in the South-east by the Indian Ocean, which is an important outlet and means of sea contact. (Fig. 1.1)

Located approximately between latitudes $4.^{o}$ 21' N and 4^{o} 28' S; and between longitudes 34^{o} and 42^{o} E, Kenya is almost bisected by the Equator and by longitude 38^{o} E. (Fig. 1.2).

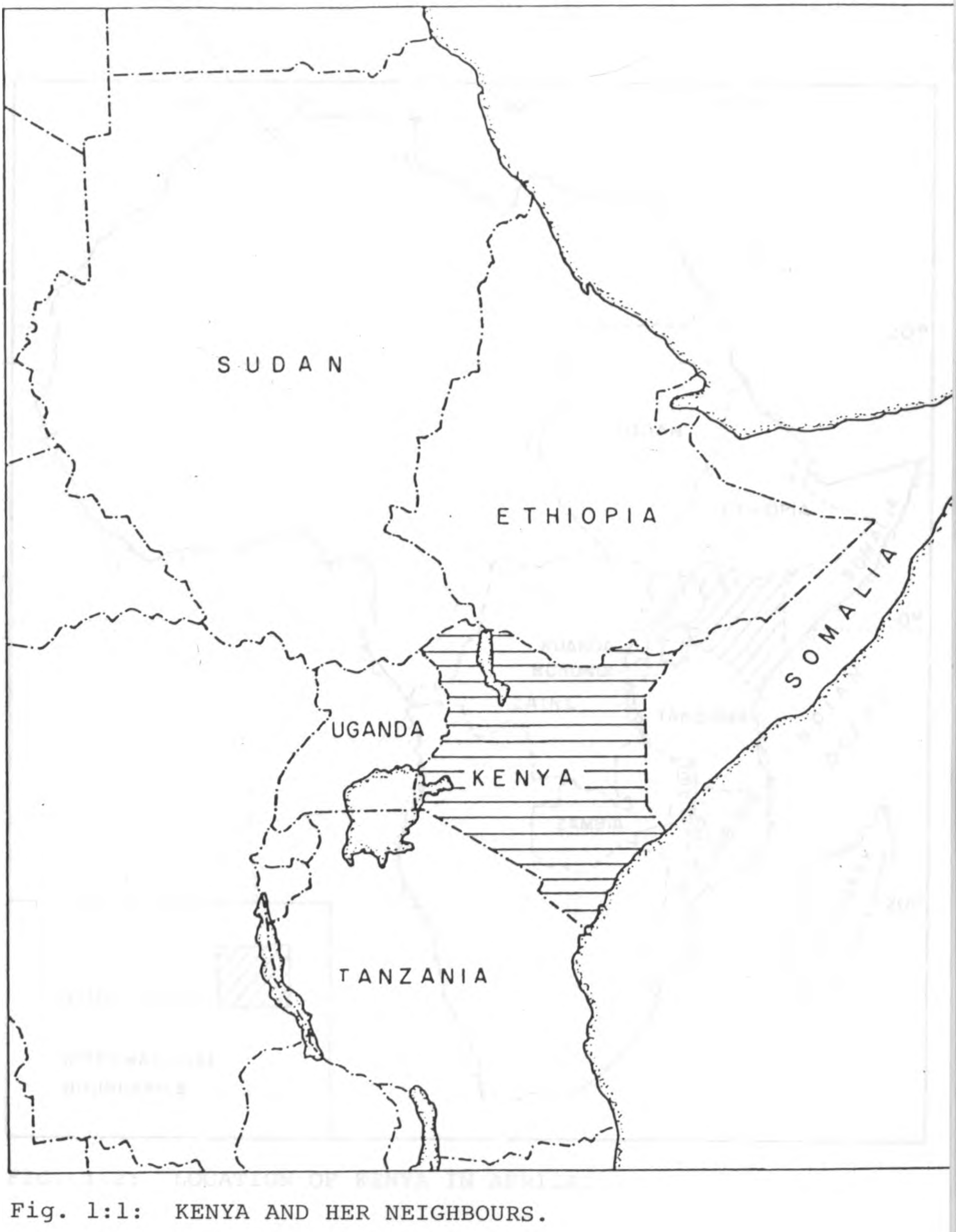

Fig. 1:1: KENYA AND HER NEIGHBOURS.

FIG. 1.2: LOCATION OF KENYA IN AFRICA.

She has an area of 224,960 sq.miles (582646.4 km^2). Of this, water occupies about 2.3% (5171 sq.miles : 13392 km^2) of the area of the country, thus leaving 219789 sq. miles (569253.5 km^2) of dry land, of which about two-thirds is either semi-desert or desert. Thus between only 54947.3 and 73189.7 sq. miles (or 14231.5 to 1899561.3 km^2) of Kenya is arable. The greater part of the suitable area is in the wetter south-western part of the country, but there is also a narrow strip along the Indian Ocean in the south-east which is habitable to a variable extent.

SCOPE AND ASSUMPTION

Kenya is a big and diverse land mass in terms of physical features and climatic factors. These characteristics, including geological structure and altitudinal diffential make Kenya a country of notable variables worth considering, especially as one sets out to study her flora as potential source of dye and her soils in terms of earth colours. The variables thus necessitated the research being undertaken in two areas, the whole of Kenya being too wide for this study. However, the Lake Basin and the Coastal region of Kenya are characteristically distinct from each other and the contrast in physical features and climatic factors so diverse as was thought to augur well for a representative study sampling for the whole country. The assumption was that the research findings in Kenya would eventually reveal that every kind of plant from which a dye is obtained is a product of geographical environment and that the quality of dye depends on climate, soil, water, aspect and other conditions.[8]

The interdisciplinary implication for this study was also obvious. The physical characteristics of the dye-producing flora being basically botanical, the documentation process was possible only after positive identification of the specimen, hence the need for guidance from an authority in this field, the botanist. There was a similar need for a geologist in the identification process of locally available earth colours as well as the need for a chemist and designer (textile/graphic) both at the level of chemical extraction of and application tests of dye and paint on textile material and paper respectively. Another implication of scope was based on the academic need for the Thesis. The Thesis was set to cover upto and including the laboratory experiments and studio application tests of vegetable dyes on selected textile material(s).

JUSTIFICATION OF THE STUDY AREAS

Initially, this study strove to investigate the potential of locally available natural material (parts of plants) as source of vegetable dyes and the different types of earth colour which are traditionally used as painting or decorating material by the indigenous peoples of Kenya. In retrospect, however, the national investigation approach was considered too wide in scope for this study and a reconsideration to specialize in only two smaller areas was made with an aim to studying the earth colours and vegetable dye-potential in greater detail. Moreover, the possibility of floral and earth colour specimens under study recurring here and there all over the country did suggest the unnecessary energy, time and funds being spent for no important reason other than perhaps for mere speculation and adventure. Accordingly therefore, areas situated at extreme ends of the country, that is, the Lake Basin and Coastal Region of Kenya were duly identified for preliminary research.

> "The greater part of Kenya is unsuitable for agricultural activities, those aspects of this study which are associated with activities based on natural or imported resources are mainly to the more habitable south-western and coastal belts of Kenya."[9] "Both altitude and aspect of the land, to a large extent induce the climatic differences which appear so marked in Kenya."[10]

It was thus considered that the diverse contrast in physical features including geological structure, altitude and different climatic conditions prevailing in these areas augured well for a representative sampling of a large part of the country in terms of flora and earth colours. It was also strongly felt that the justification to sample other areas of Kenya in this context would be established only in event of fairness to this representation, in the course of this study or in the end, raising reasonable doubt.

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CHAPTER III

THE KENYAN EXPERIENCE

HISTORICAL ACCOUNT OF DYEING IN KENYA

The Practice of home dyeing with natural vegetable pigments as an old African (especially Egyptian and Oriental art that started centuries ago) has already been broadly traced. Coming from behind and thriving through trial and error, the European dye techniques improved slowly until the middle of the eighteenth century when a number of French chemists began Textile dyeing. Notably, Perkin's discovery in 1856 of a lavender dye made from aniline marked the turning point in the natural dye-stuff era. At the turn of the ninenteeth century all except a handful of natural dyes such as logwood, indigo, catechu and cochineal had been replaced by manufactured dyes. During World War I, however, America was cut off from the German supplier causing dye-famine.

During the Second World War a similar phenomenon affected many parts of the world including Kenya. A global dye-famine prevailing at the time prompted the Kenya Government to encourage home dyeing by vegetable pigments with an aim to meeting local demand. "The East Africa Hand Spinning and Weaving Committee" under the East African Women's League was consequently formed to undertake this task; a project which unfortunately was brought to indefinite stagnation with the reintroduction of the synthetic dye-stuff into the market after the war.[11]

The imbalance between the rise in the cost of all manufactured goods and the decline in monetary value together with low per capita income, has adversely affected the common Kenya housewife, majority of whom are unemployed. For a long time the women bought synthetic dye-stuffs for dyeing plain cloths and dresses for sale in the form of Tie-and-Dye finished products for making a living. The same synthetic pigments have been used by Kenya women to dye fibres for weaving local baskets ('kiondo') for sale. However, persistent price increases has dictated preference of natural dyes to the synthetic ones.

The foregoing effort by Kenya women has not passed unnoticed. It has in time generated concern and interest. Thus sometime in 1977 the National Christian Council of Kenya demonstrated the age-old vegetable dyeing craft at its craft stand at the Nairobi International Agricultural Show. On hand, a Lorna Hindmarsh, an elderly European woman was engrossed in this natural technique as she watched a dyeing demonstration with onion skins. Intrigued, Lorna later ran all over Nairobi looking for further information on natural dye-producing flora and natural dyeing methods. She finally found only two or three articles written on Home Dyeing in a pamphlet.[12] To start her off on a long, experimental research trail were only eight plants listed as source of dye-pigments in the pamphlet.

These were:

1. <u>Rubia cordifolia</u> roots;
2. <u>Erythrina tomentosa</u> bark;
3. <u>Mexican marigold</u>;
4. <u>Datura stramonium</u>;
5. <u>Weld</u>;
6. Banana leaves;
7. Potato leaves;
8. <u>Parmelia-Lichens</u>.

Hindmarsh has so far worked on numerous plant dyes on her farm at Njoro. Some other teams have also carried out similar work privately elsewhere in the country. Some, so far have introduced dye-projects in the Adult Study Schemes and Weaving Departments in the Rural Polytechnics. Unfortunately, however, the aspiring industrial technology has gained considerable momentum without scientific bias.

Unlike the Yoruba method of preparing indigo as earlier described by Nancy Stanfield, another report reveals an intriguing urine vat recipe. In this report many species of Indigofera growing in Kenya, have been cited but that only two give blue dye: Indigofera arrecta and Indigofera tinctoria.[13] The former fortunately and conveniently for Lorna, grows at Njoro where she lives and works on her farm and the latter grows at lower altitudes. From her experience, fresh young leaves give blue but that plants suffering from drought give no colour.

Her earlier experiments with indigofera arrecta were unsuccessful until after an advice from a one Dr. David Hill of Bristol University. When she put the indigofera leaves in the deep freeze until well frozen she got positive results. She reveals indigo as a non-mordant but confesses a long and tricky production process.

Indigo is insoluble in water which means that during the dyeing process, oxygen is extracted from the solution thereby liberating hydrogen which reduces indigo to a colourless compound. This compound, called indigo white, is soluble in alkaline solution. At this stage, the wool fibres to be dyed, are introduced. After they are soaked in the solution, they are exposed to the air. The oxygen in the air converts indigo white back into an isoluble blue pigment which marries to the fibre.

The following are the two methods which Hindmarsh has used with success:[14]

HYDROSULPHITE VAT

- stripping leaves from indigofera plant;
- placing stripped leaves in deep freeze until well frozen;
- pounding frozen leaves in pestle and mortar until they are completely broken up and mushy;
- preparing enough leaves to fill a 4 lb. (2 kg.) glass jar to a depth of about 2 inches;
- adding enough methylated spirit to moisten leaves and make them stick together;
- heating 20 fl. oz. (550 ml.) of water to 140° F (60° C);
- adding to indigofera, a little at a time, mixing well but avoiding making bubbles;
- adding 1¼ fl. oz. (35 ml.) caustic soda (sodium hydroxide);

- sprinkling in 1 oz. (25 gm.) hydros. (sodium hydrosulphite) stirring well but gently;
- standing the jar in a pan of hot water (a pad of newspaper underneath helps prevent it from cracking);
- heating the dye in the glass jar until the temperature is 130° F (55° C);
- letting the temperature rise to 140° F (60° C) but no higher lest the vat becomes useless and the process starts all over again;
- maintaining the heat at 140° F (60° C) or a little under 10 minutes;
- the liquid in the vat appears dark green but if a glass rod or the glass thermometer is dipped into the liquid and drawn out gently, it shows a clear yellow; any white specks are undissolved indigo white;
- adding a few drops of hydros to take up the oxygen.

THE DYEBATH

- heating up a karai of water and placing an enamel basin inside it;

- filling the enamel basin with enough water to cover the wool; the water heated upto 120° F (50° C) but not higher;
- adding 1/5 oz. (5 gm.) hydros to the water to take up the oxygen;
- adding 8 tablespoonfuls from vat to dye-bath, being careful not to make bubbles;
- keeping temperature at 120° F (50° C) for 15-20 minutes;
- removing the wool and hanging out to oxidize, removing excess water by squeezing the skein firmly from top to bottom, without wringing or twisting ... as the wool is removed from the bath, it appears light yellow, almost white, and as oxidation starts, the wool slowly turns turquoise blue;
- leaving the wool to oxidize for 30 minutes;
- adding another 1/5 oz. (5 gm.) of hydros and bringing the bath upto 120° F (50 C);
- putting the oxidized wool back into the bath using the same process as the first dip;

- hanging out to oxidize again after 15-20 minutes; this time the turquoise appearing a little stronger;
- dipping the wool upto 5 to 6 times, the colour getting stronger with each dip;
- the wool begins to matt as caustic soda degrades the wool beyond 5 dips;
- hanging the dyed wool in the shade after the last dip for 3 days and the colour slowly turning from turquoise blue to true blue;
- soaking the wool after 3 days in a solution of acetic acid (¼ fl. oz.) (7½ ml.) acetic acid per gall. (4½ l.) for 30 minutes or using vinegar (1 tablespoonful to 1 gall.) instead to help neutralize the caustic soda and render the dye fast;
- rinsing the skeins twice in warm water;
- washing in warm liquid soap solution;
- rinsing twice in warm water;
- drying in the normal way.

URINE VAT

- collecting enough urine to almost

fill a gallon (4½ l.) glass jar and leaving it to mature for six weeks;

- stripping the leaves from the indigofera plant and freezing them well;
- pounding the leaves in a pestle and mortar;
- adding about 6 oz. (150 gm.) pounded leaves to urine, stirring them for a few days;

  the bacteria and ammonia in the urine reduce and dissolve the indigo to indigo white;

  when the colour of the vat solution turns cloudy yellow-green, it gets ready for use;

- soaking 4 oz. (100 gm.) of wool in warm urine or warm water until well-wetted;
- adding wool to urine vat gently so as not to introduce oxygen and moving the wool around in the vat gently. Warming the vat is desirable but temperatures over 140^{O} F (60^{O} C) destroys the indigo white;

  the depth of blue that is obtained depends on how long the wool is left in the urine. To get a dark charcoal blue, the wool should be left in the urine for three weeks. When the desired colour is obtained, the wool is removed and rinsed twice in warm water;

- washing the wool in warm liquid soap solution to remove some of the smell;
- rinsing twice in warm water again;
- hanging up to dry in the shade - drying thereafter in the open air removes the rest of the strong smell;

the blues obtained by this method are not as clear as the blues obtained from hydros vat, but a much deeper blue can be obtained. The main objection is the smell so it is advisable to work in the open air.

