Tanzanian Mpingo '96

A Cambridge University Approved Expedition in association with Dar Es Salaam University and the Wildlife Conservation Society of Tanzania; supported by Fauna & Flora International, the Royal Geographical Society (RTZ fund), BP & Birdlife International.

Final Report

Ball, S.M.J., Smith, A.S., Keylock, N.S., Llewellyn, K.S., Manoko, L., Mlay, D., Morgan, E.R., Ormand, J.R.H., Timothy, J.

In Memory of Baba Chilima

Tunamkumbuka Baba Chilima

Contents

Abstract

Tanzanian Mpingo 96 was formed in response to the lack of information available on the ecology and exploitation of *Dalbergia melanoxylon*. Highlighted at the 1995 Maputo conference organised by Fauna & Flora International, this lack was holding back the design of a practical management plan to conserve the species. The team, comprising students from Cambridge and Dar Es Salaam Universities and a Tanzanian forester, spent seven weeks camped on the edge of Mchinga village, about 30km north of Lindi in South-East Tanzania. The core part of the expedition was a detailed botanical survey of a 1km² patch of woodland rich in *D. melanoxylon*. This was complemented by short trips to assess other *D. melanoxylon* rich sites in the Lindi region, and a series of meetings with local people to discover their knowledge of and attitudes towards the species. The research has produced a set of baseline data – the largest of its kind for the tree. The *D. melanoxylon* at Mchinga appeared to be faring reasonably well – it was the third most common tree at the site – but a high proportion of trees with thick stems had been felled. Seedlings were plentiful and regeneration did not appear to be suffering. The local attitude was predominantly indifference, but this generally appeared to result from their lack of a stake in the land or the trees. Considerable further research is required to develop a database sufficiently large to confidently draw conclusions relevant to the state of *Dalbergia melanoxylon* across Tanzania.

'Tanzanian Mpingo 96' iliundwa kutokana na ukosefu wa maarifa kuhusu ikolojia na utumiaji wa *'Dalbergia melanoxylon'* (jina la mti wa mpingo kwa Kilatini). Ukosefu huu uligundulikana katika mkutano wa Maputo 1995 ulioandaliwa na 'Fauna and Flora International'. Ukosefu wa maarifa ulikuwa ukizuia ubunifu wa mradi kuuhifadhi mti huu. Timu ya utafiti, iliyokuwa na wanafunzi kutoka vyuo vikuu vya Cambridge na Dar Es Salaam, ilipiga kambi katika kijiji cha Mchinga. Kijiji hicho kiko umbali wa 30km kaskazini mwa Lindi Tanzania kusini. Azma kuu ya utafiti huo ulikuwa ukaguzi wa kibotania (sayansi ya muundo wa mimea) wa sehemu ya msitu (1 KMsq. yaani 1km x 1KM) iliyokuwa na mipingo mingi. Zaidi ya hayo, ziara ndogo zilifanyika kwa ajili ya kukagua sehemu nyingine zilizokuwa na mipingo mingi (y. *D. melanoxylon*) mkoani; pia mikutano na wenyeji ilifanyika ambapo wenyeji walipata fursa kuchangia maarifa na mawazo waliyokuwa nayo. Zao kuu la utafiti huu, lilikuwa data ya msingi kuhusu mpingo (y. *D. melanoxylon*); mkusanyiko huu wa maarifa hayo ni mkubwa kuliko mwingine wo wote ule duniani. Mchinga, mipingo ilikuwa inaendelea vizuri, (kulikuwa na aina mbili za miti zilizokuwa na idadi kubwa kuliko mpingo), lakini mingi iliyokuwa na shina kubwa ilikatwa. Miche ilikuwa mingi lakini athari ya kukata miti kwa muda mrefu kwenye wongofu wa miti haijajulikana bado. Wenyeji hawakuwa na mawazo mengi kuhusu hali hiyo, lakini inaonekana kuwa hawakuwa na kitegauchumi kilichotokana na ardhi wala miti yenyewe. Utafiti zaidi unahitajika kwa ajili ya kutengeneza 'database' (maanake hifadhi ya maarifa) itakayotuwezesha kuithibitisha hali ya mpingo (*D. melanoxylon*) Tanzania nzima.

Part I : The Science

Introduction

The Tree

Mpingo, mugembe, poyi, grenadilla and zebra wood are all common names given to *Dalbergia melanoxylon,* the East African blackwood (Treeroots Network 1993). It is also commonly mistakenly referred to as (East African) ebony, although the *Dalbergias* (rosewoods), belonging to the Leguminosae family, are not closely related to the *Diospyros* genus in the Ebenaceae family – the true ebonies. The name *melanoxylon* is appropriate – meaning literally black (*melano*) wood (*xylon*).

The tree, Tanzania's national tree, is most commonly found in dry coastal forests from the Tana River in Kenya south through Tanzania and most of Mozambique (McCoy-Hill, 1993). It is also a common component of the open miombo woodland and savannah habitat which covers about two thirds of Tanzania, and described by the Cambridge Encyclopedia of Life Sciences as "arguably the most important wildlife reserve in the world". However its distribution is much wider than this: the tree is native to the whole of sub-Saharan Africa, ranging from northern Ethiopia, south to Angola and the Transvaal and west to Senegal (Lovett 1988). It has also been introduced to the Indian subcontinent. It is present in commercially significant levels only in Tanzania and Mozambique, with some harvesting also occurring in Zambia and Malawi – Kenya's stocks are now reportedly negligible.

D. melanoxylon is often multi-stemmed and extensively branched. The trees grow very slowly and in very gnarled and twisted shapes; annual increases in height and girth are small: Mugasha (1978) suggests up to 0.6-0.7m vertical growth per year. Timber size is not reached until at least 50 years (McCoy-Hill 1993), with most estimates set at 70 to 100 years (Platt & Evison 1994, Moore & Hall 1987 amongst others). The average height of adult trees is between 3 and 7.5 metres, but some reach as high as 15m (McCoy-Hill 1993). The average diameter reached at breast height is 38cm (Dale & Greenaway 1961).

The bole is typically heavily fluted and the crown irregular. Stems and branches bear characteristic 2-3cm long woody spines (Puhakka 1991). Bark is grey to greyish-brown and generally smooth, papery and flakes with age (Bryce 1969). Beneath it lies yellowish sapwood (1-2cm thick), and inside this the purplish or brownish black heartwood (McCoy-Hill 1993). The leaves are pinnate with 3 or more alternate-subopposite dark green leaflets 0.8 to 3.5cm long by 0.8 to 2.5cm wide. They are commonly shed during the dry season. The flowers are small, whitish and sweetly scented in axillary panicles with 10 stamen united into a tube. Fruits are indehiscent, unwinged pods about 4cm long containing 1 to 4 seeds (Lovett 1988). Flowering and fruiting seasons are not well defined (Sharman 1995).

In common with many other Leguminosae species, *D. melanoxylon* possesses nitrogen-fixing nodules in its roots (Prasad et al. 1994). The species could therefore potentially play a very significant ecological role in the habitats where it is present (Puhakka 1991), although this is very difficult to assess.

The wood of *Dalbergia melanoxylon* is East Africa's most valuable (Lind & Morrison 1974). In 1988 Lovett reported sawn logs fetching up to US $9,000 per cubic metre, and processed timber selling for US $13,000/m³, with the highest prices obtained for the purest black timber. The same author (1987) states that *D. melanoxylon* exports earned Tanzania US $M0.5 in 1982 – extremely valuable hard currency for a poor country. Infrastructure problems subsequently caused a dip in Tanzanian export volumes in the mid 1980s, but since then exports have risen steadily (Moore & Hall, 1987). The wood is extremely hard and heavy, naturally oily and of fine texture; growth rings are usually indistinct (Bryce 1969). These qualities make it ideal for the manufacture of musical instruments as it can hold metal fittings, and does not warp with changes in temperature and humidity – ensuring that it holds its tone well; in addition it has an attractive look to it. Clarinets and oboes are the most common instruments made from the wood, although bagpipes, recorders and piccolos are also manufactured from it, as are piano keys and the fret boards of guitars (Lovett

1988). According to UNEP (1988) it is the finest material available for woodwind instrument manufacture.

Dalbergia melanoxylon wood is thought to be ebony of the Ancient Egyptians. They are believed to have mounted major expeditions south through Nubia (ancient Ethiopia) to obtain the wood, which they used to make ceremonial rods and other luxury items (Puhakka 1991). It has been traditionally used by the African people to make various utensils and tools: hoes, from which the tree gains the local name “mugembe”, pestles, combs, cups, knife-handles and even walking sticks (although these are reportedly impractically heavy) (Bryce 1969). More significantly, it is the material of choice for wood-carvers throughout the region, and the distinctive carvings will be familiar to any visitor. Those of the Makonde people from Southern Tanzania have gained the most recognition for artistic merit: witches and devil spirits from traditional stories are commonest motifs, and the best examples are quite beautiful and eye-catching, demonstrating a smooth-flowing style. The tradition is strong amongst carving families and passed from one generation to the next, but new styles are being continuously developed (Puhakka 1991). Western themes have always been catered for: chess pieces, paper knives, marquetry, and more recently Coca Cola bottles can all be purchased. Today the production of carvings for tourists is a major business, with Mwenge Carvers Society in Dar Es Salaam, the largest co-operative, comprising several hundred carvers. The market is not well understood, but it is growing rapidly and could one day equal the export timber trade in value, if it does not already.

More prosaically, both sapwood and heartwood are very high energy fuels, and are often used in making charcoal (Nshubemuki 1993). The leaves and bark of *Dalbergia melanoxylon* also have their uses - as fodder for animals, mulch for the earth and medicines against a diverse range of complaints including headaches and diarrhoea (Sharman 1995).

Concerns

While there is little danger that *Dalbergia melanoxylon* will become extinct it is currently very vulnerable to commercial and local extinction (Puhakka 1991; UNEP 1988). The population in Kenya is now very low indeed, and some estimate that there will be no harvestable wood left in Tanzania in as little as twenty years time with potentially disastrous consequences for the local economy (UNEP 1988). It is still a common tree, with populations in many protected areas such as the Selous Game Reserve and Mikumi National Park (Lovett 1987; Norton & Hawkins 1995). However, there is growing concern that the supply of high quality wood is limited and may become exhausted if exploitation of the species continues uncontrolled (Lovett 1987). Unlike the ivory once used for piano keys, there is no viable alternative for top quality woodwind instruments (UNEP 1988). Plastic is not a respected substitute for the serious player, but in recent times reconstituted wood from *D. melanoxylon* has been developed as an alternative to pure timber. This method makes the wood go further, and decreases the reliance on faultless pieces of timber.

Trees with very deeply fluted and gullied boles, branch knots, or holes or rotting regions within their heartwood (all common occurrences) are unsuitable for supplying the woodwind trade. They cannot yield a piece of heartwood large enough for the production of a clarinet, for example (Haughton-Sheppard 1958). Any faults in the wood will cause it to split immediately it is put on the lathe, although carvers tend to incorporate the natural twists and turns of the wood into their works (Lovett 1988). This problem is exacerbated by poor harvesting practices: felling by axes instead of saws and failure to seal the ends of logs against splitting in the sun before transport to the saw mill. In addition, stump level is often unnecessarily high, and tops and branches containing sound wood, and even rejected logs totalling as much as 40% of the available volume being left in the bush. The recovery rate from wood reaching the mill is also very low, with most estimates in the range 7% to 9% (Moore & Hall 1987).

In Tanzania large scale logging of *D. melanoxylon* for export was begun by the German colonists early this century. The practise continued under British rule, and after World War II higher levels of demand led to an increase in sawmill capacity (Moore & Hall 1987). Independence came in 1961, and then in 1967, as part of an effort to boost local industry, the export of unprocessed logs was banned and volumes dropped sharply. Since then exports have been confined to processed sets, and levels have risen steadily.

A permit is required to fell or kill the species, but the forestry officials are ridiculously over-stretched and short of resources. Illegal harvesting is rampant, and even in forest reserves unlicensed felling poses a significant threat. Outside these areas, land clearance for permanent and shifting agriculture is “by far the largest destructive activity” occurring in the miombo woodlands (Moore & Hall 1987). Moreover the expanding population means this factor must inevitably worsen. There are currently no controls on land clearance outside of gazetted reserves and National Parks.

In the light of the increasing exploitation of *D. melanoxylon* and the concern regarding its long term supply, an international workshop on the subject was held in November 1995 in Maputo, Mozambique, sponsored by Fauna and Flora International (FFI). Here it was pointed out that in order for a clear management plan to be formed with a view to the long term conservation of *Dalbergia melanoxylon* much more data (qualitative and quantitative) on the species is needed than is currently available (FFI, 1995). Despite its high exploitation by man, there has been little academic study of the species, and there are large gaps in current knowledge.

There was a move to propose *D. melanoxylon* for inclusion in Appendix II of CITES (the Convention on International Trade in Endangered Species) (Beale 1995; FFI 1995). Such listing would mean the requirement for permits for the export of *D. melanoxylon* wood, issued by the Tanzanian authorities, and reports by the state on the amount of trade in *D. melanoxylon* for submission to the CITES secretariat. However, a proposal which was due to be made at the 1994 conference of the parties of CITES was withdrawn. At the Maputo workshop it was decided that insufficient data is available on *D. melanoxylon* upon which to base a CITES proposal. Furthermore the consensus was against another proposal in the near future, but to utilise other methods of conservation instead. It was agreed that research into local exploitation and the general ecology of the species is of the utmost importance.

Research to Date

Moore and Hall (1987) report just 3 forest inventories carried out in *D. melanoxylon*’s range in Tanzania. These concentrated on harvestable volume obtainable from the areas surveyed. From these 3 inventories Moore and Hall estimate that the Lindi and Mtwara regions alone held in excess of 2,000,000m^3 of merchantable volume.

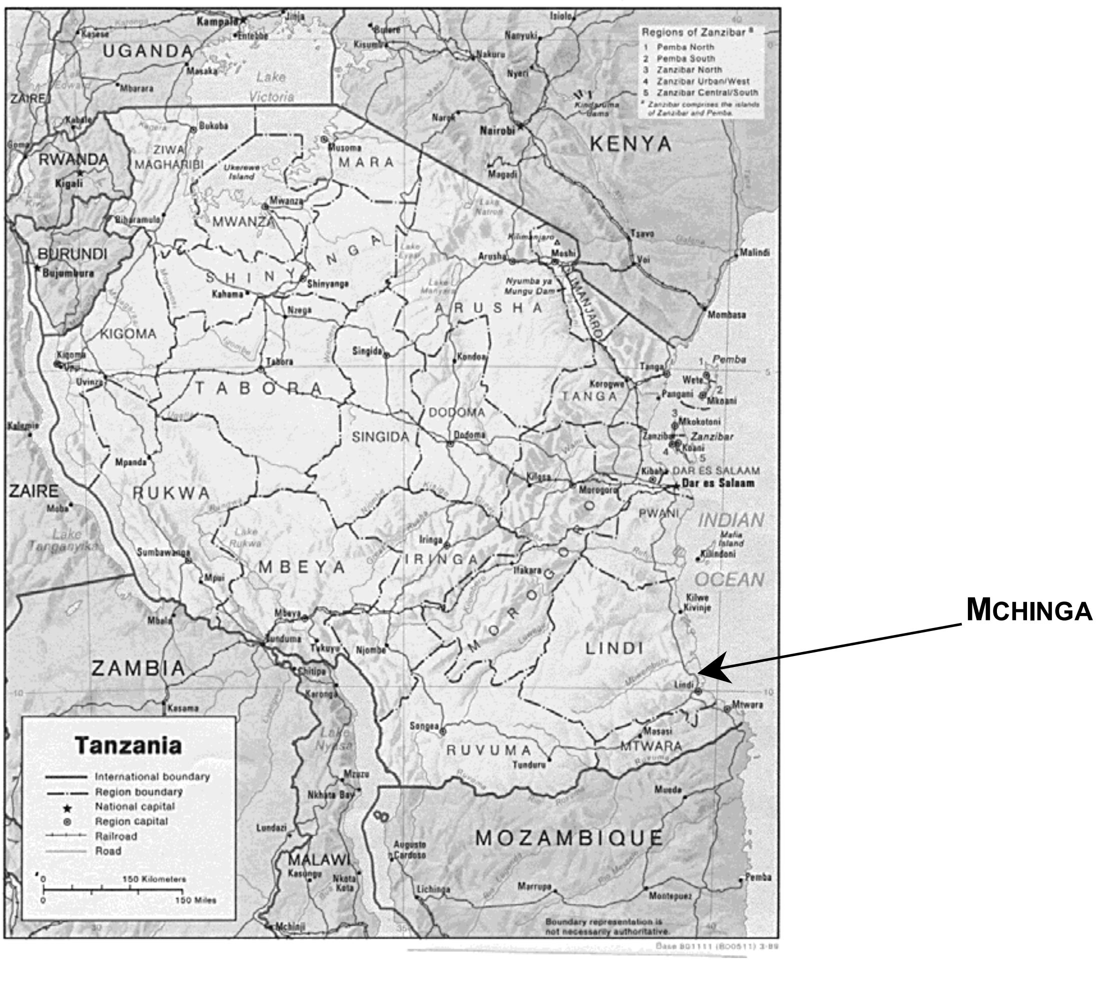
In 1995 Guy Norton and colleagues conducted a basic survey of the *Dalbergia melanoxylon* population in the Mikumi National Park in Tanzania, where the tree is protected from human exploitation (Norton & Hawkins 1995). *D. melanoxylon* is found at a very low density in their seasonally monitored plots – 14 trees per km^2 representing only 0.7% of the total tree density. Regeneration of *D. melanoxylon* in the plots (although not in all areas of the park) is limited, and a strikingly high ratio of dead to living wood (35:1) was found. The authors believe that this is due either to a gradual die off of *D. melanoxylon* trees which are very slow to decompose, or a single large-scale die off of *D. melanoxylon* at some time in the past. They also suspect that the dead wood may help create micro-habitats protected from fast moving bush fires.

In addition Professor Malimbwi at Sokoine University of Agriculture has recently commenced some research into the species, but beyond this there has been a dearth of quantitative data collected, with most commentators basing their conclusions on unsubstantiated field observations. The bibliography lists a string of papers and reports on the species, but the only real quantitative data appearing in these is harvesting figures. Through such research as Moore and Hall’s (1987), McCoy-Hill’s (1993), Platt and Evison’s (1994) and others we have a reasonable understanding of the problems and pressure involved in this side of the problem, and plenty of positive recommendations on improving efficiency have been aired. Up until recently, though, the ecological side has been largely ignored, and it was to address this deficiency that the Cambridge Mpingo Project was established and this expedition formed.

Study Site

The expedition's principal study area was close to the coastal village of Mchinga in the Lindi region of South East Tanzania, some way south of the capital, Dar Es Salaam. The whole area south area south of the Rufiji River is one of the poorest in Tanzania, and industrial development is virtually nil. The Rufiji presents an impassable barrier in the wet season, and the roads are completely unsurfaced for the most part and deeply rutted. The towns of Kilwa and Lindi were important centres of the slave trade in centuries past, but are now little more than decaying former colonial bases (Briggs 1993). The Makonde plateau (home of the Makonde people famed for their mpingo carvings) straddles the Lindi-Mtwara border inland from the coast. The region is a major centre of the carvings trade – the only large carvers co-operative outside Dar Es Salaam is in Mtwara – and harvesting of *D. melanoxylon* wood for export is an important economic activity.

The village of Mchinga itself is 30km north of Lindi – the two hour journey time by bus is an indicator of the poor state of the road. It is situated right on a beautiful bay which bears the same name. Primary occupations in the village are agriculture and fishing. Most of the good quality fish is sold to traders operating out of Lindi and Mtwara, with only the small specimens sun dried for local consumption. Climate is typical of the coastal strip – generally hot and humid, alleviated by light sea breezes. Seasons are monsoonal with the short rains from October to December, the long rains March to May, and the main dry season stretching from June to September.



The study area was located to the west of Mchinga village, approximately 40 minutes brisk walk from the camp. It was located on the top of a plateau. The actual study site, which only covered a small part of the plateau was approximately 1km^2 in total area.

A well-used path ran from north to south along the eastern side of the study site. This lead to several small homesteads, located just outside of the study site. Paths also ran off to the west of the study site, again leading to homesteads. These are marked on the site map opposite.

The study area consisted of two areas of deciduous woodland, flanking an area dominated by savannah grasses and small evergreen shrubs. The grassland accounted for approximately 50% of the total study area, and also contained numerous *Dalbergia melanoxylon* seedlings. There were many signs of fire upon this savannah area, and dry riverbeds were also seen through the grassland running east to the sea.

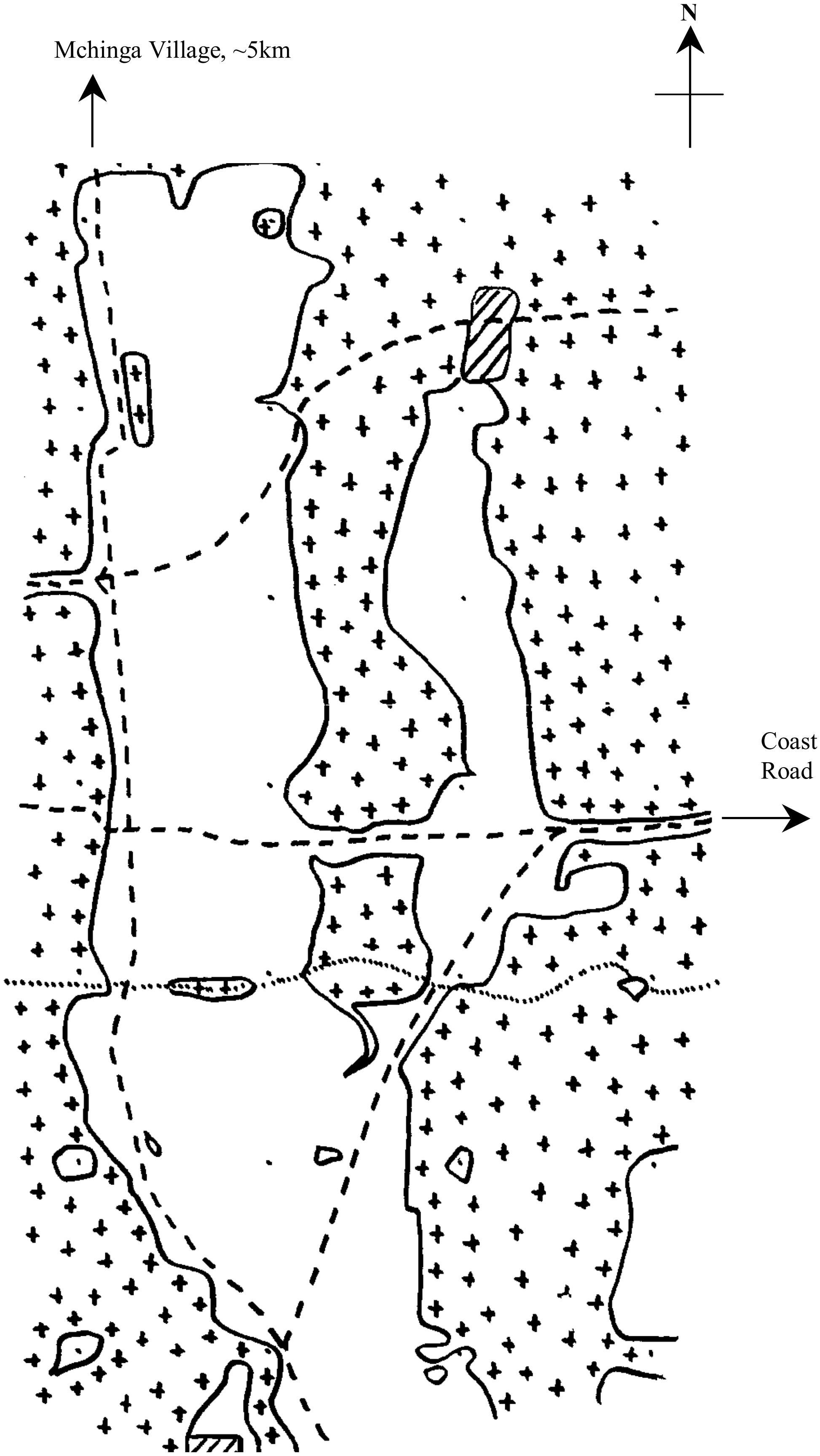
The woodland was dominated by a few common tree species, characteristic of the miombo woodland that is found throughout this region. Species that were found regularly included *Acacia spp., Commiphora spp.,* and *Combretum spp.* Certain species in the Euphorbiaceae family were also well represented, especially *Spirostachys africana.* The woodland was very dense, and numerous small shrubs grew in the gaps between trees. Lianas were also common, growing on most of the tree species that were found in the thicket.

