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African medicinal plants

Setting priorities at the interface between conservation and primary healthcare

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African medicinal plants

SETTING PRIORITIES AT THE INTERFACE BETWEEN CONSERVATION AND PRIMARY HEALTHCARE

Abstract

Sustainable management of traditional medicinal plant resources is important, not only because of their value as a potential source of new drugs, but due to reliance on traditional medicinal plants for health. The vast majority (70-80%) of people in Africa consult traditional medical practitioners (TMPs) for healthcare. With few exceptions, traditional medicinal plants are gathered from the wild. Although reliance on TMPs may decline in the long term as alternative healthcare facilities become available, increasing demand for popular herbal medicines is expected in the foreseeable future. Over the same period, certain vegetation types that were sources of supply of traditional medicines will drastically decline due to forest clearance for agriculture, afforestation of montane grasslands, uncontrolled burning and livestock grazing. Exclusion from core conservation areas adversely affects TMPs who previously gathered medicinal plants in those sites. In addition, supplies of herbal medicines to TMPs are affected by competing resource uses such as timber logging, commercial harvesting for export and extraction of pharmaceuticals, and use for building materials and fuel. This creates a growing demand for fewer resources, in some cases resulting in local disappearance of favoured and effective sources of traditional medicine and reduced species diversity.

The most vulnerable species are popular, slow growing or slow to reproduce, or species with specific habitat requirements and a limited distribution. Although in theory, sustainable use of bark, roots or whole plants used as herbal medicines is possible, the high levels of money and manpower required for intensive management of slow growing species in multiple-species systems are unlikely to be found in most African countries. The cultivation of alternative sources of supply of popular, high conservation priority species outside of core conservation areas is therefore essential. However, commercial cultivation of such species is not a simple solution and at present is unlikely to be profitable due to the slow growth rates for most tree species and low prices paid for traditional medicines. These slow growing species are a priority for *ex situ* conservation and strict protection in core conservation areas. By contrast, the high price paid for some species does make them potential new crop plants for agroforestry systems (e.g. *Warburgia salutaris, Garcinia kola, G. afzelii, G. epunctata)* or agricultural production *(e.g. Siphonochilus aethiopicus).* Pilot studies on these species are needed.

Priority areas for cooperative action between healthcare professionals and conservationists are rapidly urbanizing regions with a high level of endemic taxa, particularly west Africa (Guineo-Congolian region), specifically Côte d'Ivoire, Ghana, and Nigeria; east Africa (Ethiopia, Kenya, Tanzania); south-eastern Africa (South Africa, Swaziland). The most threatened vegetation types are Afro-montane forest and coastal forests of the Zanzibar-Inhambane regional mosaic.

Contents

Introduction

"If there is to be any real improvement in the health of the under-served populations of the world, then there will have to be full utilization of all available resources, human and material. This is fundamental to the primary healthcare approach. Traditional medical practitioners constitute the most abundant and in many cases, valuable health resources present in the community. They are important and influential members of their communities who should be associated with any move to develop health services at a local level."

Akerele (1987)

"First the unukane (*Ocotea bullata*) trees were killed by ring-barking for sale in the cities. Now the same is happening to igejalibomvu (Curtisia dentata) and umkhondweni (*Cryptocarya myrtifolia*) trees. Soon they will be gone as well and we will have to buy the barks from the herb traders."

Herbalist, Nkandla forest, Natal, South Africa, 1987

The populations of developing countries worldwide continue to rely heavily on the use of traditional medicines as their primary source of healthcare. Ethnobotanical studies carried out throughout Africa confirm that native plants are the main constituent of traditional African medicines (Adjanohoun *et al.*, 1980; Adjanohoun *et al.*, 1984; Adjanohoun *et al*, 1985; Adjanohoun *et al.*, 1986; Adjanohoun *et al.*, 1988; Ake Assi, 1988; Ake Assi *et al.*, 1981; Hedberg, *et al.*, 1982; Hedberg *et al.*, 1983a; Hedberg *et al.*, 1985b; Kokwaro, 1976; Oliver Bever, 1987). With 70-80% of Africa's population relying on traditional medicines, the importance of the role of medicinal plants in the healthcare system is enormous. Medicinal plants are now being given serious attention, as is evidenced by the recommendation given by the World Health Organization in 1970 (Wondergem *et al.*, 1989) that proven traditional remedies should be incorporated within national drug policies, by recent moves towards a greater professionalism within African medicine (Last and Chavunduka, 1986) and also by the increased commercialization of pharmaceutical production using traditional medicinal plants with known efficacy (Sofawara, 1981).

Little attention however, has been paid to the socio-economic and conservation aspects of medicinal plant resources, probably due to the relatively small volumes involved and the specialist nature of the informal trade in them. However, the management of traditional medicinal plant resources is probably the most complex African resource management issue facing conservation agencies, healthcare professionals and resource users. As pressure is increasing on diminishing medicinal plant supplies, constructive resource management and conservation actions must be identified, based upon a clear understanding of the surrounding medicinal plant use.

This study seeks to respond to three central questions:

(1) What are the causes behind the depletion of wild populations of medicinal plant species in Africa?
(2) Which species are of particular concern and should be given priority for positive action?
(3) What can be done to ensure the effective conservation of all medicinal plant species?

An explanation of the present situation in the first section ("Medicinal plant use in Africa") illustrates the urgent need for action. The actions required to alleviate problems and an assessment of priorities for medicinal plant conservation and resource management are discussed in the second section ("Policy priorities in conservation and primary healthcare").
The study is based on research and literature surveys, correspondence with other researchers, field visits to establish contact with traditional medical practitioners (TMPs) and herbalists and visits to Côte d'Ivoire, Malawi, Mozambique, Swaziland, Zambia and Zimbabwe in 1990.

I have chosen not to make distinctions between plant species with symbolic or psychosomatic uses and those with active ingredients in this study, the main issue being whether or not a species is threatened.

Medicinal plant use in Africa

The role of traditional medical practitioners

In contrast with western medicine, which is technically and analytically based, traditional African medicine takes a holistic approach: good health, disease, success or misfortune are not seen as chance occurrences but are believed to arise from the actions of individuals and ancestral spirits according to the balance or imbalance between the individual and the social environment (Anyinam, 1987; Hedberg *et al*., 1982; Ngubane, 1987; Staugard, 1985; WHO, 1977). Traditionally, rural African communities have relied upon the spiritual and practical skills of the TMPs (traditional medicinal practitioners), whose botanical knowledge of plant species and their ecology and scarcity are invaluable. Throughout Africa, the gathering of medicinal plants was traditionally restricted to TMPs or to their trainees (Photo 1). Knowledge of many species was limited to this group through spiritual calling, ritual, religious controls and, in southern Africa, the use of alternative (hlonipha) names not known to outsiders.

Hedberg *et al*., (1982) observed that the number of traditional practitioners in Tanzania was estimated to be 30 000 - 40 000 in comparison with 600 medical doctors (Table 1) (MP and TMP : total population ratios were not given). Similarly, in Malawi, there were an estimated 17 000 TMPs and only 35 medical doctors in practice in the country (Anon., 1987).

Economic and demographic projections for most African countries offer little grounds for optimism. A shift from using traditional medicines to consulting medical doctors, even if they are available, only occurs with socio-economic and cultural change, access to formal education (Kaplan, 1976) and religious influences (e.g. through the African Zionist movements, which forbid the use of traditional medicines by their followers, substituting the use of ash and holy water instead; Sundkier, 1961). Access to western biomedicine, adequate education and employment opportunities requires economic growth. Unfortunately, most African countries are affected by unprecedented economic deterioration. Per capita income has reportedly fallen by 4% since 1986, whilst Africa's foreign debt is three times greater than its export earnings. In Zambia, government spending on education has fallen by 62% in the last decade, and that on essential pharmaceutical drugs by 75% from 1985 to 1989 (Zimbabwe Science News, 1989). At the same time, the African population has grown by 3% per annum, increasing the difficulty of adequate provision of Western-type health services. For this reason, there is a need to involve TMPs in national healthcare systems through training and evaluation of effective remedies, as they are a large and influential group in primary healthcare (Akerele, 1987; Anyinam, 1987; Good, 1987). Sustainable use of the major resource base of TMPs - medicinal plants - is therefore essential.

Customary controls on medicinal plant gathering

The sustainable use of medicinal plants was facilitated in the past by several inadvertent or indirect controls and some intentional management practices.

Taboos, seasonal and social restrictions on gathering medicinal plants, and the nature of plant gathering equipment all served to limit medicinal plant harvesting. In southern Africa (and probably elsewhere) before metal machetes and axes were widely available, plants were collected with a pointed wooden digging stick or small axe, which tended to limit the quantity of bark or roots gathered. For example, traditional subsistence harvesting of *Cassine papillosa* bark causes relatively little damage to the tree (Figure 1). Pressure on medicinal plant resources has remained low in remote areas and in countries such as Mozambique and Zambia where the commercial trade in traditional medicines has only developed to a limited extent due to the small

Photo 1. Trainee diviner (twasa) with a small quantity of *Boophane disticha* (Amaryllidaceae) bulbs for local use.

size of major urban centres. Examples of factors which have limited pressure on species which would otherwise be vulnerable to over-exploitation include:

(1) Taboos against the collection of medicinal plants by menstruating women in South Africa and Swaziland; it is believed that this would reduce the healing power of the plants (Scudder and Conelly, 1985).

(2) The tendency in southern Africa for women to practise as diviners, while men practise as herbalists (Berglund, 1976; Staugard, 1985). This limits the number of resource users.

(3) The perceived toxicity of some medicinal species which reduced their use in the past: the level of toxicity is sometimes given mythical proportions. *Synadenium cupulare* for example, is considered so toxic that birds flying over the tree are killed; special ritual preparations are made in west Africa before the bark of *Okoubaka aubrevillei* is removed (Good, 1987).

(4) The traditional use of a wooden batten for removal of bark from *Okoubaka aubrevillei* - under no circumstances may a machete or other metal implement be used (Good, 1987).

For any society to institute intentional resource management controls, certain conditions have to be fulfilled:

(1) the resource must be of value to the society;

(2) the resource must be perceived to be in short supply and vulnerable to over-exploitation by people;

(3) the socio-political nature of the society must include the necessary structures for resource management.

Intentional resource management controls have endured in Africa in various forms and for various reasons and some have affected the abundance and availability of medicinal species. The widespread practice in Africa of conserving edible wild fruit-bearing trees for their fruits or shade also ensures availability of some traditional medicines as several are multiple-use species. For example the following six trees are conserved for their fruit: *Irvingia gabonensis* and *Ricinodendron heudelotii* in west Africa (barks are used for diarrhoea and dysentery); from southern Africa *Trichilia emetica* (enemas), *Parinari curatellifolia* (constipation and dropsy), *Azanza garkeana* (chest pains), and *Sclerocarya birrea* (diarrhoea). *Albizia adianthifolia*, used for enemas, is conserved for its shade.

Protection of vegetation at grave sites, for religious and spiritual reasons, is a common feature in many parts of Africa (including Kenya, Malawi, South Africa and Swaziland) and an important means through which biotic diversity is maintained outside core conservation areas. In south-eastern Africa during the nineteenth century, specific Zulu regiments were called up annually to burn fire-breaks around the grave sites of Zulu kings: these woodland or forested sites were considered to be a sanctuary for game animals (Webb and Wright, 1986). An important feature of vegetation conservation around grave sites is that this practice is maintained even under high population densities and tremendous demand for arable land, for example in Malawi. The practice might possibly be strengthened through the burial of prominent leaders in conservation areas.

Religious beliefs have also helped to ensure careful harvesting of Helichrysum kraussii, an aromatic herb known as impepho in Zulu which is widely burnt as an incense in Natal. Diviners

Table 1. Ratios of traditional medical practitioners (TMPs) and medical doctors to total population in selected African countries.

COUNTRY	TMP : TOTAL POP.	MD : TOTAL POP.	REFERENCE
NIGERIA			
Benin City	1 : 110	1 : 16 400	Oyenye & Orubuloye, 1983
National average	?	1 : 15 740	Gestler, 1984
GHANA			
Kwahu district	1 : 224	1 : 20 625	Anyinam, 1984
KENYA			
Urban (Mathare)	1 : 833	1 : 987	Good, 1987
Rural (Kilungu)	1 : 146 - 345	1 : 70 000	Family Health Institute, 1987
TANZANIA			
Dar es Salaam	1 : 350 - 450	?	Swantz, 1984
ZIMBABWE			
Urban areas	1 : 234	?	
Rural areas	1 : 956	?	Gelfand et al, 1985
SWAZILAND	1 : 110	1 : 10 000	Green, 1985
SOUTH AFRICA			Savage, 1985
Venda area	1 : 700 - 1 200	1 : 17 400*	Arnold & Gulumian, 1987

* so-called “homeland” areas only

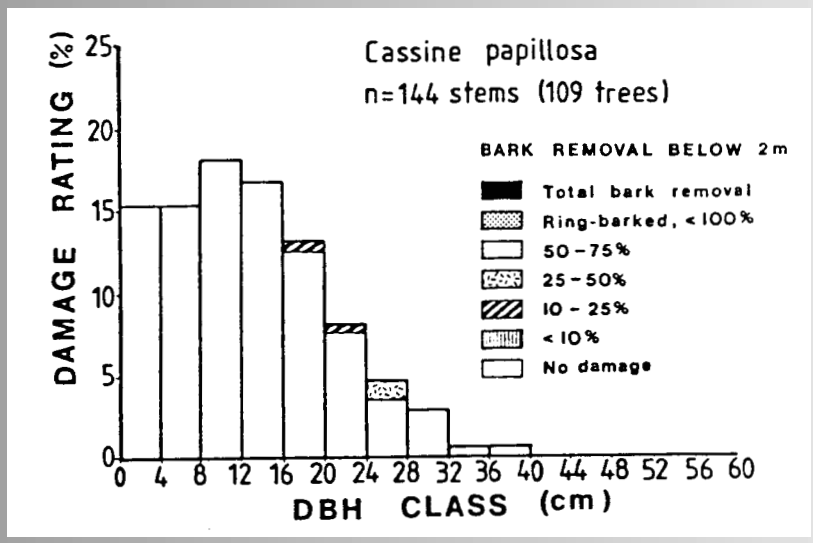


Figure 1. Assessment of debarking damage to *Cassine papillosa* (Celastraceae) trees in an area where subsistence harvesting rather than commercial exploitation is taking place (Cunningham, 1988a)

are careful not to rip the plant out by its roots (Cooper, 1979).

In Swaziland and South Africa, taboos also restrict the seasonal (summer) collection of *Alepidea amatymbica* roots, *Siphonochilus aethiopicus* and *Agapanthus umbellatus* rhizomes. In each case, collection is restricted to the winter months after seed set as summer gathering is believed to cause storms and lightning. In Zimbabwe, clearance has to be obtained from ancestral spirits before entering certain forests where *Warburgia salutaris* occurs. In each of the above cases (excepting *Agapanthus umbellatus*), the species concerned are popular, scarce and effective. These intentional conservation practices may be due to the century-old history of trade in these plants in the southern African region.

Government legislation has played a largely ineffective role in controlling the use of medicinal plants in Africa. Under colonial administration, religious therapy systems practised by diviners were equated with witchcraft and legislated against almost everywhere (Cunningham, 1990; Gerstner, 1938; Staugard, 1985). In South Africa (and possibly other parts of Africa) during the colonial era, there were also attempts to prohibit the sale of traditional medicines within urban areas, such as the efforts made by the Natal Pharmaceutical Society in the 1930s in Durban, South Africa. Apart from having the temporary effect of driving informal sector plant sellers and TMPs underground, this kind of legislation has been ineffective in reducing traditional medicine use. Attempts to suppress traditional medicine are not, however, solely restricted to the colonial era: in post-independence Mozambique, for example, diviners involved in symbolic or magico-medicinal aspects of traditional medicine were sent to re-education camps in an effort to do away with "obscurantism" (Adjanohoun *et al*., 1984).

Although forest legislation in most African countries generally recognizes the importance of customary usage rights (including gathering of dead-wood for fuel, felling poles and gathering latex, gums, bark resins, honey and medicinal plants) conservation land or certain plant species are often set aside for strict protection (Schmithusen, 1986). In South Africa, for example, forestry legislation was promulgated in 1914 for the protection of economically important timber species such as *Ocotea bullata*. Specially protected status has been given since 1974 to all species within the families Liliaceae, Amaryllidaceae and Orchidaceae due to their prominence in the herbal medicine trade.

At best, this legislation has merely slowed down the rate of harvesting. Extensive exploitation within forest reserves still occurs in South Africa. One of the main reasons for this is that legislation for core conservation areas (CCAs) in the past has concentrated on a "holding action" to maintain the status quo and neglected

to provide local communities with viable alternatives to collecting customary plants.

Dynamics of the commercial trade

If effective action is to be taken to deal with the over-exploitation of medicinal plants, there has to be a clear understanding of the scale and complexity of the problem.

Domestic trade

Africa has the highest rate of urbanization in the world, with urban populations doubling every 14 years as cities grow at 5.1% each year (Huntley *et al*., 1989). In rural areas throughout Africa, wild plant resources fulfill a wide range of basic needs and are a resource base harvested for informal trade or barter, whereas in urban areas, a much smaller range of species and uses is found. In rural areas of the Mozambique coastal plain for example, 76 edible wild plant species are used (Cunningham, 1988a) but only five species are sold in urban markets in Maputo. Urbanization results in this general reduction in the number of species and the quantities of certain wild plant resources used as people enter the cash economy, and alternative foods, utensils and building materials become available. However, informal sector trade in two categories of wild plant resources continues to be very important in many cities: fuelwood (alternative energy sources such as electricity, gas and paraffin are not available or affordable; Eberhard, 1986; Farnsworth, 1988) and medicinal plants.

The range of commercially sold medicinal species in southern Africa remains wide despite urbanization (over 400 indigenous species in Natal, South Africa, for example; Cunningham, 1990). Little attention has been paid to the cultural, medical, economic or ecological significance of the herbal medicine trade, yet traditional medicine sellers are a feature of every African city (ECP/GR, 1983). Cities are concentrated centres of demand drawing in traditional medicines from outlying rural areas and across national boundaries. Despite the differences in volume and range of species used, parallels can be drawn between the trade in medicinal plants and that in fuelwood:

(1) high proportions of people use medicinal plants (70-80%) and fuelwood (60-95%) (Leach and Mearns, 1988);
(2) high urban demand can undermine the rural resource base by causing the depletion of favoured but slow growing species such as *Combretum* (fuelwood, Botswana; Kgathi, 1984) and *Warburgia salutaris* (bark medicines, Zimbabwe);
(3) harvesting is a strenuous and labour intensive activity with financial returns, carried out by rural people with a low level of formal education and poor chance of formal employment;
(4) supplies may be drawn from a long distance away - from 200-500 km for fuelwood in many African cities (Leach and Mearns, 1989) and as far as 800-1200 km for certain medicinal plants in west Africa such as *Entada africana* and *Swartzia madagascariensis* or *Synaptolepis kirkii* in southern Africa (Cunningham, 1988a).

The herbal medicine trade is characterized by two features. First, from being almost solely an activity of traditional specialists, medicinal plant collection has now shifted to involve commercial harvesters in the informal sector, and (in South Africa at least) formal sector traders (Table 2) who supply the large urban demand. Women, rather than men, are increasingly involved as non-specialist sellers of traditional medicines, and this general pattern is seen throughout Africa. In rural areas and small villages, male and female TMPs practise from their homes. In larger villages, herbalists (mainly men) dispense from a small quantity of traditional medicines that they have gathered themselves. In towns, larger quantities of material are sold, some of which are bought from commercial harvesters, and in cities or large towns, large quantities of plant material are supplied by commercial harvesters and sold through increasing numbers of informal sector sellers (mainly women) to urban herb traders or herbalists for self-medication. Men drop out of non-specialist sales as it becomes an increasingly marginal activity, and only persist as sellers of animal material. Second, demand for traditional medicines is highly species specific and alternatives are not easily provided due to the characteristics of the plant or animal material, their symbolism, or the form in which they are taken. These large urban areas dictate prices, which are kept low because of rising unemployment, over-supply and cheap labour. Thus nothing is paid towards the replacement of the wild stocks.