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CHAPTER IV

METHODOLOGY AND PROCEDURE

RECONNAISSANCE

Reconnaissance Survey of the research areas was carried out in two regions that is, the Lake Basin and the Coastal parts of Kenya. (Fig. 1.3). As has been cited in the scope for this study before, the survey was controlled by such factors as size, physical features, climatic factors and geological structure of the country. The fact that Kenya is a large land mass of notable climatic variables in terms of studying the obtaining flora and their dye-producing characteristics as well as the country's soils in terms of their earth colour potential. The Lake Basin and the Coastal Region, being so characteristically distinct from each other in physical features and climate, were identified as a representative study sampling for the country. These considerations aside, there was also the assumption that the research findings could reveal the fact as already established for other parts of the World (especially Europe) that every kind of plant from which a dye is obtained is a product of geographical environment and therefore that the quality of the dye depends on climate, soil, water, aspect and other conditions.

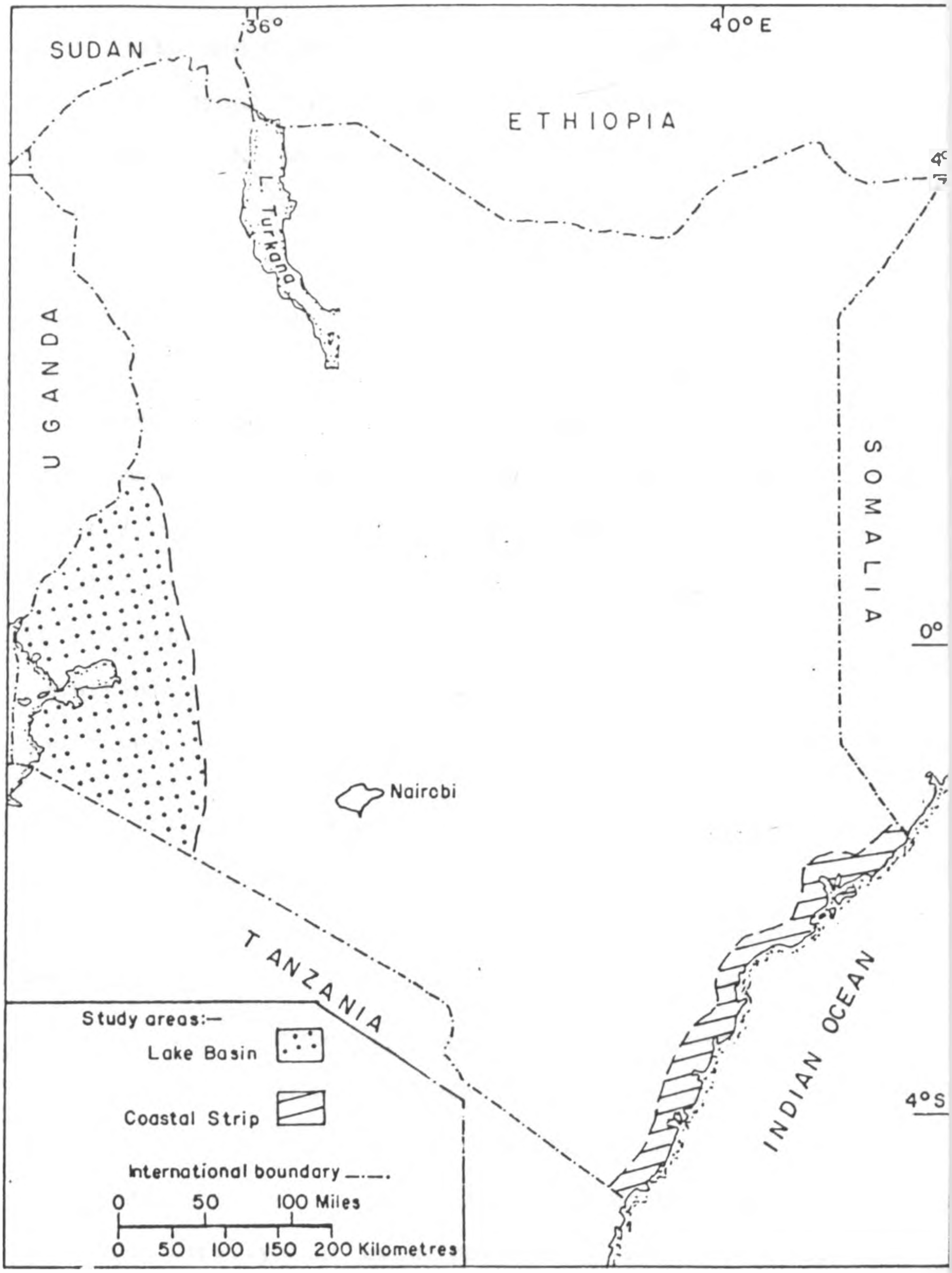


FIG. 1.3: LOCATION OF STUDY AREAS - LAKE BASIN AND THE COASTAL STRIP.

With the foregoing in mind, a general survey of the sub-research areas, that is, the Lake Basin and Coastal Region was carried out. From the actual field experience, the Lake Basin was found to be abundant in the dye-producing flora than the Coastal Region. Although few in range, more of the available and locally established dye-producing flora species were found in the Lake Basin than the Coastal Region. Reason for this disparity may be attributable to the heterogeneous and homegeneous character of the Lake Basin and Coastal vegetation respectively. Whereas the 10-mile strip of the Coastal Region for instance, is sustained by characteristic climatic and resultant vegetational homegeneity, the Lake Basin vegetation is varied and diverse.

Initially during reconnaissance survey, a general local running of the sub-research areas was made. The general character and distribution of flora in terms of patterns, that is, a recurring phenomenon of species was observed, noted and established. Notes taken were used for future reference. For example, a reconnaisaance survey of the Coastal strip from Lungalunga to Malindi showed a largely continuous recurrence of mangroove, a repeating pattern of coconut plantations, citrus fruit farms, mangoes, cashew nut plantations, sporadic cultivated henna, tamarind, the solitary baobab, bixa gardens and bixa farms.

> The interrelation of climate and soils is very close, and this has a far-reaching influence on the vegetation, especially in terms of available water. Areas of deep sand, such as those to the south, have low water retention capacity, whereas in the transitional zone there is shale underneath a shallow top soil, which holds water well.[15]

The unbearably humid heat at the coast, low altitude, the accompanying strong wind systems, (the monsoon, the easterlies, westerlies and the heavy rainfall), all add up to the unique characteristic variables which inevitably affect and influence the Coastal vegetation. The geological structure is also crucial; the general sandiness, the coral-reefed seafront, the saltiness all go to temper the nutritional character and value of the coastal soils.

A similar survey at the Lake Basin, however, revealed a more vivid picture of varied vegetation. The dry heat - the winds to and from the fresh water Lake Victoria - the forests of Lambwe Valley - the indigenous rain forests of Kakamega - the Eucalyptus and Accacia plant species - the towering Albizia coriaria - the abundantly wild Tithonia diversifolia and Harungana madagascariensis - the legendary

"Simbi Nyaima" crater lake and its frothing bluish-green soils - the ochre pits at Kajulu hills - the limestone, yellow and grey soils of Gem ..... all combine and give the Lake Basin a diverse potential for research on dye-producing and various earth colours.

COLLECTION OF MATERIALS

It was not difficult to randomize the specimen collection of the dye-producing flora and earth colours from the notes taken during the preliminary survey of the sub-research areas. An elaborate approach was employed. In the absence of proper documentation on materials under study, the oral tradition as prime source of information was resorted to. Services of a guide from the local research setting were found useful. (Fig. 1.4).

Working initially with the chief or his assistant, certain "wazee" were approached and brainstormed into recollecting as much as they could remember of contemporary traditional pigment-producing plants and earth colours used by the local people.

It was found that various types of these materials had invariably been used in traditional ceremonies, in decoration of artifacts, body covers or walls of traditional huts.

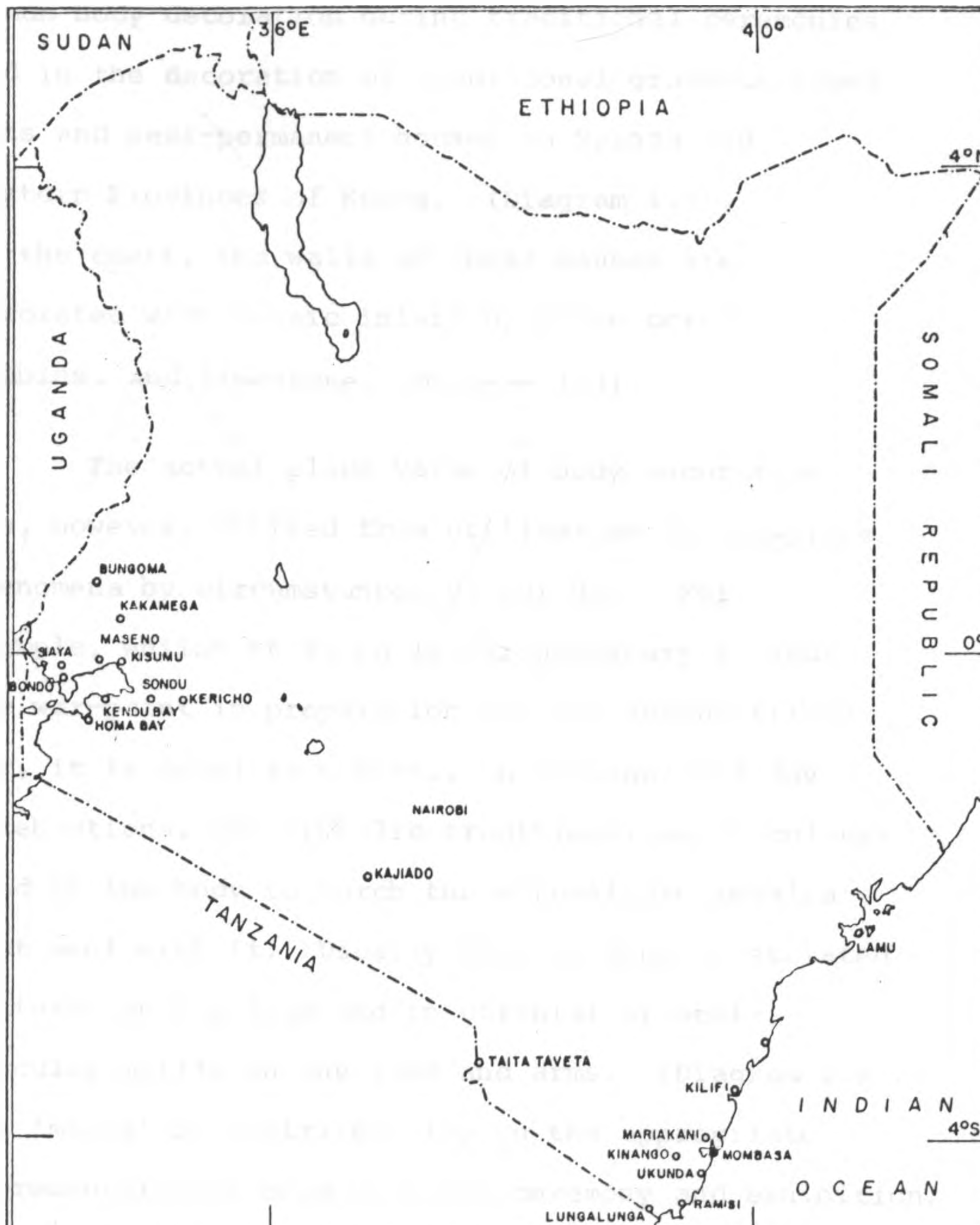


FIG. 1.4: SPECIMEN COLLECTION AREAS

There are recollections and records that earth colours were and are still in use today in human body decoration during traditional ceremonies and in the decoration of traditional grass-thatched huts and semi-permanent houses in Nyanza and Western Provinces of Kenya. (Diagram 1.3). At the coast, the walls of local houses are decorated with mosaic inlaid by white coral pebbles, and limestone, (Diagram 1.4).

The actual place value of body decoration has, however, shifted from utilitarian to showpiece phenomena by circumstances of our day. For example, whilst it is no longer necessary to wear the war-paint in preparation for the actual tribal war, it is novel to witness, on national holiday celebrations, the symbolic traditional earth colours used on the body to march the ritualistic regalia that went with it. Usually this is done in striated patterns on the legs and in circular or semi-circular motifs on the face and arms. (Diagram 1.5). The 'masks' so contrived play up the appropriate representational mood both for ceremony and exhibition. White colour with a range of ochre from yellow to dark-brown hues have been handed down from one generation to the next in this traditional practice. Luo traditional dancing troupes, one from Kajulu on the foothills of Nandi hills in Kisumu district and

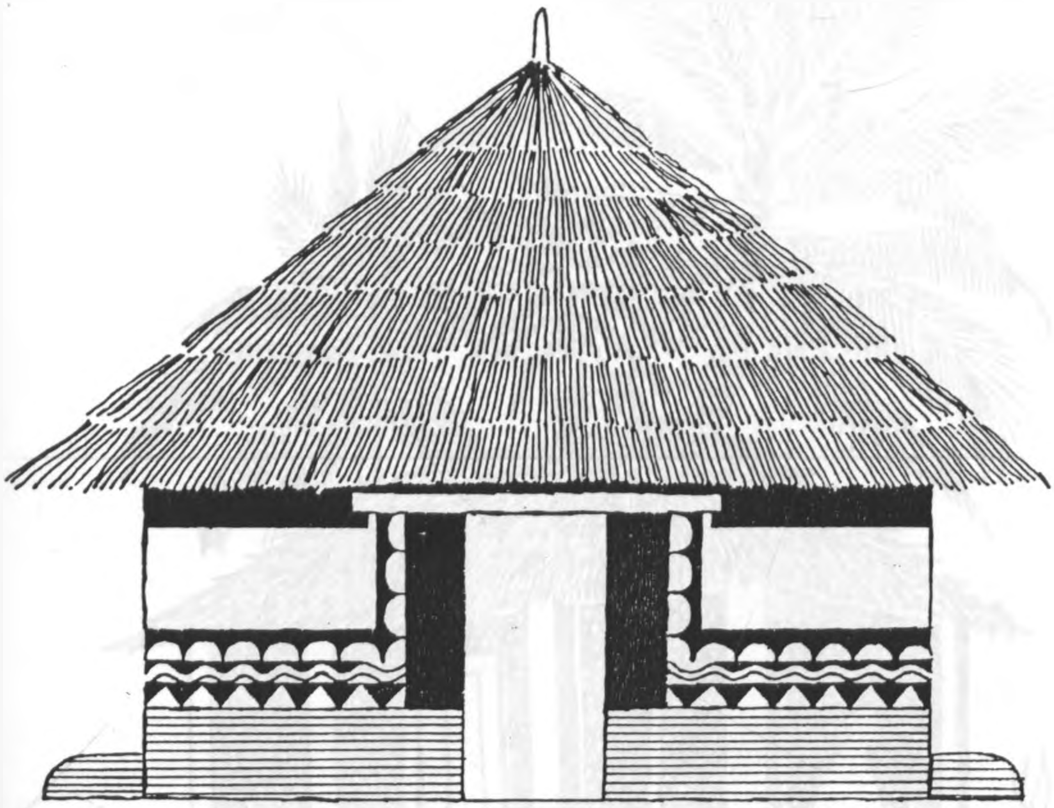
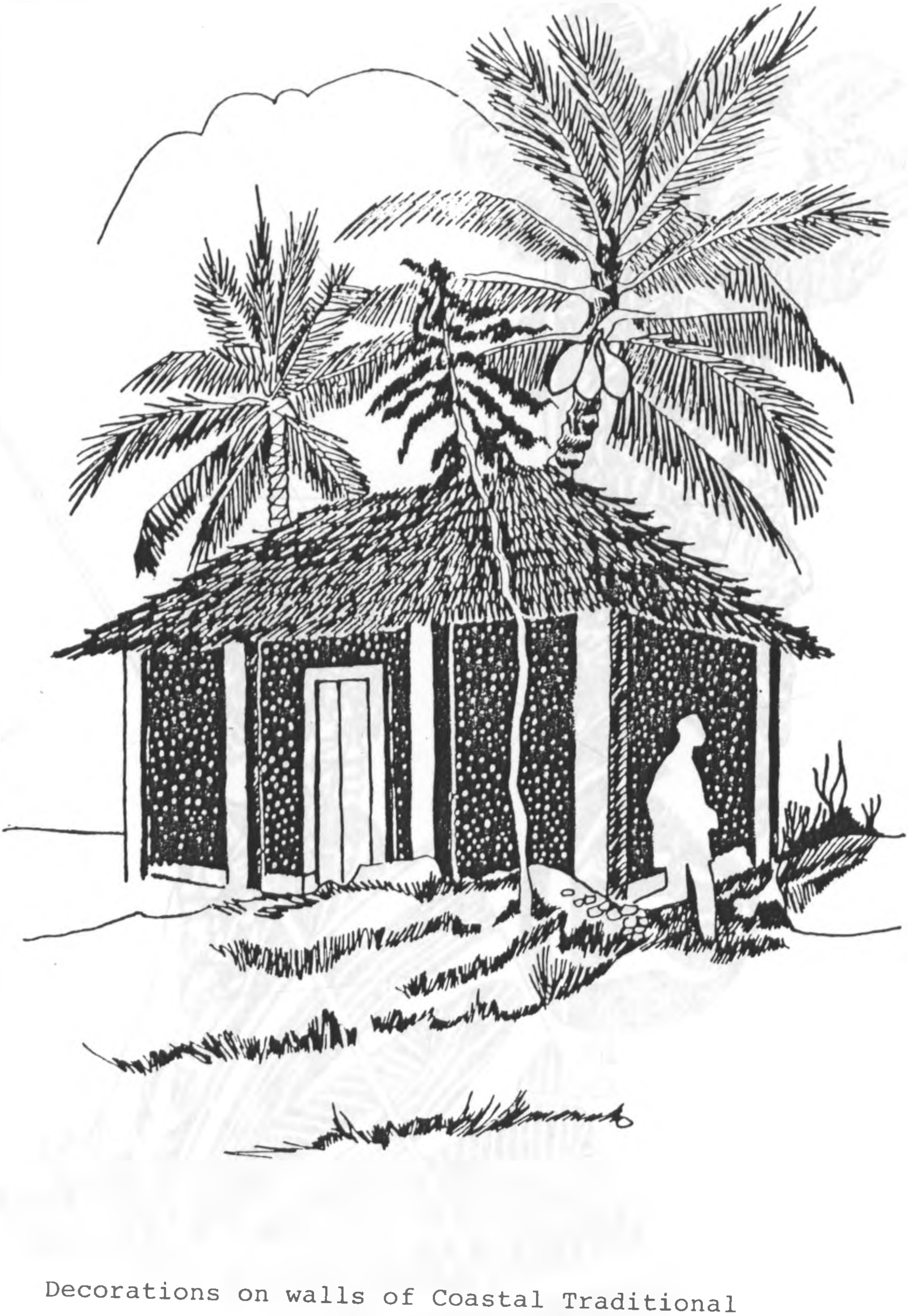