The survey took place during the dry season, and hence the grass was yellow. This was also the case in the woodland, where the deciduous species that grew there had begun to shed their leaves. As leaf shape is a crucial component of tree identification, this lead to problems in identifying many species later in the survey. No surface water was found anywhere on the study site, which was another indication of the aridity.

There was moderate sign of animal presence at the study site. Spoor of hyena was frequently seen, and tracks of dik-dik in one plot where there was a dried-up waterhole. A pair of black-backed jackals were also seen in one of the plots. Tracks of bush pigs were frequently seen and the locals hunted them there using fire to flush them out of the thick bush. Tortoise sign was spotted, as were a variety of lizards including chameleons. Snakes were a much-encountered hazard: usually puff adders, but mambas and vine snakes were also seen at the study site. Bird-life was plentiful and varied: raptors were common, a group of hornbills lived in the vicinity, and many smaller birds common to this type of woodland were seen (see the species list in Appendix II). Termites and ants were abundant.

Key to Map of Study Site

+ + + +	Forest	///	Human habitation
	Grassland	— — —	Path
•	Plot point	....	Dry stream bed


N
Mchinga Village, ~5km
Coast
Road

Methodology

The first activity at the study site was to produce a rough map of the area simply by noting vegetation types and landmarks encountered during walks over the plateau, of area approximately $1km^2$, in a South – North direction. The main part of the study involved walking four transects (again in the South – North direction) 200m apart. A study plot was set up every 200m along these transects such that the plots set out a 200m by 200m square grid. The plots were of radius 30m. Upon reaching each one, four 30m strings were laid out from the centre to the North, South, East and West. The work within each plot was divided into four tasks:

Plot description and soil collection

A basic map of the plot was drawn, and the predominant vegetation type (e.g. thicket, grass, cultured land), relief and landmarks were recorded. Soil samples were taken from the plot centre, and 20m due North, East, South and West of it. These were analysed later at the camp (see Soil Analysis section).

Dalbergia melanoxylon data collection

Every *D. melanoxylon* tree or sapling was examined. We classed individuals with a circumference at breast height (CBH) of 10-30 cm as saplings and those with a CBH greater than 30cm as trees. Smaller individuals were classed as seedlings, and not dealt with in this section.

The following information was collected for each *D. melanoxylon* tree and sapling:

- Distance and bearing from plot centre, measured using 30m and 50m tapes and Silva compasses.
- Number of stems or branches at breast height (1.4m) and the CBH of each one, measured with a sewing tape.
- Height, the measurer stood 10m from the highest point of the tree (judged by eye), and aimed a clinometer at the top. The height was calculated later using the equation

$$H = 10(\sin a) + h$$

- where H is the height of the tree, a the angle shown on the clinometer and h the eye-height of the measurer.
- Canopy Area. The greatest diameter and the greatest width perpendicular to it were measured using long tapes. Canopies were assumed to be elliptical in shape and areas calculated using the formula

$$A = \quad ab$$

- where A is canopy area, and a and b the measured dimensions.
- Damage. Any visible damage to a tree was recorded, and the cause (e.g. fire, human activity, etc.) was noted where possible. We found termites to be widespread, and devised a scale for the degree of infestation of trees ranging from T0 (termites absent) to T5 (very serious infestation).
- Any other observations: the presence of cocoons, nests, webs, galls, lichens and fungi etc. on each tree were noted.

Other tree species data collection

Trees other than *D. melanoxylon* were identified as far as possible. Those which we could not identify were simply known to us as “Species A”, “Species B” etc. They were recorded as being greater or less than 30cm in CBH and their phenology was also recorded. If fruits were visible on trees they were noted as mature. All trees were also checked to see whether they were within 3m of a *Dalbergia melanoxylon* tree, sapling or seedling.

Point sampling

This was carried out to give us an idea of the abundance of *D. melanoxylon* seedlings in a plot. Within the plot, 1m radius points 10m apart were examined. The following features of each were recorded:

- Vegetation at the foot of the observer (i.e. at the centre of the point).
- Dominant vegetation.
- The presence of trees, shrubs, *D. melanoxylon* trees and *D. melanoxylon* saplings.
- The presence and number of *D. melanoxylon* seedlings. Seedlings were recorded as being taller or shorter than breast height (1.4m).

Soil Analysis

The five soil samples taken from each plot were tested for pH and texture. The pH was measured using a calibrated pH stick, which was dipped into a 1:2 soil – distilled water mixture. To examine texture, a small amount of soil was mixed with a few drops of water, and the mixture squeezed into a ribbon between thumb and forefinger. The length of ribbon achieved before breaking was used to categorize the soil according to sand and silt content. The higher the silt content, the finer the texture and the longer the ribbon.

Survey Results

General area

A total of 25 plots were surveyed, each of 2,800m². Together they cover an area of 71,000m². This is 7.1% of the studied area, which covered 1km². However 2 of the plots were predominantly thick bush with no *D. melanoxylon* to be seen, so, in order to conserve time, they were not fully surveyed, and another had bush so thick that time ran out on us before we could get anything other than the data on *D. melanoxylon* within it. The other 22 plots cover 6.2% of the studied area. In each of these plots 29 sub-plots of 1m radius were checked for seedlings. Thus of each plot 91m² was inside a sub-plot, comprising 3.2% of each plot. In total all 638 sub-plots covered an area of 2,000m², or 0.20% of the whole studied area.

In the fully surveyed plots a grand total of 2027 trees and saplings (i.e. individuals with a Circumference at Breast Height – CBH – of 10cm or greater), including *D. melanoxylon*, were counted at mean density of 32,000 individuals per km². Of these 922 were classed as trees 'proper' (i.e. they had a CBH of greater than 30cm). The mean density of trees over the whole area was 15,000 km^{-2}.

Including stumps, the mean density of *Dalbergia melanoxylon* was 3,400 specimens (i.e. trees and saplings) per km². The species accounted for 11.9% of all trees and saplings, and 7.9% of trees.

The following table summarises the habitat data results from the point sampling:

Dominant Ground Cover	% of Total
Bare	3.6
Burnt	8.3
Grass	47
Litter	15
Shrub	15
Trees	12

Table 1. Dominant vegetation as recorded in point sampling.

Most commonly recorded tree species

A complete list of the tree species identified at the site is shown in Appendix II. The seven most commonly recorded (in rank order) were *Spirostachys africana*, *Commiphora* sp (likely to be either *C. africana* or *C. confusa)*, *Dalbergia melanoxylon*, *Fernandoa magnifica, Combretum apiculatum*, *Acacia nilotica* and *Combretum molle*. These species accounted for the bulk of the identifiable trees recorded. Fewer than 50 individuals of any other species were seen in our plots.

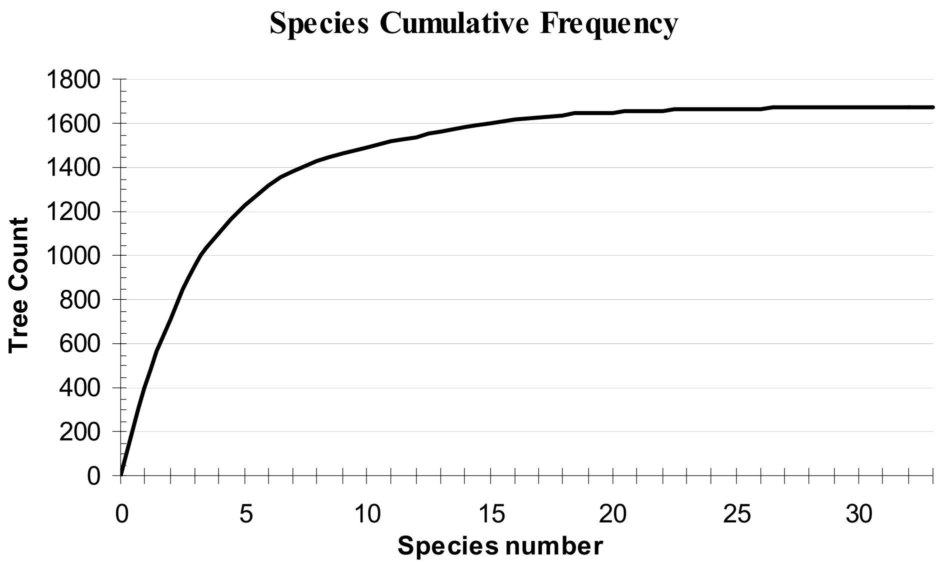


Figure 1. Cumulative number of trees and saplings of all identified tree species. Unidentified species are not included.

Difficulties were encountered in identifying some tree species. Unidentified trees were not counted according to species in some plots, and are not included in figure 1, although they are included in earlier density calculations.

Soil

Sharman (1995) reports *Dalbergia melanoxylon* growing in a variety of soil types. The pH of the soil samples ranged from 6.0 to 8.4 with an overall average of 7.6 – i.e. slightly alkaline soil. However, all of these samples were removed from the top 6 inches of earth. The chemistry of this topsoil could be quite different from that lower where most of the trees' root-systems are to be found, so it is unwise to read too much into these figures. Analysis of the soil consistency was not felt to be very reliable, and, given the previous misgiving, it was not thought constructive to include details of this in this report.

Dalbergia melanoxylon trees and saplings

Distribution

A total of 242 trees and saplings (including stumps) were recorded in different 20 plots. The maximum number in one plot was 60 specimens, which corresponds to a density of 21,000 trees per km². Including seedlings, *D. melanoxylon* individuals were noted in 23 out of 25 plots.

The number of *D. melanoxylon* individuals as a percentage of the total number of trees and saplings in a plot ranged from 0 to 40%, the mean being 13% (std dev = 11%). The large standard deviation indicates that the distribution of *D. melanoxylon* across the study site was far from uniform.

In order to test whether there were any affinities between the most common species found and *D. melanoxylon*, plots containing *D. melanoxylon* were divided arbitrarily into two classes:

Class I: Plots with fewer than 10 *D. melanoxylon* trees and saplings.

Class II: Plots with 10 or more *D. melanoxylon* trees and saplings.

10 trees per plot is equivalent to a density of 3,500 per km² and is close to the mean value. The relative frequency of the six most common species (excluding *D. melanoxylon*) was calculated for each plot. The mean value of this frequency for each species was compared for the two classes of plots:

Class	*Spirostachys africana*	*Commi-phora sp*	*Fernandoa magnifica*	*Combretum apiculatum*	*Acacia nilotica*	*Combretum molle*
I	0.16	0.15	0.08	0.06	0.06	0.08
II	0.24	0.20	0.07	0.10	0.05	0.01
Std Dev	0.16	0.10	0.06	0.11	0.06	0.09
p	0.30	0.52	0.97	0.35	0.64	0.19

Table 2. Relative frequency of the most common species for Class I & Class II plots. The p value (probability) is computed from the Student's T-test with 1 degree of freedom.

None of the species show any great variation compared with its standard deviation. This fact was confirmed by use of the Student's T-test, which did not give any p value below or close to the 5% significance level. A similar result was found testing presence and absence of these common species. There are three possible explanations for this. Firstly *Dalbergia melanoxylon* as a species simply does not exhibit any affinities or aversions for these species within this habitat type. Secondly it could be an artefact of our large plot size, which allows for variation in vegetation within a plot. Thirdly it could illustrate the fact that we surveyed an area rich in *D. melanoxylon*, and therefore we cannot expect to find sufficient variation in this data alone to draw any conclusions about species affinities or aversions of *D. melanoxylon*.

The data collected on whether a tree was close to a *D. melanoxylon* tree, sapling or seedling provides another way of evaluating species affinities and aversions. This data is also not subject to any distortions due to plot size. For the six most common species, a Chi-squared test was conducted on the relative incidence of a close tree or sapling, against the average relative incidence for all other trees (20%). Table 3 collates the results:

	Spirostachys africana	*Commi-phora sp*	*Fernandoa magnifica*	*Combretum apiculatum*	*Acacia nilotica*	*Combretum molle*
% close to *D.m.*	23	17	25	12	14	19
χ^2	3.2	1.1	2.4	5.2	2.1	0.03
p	0.1	-	-	0.025	-	-

Table 3. Relative incidence of a *D. melanoxylon* tree or sapling within 3m. The p value is calculated from 1 degree of freedom; - indicates $p > 0.1$.

This suggests that *Combretum apiculatum* has a negative association with *D. melanoxylon*. However since the density per plot of this species rises from Class I to Class II plots more work is required before any firm conclusion can be drawn. It may be that a larger sample size may negate the result.

Size

For multi-stemmed trees largest CBH measurement taken from each tree has been used, as this is the measurement most likely to reflect the age of the tree. Some measurements were well over 100cm, but most of these were stump circumferences (see below) taken near the ground rather than at breast height, and as such may well be larger than CBH measurements for the same trees would have been had we been able to take them.

CBH ranged from 10cm (the minimum measured) to 138cm, the mean value being 25.8cm (std dev = 21.0cm). This translates to a mean diameter at breast height (DBH) of 8.3cm (range 3.2cm to 43.95 cm, std dev = 6.7cm). There is no significant correlation between the mean *D. melanoxylon* CBH (excluding stumps) and the total number of trees in a plot (p.m.c. coefficient $\rho = -0.289$, n = 19), that is to say that the tree does not appear, from this evidence, to grow particularly better in the open or in the thicket.

Where the largest stem of a tree had been cut or broken, a stump circumference was recorded. The total number of stumps recorded was 21 (8.7% of the total tree and sapling count), the mean stump circumference being 98.5cm (range = 25cm - 200cm). At least 11 of the trees with stumps were clearly living, either there were remaining live stems or the stumps had produced shoots. None of these (21) trees was seen to be completely dead, although 8 had suffered fire damage.

Figure 2, below, shows the size distribution of *D. melanoxylon* trees and saplings, and the proportion of individuals in each size-group which had stumps. The proportion of trees with stumps is significantly greater for larger trees (Chi-squared: $\chi^2 = 62.3$, DF = 4, p = 0.001), suggesting that these are selectively cut as would be expected.

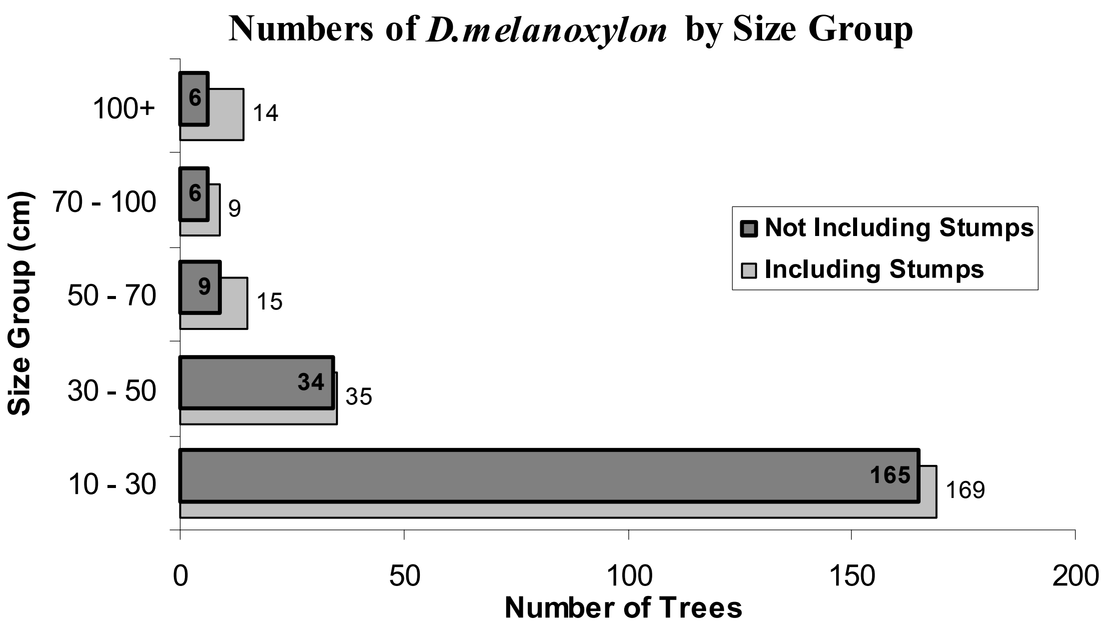


Figure 2. Number of *D. melanoxylon* trees and saplings in 5 size-groups (listed below), showing the number of individuals in each group with one or more stumps. To control against stump circumferences distorting breast height figures all trees with a circumference over 100cm have been grouped together.

Exact measurements of CBH were not taken from trees of other species. Instead, it was simply noted for each one whether or not (maximum) CBH was greater than 30cm. The mean percentage of individuals of all species with CBH 30cm or over in a plot was 48%, while for *D. melanoxylon* the figure is 30%. This is probably a factor of the species smaller size in general than an indication of poor local conditions.

The mean height of *D. melanoxylon* individuals (stumps without associated standing stems excluded) was 6.6m (range 2.4m - 14.1m, std dev = 2.5m). There is no significant correlation between the mean height of *D. melanoxylon* individuals in a plot and the total number of trees, further confirming the observation above that the tree does not especially favour open areas or thicket.

Canopy area ranged from 0.9m² to 130m², with a mean value of 15m² (std dev = 18m²). There is a significant negative correlation between mean *D. melanoxylon* canopy area and the total number of trees in a plot ($\rho = -0.4571$, n = 19, p = 0.05). This is as would be expected; it is generally seen that densely packed trees spread out less than those standing in wide open space.

Stems

The number of stems of *D. melanoxylon* individuals ranged from 1 to 16, the mean value being 2.5 (std dev = 2.3). Single-stemmed individuals were the most common, as Fig 3 (below) illustrates. There is a positive correlation between the proportion of *D. melanoxylon* trees with one stem only and the total number of trees in a plot ($\rho = 0.423$, n = 19). This is probably a feature of trees in areas of dense thicket being encouraged to grow straight upwards due to competition for light, and also ties in with the fact noted above that canopy area tends to be smaller in more crowded areas.

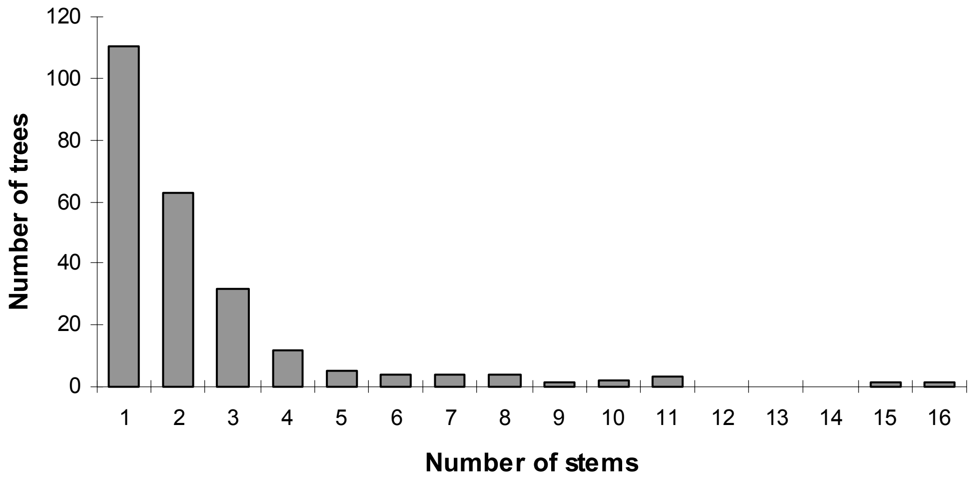


Figure 3. Frequency of *D. melanoxylon* trees and saplings with different numbers of stems.

Invertebrates

Termites appeared to be widespread in the study area; termite mounds were seen in four plots, but damage, ranging from T_1 (light) to T_5 (heavy) on our own scale, was recorded in 19 plots. Figure 4 shows the numbers of trees placed into the categories T_0 to T_5.

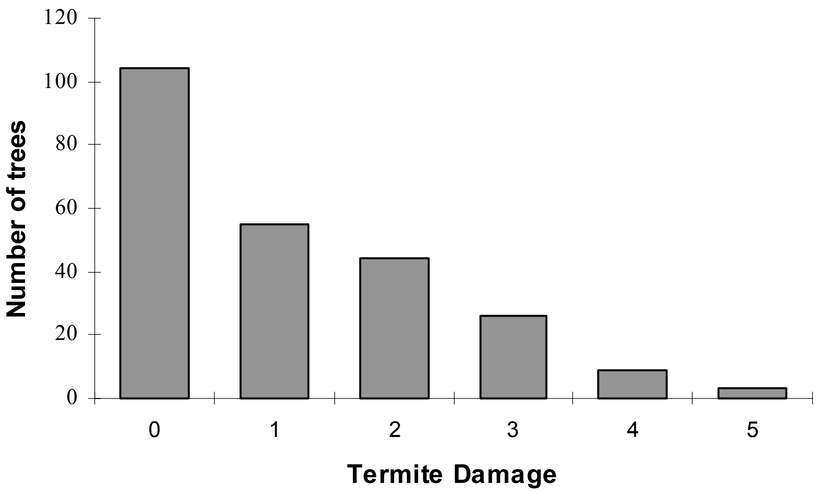


Figure 4. Numbers of trees considered to be suffering from different degrees of termite damage.

Overall, the mean T value given was 1.1 (st dev = 1.3). In three of the four plots which contained termite mounds, the mean termite damage value was higher than 1.1. The highest plot-mean was 3.8, found in plot 11 which did contain a termite mound. Two of the four *D. melanoxylon* individuals in the plot, of 70cm and 100cm CBH, were recorded as being dead (these were the only examples of dead *D. melanoxylon* trees or saplings recorded). Each was given a termite damage value of T_5, although it was impossible for us to tell whether the death of the trees had been caused by the termites.

It seems possible that trees which have been damaged - by fire, or by the loss of a stem - may be more susceptible to termites than those apparently undamaged. In order to test this idea, the total numbers of damaged and undamaged *D. melanoxylon*, with and without evidence of termite presence, were compared in plots within which damaged *D. melanoxylon* trees or saplings had been recorded. There is no significant difference between the relative numbers of damaged and undamaged trees recorded as suffering termite damage (Chi-squared $\chi^2 = 0.22$, DF = 1, $p > 0.1$). Our results, therefore, do not suggest that damaged trees are more prone to termite attack than undamaged ones.

In addition to the termites, a number of other invertebrates were found on *D. melanoxylon*. These included small black ants feeding on shoots, insect larvae and beetles found inside branches, millipedes, homoptera, locusts, scorpions, spiders and snails. We were not able to identify any of these to species level. Snail and insect eggs were found on leaves, thorns and dead branches. There were signs of damage caused by insects on some trees: some leaves appeared to have been eaten and bore holes were found in branches. Wasp nests and spiders' webs were found on some *D. melanoxylon* trees and saplings.

Fungi, lichens and galls found on *D. melanoxylon*

Nine species of fungus and five lichens were found growing on live and dead *D. melanoxylon* specimens at the main study site. They were not identified. Many of the trees had galls growing on some of the younger branches. The galls were brown and powdery inside. Their cause could not be determined.

Dalbergia melanoxylon seedlings

Seedlings were defined as having CBH < 10cm, and were surveyed separately from larger individuals by point sampling carried out in each study plot. They were recorded in 16 out of 25 plots.

A total of 346 seedlings, found in 92 of the 1m radius points sampled, were counted. Their size was not recorded, although a great range of sizes was present: from very tiny individuals to those well above breast height.

There is a significant negative correlation between the number of points containing seedlings and the number of trees in a plot ($\rho = -0.447$, $n = 21$, $p = 0.05$). (The number of points rather than the actual number of seedlings counted was used here to control against the possibility that seedlings growing from the same root stock may have been counted as distinct individuals). Furthermore, the total number of points where grassy, bare or burnt ground was recorded (by point sampling) as the main space-taker was very significantly greater in plots which did contain seedlings (366) than in those which did not (101) (Chi-squared $\chi^2 = 150.4$, DF = 1, $p = 0.001$). These results suggest that seedlings are less likely to grow in dense thicket than in open areas, which is certainly in line with our observations.

A similar test to that done with *D. melanoxylon* trees and saplings was carried out with seedling incidence close to the six commonest species. Table 4 below presents the data.

	Spirostachys africana	*Commi-phora sp*	*Fernandoa magnifica*	*Combretum apiculatum*	*Acacia nilotica*	*Combretum molle*
% close	10	12	21	30	14	22
χ^2	3.9	0.3	8.0	29.3	0.1	4.5
p	0.05	-	0.005	0.001	-	0.05

Table 4. Relative incidence of at least one *D. melanoxylon* seedling within 3m by tree species, mean value for all trees at the site was 13%. The p value is calculated from 1 degree of freedom; - indicates p > 0.1.