In the stressful environment which is a feature of many urban areas in Africa, it is not surprising that demand has increased for traditional medicinal plant and animal materials which are believed to have symbolic or psychosomatic value.

Box 1: Case study: The trade in chewing sticks

Dentists are scarce in many parts of Africa, particularly in rural areas. The ratio of dentists: total population in Ghana was 1 : 150 000 (compared to 1 : 3 000 in Great Britain) (Adu-Tutu *et al*., 1979). Although diet plays a major role in causing dental caries, the practice of dental hygiene is also important. While toothpaste and toothbrushes are widely used by the sector of the population with a high level of formal education, toothpaste consumption is still low (e.g. Adu-Tutu *et al*., 1979 in Ghana) and chewing sticks are still in common use in many parts of Africa, particularly west Africa. Even when people would prefer to use toothbrushes, they do not have access to toothpaste due to high cost or remoteness. Continued access to popular and effective sources of chewing sticks, which have anti-bacterial properties, is important as a primary health care measure.

While many hundreds of medicinal plant species are used within a region, a smaller number of the most popular species accounts for much of the commercial trade to urban areas. This applies equally to chewing sticks. In Mozambique for example, *Euclea divinorum* and *Euclea natalensis* (Ebenaceae) are the most commonly sold species, although other species are used countrywide. In Côte d'Ivoire, the most popular sources of chewing sticks are *Garcinia afzelii* and *Garcinia kola* and less commonly used chewing sticks were *Zanthoxylum macrophyllum*, *Maytenus senegalensis*, *Pycnanthus angolensis* and *Enantia polycarpa*. In Cameroon, only *Garcinia mannii* and *Randia acuminata* were the basis of a chewing stick "cottage industry" (Staugard, 1985). Similarly, in southern Ghana, from a sample of 880 people interviewed, six species (distinguished by four local names) accounted for 86% of all usage and the majority of the commercial sales. The majority of all these respondents depend on bought material rather than collecting it themselves, irrespective of size of settlement they live in or their educational status (Figure 2). The species used were: nsokodua (*Garcinia afzelii* and *G. epunctata* (51.1%; 597 people); tweapea (*Garcinia kola* (18.7%; 218); sawe (*Acacia kamerunensis* and *Acacia pentagona* (9.2%; 108); and owebiribiri (*Teclea verdoorninana* (6.7%; 77).

Table 2. Number of traditional medicine sellers (this excludes chewing stick sellers) and herb trader shops in selected African urban areas, small towns (#), large towns (*) and cities (capital letters) from counts during 1989 and early 1990.

COUNTRY	CITY/TOWN (No. markets)		MARKET-BASED SELLERS Total	Men	Women	HERB TRADERS
SOUTH AFRICA	DURBAN	(3)	392	22	270	c.100
COTE D'IVOIRE	ABIDJAN	(4)	111	4	107	0
	Bouake*	(1)	64	26	37	0
ZIMBABWE	Harare*	(2)	36	25	11	0
MOZAMBIQUE	Maputo*	(1)	25	19	6	0
ZAMBIA	Lusaka*	(2)	16	5	11	0
	Mongu#	(1)	3	3	0	0
MALAWI	Lilongwe*	(1)	3	3	0	0
	Blantyre*	(1)	8	8	0	0
	Zomba#	(1)	3	3	0	0
	Mzuzu#	(1)	2	2	0	0
SWAZILAND	Mbabane*	(1)	3	2	1	0
	Manzini#	(1)	4	2	2	0

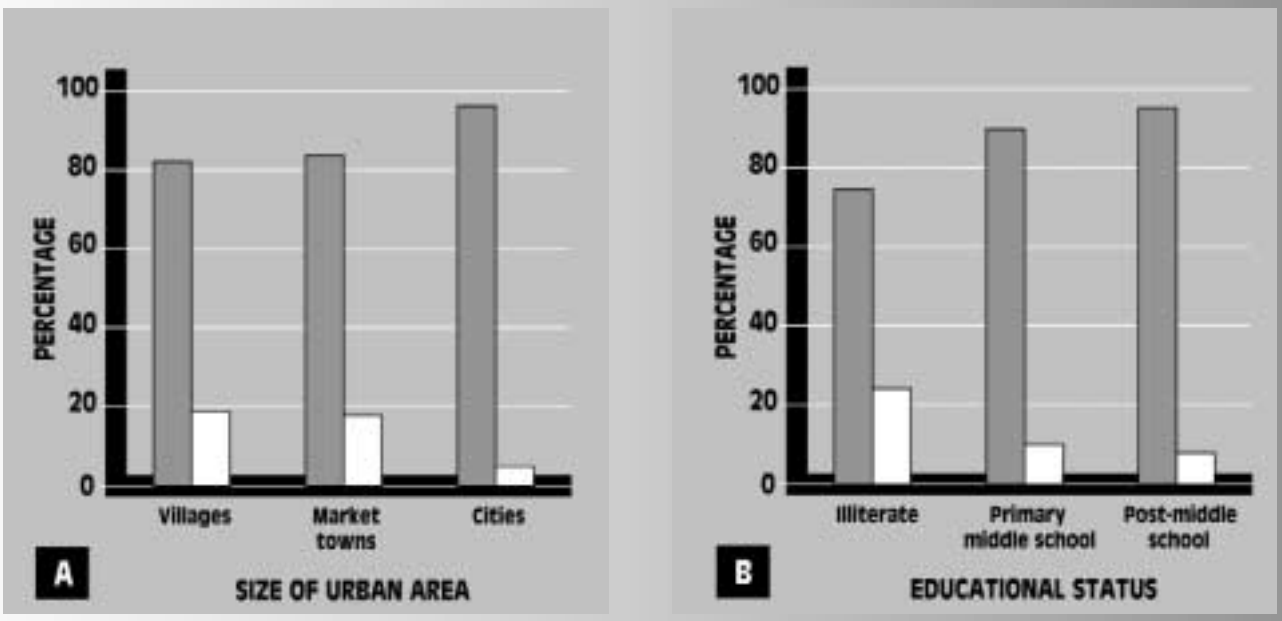


Figure 2.
A. Acquisition of usual chewing stick by buying (shaded columns) and collecting (open columns) among people of various sizes of settlement (after Cunningham, 1988a)
B. Acquisition of usual chewing stick by buying (shaded columns) and collecting (open columns) among people differing in educational background (after Adu-Tutu *et al*. , 1979).

Traditional plant or animal materials which bring luck in finding employment, which guard against jealousy (such as that engendered when one person has a job whilst their peer group are unemployed), or love-charms and aphrodisiacs to keep a wife or girlfriend are popular. Thus, employment options for TMPs have increased with the stresses of urban life. In addition, western-type medical facilities have not been able to cope with the rapidly growing urban population. In Lagos, Nigeria, for example, the ratio of medical doctors to total population was 1 : 5000 in 1975 compared with 1 : 2000 in 1955 (Udo, 1982).

Traditional medical practitioners are therefore attracted to urban centres where employment benefits can be good, as shown in studies in Nairobi (Kenya), Dar es Salaam (Tanzania), Kampala (Uganda), Kinshasha (Zaire) and Lusaka (Zambia) (Good and Kimani, 1980) (Table 1).

In Zimbabwe there is a higher ratio of TMPs to total population in urban areas (1 : 234) than in rural areas (1 : 956) (Gelfand et al., 1985). This is not always the situation, however: in the Kilungu district of Kenya, the ratio of rural TMPs to people averaged 1 : 224, while in urban Mathare, the overall ratio was 1 : 883 (Good, 1987).

International trade

The herbal medicine trade is booming business worldwide. In India, for example, there are 46 000 licensed pharmacies manufacturing traditional remedies, 80% of which come from plants (Alok, 1991). Another example is Hong Kong, which is claimed to be the largest market in the world, importing over US$ 190 million annually (Kong, 1982). In Durban (South Africa), in 1929 there were only two herbal traders; by 1987, there were over 70 herbal trader shops registered. The species specific nature of the demand for medicinal plants is responsible for generating long distance trade across international boundaries. According to Malla (1982), 60-70% of the medicinal herbs collected in Nepal are exported to India, with 85-200 tons exported annually between 1972 and 1980. Similarly the Hong Kong market imports Aquilaria heart-wood for incense manufacture from rain forest in Thailand and Malaysia. This is devastating Aquilaria populations in core conservation areas such as Khao Yai National Park, Thailand (Cunningham, pers. obs.; Cunningham, 1988a; Cunningham, 1988b). Africa is no exception to this pattern and an informal sector trade in medicinal plants spans long distances:

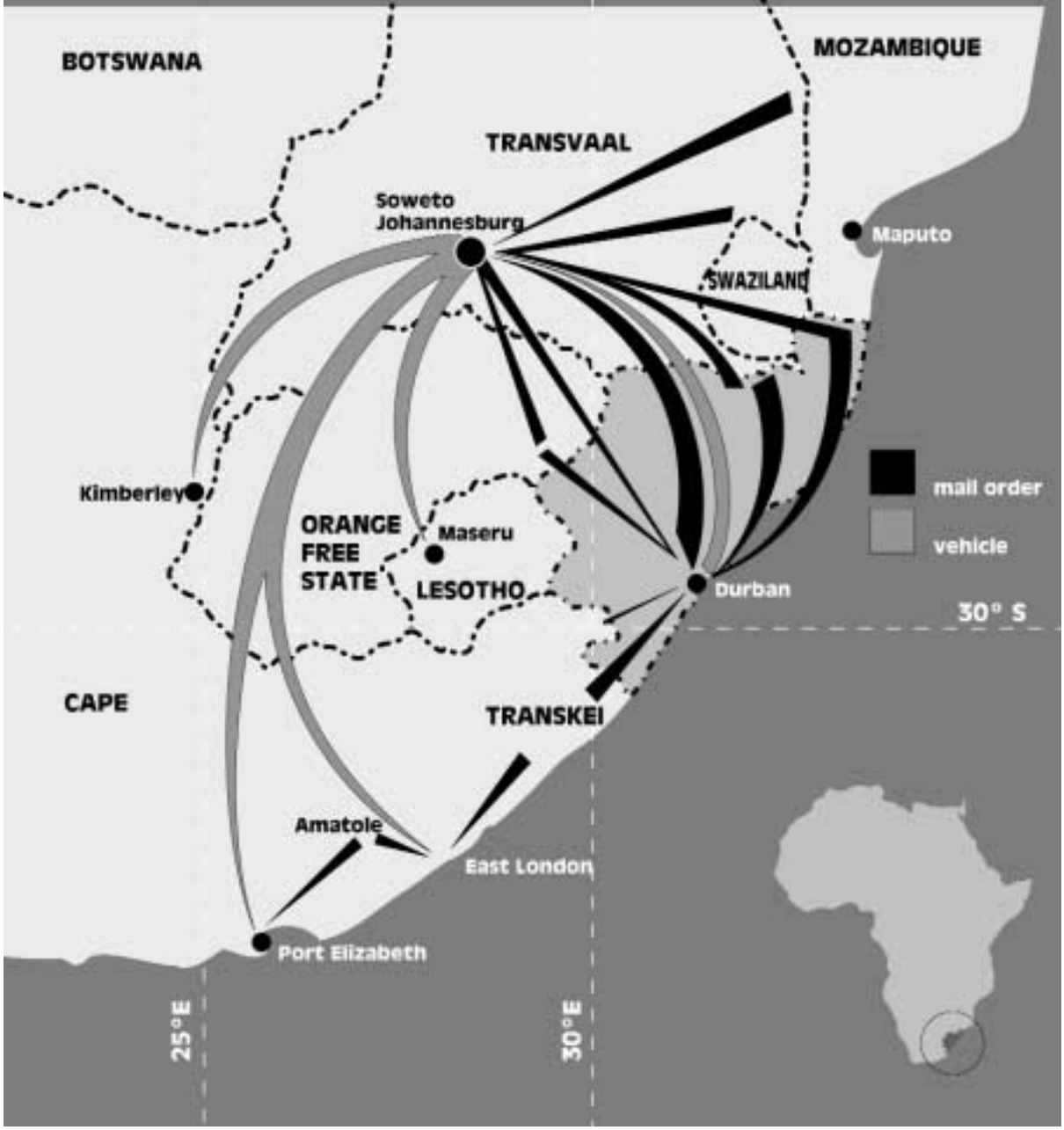


Figure 3. Long distance trade in Natal province, South Africa, from the remotest rural areas to major urban centres through formal and informal trade networks, including mail order sales.

(1) the roots of *Swartzia madagascariensis* and *Entada africana* are traded 500-800 kms from Burkina Faso and Mali to Abidjan, Côte d'Ivoire;
(2) the roots of *Synaptolepis kirkii* are traded 1200 km from the southern border of Mozambique and South Africa, via Johannesburg, to Maseru (Lesotho);
(3) the bark of *Warburgia salutaris* is traded from Swaziland to Johannesburg (South Africa) and Namaacha (on the Swaziland/Mozambique border) to Maputo (Mozambique);
(4) the roots of *Alepidea amatymbica* and bark of *Warburgia salutaris* are traded from the Eastern Highlands (Zimbabwe) to urban centres in the west of the country such as Bulawayo;
(5) mail-order trade in traditional medicines is common in South Africa (Figure 3).

An average of 25% of prescription drugs sold in the USA during the period 1959-1973 contained active principles extracted from higher plants (Farnsworth and Soejarto, 1985). Many of these are derived from the same source as those used in traditional medicine. On a global scale, 74% of these chemicals have similar or related uses in traditional medicine (Farnsworth, 1988). Similarly, many African plant species are the source of a number of active ingredients for the export market (Table 3, Photo 2). Because of the low price

Table 3. Indigenous plants that are harvested as a source of active ingredients for export purposes, indicating what part of the plant is harvested for extraction of active ingredients and whether the plants are used in traditional medicine or not.

SPECIES	PART USED	INGREDIENT	SOURCE AREA	TM
Adhatoda robusta	?	?	Ghana (1)	-
Allanblackia floribunda	fruit	fat**	Cote d'Ivoire (2)	*
Ancistrocladus abbreviatus	?	?	Ghana (1)	-
Corynanthe pachyceras	?	corynanthine corynathidine yohimbine	Ghana (1)	*
Dennetia tripetala	?	?	Ghana (1)	-
Duparquetia orchidacea	?	?	Ghana (1)	*
Griffonia simplicifolia	seed	BS11 lectin	Côte d' Ivoire, Cameroon & Ghana (1,2,5)	*
Harpagophytum procumbens	root	glucoiridoids	Namibia (3)	*
Harpagophytem zeyheri	root	glucoiridoids	Namibia (3)	*
Hunteria eburnea	bark	eburine and other alkaloids	Ghana (1)	*
Jateoriza palmata	root	palmatrin jateorhizine colambamine	Tanzania (4)	*
Pausinystalia johimbe	bark	yohimbine	Cameroon (5)	*
Pentadesma butryacea	fruit	fat**	Côte d'Ivoire (2)	*
Physostigma venenosum	fruit	physostigmine (eserine)	Côte d'Ivoire (2) Ghana (1)	* *
Prunus africana	bark	sterols triterpenes n - docosanol	Cameroon, Kenya Madagascar (6)	*
Rauvolfia vomitoria	root	reserpine yohimbine etc.	Zaire, Rwanda, Mozambique	*
Strophanthus spp.	fruit	ouabain	West Africa	*
Voacanga africana	seed	voacamine	Côte d'Ivoire, Cameroon, Ghana (1,2,5)	*
Voacanga thouarsii	seed	voacamine	Cameroon(1,2,5)	*

Note : Fat from *Allanblackia stuhlmannii* fruits, used in soap making and cosmetics industry (Lovett, 1988).
Use of products from *Jateorhiza* now limited mainly to veterinary medicine (Oatley, 1979).
References: 1 = (Abbiw, 1990); 2 = L. Ake Assi, pers. comm.; 3 = (Nott, 1986); 4 = J. Seyani, pers. comm.; 5 = (FAO, 1986); 6=(Catalano *et al.*, 1985).

demanded by plant traders, even when technology for chemical synthesis is available, it can be cheaper for pharmaceutical companies to continue to extract the active ingredients from plants. In the mid-1970s, for example, synthesis of reserpine cost $1.25 g-1, compared to a cost of $0.75 per g-1 for commercial extraction from *Rauvolfia vomitoria* roots (Oldfield, 1984).

According to the UNCTADD/GATT International Trade Centre, the total value of imports of medicinal plants for OECD countries, Japan and the USA increased from US$ 335 million in 1976 to US$ 551 million in 1980 (Husain, 1991). Of the 200 tons of Harpagophytum procumbens and H. zeyheri tubers exported annually from Namibia, Germany imported 80.4%, with the remaining

Photo 2. Medicinal plant seller at a market in Abidjan, Côte d'Ivoire, showing the dominance of fresh leaf material as a source of herbal medicines.

12.8% sold to France, 1.9% to Italy, 1.5% to USA, 1% to Belgium and 1.2% sold locally or to South Africa (Nott, 1986). Unfortunately, the low prices paid for the plants do not cover replacement or resource management costs, and as such, major importers demanding high volumes of plant material are contributing to the decline of medicinal plant species in Africa.

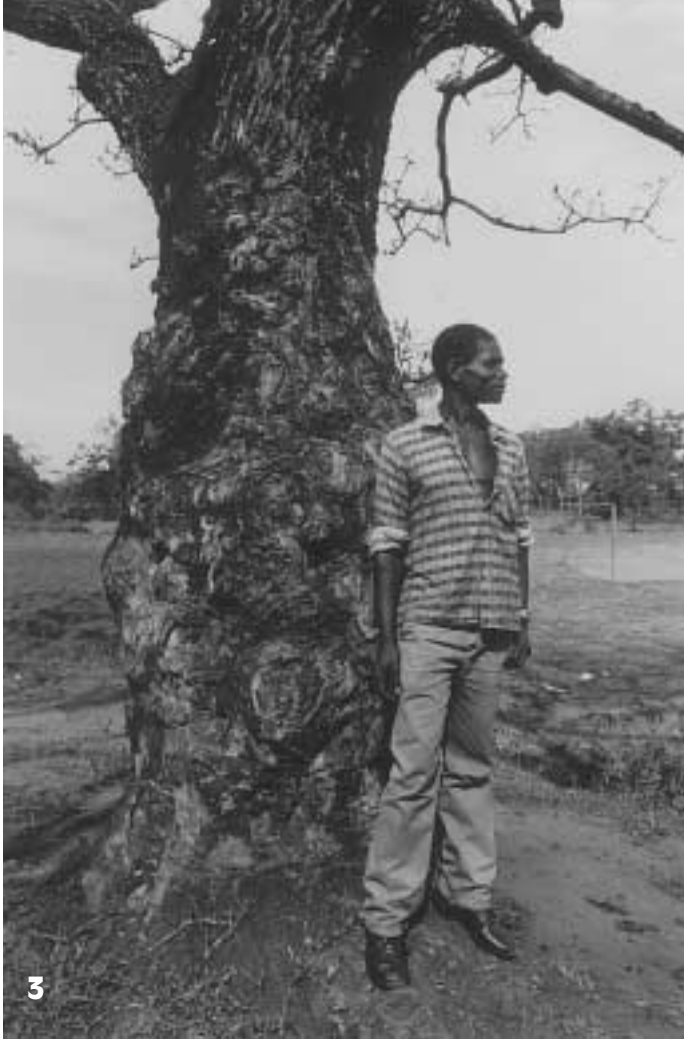
The impact of the trade in medicinal plants

Commercial gathering of traditional medicines in large countries with small urban populations (e.g. Mozambique, Zaire and Zambia) is limited and cases of over-exploitation are rare. Harvesting by TMPs continues usually to be selective and on a small scale, and traditional conservation practices, where they exist, would be expected to be retained. In African countries with high rural population densities and small cities (e.g. Rwanda), gathering is also expected to be small scale, and where a species is popular and supplies are low due to habitat destruction and agricultural expansion, the tree will suffer a "death of a thousand cuts" rather than one-off ring-barking due to commercial harvesting (see Photo 3).