Diagram 1.3: Wall decorations on some well designed traditional Luo grass-thatched huts.



Decorations on walls of Coastal Traditional houses.

Diagram 1.4

Diagram 1.5: Notice the striated traditional paint patterns on face, arms and shields.

another from South Nyanza both use these traditional ochre motifs well.

It is also quite interesting to note how the Maasai use ochre. To the Maasai, ochre is beauty itself. The soil is ground into very fine powder and the different types of ochre powder made into pomade and used as cosmetic. The preparation of the pomade involves a concoction of finely ground ochre powder mixed with animal fat which is then smeared on well made spindly strands of hair. (Diagram 1.6). The hair is well arranged in a forward and backward flow allowing the forward strands to be tied in a neat knot above the forehead. The body concoction consists of a mixture of finely ground ochre powder and animal urine. This is usually smeared on legs and arms.

The Maasai ochre shades of red and brown differ from place to place. For example, there is a clear distinction between the Loitokitok, Kajiado and the Narok shades.

The Maasai ochre is traditionally used for varied ceremonies all in which the pomade is used on the body as a supporting backdrop to various bead colours and patterns.

Ochre is known to possess medicinal ingredients which are used with its application on the body for healing purposes. It has also been

Diagram 1.6: Pomade of finely ground ochre powder mixed with animal fat and smeared on well made spindly strands of Maasai hair.

mentioned as a healing ingredient in certain circumcision situations in which a mixture of reasonable consistency is applicable on surgical points where the mixture cakes on drying thus helping in faster healing process.

The coastal troupes wear gaudy costume and less paint. Perhaps the sandy characteristics of the coastal soils render the colours gritty and coarse for comfortable body application.[16]

In Western Kenya, particularly Siaya District, elderly mothers who have now bequeathed expertise to a younger female generation recount techniques and processes involved in identification, collection and use of soils in hut decoration. The floor of the local hut was and is still smeared with a well-mixed concoction of prepared earth and cowdung. The thorns of the aloe plant are then used with a clockwise movement of the hand to create beautiful semi-circular or zigzag incisions on the wet smeared floor surface. (Diagram 1.7). On the outside, on the foot or half-way up the earth wall and running horizontally round the hut, a white earth colour "atoya" - Luo - is smeared above a band of brown earth colour or, related one to the other, in a saw-toothed motif or wavy motion, both forming pleasant, simple pattern. (Diagram 1.8).

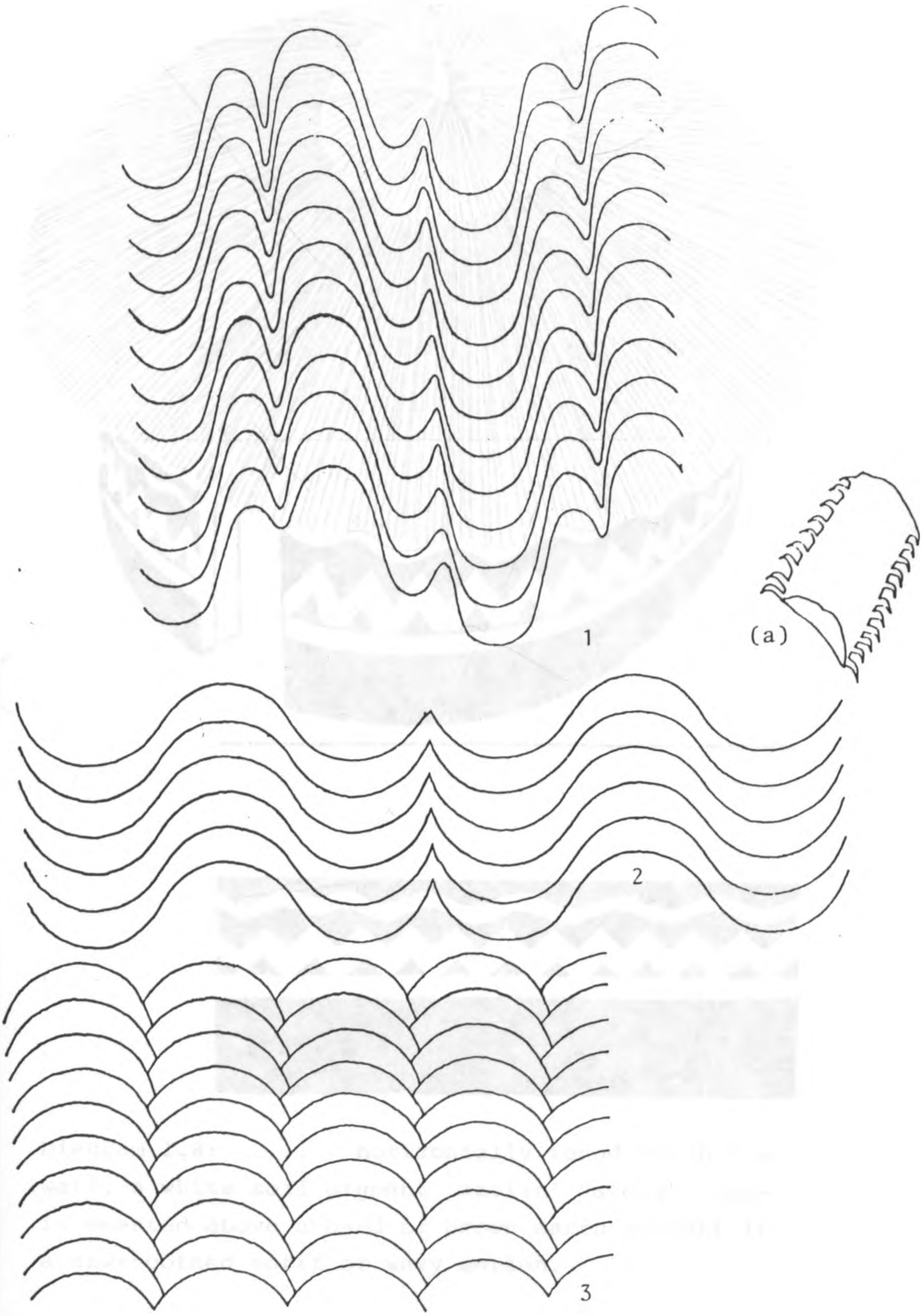


Diagram 1.7: Notice part of thorn of the aloe plant (a) and the semi-circular and zigzag incisions on wet smeared floor surface 1, 2 and 3.

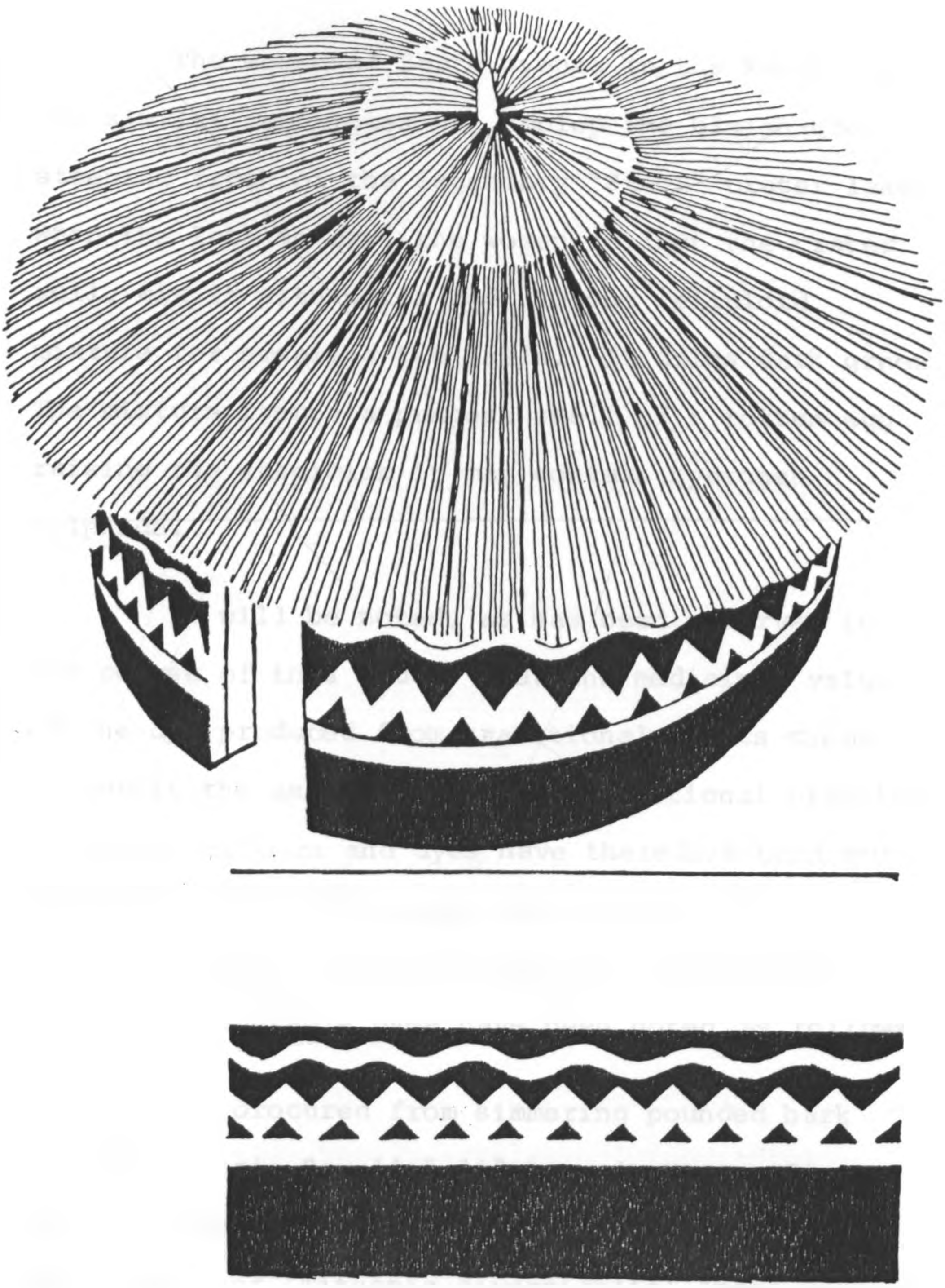


Diagram 1.8: ...... horizontally round the hut's wall, a white soil pigment 'kaolin' "atoya" -Luo- is smeared above a band of brown earth pigment in a saw-toothed motif or wavy motion.

The women of South Nyanza in the Kendu area use similar techniques but employ the bluish-green steeping froth of the legendary "Simbi" crater lake. When the lake is dry, the women collect the crater soil, mix it with water and use the celluloid mixture for smearing the walls. It dries dark green. The mixture issues a pungent smell of a rotten egg raising the suspicion it may contain hydrogen sulphide.

It will be noted, as has been observed in the course of this study, that the medicinal value of the dye produced from traditional plants seems to outwit the aesthetic value. Traditional practices involving colours and dyes have therefore been more manifest with traditional earth colours than with vegetable dyes. However, a handful of examples involving vegetable dyes have been noted as follows:

Dye procured from simmering pounded bark of some 'Acacia Seyal' "ali"-Luo- in Uyoma, Siaya District, was and is still used for dyeing sisal. The flowers of '<u>Tithonia diversifolia</u>' "maua makech" -Swahili/Luo-, "apala ligare"-Luo-(parts of a species which appears all over Nyanza and Western Provinces of Kenya), have also been used for dyeing sisal. '<u>Albizia coriaria</u>' "Ober"-Luo- has had its bark pulped and simmered to produce pigment for general dyeing purposes. Tannin-producing plants like black wattle at higher altitudes and mangrove at the coast have been used to dye leather articles.

> "Tannin is the material containing tannic acid in which raw hide is soaked to change it into leather. Natural tannins are substances which have the property of tanning animal skins. This means they combine chemically with the protein of the skin in such a way that these are transformed into leather, the skin thus becoming soft and durable."[17]

IDENTIFICATION OF SPECIMENS

The 'mangrove' was found to be the main dye-producing plant at the coast. It actually produces a range of browns from pink-brown to beige tannin depending on how long dyed articles stay in the dye solution. The mangrove is a dye and tanning crop at the Kenya coast extending in a strip along the sea-shore from the south to the north in Lamu. It is also one of the hardest woods locally available for building local houses and for many years has been an item of trade as a building material. This trade has, however, continued at the expense of the well-being of one of the rarest plant species and because of this, the plant has now been listed among the endangered plant species and enjoys the Kenya Government protection from possible extinction.

Another dye crop grown and known at the Kenya coast as "Annatto' or 'Bixa orellana' is used in its natural state for food colouring.

'Henna' is widely used by Swahili and Moslem women for decoration of palms and feet on certain occasions or ceremonies. It is the pounded leaves that yield dye after a short spell of fermentation.

The 'Baobab' produces light brown dye from its root and a range of pink from its fruit fibre. 'Rhus Natalensis' "mkono chuma" - Swahili - produces dye from leaves and roots.

'Harungana madagascariensis' "kuma maji" - Swahili - produces dye from bark.