C. apiculatum and *F. magnifica* both show higher levels of coincidence, and *C. molle* also exhibits a positive correlation while *S. africana* is negatively associated, although it was prevalent throughout the site. The *Combretum apiculatum* result is particularly intriguing when compared with its apparent negative association with adult *D. melanoxylon* (see Table 3 above). The probable explanation for all of this lies in the marked spatial distribution of the *D. melanoxylon* seedlings as noted above. *C. apiculatum*, *C. molle*, and *F. magnifica* all possibly favour the higher light levels in the open and at the edge of thickets, while *S. africana* may be a less effective competitor in higher light levels, and as such might usually be found in the centre of thickets.

The effect of fire on seedlings

Part of the study site was burned during our period of investigation. This gave us the opportunity to examine the short term effects of fire on the survival *of D. melanoxylon* seedlings. Many of the taller stems appeared to survive these fires whilst individuals smaller than 1m in height were not likely to survive. We improvised a test for dead seedlings by attempting to snap off the top of the stem. If it broke easily it was assumed to be dead. However this does not take into account that the roots may still be very much alive even if the stem snaps easily, and so much more research – preferably in controlled conditions – is needed before we can make firm conclusions about the effects that fire has on *D. melanoxylon* seedlings.

Dalbergia melanoxylon seedling by John Leonhardt

Local Use and Knowledge of Mpingo

In order to learn more about the importance of *Dalbergia melanoxylon* to the people of Mchinga, meetings were held between team members and groups of people from the village and outlying areas. The aim of the meetings was to gather information on the following subjects:

Nature of the human utilisation of *D. melanoxylon* in the villages

Extent of the exploitation of *D. melanoxylon*

How reliant the local people are on *D. melanoxylon* specifically

Importance to the local economy of *D. melanoxylon*

Nature and extent of utilisation of other tree species present

Exploitation of the land itself

Any apparent trends in these factors

Local knowledge about *D. melanoxylon*

The instinctive barriers between local people and outside interviewers presents a significant problem in this sort of work. Uncertainty of the motives for the questioning, and of the destination and use made of the answers, can lead to incomplete, guarded or false information. We were fortunate in being based at one village for the duration of the expedition. This allowed us several weeks' grace to allow the villagers to get used to our presence, and to build relationships with influential residents, before commencing our inquiries. An excellent relationship with the village secretary and his family was crucial to our success in eliciting any information at all, and the presence within the team of Tanzanian counterparts and a Swahili-speaking Cambridge-based member helped to further break down the boundaries. We also gained valuable supplementary information in various unplanned conversations with villagers which took place during the course of our stay at Mchinga.

Participatory Rural Appraisal

In an attempt to fully utilise the pooled experience of the local people, and to avoid the pitfalls of a formal interview scenario, the techniques of Participatory Rural Appraisal (PRA) were used (Freeman 1996). In this approach large communal diagrams are constructed and completed by groups of local people, representing for example a calendar of the phenology of a certain species, or a map of the local area showing land uses. The diagrams can be drawn in the ground, and local produce can be used to represent land use or activities, e.g. beans to represent bean fields or work on beans at a particular time of year. The size and complexity of the diagrams will depend on the resources available and whether or not they will be kept intact for display. More pertinent is that their construction harnesses debate and turns the inconsistency of individuals' opinions into an easily recordable consensus. The debating also distracts participants from the presence of outside observers (who should remain low key after the initial introductions) and so reduces the problems of reticence or the tendency to say what it is believed the interviewer wants to hear, rather than the truth. Both are common reactions to interview in Africa and elsewhere. PRA gives control of the information content to the villagers, making them feel more confident and bringing out information which might not be revealed when talking to people one-to-one with a specific agenda to be met.

Mchinga meetings

Our meetings took place in the village hall, with the village chairman or secretary sitting in, and each followed a similar format. The team members introduced themselves to the group, and Steve explained (with one of the Tanzanian team members acting as interpreter) the purpose of our expedition, emphasising the fact that hopefully the data we were collecting would be of use in the design of a management plan for *D. melanoxylon* which could potentially directly benefit the villagers. Questions were put to the group which they answered in the manner Steve requested, and the answers were recorded by other team members.

Three meetings were held: one with a group of farmers from Mchinga itself, one with farmers from outlying areas, and one with Mchinga's elders. The latter covered a narrower range of topics due to the pressures of time. Dates of the meetings were 30/8/96, 31/8/96 and 1/9/96 respectively.

Topics of discussion were:

1. The phenology of *D. melanoxylon* (when it comes into leaf, flower and fruit) and animals seen feeding on it at various times of year.
2. The dates and patterns of burning activity on the plateau.
3. Logging of *D. melanoxylon* and other species.
4. Agricultural activities taking place locally.
5. The uses of *D. melanoxylon* and other woods in and around the village.

Topics 1 to 4 were explained by means of calendars. Thirteen sticks were laid on the ground like the rungs of a ladder, the gaps between each pair of sticks representing a month. The participants were asked to place beans in the appropriate months in response to questions about the phenology of the tree or when various activities occur. This method of answering proved very effective. The participants discussed each answer between themselves. All had their say and generally all were in agreement before beans were put in place.

Topic 5 – the use of *Dalbergia melanoxylon* versus other woods for various tasks – was investigated by two different means. In the first meeting the farmers were simply asked which woods they used to do particular jobs, then in the subsequent meetings we employed a ranking exercise. The local names of all the tree species we had encountered on the plateau (which were given to Manoko by Ali Mohammed, our guide) were written on pieces of paper to be placed by the participants into appropriate spaces in the stick-ladder on the floor. For this exercise only five sticks were required, the four gaps representing four different categories:

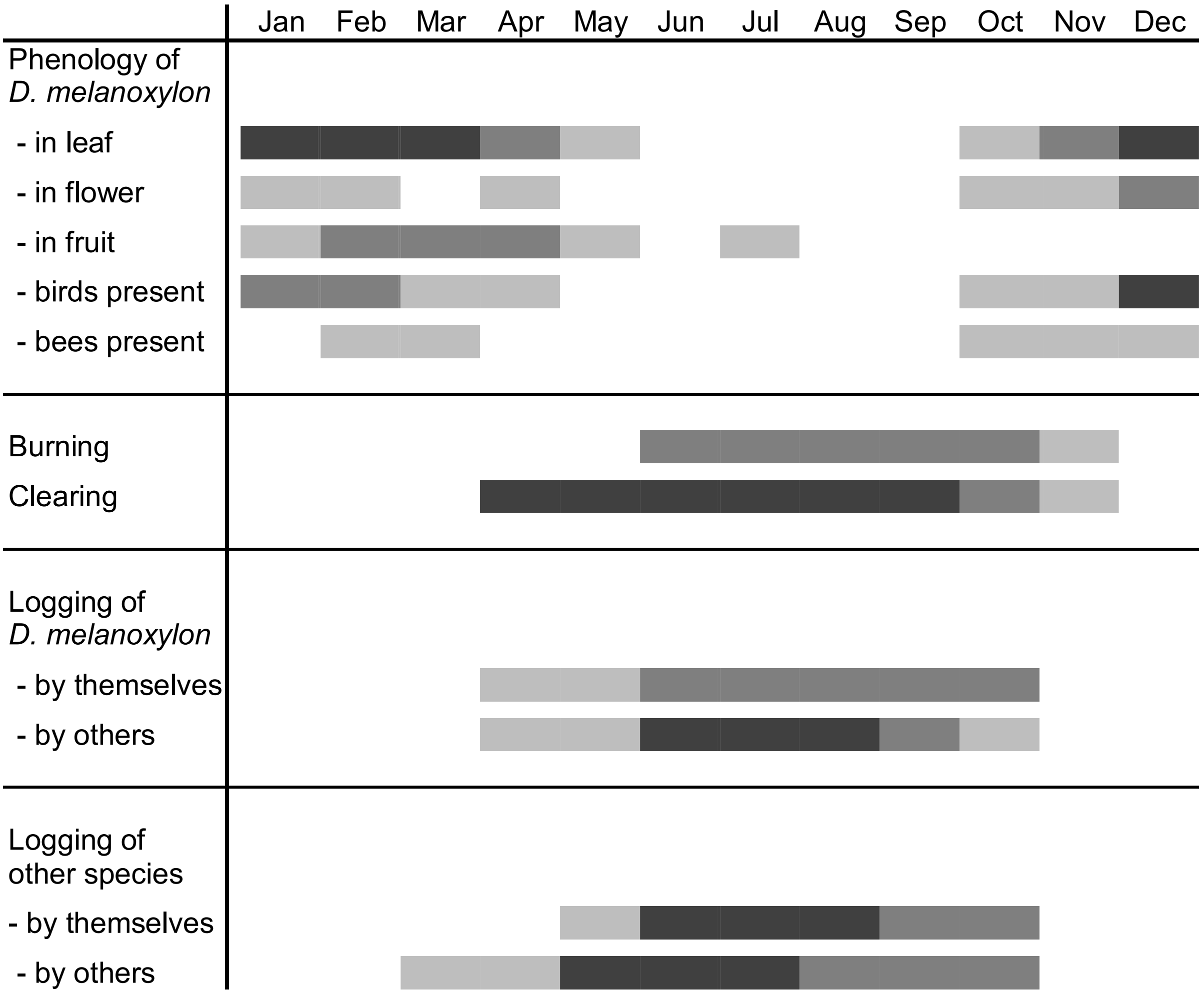
- Better than *D. melanoxylon*
- Same as *D. melanoxylon*
- Worse than *D. melanoxylon*
- Not used for this purpose

For a list of tasks (logging, house-building, charcoal-making and so on) the participants were asked to place each tree name in the appropriate category, which they did, once more, with much debate before each result. The village elders supplied information on medical uses of the various trees.

Results

The results obtained from each of the three groups were broadly similar on most topics, strengthening their validity. However, the groups did disagree markedly on several questions. These inconsistencies may be worthy of special attention in future work on the subject, but should not detract from what was overall a very productive exercise.

Table 1: Mpingo calendar for Mchinga area



Key:

(darkest)	All 3	groups said that this happened during this month.
(dark grey)	2 of the	.. ..
(light grey)	Only 1	.. ..
(white)	None of the	.. ..

A breakdown of these results by group can be found in the PRA Appendix, as can a calendar of the principal agricultural activities around Mchinga.

Putting the data into context: the long rains last from March to May, and the short rains from October to December. Thus *D. melanoxylon* would appear to be in leaf from the start of the short rains to the end of the long rains, during which time it also flowers and fruits. This is when it attracts birds and bees, but it is not clear whether the birds are attracted by the flowers, fruits or another food source. Sharman (1995) reports a belief that the species is insect pollinated, which supports these findings. Most of the activities potentially destructive to *D. melanoxylon* take place during the dry season.

The greatest inconsistencies in the answers we received are displayed in the answers to questions on the phenology of the tree. This could partly be explained by the variable habits of the species itself. Norton and Hawkins (1995) report inconsistencies in the flowering season of *D. melanoxylon*, and this would correspondingly affect the fruiting phenology. The pattern of leaf presence here is in general agreement with that discovered in Malawi by Hall-Martin and Fuller

(1975). Herbarium data suggests that *D. melanoxylon* in Tanzania can flower from June to March, and bear fruit from March to January (Sharman 1995).

On the subject of logging, the village elders seemed generally out of touch with the current farmers, perhaps reflecting a change in practice from one generation to the next. Ignoring their answers, it would appear that most logging takes place during the months of June to October, but we should stress that we saw no logging take place while we were there, and there was little sign (other than the *D. melanoxylon* stumps) of it taking place generally.

Local use of tree species

We collected a lot of data on the use of other species growing in the Mchinga vicinity. However all of this was recorded against local tree names, and the (slightly suspect) list of translations we had was unfortunately mislaid during the return journey home. It is hoped that we may eventually be able to recover it, or obtain a new list. In the meantime, though, other sources available in the UK have not proved very helpful. Many of the vernacular names we had were simply not listed. The answers given for others seemed inappropriate, such as montane forest species, or *Acacia* sp. for a tree that is logged for timber. The final set of trees which we could confidently identify was so much smaller than the complete data set, that it was of little use. In *Appendix III : Local Uses & Knowledge Data Tables* we have tabulated all the data we have against vernacular name, but without identification of the species this break-down is not very revealing. In addition, even a quick comparison of the two tables will reveal various inconsistencies, and these become even more apparent when examining the basic data given by the three groups.

However we can draw some qualitative results. That is for every major use of *Dalbergia melanoxylon*, the villagers had alternative trees that they could use, and frequently would do so, particularly as *D. melanoxylon* is so arduous to cut down. For firewood, charcoal and house-building, three of the most frequently quoted uses for the wood, the villagers were able to list many alternative species, and indicated that *D. melanoxylon* was not that commonly used for any of the three. In order to place this in context we need to identify the alternative species. Then we can consider under what conditions *D. melanoxylon* will become an important provider of wood for these purposes. Of the more esoteric uses of *D. melanoxylon*, burning the wood to provide light for fishing, making walking sticks, and the medicinal properties of leaves were all mentioned.

Apart from *Dalbergia melanoxylon*, people were reported to come from outside the village to cut a few other species, including Mninga/Mtumbati (*Pterocarpus angolensis*). At present no money is received from outsiders for timber extracted from common land, but a few villagers benefit from the employment generated in transporting the timber down to the road. This is sporadic employment and is not reported to be an important factor in the local economy.

Conclusions

The people of Mchinga know the *Dalbergia melanoxylon* tree well and they have a variety of uses for it. It is valued for firewood and medicinal purposes, but particularly for house construction. Despite the value attached to it in this role, *D. melanoxylon* did not seem to be sought out and felled specifically by the villagers, instead being used on an ad hoc basis when a tree had been cut for other purposes, e.g. land clearance or logging. Its use as firewood also appeared to be determined by whether dead wood of the species was available nearby.

Logging, on the other hand, was an operation specifically aimed at extracting *Dalbergia melanoxylon* and other valuable trees from the area. The scale of the operation was unknown but it seemed fairly low key. Extraction was carried out by outsiders with the assistance of villagers, and the wood, we were told, was destined for Makonde carvers. It is difficult to gauge how reliable this information is. This harvesting was not organised: the loggers simply turned up when they wanted more *D. melanoxylon*.

Apparently, in the past Makonde carvers did not come as far as Mchinga to obtain *D. melanoxylon* wood, but more recently have been forced to do so because more accessible stocks have been depleted. The villagers are aware of the tree's value to carvers from outside the village and acknowledge its potential as a source of income, although it does not have this status at present. A willingness to adapt land use or take other action to favour *D. melanoxylon* was indicated should some kind of incentive be offered to do so. The attitudes were similar at the neighbouring village of Mchinga II (cf. *Reconnaissance Trips to Other Mpingo Sites*), although the pressures on *D. melanoxylon* there appeared to be different.

Conversations with Forestry Officials

The local foresters are the people concerned day to day with the mpingo problem, and as such they have more understanding of the situation than most other people. The expedition met only a very few of the forestry officials working throughout Tanzania, and so we should be wary of taking their views as representative of the whole, and some of their contentions need to be tested empirically; but their opinions are extremely valuable nevertheless. Mr Kitale, the Regional Forestry Officer for the Lindi region, who provided us much assistance on the expedition, was the most informative of those we met, but many District Officers have also contributed to the information outlined below.

The first thing to note is that they are all very concerned about the mpingo situation. In Tanzania there is strict legislation against any person felling live *Dalbergia melanoxylon* without a licence, and the local foresters are charged with enforcing this. The unfortunate reality, in the Lindi region at least, is that they lack all resources to do this. Manpower is insufficient, and crucially they are without reliable transport. Mr Kitale actually had to borrow other peoples' vehicles – his own had broken down and he scarcely had the funds to get it repaired. It was a similar story elsewhere. Even if they do have easy access to a 4WD vehicle, fuel is expensive, limiting the number and scope of patrols and inspection visits. The cost of maintenance is also a severe drain on funds, and is frequently foregone – an uneconomic approach given the extremely poor state of the roads in the area. However, none of this will be unfamiliar to anyone experienced with the problems of the developing countries in Africa.

Exactly how high in their list of priorities the mpingo problem comes it was hard to tell. The foresters would seem to welcome any outside efforts which would make their task easier, and were generally willing and happy to help where possible. If *Dalbergia melanoxylon* is to be conserved in the wild then clearly local forestry officials will need considerable extra assistance in order to realise the necessary protection. This would then have benefits across the whole spectrum of their duties, and we think they understand this and are prepared to co-operate with any sensible project which attempts to achieve effective conservation. Although the poor state of the infrastructure is a hindrance to the foresters, it is also a hindrance to potential loggers. It would appear that illegal felling in the region is currently only happening at a low level at sites close to roads. Mr Kitale feared that should the mooted surfacing of the main coastal road all the way from Dar Es Salaam ever take place then it will sound the death knell for the region's forests, *D. melanoxylon* and otherwise, with the arrival of large scale logging at an unmanageable intensity.

The other major threat to the species is land clearance. Most farmers are reportedly well aware of the restrictions on the felling of *Dalbergia melanoxylon*. They get around this by clearing everything else and then lighting regular fires around any inconveniently positioned *D. melanoxylon* until the tree dies, whereupon they cut it down. This concurs with the observations of Moore and Hall (1987), and indeed we saw evidence of this on our reconnaissance trip to Liwale. It was also suggested that the burning makes it easier to chop down the tree which normally requires considerable extra effort due to the extraordinary density of the *D. melanoxylon* heartwood.

In fact our forestry contacts generally regarded fire as a critical factor in the conservation of *Dalbergia melanoxylon*. Back in the 1970s, we were told, the Forestry Department had enough money to provide financial incentives to farmers to burn sensitive areas early in the dry season. The less flammable material at this point means that a fire in a forested environment is not so hot and hence causes less damage. However, with the disappearance of these funds, farmers have reverted to the late-burning techniques ideal for savannah, but which cause more damage to forested areas. In addition to this, fires are also lit to flush out game animals when hunting (examples of which we saw at Mchinga and elsewhere) or even just for fun (apparently a big problem around Kilwa), all causing further problems to *D. melanoxylon* growing in the area, especially if the fire rages out of control. *D. melanoxylon* is not the only valuable species being harmed in this manner: even such obviously useful species as coconut trees are frequently caught in these conflagrations, and a generally reckless attitude to the land by some locals would appear to be a major hazard to the woodlands.

Reconnaissance Trips to Other Mpingo Sites

Introduction

A key goal of the expedition was to assess the suitability of other areas in the region as potential future sites for the study of *Dalbergia melanoxylon*. It was also important to this expedition to see how *D. melanoxylon* fared in different habitats under different pressures and how this compared with the situation at the Mchinga study site.

Kilwa

Date of trip:	19/8 – 21/8
Trip members:	Steve & Digna accompanied by Mr Kitale, the Lindi Regional Forestry Officer in his vehicle.
Contacts:	Mr. Mfangavo, the District Forestry Officer & Mr. Mnayahe, the District Commissioner – both of whom were very helpful.

The first visit in this area was to a site a short distance along the Nangurukuru to Liwale road. The site stretches for approximately 15km along the road and up to 2km on either side of it, and encompasses the village of Migeregere. The edges of the site are defined where the woodland, composed of largish trees, changes into dense scrub. Generally the woodland is on the higher ground, and the scrub in the valleys. The site is characterised by regular burning by the local people even though some of it falls inside Mitarure Forest Reserve – which makes it illegal without a license. Burning allegedly takes place every dry season, and means that, apart where trees are growing, the ground is generally bare except for a few tufts of grass. There is very little vegetation in the shrub class. Hence there are also no saplings present (of any species), and the only seedlings to be seen are very young. The burning, allegedly, does not occur for agricultural purposes but rather for hunting, and also just for amusement: there are frequent competitions to see whose fire will burn for the longest distance.

Throughout the site there are many mature *Dalbergia melanoxylon*. The ones closest to Nangurukuru (before you get to Migeregere) are quite small, but there was a noticeable trend to larger trees as the distance from Nangurukuru increased. At the far end of the site there is evidence of extensive logging of *D. melanoxylon* with many stumps. There is little sign of successful coppicing noticed elsewhere - fire is the suspected cause of this. All of the *D. melanoxylon* observed were much straighter then at Mchinga, though many showed signs of deep fluting and co-axial twisting. Spore from the following game animals was observed in the area: buffalo, impala & dik-dik and an unidentified antelope. Elephant tracks were spotted, and vervet monkeys were present. Informed opinion was that while leopard and hyaena are locally scarce, there are many lions: the previous year a woman was killed in the village of Migeregere by a lion.

The second visit was into the heart of the Mitarure Forest Reserve, further down the Liwale road. Oil prospecting by a Dubai based company has been taking place in this area since 1971 and now drilling is about to commence in an area on the edge of the reserve. So far an area of open forest, about 0.5 km² in size has been cleared although not entirely. Intriguingly a few trees, principally *D. melanoxylon* have been left standing, apparently for shade – although the *D. melanoxylon* that is left could be simply be a result of its incredible toughness rendering the task more hassle than it is worth. There has also been further tree clearance at the edge of the road to widen the route for trucks and tankers. Another development being proposed is the construction of a pipeline to Kilwa Harbour which would cut through the forest reserve.

There were many small dense stands of young *Dalbergia melanoxylon* growing in and around clearings in the reserve. This would seem to support the widely held theory that *D. melanoxylon* regenerates quickly and easily from disturbed root systems giving rise to these clusters of trees. Transient ‘slash and burn’ agriculture would seem to promote this sort of regeneration, and if the theory is true then this type of agriculture could be beneficial to *D. melanoxylon* – enabling it to dominate early on in the recolonisation of abandoned plots.

The consensus opinion was that the area as a whole has potential for more detailed study especially on the effects of burning on *D. melanoxylon* and transient land-clearance. From a logistical point of view, without a vehicle there would be problems obtaining food and water if camped in/by the reserve (the well in the reserve is dry). Also to consider is the large-mammal population in the area. Warthog were seen and elephants had left their mark; including damaged *D. melanoxylon* trees! Whilst they may not pose a great risk to anyone, the presence of a study group there for a prolonged period may disturb the animals.

Mchinga II

Date of trip:	24/8
Trip members:	Eric & Jonas
Contacts:	In addition to the many people at Mchinga A, Mr Mpindula proved an excellent guide of the are and could tell the age of the trees.

Mchinga II village is situated about 3 miles north of Mchinga. It can be reached via the coastal road, the beach or via a short cut that fords the river. There then follows a half-hour walk up onto the plateau along a track (that links Mchinga II with 3 smaller villages) to reach the *Dalbergia melanoxylon*. Whilst it is also an area of grassland and woodland, this site differs from that at Mchinga in that the trees are generally distributed more densely and evenly, but there is less actual thicket. Also *D. melanoxylon* trees are more mature and in greater abundance. Many of the larger specimens were found in clusters; convenient for logging and yet so far the trees here have avoided exploitation despite also being more accessible than those at Mchinga. Two possible explanations were put forward: either the wood is of inferior quality for carving, or this area had simply not been noticed or brought to the attention of the loggers who visited the study site at Mchinga.

Farming was much in evidence at the site; areas had been cleared to make way for cashew nut and mango plantations. Canvassing the locals revealed a similar regard for *D. melanoxylon* as at Mchinga; that it is of little worth to them at present being too thorny to use as firewood, too twisted for poles, and anyway too hard to bother cutting down. However, examples of its use in house building (c.f. *Local Use and Knowledge of Mpingo*) were spotted, especially in vertical supports. Although the amount of land available to farm is not in short supply, at the moment there is little reason to avoid areas in which *D. melanoxylon* grows, and the latest land being cleared did support a reasonably large population of the species. Any change in the situation that enabled the villagers to exploit this as yet untapped resource would be welcomed.

This site would seem to offer a lot of potential for worthwhile, detailed study. The size and distribution of the *D. melanoxylon* trees here makes the site distinctive from the one at Mchinga and potentially more valuable. Camping at Mchinga II is unlikely to be a problem; there is water there and the villagers were very helpful.

Nachingwea / Liwale

Date of trip:	2/9 – 7/9
Trip members:	Steve, Manoko & Nick

Liwale

11km south of Liwale there is a small village called Likombora. The area of land surrounding the village is quite heavily populated by *Dalbergia melanoxylon*. This land has been in the past or is currently being used for agriculture by the village farmers and thus it presented an ideal opportunity to see the effects of traditional farming practices on *D. melanoxylon*.