The emergence of commercial medicinal plant gatherers in response to urban demand for medicines and rural unemployment has resulted in indigenous medicinal plants being considered as an open access or common property resource instead of a resource only used by specialists. The resultant commercial, large-scale harvesting has been the most significant change, although seasonal and gender related restrictions have also altered. Rural traditional medical practitioners and the hereditary chiefs who traditionally regulate resource management practices admit that ring-barking and over-exploitation by commercial gatherers are bad practices that undermine the local resource base. In Natal (South Africa) it appears that restrictions placed by traditional community leaders and enforced by headmen and traditional community policemen have reduced commercial exploitation of local traditional medicinal plant resources. With cultural change, increased entry into the cash economy and rising unemployment however, these controls are breaking down.

Ring-barking or uprooting of plants is the commonest method of collection used by commercial gatherers (Photo 6). Where urban populations (and resultant commercial trade in traditional medicines) are relatively small, but high rural population densities and an agricultural economy have cleared most natural vegetation, tree species such as *Erythrina abyssinica* and *Cassia abbreviata*, which are popular and accessible, have small pieces of bark removed (Photos 3 and 4), rather than a one-off removal of trunk bark (Photos 5 and 6).

In South Africa, where the taboo against gathering of traditional medicines by menstruating women was widespread in the past, urban herbalists now no longer place importance on this when buying plants from urban markets,

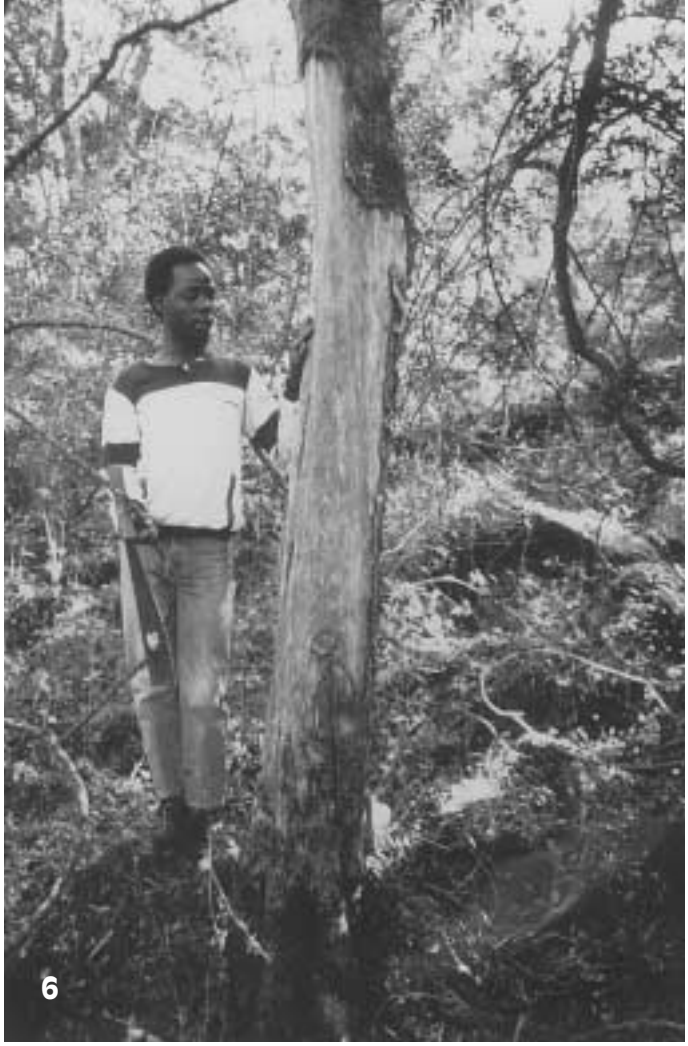


Photos 3 to 6. Declining rural resource base under non-commercial demand, but limited supplies (3) *Erythrina abyssinica* (Fabaceae), Malawi ("death from a thousand cuts") and (4) *Cassia abbreviata* (Fabaceae), Zimbabwe, (5) Large pieces of *Warburgia*

or in some cases, treat the plants to magically "restore their power". Strict seasonal restrictions are still placed on the gathering of *Siphonochilus aethiopicus* rhizomes in South Africa and Swaziland, but commercial collection of *Alepidea amatymbica* rhizomes now takes place "on misty days" in summer (although harvested material is stored away from the homestead for fear of lightning). Even where seasonal restrictions are still in place, demand can exceed supply. *Siphonochilus natalensis* for example, had disappeared from its only known locality in Natal before 1911 as a result of trade between Lesotho and Natal (South Africa) (Medley-Wood and Evans, 1898).

It is clear that medicinal plant species gathered for commercial purposes represent the most popular and often most effective (physiologically or psychosomatically) herbal remedies. From historical records (Gerstner, 1938, 1939; Medley-Wood, 1896) it is clear that the majority of species that were popular in the past are still popular today. Examples in southern Africa include *Erythrophleum lasianthum*, *Cassine transvaalensis*, *Alepidia amatymbica* and *Warburgia salutaris*. Commercially sold species thus represent a "short list" of the medicinal plants used nationally, since many species that are used to a limited extent in rural areas are not in demand in the urban areas. Also important from a resource management point of view, is that in virtually all African countries, it is not the limited, selective harvesting by specialist TMPs that represents the problem. In most cases, non-sustainable use of favoured species results from commercial harvesting to supply an urban demand for traditional medicines, after clearing for agricultural or urban associated development has already taken place. The widespread commercial harvesting and sale of the same genera and species throughout their distribution range is significant (e.g. *Solanum* fruits, *Erythrophleum* bark, *Abrus precatorius* seeds, *Myrothamnus flabellifolius* stems and leaves and *Swartzia madagascariensis* roots) (Appendix 1).

Medicinal plant gatherers are familiar with which species are becoming difficult to find, either because of limited geographical distribution, habitat destruction or over-exploitation.



salutaris (Canellaceae) bark from Namaacha on the Swaziland border commercially gathered for sale in Maputo, Mozambique, (6) *Curtisia dentata* (Cornaceae) tree in Afromontane forest, South Africa, debarked for sale in Durban, a city 100 km away.

Their insights, coupled with botanical and ecological knowledge of the plant species involved, provide an essential source of information for a survey of this type. In this survey, it was not considered constructive to distinguish between plant species with symbolic uses and those with active ingredients. The important question here is whether the species are threatened or not, because:

(1) species that have a purely symbolic value are nevertheless important ingredients of traditional medicines for their psychosomatic value and are as effective as placebos are in urban-industrial society;

(2) the majority of traditional medicines have not been adequately screened for active ingredients and a number of species, for example *Rapanea melanophloes* in southern Africa, while being primarily used for symbolic purposes, also have active ingredients. Conservation efforts must therefore be directed at all species vulnerable to over-exploitation.

For any resource, a relationship exists between resource capital, resource population size and sustainable rate of harvest. Low stocks are likely to produce small sustainable yields, particularly if the target species is slow growing and slow reproducing. Large stocks of species with a high biomass production and short time to reproductive maturity could be expected to produce high sustainable yields, particularly if competitive interaction is reduced by "thinning". The impact of gathering on the plant is also influenced by factors such as the part of the plant harvested and harvesting method.

Sustainable supplies of traditional medicines

Demand for fast growing species with a wide distribution, high natural population density and high percentage seed set can be met easily, particularly where leaves, seeds, flowers or fruits are used (Photo 7). The common sale and use of medicinal plant leaves as a source of medicine in Côte d'Ivoire and possibly other parts of west Africa (Photo 2) is therefore highly significant as it differs markedly from the high frequency of roots, bark or bulbs at markets in

Photo 7.
Medicinal plants
for sale at a market
in Bulawayo, Zimbabwe,
showing
the dominance of bark
and root material
as a source
of herbal medicines.

the southern African region (Photo 7). Throughout Lesotho, Malawi, Mozambique, Swaziland, Zambia, Zimbabwe, and particularly South Africa, herbal material that is dried (roots or bark), or has a long shelf-life (bulbs, seeds and fruits) dominates herbal medicine markets (see Appendix 1). In contrast, six sellers in Abidjan, Côte d'Ivoire, primarily sold leaf material (20-41 spp.), followed by roots (1-16 spp.), bark (0-8 spp) and whole plants (0-3 spp.). This situation was typical of the 111 traditional medicine sellers in Abidjan, apart from those bringing material from Burkina Faso and Mali, who sell more root and bark material. The situation with chewing stick sellers in Côte d'Ivoire and other parts of west Africa is somewhat different however, as stems and roots are the major plant parts used, with consequent higher impact on favoured species.

Despite limited information on the population biology of medicinal plants, it is possible to classify target plant species according to demand, plant life-form, part used, distribution and abundance (Cunningham, 1990). The large category of traditional medicinal plants which are under no threat at all are the cause of little concern to TMPs or to conservation biologists. For these species, demand easily meets supply. From a conservation viewpoint, on an Africa-wide scale, there are two categories of medicinal plants that are of concern:

(1) Slow growing species with a limited distribution which are the focus of commercial gathering where demand exceeds supply. Harvesting expands to areas progressively further afield, where rising prices for the target species are incentives to collect. This results in the species being endangered regionally and causes widespread depletion of the rural resource base of TMPs. Examples of this include *Warburgia salutaris* in east and southern Africa and *Siphonochilus aethiopicus* in Swaziland and South Africa. Endemic species with a very localized distribution are a particular problem, for example:
   (a) *Ledebouria hypoxidoides*, which is endemic to the eastern Cape region (South Africa). Herbalists were observed removing the last bulbs from the locality near Grahamstown (F. Venter, pers. comm.).
   (b) *Mystacidium millari*, also endemic to South Africa, which is threatened due to harvesting and commercial sale as a traditional medicine in the nearby city of Durban, South Africa (Cunningham, 1988a).

(2) Popular species which are not endangered because they have a wide distribution, but where habitat change through commercial harvesting is cause for concern. *Trichilia emetica* and *Albizia adianthifolia* for example, are not a high priority for conservation in southern Africa, although they are a popular source of traditional medicines. What is of concern however, is that ring-barking in "conserved" forests is causing canopy gaps and changing the forest structure, which can lead to an influx of invasive exotic species. This is important for local habitat conservation.

Both categories are of particular concern in protected area management, as core conservation areas will ultimately come under pressure from harvesting for favoured species if they are difficult to obtain elsewhere.

Information on the quantities of traditional medicines being harvested or sold is sparse,

whether for the local trade in traditional medicines, or for export and extraction of active ingredients. Apart from placing the quantities required from cultivation into perspective, the information available is of little relevance unless expressed in terms of impact on the species concerned. In South Africa, harvesting from wild populations of certain species is on a scale that gives cause for concern amongst conservation organizations and rural herbalists, and a listing of priority species is available (Cunningham, 1988a) (Box 2). The same applies to some chewing stick species, such as *Garcinia afzelii* in west Africa. The only quantitative data on the volume of plant material sold comes from Natal (South Africa), where medicinal plants are ordered by urban based herb traders in standard-size maize bags (Table 4).

Table 4. The quantities of the herbal medicines sold annually in the largest quantity (in standard 50 kg size maize bags) by 54 herb traders in the Natal region, South Africa. Although very popular, *Helichrysum odoratissimum* (Asteraceae) is excluded here as it is sold in large bales (Cunningham, 1990).

PLANT NAME	ZULU NAME	PART USED	QUANTITY
general term	Lawu, -ubu		1966
general term	Ntelezi, -i		1924
general term	Khubhalo, -i		1883
general term	Mbiza, -i		1211
Scilla natalensis	Guduza, -in	bulb	774
Eucomis autumnalis	Mathunga, -u	bulb	581
Alepidia amatymbica	Khathazo, -i	root	519
Adenia gummifera	Fulwa, -im	stem	459
Albizia adianthifolia	Solo, -u	bark	424
Cilvia miniata	Mayime, -u	bulb	397*
Clivia nobilis	Mayime, -u	bulb	397*
Pentanisia prunelloides	Cimamlilo, -i	root (lt)#	343
Senecio serratuloides	Sukumbili, -in	leaves/stem	340
Gunnera perpensa	Gobho, -u	root	340
Rapanea melanophloeos	Maphipha-khubalo, -u	bark	327
Dioscorea sylvatica	Ngwevu, -i	whole plant	326
Warburgia salutaris	Bhaha, -isi	bark	315
*Bersama species**	Diyaza, -un	bark	295
unidentified species	Bhadlangu, -u	root	288
Kalanchoe crenata	Mahogwe, -u	leaves/stem	284
Boweia volubilis	Gibisila, -i	bulb	257
Trichilia emetica (& T. dregeana)	Khuhulu, -um	bark	252
Turbina oblongata	Bhoqo, -u	root	249
Rhoicissus tridentata	Nwazi, isi	root	244
Bulbine latifolia	Bhucu, -i	bulb	240
Ocotea bullata	Nukani, -u	bark	234
Stangeria eriopus	Fingo, -im	root (lt)#	233
*Cryptocarya species***	Khondweni, -um	bark	228
Anemone fanninii	Manzemnyama, -a	root	227
Eucomis sp. cf. bicolor	Mbola, -i	bulb	224
Rhus chirindensis	Yazangoma-embomvu	bark	222
Helinus integrifolius	Bhubhubhu, -u	stem	222
Schotia brachypetala	Hluze, -i	bark	220
Vernonia neocorymbosa	Hlunguhlungu, -um	leaves/stem	216
Dioscorea dregeana	Dakwa, -isi	whole plant	212
Ornithogalum longibracteatum	Mababaza, -u	bulb	208
Erythrophleum lasianthum	Khwangu, -um	bark	201
Solanum aculeastrum	Tuma, -in	fruit	198
Curtisia dentata	Lahleni, -um	bark	197

* *Bersama* species = *B. tysoniana*, *B. lucens*, *B. stayneri* and *B. swynii*
** *Cryptocarya latifolia* and C. *myrtifolia*
\# root (lt) = root (ligno-tuber)

Sustainability of chewing stick harvesting

Chewing sticks are obtained from wild populations of indigenous plants, apart from the infrequent sale of exotic species such as *Azadirachta indica* and *Citrus sinensis* (Appendix 1). *Garcinia afzelii* is considered to be threatened by this trade (Ake Assi, 1988b; Gautier-Beguin, pers. comm.). In Nigeria, Okafor (1989) reports that *Randia acuminata* chewing sticks are still collected from primary and secondary forest within 3 km of villages, but that the distance is increasing, which indicates that the resource is being depleted. At a single depot, for example, Okafor (1989) recorded that five commercial chewing stick collectors assembled 1144 bundles of chewing sticks, made up of seven or eight split stems one metre long per bundle. What is highly significant from a resource management viewpoint, and has not been taken into account previously, is that whilst peeled twigs are used as chewing sticks from most species, split stems and roots are the source of the commercially sold chewing sticks. Among the 27 species used in Ghana, for example, high impact harvesting of stem wood or root material from only seven species accounted for 88% of chewing sticks used. The low impact use of peeled twigs as chewing sticks accounted for the other 12 % of sticks used and for the remaining 20 species (Ake Assi, 1988b). Impact on those source species which are cut down or up-rooted to supply urban demand is therefore high.

Supplying international trade

Few data are available on the quantities of raw material harvested for the pharmaceutical trade, or the environmental impact of harvesting. It is clear however that large quantities of material are collected from the wild and that harvesting can be very destructive. The same can apply to plant material collected for screening purposes. Juma (1989) offers the example of *Maytenus buchananii:* 27.2 tons of plant material were collected by the American National Cancer Institute (NCI) from a conservation area in the Shimba Hills (Kenya), for screening purposes as a potential treatment for pancreatic cancer. When additional material was required four years after the first harvesting in 1972, regeneration was so poor that collectors struggled to obtain the additional material needed.

No studies are known to have been carried out on the social or environmental consequences of harvesting, for example:

(1) the 75-80 t of *Griffonia simplicifolia* seed exported each year to Germany from Ghana (Abbiw, 1990);
(2) the medicinal plant material exported from Cameroon to France (*Voacanga africana* seed (575 tons); *Prunus africana* bark (220 tonnes), *Pausinystalia johimbe* bark (15 t) (United Republic of Cameroon, 1989).

However, Ake-Assi (pers. comm.) reports that commercial gatherers in Côte d'Ivoire chop down *Griffonia simplicifolia* vines and *Voacanga africana* and *Voacanga thouarsii* trees in order to obtain the fruits. Concern has been expressed about a similar situation in Indonesia, where Rifai and Kartawinata (1991) point out that:

"Export of medicinal plants has been going on for many years, and the demand in the international market keeps increasing. One big Swiss pharmaceutical company, for example, has requested eight tons of seeds of *Voacanga grandifolia* and are willing to pay a high price. This species is rare and has light seeds. To satisfy the above request, all available seeds in the forest will perhaps have to be harvested, leaving nothing for regeneration. Similarly, five tons of rhizomes of a rare *Curcuma* (tema badur) has been sought by a West German pharmaceutical company, and 100 kg year-1 of pili cibotii (fine hairs of *Cibotium barometz*) by a French firm. It can be imagined how many plants of these species will have to be destroyed should such requests be satisfied."

If the international companies involved in this trade are to operate in a responsible manner, then this situation needs to change to one of commercial cultivation and sustainable use.

The real price of trade

The categories of medicinal plant species that are most vulnerable to over-exploitation can be identified by combining the insights of herbal medicine sellers with knowledge on plant biology and distribution (Cunningham, 1990). However, due to the number of species involved and the limited information on biomass, primary production and demography of indigenous medicinal plants, no detailed assessment of sustainable off-take from natural populations is possible. Even if these data were available, their value would be questionable due to the intensive management inputs required for managing sustainable use of vulnerable species in cases where demand exceeds supply.

Unsustainably high levels of exploitation are not a new problem, although the problem has escalated in regions with large urban areas and high levels of urbanization since the 1960s.

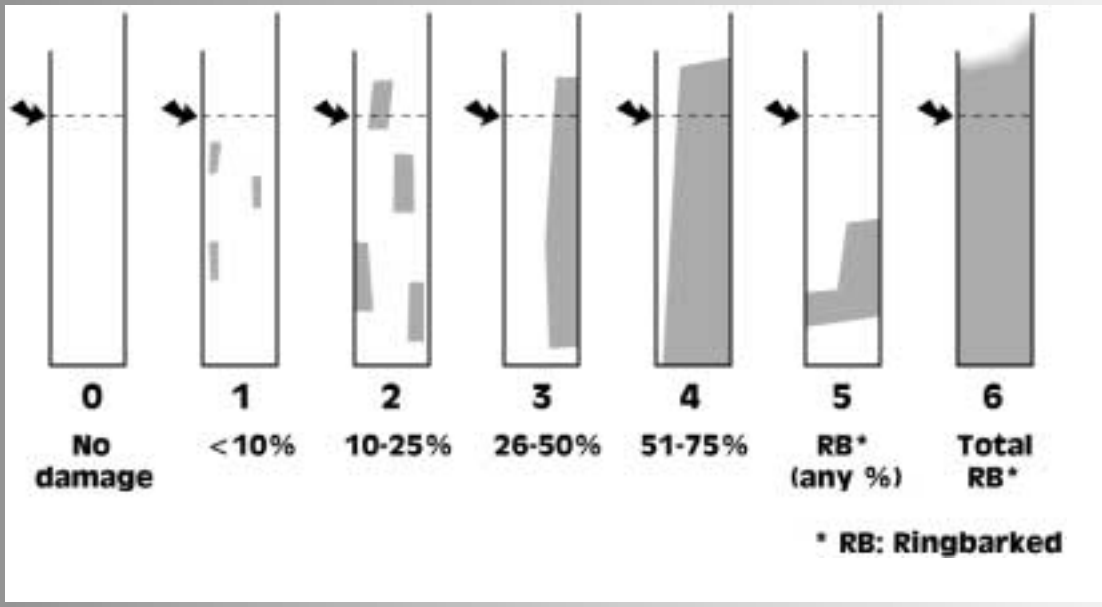


Figure 4. The seven-point scale used in field assessment of bark damage. All assessments represent the degree of bark removal below head height (2 m), which is marked by the dotted line and arrow in the figure (Cunningham, 1988a).