'Euclea divinorum' "mdaa" - Swahili - which is a traditional African dye, produces dye from bark and root bark.

The following trees and shrubs, most of which were collected from Western Kenya, were preliminarily screened and found to produce dye from the part(s) in brackets:

+ ACACIA MEARNSII 'black wattle' (bark). 18

* ADANSONIA DIGITATA 'baobab' "mbuyu" - Swahili - (rootbark, fruit fibre). 19

** ALLIUM CEPA 'onion' (red onion skins). 20

** BIDENS PILOSA 'black jack' "onyiego" - Luo - (seed filaments). 21

* BIXA ORELLANA 'annatto' "rangi" - Swahili - (seeds, leaves). 22

* BOMBAX RHODOGNAPHALON "msifu mwitu" - Swahili - (bark). 23

** BOUGAINVILLEA FORMOSA (leaves). 24

** CANNA (flowers, leaves). 25

** CASSIA DIDYMOBOTRYA (flowers, bark, seed pods, root bark, leaves). 26

\+ CORDEAXIA EDULIS 'yeheb nut' (nut). 27

** CYPHOSTEMMA NODIGLANDULOSUM (leaves, stalks, flowers). 28

** DAHLIA (flowers, tubers). 29

** DATURA STRAMONIUM 'Jimson weed' (leaves, stalks, seeds, pods). 30

\+ DIANTHUS CARYOPHYLLUS 'carnation' (flowers, fermented flowers). 31

** DOVYALIS CAFFRA 'kei apple' (leaves). 32 (Draw.1.0)

* ERYTHRINA ABYSSINICA 'red hot poker tree' (leaves). 33

** EUPHORBIA COTINIFOLIA 'red euphorbia' (leaves). 34 (Draw.1.1)

** FRAGARIA ANANASSAE 'strawberry' (fermented fruit) 35

** HARUNGANA MADAGASCARIENSIS "kuma maji" - Swahili - (bark). 36

** IPOMOEA BATATAS 'sweet potato' "rabuond nyaluo" - Luo - (leaves). 37 (Draw.1.2)

** LANTANA TRIFOLIA "atek" - Luo - (leaves, stalks and flowers). 38 (Draw.1.3)

* LAWSONIA INERMIS 'henna' (leaves). 39

** LEONOTIS NEPETIFOLIA "osunosuno" - Luo - (leaves, stalks, flowers). 40 (Draw.1.4)

** MORUS NIGRA 'common mulberry' (fruit). 41

** MORUS JAPONICA tended in plantation (leaves). 42

** NICOTIANA TABACUM 'tobacco' "ndawa" - Luo - (leaves). 43

\+ PLECTRANTHUS BARBATUS "moigoya" - Kikuyu - (leaves, stalks, flowers) 44

+ PLUMBAGO CAPENSIS (flowers, leaves). 45 (Draw.1.5)

** RHUS NATALENSIS "mkono chuma" - Swahili - "Sangla" - Luo - (leaves, roots)46

** RICINUS COMMUNIS 'castor oil plant' "odagwa" - Luo - (leaves, stalk, seed pods). 47 (Draw.1.6)

+ RUBIA CORDIFOLIA "gakaraku" - Kikuyu - (mixed young, old roots). 48

+ RUMEX ABYSSINICUS "mugagatio" - Kikuyu - (mixed young, old roots). 49

** TAGETES MINUTA 'mexican marigold' "anyach" - Luo - (leaves, stalks and flowers). 50 (Draw.1.7)

* TARCHONANTHUS CAMPHORATUS "mkalambati" - Swahili - "leleshwa" - Maasai - (leaves).51

** TITHONIA DIVERSIFOLIA 'apala-ligare' - Luo - (flowers, leaves). 52 (Draw.1.8)

* ZINGIBER OFFICINALE 'ginger'
(leaves). 53

KEY:

Vegetable dye sources:

* Coast

** Lake Basin

+ Others

DYE-PRODUCING FLORA AT LAKE BASIN AND THE COAST: A PROFILE

Albizia coriaria "Ober" - Luo -

This deciduous species is found in Western Kenya. It has multiple leaves and sheds once a year. It develops into a big tree with big boughs which generally sprawl into a horizontal bearing to the trunk. The bark is rugged and furrowy. A gummy honey-like jelly invariably exudes from the bark and settles down as hard as putty mainly on the trunk. The bark is gummy when first peeled off. This bark, when allowed to dry, pulped and later simmered, produces a rich, coffee brown dye. The leaves are popularly used in Bunyore and Maseno area for hastening the ripening of sweet bananas apparently due to heat the leaves generate while in confinement.

Bixa orellana 'Annatto' - "rangi" - Swahili -

A native of Tropical America where the American Indians used it to paint their bodies when going to war, 'Annatto' must have been introduced into Kenya, especially along the coast, by early explorers. The time of its introduction is not well known. However, Dr. J. O. Kokwaro, Professor of Botany at the

University of Nairobi remembers as a young boy in the early 1950s collecting pods of a Bixa tree cultivated in Gem, Siaya District, Nyanza Province by an ex-policeman in the colonial days. He thinks the policeman must have brought the seeds or seedling from the coast to Western Kenya. As young children, they (Kokwaro and his peers) were simply interested in playing with the dye from the pods but he remembers the policeman asking them to polish his shoes with the dye!

Bixa is a small tree with pink flowers and red pods covered with stiff hairs. A red dye is produced from the pulp surrounding the seeds, and the dye is used for colouring dairy products and cosmetics. It had been grown as a cash crop along the coast particularly during the 1960s. For some time its cultivation dwindled on a commercial scale but has recently been resuscitated to feed the KENYA BIXA LIMITED, a factory which processes the semi-finished Bixa cakes for export to Japan.

Bidens pilosa 'black jack' "onyiego" - Luo -

This is a weed which grows abundantly in gardens after harvesting. Fast-growing and quick-maturing, it grows en-masse and thickly.

It produces small flowers which on drying give rise to thin black projected filaments the ends of which have spiky tops which stick easily to objects which may brush against them, usually animal skin or clothes. The black filaments, which are seeds themselves, yield yellow or orange dye under varied dyeing conditions.

Bridelia scleroneuroides "orwech" - Luo -

This is a native of Western Kenya. It is found in Maseno area of Kisumu District, Bunyore in Kakamega District and Homa Bay in South Nyanza District. It belongs to the *Euphorbiaceae* group, looks like though neither grows as big nor as tall as *Acacia Abyssinica*, the 'thorn tree'. It has small complex leaf structure and small thorns on twigs and branches. It produces the 'potter's dye'. Usually the bark is peeled off, pulped and simmered until a black solution forms. This is the dye which is used as a decorative aspect of traditional pottery.

At firing time, the black dye solution is thrown and splashed onto the hot, baking pot using broad leaves which are dipped into the dye from time to time. This results in a permanently tinted spray, an all-over spontaneous decoration on the pot's body.

The plant's herbal concoction is well known for the treatment of venereal disease.

Lawsonia inermis 'henna'

Naturally a wild shrub, henna is sparcely cultivated in certain coastal homesteads. It grows vegetatively and produces small green compound leaves on thin, long thorny stems. It also produces small green seeds. Its dye preparation involves the picking of leaves and drying these in the sun for a day. The following day the dry leaves are pounded with pestle in mortar and then sieved. The resulting powder is mixed with either lemon juice "limao" - Swahili - or 'tamarind' "kwanju" - Swahili - "chwa" - Luo -. This mixture is then exposed to the sun to harden into jelly after which it is ready for use. Often people think that henna has a scent of its own. On the contrary, it takes the scent of whatever perfume is mixed with it.

Henna is usually used by Swahili and Moslem women for decoration of palms and feet on certain occasions or ceremonies. Besides being mixed with tea, it is also used especially by women for dyeing hair into a brown - reddish colour.

Preservation of the dye is tricky. The left-overs must be locked in tight conditions to keep. Otherwise, it easily loses its colour quality upon contact with cockroach which incidentially is the only insect which affects it.

The preservation period hardly lasts beyond two days. However, the dye, usually deep orange or reddish orange, once used on hands or feet, lasts between 2 weeks to about 3 months. Stains on cloth stay much longer. It can be preserved in powder form for a long period.

<u>Tithonia diversifolia</u> "apala ligare" - Luo -

This plant was introduced from America and appears almost all over the country now but it is particularly plenteous in Nyanza and Western Provinces of Kenya.

It has a peculiarly bad smell when touched and quinine-like to the taste.

It has beautiful flowers, yellow in colour. The flower very much resembles the sunflower and has the same structure and colour though much smaller in size. It has broad, sharp-pointed soft green leaves which easily lose turgidity and droop almost instantly on plucking. Both flower and leaf yield dye on simmering.

Traditionally, flowers have been used for dyeing purposes especially sisal fibre onto which the yellow flower petals are rubbed direct. The yellow colouring stays on the fibre for a reasonably long period.

Flowers produce yellow or cream and leaves produce yellow ochre, orange or yellow green as the conditions for simmering and mordanting dictate. Medicinally, this plant is used in the treatment of acute stomachaches.

GENERAL LIST OF FLORA

The following is a list for Kenyan plants which have been screened for dye content. The family and names of plants and respective parts used in the general screening process are accordingly listed:[54]

Names and Family	Parts Screened
<u>ACANTHACEAE</u>	
1. Brillantasia Nyanzarum	whole plant
2. Dyschoriste radicans	whole plant

Names and Family	Parts Screened
AMARANTHACEAE	
3. Achyranthes aspera	flowers, leaves
4. Amaranthus lividus	leaves
5. Amaranthus spinosa	flowers, leaves
ANACARDIACEAE	
6. Lannea stuhlmanii	bark, leaves
7. Rhus natalensis	leaves
8. Sclerocarya birrea	back, leaves
BALANITACEAE	
9. Balanites aegyptiaca	leaves
BIXACEAE	
10. Bixa orellana - 'Annatto'	seed
BURSERACEAE	
11. Commiphora africana	leaves
CAESALPINACEAE	
12. Bauhinia variegata	leaves
13. Caesalpinia melarnocarpa	leaves
14. Cassia didymobotrya	flowers, leaves bark
15. Cassia floribunda	flower, leaves

Names and Family	Parts Screened
16. Cassia mimosides	leaves
17. Cassia occidentalis	flowers, leaves
18. Cassia saligna	leaves
19. Cassia spectabilis	leaves
20. Delonix regia	leaves
21. Tylosema fassoglensis	leaves
22. Piliostigma thonningii	leaves
CAPPARACEAE	
23. Boscia salicifolia	leaves
24. Gynadropsis gynandra	leaves
CARYOPHYLLACEAE	
25. Dianthus barbatus	flower, leaves
COMBRETACEAE	
26. Combretum aculeatum	leaves
27. Combretum apiculatum	leaves
28. Combretum molle	leaves, bark
29. Terminalia brownii	leaves, bark
30. Terminalia orbicularis	leaves
31. Terminalia spinosa	leaves
COMPOSITAE	
32. Anisopappus oliveranus	flowers, leaves
33. Aspilia mossambicensis	flowers, leaves

Names and Family	Parts Screened
34. Bidens pilosa	flowers, leaves
35. Erlangea cordifolia	flowers, leaves
36. Gamolepsis chrysa-themoides	flowers, leaves
37. Guizotia scarba	flowers, leaves
38. Helichrysum odoratissimum	flowers, leaves
39. Osteosperm vailanti	flowers, leaves
40. Senecio dissertolites	flowers, leaves
41. Senecio nandesis	flowers, leaves
42. Senecio syringifolius	flowers, leaves
43. Sonchus oleraceus	leaves
44. Sonchus schweinfurthii	leaves
45. Sphaeranthus bullates	flowers, leaves
46. Sphaeranthus cyathuloides	flowers, leaves
47. Sphaeranthus napierae	flowers, leaves
48. Tagetes erecta	flowers, leaves
49. Tagetes minuta	flowers, leaves
50. Tagetes patula	flowers, leaves
51. Tithonia diversifolia	flowers, leaves
52. Vernomia lasiopus	flowers, leaves
CUCURBTACEAE	
53. Zehneria scabra	whole plant
54. Cucumis figarei	leaves

Names and Family		Parts Screened
55.	Lagenaria sphaerica	leaves
EUPHORBIACEAE		
56.	Croton megalocarpus	leaves
57.	Bridelia scleroneuroides	leaves, bark
58.	Ricinus communis	leaves
59.	Euphorbia leucocephala	leaves
60.	Euphorbia cotinifolia	leaves
61.	Euphorbia pulcherima	leaves
FLACOURTACEAE		
62.	Dovyalis caffra	leaves
63.	Trimeria grandifolia	leaves
LABIATEAE		
64.	Ajuga remota	whole plant
65.	Leonotis nepetifolia	leaves
66.	Plectranthus barbatus	leaves
67.	Salvia coccinea	leaves, flowers
68.	Ocimum basilicum	leaves
LYTHRACEAE		
69.	Lawsonia inermis	leaves
70.	Nassea lythroides	whole plant

Names and Family		Plants Screened
MALVACEAE		
71.	Sida acuta	leaves
72.	Sida cordifolia	leaves
MIMMOSACEAE		
73.	Albizia coriaria	leaves, bark
OCHNACEAE		
74.	Ochna ovata	leaves
OLEACEAE		
75.	Fraxinus excelsia	leaves
76.	Jasminum dichotomum	leaves, flowers
77.	Jasminum floribunda	leaves, flowers
78.	Jasminum nudiflorum	leaves, flowers
79.	Screbera alata	leaves
PAPILIONACEAE		
80.	Albrus precatorius	leaves
81.	Aeschynomene schimperi	leaves
82.	Alysicarpus rugosus	leaves, flowers
83.	Calpurea aurea	leaves
84.	Crotolaria brevidens	leaves
85.	Crotolaria oliotoris	leaves
86.	Crotolaria spinosa	leaves
87.	Dalbergia melanoxylon	leaves
88.	Dalbergia vacciniifolia	leaves

Names and Family		Parts Screened
89.	Erythrina abyssinica	leaves, flowers, bar
90.	Lathyrus hygrophylus	leaves
91.	Pterogyne nitens	whole plant
92.	Tephrosia interrupta	leaves
93.	Tephrosia linearts	leaves
94.	Tephrosia villosa	leaves
95.	Tipuana tipu	flowers, leaves

POLYGONACEAE

96.	Rumex abyssinica	leaves, roots
97.	Rummex baguaaerti	leaves, roots
98.	Rummex crispus	leaves, roots
99.	Rummex usambarensis	leaves, roots bark

RUBIACEAE

100.	Gardenia spathulifolia	leaves
101.	Rubia cordifolia	leaves, root-bark

SIMAROUBACEAE

102.	Harrisonia africana	leaves

SOLANACEAE

103.	Datura stramonium	leaves
104.	Physalis paruviana	leaves
105.	Solanum incanum	leaves

Names and Family		Parts Screened
106.	Solanum mauritianums	leaves
107.	Solanum nigrum	leaves