The farmer will clear a small plot of land by first cutting down the trees, normally to about waist height (that most convenient for chopping with a panga). Actually uprooting the trees requires a disproportionate amount of effort, but cutting the trees in this way removes any shading or other deleterious effects they might have on the growing crops. The area is subsequently burnt to remove the scrub. In common with the region as a whole, the dominant crops being grown were cassava, pigeon-peas, cashew nuts and mangoes. Due to the recent resurgence in the cashew nut market many farmers were redirecting their attention to neglected cashew nut trees. These plots last only a few years; they then become exhausted of their nutrients and are abandoned. Inadvertently, because the trees were not uprooted, many are subsequently able to regenerate after abandonment. Since different plants vary in their ability to re colonise these new areas either by regeneration or from seed growth, this method of farming shapes the species composition of the forest. Because *Dalbergia melanoxylon* can allegedly regenerate from damaged or disturbed roots it can sometimes come to dominate in the re colonisation of such areas. There was one striking example of this at Likombora. A plot of about 2 acres in size that had been abandoned 25-30 years ago now consists almost entirely of *D. melanoxylon* that had developed from a few original trees that had been cut when the area had been cleared. Unsurprisingly all of these *D. melanoxylon* trees were of a similar size; about 8 metres high with a CBH of about 30cm. Apparently there was another slightly larger area of *Dalbergia melanoxylon* ‘forest’ nearby.

There were a few instances where a large *D. melanoxylon* tree had proved too hard to cut and so had either been left or stripped of its sapwood and burnt to kill it. The *D. melanoxylon* though was not just a nuisance to the villagers; there were examples of it being used by them. Heartwood had been chopped off dead trees to make knife-handles and short Y-shaped branches/stems were being used as corner-props/stilts for the granaries (the heartwood is resistant to termite damage). Incidentally, some of the villagers’ beehives, made from hollow logs or rolled up bark, had been erected high up in large *D. melanoxylon* trees, but there was no evidence that they were particularly favoured for this.

Once again the locals were very open and willing to assist. The site is worth visiting to witness the role agriculture can play in the propagation of *D. melanoxylon* but it is too small to sustain any prolonged study. Also from a practical point of view, the village could not support a study group and is too remote to commute from Liwale. There was no evidence of large mammals in the area although apparently lions do visit in the rainy season.

The Natural Resources Officer in Liwale suggested 2 other sites nearby that would be worth investigating; one at Kitogoro, 40km to the east of Liwale (towards Nachingwea) and one at Mtaurango, 40km to the north. Kitogoro sounded especially interesting because the *Dalbergia melanoxylon* there encroaches into a forest reserve.

The biggest obstacle to studying anywhere in this region is finding transport. All of the Natural Resources and Forestry Departments’ vehicles were in use as were those belonging to the Selous Game Reserve. It is not surprising that the few vehicles in operation are in great demand at this time of the year when they can actually be used; i.e. in the dry season. Unless the group has its own vehicle the only alternative is to hire private vehicles which is prohibitively expensive.

Nachingwea

Lyonja Forest Reserve is situated about 30 miles from Nachingwea. The forest is quite open and comprised mostly of large, mature trees interspersed with bamboo. These established trees may have suppressed the growth of tree seedlings, saplings or shrubs. Instead the ground was covered in grass; burnt in patches, often deliberately by poachers in an attempt to drive out game (Eland and other antelope are common there).

The area of the forest visited in which *Dalbergia melanoxylon* was in abundance (one of many such areas) was about 2-3 acres in size. All of the *D. melanoxylon* seen were very large and either dying or dead with no sign of regeneration. The reasons for this were not clear. Certainly no other tree species appeared to be faring so badly but there was no sign of disease and light wasn’t limiting. This is a pattern also observed by Norton *et al.* (1995) in Mikumi National Park. Although intriguing because of this, perhaps warranting further investigation, the area would not be worth a thorough survey.

Once again problems encountered acquiring a vehicle hampered the trip and although eventually a vehicle was forthcoming from a local logging company, fuel was very expensive. One of the company’s trucks was actually operating in the reserve that day, loading up with *D. melanoxylon* that they had previously felled. These invariably were trees that grew near to the tracks running through the reserve.

Nachingwea, like Liwale, has sufficient means to support a study group although the tap water was too salty to drink. Interestingly, just outside the forestry office in Nachingwea there is a small plantation of *D. melanoxylon* trees; 40 in all. These were planted from seedlings back in 1979. They are now about 7m high with CBHs of about 30cm; giving some idea of the sort of growth rate of *D. melanoxylon*. There was also an older, larger tree there still in fruit; something not seen elsewhere. According to the forester there, *D. melanoxylon* will fruit once it's just 3 years old.

Tendaguru

Date of trip:	6/9 – 8/9
Trip members:	Anne-Marie, Justin & Jonas accompanied by Hans Blom van Asendelft in his vehicle.

The forest here is dominated by *Brachystegia*, *Combretum* and *Commiphora* tree species. *Dalbergia melanoxylon* trees were sparse, mostly large, very twisted trees; one of which was over 15m tall. There were no *D. melanoxylon* seedlings and very few saplings. In the area generally, the *D. melanoxylon* trees were limited in their distribution to isolated belts, outside of which they appeared to be out-competed by the faster growing, more abundant bamboo. There was very limited human impact upon *D. melanoxylon*; the area is too inaccessible to be logged and is too hard for the locals to cut down. Every dry season the land is burnt to drive away lions, trap kudu (antelope) and to remove the ground vegetation to deter pigs from encroaching into the fields and destroying the crops. This burning adversely affects the *D. melanoxylon*; charring the trunks of the trees and killing the seedlings, preventing regeneration.

There was another patch of comparatively 'virgin' *Dalbergia melanoxylon* forest about 8km along the southbound road from Namapuia. Here there were no signs of clearing or burning and seedlings were much in evidence. On the whole Tendaguru showed little promise as a potential study site. There was barely any regeneration of the *D. melanoxylon* trees and they were too scattered for localised study. Worse still are the logistical problems associated with the area. Once off the Kilwa road the driving conditions degenerate rapidly. Even with a 4WD vehicle and hired 'road clearers' (men with pangas) the journey from Mnyangala to Namapuia, a distance of 47km took 9 hours! There is little in the way of food there and water is difficult to come by and of dubious quality. Although rumours that there were man-eating lions terrorising the area proved to be unfounded, lions and other large mammals are common (at least in the dry season). A number of uprooted trees, including *D. melanoxylon*, marked the trail of passing elephants.

Conclusions of Reconnaissance Trips

All of these trips required a degree of forward planning and preparation. It was essential to obtain letters of introduction from the forestry office in Lindi to present to officials and chiefs at the places visited as a diplomatic gesture and to explain who we were and why we were there. This was especially important when visiting forestry reserves as the local people can be very protective and justifiably wary of foreign visitors. Proper acquaintance with the village-chief ensured that the group was supplied with a suitable person from the village to act as a guide. Invariably the local people were both welcoming and co-operative, as were the Forestry and Natural Resources people who helped as best they could with the limited manpower and resources they have. This highlighted the need for the group to be self-reliant by having their own vehicle and to plan well in advance to forewarn the relevant people of their visit. Either way such trips are almost always likely to be expensive because of transport costs even though living costs were very cheap if camping or staying in a 'guest house'.

At all of these places visited, especially those further inland and more remote, there were clear indications of large-mammal presence, though much reduced during the dry season. While it was important to be aware of this and take precautionary measures where necessary (such as hiring a guard) this was not deemed to be such a risk that it would rule out working in any of these places.

Also some areas in the region are plagued by tsetse fly but once again only a few were ever seen and where it is a genuine problem there are no people living there.

Although worth a visit, there would be little point in a follow-up expedition returning to redo a detailed survey of the site at Mchinga A unless this was after a number of years. Of the places visited on these trips, Kilwa and Mchinga B turned out to be the only places suitable for a group to conduct any long term study in terms of both the *Dalbergia melanoxylon* and the logistical considerations. Nevertheless, all of the trips yielded a lot of useful information on how *D. melanoxylon* fares in different environments.

General Conclusions

Species distribution

Of the trees we were able to identify in our plots, *Dalbergia melanoxylon* was the third most common, accounting for about 8% of the overall tree density. This is strikingly different to the situation recorded by Norton and Hawkins (1995) in study plots in Mikumi National Park in central Tanzania. There the average tree density was much lower than that at our site (only about 200 trees/km² compared to 3000 trees/km²) and *D. melanoxylon* accounted for only 0.7% of this, an average of 14 trees/km². Norton and Hawkins also report a much higher average diameter at breast height (DBH) than we observed in Mchinga: 36cm compared to 8cm.

It seems therefore that on average the trees in thicketed areas at Mchinga are considerably younger than those at Mikumi. Trees in a plantation at Nachingwea (see *Reconnaissance Trips to Other Mpingo Sites*), known to be 27 years old at the time of our visit measured 30cm in CBH (or 9.5cm DBH). This indicated that the average age of the *Dalbergia melanoxylon* trees at Mchinga is less than 27 years (although the possibility of differences in tree growth conditions and rates between the two sites must be remembered – since trees were not tended in any way at Mchinga their growth may be expected to be slower). Taking the size and age of the Mchinga trees and extrapolating linearly (ignoring slower growth rates early and possibly later in life) suggests that trees will reach harvestable size (DBH ≥ 30cm, or CBH ≥ 94cm, according to Puhakka 1991) at an age of around 85 years. This is in line with the commonest estimates reported in the literature (e.g. Platt & Evison 1994) of 70 to 100 years. The largest trees at Mchinga, we saw a stump with a circumference exceeding 160cm (diameter greater than 50cm), were probably much older than this.

Although unfortunately we do not have a detailed history of the area, we did find signs of human habitation in some of our study plots, so perhaps much of the land there has been relatively recently released from human use. The few very large trees we saw might be survivors of a previous land clearing effort, either because of a local respect for the tree, or because they are so difficult to cut down (Moore & Hall, 1987). *D. melanoxylon* is often cited as being good at colonising unforested areas (e.g. Sharman, 1995), possibly due to its ability to fix nitrogen (Prasad, 1994). However, it is thought to be a poor competitor against other tree species (Forest Division 1994). It would be interesting to re-assess the relative numbers of tree species at Mchinga in the future. A successional pioneer species would be expected to become less common over time, although the time scale of such a change may be very long. If it were possible to work out historical changes in the structure of Mikumi's woodland (by looking at pollen records, for example), it may emerge that *D. melanoxylon* has been far more common in the past in this area. Norton and Hawkins report a large amount of dead *D. melanoxylon* wood at Mikumi, and suggest gradual die off and slow decomposition of trees as one possible explanation – perhaps the species's low ability to compete for resources has contributed to this past die off. Whether or not this is the case, it seems likely that the structure of the apparently young woodland at Mchinga, and *D. melanoxylon*'s status as the third most common tree species, will change over time.

Age distribution & Regeneration of *Dalbergia melanoxylon*

At Mchinga, we observed trees of a great range of sizes, from tiny seedlings to very large, ancient looking specimens. We did not encounter any obvious gaps in this range, unlike Norton and Hawkins (1995) who reported the large shrub/small tree size group to be missing from their study plots at Mikumi, or Puhakka (1991) who found seedlings to be lacking in a survey of *Dalbergia melanoxylon* in the Mtwara region. The age distribution at Mchinga is heavily skewed towards younger trees - we encountered a few very large individuals, which were often outside thicketed areas, and seedlings and saplings were much more commonly recorded. This in itself is not surprising - as it is thought that few seedlings in the wild attain maturity due to fire and drought (Mugasha 1978) one would expect a decrease in numbers between seedling and older stages. The very striking thing about the age distribution of trees at Mchinga is the fact that for the most part seedlings are not found in the same locations as trees and saplings. Almost all of the seedlings we counted were growing in grassland or on bare ground, rather than amongst older individuals which were mostly in thicketed areas. The seedlings were quite widely distributed over the grassland, in many cases a considerable distance from a putative parent tree giving the impression that some seed dispersal was taking place. *D. melanoxylon* regeneration can also occur from the root crown (see *Conversations with Forestry Officials*), which may explain the fact that we saw several clumps of seedlings. It is also possible that at least one dense stand of *Dalbergia melanoxylon* saplings which we saw growing just outside our plots could be a result of this.

Why were no seedlings seen amongst densely distributed older trees? Perhaps the trees growing in the dense areas have not yet reached reproductive age - as none of the trees at the site were in flower or fruit at the time of our study we could not assess this. Information on when individuals begin to bear fruit is variable - one Forestry Officer in Nachingwea told us trees can start to produce flowers after 3 years, whereas Platt and Evison (1994) report hearing from an interviewee that seeds are not produced for the first 20 – 30 years. If either of these estimates is correct it seems likely that seeds are produced by some trees within thicket. In any case, wind is believed to play some part in the dispersal of seeds of the species (Von Mydell 1986), so it is possible that seeds could have been blown into thicket (many of the largest trees we saw were in more open areas) and still failed to set. Excessive shading may be the main reason for this (Sharman 1995), but other factors may be important – below-ground competition with larger trees (though grass also provides intense competition), or perhaps increased risk of attack by termites or herbivores such as dik dik or rodents (seedlings in grassland may be better concealed than those in thicket where there is very little ground level vegetation). If this is the case, regeneration of *D. melanoxylon* (and probably other species) in a forest without open spaces will be extremely slow – this may be one reason for *D. melanoxylon*'s supposed poor competitive ability (pioneer species are often intolerant of competition). Sustainable use of the *D. melanoxylon* growing in forests is unlikely to be workable without management to provide such open spaces. This, along with other ideas for *D. melanoxylon* conservation will be discussed presently.

Mature *D. melanoxylon* trees are fire resistant (e.g. Norton & Hawkins 1995), although Moore and Hall (1987) suggest that it may make them more susceptible to fungal infection. Seedlings in grassland are thought to be highly vulnerable to the effects of fires which occur naturally and as a result of human activity in areas such as Mchinga. *D. melanoxylon* seedlings, like those of many other African species, spend the early stages of their lives developing extensive root systems, and as a result surface damage caused by fire is not necessarily fatal to the individual (Platt & Evison 1994). Still, Mr. Kitale, the Lindi District Forestry Officer (and many others, e.g. Moore & Hall 1987; Puhakka 1991; Sharman 1995), feels that fire is one of the greatest pressures affecting the regeneration of trees such as *D. melanoxylon*.

During our study, seedlings standing in recently burned areas were examined, and although this cannot be said with great certainty, many seemed still to be living. Even if they were not, there was definitely a large variation in seedling size and, since *D. melanoxylon* is slow growing (Bryce 1969), this indicates a broad age-range among the seedlings seen, demonstrating that some seedlings may have been surviving from one year to the next. If we were experiencing a typical dry season it would follow that some must have been surviving fires. More careful long term monitoring is required to enable us to be sure of this. Platt and Evison (1994) report that two years of fire protection may be sufficient to allow seedlings to become established. Competition is another reason for low seedling success (Sharman 1995), and grass, which is an extremely important competitor for young trees, is mostly lost when fire sweeps through an area. It is possible that burns at the correct time of year could benefit established seedlings to some degree by allowing them greater access to water and nutrients in the soil. However, even if this benefit does occur, damage to seedlings does seem inevitable and it seems unlikely any silvicultural programme would include it as an effective 'weeding' method.

Various studies have suggested that in some areas *D. melanoxylon* is not regenerating well, (e.g. Moore & Hall 1987; Puhakka 1991). Puhakka clearly believes fire to be the main reason for this, and Moore and Hall report seeing apparently successful *D. melanoxylon* regeneration only in areas where trees were protected from fire. However, regeneration does seem to be occurring at Mchinga at the present time even though fires were not uncommon during our period of study. Following the progress of seedlings there to determine a 'success rate' may be of benefit. It would also be useful to compare areas where regeneration is thought to be low or absent with those where it appears to be taking place, to try to isolate further factors which may effect seedling establishment or survival. The availability of relatively open (i.e. non-thicketed) and largely undisturbed areas (there was no domestic stock on the plateau, and people tended to stick to paths when walking through the grass) may prove to be important.

Harvesting of wood

Of the 14 trees recorded at Mchinga which were over 100cm in CBH or stump circumference, 9 had been cut. This was a larger proportion than was found in any other size group, which clearly suggests that these trees are being selectively cut. Residents of the one house directly adjacent to the study site informed us that at least one of these trees had been taken by carvers. As far as we know there was no supply of Mchinga wood to saw mills, and the local people rarely harvest *D. melanoxylon* for themselves, so carvers may be responsible for the cutting and removal of much more of the wood.

It is difficult to predict the effects that removal of the largest, and therefore probably the oldest trees from the site will have on the *Dalbergia melanoxylon* population. The felling of trees in thicket will promote tree regeneration (although not necessarily of *D. melanoxylon*). However, the majority of the very large trees we encountered were actually outside thicket in more open areas. Whether the removal of these trees would dramatically reduce the seed set of the population as a whole depends upon the age at which *D. melanoxylon* trees begin to set seed, and how volume of seed produced varies with age (as explained above, this is unclear). Clearly loss of all large trees would have a very severe impact, but it may be that much smaller trees set seed also. Further, we observed new shoots growing from the stumps of cut trees. *D. melanoxylon* is known to coppice well, although it is thought that its ability to do so may be lost in old trees (McCoy-Hill 1993; Forest Division 1984) – data upon flowering and fruiting of coppice stools would help to clear up the above questions.

Even if it is thought that the harvesting of these large trees may not be detrimental to the total regeneration of the *Dalbergia melanoxylon* population, it is important to consider that other organisms might be affected. In general, very old trees with their various nooks and crannies can provide habitat for invertebrates, as well as nesting birds and so on. We found galls on some *D. melanoxylon* trees, and clusters of small snails in holes in the trunks of others. These holes could provide a locally humid environment in which snails are able to wait out the dry season, and standing dead wood may be useful for similar reasons. Cut wood left on site (as indeed much was, at least temporarily) might also be used by bark beetles and other boring insects, for example. While, according to Norton and Hawkins (1995), *D. melanoxylon*'s heartwood is almost indecomposable, we did see some dead *D. melanoxylon* branches whose exposed inner wood looked very earthy, as if it had been attacked by termites. Whether much or any heartwood had been broken down, it was hard to say, but the possibility could not be ruled out. Further, Moore and Hall (1987) report that pin-holes in *D. Melanoxylon* logs may be caused by one boring insect, a cerambycid larva. In any case, much of the dead heartwood we encountered did appear very much intact.

Norton and Hawkins suggest that such dead wood may serve to provide fire-protected microhabitats for plants and perhaps small animals. We certainly saw one or two live trees which seem to have done so – one spectacular looking specimen was observed in the middle of a large, recently burned area with a small area of unburned grass surrounding it and with a millipede curled up in an indentation of the trunk. It has been suggested (Norton, pers. comm.) that the moisture held in the tree's root crown may have been the reason for the apparent lack of fire damage.

Whether the removal, either of large living trees or of dead ones, could have a detrimental affect upon specific organisms – i.e. whether anything actually relies upon this kind of protection – is an issue which ought to be considered alongside that of the dangers of over-exploitation to *Dalbergia melanoxylon* itself. Should evidence be found that such wood does provide irreplaceable habitat for any organism(s), further measures (on top of the current licensing system) may be required to protect certain trees, both living and dead. Encouraging harvesters of the wood simply to leave a proportion of what they felled behind would help to maintain a supply of dead wood within an area, but, as Moore and Hall (1987) point out, this practice wastes potentially useable wood, and leads to the harvesting of a greater number of trees over all.

The Threat to *Dalbergia melanoxylon*

John Hall (UNEP 1988) predicted that there could be less than 20 years' supply of good quality *Dalbergia melanoxylon* timber (i.e. desirable to carvers and saw-millers) remaining in Tanzania. Desirable trees, are, according to Puhakka (1991), those of DBH greater than 30cm (or CBH greater than 94 cm). We found a total of 14 trees and stumps of this size in the $1km^2$ patch we surveyed. Hall and Moore (1987) estimate that, counting both legally and illegally harvested wood, the amount used by sawmills is approximately $2600m^3$ per year, and that used by carvers is $1500m^3$ per year, giving a total of $4100m^3$ of harvested wood per year. As each harvested tree yields on average 2 logs, and $1m^3$ of wood consists generally of about 20 logs (again, according to Moore and Hall, 1987), around 10 trees are required for $1m^3$ of quality heartwood. This gives a total tree harvest of 41,000 trees per year. Combining this figure with our own, for density of harvestable trees in a *D. melanoxylon* - rich area, it seems that upwards of $2,900km^2$ of such habitat would be required to meet each year's harvesting demand. The actual figure is likely to be much higher.

In order to put this figure properly into context an idea of the total area of land in Tanzania, outside Forest Reserves, which supports reasonable *Dalbergia melanoxylon* populations is required - such a figure does not seem to be available at this time; however the idea that $2,900+km^2$ of land may be denuded of harvestable *D. melanoxylon* trees each year is alarming. It should be noted that the harvesting of *D. melanoxylon* is regarded here as a separate issue to deforestation; although some proportion of the *D. melanoxylon* wood which is processed may come from deforested areas, the trees seem often to be removed from forested areas which are otherwise left intact.

There are problems with calculating a figure like this - for example, it does not take into account the number of large *D. melanoxylon* trees which may be considered to be of too poor a form (due to twisting and so on) for harvesting. Also, we cannot at this stage be certain of how similar our study site is to other *D. melanoxylon*-rich areas. As mentioned above, it seems likely that many of the very old trees at Mchinga may have been left behind from a land clearing in the past, as the trees in thicket tend to be smaller. This may give a bias in the size distribution which would not apply if the trees were not of separate 'forest generations'. Finally, as Moore and Hall (1987) predicted, the demand for *D. melanoxylon* wood both from saw-mills and carvers is likely to have increased considerably since the time of their research. However, it is useful to be able to envisage the general scale of exploitation. With further gazetting of *D. melanoxylon*-rich areas, along with research of the species's growth-rate and so on, it will be possible to fit it into management strategies for the future.

Whatever the specific effects of harvesting of *Dalbergia melanoxylon* at Mchinga, it seems likely that the supply of very large trees there could well become exhausted before too many years have passed. We do not know the rate at which trees are being cut, but even if only one is taken per year they may all have been removed faster than the remaining trees re-grow. This may push users of *D. melanoxylon* to start taking smaller trees, which may further affect regeneration in the area. It has been suggested that such use of younger trees in the Iringa region has led to a situation where neither young trees nor older trees of seed bearing age exist in one area (Platt & Evison 1994). Alternatively, it may push harvesters away from the area altogether, in search of a new source of wood. This type of effect is also mentioned by Platt and Evison (1994) who report hearing that loggers may have to travel up to 200km to find suitable trees. If this pressure is sustained, then large areas may well be denuded of all of their large *Dalbergia melanoxylon* trees in the foreseeable future.

Dalbergia melanoxylon is in fact a protected species in Tanzania, and by law a licence is required to fell a tree. However, there are many reports that a substantial proportion of the *D. melanoxylon* harvesting in Tanzania takes place illegally. Both stumps and logs of legally cut trees should be marked by an official, and certainly none of the stumps we saw at Mchinga had been marked.

Moore and Hall (1987) estimate that about the same amount of illegal as legal harvesting goes on, and Platt and Evison also came across this view in interviews during their 1994 study.

Felling licences are issued by District Forest Officers, but it is generally felt that they do not have the resources to enforce the law effectively. For example Moore and Hall (1987) report a severe shortage of vehicles, and the Lindi office were experiencing difficulties with their single Landrover at the time of our study.

Moore and Hall (1987) suggest that the decentralisation of forest administration in Tanzania has led to a lack of co-ordination and information sharing etc. at a regional and national level. The District Forest Officers currently act according to local plans and report to the District Councils and the Ministry of Local Governments and Co-operatives, rather than directly to the Director of Forestry or to the Minister of Lands, Natural Resources and Tourism. Regional Forest Officers have a co-ordinating role between District and National offices, but Moore and Hall feel that firmer central control is required and would be provided should District and Regional Offices be brought back under the direction of the national authorities.

An anonymous article in the Wildlife Conservation Society of Tanzania *Miombo* newsletter in 1995 expresses the opinion that decentralisation of power over the forests is not in itself a problem, but that it must be better tailored to involve the users of the forests if it is to be effective. It also recognises the problem of short staffing, stating that the number of Forest Guards has not increased over the last 20 years, unlike number of personnel in the wildlife sector.

One result of the 1992 Rio Earth Summit is a commitment by signatories to give local people a stake in wildlife management. Speaking at the recent (May 1998) Royal Geographical Society seminar upon the Mkomazi Ecological Research Programme, Bakari Mbano, Director of the Division of Wildlife, Ministry of Natural Resources and Tourism explained that the treaty had been ratified by the Tanzanian government, and that changes in the law to facilitate this commitment had been passed, and more were expected. Pilot schemes have apparently successfully in various parts of the country (the same anonymous article in *Miombo* remarks on two schemes in forests in Babati and Singida). Mr. Mbano announced that Community Conservation Areas would be declared on the borders of Mkomazi Game Reserve as the best way of providing a buffer between the wildlife inside and the pastoralists outside the reserve. He also subsequently remarked that this was in line with many new initiatives across Tanzania.