Prior to 1898, local extermination of *Mondia whitei* had been recorded in the Durban area of South Africa due to collection of its roots "which found a ready sale in stores". By 1900, *Siphonochilus natalensis* (an endemic species now considered synonymous with *Siphonochilus aethiopicus*; Gibbs-Russell *et al*., 1987) had disappeared from its only known localities in the Inanda and Umhloti valleys due to trade to Lesotho. This occurred despite a traditional seasonal restriction on harvesting this species. By 1938, all that could be found of *Warburgia salutaris* in Natal and Zululand was "poor coppices, every year cut right down to the bottom" (Gerstner, 1938). Most botanical and forestry records reflect the impact of commercial collection of *Ocotea bullata* bark due to the importance of this species for timber. Oatley (1979) for example, estimated that less than 1% of 450 trees examined in Afro-montane forest in South Africa were undamaged, and in the same region, Cooper (1979) estimated that 95% of all *Ocotea bullata* trees had been exploited for their bark, with 40% ringbarked and dying. The situation would appear to be similar in Kenya, where Kokwaro (1991) records that some of the largest *Warburgia salutaris* and *Olea welwitschii* trees have been completely ring-barked and have died. In Zimbabwe, due to the high demand and limited distribution of this species, the situation is worse, and all that remains of wild *Warburgia salutaris* populations are a few coppice shoots (S. Mavi pers. comm., 1990). In Côte d'Ivoire, *Garcinia afzelii* is considered threatened due to harvesting for the chewing stick trade (Ake Assi, 1988b). Destructive harvesting of *Griffonia simplicifolia*, *Voacanga thuoarsii* and *Voacanga africana* fruits for the international pharmaceutical market is also of concern (L. Ake-Assi, pers. comm., 1989). In Sapoba Forest Reserve, Nigeria, despite traditional restrictions on bark removal, Hardie (1963) observed how the trunk of a large *Okoubaka aubrevill*ei tree (a very rare species in west Africa) "was much scarred where pieces of bark had been removed". There appears to be nothing published on the current status of this species. Botanical records are also scanty for bulbous or herbaceous species, where little remains to indicate former occurrence after the plant has been removed. It would therefore be useful to carry out damage assessments for species such as:

(1) *Okoubaka aubrevillei*, *Garcinia afzelii*, *G. epunctata*, and *G. kola* in Côte d'Ivoire , Ghana, and Nigeria;
(2) *Warburgia salutaris* in Kenya, Tanzania and Zimbabwe;
(3) assessments of the impact of *Prunus africana* and *Pausinystalia johimbe* bark harvesting in Cameroon and Madagascar, and fruit harvesting of *Griffonia simplicifolia*, *Voacanga thuoarsii* and *Voacanga africana* for the international pharmaceutical market.

Table 5. The top 15 medicinal plant species nominated as becoming scarce by herb traders in South Africa (n = 44)

SPECIES	ZULU NAME	PERCENTAGE	No. of traders
Warburgia salutaris	isibaha	90	40
Boweiea volubilis	igibisila	84	37
Siphonochilus aethiopicus	indungulo	68	30
Eucomis species	umathunga	64	28
Ocotea bullata	unukane	61	27
Hawarthia limifolia	umathithibala	55	24
Synaptolepis kirkii	uvuma-omhlophe	52	23
Scilla natalensis	inguduza	36	16
Eucomis species?	imbola	34	15
Erythrophleum lasianthum	umkhwangu	32	14
?	uvuma obomvu	32	14
Curtisia dentata	umlahleni	27	12
?	uphindemuva	27	12
Asclepias cucullata	udelenina	27	12
Cinnamomum camphora	uroselina	25	11
Begonia homonymma	idlula	25	11

In South Africa, bark damage assessments using a 7-point scale (Figure 4) were carried out for key "indicator species" (medicinal plants chosen for their relatively slow growth rate - all were trees), popularity as a source of traditional medicines, their scarcity (all were forest species, and indigenous forest only covers 0.3% of South Africa), and where bark removal took place.

Bark damage assessments confirmed most of the observations of herbalists and herb traders (Tables 5 and 6), the exceptions being species that were scarce not because of over-exploitation, but due to limited geographical distribution in the region, such as *Acacia xanthophloea* and *Synaptolepis kirkii*. They also demonstrate the very different situation to customary subsistence use, and this fact needs to be taken into account in legislation covering protected area management where conservation of biotic diversity is a primary objective. Although the degree of bark damage varies, the level at all sites where commercial gathering is taking place is high and concentrates on large diameter size classes. What is significant is that extensive damage has taken place in State

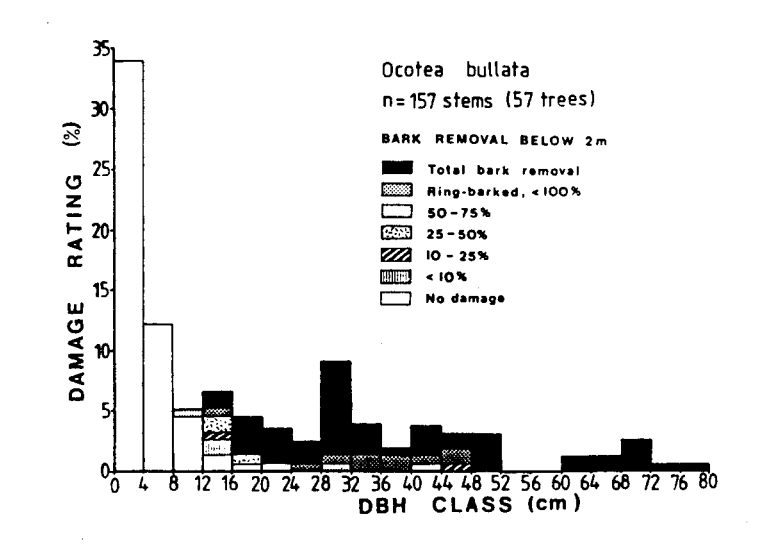
Table 6. The top 15 medicinal plant species nominated as becoming scarce by rural herbalists in South Africa (n = 20)

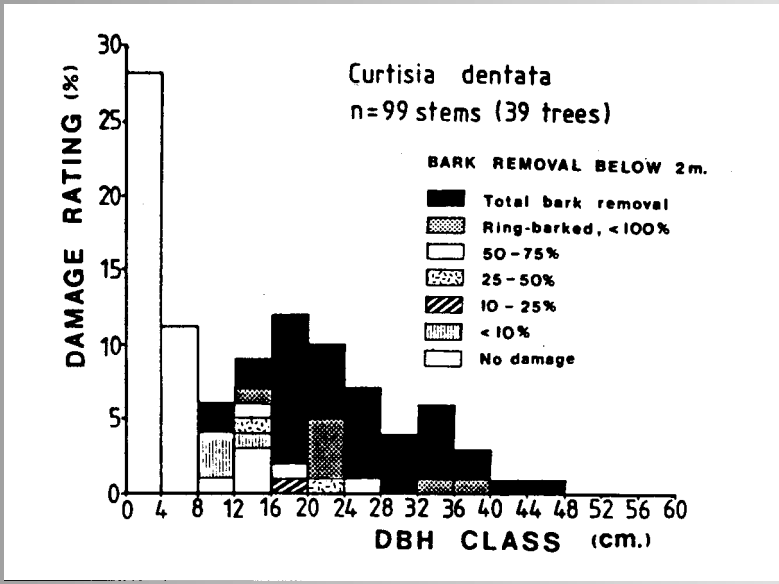
SPECIES	ZULU NAME	PERCENTAGE	No. of traders
Ocotea bullata	unukane	90	18
Warburgia salutaris	isibaha	85	17
Boweiea volubilis	igibisila	70	14
Scilla natalensis	inguduza	65	13
Helichrysum species	imphepho	60	12
Eucomis species	umathunga	55	11
Hawarthia limifolia	umathithibala	55	11
Cassine transvaalensis	ingwavuma	55	11
Alepidia amatymbica	ikhathazo	50	10
Pimpinella caffra	ibheka	45	9
Acacia xanthophloea	umkhanyakude	45	9
Curtisia dentata	umalhleni	45	9
Gunnera purpensa	ugobho	45	9
Cassine papillosa	usehlulamanye	45	9

Forest, theoretically set aside for maintenance of habitat and species diversity (Figure 5). In the eMalowe State Forest, Transkei, South Africa, if coppice stems less than 2 cm diameter are excluded, then the level of damage to *Curtisia dentata* and *Ocotea bullata* trees encountered represents 51% and 57% of trees having more than half the trunk bark removed. All *Warburgia salutaris* trees found outside strict conservation areas in Natal were ring-barked, and many of those inside conserved areas had their bark removed as well.

Even fewer data are available on the impact of harvesting bulbs, roots or whole plants although local depletion of *Stangeria eriopus*, *Gnidia kraussiana* and *Alepidea amatymbica* is known from Natal, South Africa. According to C. Stirton (pers. comm.) there has also been a marked reduction in numbers of the Afro-montane forest climber *Dumasia villosa*, which is sold in large quantities in herbal medicine shops (Cunningham, 1988a). C. Hines (pers. comm.) has similarly recorded exploitation of *Protea gauguedi* populations to the

Figure 5. Damage to selected tree species in "protected" forest reserves where commercial bark exploitation is taking place:
Ocotea bullata (Lauraceae) and *Curtisia dentata* (Cornaceae) in eMalowe Forest Reserve, South Africa. (Cunningham, 1988a). Note the selection for bark from large trees. DBH = stem diameter at breast height.





point that, with the possible exception of the eastern Caprivi, the species could be considered extinct in northern Namibia despite attempts by the conservation department to protect it. What is noteworthy in this case is that it has taken place in response to a local trade in an area where urban centres are small. Commercial harvesting of Harpagophytum procumbens tubers in Botswana removed up to 66 % of plants (Leloup, 1984). In Nambia, however, this species was not considered threatened as the 200 t exported each year only represented 2% of total stocks (de Bruine *et al*., 1977).

Increasing scarcity of popular species is followed by a increased price, which in turn results in greater incentives to harvest remaining stocks. The effects of this are firstly, decreased self-sufficiency of traditional medical practitioners as local sources of favoured species decline, and secondly, higher prices which people have to pay for those species. As demand is a one of the root causes of over-exploitation, the most popular and effective species are the most vulnerable.

The reasons for concern

In spite of increasing urbanization, a large proportion of the African population has retained their reliance upon this traditional approach to healthcare and continue to consult TMPs for medical treatment. Even where western medicine is available, it is unlikely that it will be adopted without first establishing a framework for national economic growth which would allow for socio-economic and cultural changes to take place, and give access to formal education. Good (1987) writes:

"Although most countries in Africa routinely allocate substantial portions of their budgets to health services and related infrastructure such as water supplies, sanitary works and roads, sustained improvements in community health status and increased accessibility to government and private health services have not materialized. Instead, health ministries find themselves preoccupied just with preventing the deterioration of existing "aspirin and bandage" services."

In reality, most African countries are experiencing an unprecedented economic deterioration with per capita income having fallen by an average of 0.4% since 1986, and Africa's debt being roughly three times greater than its export revenue. The heavy reliance upon traditional medicine therefore is unlikely to change. At the same time, there is significant evidence to show that the supply of plants for traditional medicine is failing to satisfy demand. This problem has been exacerbated by three main factors:

(1) A high rate of population growth and urban expansion, generating an informal and growing species-specific trade network which extends across international boundaries.

(2) The change from medicinal plant harvesting being a purely specialist activity of TMPs, to one involving an informal sector group of commercial plant harvesters whose prime motivation is profit. This is a response to increased population and greater demand and is resulting in a disregard for traditional conservation practice and a breakdown of taboos and customs in the opportunistic scramble for divining supplies. High unemployment means that labour is plentiful and cheap, keeping prices low and sales high. In the case of medicinal plants which are harvested and exported for the pharmaceutical industry, the price is kept artificially low through price agreements and does not reflect the resource replacement costs.

(3) A decline in the total area of natural vegetation as a source of supply for medicinal plants has occurred partly as a result of competition for the land for other uses such as forestry, agriculture, fuel supply, etc., and partly due to the commercial over-exploitation of the medicinal plant themselves. Examples where over-exploitation has occurred include *Monanthotaxis capea* which was formerly harvested for its aromatic leaves and traded from Côte d'Ivoire to Ghana. It is now extinct in the wild after its last remaining habitat in a forest reserve was declassified and cleared for agriculture. *Pericopsis alata* in Côte d'Ivoire and *Pericopsis angolensis* in Zambia and Malawi have both been affected by timber logging and *Griffonia simplicifolia* in west Africa has been affected by commercial harvesting for export for the production of western pharmaceuticals.

Focus of management effort

The need in Africa for institution building, and better staffing and funding of herbaria, particularly in high conservation priority areas is well known (Davis *et al*., 1986; Hedberg and Hedberg, 1968; Kingdon, 1990; Leloup, 1984). There is a great need for international co-operation to conserve large regions of high biotic diversity with small human populations such as Guineo-Congolian forest of the Zaire Basin. However, medicinal plant resource management problems exist not in these areas but in densely populated and rapidly urbanizing regions, and it is here that reaching a balance between human needs and medicinal plant resources is most urgent. This involves:

(1) identification of habitat with a high density of endemic families, genera and species with medicinal properties;
(2) pro-active management effort around core conservation areas through interaction with resource users and provision of alternatives to wild populations of threatened species; this would include species that are a high conservation priority on a national scale. In the areas visited, a preliminary listing is given in Box 2.

Sites that are a conservation priority from a more general species conservation viewpoint may therefore not be a priority with regard to conservation of traditional medicinal plants. From surveys of medicinal plant markets in selected African countries for example, it is clear that while the Cape Floral region (which is of high conservation priority due to the large number and proportion of endemic species) is not under threat from the herbal medicine trade, but from habitat destruction.

From human demography data, we know that the west and southern African regions have highest rates of urbanization. We also know that the bigger the urban settlement, the larger the traditional medicine markets (Table 2). At a macroscale, priority areas for resource management action can be determined through mapping overlay of the main African phytochoria (Figure 6), where information is known on numbers of endemic plants, birds and mammals (Table 7) with the major urban growth points (Figure 7). As discussed previously, (Cunningham, 1990), demand is most likely to exceed supply for slow growing, slow reproducing species with specific habitat requirements (primarily forest trees).

Box 2. Preliminary listing of high conservation priority traditional medicinal plant species in countries visited during this survey.

1. COTE D'IVOIRE (see Ake-Assi, 1988)

EXTINCT IN THE WILD

Monanthotaxis capea (Annonaceae) - aromatic leaves used for washing for cosmetic purposes.

VULNERABLE AND DECLINING

Garcinia afzelii (Clusiaceae) - favoured and important source of chewing sticks in Ghana, Côte d'Ivoire and Nigeria.

Garcinia kola (Clusiaceae) - more widespread than *G. afzelii*, but also heavily exploited as a source of chewing sticks (Ake Assi, 1988).

Okoubaka aubrevillei (Oknemataceae) - used symbolically to ward off evil spirits. Potent allelopathic effect on most surrounding plants. Endemic family to Guineo-Congolian region. Potential source of new and interesting organic compounds.

NOTES : Also important are the following species with medicinal properties (Ake Assi, 1983; Ake Assi, 1988): *Diospyros tricolor* (Ebenaceae), a source of naphthoquinones; *Rhigiocarya peltata* (Menispermaceae); in the family Fabaceae; the tree species *Haplormosia monophylla*, *Loesenera kalantha* (genus *Loesenera* endemic to Guineo-Congolian region), and *Afrormosia elata* which has been heavily logged for timber, Apocynaceae; *Strophanthus barteri* and *S. thollonii*. The status of *Epinetrum undulatum* (Ebenaceae), a rare species occurring in the mountains near Man, north-west Cote d'Ivoire whose roots are used in traditional medicine also needs to be investigated.

2. ZAMBIA

Although local over-exploitation of *Eulophia petersiana* (Orchidaceae) (restricted to limestone outcrops; used as a lucky charm and for a "swollen stomach") and possibly *Selaginella imbricata* (Selaginellaceae) (also a limited distribution, used as a lucky charm to prevent one from being wasteful (particularly with money) due to the "closed hand" shape of the leaves) may occur, and numbers of *Pterocarpus angolensis* (Fabaceae) (roots used to treat diarrhoea and abdominal pains) have declined around Lusaka due to demand for timber, no species are threatened by the herbal medicine trade at this stage due to the low human population density and relatively small size of the urban population.

Forests also contain a high number of medicinal plant species, yet represent a small (and declining) proportion of total land area in the eastern section of Africa and trees are often subject to

3. MOZAMBIQUE

Local over-exploitation of some species on Inhaca island, but as in the Zambian example, no species known to be threatened on a national scale due to the relatively small urban population and low population density.

4. ZIMBABWE

ENDANGERED

Warburgia salutaris (Canellaceae) - only known at present from a few small coppice shoots found in the Mhangura Forest, Eastern Highlands, Zimbabwe (S.Mavi, pers. comm.) where it was heavily exploited for commercial purposes (national trade to urban centres and rural TMPs) as well as by guerillas sheltering in the forests during the war, as access to pharmaceutical medicines very limited. Bark is used as a panacea for all ills, and specifically for headaches, abdominal pains, an abortifacient and to treat venerial disease (Gelfand et al., 1985). Widely acknowledged to be scarce, and probably the most expensive traditional medicine sold in Zimbabwe.

VULNERABLE AND DECLINING

Alepidea amatymbica (Apiaceae) - very limited distribution in Zimbabwe (a few localities in the eastern Highlands, yet sold in small quantity at all markets visited during this survey, where it is widely acknowledged to be becoming scarce. Although this species is heavily exploited in South Africa, leading to local disappearance of this resource in some cases, it is far more widespread there than in Zimbabwe.

NOTES : *Spirostachys africana* (Euphorbiaceae) (wood burnt and smoke inhaled to drive away bad spirits) was also regularly mentioned by herbalists during this survey as a species that was becoming scarce. This is a reflection of the limited distrubition of this tree in Zimbabwe, although the species is widespread in southern Africa. Local over-exploitation due to demand for the timber is a more likely threat than the herbal medicine trade. Of more concern in terms of local depletion of stocks is the commercial scale collection of *Erythrophleum suaveolens* (Fabaceae) bark for sale in Mbare market, Harare as the species is limited to the eastern section of Zimbabwe. It is also a highly toxic species which is used as an ordeal poison. The status of *Phyllanthus engleri* (Euphorbiaceae) populations also needs investigation,as this is a high priced species mentioned by a few herbalists as being scarce.

5. SWAZILAND

VULNERABLE AND DECLINING

Warburgia salutaris (Canellaceae) - used for coughs, colds, upset stomach and as a snuff for headaches.

Alepidea amatymbica (Apiaceae) - used for coughs and colds.

Siphonochilus aethiopicus (Zingiberaceae) - used for coughs and colds, as well as for proection against lightning.