TILIACEAE

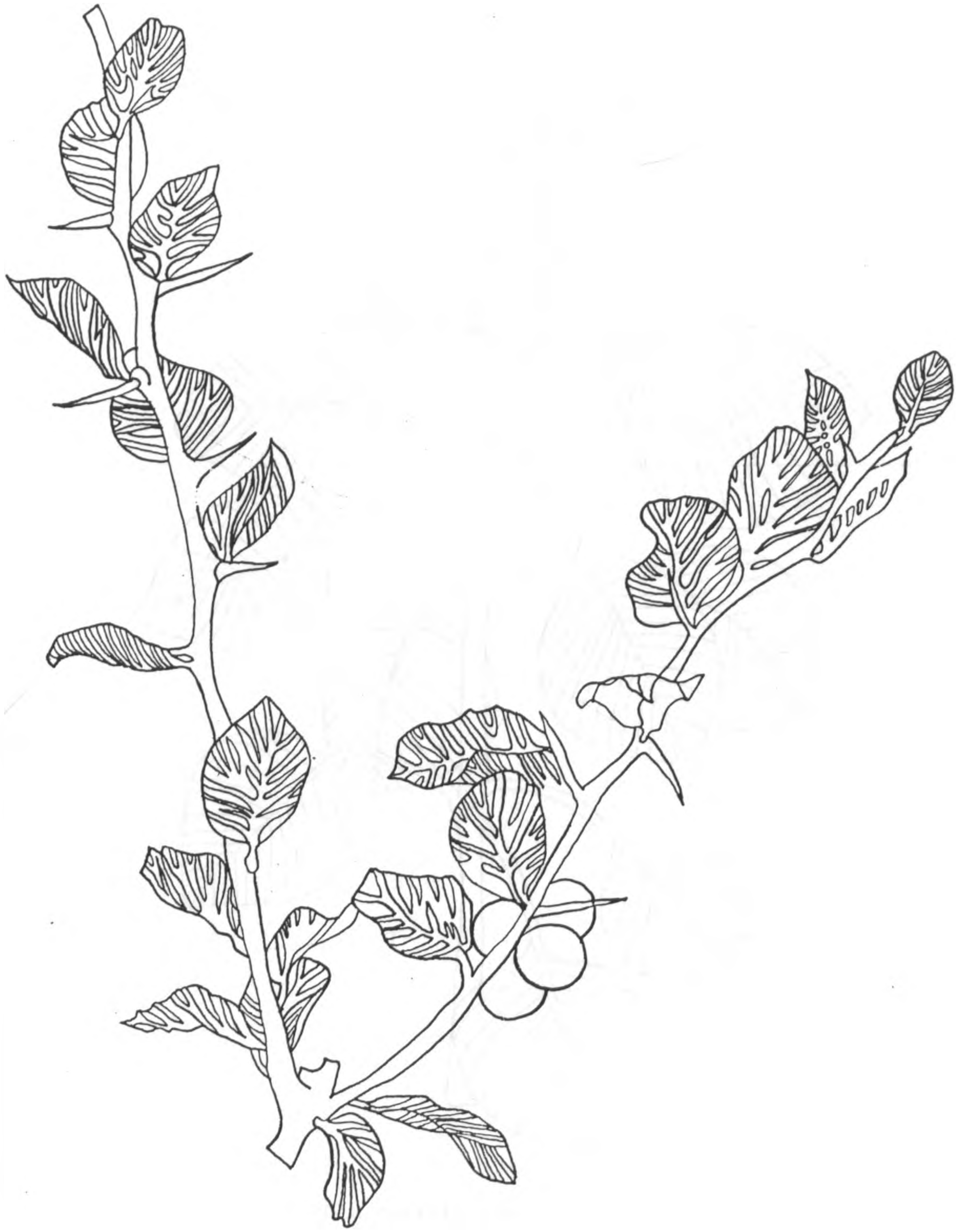
108.	Grewia molle	leaves
109.	Grewia similis	leaves
110.	Grewia trichocarpa	leaves
111.	Grewia villosa	leaves
112.	Triumpheta rhomboides	leaves

VERBENACEAE

113.	Lantana camara	leaves, flowers
114.	Lantana sellowiana	leaves, flowers
115.	Lantana trifolia	leaves, flowers
116.	Lantana sp.	leaves, flowers
117.	Verbena bonariensis	leaves, flowers

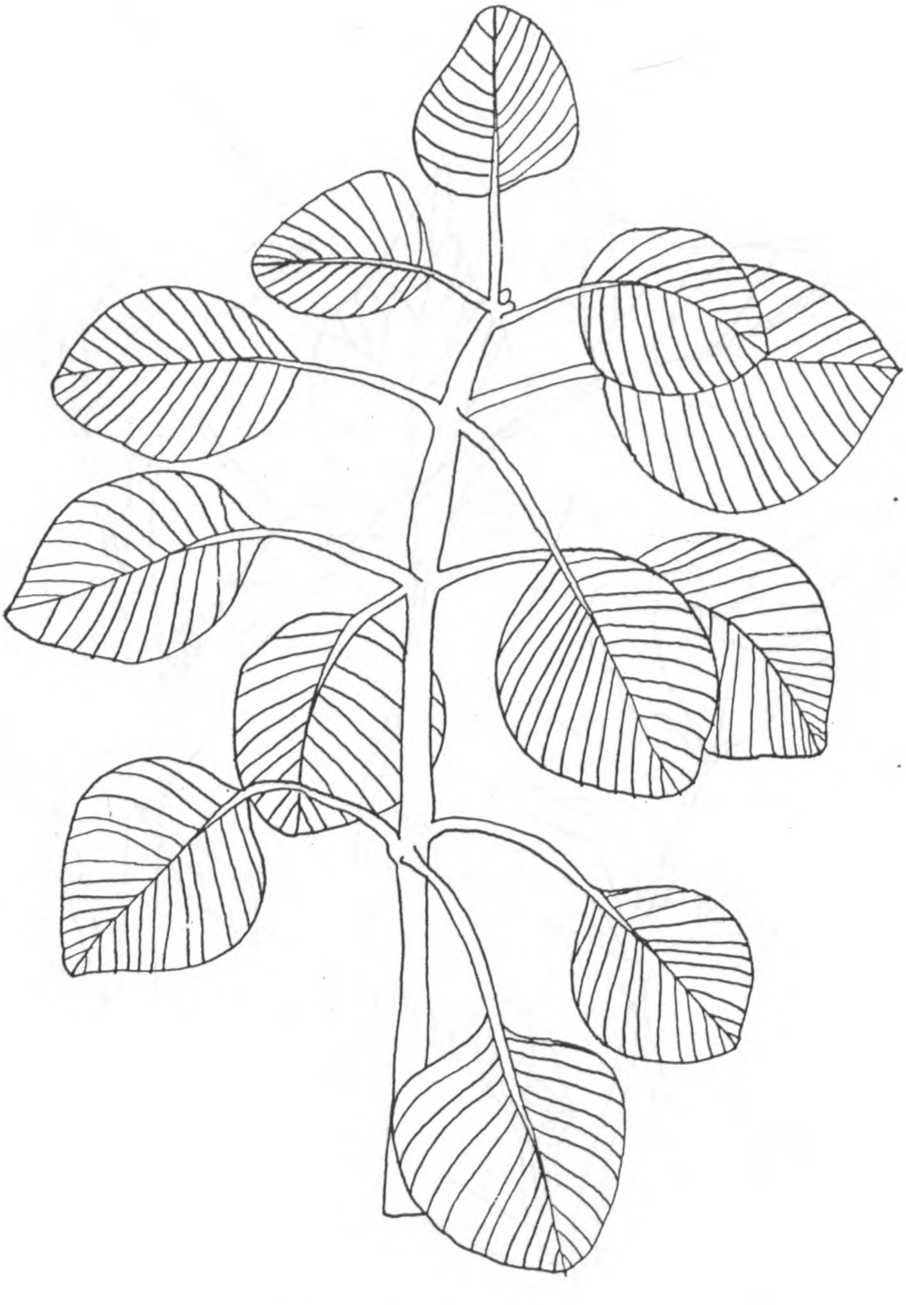
VITACEAE

118.	Cyphostemma nierense	whole plant
119.	Cyphostemma orondo	whole plant



Dovyalis caffra

(Drawing 1.0)



Euphorbia cotinifolia

(Drawing 1.1)

Ipomoea batatas

(Drawing 1.2)

Lantana trifolia

(Drawing 1.3)

Leonotis nepetifolia

(Drawing 1.4)

Plumbago capensis

(Drawing 1.5)

Ricinus communis

(Drawing 1.6)

Tagetes minuta

(Drawing 1.7)

Tithonia diversifolia

(Drawing 1.8)

TEXTILE MATERIALS, MORDANTING AND MORDANTS

As cited earlier in the study objectives, the application tests on textile materials and paper, raise the need beforehand for basic knowledge of features, types and physical characteristics of these materials.

The essential and desirable features of natural fibres like wool and cotton have therefore been discussed. Also discussed are the two classes of dyes, the non-mordants and the mordants and their effect on wool, silk, cotton and linen.

1. TEXTILE MATERIALS

ESSENTIAL FEATURES OF A FIBRE

There are certain essential features and properties which all fibres must possess; and for any substance to be classed as a textile fibre it is necessary that it be fibrous (that is, the length should be at least a thousand times its diameter, which itself should not exceed 100 microns - the thickness of a human hair; and the finer, the better).[55] It should also possess sufficient and regular length, strength, elongation and elasticity, to be spun into a yarn and made into fabric. Durability in wear and in laundering or washing is also a necessity and inorder to be marketable the ability to absorb dye colour is vital to satisfy the colour conscious consumer.

In addition to the essential features, certain others are highly desirable: to be pleasant and comfortable in handle and wear; (though this is obviously not a desirable characteristic in warm or hot Tropical climate) to be easy to wash and launder (with the implied helpfulness of 'drip-drying' and no ironing); and the ability to be shaped into pleats which are durable; resistance to damage by light, washing, fungi (mildew) and the larvae of moths are obvious advantage.

(a) WOOL

FIBRE

What determines the properties and features of the wool fibre is its physical structure. This structure is governed by its growth which in turn is conditioned by environmental factors. The behaviour of the fibre is a function of its properties: the properties of fineness; elongation, elasticity, plasticity and resilience; of heat insulation, moisture absorption, susceptibility to alkaline damage and felting; and the features of lustre and wax content.

WOOL WAX

In its natural state, wool is known as 'Greasy Wool' because it is coated with a yellowish, waxy substance which melts at about 40° C and which is not actually a grease.

The wax is produced from the sabaceous glands and has the function of lubricating the fibre, preventing damage during growth, and being itself insoluble in water, acting as a water-proofing agent. During industrial scouring, this wax is all lost and costly oils to lubricate the fibre during the processing of spinning have to be used to replace the natural wax.

The amount of wax varies with sheep types and breeds.

The greater the quantity of wax removed in the scour, the cleaner the wool produced and, the cleaner the wool produced, the more expensive it is.

About half the weight of Merino wools is lost in the scouring process. Accompanying the loss of wax in the scour is suint which is usually dried perspiration and soil. The wax and suint content are together known as yolk whose content varies first, with the breed of sheep; second, with the location of the locks upon the fleece;

third, with its location on the fibre and fourth, with the fineness of the fibre.

TERMINOLOGIES

SUINT

The waste materials within the animal's body - building system are rejected and got rid of in the form of sweat or suint, a solution of the waste salts and acids and fatty matters. This dries on the animal's body and although deposited on the fibre is readily washed out. When on the sheep's back it is said in some measure to protect the wool fibre from the effects of sunlight.

SOIL

This foreign matter present on greasy wool consists of earthy dirt, light dust and heavy sand, which is picked up by the animal and adheres to the wool by virtue of the wax component. When excessive amounts of dry dust are absorbed by the wax, the wool is rendered harsh and dry. Generally these are removed on scouring. The quality of such mineral matter present varies considerably and it is significant to note that variation in dirt content has a more important influence on yield than variation in wax content.

VEGETABLE MATTER

The presence of vegetable matter can be expensive, for it has to be removed inorder to process the fibre. The nature of the seeds and burrs depends on the natural vegetation associated with the climatic conditions of the area.

DUNG

The wool is often contaminated with sheep dung or excreta, which is readily picked up by the staples, particularly if the animals herd together or are closely confined. Urine-stained wool is another unfortunate but unavoidable factor which lowers the value of the fleece - unless the stained portions are removed by "skirting" that is, pulled off before marketing.

YIELD

In scouring, the yolk (wax and suint) and the dirt are removed, and the resulting clean wool (expressed as a percentage of the original greasy weight) is referred to as yield.

THE OUTSTANDING FEATURES OF WOOL

In wool, the essential features are evident to a marked degree; the desirable features of handle and comfort in wear, wool possesses naturally; and others can be imposed upon the fibre by simple treatments, with the exception of resistance to damage in washing, where extreme care is the only remedy. Over and above these, wool has outstanding characteristics and unique features which combine to make the wool fibre pre-eminent, inimitable and outstanding. In wear it is the pleasantest of all apparel fibres with its micro-cellular structure, its flexible scale formation, and the natural crimpiness, providing great resilience and compressibility as well as great elongation and elasticity. Its warmth - retaining features and high absorption of moisture and odours, make it the most comfortable fibre to wear.

CLASSIFICATION

There is a trade classification of wools - quite a broad classification perhaps - but one which is in common use, namely:-

MERINO
CROSSBRED and
CARPET

At first glance this may appear a simple classification of fine, medium and coarse wools; but the definitions are too broad - particularly the 'CROSSBRED' category. MERINOS are reputed to be very fine wools - usually not greater than 23 microns diameter i.e. 60's + quality fineness number; and CARPETS - those generally too harsh or too coarse to be used for wearing apparel. The intermediate group designated CROSSBRED are more or less nondescript. The term implies that all wools thicker than MERINO but finer than the CARPET are lumped together as CROSSBRED.

The term 'CROSSBRED' therefore is a blanket classification covering a wide spectrum of sheep types, wool types, fineness and features. In other words, coarser grades of wool are generally used in carpet weaving.[56]

MICRON

This is the measurement of a fibre in terms of its diameter. A micron is quite a minute measure therefore - usually a millionth of a metre. More commonly, however, fineness is referred to in the wool trade as a "quality fineness number." The finest fibres naturally have a high number for instance, syperfine MERINO fibre is likely to qualify as 80's, a fine MERINO as 70's; a less fine MERINO as 64's or 60's.

Usually, as said earlier, CROSSBRED category is a little "too embracing" to indicate and describe clearly the features of the wool; it simply refers without distinction to all wools used for clothing, not fine enough to be categorized as MERINO type, and too good to be used for normal carpet trade.

The classification, therefore, could be re-written:-

1. MERINO - above 60's quality (23 microns and finer).
2. ALL NON-MERINO WOOLS SUITABLE FOR APPAREL and of a diameter greater than 23 microns - below 60's quality, and generally finer than 50 microns (40's quality fineness number).
3. WOOLS SUITABLE ONLY FOR CARPETS AND MATTRESSES.

(b) COTTON

FIBRE

ORIGINS AND LOCAL HISTORY

Archeological findings which have produced evidence of the existence of cotton cloth in the Indus civilization of c. 3000 BC and the pre-Columbian civilization of America growing their own species of New World cottons clearly show that cotton existed in the East as well as Western ancient civilizations.

'Hirsuta Herbacea' species of the old world comprises two main cotton species Gossypium hirsutum (G. hirsutum) and Gossypium barbadense (G. barbadense) each with sub-species or races. Imported from Americas the Annual forms of the two species eventually became all-important for Africa with G. hirsutum thriving Africa south of Sahara and the Egyptian G. barbadense for nothern Africa.[57]

There are several species in the genes Gossypium, e.g. G. arboreum, a perennial with short hairs which is grown by some peasant farmers in India. There are, however, only two species which are important i.e. the already mentioned G. hirsutum and G. barbadense. G. hirsutum, commonly called upland cotton, is the cotton of commerce in East Africa. G. barbadense is less important and contributes only about one third of the World's cotton. It produces lint of high quality, notably Sea Island cotton from the West Indies which has a staple length of over 2 in. (c.5 cm.) G. barbadense is grown commercially in West Indies, Peru, Brazil, Arizona and New Mexico in the U.S.A., Egypt and the Sudan. Perennial varieties of G. barbadense grow wild in East Africa, notably in some drier parts of Kenya. They are of no commercial importance although their lint is sometimes collected for local use. The physical difference between G. barbadense and G. hirsutum are as follows:- G. barbadense has leaves which are darker green and more deeply lobed; they are normally hairless and shiny. Its petals are deep yellow with a purple spot at their base. Its bolls are heavily pitted instead of being smooth-walled and its seeds have no fuzz with the exception of a turf at one end.