It is hard to imagine a successful conservation scheme, for *D. melanoxylon* or any other species, over which the users of the tree and the land on which it occurs do not have some control. Certainly, from our meetings at Mchinga we gathered that people would, in general, be quite prepared to look after trees growing on their land, provided that some incentive was offered. Looking at the protection of *D. melanoxylon* as a single species, rather than as part of a wider system, there are various possibilities which could be investigated.

As discussed earlier, it is commonly felt that the greatest barrier to regeneration of *Dalbergia melanoxylon* is fire (e.g. Moore & Hall 1987; Puhakka 1991; Sharman 1995). We were told by Mr. Kitale that there had previously been a system in place whereby people were paid to burn their land only early in the dry season, rather than later when fires can be hotter and more severe due to the accumulation of dry matter. Such a system, or one which involved people avoiding burning their land altogether and perhaps actively clearing fire guards around areas where regeneration of trees was occurring may considerably boost *D. melanoxylon* regeneration. One might even consider burning experimental areas where it is thought that regeneration might occur without the barrier of regular fires.

McCoy-Hill (1993) describes the system known as *Tungya* which has been used by the Burmese Forest Service to maintain and increase supplies of teak (*Tectona grandis*). People cultivating the land would plant teak trees amongst their crops, and tend them until such time as they moved on to a different area. The areas left behind by cultivators were then left for natural regeneration to occur. McCoy-Hill feels that such a system could well work in East Africa, given an incentive provided by the state to the people who practise shifting agriculture on their home lands. He suggests that, as in Burma, tribal Elders could best decide and instruct as to where and for how long certain pieces of land should be used for agriculture. Perhaps in a village such as Mchinga the Village Cabinet would assume this role. The idea could possibly be extended to include safe-guarding older trees against fire and other hazards as these trees are often left standing when land is cleared for agriculture.

A problem with schemes like this is that in order for them to be successful incentives must be provided up front and as work is going on. Whether money to fund such programmes is available to the state and could be made available to the districts is an important question. We made no attempt to gauge what sort of payment the people of Mchinga would expect or require if asked to help with the conservation of *Dalbergia melanoxylon*, but presumably it would have to at least equal, and probably exceed, any loss in production they may make by using agricultural land for other purposes. Perhaps extra money could be raised through sales and exports of *D. melanoxylon* wood - adding a 'conservation tax' to its value, for example. Sales of carvings (from larger co-operatives at least) could also be taxed, and the revenue raised channelled into conservation programmes. Research into whether such a move would adversely affect trade would clearly be required, although if the demand for the wood is genuine we feel that the likelihood of this is low. It does not seem unreasonable that Westerners using a rare foreign resource should recognise the importance of its conservation and take some responsibility for it. Also, having ourselves been tourists in Tanzania we believe that parting with more money than often is paid for carvings, particularly given the knowledge that some percentage would go towards conservation of the exploited tree, would not be excessively painful to most purchasers.

There is also scope for making the trade in *Dalbergia melanoxylon* products more efficient. Conversion of logs to billets for musical instrument production is very wasteful – recovery rates are usually below 10% (Moore & Hall, 1987). The same authors suggest that carvers could make good use of the off-cuts from saw mills. In this way greater returns to the conservation programme could potentially be made, should such a system be established. However, it is important that the cultural importance of Makonde art is not forgotten, and that carving is not simply written off as a second-rate trade. Encouragingly, one form of waste is now being put to good use, namely the saw-dust created in processing *D. melanoxylon* for clarinet manufacture. As featured on a recent edition of Radio 4's Today programme, Boosey & Hawkes's new *Greenline* clarinets are made using a combination of the saw-dust and epoxy resin. Perhaps, if cost effective – this would also require investigation, off-cuts from saw-mills unsuitable for use by carvers could be ground to saw-dust and used in this way. *Greenline* clarinets are reportedly highly regarded by some top teachers and performers – possibly being superior in sound even to those constructed from solid wood (David Campbell, pers. comm.). For the average amateur, though, the solid wood version is still apparently the preferred option. Theoretical physics dictates that the quality of sound produced by wind instruments is dependent not on the material from which they are made, but rather on the care taken in crafting them (Harby 1998). Unfortunately most musicians adamantly believe otherwise.

Various studies into silviculture of *D. melanoxylon* have been carried out (Mugasha 1983; Mugasha & Mruma 1983), and the best methods are discussed in these papers and by Moore and Hall (1987). Moore and Hall believe that with the right protection and care, *D. melanoxylon* can successfully be grown in plantations. One of the areas they refer to is the plantation at Nachingwea which being next to the District Forest Office has received adequate protection. Once again silvicultural programmes could be part-funded through earnings from trade in the wood.

The problem with silviculture is that plantations of single species are obviously of low biodiversity. The clearing of forest land to start up such projects would cause considerable loss of biodiversity which would seem a very regrettable effect of any conservation programme.

All of the ideas for promoting *D. melanoxylon* conservation discussed above are based on the fact that public land is cleared for agriculture. There is, according to Moore and Hall (1987), very little that Forestry Offices can do about this, even if in the process of land clearing people fell protected trees. It is a major threat, not only to the trees themselves but to all of the organisms which rely in some way upon woodland habitat, and it seems currently to be an important factor at Mchinga II where there are many supposedly desirable *D. melanoxylon* trees (see *Local Use and Knowledge of Mpingo* and *Reconnaissance Trips to Other*

Mpingo Sites sections). Moore and Hall (1987) take the view that such clearance is the most destructive force acting on the miombo woodlands of Tanzania, where much *D. melanoxylon* is found. Given the assertion made in the Cambridge Encyclopedia of Life Sciences that miombo forest may be the most important ecosystem in the world with respect to the plant and animal species connected to it, the consequences of continued clearance may be severe.

Of course *Dalbergia melanoxylon* conservation is in some ways a self-contained issue, given that it is, in some places, exploited to a greater degree than other forest species. However, it is important not to neglect the wider picture by focussing exclusively on *D. melanoxylon*. Using their economic value and cultural importance as selling points, trees such as *D. melanoxylon* could be promoted as ‘flagship species’, representing the worth of sustaining forest areas for continued use.

Experimenting with forest management would require very long term work, and given the losses which could occur only very carefully planned strategies should be tried at all. Shifting agriculture is traditional in Tanzania (Briggs 1993), and it seems very likely that in the past it has been in tune with the resources available. Perhaps it would be possible for the Forestry Offices and the people who know and understand the land to carefully plan which block or blocks of forest should be cleared for crop-planting in any given year, and the time scale on which shifting should operate. Wood felled during clearing, including *D. melanoxylon* wood if necessary, could be harvested and stored for later use – it is important not to forget the general uses which people have for *D. melanoxylon*. Workable systems would probably require very large areas within which some sections could be excluded from clearing altogether. Valuable trees in cleared areas, if not required for local use, could be left standing and protected as discussed above. Valuable trees could be left standing, and their protection incorporated into farming practices as discussed above would be necessary. After a section of land has been deserted, the plot may actually prove important in providing open space (which would possibly still have to be fire-protected) for the regeneration of *D. melanoxylon* and other trees. The idea is similar to that of coppice management of some British woodlands, although given the small size of some of these, cycling in Tanzanian forests would probably occur over a much longer time-scale. In addition, the amount of land required for agriculture could possibly be reduced were people able to make money out of forestry rather than selling agricultural produce.

In order to assess the true potential for a scheme such as this, detailed knowledge of the areas available and the demographic pressures in different regions would be required. As the human population grows, demand for land becomes greater, and such regulation of the use of public lands may not be practicable. However some action is required if the loss of biodiversity due to deforestation in Tanzania is to be slowed. Organised forest use, if feasible, seems far preferable than attempting to exclude people from further areas of forest by declaring them as forest reserves.

In conclusion, our study has provided important basic data, as well as much food for thought regarding the issues surrounding the conservation of *Dalbergia melanoxylon*. Clearly, Mchinga is a small and somewhat isolated place and much of the information gained there will be specific to the area. Comparing it with data from other areas in the future will be more instructive than looking at it in isolation, although as a starting point we feel it serves well.

In order to gain sufficient information to construct an effective long-term management plan for *D. melanoxylon* a great deal of further research is required. As well as ecological and distribution information for the species, the views of users and buyers of the wood must be considered since commerce will necessarily be a part of the management strategy. On the ecological side, detailed data such as that gathered by ourselves is vitally important, as are very basic surveys to assess the total area of forest in which *D. melanoxylon* occurs.

The Cambridge Mpingo Project now intends launching a ten year programme of research to continue the work of this expedition and gain a much more complete picture of the distribution, ecology and exploitation of *D. melanoxylon*. This will make the realisation of a successful management plan under Fauna & Flora International’s Soundwood Project much more achievable, and safeguard the future of *Dalbergia melanoxylon*, the mpingo tree, as an ecological, economic and artistic resource for generations to come.

Part II : The Realisation

Organisation Phase

Small Beginnings

Our mentor, Guy Norton, senior lecturer in biology at Anglia Polytechnic University, supplied the idea when we went to meet him for the first time. This was in late October and already we were cramped for time. We proved that you can organise an expedition such as this in only eight months, but we recommend that anyone contemplating something similar start as early as possible. The study area was suggested by Phil Clarke who had previously visited the area during his employment with Frontier. Armed with this we were able to take our first active step: application to the Cambridge Expeditions Committee for official university approval (which confers charitable status), and the form (the first of many) was completed in a mad frenzy of activity over 4 days preceding the deadline for submissions to the November meeting.

Once approval had been granted, Steve set about recruiting more people for the team (at this stage only Eric and Huw Nicholas were on board), and Anne-Marie and Kate were accepted on to theam just before the end of the Michaelmas term in early December. Huw unfortunately had to drop out at Easter due to financial and time pressures. Luckily, a second round of recruitment produced a group of first years of such quality, that we took on not one but two (Justin and Nick) to replace Huw. The labour-intensive nature of the surveying meant that this was both practical and desirable even at this late stage, and is unlikely to have had much effect on our eventual financial problems.

Development of the Methodology

Our principal task over the Christmas break was to familiarise ourselves more thoroughly with the subject. Guy thankfully provided us with copies of everything he had found specifically mentioning *Dalbergia melanoxylon* in the course of an exhaustive literature search earlier in the year. We also consulted various sources on the techniques of vegetation surveying. Following Guy's suggestion, our proposed surveying method was to use variable radius plots whose radius would be equal to the mid-point between the distance from the plot centre to the tenth and eleventh nearest *D. melanoxylon* trees. This idea was discarded in the field because of practical difficulties measuring variable radius plots in the study environment. Jon Lovett provided much appreciated advice in a number of areas. Many other people also helped us with uncountable ideas and suggestions – they are all listed at the end of this report.

The peripheral studies were developed later. The higher zoological expertise of the team (in comparison to our botanical experience) encouraged us to plan a minor investigation of small mammals in the area based around trap-and-release methods. A workshop organised by CUETC on PRA was extremely helpful in the genesis of our investigation into local attitudes, but this part of the project suffered with the departure of Huw, whose responsibility it had been.

Liaising with Tanzanian Universities and NGOs

This was possibly the most frustrating part of the expedition organisation. Any letters written around December time concerning an expedition in June tend to get left to one side – after all these are often very busy people and June is a long way from December. Little do they seem to realise quite how much practical planning and fund-raising can depend on the ability to show a reasonable level of contact with the host nation. We suggest anyone in a similar position emphasise the need to reply soon, and make clear the reasons for this. Obviously a reconnaissance trip can work wonders, but just as this was not possible for us, so it is out of the question for many others. Also beware that the lack of reply does not mean that they are not expecting you. We were informed by one valuable contact when we arrived that he thought the expedition had failed (because we had not written to him since the second unacknowledged letter was sent in March), and yet we thought that he was the one who had failed us (though he later proved very helpful).

Key contacts at Dar Es Salaam University were Prof. Semesi at the Botany Department and Prof. Kim Howell at the Zoology Department. Both are good first points of approach, although also very busy. Herbert Lyaruu, at the Botany Department, has a particular interest in *D. melanoxylon*, and was a crucially important contact for us. The Wildlife Conservation Society of Tanzania were very helpful, especially Stan Davies (though he has now finished his period of secondment there). Allan Rodgers at FAO is very influential and was also invaluable as a link man to WCST when their fax machine packed up. At Sokoine University of Agriculture, Prof. Malimbwi is also researching *D. melanoxylon*, and is someone we wished we had known about earlier than we did.

Raising the Funds

Since Huw was our original treasurer, the main fund-raising effort was delayed considerably, far beyond the ideal. In the course of this we missed several deadlines. However, we did not fail with two of the most prestigious award schemes: the BP Conservation Awards run in conjunction with Birdlife International and Fauna & Flora International, and the Royal Geographical Society Expeditions Awards. Of the others, the most significant grants came from the Cambridge Commonwealth Travel Bursaries and Cambridge Expeditions Fund. All individuals and organisations who supported the expedition in any way are listed at the end of the report.

For alternative fund-raising a good, eye-catching brochure is essential, and we opted for a folded A3 format (i.e. A4 size) to avoid the small type you must use with folded A4. The downside of this is that without opting for expensive card (and beware many printers cannot cope with thick card especially for A3) it is somewhat flimsier. Colour costs, but colour sells. We opted for a compromise whereby we produced 50 versions of the brochure with one side colour and the whole thing laminated to give an extra sheen plus sturdiness. These 50 would be sent to specifically targeted companies. 400 more all black-and-white on ordinary paper were printed for all other purposes – together these cost less than the 50 colour ones.

Blessed with the musical connection of the project, we had high hopes of raising substantial funds, especially from the instrument manufacturers. About half of the colour brochures were sent to manufacturers, for the return of only one small donation. The rest of them were sent to a selection of companies in the musical industry to no avail. We effectively lost money on the production of the colour brochure. Although we would hopefully have raised awareness as well (and this should not be denigrated) it was not the purpose of the colour brochure, and we would caution other expeditions taking a similar gamble unless they are confident of a decent return. An article was submitted to, and subsequently printed by Clarinet and Saxophone magazine – this raised a further £50.

In the end we had to raise the level of personal contributions from £400 to £600 as a precautionary measure. A bad estimate of our costs while in Dar Es Salaam meant that none of this could be returned to members, and our counterparts would be disappointed in the level of bonuses received. All this goes to show the benefits of an early start to planning any expedition. If the brochure had been produced before Christmas (instead of March) and we had been able to concentrate mostly on the fund-raising during the Spring then this should not have been the problem it was.

Obtaining Permission

The expedition very nearly fell apart over the problem of obtaining our research permits from the Commission for Science and Technology (COSTECH) in Tanzania. We made our initial contact to Mr Nguli there in plenty of time back in December 1995. However it was not until Easter that we filled out the forms. Because it was a little late we sent them in 3 separate ways: by email, by direct mail, and courtesy of the diplomatic bag from the Tanzania High Commission in London, the use of which we had been generously been offered by the High Commissioner. It is doubtful whether any good was accomplished by sending the application by email, as nothing would be done about it until the US $50 application fee was received. Unluckily we decided to send this in the diplomatic bag – unluckily because it almost certainly took longer.

In the instructions we had received it had specified payment by Traveller's Cheque. However a signed TC is the equivalent of cash, so we took this to mean a banker's draft which is recognised internationally and cannot bounce. This was a grave mistake for the reason COSTECH demand a TC is to avoid the high bank fees they get charged to cash ordinary cheques and banker's drafts. We recommend anyone in our position in the future follow the instructions to the letter. Mr Nguli is aware that this can be a problem, and also that the permits are very expensive for a short project such as this. He said that COSTECH is looking into ways to improve it, though this may take some time.

By the time Mr Nguli had received the useless banker's draft it was June, and the team were all sitting university exams, so the email explaining the difficulty had to be temporarily put on one side. Afterwards, we did briefly investigate the possibility of directly wiring the money, but the charges almost doubled the cost, and moreover the slow speed it can take meant it barely arrive before we did, so we resolved to just fly out and pay it along with the fee for the permits themselves. When the advance party arrived in Dar Es Salaam, visiting COSTECH was a high priority. There Mr Nguli informed Steve that the lack of payment meant that our application had not yet been considered. The next meeting of the applications committee was not until mid-August, and we would have to wait until then to receive our permits.

Never give up! Sometimes good contacts can be invaluable. When Steve asked whether there was any way this process could be hastened, this was met with the response that the Director-General was tired of foreigners arriving in Tanzania without having properly followed the applications procedure, and did not like working 'unsociable hours' in order to expedite their requirements. However, when Steve asked if some of our contacts might be able to help, the revelation that Prof. Semesi was in favour of the expedition, produced a much more encouraging reply. Within a week we had our permits, and we are exceedingly grateful to Prof. Semesi.

Logistics

1. Dates of the Expedition

11 July	British Advance Party arrives
18 July	British Main Party arrives
24 July	Travel to Mtwara
26 July	Arrive Lindi
27 July	Arrive Mchinga
19 – 21 Aug.	Kilwa trip
2 – 7 Sept.	Nachingwea & Liwale trip
6 – 8 Sept.	Tendaguru trip
10 Sept.	Tanzanian Members return to Dar Es Salaam
13 Sept.	British Members returns to Dar Es Salaam - end of expedition

2. Exchange Rates

Costs below are given in Tanzanian Shillings. During our time there the exchange rate was approximately:

GBP £1 = TSh 900/- or USD $1 = TSh 600/-

Inflation is a big problem, especially in Dar Es Salaam, and it is likely that even costs in hard currency will increase substantially in the next few years. We found prices, for accommodation particularly, were on average 50% higher in real terms that was quoted in guide books only a couple of years old.

3. Transport

3.1 Travel to Tanzania

The Advance Party and two of the Main Party flew out to Dar Es Salaam from London Heathrow by Gulf Air. The other two British members flew to Nairobi with Alitalia, as no more cheap flights to Dar were available. They bussed down to Tanzania with the Arusha shuttle, operated by TNT, and were given a lift to Dar from Arusha. The team then met up, and stayed at the *Safari Inn* just off Libya street whilst arrangements for counterparts were completed and other preliminary business dealt with. The *Safari Inn* is one of the cheapest hotels in the centre of Dar, and of reasonable quality, but it still cost us TSh 8,000/- per night for a twin fitted with fan and shower, and including breakfast.

3.2 Travel to Lindi & Mchinga

Travel to Lindi was undertaken using the ferry Canadian Spirit, which runs from Dar via Mafia Island to Mtwara. The cost of the journey is TSh 14,300/- per person in first class. The journey lasted an unexpected and debilitating 32 hours in stormy weather. This is an extremely rough voyage for which this ship is not really suited (it is an old Greek island hopper). First class is not to be recommended on this voyage, due to its close proximity to the bows of the ferry and the engine room, although there is undoubtedly more room than in second class. We later heard that there were official doubts as to the ship's sea-worthiness. Most of the expedition were sick, and our verdict is best expressed by the alternative route taken back to Dar.

The expedition arrived late into Mtwara, and stayed at the NBC club, approximately 2km out of town and a fairly comfortable if morally defunct establishment (TSh 1,500/- per night for a twin). The next day we took the bus to Lindi, and purchased other items of equipment that we needed, and met the local forestry officers before staying in two guesthouses (neither had space for all of us). The City Guest House (TSh 1,200/- per night for a twin) was very poor and infested with mosquitoes. The South Honour Guest House (TSh 2,000/- per night for a twin) was much more pleasant.

Mr. Kitale, the Regional Forestry Officer drove an advance party to Mchinga early the next morning, to present ourselves to the late Baba Chilima, then village secretary of Mchinga. The remainder of the expedition arrived later that day having purchased sufficient supplies to last us several days, and the camp was established.

3.3 Kilwa trip

Mr. Kitale drove the two members to Kilwa, as he had business there. In the absence of such convenient transport Kilwa is still not difficult to reach: buses travelling the coastal route from Mtwara to Dar Es Salaam stop off in the nearby town of Nangurukuru, from where it should be easy to find a lift. The drive from Mchinga took 3½ hours. Accommodation was at the Mjana Enterprises Guest House is good value at TSh 3,000/- per night for a twin with fan and mosquito nets. It has a reasonable restaurant attached. One day a vehicle was loaned to us by Mr. Mnayahe, the District Commissioner, but we had to pay for fuel at TSh 7,500/- for 20l of fuel to cover about 100km. The second day Mr Kitale was once again able to provide transport. Mitarure Forest Reserve is about two hours drive from Kilwa.

3.4 Nachingwea & Liwale trip

The expeditioners travelled down to the area by bus, a journey that took a considerable amount of time due to the extreme remoteness of the area. The bus from Lindi to Nachingwea took around 4½ hours and cost TSh 1,800/- per person. At Nachingwea we stayed in the pleasant and garishly coloured Ruvuma Guest House (TSh 1,200/- per night for a single with electricity and mosquito nets). The water in Nachingwea is too salty – water must be brought in from wells outside the town. This time we had to pay TSh 10,200/- for 30l of fuel. Lyonja Forest Reserve is about an hour's drive away.

The bus from Nachingwea to Liwale took 6 hours and cost TSh 2,000/- per person – the road is extremely poor and impassable in the wet season. We stayed (with a lot of timber workers) at the Singea Hotel: twin rooms cost TSh 1,500/- per night including fans but no nets. Food at Liwale was generally poor, and was the suspected cause of a severe attack of diarrhoea. We had to hire a vehicle for TSh 5,000/- (over-priced especially considering its state of maintenance) to reach Likombora, which is substantially less than an hour away if you are in a half-way reliable vehicle. Petrol was a further TSh 5,300/- for 10 litres. Further breakdown difficulties were experienced on the buses back to Nachingwea and Lindi.

3.5 Tendaguru trip

This was the remotest area visited and was not accessible by public transport. It can be reached via the northern road to Kilwa, turning off at Nkwguui to Mnyangala and from there to Namapuia. It's an hour walk from there to the top of Tendaguru Hill. Hans Blom van Asendelft, the VSO worker in the forestry office, drove the expeditioners on this excursion. As a precaution against rumoured man-eating lions a game-guard was hired at a cost of TSh 3,500/- per day. A 4WD is essential after Nkwguui. The road from Mnyangala was dreadful, and it took 9½ hours to travel 47km due to elephant damage to the forest. Assistants (TSh 2,000/- for the day) were indispensable to clearing the road. Total fuel costs were TSh 25,000/-. The water at Tendaguru is a most disturbing colour. An injury to one member's eye meant that the return journey came back via Rondo, and Ndanda hospital.

3.6 Return journey to Dar Es Salaam

All parties travelled back on one of the regular bus services to Dar, on different dates. One of these services, the Kivugu Vugu Bus was not actually in a roadworthy condition, resulting in grueling journey time of 27 hours due to the many breakdowns it experienced. Nevertheless, this is true of many buses on this route, and we would still recommend it above the boat. It cost between TSh 6,500/- and 8,000/- for the journey back depending on the quality of the bus.

3.7 Return home

Two members returned to Kenya by bus, the remainder flew out from Dar Es Salaam.

4. Equipment

4.1 Camp equipment

Brought from UK:	Bought in Dar Es Salaam:	Borrowed from Mama Chilima:
5 tents	3 pans and cleaning items	2 charcoal burners
Sleeping kit	Cutlery and plates	Seats
Personal kit	Frying pan	Assorted pans
Groundsheet	Bucket	Buckets and other cooking utensils
Scientific equipment	Kerosene lamps	
Medical Kit	Kitchen knife and 2 machetes	

All equipment purchased in Dar Es Salaam was bought on India Street, off Morogoro road. Other equipment was bought in the YHA Adventure Shop in Covent Garden, London where we received a 20% discount on non-sale items.

4.2 Scientific equipment

5 Silva compasses
3 30m measuring tapes
2 50m measuring tapes
3 3m measuring tapes
5 clinometers
10 hand lenses
1 trowel
Resealable bags
Secateurs

Books:

Kenya trees shrubs and lianas (H.Beentje)
Trees of Kenya (T. Noad and A.Birnie)
A field guide to the larger mammals of Africa (Collins)
A field guide to the birds of East Africa (Collins)
Wildflowers of East Africa (Collins photo guide)

All scientific equipment was borrowed from the University of Cambridge, except the clinometers, which were borrowed from Helsby High School. All books were bought in Nairobi, or borrowed.

5. Supplies & Finances

All supplies were bought in Lindi and Mchinga. A weekly trip was taken to Lindi, where the basics such as rice, flour and maize-meal were bought, as the prices here were often cheaper than in Mchinga, and the produce of better quality. This weekly trip was also used to collect and send post, to liase with the Forestry Office and also to change money.