All of the above species were recorded in this survey as being heavily exploited for local demand as well as in response to the urban demand in South Africa. According to local herbalists, *Siphonochilus aethiopicus* has disappeared from known localities outside Malolotja Nature Reserve, Swaziland.

6. MALAWI

VULNERABLE AND DECLINING

Dioscorea sylvatica (Dioscoreaceae)

Cassia species (known locally as muwawani) - used for stomach ailments and to treat venereal disease.

Local over-exploitation of *Erythrophleum suaveolens*, *Erythrina abyssinica* (Fabaceae), and an unidentified species known locally as kakome is an emerging problem.

7. SOUTH AFRICA (Cunningham, 1990)

EXTINCT IN THE WILD

Siphonochilus natalensis (Zingiberaceae) - note that although this species is listed separately to *Siphonochilus aethiopicus* (Zingiberacae) in the latest national plant list (Hardie, 1963), the two species are now considered to be synonymous (R M Smith; pers. comm).

removal of bark or roots rather than leaves for medicinal preparations (e.g. Kenya, where forest reserves cover 2.7%; Tanzania, 1-2%; South Africa, 0.3%; (Cooper, 1985; Davis *et al.*, 1986; Kokwaro, 1991). The urgent challenge is therefore to meet the increasing demand from rapidly growing urban areas, restore the self-sufficiency of TMPs affected by this trade,

ENDANGERED

Warburgia salutaris (Canellaceae) - used for coughs, colds, as a snuff for headaches (powdered bark mixed with bark from *Erythrophleum lasianthum* (Fabaceae).

Siphonochilus aethiopicus (Zingiberaceae) - used for coughs and colds, to treat hysteria, "sprinkling medicine" for good crops and to keep away lightning.

VULNERABLE AND DECLINING

Dioscorea sylvatica (Dioscoreaceae) - tuber used as a douche for swollen udders of cattle, for chest complaints and for magical purposes.

Bersama tysoniana (Melianthaceae) - bark used by diviners together with saponin rich species such as *Helinus integrifolius* in an ubulawu mix to enable them to interpret dreams clearly.

Ocotea bullata (Lauraceae) - used for symbolic purposes to make a person "smell and become unpopular".

Ocotea kenyensis (Lauraceae) - use as above.

Curtisia dentata (Cornaceae) - red coloured bark used for magical purposes. Use unknown and kept very secret.

Pleurostylia capensis (Celastracaeae) - use unpublished.

Faurea macnaughtonii (Proteaceae) - bark used to treat menstrual pains, also for tuberculosis.

Loxostylis alata (Anacardiaceae) - use not recorded.

Mystacidium millarii (Orchidaceae) - not a species specific use. Common Mystacidium capense not distinguished by herbalists as different. Both species (and many other epiphytes used for symbolic purposes).

Ledebouria hypoxidoides (Liliaceae) - bulbs used to prepare enemas.

NOTE : Traditional medicinal plants in other categories are given in Cunningham 1988b; 1990. Particularly noteworthy are *Anemone fanninii* (Ranunculaceae) and *Stangeria eriopus* (Stangeriaceae), endemic to south-eastern Africa (declining).

and provide acceptable alternative resources outside increasingly fragmented core conservation areas to stop over-exploitation of favoured species inside them.

Conditions for cultivation as an alternative source of supply

Commercial gatherers of medicinal plant material, whether for national or international trade, are poor people whose main aim is not resource management but earning money.

Cultivation as an alternative to over-exploitation of scarce traditional medicinal plants was suggested over 50 years ago in South Africa for scarce and effective species such as Alepidea amatymbica (Gerstner, 1938) and *Warburgia salutaris* (Gerstner, 1946). Until two years ago, no large scale cultivation had taken place. There are two main reasons for this, and both apply elsewhere in Africa:

(1) lack of institutional support for production and dissemination of key species for cultivation;

(2) the low prices paid for traditional medicinal plants by herbal medicine traders and urban herbalists.

If cultivation is to be a success as an alternative supply to improve the self-sufficiency of TMPs and take harvesting pressure off wild stocks, then plants have to be produced cheaply and in large quantity. Any cultivation for urban demand will be competing with material harvested from the wild that is supplied onto the market by commercial gatherers who have no input costs for cultivation. Prices therefore increase with scarcity due to transport costs, search time and the long-distance trade. At present, low prices (whether for local or international pharmaceutical trade) ensure that few species can be marketed at a high enough price to make cultivation profitable. Even fewer of the potentially profitable species are in the category most threatened by over-exploitation.

At present, cultivation of herbs and medicinal plants is chiefly restricted to temperate areas (Staritsky, 1980) and with the exception of India (Kempanna, 1974) and Nepal (Malla, 1982), few tropical countries have investigated the potential of cultivating medicinal plants on a commercial scale. Cultivation of herbs and medicinal plants is widespread in eastern Europe, but even where cultivation is well developed, such as in the Russian Federation, about half of the supplies are gathered from wild populations (Staritsky, 1980). In all cases where cultivation has taken place, whether in Europe, Asia or Africa, plants have been grown for profit or a high level of resource returns

(e.g. multiple use species for fruits, shade and medicinal properties) and are either fast growing species, or plants where a sustainable harvest is possible (e.g. resins (*Bosweilia*), leaves (*Catha edulis*).

With few exceptions, prices paid to gatherers are very low, taking no account of annual sustainable off-take. In many cases, medicinal plants are also an open access, rather than a limited access or private resource. To make a living, commercial medicinal plant gatherers therefore "mine" rather than manage these resources. If cultivation of tree species is to be a viable proposition as an income generating activity then either:

(1) the flood of cheap bark/roots "mined" from wild stocks is reduced through better protection of conserved forests in order to bring prices to a realistic level; or,
(2) wild populations will have to decline further before cultivation is a viable option.

Cultivation for profit is therefore restricted to a small number of high priced and/or fast growing species (Box 3).

Although some of these species are threatened in the wild (e.g. *Garcinia afzelii* and *Warburgia salutaris*), low prices ensure that few slow growing species are cultivated. With the declining economic state of many African countries, it is unlikely that subsidized production of these species is likely to occur, and collection of seed or cuttings for establishment of field-gene banks (for recalcitrant fruiting species) and seed banks must therefore be seen as an urgent priority.

Strong support and commitment are necessary if cultivation is to succeed as a means of meeting the requirements of processing plants for pharmaceuticals (whether for local consumption or export) or urban demand for chewing sticks and traditional medicinal plants. If cultivation does not take place on a large enough scale to meet demand, it merely becomes a convenient bit of "window dressing", masking the continued exploitation of wild populations. The regional demand for wild *Scilla natalensis* (Liliaceae) in Natal, South Africa is 300 000 bulbs yr-1, all at least 8-10 years old. On a 6-year rotation under cultivation at the same planting densities as Gentry *et al*., (1987) used for *Urginea maritima*, 70 ha would be required (Cunningham, 1988a). Due to their slow growth rates, the rotational area required for tree species would be far greater, with total area dependent on demand.

The success of cultivation also depends on the attitude of TMPs to cultivated material, and this varies from place to place. In Botswana, TMPs said that cultivated material was unacceptable, as cultivated plants did not have the power of material collected from the wild (F. Horenburg, pers. comm.). Discussions with some 400 TMPs in South Africa over a two year period showed general acceptance of cultivated material as an alternative. Similarly, TMPs in the Malolotja area of Swaziland accepted cultivation as a viable alternative. In both countries there is a tradition of growing succulent plant species near to homesteads to ward off lightning. Similarly, in Ghana, plants of spiritual significance such as *Datura metel*,

Table 7. The seven centres of endemism in Africa, with numbers of seed plants, mammals (ungulates and diurnal primates) and passerine bird species in each, and the percentage of these endemic to each unit (after MacKinnon and MacKinnon, in press)

BIOGEOGRAPHIC UNIT	AREA ($1\,000\ km^2$)	PLANTS		MAMMALS		BIRDS	
		No. of species	% endemic	No. of species	% endemic	No. of species	% endemic
Guineo-Congolian	2 815	8 000	80	58	48	655	36
Zambesian	3 939	8 500	54	55	4	650	15
Sudanian	3 565	2 750	33	46	2	319	8
Somali-Masai	1 990	2 500	50	50	14	345	32
Cape	90	8 500	80	14	0	187	4
Karoo-Namib	629	3 500	50	13	0	112	9
Afro-montane	647	3 000	75	50	4	220	65

Pergularia daemia, *Leptadenia hastata* and *Scoparia dulcis* are tended around villages. Therefore, although little is known about attitudes to cultivation of medicinal plants in west Africa, it is possible that TMPs would be in favour of cultivation of alternative supply sources.

An interesting model is provided in Thailand where a project for cultivation of medicinal plant of known efficacy has been initiated in about 1000 villages and traditional household remedies, with improved formulae, are produced as compressed tablets packed in foil and distributed to "drug co-operatives" set up through a Drug and Medical Project Fund in more than 45 000 villages as well as in community hospitals (Desawadi, 1991). Wondergem et al. 1989; WHO, 1977) have already drawn on the Thailand experience in making recommendations regarding primary healthcare in Ghana.

Box 3. Medicinal plant species which are in high enough demand and short enough supply to have commercial production potential.

ZIMBABWE
Warburgia salutaris (Canellaceae)*
Alepidea amatymbica (Apiaceae)
Cassia abbreviata (Fabaceae)

SWAZILAND
(for local market and for export to South Africa)
Warburgia salutaris (Canellaceae)*
Alepidea amatymbica (Apiaceae)
Haworthia limifolia (Liliaceae)
*Siphonochilus aethiopicu*s (Zingiberaceae)

SOUTH AFRICA
Pimpinella caffra (Apiaceae)
Asclepias cucullata (Asclepiadaceae)
Begonia homonymma (Begoniceae)
Dianthus zeyheri (Illecebraceae)
Plectranthus grallatus (Lamiaceae)
Haworthia limifolia (Liliaceae)
Boweia volubilis (Liliaceae)
Siphonochilus aethiopicus (Zingiberaceae)
Warburgia salutaris (Canellaceae)*
Alepidea amatymbica (Apiaceae)

COTE D'IVOIRE
Garcinia afzellii (Clusiaceae)*
Monanthotaxis capea (Annonaceae)

MALAWI
Cassia (unidentified species known as muwawani)
Unidentified species known as kakome

NIGERIA
Garcinia afzelii (Clusiaceae)*
Garcinia mannii (Clusiaceae)*

* trees/shrubs with agro-forestry potential.

Figure 6.
The main African phytochoria (after White, 1983) showing one high conservation priority area ▭ and focal priority areas for action on medicinal plant conservation ■ .

I. Guineo-Congolian regional centre of endemism.
II. Zambezian regional centre of endemism.
III. Sudanian regional centre of endemism.
IV. Somalia-Masai regional centre of endemism.
V. Cape regional centre of endemism.
VI. Karoo-Namib regional centre of endemism.
VII. Mediterranean regional centre of endemism.
VIII. Afromontane archipelago-like centre of endemism (including IX, Afroalpine archipelago-like region of extreme floristic impoverishment, not shown separately).
X. Guinea-Congolia/Zambezia regional transition zone.
XI. Guinea-Congolia/Sudania regional transition zone.
XII. Lake Victoria regional mosaic.
XIII. Zanzibar-Inhambane regional mosaic.
XIV. Kalahari-Highveld regional transition zone.
XV. Tongaland-Pondoland regional mosaic
XVI. Sahel regional transition zone.
XVII. Sahara regional transition zone.
XVIII. Mediterranean/Sahara regional transition zone.

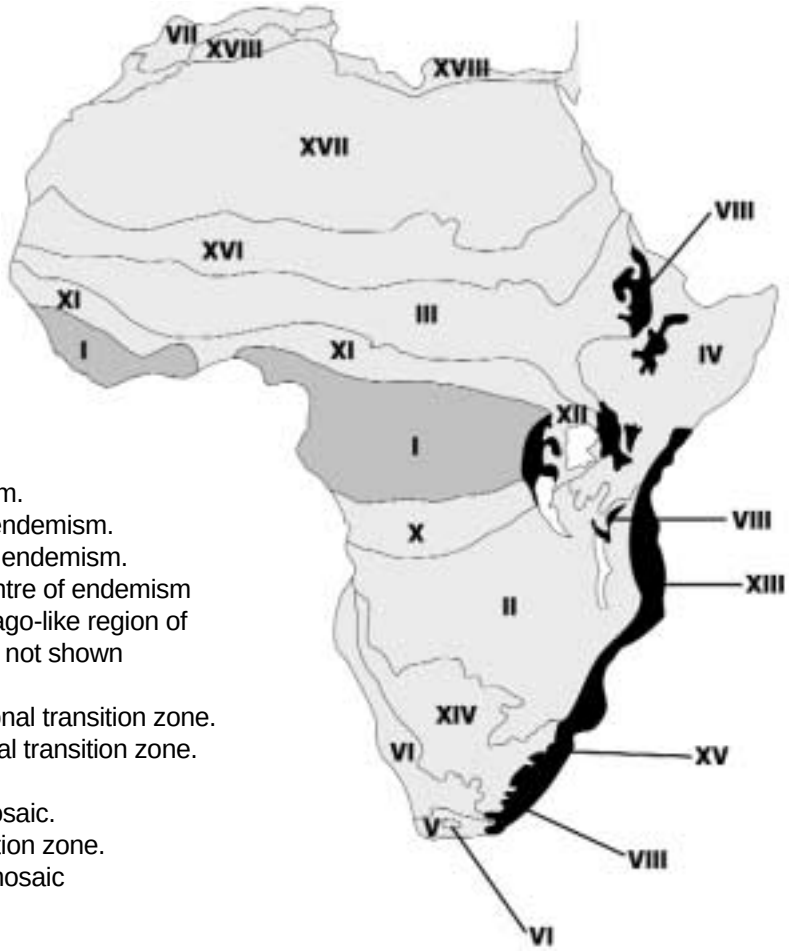


Figure 7.
The relative size and distribution of major urban centres in sub-Saharan Africa (after Udo, 1982).

Policy priorities for conservation and primary healthcare

Key issues

In order to ensure the effective conservation of African plants which have medicinal value, the recommendations recognize the importance of the following two issues:

(1) the destruction of natural habitat through agricultural expansion, logging, plantations, dam construction, urban associated development, etc.;
(2) the over-exploitation of particular plant species to satisfy demand e.g. *Warburgia salutaris* in South Africa, Swaziland and Zimbabwe.

Conservation strategy

The conservation strategy for African medicinal plants must address the problem at two levels: recommendations which have socio-economic effects must be incorporated at the policy level and recommendations for conservation methodology must be addressed at the national and local levels. The recommendations cover the following areas:

(1) international and national policy;
(2) *in-situ* and *ex-situ* conservation methods;
(3) education and research.

Policy recommendations

International and national policy

Policies made at both the international and national level will have substantial effects on the success of an overall conservation strategy through the easing of wealth inequalities between nations. International policies such as trade and tariff agreements, GATT and EEC subsidized imports all aim to make trading between wealthier and poorer nations easier: in addition, international aid and financial support by such bodies as the World Bank plays an important role. At the national level, policies affecting agricultural expansion, plantations, urban and industrial developments, education, employment, healthcare, the provision of social services and funding affect the potential success of any conservation strategy.

The policy making process should:

(1) recognize the international and national price paid for habitat destruction, including the loss of medicinal plant resources and a reduced quality of healthcare;
(2) ensure that commodity prices at both the national and international levels are realistic enough to reflect the cost of resource replacement;
(3) ensure that incentives exist for the sustainable management of medicinal plant resources;
(4) encourage equitable financial partnership agreements and incentive packages to conserve biological diversity; tropical zone countries with the richest biological wealth have the poorest economic wealth with which to conserve those resources (debt swaps go some way to ameliorate this discrepancy);
(5) provide the framework for greater incentives such as security of land tenure to encourage longer term investment in sustainability;
(6) recognize the relationship between social services and dependence on natural resources as a means of generating income.

Sharing the costs

International conservation agencies, in conjunction with governments and NGOs, need to determine a mechanism whereby those

benefiting from the conservation of biotic diversity also contribute towards the costs of conserving it. It is essential that this applies as much to plant genetic resources as to forest products such as timber and bark or seeds for processing pharmaceutical products. Collection of plant genetic material from developing countries without legal agreements ensuring adequate payment for those resources, is a means for "devaluing" natural source areas for this material and reducing incentives for *in situ* conservation.

Conservation methods

It is recommended that the conservation of medicinal plants takes place within four main areas:
(1) *in-situ* conservation
(2) *ex-situ* conservation
(3) research
(4) education and training

In-situ conservation

In order to ensure that representative wild populations of vulnerable medicinal plant species are maintained, core conservation areas or other protected habitats that will allow natural processes to continue undisturbed by human activities should be designated. As a strategy to relieve the pressure on CCAs, buffer zones may be designated around the CCA wherein pro-active rural development and resource management is encouraged. Conservation agencies are already well-acquainted with the establishment of CCAs and buffer zones, equipment and infrastructure.

In order to ensure the successful establishment of *in-situ* conservation systems, the following points are recommended:
(1) the identification and effective protection of vegetation associations which contain a high density of vulnerable medicinal plant species in regions where commercial exploitation is taking place, especially: Côte d'Ivoire, Ghana, Nigeria, Kenya, South Africa Swaziland and Tanzania;
(2) the phasing out of harvesting of medicinal plants, cuttings or seed within CCAs; sustainable harvesting within CCAs is not recommended as there is a lack of money and manpower necessary to maintain the intensive management input which would be required to control harvesters.

Buffer zones and ex-situ conservation

Buffer zones

It is recommended that buffer zones are set up in conjunction with CCAs to support the harvesting of favoured species. In order to maintain future options for the supply of seed and cuttings, resource harvesting in buffer zones must be sustainable. In some cases this may be difficult as certain species may be especially vulnerable, for example *Faurea macnaughtonii* and *Podocarpus falcatus*, where the removal of patches of bark for local medicinal purposes initiates fungal and borer attack and stem heart rot.

Cultivation of favoured species within the buffer zone can make economic as well as conservation sense; Muir (1990) determined that sustainable management of pole harvesting in the Hlatikulu forest reserve in South Africa would cost US $ 105 000 annually, whereas to provide the equivalent amount of poles through establishment of woodlots would cost US $24 000. This could well apply to certain medicinal plants in high demand.

Customary restrictions that are a feature of traditional conservation practices need to be seen as an important guide to control measures in resource areas where medicinal plants are used. They indicate the forms of control to which the local user groups can relate. The following forms of control could therefore be implemented:
(1) seasonal restrictions for certain species;
(2) the prevention of up-rooting or ring-barking; and,
(3) the involvement of specialists rather than commercial gatherers.

Other customary practices, such as ensuring access to ancestral burial sites, also need to be taken into account as part of resource management.

Traditional medical practitioners

TMPs are very aware of the conservation status of local medicinal plant resources and can be influential in changing local opinion so as to limit over-exploitation. It is recommended that support is given to the formation of rural TMP associations and the self-sufficiency of TMPs, particularly in buffer zones. This might possibly be through local health services with the support of the WHO Traditional Medicine Programme. In particular, information should be disseminated to rural communities on appro-

priate cultivation methods for medicinal plants which are in local demand. Very little goes unnoticed in communally owned areas so that if problems arise regarding the depletion of valued local resources, TMP associations or community leaders are likely to be at least as effective as forest guards and could draw on conservation or forest guard support where necessary.

Conservation through commercial cultivation

It is recommended that there should be rapid development of alternative supply sources through cultivation in large enough quantities and at a low enough price to compete with prices obtained by gatherers of wild stocks. This will satisfy market demands, result in more secure jobs and provide fewer incentives to gather from the wild. If this does not occur, key species will disappear from the wild, thereby undermining the local medicinal resource base.