During the first decade of this century many American upland varieties i.e. G. hirsutum, were introduced in East Africa. These became physically mixed and eventually, lost their identity owing to cross pollination; at the same time they underwent natural selection and adaptation to the East African environment. The most important of the resulting mixtures which were of great genetic diversity became known as the Baganda Local, Mwanza Local and the Malawi Upland (formerly the Nyasaland Upland). The main varieties which were selected from these by further selection were BP 52 and 547 in Uganda and the UK multiline seed issues in Tanzania. BP 52 was selected at Bukalasa (BP stands for Bukalasa Pedigree); it was selected from Nyasaland Upland and was first released in

1943. It gave longer, stronger lint than 547 but this was partly due to the fact that it was grown in a higher rainfal area nearer Lake Victoria. 547 was selected at Serere from BP 50 which was a Buganda Local Selection; it was first released in 1947. Selection from Mwanza Local started at Ukiriguru in the 1930's and led to the UK series of multiline seed issues.

The most significant development in cotton breeding in East Africa has been the introduction, during the 1950's, of Albar; derived from the Nigerian Allen (providing the letters AL) and is highly blackarm resistant (hence the last three letters). It was introduced because although previous selection programmes had imparted a certain degree of resistance to blackarm (not to mention great increases in lint yield and quality and virtual immunity to jassids), this degree of resistance was not considered satisfactory. In Uganda, selections from Albar produced the new varieties BPA and SATU. BPA stands for BP Albar; the letters BP were retained for trade purposes inorder to indicate that the new variety has the same characteristics as BP 52 i.e. long, strong lint. BPA was released in 1966 and is grown in the wetter parts near the lake both in Uganda and Kenya, where these lint characteristics have the best chance of being expressed. SATU stands for Serere Albar Type Uganda; it was released in 1964. At Ukiriguru, Albar was crossed with the local varieties and selections from the resulting populations gave lines which are designated by the prefix UKA. In Tanzania, UKA lines have been solely used for all seed issues after and including UK 61; these seeds are now widely distributed. A single line UK 59/240, has recently replaced UK 51 in all Kenya's cotton growing areas east of Rift Valley.

LINT AND LINT QUALITY

Cotton is grown primarily to produce lint for spinning; the seed may be one of the most valuable oil seeds in the world, and the rotational value of cotton may be significant in a country's agriculture, but, set against the lint, such values have only a secondary or by-product importance. The lint is consequently paramount.[58]

Lint, which is the word often cognate with lint-seed and linen and line, is the commodity of commerce, and is variously known as 'raw cotton' or 'cotton-fibre' or simply as 'cotton' especially when it becomes clear from the context that the lint and not the plant is intended.

Lint hairs can be spun, that is laid together, drawn out and twisted into threads. In parts of Asia and Africa, notably Nigeria, spinning of home-grown and home-ginned lint is still practised, and Gandhi's name is traditionally associated with the attempt to promote weaving and spinning of cotton in the villages of India. The great bulk of the world's cotton, however, is destined for the Industrial spinning mill. Cotton from the field is usually ginned, baled, shipped and sold to the spinner according to its suitability for various needs. At several stages along the marketing chain, the produce is graded for quality.

SEED COTTON: GRADING IN THE FIELD

Peasants in Africa usually harvest their field cotton crop by hand. This crop is usually graded into two basic classes: clean and stained or dirty. Seed cotton stains may be due to insects, fungi or bacteria and the contents of a single boll may be partly clean and partly stained and separation of the two slow up the costly operation of picking. The dirt in seed cotton may be in the form of small pieces of leaf or other trash and the removal of this is quite time-consuming. Stained cotton is weakened and is the cause of an undue number of breakages of the thread in the spinning process, and staining, moreover, can create problems with the dyeing process, while trash can also give trouble in spinning and dyeing. The difference between good, clean cotton and low-grade produce is thus substantial in price. Some countries allow the cotton growers more than two grades: Nigeria for instance, has three grades while Zimbabwe's field crop may be classified as first, second or third grade, or 'unclassified', with prices respectively roughly in the ratio 7:6:4.5:3.5. Much trash in cotton is a lot more encouraged through mechanical picking than by hand-picking and although most of this can be removed by special cleaning machinery both before and after ginning, the lint quality is normally down-graded appreciably. In recent years, greater amounts of cleaner seed cotton have resulted from the usage and effectiveness of insecticides in the field.

SEED COTTON: GRADING AT THE GINNERY

After harvesting, the seed cotton eventually reaches the ginnery. It may reach the ginnery either directly from the field as it happens in U.S.A. or it may be sold in local markets or 'cotton buying posts' as is usual in Africa, for eventual transport to the ginnery. Much care has to be taken at this stage to avoid contamination from containers used by cotton sellers, the presence of hard fibres from sisal sacks or from containers woven roughly from banana leaves or other local materials. General education of the cotton-growing community on proper cotton handling habits is necessary. It is common practice that the seed cotton is sold by the kilogramme or the pound. Incidentally, the less simple peasant has been known to put a lump of stone or iron in the middle of the sack in the hope that his produce weighs more without the foreign body being detected, but the malpractice usually causes heavy damage to the gins and must be discouraged.

At the country markets the seed-cotton is turned out after buying and transported loose or in sacks holding about 22 kg. (50 lbs) to the ginnery. The jute woolpack with a capacity of 160-180 kg. (350-400 lbs) is being increasingly used for transport of seed-cotton, especially by rail.

Arrivals from different buying posts tend to have their own characteristics in terms of slight differences of varied degree of trash or staining or intrinsic quality even within top grade produce and a skilful classifier would accordingly make 'mixings' of similar lots, large enough to allow an uninterrupted runs to the gins.

As said earlier, foreign objects in the lint need to be checked to avoid possible damage to the gins.

The channelling of the correct cotton to the appropriate mill involves a worldwide network of specialised and highly skilled brokers and graders.

All in all, the properties of the raw cotton naturally largely determine the characteristics of the thread or 'yarn' that can be spun, and the length, strength and fineness of the fibres all make their important contribution to quality in the yarn.

DEVELOPMENT OF LINT

All species of Gossypium have some form of hair on the seed surface. In commercial cotton the hairs are of two types: lint and fuzz. The cotton of commerce are the lint hairs and are distinguishable by being convoluted. The fuzz hairs or linters are generally shorter, have a greater basal diameter, smaller lumen and a much thicker collulose deposit in the secondary wall, which prevents the formation of convolutions when the cell dries out at maturity. This condition makes the fuzz unspinnable but makes it, nevertheless, marketable for upholstery stuffing and for production of cellulose. Not all the commercial cottons have fully fuzzy seeds. The barbadense group of long staple cottons, for instance, generally have almost fuzzless seeds.

Both lint and fuzz are unicellular outgrowths of the seed coat and consist of a thin primary wall and a secondary cellulose wall which develops after growth in length has ceased. The whole hair is enclosed in a cuticle of waxy material. The development of lint hairs inside the boll can be divided into two phases: first, that of elongation of the cell during the first 15-37 days after flowering and second, that of the development of the secondary cellulose wall, which begins when growth in length ceases and continues until shortly before boll-split. The individual lint hairs are tubular until they ripen about the time the boll matures, when they collapse around their central hollow axis or lumen, adapting a certain degree of spiral twist in the process. The twists or convolutions, numbering about sixty for every centimetre of hair length in a cotton with a moderate degree of wall-thickening, give the lint hairs the power to cling to one another and thus form a continuous thread when spun. (The hairs of the fruit of the botanically related kapok, known for a long time as the lifebelt stuffing par excellence, look superficially like cotton, but do not collapse on ripening and simply slide over one another if an attempt is made to spin them into thread).

For many years cotton has traditionally measured in inches and fractions, specifically in Lancashire and the rest of English speaking Europe including parts of Africa and the Americas. However, in recent years the vulgar Imperial Units are increasingly being superseded by the simpler Metric System.

Generally speaking, length of lint is a widely understood and easily acceptable unit component of quality. The longer the lint, other qualities being equal, the finer the thread can be spun to a given strength and the finer the eventual cloth. In the early stages of selection, the sorting out is generally done simply in classes of 'Pass' or 'Fail'.

II MORDANTING AND MORDANTS

A mordant is a chemical substance which is soluble in water; when applied to the wool fibres, it brings about a chemical change, enabling dyestuff which is also soluble in water, to combine with the wool to produce an insoluble compound, or wash-fast dye.[59]

There are two classes of dyes: Non-mordant and Mordant dyes.[60]

NON-MORDANTS

The Non-mordant dyes are sometimes called 'substantive dyes' - meaning, they impart their colour direct to the wool or other material without any preliminary preparation. Of these, the lichens are the most important.

MORDANTS

These are sometimes called 'abjective dyes' - meaning, the fibre to be dyed has to receive special preparation before it can absorb the colour. The process of preparation is called mordanting.

Mordanting is quite as important as dyeing; in fact, the success of the dyeing rests chiefly on the mordanting. An unevenly dyed skein of wool can never be an evenly dyed skein. Wool is easy to mordant as the fibres are porous. Silk is tiresome to do. "Silk boiled is silk spoiled" once the first casing of gum is off, and it has to be steeped for a long time in a tepid or cold mordant solution.

Cotton and linen are both difficult to do well. The fibres are very tough and strong and it is difficult to get the mordant to penetrate.

Different mordants produce different shades of colour; for example: a tin mordant usually brightens a colour, an iron mordant generally darkens it.

There are many different mordants 'maerua subcordata'[61] included. However, the four most useful at preliminary level are: alum, tin, chrome and iron.

ALUM

This is potassium aluminium sulphate and is the most commonly used of all the mordants, and was known and employed by dyers from the most ancient times. It is generally used in combination with cream of tartar, as this brightens and evens the colour.

TIN

Tin, usually bought as crystals of tin, muriate of tin or as stannous chloride, is chiefly used when very bright shades of red and yellow are wanted for wool and silk. It is sometimes used as a mordant, sometimes only put into the dye-bath towards the end of dyeing so as to brighten the colour. Most often used with cream of tartar or sometimes in combination with oxalic acid and cream of tartar. The cream of tartar should be dissolved in the water before putting in the tin. Tin should always be carefully dissolved before putting into a pot of galvanized iron, as it corrodes the surface.

CHROME

The preparation generally used for chromium is bichromate of potash.

This is a very useful mordant, as it gives wool a very soft and silky feel. A lid should be kept on the pot of bichromate of potash mordant, as it is very sensitive to light, and the dye maybe uneven if this is not done. For the same reason wool should not be exposed to light after mordanting, and if it is not going to be used for some time, it should be put in a closed drawer or linen bag away from light.

IRON

This is ferrous sulphate or copperas. Iron or copperas is rather a difficult mordant to use, as wool mordanted with it is apt to dye unevenly if great care is not taken. Cream of tartar is almost always used in combination with it. The tendency of iron is to darken and dull colours. In the case of the other mordants mentioned, the mordanting precedes the dyeing. With iron, the reverse process is often the case for wool. The wool is boiled with the dye first and the mordant added after.

OTHER MORDANTS

Copper sulphate and chrome alum are two other mordants sometimes used, but need more experience before they can be used.

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CHAPTER V

EXPERIMENTS

IDENTIFICATION

The various plant specimens collected from sub-research areas, that is, the Lake Basin and the Coastal region of Kenya were brought to the research centre, identified in the Department of Botany at the University of Nairobi and listed under the general family name under the supervision of Professor J. O. Kokwaro.

SCREENING TESTS

The screening tests of the plant specimens were carried out in the Department of Chemistry, University of Nairobi under the guidance of Dr. J. A. Ogur.

The plants used were tested for their active parts by trying the flowers, leaves, stem bark and root bark all separately.

MORDANTING

Some wool thread was mordanted. A roll of pure twine wool from the Spinners and Weavers of Kenya was weighed, soaked in cold water and excess water squeezed out. Three grammes (3 gms.)

of potassium bichromate for every one hundred grammes (100 gms.) - 3:100) was weighed and dissolved in some hot water in a large glass bowl. Cold water was added and the wet wool placed in the bowl and then it was boiled gently for one hour. It was then left to cool to room temperature then the wool squeezed gently to rid it of excess salt. The wool was dried and kept in a dark place (in a drawer) ready for use as mordanted thread. The same process was repeated with potassium aluminium sulphate.

SCREENING PROCESS

Leaves (plant parts) were placed in a 500 ml. beaker which was then completely covered with tap water.

Eight pieces of wool (4 mordanted and 4-non-mordanted) and each measuring about 3 inches long were also submerged by the same water.

The contents of the beaker, that is, the water, plant part and the mordanted and non-mordanted parts of wool were heated for 60 minutes. At every 15-minute interval a pair of wool (1 mordanted and 1 non-mordanted) was withdrawn from the dye-bath and washed thoroughly in plenty of cold water until there was no coloured water seen.

The washed materials were dried in the shade. This process continued until the last pair of wool threads was also washed out.

OBSERVATIONS

The time of heating was recorded as from the time water started boiling. The following observations were made:

- Wool thread from 1st dye-bath is much stronger than the thread from subsequent dyes;
- Longer dips in the 1st dye-bath enhance the quality of the dye, in fact make it darker;
- Shorter dips produce lighter results proving that results can be achieved as desired. For instance, faint, subtle hues are possible in either of two possible ways: either from shorter dips in 1st dye-bath or longer dips of fresh thread in 3rd or 4th dye-bath;
- Range of hue can be achieved in two ways: First range of hue can be achieved by time exposure of a number of dyeing threads which are dipped in the 1st dye-bath

together and removed one after the other at regular intervals. The strength of dye on thread increases with time of contact with dye-bath. In other words, the shorter the stay of thread in the dye-bath, the lighter the dye and vice versa;

- Second, range of hue can be achieved by simmering fresh mordanted threads in successive dye-baths, say in 1st, 2nd 3rd and 4th dye-baths. Results show regular final gradation of dye from dark to light. In other words, the dye content gets more diluted with successive dips in the dye of fresh mordanted thread;

- Older dye-producing plant parts produce weaker hues. Younger specimens produce better results;

- Rate of absorption of dye is greatly enhanced through mordanting. Mordants also enhance quality of dye. Non-mordanted and mordanted wool threads nearly always absorb different hues from the same dye-bath. The dye quality in the mordanted wool thread is more often better.

DISCUSSION OF RESULTS

Results obtained from experiments carried out with wool threads were quite striking. It was observed that mordants that were used, namely: alum (potassium aluminium sulphate) and chrome (potassium bichromate) brought out the colour of dye quite well. It was also noted that each mordant had effect peculiar to itself when simmered together with either same part or different parts of plant specimen under study. The simmering together of similar or different parts of plants with similar or different mordants also portrayed peculiar trends and results.

There were exceptions though. A few cases were noted where the resulting hue of dye was constant irrespective of plants of same or different specimen parts used. For example:

TREND I:

Same part of a plant which produced same hue of dye with different mordants.

Table Ia.

Plant	Part	Mordant	Dye/hue
Cyphomandra batacea 'tree tomato'	leaves	alum chrome	light grey light grey

b.

Phytolacca dodecandra	leaves	alum chrome	yellow-green yellow-green

c.

Plectranthus barbatus	leaves stalks, flowers	alum chrome	green-brown green-brown

d.

Rubia cordifolia "gakaraku"-Kikuyu-	roots	alum chrome	red-brown red-brown

TREND II:

Same parts of Common plants which produced different hues of dye with different mordants (See plates 1 & 4) as follows:

Table 2a.

Plant	Part	Mordant	Plate/Dye hue
Dahlia Dahlia	flowers flowers	chrome alum	4u 4v

Table 2b.

Plant	Part	Mordant	Plate/Dye hue
Dovyalis Caffra	leaves	alum	le
Dovyalis Caffra	leaves	chrome	4x

TREND III:

Same parts of Common plants which produced different hues of dyes with Common mordant (See plates 3 and 4) as follows:

Table 3.

Plant	Part	Mordant	Plate/Dye hue
Dahlia	flowers	alum	3p
Dahlia	flowers	alum	4v

TREND IV:

Different parts of different plants which produced different hues of dyes with a Common Mordant. (See plates 1, 2 and 3) as follows:

Table 4a.