Money was changed at the National Bank of Commerce on the harbour. The exchange rate was as elsewhere, although a charge of TSh 1000/- was made for postage of each Travellers Cheque. It is advisable to take big cheques to limit this cost.

Other supplies such as beans, fish and seasonal fruit and vegetables were bought at Mchinga market, although villagers often brought food to sell at the camp.

Transport to Lindi was by lorry, which left Mchinga daily at 7a.m. There was the option of returning with the lorry, but the regular bus service (going all the way to Dar) was preferable. The round cost was TSh 1,100/-, and the journey took about 2 hours each way although it is only about 30km long.

6. Camp Details

6.1 Location

The camp was located just outside Mchinga village to allow the locals to cause minimum interference to the lives of the local people. The camp was situated in a grove of Baobab trees, off the main path to the study site.

6.2 Layout

The main camp consisted of the sleeping and cooking area, which was located downwind of the tents and the other side of a baobab tree. The area was cleared of all vegetation, due to the length of stay, and the need to deter insects and animals from coming to the camp. A firebreak was burnt around the camp to drive away the snakes which had been attracted to the campsite.

The toilet was built 40 yards away downwind of the camp for hygiene reasons, and the route was marked by a clear-cut path so any snakes could be easily seen. Also off this path were the washing area and the garbage dump.

All organic matter was burnt daily, whilst the remainder was buried. This was an attempt to curb the snake problem, caused by mice and other rodents attracted to the rubbish.

7. Modus Operandi

7.1 Camp duty

2 people were always left in camp in order to guard the camp, prepare the days food, and perform camp duties. This was a full day's work, involving rising at 5:30a.m to prepare tea and breakfast. After the rest of the team had departed, lunch would be prepared, and later on supper was also the responsibility of those on camp duty.

7.2 Scientific work

At the beginning of the expedition, we left camp at 8a.m, and conducted research until 1pm. Lunch was eaten up at the study site, an hour's walk from camp. Work then continued in the afternoon, before returning to camp for dinner.

This plan was refined, to create a more efficient schedule, as the midday heat prohibited much work in the early part of the afternoon after lunch. It was decided to leave camp at 6am, work until 1pm, and return to camp. The afternoons were spent more productively in the cooler camp either analyzing and collating data, identifying specimens, or analyzing the soil samples. Late afternoons were spent at the beach.

Work was carried out from Monday to Saturday. Each person rotated through a system, doing time in the field and in the camp. Sunday was a rest day. Popular activities were bird-watching, reading, fishing, swimming, and trips into town, interspersed with the occasional game of beach volleyball.

Weekly evenings were spent relaxing, and preparing for the next day. The expedition generally retired to bed at about 9pm each night.

Health and Safety

1. Preparatory stages

Advice on all medical aspects of the expedition was sought and received from Cambridge University Occupational Health Service at Fenners, Gresham Road, Cambridge (tel. 01223 336590), who were very helpful. Their role in ensuring that we suffered no major health related incidents on the expedition is acknowledged with gratitude. Valuable information was also gleaned from reports of previous expeditions to the area, and from individual doctors.

All British members of the expedition were fully immunised before departure against the following diseases:-

Yellow fever (certificate required for entry into Tanzania), typhoid, polio, tetanus, meningococcal meningitis, hepatitis A, and rabies.

2. Medical Kit

The expedition medical kit contained the following:-

Fansidar and Quinine (malaria treatment, 3 courses), Triludan (antihistamine), Rehydrat (rehydration sachets), Lorexane (antiparasitic cream), Senokot (laxative), Codeine phosphate (antidiarrhoeal), Autan (insect repellent, 9 tubes), DF118 (painkiller), sun cream (factors 10 and 20), antiseptic, Hydrocortisone, Paracetamol, Lomotil (antidiarrhoeal), Micotil (fungicidal foot powder), Chloramphenicol (antibiotic eye ointment), Puritabs (chlorine water sterilisation tablets, x1500), a range of antibiotics in tablet form (ampicillin X 5 courses, augmentin, tetracycline, metronidazole, tinidazole), a thermometer, and a dressing pack (various adhesive plasters, bandages, scissors, safety pins, antiseptic ointment, etc.).

In addition, each expedition member brought their own small first aid kit containing plasters and any medication they were likely to need, including a small supply of aspirin, sun-cream etc., to avoid placing excessive demands on the main medical kit.

3. Medical risks and incidents on the expedition

3.1 Malaria

The greatest risk to the health of expedition members was assessed to be that of malaria, which is prevalent along the coast of East Africa. This area is particularly plagued by drug resistant strains of malaria, and choice of prophylactic medication posed a dilemma. In the absence of effective alternatives, mefloquine (marketed as Lariam) was recommended as the drug of choice. Of the British members, two elected not to take mefloquine, one for fear of side effects (who took chloroquine and paludrine instead) and one who as a resident of Kenya had their own prophylactic strategy already in place. The Tanzanian members of the expedition had lifelong experience of exposure to malaria and relied on their acquired resistance to infection.

In our antimalarial plan, great emphasis was placed on prevention of mosquito bites. Mosquito nets were generally used whenever sleeping outside the tents, which had their own inbuilt nets, and ample supplies of insect repellent were carried, as well as knock down insecticide sprays. In the event, the bush around the campsite at Mchinga, two months into the dry season, was devoid of surface water and we saw no mosquitoes at all during our stay there. Mosquitoes were, however, noted in great abundance locally in Lindi, and the prevalence of malaria borne out by several cases of the disease among the local people, one tragically fatal. The threat of infection was taken very seriously by the expedition, and although none of the drugs we took with us for treatment were used, they were always to hand and any headaches, lethargy or fever closely monitored.

Of the Tanzanian members, one developed symptoms of malaria, and was treated with Septrin and paracetamol, a combination they were used to and had proved effective previously, in preference to the stronger drugs in the medical kit. It is thought that this illness was a flare-up of an established infection and not a new infection contracted at Mchinga. One of the British members contracted malaria after the end of the expedition, but the infected bite probably occurred during the final phase in Dar Es Salaam. The combined quinine and Fansidar course proved effective in curing it.

3.2 Camp hygiene and gut infections

Apart from the risk of serious food and water borne pathogens such as cholera and hepatitis A, any diarrhoea could have serious effects, particularly where dehydration is potentiated by a hot climate. The most important preventative measures against traveller's diarrhoea and other gut infections are strict hygiene, thorough cooking of food, and a source of clean water.

At the Mchinga camp food and water sources and treatment were under the expedition's control and hygiene was easy to monitor. Water came from the village well: drinking water was treated with tincture of iodine (20 drops per litre), and treated/untreated water was kept in separate, labelled, containers. Food was purchased from Lindi market or from the village, and most was cooked thoroughly over a wood or charcoal fire. Any vegetables eaten raw were soaked in weak disinfectant solution (Milton) and rinsed in iodinised water.

Camp hygiene was facilitated by careful camp design and strict routine. Almost all rubbish was burnt daily: the rest was discarded in a rubbish pit some thirty metres downwind of the main camp and buried over weekly. The latrine was some fifty metres from the main camp. It consisted of a 2m x 0.5m x 1m deep trench covered with wooden slats, plastic sheeting and compacted earth, leaving a narrow slit which when not in use was covered with a palm frond. When nearly full - about every two weeks - the latrine was filled in with earth and a new one dug nearby. The latrines tended to become colonised by maggots very quickly, which started to produce flies by the end of the latrine lifespan. Pouring kerosene in and then igniting it seemed to make little impact on the maggots and, while applications of ash from the fire may have deterred the flies, frequent burying and re-siting was the only real solution to the problem. A tub of disinfectant, replaced daily, was kept at the main camp for use after the latrine.

Despite taking reasonable care over the disposal of organic debris, vermin were a source of concern. The small mammal population around the camp certainly seemed to increase judging from the rustling noises in the bush, and this may account for the increased sightings of snakes in the camp during the latter part of our stay. No larger scavengers were sighted in the camp, though a hyaena passed within twenty metres one night. The cooking area was separated from the tents by several metres and the trunk of a large baobab tree as a precaution.

While at Mchinga camp no gut infections occurred among the group that required treatment. Elsewhere we were not so fortunate, particularly in the first two weeks of being in Tanzania, and on the trip to Nachingwea and Liwale. In all, six of the nine expedition members - including one Tanzanian member - needed treatment for diarrhoea. In the first instance, rehydration by drinking plenty of water, and a salt/sugar solution, was recommended. If the inconvenience caused by the diarrhoea was likely to be considerable, e.g. when travelling, codeine phosphate was dispensed. If the diarrhoea persisted for more than 24 hours and/or was accompanied by nausea and vomiting, or was recurrent, or became totally liquid or contained blood, a five day course of Ciprofloxacin was dispensed. This was effective in all cases.

The hot dusty climate and inevitable sweatiness made good personal hygiene imperative. Several members bathed daily in the Indian Ocean (what a chore!), while others managed with a basin and some well placed trees. Water was thankfully not in short supply.

3.3 Climate

The climate throughout our stay in Tanzania was warm and dry, and rainfall was insignificant. The main climate-related health risks were dehydration and sunburn. Temperatures soared late in the morning and generally stayed uncomfortably hot from 11am to 3pm, even after acclimatisation, though a steady coastal breeze in Mchinga attenuated the heat. Exposure of skin to direct sunlight was minimised between these times by donning hats and appropriate clothing, at least by the majority of expedition members. Suncream or sunblock was applied according to individuals' complexion and paranoia/awareness, and sunburn never became a problem. Sunglasses were essential.

Dehydration was avoided by resting in shelter during the hottest parts of the day, and by drinking water freely. Once acclimatised to the heat, individuals settled into appropriate patterns of water intake, and there were few problems apart from the occasional cautionary headache. Estimated intake ranged from three to eight litres of water per day in addition to that contained in food. Heat exhaustion (in which general exhaustion probably played a large part) was encountered on one occasion, and was treated by shade, rest and drinking water.

3.4 Infection and Infestation

Ticks abounded in the long grass of the study site, and were found frequently on clothing or skin. Long trousers were worn to discourage them, but remarkably even when found on skin they were never seen to bite. Jigger fleas were more of a problem, afflicting three of our number. These parasites bury themselves in toes or under toenails and lay eggs: thankfully they were discovered before this stage and dug out with penknife or using the local sharpened stick method.

Infection is alleged to progress faster in tropical climates, and indeed any minor wounds or scratches tended to produce pus within hours. Skin abscesses drained and disappeared once lanced, and we never had cause to resort to antibiotics for this problem. In one case, a long forgotten insect bite turned septic a month after returning to the U.K., causing a little consternation.

3.5 Dangerous Animals

Unknown insects and arachnids (the majority of those observed) were generally treated with suspicion lest they inflict pain or illness, a fear rarely justified. Ant stings and bites were not rare, or appreciated, and a few large spiders were undoubtedly best left alone, but on the whole the arthropods did not bother us. A number of small scorpions were encountered in the camp at Mchinga, and did inflict one sting on an imprudently bare foot, which caused pain and then numbness. Paracetamol and topical antihistamine were the only treatment needed.

Of the larger dangerous animals, there was evidence of hyaena and leopard near the camp, and rumours of lions, but these caused us no problems. Snakes, however, were a cause of some concern. Black mamba, spitting cobra, puff adder and vine snake were all sighted dead or alive in the camp, village or study site, as well as other unidentified species. Puff adders were particularly common, and too close for comfort on more than one occasion. Vine snakes by virtue of their excellent camouflage were probably more common than we realised at the study site and we worked with caution. Dangerous snakes that entered the camp (in the event, just one puff adder) were killed. Snakes sighted elsewhere were kept under observation from a safe distance by one of the group until we or it moved on. There was no antivenom in the medical kit or in the village of Mchinga: in the event of a bite immediate evacuation was the contingency plan.

3.6 Emergency evacuation plan

In addition to the main expedition medical kit, a first aid kit was routinely carried to the study site. In the event of an accident beyond our competence, the first port of call would have been the dispensary at Mchinga, which had very basic medical facilities. Thereafter, evacuation would be arranged to Lindi or Ndanda hospitals, the latter further than Lindi in the same direction but reputedly better. There was a truck and three motorbikes in Mchinga, which could be called upon by the Village Secretary instantly. The motorbikes would be used to fetch help and vehicles as necessary from neighbouring villages. For more serious accidents, evacuation to Dar Es Salaam and the U.K. was possible from Lindi airstrip. The expedition's medical insurance covered air ambulance and repatriation costs.

4. Security

Security advice was received from the British Foreign Office and from British Petroleum, one of the expedition's sponsors. Though in a state of political change, Tanzania was not considered to be at risk of violent instability during the expedition's stay. Tribal violence is not a big problem in Tanzania, in contrast to many of its neighbours, and crime is said to be much rarer than in Kenya, for instance. While at Mchinga, nothing was stolen and no trouble encountered. The practice of never leaving the camp unattended was a sensible precaution, but security could never be foolproof and it was probably never tested.

Part III : Appendices

Appendix I : Main Survey Data Tables

Results of *D. melanoxylon* Survey

Plot no.	Tree	Dist. (m)	° N	Stem no.	CBH (cm)	Ht. (m)	CA (m²)	TD	Other obs.
1	1	1.2	17	4	165	7.9	12	2	3S
	2	8.0	307	1	74	-	-	-	BS
	3	16.7	297	1	14	5.1	4.7	2	-
	4	19.7	230	1	123	-	-	-	BS
	5	3.0	98	2	17	7.4	6.0	1	-
	6	7.5	68	3	59	-	-	3	3CS
	7	6.3	86	1	13	6.1	2.7	2	-
	8	30.0	178	1	56	-	-	2	CS
	9	9.1	90	1	17	6.5	5.2	1	-
	10	6.3	23	7	56	9.7	22	4	2S,cl
2	1	4.6	138	8	77	9.9	92	0	-
3	1	5.0	20	2	14	4.3	4.5	0	-
	2	20.9	8	2	12	4.1	2.6	0	-
	3	21.0	10	1	17	3.9	4.5	0	-
	4	20.9	12	2	14	4.9	5.4	0	-
	5	20.1	70	3	20	4.9	21	0	-
	6	5.8	123	2	22	5.2	7.8	0	-
	7	5.1	125	3	10	3.9	1.2	0	-
	8	29.0	282	2	20	3.9	18	0	-
	9	27.3	298	2	13	4.1	2.6	0	-
	10	23.7	296	2	10	3.2	2.5	0	-
	11	18.3	346	2	15	4.7	4.0	0	-
	12	21.8	346	1	10	4.3	2.4	0	-
4	No *D. melanoxylon* trees or saplings.								
5	No *D. melanoxylon* trees or saplings.								
6	1	14.8	36	3	21	5.0	8.2	4	-
	2	16.8	40	1	14	4.2	8.4	2	-
	3	29.3	50	11	72	8.9	65	0	-
	4	11.9	50	2	21	5.7	5.9	2	-
	5	12.2	47	2	16	4.3	3.5	2	-
	6	8.3	58	1	11	3.9	1.5	1	-
	7	9.9	80	1	12	4.3	4.6	2	-
	8	8.9	83	1	14	6.1	6.8	0	-
	9	8.7	90	3	13	5.7	7.9	1	-
	10	8.7	89	1	14	4.7	7.5	1	-
	11	8.6	95	3	15	5.9	8.8	0	-
	12	6.7	90	3	21	6.5	7.0	0	-
	13	6.4	122	4	12	4.5	5.7	2	-
	14	8.9	128	4	13	5.2	3.0	2	-
	15	18.2	114	3	14	5.2	2.0	2	-
	16	18.7	116	2	10	4.7	3.7	0	-
	17	20.2	112	2	18	4.3	4.0	0	-
	18	24.2	112	2	15	6.3	6.6	2	-
6	19	24.6	122	5	30	10.6	22	3	-
	20	24.0	123	2	20	8.1	13	2	-
	21	25.7	122	3	29	8.4	32	3	-

Plot no.	Tree	Dist. (m)	° N	Stem no.	CBH (cm)	Ht. (m)	CA (m²)	TD	Other obs.
	22	23.7	116	1	27	8.1	7.7	3	-
7	1	13.1	0	3	19	6.5	8.1	0	IDL
	2	18.7	12	4	16	6.1	4.3	1	IDL,cl
	3	13.1	10	11	33	7.6	30	0	IDL
	4	10.0	22	1	11	6.7	2.1	0	-
	5	7.0	10	3	22	6.3	17	0	IDL
	6	7.5	7	5	29	6.9	25	0	IDL
	7	6.1	40	16	62	6.1	73	3	IDL
	8	8.0	28	6	26	7.6	15	2	IDL
	9	6.5	28	3	12	6.1	7.0	0	IDL
	10	19.0	52	5	16	5.2	9.2	1	-
	11	15.1	56	8	40	6.6	38	2	-
	12	9.4	66	2	19	4.2	4.7	1	-
	13	7.7	66	8	28	4.8	27	3	cl
	14	8.0	52	1	29	5.6	17	0	cl
	15	8.1	56	1	25	5.6	17	2	-
	16	6.1	70	1	14	4.8	5.5	1	IDL
	17	29.7	110	4	32	6.9	25	1	IDL
	18	26.8	112	2	10	4.0	7.8	0	-
	19	27.6	115	2	18	3.0	8.0	1	-
	20	27.5	116	2	10	4.4	4.4	1	-
	21	30.0	116	1	30	7.1	7.7	0	IDL,cl
	22	29.2	116	1	11	5.4	3.1	1	-
	23	29.1	117	2	17	5.4	7.6	1	IDL
	24	28.8	117	2	15	4.4	8.0	0	IDL
	25	2.8	280	1	26	4.9	8.3	0	cl
	26	4.1	300	1	35	6.3	12	0	cl
	27	2.0	297	1	10	3.9	3.5	0	-
	28	8.6	328	1	13	3.7	1.9	3	-
8	No *D. melanoxylon* trees or saplings.								
9	1	9.4	0	1	49	-	-	-	BS
	2	28.0	31	4	52	-	-	-	BS
	3	24.0	25	1	78	7.5	13	0	-
	4	23.5	25	2	51	-	-	-	BS
	5	15.2	91	10	26	5.0	9.1	2	1S
	6	1.9	220	3	12	3.4	6.1	2	-
	7	12.9	332	1	88	-	-	1	CS
	8	13.7	332	1	70	-	-	1	CS
	9	19.6	336	1	12	4.4	2.5	0	IDL,cl
	10	20.9	336	1	12	3.3	6.3	2	IDL,cl
10	No *D. melanoxylon* trees or saplings.								
11	1	23.8	84	1	55	7.1	22	3	-
	2	7.7	83	1	110	9.3	15	5	Dd
	3	11.3	285	1	72	8.6	7.4	5	Dd
	4	28.5	316	1	25	8.1	5.1	2	-
12	1	6.3	026	2	30	7.0	14	4	IDL
	2	7.2	030	2	16	6.9	4.9	2	-
12	3	8.0	034	1	12	6.5	1.9	2	-
	4	8	034	1	12	6.1	3.3	1	-
	5	10.3	033	2	18	8.3	9.8	3	-
	6	11.0	021	2	12	8.3	8.5	1	-

Plot no.	Tree	Dist. (m)	° N	Stem no.	CBH (cm)	Ht. (m)	CA (m²)	TD	Other obs.
	7	9.9	066	3	30	8.1	16	2	-
	8	11.3	031	2	17	8.1	12	3	-
	9	12.0	030	2	13	6.1	4.0	3	-
	10	16.4	059	1	16	6.7	7.5	1	cl
	11	24.5	044	1	11	4.3	0.9	2	-
	12	24.5	086	2	20	7.1	6.5	3	cl
	13	25.3	087	3	25	8.1	11	4	-
	14	26.6	090	1	13	4.3	2.4	1	-
	15	29.1	092	2	10	3.2	6.3	1	-
	16	19.9	099	4	11	3.6	1.8	2	-
	17	20.2	116	1	16	6.6	2.4	2	-
	18	21.5	134	1	11	3.2	2.6	0	-
	19	17.8	134	1	17	6.6	5.8	2	-
	20	20.9	136	1	11	5.6	1.7	1	-
	21	26.0	135	1	11	5.6	1.7	2	-
	22	29.9	253	2	38	8.0	13	2	-
	23	17.6	200	1	17	7.3	11	2	-
	24	23.1	308	2	33	8.7	12	3	-
	25	25.9	322	1	28	8.2	9.2	1	-
13	1	16.9	028	1	13	5.2	2.5	1	-
	2	18.8	354	2	10	6.0	1.8	0	-
	3	22.5	356	1	14	5.4	2.3	1	-
	4	20.0	350	1	24	6.8	11	3	-
14	1	29.4	012	2	11	3.9	1.5	3	-
	2	28.5	014	11	14	4.2	2.6	4	-
	3	12.9	041	10	33	6.0	16	2	IDL
	4	5.6	243	15	27	8.2	40	3	-
15	1	22.5	164	1	100	14.1	39	2	cl
	2	21.5	243	4	73	10.8	41	3	-
	3	12.9	205	1	53	11.4	31	4	-
	4	20.4	268	1	34	7.5	13	0	-
16	1	22.8	026	1	134	-	-	0	S
	2	27.6	034	1	24	8.1	8.6	0	-
	3	23.0	067	2	68	11.4	62	2	-
	4	23.3	076	2	31	6.4	45	2	cl
	5	22.9	078	2	23	6.0	20	0	-
	6	22.5	078	3	33	4.8	20	1	-
	7	20.2	083	4	53	8.5	29	3	IDL
	8	20.3	084	2	12	4.4	15	3	-
	9	24.7	086	2	25	4.6	21	2	-
	10	25.3	263	4	156	4.5	40	1	3S
	11	29.3	316	2	14	6.0	17	1	-
	12	29.7	318	1	40	8.2	18	4	-
	13	23.2	330	3	26	8.0	20	1	-
	14	26.0	330	1	12	4.4	20	2	-
17	1	17.6	014	1	16	7.8	1.8	0	-
	2	24.0	070	1	25	8.0	11	0	-
17	3	15.2	116	1	18	7.5	4.5	0	-
	4	10.8	122	3	20	7.1	15	0	-
	5	10.8	123	2	19	7.5	10	0	-
	6	8.6	139	1	25	7.3	4.8	0	-
	7	8.9	140	1	13	5.4	5.5	0	-

Plot no.	Tree	Dist. (m)	° N	Stem no.	CBH (cm)	Ht. (m)	CA (m²)	TD	Other obs.
	8	9.0	146	2	15	6.4	9.1	0	-
	9	9.6	146	1	20	6.4	4.9	0	-
	10	9.9	148	3	21	6.6	4.9	0	-
	11	16.4	143	3	18	6.6	7.8	2	-
	12	20.5	142	3	23	8.0	11	1	-
	13	24.0	130	2	16	5.8	7.9	0	-
	14	30.0	133	2	23	6.6	7.3	0	-
	15	30.0	136	4	25	7.8	14	1	-
	16	27.4	142	7	23	7.3	33	0	-
	17	26.1	159	1	25	7.8	13	1	cl
	18	12.6	166	1	18	7.1	3.1	0	-
	19	21.4	177	1	25	7.8	4.0	1	-
	20	28.2	168	2	27	8.0	6.9	0	-
	21	25.1	168	3	25	7.5	9.6	0	1Dd
	22	24.2	175	2	19	8.5	3.3	0	cl
	23	26.3	177	3	30	8.5	16	3	-
	24	24.0	179	1	11	5.8	1.7	0	cl
	25	23.3	178	3	9	6.4	7.3	0	cl
	26	23.9	180	5	34	9.8	15	0	cl
	27	26.2	180	3	35	7.3	20	0	cl
	28	22.0	180	1	10	4.2	2.9	0	-
	29	26.1	182	3	28	9.6	20	0	cl
	30	19.3	190	4	24	7.8	18	0	-
	31	17.5	191	1	20	5.2	12	0	-
	32	21.3	190	2	39	9.0	29	0	-
	33	22.3	194	6	40	9.3	39	0	cl
	34	22.1	208	7	19	5.2	19	1	-
	35	15.6	210	1	25	7.1	11	1	-
	36	23.8	216	1	13	7.0	6.8	1	-
	37	22.1	220	5	26	8.4	13	0	-
	38	21.1	228	1	43	7.4	16	1	cl
	39	15.4	345	1	14	6.1	2.3	0	FD
	40	19.9	339	1	13	5.7	3.2	0	FD
	41	21.6	330	1	13	5.8	40	0	FD
	42	24.4	332	1	22	7.6	9.8	0	FD
	43	19.7	323	3	25	6.3	12	0	-
	44	21.7	313	2	17	7.1	8.6	1	-
	45	23.3	313	1	20	6.7	4.3	0	-
	46	22.1	309	1	11	5.0	1.8	0	-
	47	22.4	311	1	17	7.6	6.5	0	-
	48	23.0	312	1	13	6.0	9.7	0	-
	49	25.4	306	1	15	6.3	6.7	0	IDL
	50	21.3	292	1	14	7.2	4.3	0	-
	51	21.4	286	1	35	8.9	13	0	-
	52	21.3	276	2	51	7.2	50	1	-
	53	26.9	274	1	69	10.0	33	0	-
	54	30.0	274	2	43	8.9	16	0	-
	55	27.4	288	2	34	8.6	18	1	-
	56	20.9	203	2	38	7.6	18	0	-
	57	26.5	265	1	18	8.1	7.0	0	-
	58	29.8	256	1	26	7.2	14	1	-
17	59	27.8	245	1	23	8.6	9.1	0	-
	60	21.4	255	1	25	-	-	-	S
18	1	23.2	100	3	43	9.0	50	0	IDL
	2	11.0	180	2	10	5.2	2.5	0	-