However, the practical difficulties associated with the cultivation of medicinal plants should not be underestimated (see above). The most vulnerable category of species, by their very nature, cannot be grown profitably due to their slow growth rates, especially as the land which is most likely to be available for medicinal plant cultivation is likely to be less productive agricultural land. A good example of this limitation is the 60 year old trial plot for *Pterocarpus angolensis* on the Mozambique coastal plain where growth on nutrient poor sands has been very low. Specific recommendations to promote large scale cultivation include:

(1) Investigations to be made into the practicality of using facilities which already exist in such institutions as government and agricultural departments or commercial timber companies, to develop stocks of scarce and popular medicinal plant species from cuttings. This would provide initial plant stocks to supply plants for cultivation to farmers. Initiation of pilot studies is recommended, with WWF and WHO as possible funding co-ordinators. Key sites are those where localized overexploitation has already taken place, as on Inhaca Island (Mozambique) where TMP's now have to travel to the mainland to collect medicinal plants as a result of depletion on the islands (A. Maite, pers.comm.). Other possibilities include *Garcinia afzellii* production outside urban areas in west Africa, *Warburgia salutaris* and *Alepidea amatymbica* cultivation in Zimbabwe.

(2) Investigations into the potential for adopting recommendations already made by Wondergem *et al*. (1989) for applying principles drawn from experience in Thailand. These include: a project for the cultivation of medicinal plants of known efficacy which has been initiated in about 1000 villages in Thailand; the production of traditional household remedies with improved formulae in the form of compressed tablets in foil; these are distributed in Thailand to drug co-operatives through a Drug and Medical Fund.

(3) Implementation of an initial learning phase that takes account of experience gained from successes and failures of implemented woodlot schemes throughout Africa. This should include canvassing local opinion on plant shortages and perceived solutions to the problem.

(4) Management of buffer zones to include the cultivation of vulnerable medicinal plant species within the CCA. Potential pilot studies include the production of *Warburgia salutaris* outside Kakamega forest (Kenya), HluHluwe Game Reserve (South Africa) and Malolotja Reserve (Swaziland).

(5) Pilot production project to determine the commercial viability of growing *Monanthotaxis capea* in Côte d'Ivoire, *Garcinia klaineana* in Gabon (A.M. Louis, pers. comm.) *Warburgia salutaris* in South Africa, Swaziland and Zimbabwe, and *Siphonochilus aethiopicus* in South Africa and Swaziland.

Botanical gardens and field gene banks

One recent report on a SADCC gene bank suggested that it might be more important for the gene bank to collect information on uses and efficacy of medicinal plants than collect material for ex-situ conservation (SIDA, 1989). This is not the case, as some popular and effective medicinal plants are threatened and need to be established in field gene banks until technology is available for storage of recalcitrant seeds. The ultimate goal of the conservation process is certainly to preserve the natural habitats of vulnerable medicinal plant species and to achieve sustainable exploitation in less vulnerable areas. However, seed and gene banks of vulnerable medicinal plant species should be maintained as precaution and backup against extinction. The plants most likely to be collected for this purpose are the slow growing species where commercial cultivation is unlike-

ly and wild populations are jeopardized. The following measures are recommended:

(1) where seed/ gene banking occurs outside the countries of origin, it should be accompanied by legal agreements to cover control and payment for the use of those resources. This means the country of origin is entitled to benefit from the utilization of the plant by foreign organisations.
(2) Collections for seed and gene banks should be undertaken in order to select for commercially beneficial properties such as fast growth and highest levels of active ingredients for pharmaceutical use. Slow growing species with specific habitat requirements are a priority in this respect. This could be carried out through Health, Agriculture and Forestry Departments in producer countries with assistance from organizations such as the Oxford Forestry Institute.
(3) Support should be given to the establishment of *ex-situ* populations of threatened and endangered species in more than one botanical garden under the existing framework of the IUCN Botanical Gardens Programme.
(4) Investigations should be made into the potential for the clonal production of medicinal plants with known toxicities. This would help to standardize dosage and produce a quality end product (Gentry *et al*., 1987).

Other recommendations

(1) The local production of pharmaceuticals: strictly controlled local production of medicines would reduce the cost of medication whilst providing alternatives to plant based medicines. The formulation of patent or pharmaceutical medicines with the same name and purpose as their herbal counterpart has already occurred as a response to shortages of certain herbal medicines such "Bangalala Pills", "Isihlambezo" and "Special Imbiza". Sale of bottled preparations, or single doses, by herb traders is a common feature of some traditional medicinal preparations such as aphrodisiacs in Malawi, Zambia and Zimbabwe (or "Jamu" in Indonesia).
(2) Salvage of botanical material from prospective development sites: salvage of medicinal plants should be implemented wherever practical, either for sale or cultivation. Poor infrastructure and lack of manpower in many African countries would make this impractical. Where it is practical, however, implementation would be at a local level through liaison between developers and TMPs or plant gatherers associations.
(3) Supply from sustainably managed logging: it may be possible to supplement medicinal plant supplies where bark is discarded as a by-product of logging such as in the case of *Ocotea bullata* in the southern Cape (South Africa). However, cases of sustainable logging are rare and where it exists it may not provide an economically viable supply of plant medicine.
(4) Feasibility studies: supply for commercial harvesting, extraction of active ingredients and local production of pharmaceuticals should be accompanied by feasibility studies to ensure an acceptable quality and efficacy of drugs, and to avoid over-exploitation of naturally occurring populations of target species.

Education and training

The conservation of medicinal plants is by necessity a long term project requiring the development of trained staff supported by organizations and a general public that is aware of the issues at stake. Improvement in national education standards is a key factor in the conservation issue which will come about only as a result of economic development in the African nations. As well as policy decisions which would influence the levels of education available, the following recommendations are made with a view to increasing public awareness of the value of medicinal plant resources:

(1) Instituting campaigns that promote the importance of habitat and medicinal plant conservation and encouraging the cultivation of medicinal plants. Target groups would include: rural communities, government decision-makers, pharmaceutical companies such as Plantecam Medicam of France which works in the Cameroon and Inverni della Beffa of Italy which works in Madagascar.
(2) Implementation of a media campaign through national radio networks to publicize information on the scarcity of popular medicinal plants.
(3) Develop an information programme for senior-decision makers in African governments to link public health with medicinal plant conservation issues.
(4) Develop a well informed campaign targeted at companies that export African wild plant material for the production of

pharmaceuticals. This would include documentation of cases where habitat destruction has occurred and rural resources have been undermined, the reasons for adopting a socially and ecologically responsible approach to wild plant harvesting and the need for pricing levels to take account of resource replacement costs. Companies should also be encouraged, as a matter of urgency, to ensure that harvesting of wild stocks takes place on a sustainable basis, or to institute the commercial production of plants from selected cultivated material.

(5) Studies and research information which identify threatened medicinal plants should be circulated through the International Board for Plant Genetic Resources (IBPGR) to regional gene banks.

(6) Information relating to adverse toxic properties in medicinal plants should be circulated particularly to TMPs and in Primary healthcare training (Akerele, 1987; Anyinam, 1987; Good, 1987; Swantz, 1984).

Research and monitoring

Research into the identification of areas of high biological diversity at the macro scale and research into the properties and usage of specific plants at the micro-scale should use the complementary skills of the TMPs and conservation biologists. Sites which are renowned for their well trained TMPs and powerful medicines and which could provide focal points for co-operative efforts include northern Pondoland and Sihangwane in South Africa and Mount Mulanje in Malawi (J. Seyani, pers. comm.). Research into medicinal plants would utilize databases such as PHARMEL and NAPRALERT. Conservation efforts and the checking of plant status could be co-ordinated where plants are being conserved for uses other than for medicinal purposes. Specific recommendations include:

(1) The initiation of a series of interactive discussions involving TMPs, commercial gatherers and market based traders to discover the perceived scarcity of species, sites of diversity, the status of popular species, the perceived problems and solutions.

(2) The initial focus should be on heavily populated regions where plant scarcities are likely to occur, yet where little is known of the extent of the problems faced by TMPs, such Rwanda and Burundi, and in high priority conservation areas such as Ethiopia, Kenya and Tanzania. The medicinal plant research co-ordinated through the Paris based Agence de Cooperation Culturelle et Technique (ACCT) provides an excellent model for coordinated research in francophone Africa.

(3) "Action research" projects at pilot-study level should be set up in selected countries to assess the economic viability and social acceptability of large scale production.

(4) An experienced African based coordinator should be appointed to implement damage assessments for the following: *Okoubaka aubrevillei*, *Garcinia afzelii*, *Garcinia epunctata* and *Garcinia kola* in west Africa; *Warburgia salutaris* in Kenya, Tanzania and Zimbabwe; *Prunus africana* and *Pausinystalia johimbe* in Cameroon and Madagascar; *Griffonia simplicifolia*, *Voacanga thourasii* and *Voacanga africana*, also in west Africa.

(5) A short-term survey on animal species sold as traditional medicines, such as vultures, pangolins and chimpanzees, which occur in CCAs should be initiated.

(6) Studies should be initiated through the co-operative effort between African and European scientific institutions to study the genetic diversity and population biology of *Okoubaka aubervillei* in west Africa, *Warburgia salutaris* and *Curtisia dentata*. This can be carried out through isozyme electrophoresis. This would help to identify the degree of genetic erosion taking place in areas of over-exploitation or habitat destruction.

(7) Research work on the storage of recalcitrant seeds is already a focus of research and its importance merely needs to be stressed here.

(8) A research project, similar to the recent IUCN study of the international bulb trade, should be instituted. This would investigate the economics of the trade in plant material from developing countries for the production of pharmaceuticals and homeopathic medicines, including volumes involved and the impact of harvesting in selected sites. The study would split into two phases; phase one to be carried out by a European-based researcher with access to UNCTAD/GATT data and pharmaceutical companies; investigations would include research into pricing structures from payment to harvesters to the cost of the final product. Phase two to be field-

based, investigating the ecological and social impact of the trade in study areas such as Cameroon, Côte d'Ivoire and Ghana, using species such as *Prunus africana*, *Griffonia simplicifolia*, and *Pausinystalia johimbe*.

(9) An investigation into possible legal contract agreements should be made, that could be attached to the use of plant genetic material and the intellectual property rights issue.

(10) Permanent plots should be set up in selected sites to monitor the status of *Warburgia salutaris*, *Garcinia afzelii* and *Okoubaka aubrevillei* populations and other indicator species.

(11) The success of cultivation as a conservation method should be monitored, possibly through a growers register which indicates the area of key species under cultivation.

(12) The price for favoured species might be monitored as a potential indicator of scarcity; if cultivation is not a viable option, and demand exceeds supply, then price will rise.

Conclusions

Action should be taken now to conserve the medicinal plant base of traditional medicine in Africa, as well as safeguarding its potential for western style medicines in other parts of the world. A shift to a cash economy and the emergence of commercial harvesters into what was largely a specialist activity restricted to TMPs have resulted in medicinal plants becoming a common property resource with few incentives for resource management or traditional conservation practice. In the context of major threats posed to natural habitats and the survival of particular species by agricultural expansion, deforestation, and so on, over-exploitation of traditional medicines is occurring. Subject to uncertainties in demographic and urbanization trends, the demand for traditional medicines is set to rise, putting increasing pressures on remaining areas of natural vegetation. Neither formal conservation legislation nor customary law or conservation practices are able to control the situation, and even CCAs and botanical gardens are being exploited (e.g. Albizia suluense in Hluhluwe Game Reserve (South Africa), Erythrophleum suaveolens and Pterocarpus angolensis in Zomba Botanical Gardens (Malawi), Securidaca longipedunculata in Harare Botanical Gardens (Zimbabwe). Traditional conservation policy for CCAs which are set up to maintain the status quo will only succeed when supported by ex-situ conservation methods including large scale cultivation, buffer zones, public awareness and research. In the longer term, however, the success of conservation will depend upon national and international policy and cooperation which will lead to improvement of the socio-economic framework within African nations.

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APPENDIX 1

Plant species in 118 families sold by traditional medicine sellers in seven African countries (preliminary surveys in five countries for this study together with data gathered from markets in South Africa and Mozambique in 1986-87).
The large number of species listed for South Africa is only partly due to the more detailed study carried out there Medicinal plants for which only local names were recorded are not given here. Specimens not in the University of Natal Herbarium are indexed NH (Natal Herbarium) and RB (Royal Botanic Gardens, Edinburgh).

bb=bulb; **bk**=bark; **fl**=flower; **fr**=fruit; **l**=leaf; **r**=root; **r(lt)**=root ligno-tuber; **st**=stem; **wd**=wood; **wpl**=whole plant.

FAMILY and SPECIES	PLANT PART	COLLECTION	LOCALITY						
			S. Africa	Swaziland	Zimbabwe	Mozambique	Malawi	Zambia	Côte d'Ivoire
POLYPORACEAE									
Lentinus tuber-regium	tuber								■
Lentinus sp.	tuber		■	■	■			■	
LYCOPODIACEAE									
Lycopodium clavatum L.	wpl	2100	■	■					
SELAGINELLACEAE									
Selaginella imbricata (Forssk.) Spring ex Decne	wpl				■			■	
CYATHEAE									
Cyathea dregei Kunze	st		■						
MARSILEACEAE									
Marsilea crenata	l/st								■
ADIANTACEAE									
Actiniopteris dimorpha Pichi Serm.	wpl						■		
Pellaea calomelanos (Sw.) Link	wpl				■				
Pellaea rufa A.F. Tryon	r		■						
POLYPODIACEAE									
Microgramma lycopodioides (L.) Copel.	wpl		■						
ASPLENIACEAE									
Asplenium rutifolium (Berg.) Kunze	wpl	2107	■						
ASPIDIACEAE									
Dryopteris athamantica (Kuntze) Kuntze	r		■						
STANGERIACEAE									
Stangeria eriopus (Kunze) Baill.	r(lt)	1119	■						
ZAMIACEAE									
Encephalartos sp.	st		■						
PODOCARPACEAE									
Podocarpus henkelli Stapf	bk		■						
Podocarpus latifolius (Thunb.) R.Br. ex Mirb	bk	2615	■						
PINACEAE									
**Pinus* spp.	bk		■						
CUPRESSACEAE									
**Cupressus* spp.	bk		■						
TYPHACEAE									
Typha capensis (Rohrb.) N.E. Br.	r		■						
POACEAE									
Cymbopogon plurinodus (Stapf) Stapf	r		■						
Cymbopogon sp.	r		■						
MYRSINACEAE									
Embelia ruminata (E. Mey. ex A.DC.) Mez	r	2729	■						
Maesa lanceolata Forssk.	r,bk								
Rapanea melanophloeos (L.) Mez	bk	2614	■	■					
ARECACEAE									
Borassus aethiopum Mart.	fr								■
ARACEAE									
Anchomanes difformis Engl.	bb								■
Zantedeschia albomaculata (Hook.) Baill.	bb	2124a	■						
COMMELINACEAE									
Cyanotis speciosa (L.f) Hassk	r	936	■						

FAMILY and SPECIES	PLANT PART	COLLECTION	LOCALITY						
			S. Africa	Swaziland	Zimbabwe	Mozambique	Malawi	Zambia	Côte d'Ivoire
LILIACAE									
Agapanthus campanulatus Leighton	r		■						
Agapanthus sp. cf. *africanus* (L.) Hoffmg.	r	2636	■						
Albuca fastigiata (L.F) Dryand	bb	2689	■						
Albuca sp.cf. *pachychlamys* Bak.	bb	2078	■						
Aloe aristata Haw.	wpl		■						
Aloe chaubadii Schonl.	wpl							■	
Aloe cooperi Bak.	wpl	1107	■						
Aloe linearifolia Berger	fl	2316	■						
Aloe marlothii Berger	l		■						
Asparagus asparagoides (L.) Wright	r	2146	■		■				
Asparagus ramosissimus Bak.	r	922	■						
Behnia reticulata (Thunb.) Didr.	r	915	■						
Boweia volubilis Harv.(M: ex Hook.f.)	bb	2147	■	■	■				
Bulbine asphodeloides Spreng.	bb	2754							
Bulbine latifolia (L.f.) Roem. & Schult.	bb	1006							
Chlorophytum comosum (Thunb.) Jacq.	wpl								
Drimia elata Jacq.	bb	2141NH							
Drimia robusta Bak.	bb	2123							
Drimia spp.	bb		■	■	■			■	
Drimiopsis maculata Lindl.	bb	2590							
Eriospermum abyssinicum Bak.	bb				■				
Eriospermum cooperi Bak.	bb	2484	■						
Eriospermum luteo-rubrum Bak.	bb	997	■						
Eriospermum mackenii (Hook. f.) Bak.	bb	2687	■						
Eriospermum ornithogaloides Bak.	bb	1016	■						
Eucomis autumnalis (Mill.) Chitt	bb	2340	■	■					
Eucomis sp.cf. *bicolor*	bb	920	■						
Gasteria croucheri (Hook. f.) Bak.	wpl	2678	■						
Gloriosa superba L.	r		■		■				
Haworthia fascicularis	wpl		■						
**Haworthia limifolia* Marloth.	wpl		■						
Kniphofia spp.	bb		■						
Ledebouria cooperi (Hook. f.) Jessop	bb		■						
Ledebouria ovatifolia (Bak.) Jessop	bb	2092	■						
Ledebouria revoluta (L. f.) Jessop	bb	2131	■						
Ledebouria spp.	bb	2677	■						
Littonia modesta Hook.	r		■						
Ornithogalum longibracteatum Jacq.	bb	2514	■						
Ornithogalum spp.	bb		■	■	■		■		
Protoasparagus laricinus (Burch.) Oberm.	r	2121a	■						
Protoasparagus setaceus (Kunth) Oberm	r	2151	■						
Protoasparagus sp.			■						
Sandersonia aurantiaca Hook.	r		■						
Sansevieria aethiopica Thunb.	r	2160	■						
Sansevieria hyacinthoides (L.) Druce	r	2377	■						
Sansevieria liberica Gerome & Labroy	wpl								■
Sansevieria spp.	wpl							■	
Schizobasis intricata (Bak.) Bak.	bb	2685							
Scilla natalensis Plarlch	bb	1057	■	■					
Scilla nervosa (Burch.) Jessop	bb	2348	■	■					
Tulbaghia alliacea L.	bb	2210NH	■						
Tulbaghia sp.	bb	919	■						
Tulbaghia sp. cf. *ludwigiana* Harv.	bb	2721	■	■					
Urginea altissima (L.f.) Bak.	bb	2188	■	■		■			
Urginea delagoensis Bak.	bb	2197	■						
Urginea macrocentra Bak.	bb		■						
Urginea cf. *sanguinea* Schinz.	bb				■				
AMARYLLIDCAEA									
Boophane disticha (L.f) Herb.	bb		■	■			■		
Clivia miniata Regel	bb		■						
Clivia nobilis Lindl.	bb	2338	■						
Crinum delagoense Verdoorn	bb	2135	■						
Crinum macowanii Bak.	bb		■						
Crinum moorei Hook. f.	bb		■						
Haemanthus albiflos Jacq.	bb	1118	■						
Haemanthus deformis Hook. f.	bb	2112	■						
Scadoxus puniceus (L.) I. Friis & Nordal	bb	1060	■						
HYPOXIDACEAE									
Hypoxis latifolia Hook.	bb	2093	■						
Hypoxis nyasica	bb						■		