Plant	Part	Mordant	Plate/Dye hue
Allium cepa(onion)	skins	chrome	1a
Cassia didymobotrya	leaves	chrome	1b

b.

Plectranthus barbatus	leaves	alum	2i
Iris germanica 'purple iris'	flowers	alum	2l

c.

Canna	flowers	alum	3m
Plectranthus barbatus	leaves	alum	3o

TREND V:

Different parts of a plant which produced different hues of dye with a Common mordant (See plate 1) as follows:

Table 5.

Plant	Part	Mordant	Plate/Dye hue
Rumex abyssinicus	old roots	alum	1d
Rumex abyssinicus	young roots	alum	1f

From the foregoing results it can be seen that two important revelations have been made.

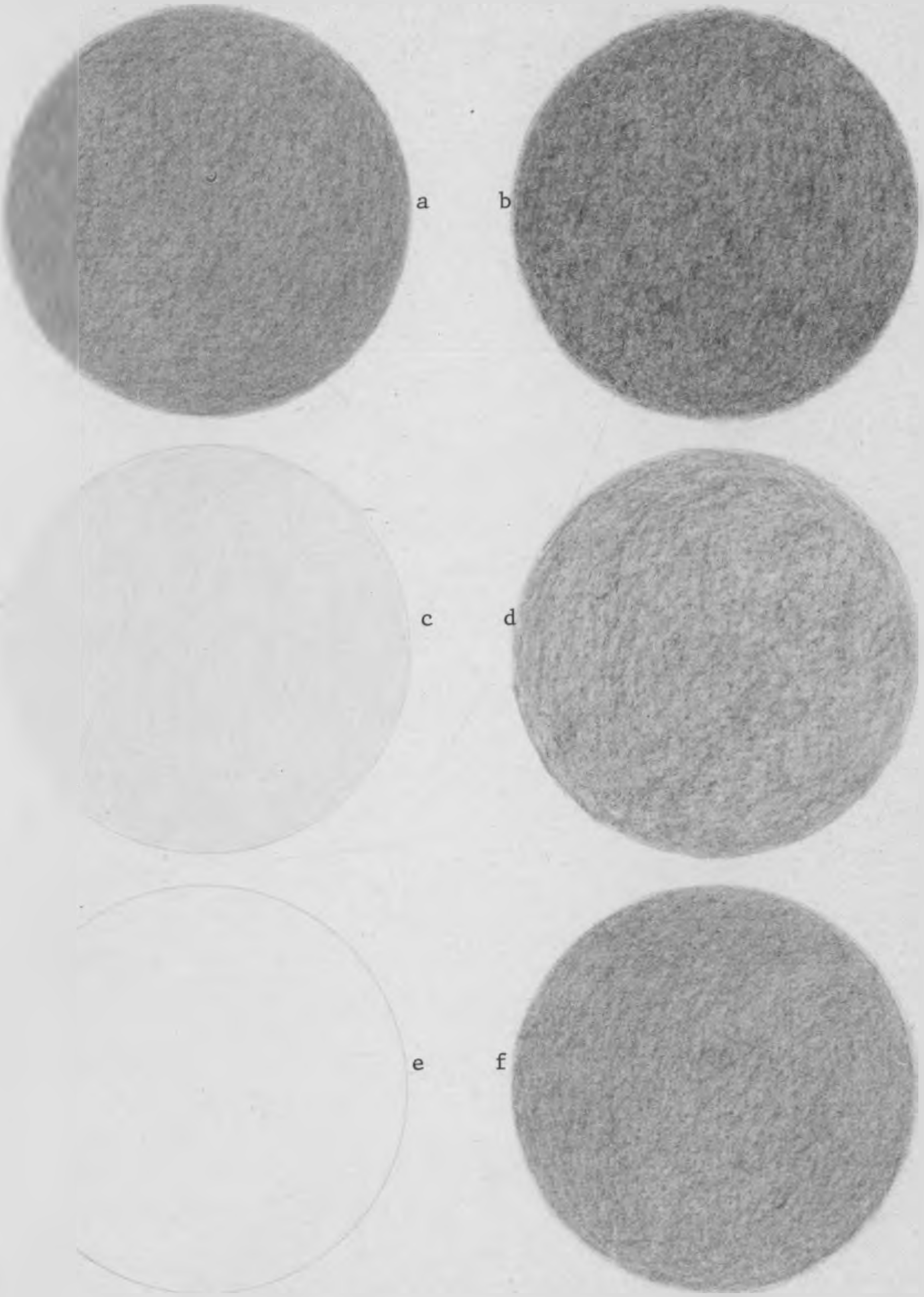
First, results from TREND I (Table la-d) show that a <u>control</u> (hereinafter referred to as as CONTROL X in future experiments or reference) has been established. Results here prove that irrespective of mordant used, the hue of dye obtained is the same provided the part of plant used in the experiment remains the same.

Second, results from TREND III (Table 3) show that another <u>control</u> (hereinafter referred to as CONTROL Y in future experiments or reference) has been established. This result may prove either of the two possibilities since the <u>same parts</u> come from common plants from <u>different places</u>. It is possible that:

- either, age of these same parts is different as is true with TREND V (Table 5);

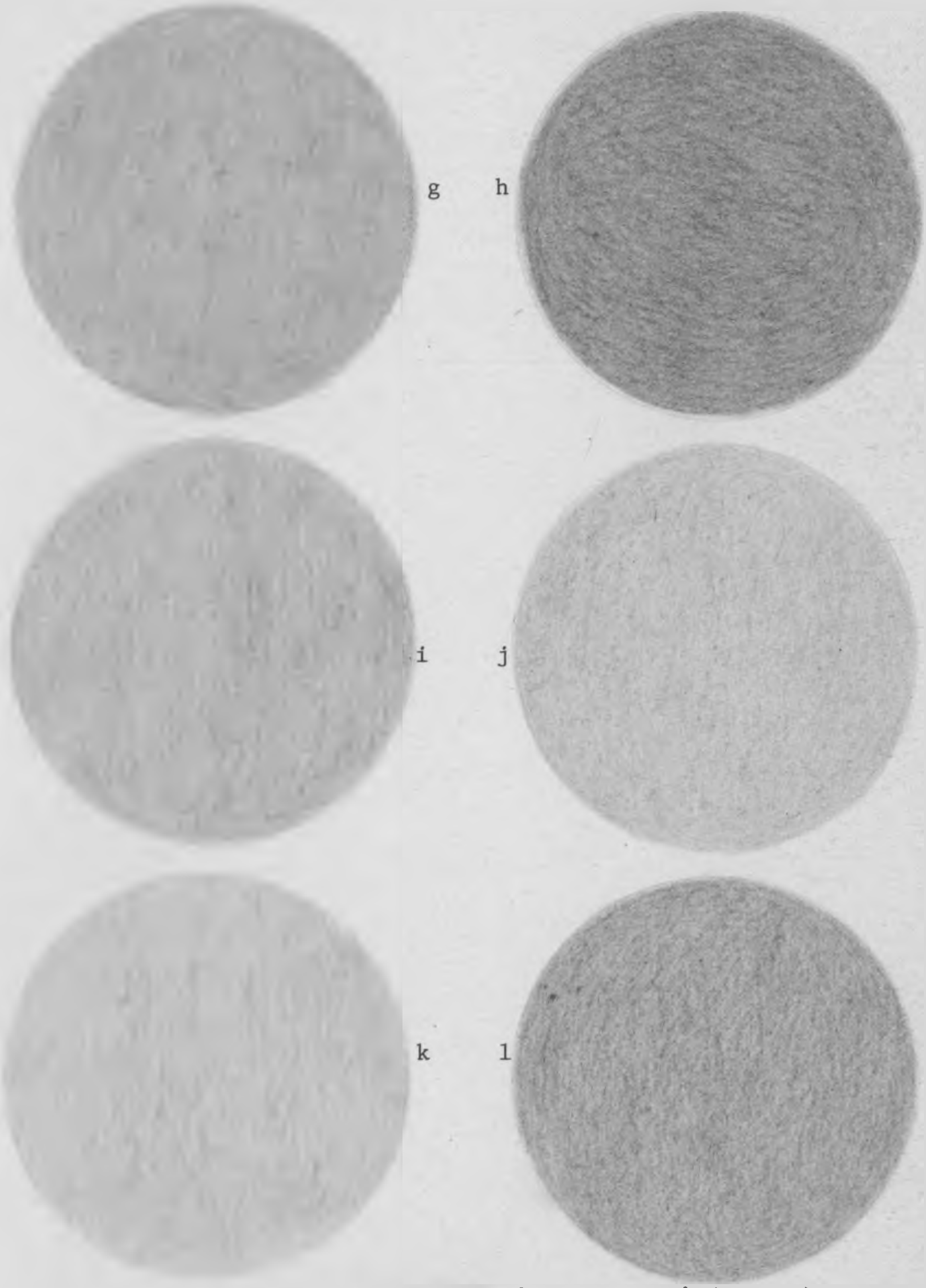
- or, mineral nutrients in soil differ.

Plate - 1



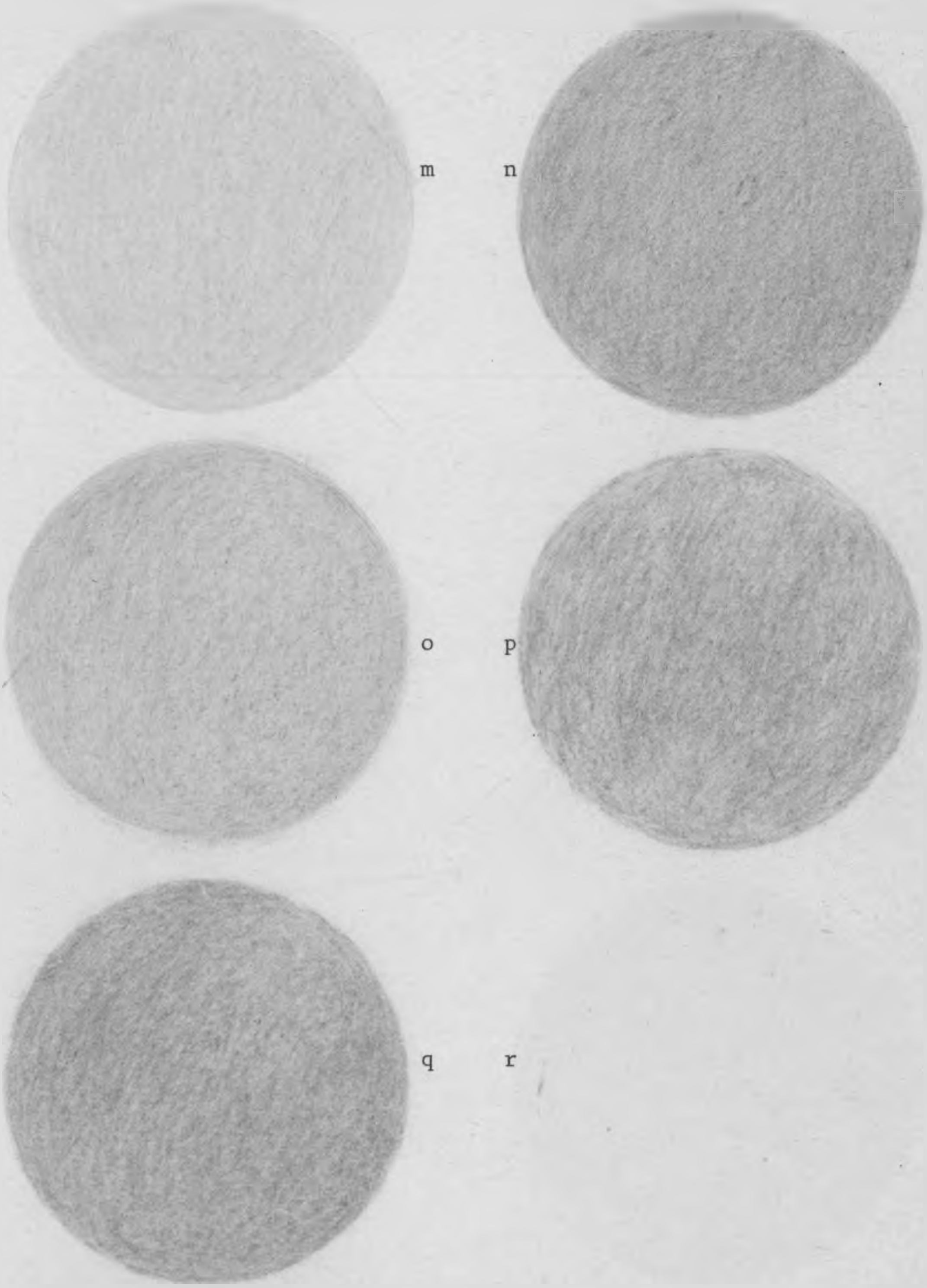
a: Allium cepa (skins). chrome.
b: Cassia didymobotrya (leaves). chrome
c: Dahlia (flowers). alum. re-use.
d: Rumex abyssinicus (old roots). alum.
e: Dovyalis caffra (leaves). alum.
f: Rumex abyssinicus (young roots). alum.

Plate - 2



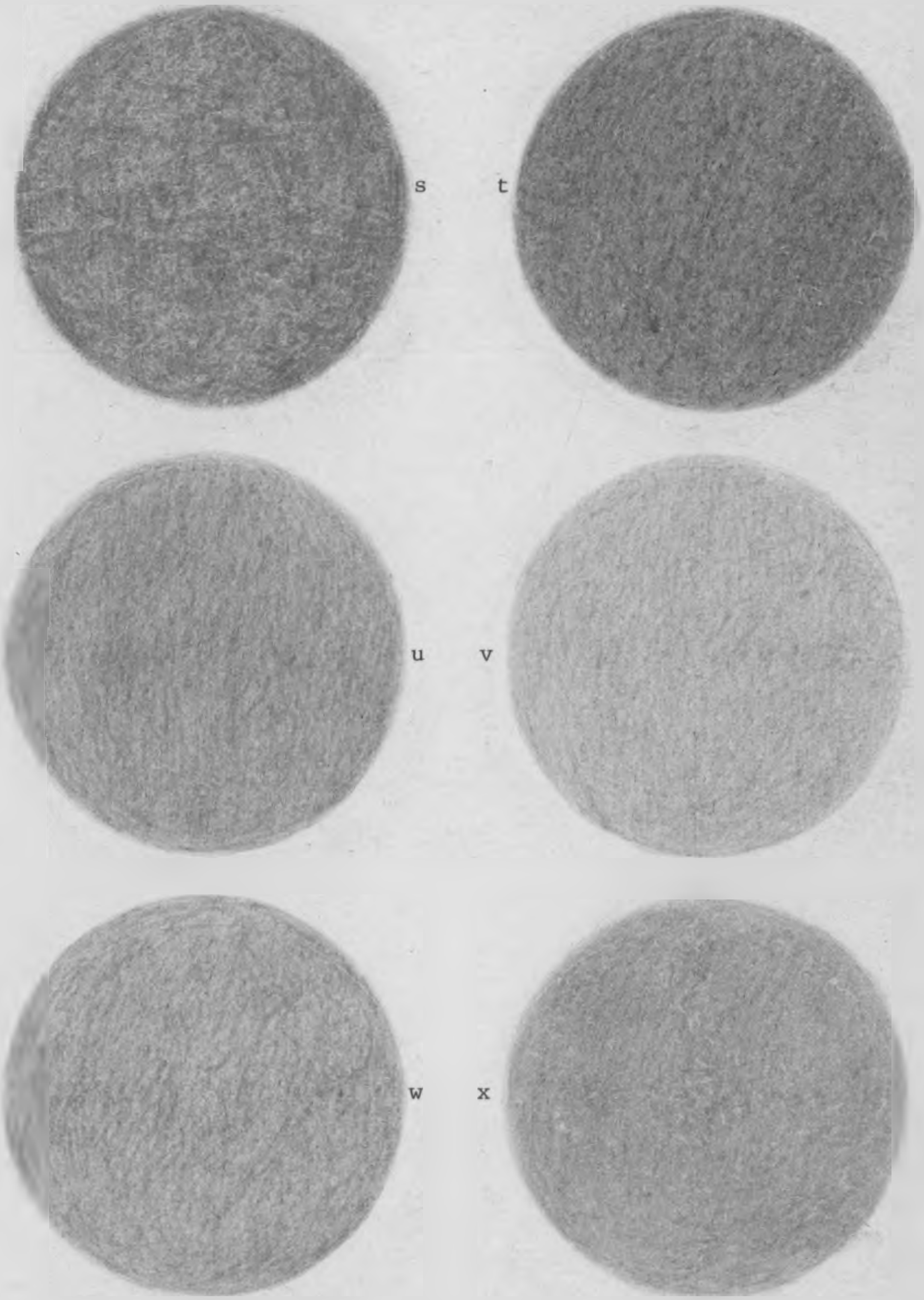
g: Euphorbia catinifolia 'copper tree' (leaves). chrome.
h: Indigofera arrecta. urine vat.
i: Plectranthus barbatus (leaves). alum.
j: Indigofera arrecta. Hydrosulphie vat.
k: Plectranthus barbatus (leaves). alum. 2nd bath.
l: Iris germanica 'purple iris' (flowers). alum.