Plot no.	Tree	Dist. (m)	° N	Stem no.	CBH (cm)	Ht. (m)	CA (m²)	TD	Other obs.
19	1	30.0	143	2	50	8.8	12	0	1S
	2	22.6	170	1	200	-	-	1	S
	3	20.5	180	1	171	-	-	1	S
	4	11.4	225	9	37	9.8	38	2	-
	5	20.0	234	3	63	12.7	19	4	-
	6	30.0	250	1	19	6.0	6.4	1	-
	7	30.0	330	1	34	7.6	9.0	3	-
	8	29.6	334	1	45	7.8	10	3	-
	9	25.0	336	6	18	5.6	3.5	3	-
	10	24.1	351	2	12	4.6	0.9	3	-
20	1	30.0	304	2	56	9.5	45	1	FD
	2	20.8	350	2	15	3.4	2.4	1	FD
	3	11.1	114	6	102	10.4	130	5	FD
	4	29.0	120	1	169	-	-	-	CS
	5	20.2	225	1	11	5.1	3.8	2	FD
	6	23.2	230	1	11	3.4	3.0	1	-
	7	24.9	230	1	14	4.1	4.9	2	-
21	1	30.0	168	1	30	5.4	17	4	FD
	2	28.6	207	1	120	11.8	98	3	cl
	3	21.5	235	1	135	8.9	25	3	cl
	4	20.0	236	1	14	3.9	3.4	3	-
	5	23.3	238	2	124	8.9	16	2	1S
	6	22.7	240	2	45	11.1	46	2	-
	7	24.2	284	2	72	9.8	95	2	-
	8	20.0	325	1	10	3.5	4.1	1	-
22	1	27.0	298	1	16	4.5	6.3	1	-
23	1	19.2	137	1	24	7.5	5.8	0	cl
	2	26.0	184	2	18	6.0	4.8	0	-
	3	27.0	190	3	40	10.6	57	0	cl
	4	23.0	220	1	13	5.8	4.2	2	-
	5	25.0	263	2	11	5.0	14.1	1	IDL
	6	30.0	270	7	23	8.5	36	0	-
	7	8.4	252	1	34	6.4	14.6	0	-
	8	28.6	270	2	11	2.4	7.3	0	-
	9	17.7	275	1	17	5.4	8.6	0	cl
	10	27.0	280	1	15	6.0	7.7	0	cl
	11	26.0	293	8	41	8.6	50	1	-
	12	17.2	338	3	138	11.8	63	0	-
24	No *D. melanoxylon* trees or saplings.								
25	1	17.0	016	1	20	5.4	13	1	cl
	2	16.4	010	1	17	5.0	6.9	1	cl
	3	22.4	010	1	10	5.7	1.0	1	-
	4	22.5	010	3	9.5	5.7	1.2	1	-

Key

- Dist. - distance in metres from centre of plot.
- ° N - bearing from centre of plot.
- Stem no. - number of stems at breast height.

- CBH - circumference of largest stem at breast height (or at greatest height if a stump shorter than breast height).
- Ht. - height of the tree in metres (1d.p.).
- CA - estimated canopy area in metres^2 (2 s.f.).
- TD - termite damage on a scale of increasing damage (0 - none to 5 - total infestation).

Other Observations (obs.):

S	–	stem is a stump
BS	–	burnt stump
CS	–	cut stem
cl	–	climbers present on tree
IDL	–	insect damage to leaves
Dd	–	tree dead
FD	–	fire damage to tree

Results of Other Tree Species Survey

Plot	Tree species	Count	CBH >30cm	Mat.	Close to *D. melanoxylon*:			Phenol.
					Tree	Sap.	Seed.	
1	*Acacia senegal*	6	1	0	0	2	0	B,L,Q
	Combretum apiculatum	7	2	0	0	0	0	L
	Combretum collinum	4	0	0	0	0	0	B,L
	Combretum molle	1	0	0	0	0	0	L
	Commiphora sp.	14	10	2	0	1	0	B,L,Q
	Erythrina buztri	1	1	0	0	0	0	B
	Fernandoa magnifica	7	2	0	1	1	0	B
	Oldfiedia somalensis	1	0	0	1	0	0	L
	Spirostachys africana	7	1	0	0	0	0	L
	Tamarindus indica	4	1	1	1	0	0	L,L/Q
	Terminalia brevipes	1	1	1	0	0	0	L
	Unidentified	29	17	1	5	1	0	B,L
2	*Acacia nilotica*	1	1	1	0	1	1	L/Q
	Combretum collinum	1	1	0	0	1	1	L
	Fernandoa magnifica	6	3	0	0	0	2	B
	Vangueria infausta	1	0	0	0	0	0	L
	Unidentified	4	4	4	3	0	0	B/Q,L
3	*Annona senegalensis*	1	0	0	0	1	0	B
	Combretum apiculatum	4	0	0	0	2	4	L
	Commiphora sp.	6	2	2	3	1	4	B
	Dichapetalum madagascanense	1	0	1	0	0	0	L/Q
	Dialium orientale	2	1	1	0	0	0	L
3	*Fernandoa magnifica*	14	8	7	0	5	9	B
	Maerua kirkii	1	1	1	0	0	1	L/F
	Spirostachys africana	4	1	1	1	3	3	L
	Vangueria infausta	2	0	2	0	1	2	B/F,L/F
	Unidentified	11	4	7	2	4	5	B,L,Q
4	*Commiphora sp.*	4	2	1	0	0	0	B,Q

12					**Close to *D. melanoxylon*:**			
	Dialium orientale	1	0	1	0	0	0	L/Q
	Spirostachys africana	6	0	0	0	0	0	L
5	*No trees or saplings*							
6	*Albizia patenciana*	1	0	0	0	1	1	L
	Combretum apiculatum	2	2	1	0	1	0	B,Q
	Commiphora sp.	22	17	8	1	4	1	B,Q
	Fernandoa magnifica	1	1	1	0	0	0	B
	Maerua kirkii	1	0	0	0	1	1	L
	Spirostachys africana	6	2	0	2	0	0	L
	Strychnos usamberiensis	1	0	0	0	0	0	L
	Unidentified	24	12	6	9	4	1	B,L
7	*Acacia nilotica*	4	2	2	1	1	1	L
	Commiphora sp.	17	11	6	4	2	2	B
	Fernandoa magnifica	8	2	0	6	3	0	B
	Maerua kirkii	6	1	2	3	1	0	B,Q
	Spirostachys africana	18	2	1	7	6	7	B,L
	Strychnos usamberiensis	2	0	0	2	0	1	L
	Vangueria infausta	1	0	1	0	0	1	L
	Unidentified	1	1	1	1	1	0	B
8	Dominant species: *Acacia nilotica, Adonsonia digitata, Albizia patenciana, Commiphora sp., Dialium orientale, Erythrina excelsa, Ficus thonningii, Spirostachys africana.*							
9	*Acacia nilotica*	4	2	1	0	0	0	L
	Combretum apiculatum	14	10	9	0	0	2	L
	Commiphora sp.	20	9	4	0	1	5	B
	Fernandoa magnifica	9	7	9	0	0	3	B
	Ficus natalensis	1	1	1	0	0	0	L
	Spirostachys africana	2	0	0	0	0	0	L
	Strychnos usamberiensis	15	8	6	3	0	0	L
	Tamarindus indica	1	1	1	0	0	0	L
	Terminalia brevipes	1	0	0	0	0	0	L
	Vangueria infausta	1	0	1	0	0	0	L
	Unidentified	19	9	10	1	0	2	BL
10	No *Dalbergia melanoxylon* - no study undertaken.							
11	*Acacia nilotica*	4	4	4	1	0	0	L,Q
	Acacia senegal	2	2	2	2	0	0	L,Q
	Albizia natalensis	3	3	3	0	0	0	L
	Albizia pateciana	6	4	4	1	0	0	L
	Combretum apiculatum	15	13	7	1	0	0	L,Q
	Commiphora sp.	25	11	10	0	0	0	B
	Dichapetalum madagascanense	1	1	1	0	0	0	L
	Ficus natalensis	2	1	1	0	0	0	L
	Oldfiedia somalensis	7	4	3	1	0	0	L
11	*Spirostachys africana*	33	22	18	1	0	0	L
	Strychnos usamberiensis	2	0	0	1	0	0	L
	Tamarindus indica	1	0	0	0	0	0	L
	Unidentified	31	13	19	4	0	0	B,L
12	*Acacia nilotica*	1	0	0	0	0	0	L
	Acacia senegal	14	9	12	1	2	4	L
	Albizia patenciana	5	2	2	1	0	0	L

					Close to *D. melanoxylon*:			
	Annona senegalensis	5	3	2	0	0	3	B
	Combretum apiculatum	20	13	12	1	3	5	B,L
	Combretum molle	2	0	0	0	2	1	B
	Commiphora sp.	29	15	10	4	3	7	B
	Dicraeopetalum stipulae	2	1	0	0	0	0	B,L
	Fernandoa magnifica	26	18	12	3	6	11	B
	Maerua kirkii	1	0	1	0	0	0	L
	Spirostachys africana	29	12	7	0	1	6	L
	Tamarindus indica	5	2	0	2	0	0	L
	Terminalia brevipes	1	1	1	0	0	0	L
	Terminalia sambesciacae	1	0	0	0	0	0	L
	Vangueria infausta	1	1	1	0	1	0	L
	Unidentified	21	13	11	0	1	3	B,L,Q
13	*Acacia nilotica*	1	1	1	0	0	0	L
	Albizia patenciana	4	3	3	0	1	0	B,L
	Annona senegalensis	5	3	4	0	0	0	B,L
	Combretum apiculatum	3	3	3	0	0	0	L
	Combretum molle	1	1	1	0	0	0	L
	Commiphora sp.	19	12	8	1	1	0	B,L
	Dialium orientale	1	1	0	0	0	0	L
	Fernandoa magnifica	17	14	7	1	2	0	B
	Markhamia lutea	8	0	0	0	0	0	B
	Maerua kirkii	1	0	0	0	0	0	L
	Spirostachys africana	26	14	12	0	0	0	B,L
	Terminalia brevipes	7	3	2	0	0	0	B,L
	Terminalia sambesciacae	1	0	0	0	0	0	B
	Unidentified	26	15	13	0	1	0	B,L
14	*Acacia nilotica*	1	1	1	0	0	0	L
	Anaacardium occidentale	8	8	7	0	1	4	L
	Annona senegalensis	18	14	14	0	2	6	B,L
	Compretum apiculatum	2	0	0	0	0	0	B,L
	Combretum collinum	1	0	0	0	0	0	L
	Combretum molle	14	8	8	0	1	1	B,L
	Commiphora sp.	8	5	4	1	0	1	B,L
	Fernandoa magnifica	18	13	11	0	3	3	B,L
	Maerua kirkii	2	0	0	0	0	1	L
	Spirostachys africana	8	5	4	1	0	1	B,L
	Terminalia sambesciacae	1	0	0	0	0	0	L
	Vangueria infausta	3	0	2	0	1	0	B
	Unidentified	15	10	9	1	1	2	L
15	*Acacia senegal*	1	1	1	0	0	0	L
	Adansonia digitata	2	2	2	0	0	0	B/Q
	Albizia patenciana	2	2	2	0	0	0	B
	Anacardium occidentale	2	2	1	0	0	0	L
	Annona senegalensis	4	3	2	0	0	0	B,L,Q
	Combretum apiculatum	11	5	4	1	0	0	B,L
15	*Combretum molle*	18	15	14	3	0	0	B,L,Q
	Commiphora sp.	7	5	5	1	0	0	B
	Ehretia syluctica	2	0	0	0	0	0	B,L
	Fernandoa magnifica	5	4	3	0	0	0	B
	Kigelia africana	1	1	1	0	0	0	L
	Magnifica indica	3	3	3	0	0	0	L
	Tamarindus indica	2	2	0	1	0	0	L
	Vangueria infausta	2	1	1	0	0	0	B
	Unidentified	30	11	8	4	0	0	B,L

					Close to *D. melanoxylon*:			
16	*Acacia nilotica*	7	4	2	3	1	3	B,L
	Acacia senegal	1	0	0	0	0	0	L
	Albizia patenciana	1	0	0	0	1	0	B
	Combretum molle	1	1	0	0	0	1	L
	Commiphora sp.	20	6	6	0	3	0	B
	Ficus natalensis	1	0	0	00	0	0	L
	Spirostachys africana	24	6	4	5	6	4	B,L
	Vangueria infausta	3	0	2	0	0	0	B
	Unidentified	11	8	8	3	1	0	B,L
17	*Acacia nilotica*	10	8	7	1	1	0	B,L
	Combretum apiculatum	3	0	0	0	0	0	B,L
	Combretum molle	3	2	2	1	1	0	B,L
	Commiphora sp.	19	8	5	4	4	0	B
	Dialium orientale	1	1	0	0	1	0	L
	Fernandoa magnifica	11	5	4	0	3	0	B
	Oldfiedia somalensis	1	0	0	0	1	0	L
	Spirostachys africana	96	42	48	13	31	5	B,L
	Tamarindus indica	3	2	0	0	0	0	L
	Terminalia brevipes	3	0	0	0	0	0	B,L
	Vangueria infausta	2	0	0	0	0	0	B,L
	Unidentified	41	6	5	3	14	0	B,L
18	*Acacia nilotica*	4	2	1	0	1	0	L
	Albizia patenciana	1	1	1	0	0	0	B
	Commiphora sp.	7	4	4	0	1	3	B
	Dialium orientale	1	0	0	0	0	0	L
	Fernandoa magnifica	4	2	1	0	1	0	B
	Hibiscus rosasinens	1	1	1	0	0	0	L
	Spirostachys africana	4	2	1	0	0	2	L
	Tamarindus indica	2	1	0	0	1	0	L
	Terminalia brevipes	5	3	2	0	0	0	L
	Unidentified	9	2	1	0	0	0	B,L
19	*Acacia nilotica*	1	1	0	0	0	1	L
	Combretum apiculatum	19	11	6	0	1	14	L
	Combretum molle	3	2	1	1	0	1	B,L
	Commiphora sp.	3	3	1	0	0	0	B
	Fernandoa magnifica	3	3	0	0	0	2	B
	Oldfiedia somalensis	2	1	1	0	0	0	L
	Unidentified	12	8	6	6	1	1	B,L
20	*Acacia nilotica*	1	1	1	0	0	0	L
	Bauhenia variegata	1	1	1	0	0	1	B/Q
	Combretum apiculatum	11	7	8	2	1	7	B,L,Q
	Combretum molle	20	16	16	0	3	10	L
	Commiphora sp.	12	5	3	2	5	8	B
20	*Fernandoa magnifica*	1	1	1	1	0	0	B
	Terminalia brevipes	2	1	1	1	0	0	L
	Unidentified	14	9	0	1	6	10	B
21	*Acacia nilotica*	1	1	1	0	0	0	B
	Albizia patenciana	27	3	2	1	4	11	B
	Annona senegalensis	1	0	0	0	0	0	L
	Balanites glabra	1	0	0	0	0	0	L
	Combretum apiculatum	3	2	3	0	1	2	B
	Commiphora sp.	10	5	2	1	3	2	B,L

					Close to *D. melanoxylon*:			
	Fernandoa magnifica	4	1	1	0	1	1	B
	Oldfiedia somalensis	2	2	2	0	0	0	B
	Spirostachys africana	17	8	5	1	0	4	B,L
	Vangueria infausta	2	0	1	0	0	1	B
	Unidentified	6	3	1	1	0	0	L
22	The thicket in this plot was too dense to conduct profitably a full survey. The dominant species were: *Acacia nilotica, Acacia senegal, Albizia patenciana, Commiphora sp., Erythrina excelsa, Fernandoa magnifica, Ficus natalensis, Spirostachys africana, Strychnos usamberiensis, Tamarindus indica.*							
23	*Acacia nilotica*	13	8	9	0	1	0	L
	Acacia senegal	1	0	0	0	0	0	B
	Albizia patenciana	1	0	0	0	0	0	B
	Combretum apiculatum	1	1	1	0	0	0	L
	Commiphora sp.	15	5	4	1	3	1	B
	Fernandoa magnifica	5	5	2	0	0	0	B
	Markhamia lutea	12	2	1	2	0	0	B
	Oldfiedia somalensis	1	1	1	0	0	0	L
	Spirostachys africana	74	37	36	7	6	4	B,L
	Strychnos usamberiensis	10	0	2	0	0	0	B,L
	Terminalia brevipes	1	1	0	0	0	0	B
	Vangueria infausta	1	0	0	0	0	0	B
	Unidentified	38	14	20	3	5	0	B,L
24	*Acacia nilotica*	1	0	0	0	0	0	B
	Bauhenia variegata	1	1	0	0	0	0	B
	Combretum apiculatum	2	0	0	0	0	1	L
	Commiphora sp.	2	1	1	0	0	0	B
	Spirostachys africana	13	2	2	0	0	0	B,L
	Unidentified	11	3	4	0	0	1	B,L,Q
25	*Acacia nilotica*	38	10	13	0	1	7	B,L
	Acacia senegal	3	0	2	0	0	0	B,L
	Combretum apiculatum	3	1	1	0	0	0	B,L
	Commiphora sp.	50	10	9	0	0	4	B
	Fernandoa magnifica	10	2	1	0	0	0	B
	Oldfiedia somalensis	1	1	1	0	0	0	L
	Spirostachys africana	30	7	8	0	1	5	B,L
	Tamarindus indica	3	2	1	0	0	0	L
	Vangueria infausta	1	0	0	0	0	1	B
	Unidentified	9	1	1	0	0	1	B,L

Key

- Tree species - those trees that could not be identified are grouped together under *Unidentified*. The species named *Commiphora sp.* is likely to be either *C. africana* or *C. confusa*.
- Count - the number of each species of tree in the plot.
- CBH >30cm - Those trees with a circumference at breast height of more than 30cm.
- Mat. - the number of trees of a species that were mature
- Close to *D. melanoxylon*... - the number of a species of tree that were within 3 metres of a *D. melanoxylon* tree, sapling or seedling.
- Phenol. - the phenology of the trees; B = bare, F = in flower, L = in leaf, Q = in fruit

Results of Point Sample Survey

Plot	No. of sub-plots whose dominant vegetation was:						No. of sub-plots containing:				M.s. count
	Bare	Burnt	Grass	Litter	Shrub	Trees	Shrub	Tree	M.S.	M.T.	
1	1	0	18	0	2	8	22	16	1	0	0/0
2	2	0	25	0	0	1	18	0	0	0	42/9
3	0	0	27	0	1	1	17	10	4	0	43/8
4	0	0	29	0	0	0	4	1	0	0	13/5
5	0	0	29	0	0	0	1	0	0	0	3/3
6	0	0	22	0	7	0	9	7	2	3	49/9
7	0	0	25	0	2	2	10	2	1	0	8/2
9	5	7	4	7	4	2	24	8	1	2	5/4
11	0	0	8	6	5	10	22	15	0	0	1/1
12	2	0	6	6	4	11	25	14	0	0	8/6
13	1	1	3	17	2	5	27	8	0	0	0/0
14	0	0	16	10	3	0	11	6	0	0	3/1
15	0	0	12	3	9	5	22	11	0	1	0/0
16	0	0	18	8	3	0	22	5	0	1	20/6
17	1	0	4	18	5	1	26	9	1	1	0/0
18	6	0	15	0	7	1	16	3	0	0	0/0
19	3	20	0	2	1	3	21	3	0	1	22/7
20	1	15	0	1	7	5	15	5	0	1	41/13
21	0	10	5	2	4	8	19	7	1	2	2/2
23	0	0	1	0	15	13	28	13	1	1	0/0
24	0	0	26	0	3	0	19	0	0	0	84/14
25	1	0	4	15	9	0	29	5	0	0	2/2

Key

- M.S. = *D. melanoxylon* Sapling
- M.T. = *D. melanoxylon* Tree
- M.s. = *D. melanoxylon* seedling

M.s. count - e.g. 42/9 means that a total of 42 *D. melanoxylon* seedlings were found in this plot, at 9 of the sub-plots sampled.

Appendix II : Species Lists

This list includes all positively identifiable species seen at the study site, camp and the general area.

Trees:

Acacia nilotica
Acacia senegal
Adansonia digitata
Albizia natalensis
Albizia patenciana
Anacardium occidentale
Annona senegalensis
Balanites glabra
Bauhenia variegata
Combretum apiculatum
Combretum collinum
Combretum molle
Commiphora sp.
Dialium orientale
Dichapetalum madagascanense
Dicraeopetalum stipulae
Ehretia syluctica
Erythrina buztri
Fernandoa magnifica
Ficus natalensis
Hibiscus rosasinens
Kigelia africana
Magnifica indica
Markhamia lutea
Maerua kirkii
Oldfiedia somalensis
Spirostachys africana
Strychnos usamberiensis
Tamarindus indica
Terminalia brevipes
Terminalia sambesciacae
Vangueria infausta

Birds:

Grey Heron	*Ardea cinerea*
Little Egret	*Egretta garzetta*
Saddle-billed Stork	*Ephippisrhyncus senegalensis*
African Fish Eagle	*Haliaeeus vocifer*
Bataleur	*Terathopius ecaudatus*
Black Kite	*Milvus migrans*
Black Shouldered Kite	*Elanus caeruleus*
Wahlberg's Eagle	*Aquila wahlbergi*
Long-crested Eagle	*Lophaetus occiptalis*
Harrier Hawk	*Polyboroides radiatus*
Ovambo Sparrowhawk	*Accipiter ovampensis*
Black-winged Plover	*Vanellus melanopterus*
Tambourine Dove	*Turtur tympanistria*
Senegal Coucal	*Centropus senegalensis*
Klaas' Cuckoo	*Chrysococcyx klaas*
Green Wood Hoopo	*Phoeniculus purpureus*
Brown-headed Parrot	*Poicephalus cryptoxanthus*
Narina's Trogon	*Apalodermea narina*
Lilac-breasted Roller	*Coracias abyssinica*
Pied Kingfisher	*Ceryle rudis*
Madagascar Bee-eater	*Merops superciliosus*
Little Bee-eater	*Merops pusillus*
Crowned Hornbill	*Tockus alboterminatus*
Trumpeter Hornbill	*Bycanistes bucinattor*
African Marsh Owl	*Asio capensis*
Palm Swift	*Cypsiurus parvus*
Golden-rumped Tinkerbird	*Pogoniulus bilineatus*
Green Tinkerbird	*Pogoniulus simplex*
Cardinal Woodpecker	*Dendropicos fuscescens*
Lark sp.	*Alaudidae*
Black Roughwing Swallow	*Psalidoprocne holomelaena*
Banded Martin	*Riparia cincta*
Yellow-vented Bulbul	*Pyconotus barabatus*
Fischer's Greenbul	*Phyllastrephus fischeri*
Zanzibar Sombre Greeenbul	*Andropadus importunus*
Tropical Boubou	*Laniarius ferrugineus*
Hunter's Sunbird	*Nectarinia hunteri*
Collared Sunbird	*Anthreptes collaris*
Scarlet-chested Sunbird	*Nectarinia senegalensis*
Peter's Twinspot	*Hypargos niveoguttatus*
Green-backed Twinspot	*Mandingoa nitidula*
Bronze Mannikin	*Lonchura cucullata*
Layard's Black-headed Weaver	*Ploceus cucullatus nigriceps*
Drongo	*Dicrurus adsimilis*

Square-tailed Drongo	*Dicrurus ludwigii*
African Golden Oriole	*Oriolus auratus*
Black-headed Oriole	*Oriolatus larvatus*
Violet-backed Starling	*Cinnyricinclus leucogaster*
Pied Crow	*Corvus albus*
Golden-breasted Bunting	*Emberiza flaviventris*
Helmeted Guineafowl	*Numida meleagris*
Green-backed Pytilia	*Pytilia melba*

Animals:

Spotted hyena	*Crocuta crocuta*
Bushbaby species	*Galago sp.*
Bush squirrel	*Paraxerus palliatus*
Giant elephant shrew	*Rhynchocyon cirnei*
Jackal species	*Canis sp.*
Green monkeys	*Cercopithecus aethiops*
Leopard	*Panthera pardus*
Puff adder	*Bitis arietans*
Vine snake	*Thelotornis kirtlandii*
Black mamba	*Dendroaspis polyepis*
Spitting Cobra	*Naja nigricollis*
Chameleon species	*Chamaeleo sp.*

Appendix III : Local Uses & Knowledge Data Tables

Table 1: Phenology of *D. melanoxylon*

	Group 1	Group 2	Group 3
Phenology			
- in leaf	Dec.-May	Nov.-Apr.	Oct.-Mar.
- in flower	April	Dec.-Feb.	Oct.-Dec.
- in fruit	July	Feb.-Apr.	Jan.-May
Animals present			
- bees	Dec. onwards	Dec.-Feb.	Oct.-Dec.
- birds	-	Feb.-Mar.	Oct.-Dec.