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FAMILY and SPECIES	PLANT PART	COLLECTION	LOCALITY							
				S. Africa	Swaziland	Zimbabwe	Mozambique	Malawi	Zambia	Côte d'Ivoire
Hypoxis obtusa Burch.	bb				■					
Hypoxis rooperi S. Moore	bb	2114	■							
Hypoxis spp.	bb			■		■				
VELLOZIACEAE										
Xerophyta equisetoides Bak.	st				■		■			
Xerophyta retinervis	st			■		■				
Xerophyta sp.	st		■							
DIOSCOREACEAE										
Dioscorea dregeana (Kunth) Dur. & Schinz	wpl	2153b	■	■						
Dioscorea rupicola Kunth	wpl	2486	■							
Dioscorea sylvatica (Kunth) Eckl.	wpl	2513	■	■	■			■		
Dioscorea sp.	wpl							■		
IRIDACEAE										
unidentified sp.	r	2635	■							
Aristea ecklonii Bak.	r		■							
Aristea gerrardii H. Weim.	r	2336	■							
Crocosmia aurea Planch. (M: Hook.) Planch.	bb		■							
Crocosmia paniculata (Klatt.) Goldbl.	bb		■							
Dietes iridioides (L.) Sweet ex Klatt	r	2111	■							
Dietes sp.	r	1114a	■							
Dierama sp.	bb		■							
**Eleuthrine plicata*	bb		■							
Gladiolus sericeo-villosus (Hook. f.)	bb		■							
Gladiolus sp.	bb		■	■		■				
Watsonia sp.	bb		■	■				■		
ZINGIBERACEAE										
Aframomum melegueta Schumman	fr								■	
Costus dubius	fl	2902							■	
Siphonochilus aethiopicus (Schweinf.) B.L. B	r	2714	■	■						
Siphonochilus natalensis Schltr. & K. Schum	r	2740	■							
Siphonochilus sp.	r				■					
**Zingiber officinale* Roscoe	r				■				■	
ORCHIDACEAE										
Acampe praemorsa (Roxb.) Blatter & McCann	wpl		■							
Acrolophia cochlearis (H. Bolus) Schltr.	wpl		■							
Aerangis mystacidii (Reichb. f.) Schltr.	wpl		■							
Ansellia africana Lindl.	l/st				■			■		
Ansellia gigantea Reichb.f.	l/st	1063	■	■		■		■		
Bolusiella maudiae (Bolus) Schltr.	wpl		■							
Calyptrochilum emarginatum	l/st	2903							■	
Cyrtorchis arcuata (Reich. f.) Schltr.	wpl	2371	■							
Diaphananthe xanthopollinia (Reichb. f.) Sum	wpl		■							
Eulophia clitellifera (Reichb. f.) Bolus	wpl		■							
Eulophia cucullata (Afzel. ex Swartz.) Steud	wpl		■	■						
Eulophia parviflora (Lindl.) A.V. Hall	wpl		■							
Eulophia petersii Reichb. f.	wpl		■	■	■			■		
Eulophia sp.	wpl	938								
Eulophia speciosa (R.Br. ex Lindl.)Bolus	wpl									
Eulophia streptopetala Lindl.	wpl		■							
Liparis remota J. Stewart & E.A. Schelpe	wpl		■							
Microcoelia exilis Lindl.	wpl		■							
Mystacidium capense (L. f.) Schltr.	wpl	2184a	■							
Mystacidium millarii Bolus	wpl		■							
Mystacidium venosum Harv. ex Rolfe	wpl		■							
Polystachya concreta (Jacq.) Garay & Sweet	wpl		■							
Polystachya ottoniana Reichb. f.	wpl	2126	■							
Polystachya pubescens (Lindl.) Reichb.f.	wpl		■							
Polystachya sandersonii Harv.	wpl		■							
Rangaeris muscicola (Reichb.f.) Summerh.	wpl		■							
Tridactyle bicaudata (Lindl.) Schltr.	wpl	2511	■							
Tridactyle tridentata (Harv.) Schltr.	wpl	2177a	■							
PIPERACEAE										
Piper guineense Schum. & Thonn.	l/st								■	
MYRICACEAE										
Myrica serrata Lam.	r	2118a	■							
ULMACEAE										
Trema guineensis (Schum. et Thonn.) Ficalho	l/st	2888							■	
MORACEAE										
Ficus sur Forssk.	bk		■							
*CANNABIDACEAE										
**Cannabis sativa* L.	fr,l		■							

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			S. Africa	Swaziland	Zimbabwe	Mozambique	Malawi	Zambia	Côte d'Ivoire
PROTEACEAE									
Faurea macnaughtonii Phill.	bk	2602	■						
Faurea saligna Harv.	bk	860	■						
Protea caffra Meisn.	fl					■			
Protea roupelliae Meisn. subsp. roupelliae	bk		■						
Protea sp.	fl							■	
LORANTHACEAE									
Tapinanthus spp.	st			■	■				
Tieghemia quinquenervia (Hochst.) Balle	wpl	2310	■						
VISCACEAE									
Thesium sp. cf. *pallidum* A. DC.	r	2724	■						
Viscum sp.	wpl	2187a	■						
Viscum verrocosum Harv.	wpl	2323	■						
Viscum sp.	wpl				■				
SANTALACEAE									
Osyridicarpos schimperianus Hochst.ex A. Rich	l/st	2318	■						
OLACACEAE									
Ximenia americana L.	r							■	
Ximenia caffra Sond.	r		■						
BALANOPHORACEAE									
Sarcophyte sanguinea Sparrm.	r	230		■				■	
Thonningea sanguinea Vahl.	fl	289							■
ARISTOLOCHIACEAE									
Aristolochia heppii Merxm.	r				■				
HYDNORACEAE									
Hydnora africana Thunb.	r	251	■	■					
Hydnora solmsiana Dinter	r				■				
Hydnora spp.	r						■		
AMARANTHACEAE									
Achyropsis avicularis (E. Mey. ex Moq.) Hook	l/st		■						
Alternanthera repens O. Kuntze	l/st								■
Celosia trigyna L.	wpl	2361	■						
AIZOCEAE									
Psammotropha myriantha Sond.	wpl	2118	■						
MESEMBRYANTHEMACEAE									
Aptenia cordifolia (L.f) Schwant.	l/st		■						
Carpobrotus edulis L. (M:L. (N.E. Br.)	l/st		■						
PORTULACACEAE									
Portulaca sp.	wpl	2322	■						
Portulaca oleracea L.	l/st								■
Talinum caffrum (Thunb.) Eckl. & Zeyh.	r		■				■		
BASELLACEAE									
Basella paniculata Volkens.	l/st	2506	■						
ILLECEBRACEAE									
Dianthus crenatus (Thunb.)	l/st	2319	■						
Dianthus zeyheri Sond.	wpl	2143	■						
Silene primuliflora Eckl. & Zeyh.	wpl	1111	■						
Silene sp.cf. *bellidiodes* Sond.	wpl	1116	■						
NYMPHAEACEAE									
Nymphaea spp.	r		■						
RANUNCULACEAE									
Anemone caffra Eckl. & Zeyh.	r		■						
Anemone fanninii Harv. ex Mast.	r	2719	■						
Clematis brachiata Thunb.	l/st	2123	■						
Knowltonia bracteata Harv. ex. Zahlbr.	wpl	917	■						
Ranunculus multifidus Forssk.	wpl		■						
MENISPERMACEAE									
Cissampelos torulosa E.Mey.	l/st	2116	■						
Jateorrhiza palmata	r						■		
ANNONACEAE									
Annona senegalensis Pers.	r	2462	■						
Enantia polycarpa Engl. & Diels.	r								■
Monanthotaxis caffra (Sond.) Verdc.	st		■						
Monanthotaxis capea (E G Camus) Verdc.									■
Uvaria afzelii Sc. El.	st								■
Uvaria caffra E. Mey ex Sond.	st		■						
Uvaria chamae P. Beauv.	r								■
Uvaria lucida Benth. subsp. virens (N.E.Br)	l/st								
LAURACEAE									
**Cinnamomum camphora*	bk		■						
**Cinnamomum zeylanicum*	bk		■						

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				S. Africa	Swaziland	Zimbabwe	Mozambique	Malawi	Zambia	Côte d'Ivoire
Cryptocarya latifolia Sond.	bk	2634	■							
Cryptocarya myrtifolia Stapf	bk	2600	■							
Ocotea bullata (Burch.) Baill.	bk	2103	■							
Ocotea kenyensis (Chiov.) Robyns	bk		■							
CAPPARIDACEAE										
Boscia albitrunca (Birch.) Gilg.	r		■			■				
Cadaba natalensis Sond.	r		■							
Capparis brassii DC.	st	2132	■							
Capparis tomentosa Lam.	st		■							
Cladostemon kirkii (Oliv.) Pax & Gilg	r	2460	■							
Thilachium africanum Lour.	1	2420	■							
HYDROSTACHYACEAE										
Hydrostachys polymorpha Klotzsch	wpl	2194a	■							
CRASSULACEAE										
Kalanchoe crenata (Andr.) Haw.	l/st	928	■							
Kalanchoe sp.	l/st									■
PITTOSPORACAEAE										
Pittosporum viridiflorum Sims	bk	2488	■		■					
MYROTHAMNACEAE										
Myrothamnus flabellifolia (Sond.) Welw.	l/st	2493	■	■	■	■	■	■		
ROSACEAE										
Agrimonia eupatoria L.	bk								■	
Prunus africana (Hook. f.) Kalkm.	bk	2608	■							
**Rubus pinnatus* Willd.	r		■							
**Rubus rigidus* J.E. Sm.	r		■							
FABACEAE										
Abrus precatorius L.	sd	2187	■	■	■	■	■	■	■	
Acacia albida Del.	r							■		
Acacia nilotica (L.) Del.	fr				■					
Acacia xanthophloea (Lam.) de Wet	bk	2166	■	■						
Afzelia africana Smith	fr								■	
Afzelia quanzensis Welw.	sd,r	2203	■	■			■	■		
Albizia adianthifolia (Schumach.) W.F.Wright	bk	2332	■							
Albizia antunesiana Harms	r							■		
Albizia tanganyinesis Bak.	r				■					
Caesalpinia bonduc (L.) Roxb.	sd		■	■		■			■	
Cassia alata L.	l/st							■		
Cassia abbreviata Oliv.	bk,l				■				■	
Cassia sp. ("MUWAWANI")	bk						■			
Crotalaria globifera	r	2130	■							
Crotalaria sp.	r	2180	■							
Dichrostachys cinerea (L.) Wright & Arn.	fr					■				
Dolichos kilmandscharicus Taub.	r						■			
Dumasia villosa DC. var. villosa	l/st	924	■							
Elephantorrhiza elephantina (Burch.) Skeels	r(lt)	2147	■	■	■	■				
Elephantorrhiza spp.	r(lt)				■			■		
Entada africana Guill. & Perr.	r,st								■	
Entada pursaetha DC.	fr		■	■			■			
Eriosema cordatum E. Mey.	r	2137	■							
Eriosema rossii C.H. Stirton	r	2138cNH	■							
Eriosema salignum E. Mey.	r	1109	■							
Erythrophleum lasianthum Corbishley	bk	1901	■							
Erythrophleum suaveolens Guill & Perr (Brenan)	bk	2867			■		■	■		
Lotononis corymbosa Benth.	wpl	2174a	■							
Mimosa pigra L.	wpl	2184NH	■							
Mimosa pudica L. var. hispida Brenan	wpl	2500	■							
Otholobium polystietum (Benth. ex Harv.) C.H. Stirton	wpl	2487	■							
Piliostigma thonningii (Schumach.) Milne-Redh.	r	2897					■	■	■	
Psoralea pinnata L.	l/st	2497NH	■							
Pterocarpus angolensis DC.	fr				■		■	■		
Schotia brachypetala Sond.	bk	2164	■							
Schotia capitata Bolle	bk	2396	■							
Stylosanthes erecta P. Beauv. (M: Pal.)	wpl								■	
Swartzia madagascariensis Desv.	r,fr				■		■		■	
**Tamarindus indica* L.	l/st	2894							■	
Tephrosia sp. cf. *marginella* H. Forbes	l/st	n								
Tetrapleura tetraptera (Schumach. L Thonn.) Taubert	fr								■	
Uraria picta L.	wpl.	2895							■	
GERANIACEAE										
Monsonia natalensis Kunth.(L.)	r		■							
Pelargonium alchemilloides (L.) L'Herit.		2157	■							

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			S. Africa	Swaziland	Zimbabwe	Mozambique	Malawi	Zambia	Côte d'Ivoire
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Pelargonium sp. cf. *luridum* (Andr.) Sweet	r	2485	■						
BALANITACEAE									
Balanites maughamii Sprague	bk	2189	■	■					
RUTACEAE									
Agathosma ovata Pillans	wpl	1105	■						
**Citrus sinensis*	l/st								■
Clausena anisata (Willd.) Hook. f.ex Benth.	r		■						
Zanthoxylum capense (Thunb.) Harv.	r	2457	■						
Zanthoxylum davyi (Verdoorn) Waterm.	r		■	■					
MELIACEAE									
Azadirachta indica A. Juss.							■		■
Ekebergia capensis Sparrm.	bk		■						
Khaya nyassica Stapf. ex Baker	bk				■		■	■	
Khaya senegalensis (Desr.) A. Juss.	bk								■
Trichilia dregeana Sond.	bk	2624	■						
Trichilia emetica Vahl	bk	2143	■						
Turraea floribunda Hochst.	r								
Turraea obtusifolia Hochst.	l/st	2426	■						
PTAEROXYLACEAE									
Ptaeroxylon obliquum (Thunb.) Radlk.	bk	2429	■						
MALPHIGIACEAE									
Acridocarpus natalitius A.Juss.	r	2088	■	■		■			
POLYGALACEAE									
Muraltia lancifolia Harv.	r	2142a	■						
Polygala cf. *sphenoptera* Fres.	wpl	2472	■						
Polygala confusa MacOwan	wpl	2709	■						
Polygala fruticosa Berg.	wpl		■						
Polygala gerrardii Chod.	wpl	2160a	■						
Polygala hottentotta Presl	wpl	2198	■						
Polygala marensis Burtt-Davy	wpl	2138a	■						
Polygala myrtifolia L.	wpl		■						
Polygala ohlendorfiana Eckl. & Zeyh.	wpl	2161a	■						
Polygala serpentaria Eckl. & Zeyh.	wpl	1053	■						
Polygala sp.	wpl	2178	■						
Polygala sp. cf. *hortboschiana*	wpl		■						
Polygala sp. cf. *natalensis*	wpl	2139a	■						
Polygala virgata Thunb. var. *decora* (Sond.)	l/st	2156a	■						
Securidaea longipedunculata Fres.	r	2882			■			■	
EUPHORBIACEAE									
Acalypha depressinerva (O. Kunze) K. Schum.	wpl	2751	■						
Acalypha glandulifolia Buchinger ex. Meisn.	wpl	2502	■						
Acalypha petiolaris Hochst.	r	2173	■						
Acalypha schinzii Pax.	wpl	2208	■						
Alchornea cordifolia (Schumach. & Thonn.)									
Muell. Arg.	l/st	2886							■
Andrachne ovalis Muell. Arg.	r	2108	■						
Antidesma venosum E. Mey. ex Tul.	bk	r	■						
Bridelia cathartiea Betol.f.	l/st		■						
Bridelia duigneaudi	r							■	
Bridelia micrantha (Hochst.) Baill.	bk	2592	■						
Croton gratissimus Burch.	l/st		■						
Croton pseudopulchellus Pax	r	1902	■						
Croton sylvaticus Hochst.	bk		■						
Euphorbia hirta L.	wpl	2898							■
Euphorbia natalensis Bernh.	wpl	2177	■						
Euphorbia pulvinata Marloth	wpl	2498	■						
Euphorbia woodii N.E. Br.	wpl	2499	■						
Hymenocardia acida Tul.	l/st	2904						■	■
Jatropha curcas L.	sd		■						
Jatropha hirsuta Hochst.	r	2136	■						
Macaranga capensis (Baill.) Benth. ex Sim	bk	2742	■						
Maprounea africana Muell. Arg.	r							■	
Microdesmis keayana	l/st	2884							■
Monadenium lugardae N.E Br					■				
Oldfieldia africana Benth. & Hook.f.	bk								■
Oldfieldia dactylophylla (Welw. ex Oliv.) J.Leonard	r							■	
Phyllanthus engleri Pax.	st				■				
Pseudolachnostylis maprounifolia Pax.	r							■	
Ricinodendron rautanenii Schinz.	sd				■	■	■	■	
Ricinus communis L.	fr		■	■	■		■	■	
Spirostachys africana Sond.	r,wd		■		■		■		

FAMILY and SPECIES	PLANT PART	COLLECTION	LOCALITY								
				S. Africa	Swaziland	Zimbabwe	Mozambique	Malawi	Zambia	Côte d'Ivoire
Synadenium cupulare (Boiss.) L.C. Wheeler	l/st	995	■							
Tragia meyeriana Muell.Arg.	r	2165a	■							
Tragia rupestris Sond.	r	2135a	■							
Tragia sp.	r							■		
ANACARDIACEAE										
Harpephyllum caffrum Bernh. ex. K. Krause	bk	2083	■							
Lannea edulis Engl.	r							■		
Loxostylis alata Spreng. f.ex. Reichb.	bk	2098	■							
Ozoroa obovata (Oliv.) R. & A. Fernandes	r	2146	■							
Ozoroa reticulata (Bak.f) R & A Fernandes	r					■				
Protorhus longifolia (Bernh.) Engl.	bk	2606	■							
Rhus chirindensis Bak. f.	bk	2516	■							
Sclerocarya birrea (A. Rich.) Hochst. subsp. caffra (Sond.) Kokwaro	bk		■			■				
Spondias mombin L.	l/st									
AQUIFOLIACEAE										
Ilex mitis (L.) Radlk.	bk		■							
CELASTRACEAE										
Cassine aethiopica Thunb.	bk	2311a	■							
Cassine papillosa (Hochst.) Kuntze	bk	2169	■							
Cassine transvaalensis (Burtt-Davy) Codd	bk	2163	■							
Maytenus acuminata (L.f.) Loes.	bk	2494	■							
Maytenus mossambicensis (Klotzsch) Blakelock	r	2117	■							
Maytenus peduncularis (Sond.) Loes.	bk		■							
Maytenus sp. "MPETU"	r					■				
Maytenus undata (Thunb.) Blakelock	bk	2632	■							
Pleurostylia capensis (Turcz.) Oliv.	bk	2617	■							
Pterocelastrus echinatus N.E. Br.	bk		■	■						
Pterocelastrus rostratus (Thunb.) Walp.	bk		■							
Pterocelastrus tricuspidatus (Lam.) Sond.	bk		■							
ICACINACEAE										
Apodytes dimidiata E.Mey. ex Arn.	r	2745	■							
Cassinopsis tinifolia Harv.	bk	2068NH	■							
Icacina mannii Oliv.	r									■
SAPINDACEAE										
Cardiospermum halicacabum L. (1)	l/st		■							
Hippobromus pauciflorus (L.f.) Radlk.	r	2580a	■							
Paullinia pinnata L.	st									■
Zahna arricana (Radlk.) Excell.	r					■		■		
MELIANTHACEAE										
Bersama lucens (Hochst.) Syzsy.	bk	2170	■							
Bersama stayneri Phillips	bk	2106	■							
Bersama swynii Phill.	bk	2593	■							
Bersama tysoniana Oliv.	bk	2106	■							
RHAMNACEAE										
Berchemia discolor (Klotzsch.) Hemsl.	bk	2200	■	■						
Helinus integrifolius (Lam.) Kuntze	st	2114	■							
Rhamnus prunoides L'Herit	r	2109	■							
Ziziphus mucronata Willd.	bk,r		■				■			
VITACEAE										
Cissus quandrangula L.	st					■	■	■	■	
Cyphostemma sp.	st		■							
Rhoicissus digitata (L.f) Gilg & Brand	r		■							
Rhoicissus tridentata (L.f) Wild & Drummond	r		■			■				
TILIACEAE										
Corchorus confusus Wild	wpl	2189a	■							
Triumfetta amuletum Sprague	fr					■	■	■	■	
MALVACEAE										
Hibiscus surattensis L.	r	2515	■							■
Sida acuta Burm. f.	wpl	2906								■
BOMBACACEAE										
Adansonia digitata L.	fr					■			■	■
Bombax buonopozense Beauv.	bk									■
OCHNACEAE										
Ochna sp. cf. *natalitia*	bk		■							
CLUSIACEAE										
Garcinia afzelii Engl.	r									■
Garcinia gerrardii Harv. ex Sim	bk	212INH	■							
Garcinia kola Heckel.	r									■
Garcinia livingstonei T. Anders.	bk	2200	■							
Harungana madagascariensis Lam. ex Poiret	bk									■