Plate - 3



m: Canna (flowers). alum.
n: Rubia cordifolia (young roots). chrome
o: Plectranthus barbatus (leaves). alum. 3rd bath.
p: Dahlia (flowers). alum.
q: Bougainvillea formosa (leaves). alum.
r: Crotolaria agatiflora (leaves, flowers). alum.

Plate - 4



s: Cordeauxia edulis (leaves). alum.
t: Plectranthus barbatus (leaves, stalks flowers). chrome.
u: Dahlia (flowers). chrome.
v: Dahlia (flowers). alum.
w: Dahlia (flowers). chrome. re-use.
x: Dovyalis caffra (leaves). chrome.

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

Lorna Hindmarsh of Njoro, deserves special commendation for her tireless efforts in trying to establish a reservoir of traditional dye sources in Kenya. Professors J. O. Kokwaro (Botany), R. W. Munavu (Chemistry) and Dr. J.A. Ogur (Chemistry) all of the University of Nairobi also get credit not only for supervising this thesis one way or the other but also for helping with identifying and classifying of vegetable materials.

This research has had the prime object of sounding out the traditional sources of vegetable dyes and traditional earth colours in Kenya with a view to firstly appreciating their potential for application on fabric and or paper; secondly, partially satisfying the need for a more relevant Materials Course in the Department of Design, University of Nairobi and thirdly, establishing a strong base for further research geared towards investigating the eventual viability of the locally available dyes for industrial production.

The age-old North, West and Central Africa traditional practices and application of vegetable dyes on fabrics (not to mention earlier records of the same in other parts of the world, notably the Mediterranean) have gone a long way to inspire and encourage the quest for similar practices here in Kenya. This backdrop naturally became an important springboard from which the research findings now contained in this Thesis sprang.

From the field research findings, plant sample screening and experiments carried out, it has become quite clear that a wide range of dye-producing plants do exist right here in Kenya from the Lake Basin through the Highlands down to the Coast. It is thus encouraging to note that most of the available vegetable dyes in Kenya actually obtain within the areas initially identified for this research study.

Nevertheless, it is equally significant to note the eventual need which developed as to have allowed this research to spill over the initially identified sub-research areas namely: the Lake Basin and the Coastal strip. Earlier experiments with plant specimens from the sub-research areas produced a general range of dye from light yellow, orange through red, dark brown to green, grey, gold and beige. This revealed the absence of indigo blues - the traditional indigofera plant by-products of which a number of examples were already well articulated from the West African traditional dyeing experience. Two facts were obvious. First, that Nigeria, Senegal and Kenya appear in the Tropics within which general vegetational similarities abound and second, that naturally therefore, indigofera species which are plenteous in West Africa, should also exist in Kenya. This was later found to be true, though on higher ground in Nyeri. In fact Lorna Hindmarsh of Njoro had earlier on been lucky to find some species of indigofera, the indigofera arrecta growing near her home. Further findings have since revealed another important member of the plant family, the indigofera tinctoria which grows in Kenya at a lower altitude.

Other unique traditional vegetable dye sources which exist outside the initially identified research areas of Kenya but which deserve mentioning here are (1) "Mukinyai" - Kamba -, a plant from Kitui District which produces black dye, (2) "Kyuasi" - Kamba -, a plant bark from Kitui which produces blue dye, (3) "Muliovindi" - Kamba -, a plant fruit from Kitui and Machakos which produces purple or pink dye, (4) "Mbumbu" and 'Nzooko" - Kamba -, leaves of plants from Kitui and Machakos which produce green dye, (5) "Mukuyu" and "Muuku" - Kamba -, bark of trees from Kitui which produce yellow dye and (6) "Kiuvi" - Kamba -, a root of plant which produces yellow dye.

The findings in the form of identification of traditional vegetable dye sources and documentation of earth colours and their traditional application together confirm, at least at this stage of research, the potential in Kenya of dyes and earth colours from local plant and earth sources respectively. However, the protection and preservation of the indigenous Kenyan flora among which the dye-producing and the endangered species thrive, continue to create great concern.

PROBLEM AREAS

Noteworthy are the various difficulties which impinge on safety and administration of plant resources as encountered as well as observed in the course of field survey and actual collection of specimens for study. The near total disappearance of some rare plant species in areas where these were hitherto available is not uncommon. This disappearance seems to be aided by various agents.

Among these are:

- Fires which are sometimes started during the long dry season either by smokers who throw away cigarrette butts carelessly onto dry grass at the countryside or by farmers preparing their gardens for cultivation. The ensuing inferno often rages relentlessly through large tracts of land supporting indigenous flora.

- Emerging industrialists who penetrate new virgin land and clear tracts with impunity in the pursuit of commercial ventures.

- Clearing of land for agricultural expansion and human settlement which often does a lot of harm to natural vegetation cover.

- Pastoralists and nomads who trek with animals and overgraze the fields.

- Depletion of water catchment areas through wanton felling of trees for burning of charcoal.

- Desertification through indescriminate felling of trees and clearing of forests for human habitation.

- Encouragement of soil erosion through poor agricultural husbandry and wrong cultivation methods.

- Replacement of indigenous plants with exotic species some of which stifle the growth and stop the existence of local competitors often ending with natural rivers being drained and water tables being lowered.

- Pollution of river waters through industrial effluents with the resulting injurious effect on immediate habitat.

- Over-reaping of parts of rare medicinal herbs which poses a danger to the preservation and protection of the endangered species. First, these rare species are naturally scarce in any given environment and second, medicinal herbs generally have strong scent which by strange coincidence has been proved to be a natural indicator for strong dye-potential. The co-existent dye-potential and traditional herbal values thus risk being lost.

- The last but probably the most interesting characteristic of the phenomenal 'disappearance' of the dye-producing plants seems to be the loss of touch of the local communities with not only the sources of traditional vegetable dyes themselves but also with their application and practices. The apparent risk therefore is that the wisdom, knowledge, expertise and traditional lore pertaining to technology of production and application of vegetable dyes have either disappeared or on the verge of doing so. This position is attested to by the oral interviews from the field. Very little seems to be known by the local communities about sources and application of traditional vegetable dyes. Practising herbalists definitely provide a good resource base for information on plants and the herbal concoctions and syrups they make. Unfortunately this base is restricted and limited to the colouration of the syrup only used as identification indicator for both therapy and herbal nomenclature. The correlation between the visual pigmentation and the inherrent applicable dye is, sadly, hardly appreciated.

So far, the dye potential from Kenya's indigenous plants has been established and documented. The dyes have been tested using a chosen fabric material namely, wool. Wool was naturally preferred to cotton at this stage of research because it is more easily workable and more receptive to dye. Cotton, although well studied and researched as a textile material, contains cellulose material which is more difficult to use before retting and scouring, processes which slowly prepare it for easier dye receptivity.

RECOMMENDATIONS

Going by the observations, findings and results arising from field research and experiments carried out three levels of recommendations come out quite clearly. First, the problems concerning safety and administration of habitat with specific reference to preservation and protection of forest and its ecology in general and that of the endangered plant species in particular strongly suggest the urgent need for legislation of policy to address general and specific measures for protection of plant life in Kenya; second, the availability of vegetable dyes from identified plants and their textile dye potential as herein partially established (as applying to wool) requires policy guidelines regulating mode and extent of exploitation with a view to making supply and demand sustainable and third, the express need for further research into and with selected vegetable dyes.

LEGISLATION OF POLICY

To begin with, there is in Kenya a definite need to address the issue of extermination threat to indigenous forests in general and the endangered plant species including dye-producing plants in particular. Despite lack of specific policy instrument on plant protection in Kenya, inferences on protection can be drawn from the broader framework of environmental policy, from ministerial statements and from international conventions to which Kenya is signatory. Two salient objectives of plant protection may emanate from these cited sources:

- preservation of outstanding botanical areas and
- protection of endangered plant species.

A plant protection law exists in Kenya in which plant conservation requirements apply through two types of legal instruments, the first type of which is directed at the protection of certain types of habitat and the second types at the protection of particular species of plant. It is a pity, however, that although complementary, the two provisions under the law do not cater for full objectives of plant protection. A plant protection law without provisions against wanton destruction of forest including endangered species of plant and prescription of penalties, incentives and the law enforcement machinery is incomplete.

The historical basis on which legislation of plant protection Act was instituted has with the lapse of time been proven both inappropriate and inadequate. It is inappropriate because it operates on early imperatives emphasizing maximization of agricultural production and empowering the Minister for Agriculture to exercise exclusive jurisdiction over and above environmental protection. Needless to say there is ever an urgent need for greater agricultural production to cater for an increasing population but this urgency must not disregard an equally urgent concern for conservation and sustainable use of the environment. This strongly suggests therefore that the currently changing perspectives of plant protection and conservation must threaten the hitherto static and inadequate legislation provisions just stated in the existing plant protection Act.

PLANT CONSERVATION AND PROTECTION

The policy guidelines regulating the eventual mode and extent of exploitation of available vegetable dyes and their sources are thus paramount. The following recommendations could be made:

- To issue explicit instructions and public warning through the media, that is, radio, television, posters, car stickers, chiefs' barazas and public rallies against destructive forest fires, wanton clearing of bushes and indescriminate felling of trees for fuel wood and charcoal burning.

- To control human settlement to help curb the tendency of humans to migrate, infiltrate and overrun gazetted forest reserves.

- To extend the jurisdiction of the Forests Act to cover and protect the forest fringes and botanical sites which not only exist outside forest areas (with restricted legal protection facilities) but also as areas where the endangered species exist. As the law currently stands, the fringes may be plundered and destroyed with impunity.

- To control nomadic pastoralism with an aim of regulating grazing habits. The tendency to overgraze and overrun vegetation cover has grave consequences on the preservation of the habitat and indigenous vegetable dye-producing resources.

- To give instruction and education on need for land adjudication and consolidation including proper animal and crop husbandry. With proper cultivation habits, it is quite possible to rear some locally identified dye-producing plants for commercial purposes. Bixa orellana whose dye is used in cosmetics and food colouring and which is currently being cultivated on a commercial scale at Lake Kenyatta near the Kenya Coast, is a good example.

- To encourage and support afforestation programmes which would help control the speed of the encroaching Sahelian brow. The southward desertification propensity which threatens to wipe out large areas of natural vegetation in Kenya can only be contained through sustained tree-planting campaigns. Fortunately non-governmental organizations (NGOs) like the Green Belt Movement including other private organizations are already supplementing government efforts in this direction. But this needs greater support and encouragement by Kenyans generally.

- To campaign against clearing and replacing of indigenous plants with fast-growing exotics. This replacement tendency has resulted in some places in the extinction or near extinction of certain rare species. The Kenyan Energy Non-Governmental

Organization Association (KENGO) has been watching this grave situation for sometime and it has lamented the total extinction recently of the tree that grew in Taita/ Taveta locally called "mkomanyoka".
The tree was said to be lethal to snakes, while a concoction prepared from its bark was used to cure an epilepsy-hysteria-like ailment in children. Now, "mkomanyoka" is no more. In Kitui, the ficus natalensis "mugumu" is now also said to be extinct. Its bark fibre was extensively used to make bags and baskets which were said to give protection against evil spirits.

- To control and convert pollutants and effluents from commercial plants into harmless, non-toxic substances and the guarantee of the release of these into rivers as non-pollutants. The co-existence of animals and plants in a healthy habitat would thus be assured and everybody would be happy.

- To encourage reaping, in the general interest of environmental protection, of leaves rather than the bark or roots of dye-producing plants in order to avoid affecting plant life.

- To strongly consider the possibility that plants that have been used for medicinal, paper-making, fuel, ornamental, cash and food purposes should be screened for dye-stuff. This, if found viable, could have the double advantage of simultaneous exploitation of the plants' consumer potential.

- To utilize more profitably the farmers' enemies in the form of weeds like Bidens pilosa ' black jack' and Tagetes minuta, 'Mexican marigold' which have been found to be good dye-producers but which have hitherto been considered utterly useless.

- To disseminate research findings on traditional earth colours and vegetable dyes in Kenya through publications, lectures, seminars, symposia, and the storage in libraries both public and private national museums and archives of the relevant and related information.

Limitations granted, the fact that legislative provisions exist for plant protection in Kenya is a matter for great commendation. The existing provisions could be added to or changed to suit the requirements of new legislation. A clarification of policy would not only be necessary but it would also have the advantage of illuminating the nature of the necessary changes in legislation.

Over and above the existing provisions for plant protection in Kenya, the following matters ought to be provided for:

- Making it compulsory for acquisition of land for purposes of plant protection.
- Incorporation of conservation of plant habitats in land-use planning.
- Specific provisions for the protection of certain plant species to include not just spectacular or endangered plant species but also medicinal plants on which the future of herbal medicine in Kenya depends.

And finally, going by what has been said before, it is never enough to merely protect species and habitat. A comprehensive legislative framework for the national management of plant resources is the ideal approach to plant protection. Therefore, the urgent need for a comprehensive legal framework which caters for the management of plant resources in Kenya cannot be over-emphasized.

AREAS FOR FURTHER RESEARCH

The foregoing research findings, conclusions and recommendations do certainly provide a strong foundation on which related research should be based in future.

First, proof is already unquestionably established about an appreciable number of hues of vegetable dyes available in Kenya and second, wool, which has a naturally high level of dye receptivity, has been proven to take these dyes well. Wool and the reasons for its choice over other textile materials at this stage of research have already been clarified.

It will be appreciated that the initial proposal for this research had been overshot. It has also been explained that a large part of this proposal was redesigned to suit the requirements of the Masters thesis. These requirements are now hereby considered accomplished in the context in which the current findings mark the end of the first phase of an ongoing research programme.

The needs for further research will be based on current findings. It is hereby proposed that the second phase of research, besides pursuing and probing deeper implications of CONTROLS X and Y (see Discussion of Results), will address four areas involved with more detailed experiments.

First, a more elaborate schedule for application tests with vegetable dyes will be required to be made on textile materials other than woollen products. Screen printing of cotton and chiffon materials would be done. Retting and scouring will be made of cotton to help remove the coat of cellulose and prepare the fabric for easier dye reception.

Second, fastness tests will be made on dyed fabrics using vinegar, ordinary soap, omo, jik, ironing and exposure to the elements: rain, sunshine and winds.

Third, dyestuffs will be stored in powder form and tested for durability. Recipes will be made and creations of these will be named.

Finally, and the most important, it is hoped and envisaged that a statistical critique based on scientific findings arising from the experiments carried out could possibly bolster appropriate technology for a locally based industry with a capacity to help ease current dependence on imported dyestuffs into Kenya.

Over and above all these is the academic need for the continued research programme - the requirement of which can hardly be under-estimated. A strong case for a proposal to pursue the second phase of this research at a more serious academic level, preferably Ph.D. is plausible.

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