Table 2: Burning and Clearing

	Group 1	Group 2	Group 3
Burning	Oct.-Nov.	Jun.-Oct.	Jun.-Sept.
Clearing	Apr.-Aug.	Apr.-Oct.	Apr.-Aug.

Table 3: Logging

	Group 1	Group 2	Group 3
Logging of *D. melanoxylon*			
- by themselves	Aug.-Oct.	Jun.-Oct.	Apr.-July
- by outsiders	Jun.-Sept.	Jun.-Oct.	Apr.-July
Logging of other species			
- by themselves	May-Oct.	Jun.-Oct.	Jun.-Aug.
- by outsiders	May-Oct.	Jun.-Oct.	Mar.-July

Figure 1: Calendar of principal agricultural activities in Mchinga

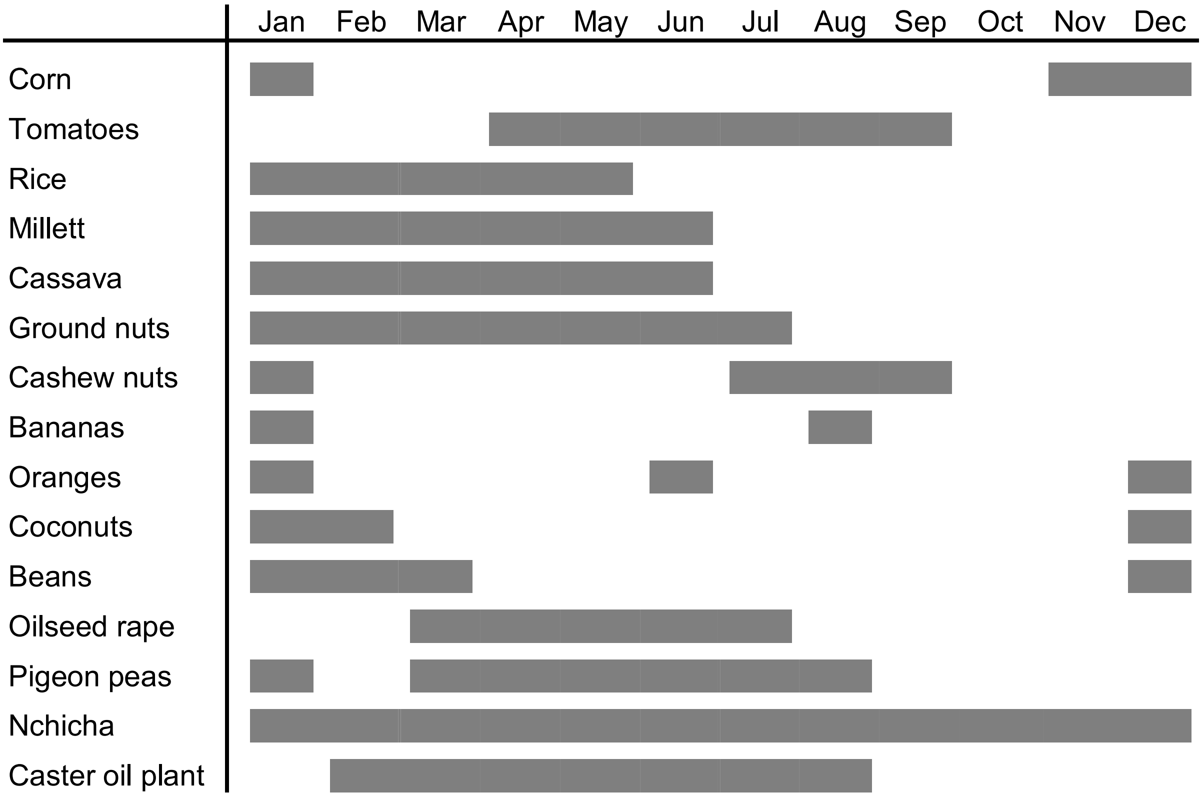


Table 4: Uses of different tree species in Mchinga

Species	Uses							
	Char-coal	Fire-wood	House building	Tools	Furni-ture	Edible Fruits	Medicin-al uses	Other uses
Mpingo		✓	✓				l	Light for fishing, walking sticks
Mbinde					✓			
Mbubundu		✓	✓			✓		
Mbuyu				✓			lbrf	Rope, Edible mushrooms at base
Mdaha		✓					r	Lipstick, toothbrushes
Mfundo		✓	✓			✓		
Mgongo	✓					✓	b	Boat building
Mkala		✓	✓					
Mkorosho	✓	✓				✓	lb	
Mkowla							lbr	Carving, Glue for Fencing
Mkulo / Msagawi	✓	✓	✓				bg	Light for fishing
Mkumbo		✓				✓	r	
Mkungwe		✓			✓			Boat building
Mkuruko							r	
Mkwaju					✓	✓	lr	Walking sticks
Species	**Uses**							

	Char-coal	Fire-wood	House building	Tools	Furni-ture	Edible Fruits	Medicin-al uses	Other uses
Mlembelembe		✓	✓				lr	
Mlezi	✓	✓	✓					
Manyani			✓					
Mnyakambi		✓		✓	✓		lb	
Mnyenye						✓		Brewing alcohol
Mpalanganga	✓	✓	✓					
Mpemba		✓	✓					
Mpwele		✓	✓	✓	✓			Walking sticks
Msokole			✓					Fishing implements
Mtachi	✓	✓	✓					
Mtandawala							w	
Mtanga	✓	✓	✓	✓				
Mtele		✓				✓	r	
Mtolowindo		✓	✓					
Mtonya		✓					r	Fencing
Mtopetope		✓		✓	✓	✓	lbr	
Mtumbati	✓	✓	✓		✓		lbr	
Muindu					✓		lb	
Mvule					✓		br	
Mwelewela	✓	✓	✓					Rope
Mwungo		✓	✓			✓	lb	Beehives
Namubhara	✓	✓	✓				b	
Ndundu	✓	✓	✓					Boat building, Light for fishing

Tree parts for medicinal uses: l – leaves, b – bark, r – roots, f – fruit, w – whole tree

Mtanga is apparently the best tree for charcoal.

Logging

People are reported to come from outside the village to cut the following species :

Dalbergia melanoxylon
Mtumbati, Numubhara, Mvule – more than *D. melanoxylon*
Mpeke – same as *D. melanoxylon*
Mgongo – less than *D. melanoxylon*

Table 5: Preference of tree species for different uses

Tree	House-building	Furniture	Firewood preferences		Firewood frequency
			Gp 2	*Gp 3*	*Group 3*
Manyani					M
Mbundubundu			S	B	M
Mgengo			W		L
Mkala					L
Mkorosho					L
Mkulo / Msagawi	S		S	B	M
Mkumbo			B	B	
Mkungwe			N	B	M
Mkuruko					M
Mkwaju		W	W		
Mlembelembe	W		B	B	M
Mlezi					L
Mmungo			B	B	M
Mnyakambe					L
Mnyenye			B	B	M
Mpamba					M
Mpelanganga			W		L
Mpweke	W	W	W	B	M
Msokole					L
Mtachi					L
Mtandawale	W	W	B	B	
Mtanga			W		
Mtolowindo					M
Mtopetope		W			
Mtumbeti		B			L
Muidu					L
Mvule					L
Mwelela	W		W	B	M
Namubhara				B	M
Ndundu					M

Key to table 5: B - Better than *D. melanoxylon*
S - Same as *D. melanoxylon*
W - Worse than *D. melanoxylon*
M - Used more than *D. melanoxylon*
L - Used less than *D. melanoxylon*

Blank spaces and absence of trees listed in Table 4 indicate that the tree is not used for the purpose(s) cited.

Appendix IV : Summary of Accounts

Income

Sponsor	**£**
BP Conservation Programme Awards	1,500
Cambridge Commonwealth Travel Bursaries	1,200
RGS Grants for Expeditions, RTZ fund	800
Cambridge Expeditions Fund	400
The Lord Mayor's 800th Anniversary Awards Trust	300
J. & L.A. Cadbury Charitable Trust	200
King's College, Cambridge	200
I.R. Watson Charitable Settlement	200
The Rayne Foundation	100
A.S. Butler Charitable Trust	100
Clare College, Cambridge	100
Sidney Sussex College, Cambridge	90
Adrian Ashby-Smith Memorial Trust	60
Ward and Winterbourne	50
The Brewers Company	50
Other	280
Personal contributions	3,000
Total Received	**£ 8,630**

The budget target was £11,000, but significant savings on insurance, camping equipment, and report production have meant that we were able to go ahead nevertheless. The contingency fund, provided at the members' expense was barely used.

Expenditure

Expense		**£**
Administration		305
Brochures		237
Official Permits	Tanzanian visas	228
	COSTECH application	45
	COSTECH permits	1,125
Medical	Kit	70
	Innoculations	50
	Prophylactics	100
Insurance		317
Equipment		328
Travel	Flights	2,840
	Departure tax	123
	Internal	381
Accommodation		293
Food/subsistence		826
Counterparts wages		841
Report		300
Extra		109
Total Expenditure		**£ 8,518**

The figure given for the Report's cost is an estimate. Any surplus, after debts to members have been paid off, will be donated to *Tanzanian Mpingo 98*.

Appendix V : The Team

Cambridge members

PROJECT LEADER & PHOTOGRAPHER:
Steve Ball, 21, British
BA (Mathematics) from Emmanuel College
Prior Experience: Independent Travel around East Africa, keen wildlife photographer.

MEDICAL OFFICER:
Eric Morgan, 23, British
5th year studying Veterinary Science inc. BA (Zoology) at Fitzwilliam College
Prior Experience: Expeditions to Greece and Ecuador with the Officer Training Corps, St. John's Ambulance First Aid certificate, Conservation work in UK with BTCV

SCIENTIFIC COORDINATOR:
Annie Smith, 20, British
2nd year studying Ecology at Sidney Sussex College
Prior Experience: Biological fieldwork in the UK

FOOD OFFICER:
Kate Llewellyn, 21, British
BA (Genetics) from Kings College

PUBLICITY OFFICER:
Justin Ormand, 19, British
1st year studying Ecology at St Catharines College
Prior Experience: Lived in Kenya for 15 years so is an excellent Swahili speaker and familiar with local conditions, Biological fieldwork in Wales, knowledge of basic vehicle maintenance.

EQUIPMENT OFFICER:
Nick Keylock, 20, British
1st year studying Ecology at Clare College
Prior Experience: Travel through Africa, Biological fieldwork in the UK.

Tanzanian members

Jonas Timothy, Forester from Kilimanjaro region
Lawrence Manoko, BSc (Botany) from Dar Es Salaam University
Digna Mlay, 1st year studying Sociology at Dar Es Salaam University

Appendix VI : Acknowledgements

Financial support

BP Conservation Programme Awards
RGS Grants for Expeditions, RTZ fund
Cambridge Expeditions Fund
Cambridge Commonwealth Travel Bursaries
The Rayne Foundation
J. & L.A. Cadbury Charitable Trust
The Lord Mayor's 800th Anniversary Awards Trust
Adrian Ashby-Smith Memorial Trust
A.S. Butler Charitable Trust
Sidney Sussex College, Cambridge
King's College, Cambridge
Clare College, Cambridge
Mr. Raymond Ball
Mr. Keith Ball
Mrs. Cynthia Reekie
Mr. A. Tredgett
M.P. Speed
Mr. D. Winterbourne, Ward and Winterbourne, London
The Brewers Company

Sponsorship in Kind

Kall Kwik, Cambridge
YHA, Covent Garden
Helsby High School

Other help, advice and interest (in no particular order)

Guy Norton and Dawn Hawkins, Anglia Polytechnic University
Jon Lovett and Phil Clarke, EEEM, University of York
Anna Jenkins, former Soundwood Project Officer, Fauna & Flora International
Niall Marriott, Consultant on the Soundwood Project, Fauna & Flora International
Dr. S.K. Eltringham, Department of Zoology, University of Cambridge
Dr. E.J.V. Tanner, Dr. P.J. Grubb, and Mr. G. Jones, Department of Plant Science, University of Cambridge
Shane Winser and Fay Hercod, Expeditions Advisory Centre, Royal Geographical Society
Katharine Gotto, Expeditions Officer, Birdlife International
Charlotte Jenkins, World Conservation Monitoring Centre
Stan Davies and John Matilya, Wildlife Conservation Society of Tanzania
Mr. Z. Kitale and Hans Blom van Assendelft, Lindi Forestry Office
Prof. Semesi and Mr. H. Lyaruu, Department of Botany, University of Dar Es Salaam
Mr. L. Mwasumbi and Mr. F. Mbago, Herbarium, University of Dar Es Salaam
Prof. K. Howell, Department of Zoology, University of Dar Es Salaam
Mr. Ntumbo, Director of Tanzanian Forestry and Beekeeping Division
Dr. A. Shareef, His Excellency the Tanzanian High Commissioner
Jacqui Booker, British High Commission, Dar Es Salaam
Mr. Nguli, Commission for Science and Technology (COSTECH), Dar Es Salaam
Allan Rodgers, UN Food and Agriculture Organisation (FAO), Dar Es Salaam
Prof. R. Malimbwi, Sokoine University of Agriculture
Ladi Nshubemuki, Tanzania Forestry Research Institute (TAFORI)

The District Natural Resources and Forestry Officers at Lindi, Kilwa, Nachingwea and Liwale
Cath Muir, Operations Director, Frontier (London)
Irene Platt
David Beale
Mr. Daniel Bangham, Wood, Wind and Reed, Cambridge
British Tanzania Society
Mr. Mike McCoy-Hill
Mr. Donald Palmer, International Tree Foundation
Lorraine Perril, Cambridge Occupational Health Service
The 1995-6 Committee of the Cambridge University Explorers & Travellers Club
The team of the aborted 1995 Cambridge Malundwe Project

Patrons

Acker Bilk
Prof. Nick Shackleton, University of Cambridge
Mark Collins, Director, World Conservation Monitoring Centre

Thank you to Mr. John Leonhardt for allowing us to use his beautiful illustrations

Finally special thanks to Baba and Mama Chilima, our guide Ali Mohammed, and all the people of Mchinga, for their wonderful help and hospitality.

Appendix VII : Bibliography

- **Ahmed, F.A. & Ahmed, A.E.** (1978) Plant cover, nutritive value and carrying capacity of a range pasture in the low rainfall woodland savanna of western Sudan. E. Afr. Agric. For. 43 : 238 – 245.
- **Anon.** (1995) Who Controls Forest Resources in Tanzania? Miombo No. 13, July 1995. Wildlife conservation Society of Tanzania.
- **Beale, D**. (1995) Tree! What Tree? A dissertation presented for the degree of Master of Science, University of Edinburgh.
- **Beentje, H**. (1995) Kenya trees, shrubs and lianas. National Museums of Kenya.
- **Blundell, Sir M.** (1982) Collins photo guide to the wild flowers of East Africa. Harper Collins, London.
- **Bonham, C.D.** (1937) Measurements For Terrestrial Vegetation. John Wiley and Sons.
- **Bredenkamp G.J.** (1986) Ecological profiles of potential bush encroacher species in the Manyeleti Game Reserve. S.-Afr. Tydskr. Plantk. 52 (1) : 57 – 59.
- **Briggs P.** (1993) Guide to Tanzania. Bradt.
- **Bryce, J.M.** (1969) The Commercial Timbers of Tanzania. Ministry of Agriculture and Cooperatives, Forrestry division.
- **Causton, D.R.** (1988) Introduction to Vegetation Analysis. Unwin Hyman.
- **Clarke, G.P.** (1993) Coastal Forest Research Programme TZ17 Progress Report to Frontier - Tanzania.
- **Cooper, C.F.** (1963) An Evaluation of Variable Plot Sampling in Shrub and Herbaceous Vegetation. Ecology 44 : 565 – 568.
- **Dale, I.R. & Greenaway, P.J.** (1961). Kenya Trees And Shrubs. Bot HI52 (A and B) : 361 - 362.
- **Division of Forest Products Research** (1988) Technical Note No.24/79: Timbers of Zambia.
- **FFI** (1995) Regional Strategy for *D. melanoxylon*. Preliminary report of the Maputo workshop (6-9 Nov. 1995) organized by FFI: "Towards Conservation and Responsible use of *D. melanoxylon*." Unpub. report.
- **Freeman, R.P.** (1996) People Oriented Research and Participatory Rural Appraisal. Unpub. report for Cambridge University Explorers and Travellers Club.
- **Gundidza, M. & Gaza, N.** (1993) Antimicrobial activity of *Dalbergia melanoxylon* extracts. Ethnopharmacology 40 : 127 – 130.
- **Hall J.E.** (1988) Report on a mission to analyze the sawmilling practices of the mpingo wood industry in Tanzania. Unpub. report to UNEP, Nairobi.
- **Hall J.E.** (1988) Report on a survey of potential export markets for mpingo by-products in Europe and N. America. Unpub. report to UNEP, Nairobi.
- **Hall-Martin A.J. & Fuller N.G.** (?) Observations on the phenology of some trees and shrubs of the Lengwe National Park, Malawi. Sth. Afr. Wildl. Mgmt. Ass. 5 (1) : 83 – 86.
- **Harby, K.** (1998) Unsound Reasoning. Scientific American, March 1998.
- **Haughton-Sheppard, P.C. (**1958). A note on African Blackwood **-** *Dalbergia melanoxylon.* Empire Forestry Review 37.

- **Lind, E.M. & Morrison M.E.S.** (1974). East African Vegetation. Longman Group Limitted, London.
- **Lovett, J.** (1987) Mpingo, the African Blackwood. Swara 10 (2) : 27 – 28.
- **Lovett, J.** (1988) Tree of the month: *Dalbergia melanoxylon.* Miombo 2: p3.
- **McCoy-Hill, M.** (1993) Mpingo (East African Blackwood). International Tree Foundation.
- **Moore, K. & Hall, J.E.** (1987) Report on a mission to assess the management and conservation of *D.melanoxylon*, or mpingo, in Tanzania. Unpub. report to UNEP, Nairobi.
- **Mugasha, A.G.** (1978) Tanzania Natural Forest Silvicultural Research - Review Report. Forestry Division, Ministry of Natural Resources and Tourism.
- **Mugasha, A.G.** (1983) The effect of planting season, different planting materials and weeding methods on early performance of *Dalbergia melanoxylon* at Kwamarukanga, Korogwe, Tanzania. Silviculture Research Note No.43. Forest Division, Ministry of Natural Resources and Tourism.
- **Mugasha, A.G. & Mruma, S.O.** (1983) Growth of *Dalbergia melanoxylon* in natural woodland and trial plots in Tanzania. Forest Division, Ministry of Natural Resources and Tourism. Silviculture Technical Notes (New Series), no.59.
- **Nair, K.K.N.** (1989) Genus *Dalbergia* L F. (Fabaceae) in Kerala State. Econ. Tax. Bot. 13 (3) : 567 – 590.
- **National Tree Seed Programme, Tanzania** (1995) Handling Seed of *Dalbergia Melanoxylon* (East African Blackwood). Seed Issue Note No. 9.
- **Noad, T. & Birnie, A.** (198?) Trees of Kenya. (Publisher unknown).
- **Norton, G.W. & Hawkins, D.M.** (1995) *Dalbergia melanoxylon* in Mikumi National Park, Tanzania. Submission to the proceedings of the Maputo Workshop.
- **Nshubemuki, L.** (1993) *Dalbergia melanoxylon*: Valuable Wood from a Neglected Tree. NFT Highlights, September 1993. NFTA, Hawaii, USA.
- **Nshubemuki, L.** (1994) Recent progress in Silviculture research on *Dalbergia melanoxylon* in Tanzania. In Westley, S.B and Roshetko, J.M. (1994) *Dalbergia*: Proceedings of an International Workshop. Nitrogen Fixing tree Research Reports Special Issue 1994.
- **Platt, I. & Evison, S.** (1994) In-country investigation into the state of knowledge about the conservation and cultivation status of mpingo (*Dalbergia melanoxylon*) in Tanzania, with notes about Mozambique. Unpub. Report for FFI.
- **Prasad, D.** (1994) Genetic diversity of *Dalbergia* species and their distribution in Karnataka, India. In Westley, S.B. and Rosheko, J.M. (1994) *Dalbergia*: Proceedings of an International Workshop. Nitrogen Fixing Tree Research Reports Special Issue 1994.
- **Puhakka, M.** (1991) Inventory of *Dalbergia melanoxylon* (Mpingo) in the Mtwara region: present state of resources and perspectives for its sustainable use in the future. Project report of the Turka - Mtwara Friendship Association.
- **Read, M.** (1993) Ebonies and Rosewoods: Requiem or Revival? FFI.
- **Sharman, H.** (1995) Investigation into the sustainable management of a tropical timber tree species, using *Dalbergia melanoxylon* as a case study. A dissertation presented for the degree of Master of Science, University of Edinburgh.
- **Tanzania Timber Marketing Co. Ltd** (1978) Timber from Tanzania
- **Treeroots Network Social Forestry Report (**1993) Vol.2, no.1 Focus on Trees: *Dalbergia melanoxylon.*

- **UNEP** (1988) Don't Stop the Music. Save the Mpingo. UNEP: Nairobi
- **Vollesen, K.** (1980) Annotated Check-list of the Vascular Plants of the Selous Game Reserve, Tanzania. Opera Botanica 59 : 2 – 117.
- **Von Maydell, H.J.** (1986) Trees and Shrubs of the Sahel: Their Characteristics and Uses. GTZ, Eschborn, West Germany.
- **Williams, J.G. & Arlott, N.** (1980) A field guide to the birds of East Africa. Collins, London

Appendix VIII : Contact Details

Cambridge Mpingo Project

The Cambridge Mpingo Project exists to facilitate long term research into *Dalbergia melanoxylon*, concentrating on obtaining quantitative data on the ecology of the tree and the impact of exploitation. It is committed to a ten year research programme conducted through two principal means: regular student expeditions from Cambridge University, and secondly by funding on-going research at other times of the year by Tanzanian students and foresters. At the time of writing, *Tanzanian Mpingo 98*, the follow-up to this expedition, is making final preparations before leaving for the field. It will carry out 10 weeks research in and outside Mitarure Forest Reserve close to Kilwa.

Steve Ball
Cambridge Mpingo Project
27 Rollscourt Avenue
Herne Hill
London SE24 0EA
United Kingdom
Tel/Fax: +44 – (0)171 – 274 – 4134
Email: steve.ball@sbcomp.demon.co.uk

Fauna & Flora International (FFI)

Fauna & Flora International, founded in 1903, is the world's oldest international conservation charity. Its mission is to safeguard the future of endangered species of animals and plants through action based on sound scientific principles. FFI has members in over 100 countries and its programmes offer creative and innovative solutions to conservation problems. They involve and empower local people, ensuring that conservation gains for threatened species are sustained into the future.

The Soundwood Project was established to promote the conservation of numerous valuable hardwoods about the world which are endangered by high rates of exploitation to supply raw materials for the manufacture of a whole range of musical instruments. *Dalbergia melanoxylon* is just one amongst many species which are threatened in this way.

Soundwood Project Officer
Fauna & Flora International
Great Eastern House
Tenison Road
Cambridge CB1 2DT
United Kingdom
Tel: +44 – (0)1223 – 461471
Fax: +44 – (0)1223 – 461481
Email: info@fauna-flora.org

Wildlife Conservation Society of Tanzania (WCST)

Wildlife Conservation Society of Tanzania
PO Box 70919
Dar Es Salaam
Tanzania