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FAMILY and SPECIES	PLANT PART	COLLECTION	LOCALITY						
			S. Africa	Swaziland	Zimbabwe	Mozambique	Malawi	Zambia	Côte d'Ivoire
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Hypericum aethiopicum Thunb.	wpl	2173a	■						
Hypericum sp. cf. *roeperianum* Schimp.	wpl	2360	■						
Psorospermum febrifugum Spach.	r				■				
CANELLACEAE									
Warburgia salutaris (Bertol. f.) Chiov.	bk	2168	■	■	■	■			
FLACOURTIACEAE									
Casearia gladiiformis Mast.	bk	2492	■						
Oncoba spinosa Forssk.	fr		■		■	■		■	
Scolopia mundii (Eckl. & Zeyh.) Warb.	bk	2610	■						
PASSIFLORACEAE									
Adenia cissampeloides Harms.	st								■
Adenia lobata (Jacq.) Engl.	st								■
Adenia gummifera (Harv.) Harms	st	2738	■			■			
Adenia sp.cf. *sinensis*	st						■		
Paropsia brazzeana Baill.	r							■	
Schlechterina mitrostemmatoides Harms	wpl	2199	■						
BEGONIACEAE									
Begonia hemonyma Steud.	r	2179	■						
CACTACEAE									
Rhipsalis baccifera (J.S. Miller) Stearn	st	251ONH	■						
LECYTHIDACEAE									
Barringtonia asiatica	fr					■			
Barringtonia racemosa (L.) Spreng.	fr		■						
THYMELAEACEAE									
Gnidia burchellii (Meisn.) Gilg	r(lt)	2140							
Gnidia kraussiana Meisn. var. kraussiana	r(lt)	2127	■	■	■				
Synaptolepis alternifolia Oliv.	r(lt)						■		
Synaptolepis kirkii Oliv.	r(lt)	2156	■	■		■			
RHIZOPHORACEAE									
Cassipourea flanaganii (Schinz) Alston	bk		■						
Cassipourea gerrardii (Schinz) Alston	bk	2167b	■						
COMBRETACEAE									
Combretum erthrophyllum (Burch.) Sond.	r		■						
Combretum kraussii Hochst.	r	2598	■						
Combretum molle R.Br. ex. G. Don	r	2349	■						
Combretum psidiodes Welw.	r							■	
Terminalia phanerophlebia Engl. & Diels	r								
Terminalia sericea Burch. ex DC.	r		■						
MELASTOMATACEAE									
Dissotis rotundifolia Triana	wpl								■
MYRTACEAE									
**Eucalyptus* spp.	bk,l		■			■			■
Heteropyxis natalensis Harv.	bk	2353	■						
**Psidium guajava*									■
Syzygium cordatum Hochst.	bk		■						
HALORAGIDACEAE									
Gunnera perpensa L.	r	943	■						
APIACEAE									
Alepidea amatymbica Eckl.& Zeyh.	r	2616	■	■	■				
Centella glabrata L. var. glabrata	wpl	2086	■						
Foeniculum vulgare A.W. Hill	l/st		■						
Heteromorpha arborescens Cham. & Schlectend.	l					■			
Lichtensteinia interrupta (Thunb.) E. Mey	r	2501	■						
Peucedanum caffrum (Meisn.) Phill.	r	2137	■						
Peucedanum thodii Arnold	l/st		■						
Pimpinella caffra (Eckl. & Zeyh.) Harv.	wpl	2471	■						
Steganotaenia araliacea Hochst.	r							■	
CORNACEAE									
Curtisia dentata (Burm. f.) C.A. Sm.	bk	2621	■						
PLUBAGINACEAE									
Plumbago auriculata Lam.	r		■						
SAPOTACEAE									
Mimusops caffra E. Mey. ex A. DC.	bk		■						
Mimusops obovata Sond.	bk	2627	■						
Sideroxylon inerme L.	bk		■						
EBENACEAE									
Diospyros galpinii (Hiern.) de Winter	r	2166a	■						
Diospyros lyciodes Desf.	r							■	
Euclea divinorum Hiern	r	2102	■		■	■			
Euclea natalensis A. DC.	r	2171	■			■			

FAMILY and SPECIES	PLANT PART	COLLECTION	LOCALITY							
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OLEACEAE										
Jasminum angulare Vahl	l/st	2021	■							
Olea woodiana Knobl.	bk	2463	■							
Schrebera trichoclada Welw.	fr	2860						■		
Schrebera alata (Hochst.) Welw.	l/st							■		
LOGANIACEAE										
Nuxia floribunda Benth.	bk	2613	■							
Strychnos henningsii Gilg	bk	2660	■							
Strychnos spinosa Lam.	fr	2351	■		■	■				
APOCYNACEAE										
Acokanthera oblongifolia (Hochst.) Codd	r,l	2461	■							
Acokanthera oppositifolia (Lam.) Codd.	r,l	2580	■							
Alstonia boonei De Wild.	bk									■
Diplorhyncus condylocarpon (Muell. Arg.)	fr	2857						■		
Rauvolfia caffra Sond.	bk	2124	■							
Rauvolfia vomitoria Afzel.	r									■
Stropanthus gerrardii Stapf.	fr		■							
Stropanthus luteolus Codd	fr	2182	■							
Stropanthus petersiana Klotzsch.	fr		■							
Stropanthus speciosus (Ward & Harv.) Reber	fr	2601	■							
Wrightia natalensis Stapf	r	2192	■							
PERIPLOCACEAE										
Mondia whitei (Hook. f.) Skeels	r		■	■	■	■	■			
Parquetina nigrescens (Afz.) Bullock	l/st	2887								■
Raphionacme sp.	r		■							
ASCLEPIADACEAE										
Asclepias cucullata Schltr.	r	2159	■							
Asclepias fruticosa L.	l/st		■							
Asclepias physocarpa Schltr.	l/st	2190	■							
Ceropegia woodii Schltr.	r	2752	■							
Huernia sp.	wpl	2440	■							
Pachycarpus sonsolor E.Mey.	r				■					
Secamone gerrardii Harv. ex Benth.	r	2113	■							
Stapelia gigantea N.E. Br.	wpl	2154	■							
Tylophora flanaganii Schltr.	st		■							
Xysmalobium sp. (*lapathifolium* ?)	r		■							
Xysmalobium undulatum (L.) Ait.f.	r	2715	■							
CONVOLVULACEAE										
Convolvulus saggitatus Thunb.	r		■							
Ipomoea cairica (L.) Sweet	r(lt)		■							
Ipomoea congesta R. Br.	r(lt)		■							
Turbina oblongata (E. Mey. ex Choisy) A. Meer	r		■	■						
BORAGINACEAE										
Heliotropium indicum L.	l/st	2890								■
VERBENACEAE										
Clerodendrum hirsutum (Hochst.) H.Pearson	wpl		■							
Clerodendrum triphyllum (Harv.) H. Pearson	wpl		■							
Lippia javanica (Burm.f.) Spreng	l/st	2163	■							
LAMIACEAE										
Becium obovatum (E.Mey. ex.Benth.) var. *obovatum*	wpl	2127	■							
Leonotis leonurus (L.) R.Br	l/st		■							
Ocimum canum Sims	l/st									■
Ocimum gratissimum L.	l/st									■
Platostoma africanum P. Beauv.	l/st									■
Plectranthus grallatus Briq.	r	2169a	■							
Tetradenia riparia (Hochst.) Codd	r	2128NH	■							
SOLANACEAE										
Physalis peruviana L.	r		■							
Solanum aculeastrum Dun.	fr	2091	■							
Solanum nigrum L.	r		■							
Solanum panduriforme E. Mey	fr	2441NH	■							
Solanum spp.	fr					■	■	■	■	
Withania somnifera (L.) Dunal	r	2728	■						■	
SCROPHULARIACEAE										
Cycnium racemosum Benth.	r	2483	■							
Graderia scabra (L.f.) Benth.			■							
Rhamphicarpa spp.	r		■							
Scoparia dulcis L.	wpl	2891								■
Striga asiatica (L.) Kuntze. (=S. lutea Lour. M)	wpl	2469	■							

FAMILY and SPECIES	PLANT PART	COLLECTION	LOCALITY						
			S. Africa	Swaziland	Zimbabwe	Mozambique	Malawi	Zambia	Côte d'Ivoire
BIGNONIACEAE									
Kigelia africana (Lam.) Benth.	bk,fr	2158	■		■	■	■	■	
PEDALIACEAE									
Ceratotheca triloba (Bernh.) Hook. f.	r	2587	■						
MARTYNIACEAE									
Proboscidea fragrans (Lindl.) Decne.	fr		■						
ACANTHACEAE									
Crabbea hirsuta Harv.	wpl	2470	■						
Crabbea sp.	l/st							■	
Justicia capensis Thunb.	wpl	2157	■						
RUBIACEAE									
Anthospermum pumilium Sond.	r	2212	■						
Burchellia bubalina (L.f.) Sims.	r	2337	■						
Canthium inerme (L.f) Kunze	r		■						
Catunaregam spinosa (Thunb.) Tirvengadum	fr		■						
Conostomium natalense (Hochst) Brem.	l/st	1014	■						
Gardenia ternifolia Schumach & Thonn	fr,								■
Gardenia thunbergia l.f.	r	2446	■						
Gardenia volkensii K. Schum.	r		■						
Kohautia amatymbica Eckl. & Zeyh.	wpl	2710	■						
Morinda lucida Benth	l/st								■
Nauclea latifolia Smith	l/st	2885							■
Pentanisia prunelloides (Eckl.& Zeyh.) Walp.	r(lt)	1058	■						
Rubia cordifolia L. subsp. *conotricha* (Gand.	l/st	2468	■						
Spermacoce natalensis Hochst.	r	2503NH	■						
DIPSICACEAE									
Cephalaria humilis (Thunb.) Roem & Schult.	r		■						
Scabiosa columbaria L.	wpl	2181a	■						
CUCURBITACEAE									
Cucumis africanus L.f.	fr	2748	■						
Cucumis hirsutus Sond.	fr	2210a	■						
Kedrostis foetidissima (Jacq.) Cogn.	r(lt)	2475	■						
Lagenaria mascarena Naud.	fr		■						
Momordica charantia L.	l/st								■
Momordica foetida Schum.	l/st	927	■						
CAMPANULACEAE									
Roella glomerata A.DC.	wpl	2480	■						
LOBELIACEAE									
Monopsis stellarioides (Presl) Urb. ssp. *stellaroides*	l/st	2112	■						
ASTERACEAE									
Acanthospermum hispidum DC.	fr	2725	■						
Achyrocline stenoptera (DC.) Hilliard & Burtt	l/st	937	■						
Adenostemma perotteti DC.	l/st	2504	■						
Ageratum conyzoides L.	l/st	2901	■						
Artemesia afra Jacq. ex. Willd.	l/st	925	■						
Aspilia natalensis (Sond.) Wild	wpl		■						
Aspilia natalensis (Sond.) Wild.	l/st		■						
Aster bakeranus Burtt-Davy ex C.A. Sm.	r	1057	■						
Athanasia acerosa (DC.) Harv.	r	2162	■						
Berkheya multijuga (DC.) Roessler	l/st	2122	■						
Brachylaena discolor DC.	r	2081	■						
Callilepis laureola DC.	r	2669	■						
Chrysanthemoides monelifera (L.) T. Norl.	l/st		■						
Dicoma sp.	l/st				■			■	
Dicoma kirkii	wpl				■		■	■	
	r							■	■
Eclipta prostata (L.) L.	wpl	2474							■
Felicia erigeroides DC.	wpl	1098	■						
Gazania linearis (Thunb.) Druce	wpl	2090	■						
Gerbera ambigua (Cass.) Sch. Bip.	wpl	2119	■						
Gerbera piloselloides (L.) Cass.	wpl	1112	■						
Helichrysum acutatum DC.	r	2133a	■						
Helichrysum aureonitens Sch. Bip.	l/st	949	■						
Helichrysum epapposum H.Bol.	l/st	2081RB	■						
Helichrysum gymnocomum DC.	l/st	2030RB	■						
Helichrysum herbaceum (Andr.) Sweet	l/st	2354	■						
Helichrysum natalitium DC.	l/st		■						
Helichrysum odoratissimum (L.) Sweet	l/st	2183NH	■						
Matricaria nigellifolia DC.	l/st		■						
Microglossa mespilifolia (Less.) B.L. Robinson	l/st	1114	■						
Osteospermum imbricatum L.	l/st	1018	■						

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Othonna natalensis Sch. Bip.	r(lt)	2482	■						
Pulicaria scabra (Thunb.) Druce	wpl	2505	■						
Senecio cissampelinus (DC.) Sch. Bip.	l/st	2104	■						
Senecio coronatus (Thunb.) Harv.	wpl	921	■				■		
Senecio gregatus Hilliard	l/st	1113	■						
Senecio serratuloides DC.	l/st	2117	■						
Senecio speciosus Willd.	l/st		■						
Spilanthes mauritiana (Pers.) DC.	l	2321	■						
Vernonia adoensis Sch. Bip. ex Walp.	l/st	1106	■						
Vernonia anisochaetoides Sond.	l/st	2120	■						
Vernonia natalensis Sch. Bip.	l/st	2175	■						
Vernonia neocorymbosa Hilliard	l/st	2622	■						
Vernonia oligocephala (DC.) Sch.Bip. ex Walp.	l/st		■						

APPENDIX 2

Plant species mentioned in the text and their families.

Abrus precatorius (Fabaceae)
Acacia xanthophloea (Fabaceae)
Afrormosia = Pericopsis elata (Fabaceae)
Afrostyrax lepidophyllus (Styraceae)
Agapanthus umbellatus (Liliaceae)
Albizia adianthifolia (Fabaceae)
Albizia suluense (Fabaceae)
Alepidea amatymbica (Apiaceae)
Artemisia annua (Asteraceae)
Asclepias cucullata (Asclepiadaceae)
Azadirachta indica (Meliaceae)
Azanza garkeana (Malvaceae)
Begonia homonymma (Begoniceae)
Boweia volubilis (Liliaceae)
Cannabis sativa (Cannabaceae)
Cassia abbreviata (Fabaceae)
Cassine transvaalensis (Celastraceae)
Cassine papillosa (Celastraceae)
Cassipourea gerradii (Rhizophoraceae)
Castanospermum australe (Fabaceae)
Catha edulis (Celastraceae)
Citrus sinensis (Rutaceae)
Curtisia dentata (Cornaceae)
Datura metel (Solanaceae)
Dianthus zeyheri (Illecebraceae)
Diospyros tricolor (Ebenaceae)
Dumasia villosa (Fabaceae)
Enantia polycarpa (Annonaceae)
Entada africana (Fabaceae)
Epinetrum undulatum (Ebenaceae)
Erythrina abyssinica (Fabaceae)
Erythrophleum lasianthum (Fabaceae)
Erythrophleum suaveolens (Fabaceae)
Euclea divinorum (Ebenaceae)
Euclea natalensis (Ebenaceae)
Faurea macnaughtonii (Proteaceae)
Garcinia epunctata (Clusiaceae)
Garcinia klaintana (Clusiaceae)
Garcinia kola (Clusiaceae)
Garcinia mannii (Clusiaceae)
Garcinia afzelii (Clusiaceae)
Gnidia kraussiana (Thymeleaceae)
Griffonia simplicifolia (Fabaceae)
Harpagophytum procumbens (Pedaliaceae)
Harpagophytum zeyheri (Pedaliaceae)
Haplormosia monophylla (Genus: Loesenera)
Haworthia limifolia (Liliaceae)
Helichrysum kraussii (Asteraceae)
Helichrysum odoratissimum (Asteraceae)
Irvingia gabonensis (Irvingiaceae)
Ledebouria hypoxidoides (Liliaceae)
Leptadenia hastata (Asclepiadaceae)
Loesenera kalantha (Genus: Loesenera)
Maytenus buchananii (Celastraceae)
Maytenus senegalensis (Celastraceae)
Monanthotaxis capea (Annonaceae)
Mondia whitei (Periplocaceae)
Myrothamnus flabellifolius (Myrothamnaceae)
Mystacidium millari (Orchidaceae)
Ocotea bullata (Lauraceae)
Okoubaka aubrevillei (Oknemataceae)
Olea welwitschii (Oleaceae)
Parinari curatellifolia (Chrysobalanaceae)
Pausinystalia johimbe (Rubiaceae)
Pentadiplandra brazzeana (Pentadriplandraceae)
Pergularia daemia (Asclepiadaceae)
Pericopsis elata (Fabaceae)
Pimpinella caffra (Apiaceae)
Plectranthus grallatus (Lamiaceae)
Podocarpus falcatus (Podocarpaceae)
Protea gauguedi (Proteaceae)
Prunus africana (Rosaceae)
Psidium guajava (Myrtaceae)
Pterocarpus angolensis (Fabaceae)
Pycnanthus angolensis (Myristacaeae)
Randia acuminata (Rubiaceae)
Rapanea melanophloeos (Myrsinaceae)
Rhigiocarya peltata (Menispermaceae)
Ricinodendron heudelotii (Euphorbiaceae)
Securidaca longipedunculata (Polygalaceae)
Sclerocarya birrea (Anacardiaceae)
Scilla natalensis (Liliaceae)
Scoparia dulcis (Scrophulariaceae)
Siphonochilus aethiopicus (Zingiberaceae)
Siphonochilus natalensis (Zingiberaceae)
Stangeria eriopus (Stangeriaceae)
Strophanthus barteri (Apocyanaceae)
Strophanthus thollonii (Apocyanaceae)
Swartzia madagascariensis (Fabaceae)
Synadenium cupulare (Euphorbiaceae)
Synaptolepis kirkii (Thymeleaceae)
Trichilia emetica (Meliaceae)
Urginea maritima (Liliaceae)
Voacanga africana (Apocynaceae)
Voacanga thuoarsii (Apocynaceae)
Voacanga grandifolia (Apocynaceae)
Warburgia salutaris (Canellaceae)
Zanthoxylum macrophyllum (Rutaceae)

The People and Plants Initiative

was started in July 1992 by WWF, UNESCO and the Royal Botanic Gardens, Kew to promote the sustainable and equitable use of plant resources through providing support to ethnobotanists from developing countries.

The initiative stems from the recognition that people in rural communities often have detailed and profound knowledge of the properties and ecology of locally occurring plants, and rely on them for many of their foods, medicines, fuel, building materials and other products. However, much of this knowledge is being lost with the transformation of local ecosystems and local cultures. Over-harvesting of non cultivated plants is increasingly common, caused by loss of habitat, increase in local use and the growing demands of trade. Long-term conservation of plant resources and the knowledge associated with them is needed for the benefit of the local people and for their potential use to local communities in other places.

The diversity of traditional plant-resource management practices runs through a spectrum from "cultivation" through to gathering "wild" plants, all of which are included in the People and Plants approach.

Ethnobotanists can work together with local people to study and record the uses of plant resources, identify cases of over-harvesting of non-cultivated plants, find sustainable harvesting methods and investigate alternatives such as cultivation.

The People and Plants initiative is building support for ethnobotanists from developing countries who work with local people on issues related to the conservation of both plant resources and traditional ecological knowledge. Key participants organize participatory workshops, undertake discussion and advisory visits to field projects and provide literature on ethnobotany, traditional ecological knowledge and sustainable plant resource use. It is hoped that a network of ethnobotanists working on these issues in different countries and regions can be developed to exchange information, share experience and collaborate on field projects.

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