7. THE IMPACT OF BEEKEEPING ON MANAGEMENT AND CONSERVATION OF FORESTS

THE IMPACT OF HONEY HUNTERS AND BEEKEEPERS ON FORESTS

All forest ecosystems contain indigenous species and races of bees, and some now contain introduced honeybee species. Not all indigenous bee species can be exploited by people for honey and wax, but in every forest ecosystem, there is usually one or more indigenous honeybee or stingless bee species that may be useful to man for honey production. In the past, honey hunting (described in Chapter 5) seems to have been practised in forests everywhere, and the value of forests for humans has almost always included their contribution to honey production. Case Study 4 gives an example from Europe.

CASE STUDY 4 - HONEY FROM EUROPE'S CHESTNUT *CASTANEA SATIVA* FORESTS

In past centuries, for people living in Europe's forested areas, which then included much of the Mediterranean's shoreline, forests of chestnut *Castanea sativa* were very important. These sweet chestnut forests extended from the mountainous uplands of Portugal and Spain, through France and into northern Germany, the west coast of Italy, and throughout central Europe as far as Turkey, and provided an important source of livelihood. In previous times, chestnuts were harvested and dried, milled into flour, or used whole with other foods, providing an excellent source of protein and carbohydrate-rich nutrition. When chestnut trees flowered between June and July, they provided abundant nectar and pollen forage for bees, from which is harvested valuable chestnut honey with a dark colour, a fruity scent like over-ripe apples, and a strong, slightly tannic flavour.

The chestnut forests provided a labour-intensive, slow-maturing harvest – the trees take 20 years to bear chestnuts, but then remain productive for a hundred years or more. The New World's quick-growing staples such as potatoes, maize and beans eventually replaced the chestnut crop. This left the forests, where chestnuts remained untended and vulnerable, no longer valued as providers of food and income. Equally at risk were the additional crops the forest supported, including the honey produced by the forest's indigenous *Apis mellifera* honeybees, as well as valuable fungi such as chanterelles and truffles.

In recent years, new harvesters have arrived in some of these forests, often escapees from urban life, who are commercially educated and aware of the need for the forests to create a livelihood. New industries have developed, using local labour and expertise to harvest the chestnuts and market them using modern methods of processing and packaging. Invisible earnings include a sustainable industry to assist the survival of smallholding communities in danger of losing their livelihoods, in addition to fine harvests of forest fungi, and the top value chestnut honey.

Forest trees and other flowering plants provide food and habitat for bees, and by pollination, bees enable them to reproduce. In addition to pollen and nectar, bees also collect propolis, honeydew and water, and trees provide nesting places for the bees.

Today's overexploitation of tree resources has many consequences that are documented elsewhere, but has also lead to decreased populations of honeybees. Loss of honeybee colonies not only deprives local people of sources of food and income, (see Case Study 6 from Benin below) but there will be consequences from lack of pollination leading to reduced biodiversity. It is impossible to value the role of bees as pollinators of trees in natural ecosystems, and understanding of the pollination of economically important crops is only partially understood. Yet, as explained in Chapter 3, most plants need an animal to visit their flowers in order for them to produce fertilised seeds, fruit, and future generations of the plant. Around half of the animal pollinators of plants are bees.

CASE STUDY 5 - HOPE IN THE CONGO

Paul Latham

The Salvation Army[10] runs a fascinating project in the lower Congo and it has been my privilege, from time to time, to have seen it in operation. It is helping rural people support themselves. As it has been in operation now for over 20 years it has achieved some impressive results.

Tata Buansa farms near Kavwaya. In the past, he farmed like his neighbours, cutting down the forest to plant his crops, until the forest had largely disappeared. Useless coarse grass still covers much of his land, taking out the goodness, which should have gone into his crops. This catches fire in the dry season killing any young tree seedlings that might germinate. However, for several years now Tata Buansa has been planting fast growing local trees in selected areas of his farm. The trees make the soil fertile, protect it from rain and encourage wild life. When they are cut down, the crops he plants afterwards grow on the stored fertility. Rather than wait for nature to replace gradually the tree cover he plants collected tree seed along with his crop so that they are protected by it and take over the land after harvest. He now runs his farm on a rotation, cropping the land every 10 years. Crop yields are up, he has plenty of firewood and building poles but he also is able to collect wild mushrooms, edible caterpillars and keep some beehives in his woodland. He finds the woodland is actually more productive than his crops!

Mama Christine is a beekeeper, also near Kavwaya. Beekeeping is a new activity in the lower Congo. In the past people simply raided wild colonies of bees living in trees or holes in the ground but now over a thousand people have taken up beekeeping and earn cash for paying school fees or medical expenses from it. From five hives, she harvested 75 litres of honey recently. That is worth more than most people earn in a year in the Congo. Beehives are usually made from wood but that is too expensive for most people. Instead, they use whatever is available and I have seen hives made out of old oil drums, plastic basins, bricks and raffia palm. African bees tend to be rather aggressive so, to protect themselves, Mama Christine and her friends use old cotton flour bags made up into bee-suits.

CASE STUDY 6 - SITUATION IN BENIN

Currently I am training beekeepers and their communities against deforestation and starting tree nurseries of specifically melliferous species at each individual site. Apparently, there has been a significant drop in honey production since the installation of the hives around year 2000 – drastic deforestation of the region has been a major contribution.

Jenny Hislop, PCV - Environmental Action, Athieme, reported in Bees for Development Journal *2005, 75, 11.*

An example where lack of pollinators has come to light is in the Amazon, where the destruction by fires of the habitat of the bee pollinators of brazil nuts (*Bertholletia excelsa*) is cited as one possible reason for the decline in Brazil nut production (Mori and Prance, 1990b). The detrimental consequence of habitat destruction, lack of pollinators, and subsequent loss of plant reproduction and habitat regeneration has been well described (Roubik, 1995). The Tanzania National Beekeeping Programme

[10] The War Cry 7 June 2003, 4-5 Reproduced with kind permission from The War Cry, The Salvation Army UK.

2001-2010 reports that bees are disappearing from many areas in the country due to the decreasing of availability of bee fodder, caused by an increase in deforestation[11].

In Africa, Asia, Central and South America it is often the most poor and most remote people, with few other livelihood options, who practise beekeeping. Many of these poorest people are living in areas that are rich in natural resources, such as tropical forests and woodlands, and beekeeping is a feasible way for them to create food and income using the natural resources around them.

Beekeepers and honey hunters are sometimes perceived to cause damage to forests, through the careless use of fire during harvesting and because they kill trees to make beehives. Beekeepers in some parts of Africa make bark hives by peeling cylindrical sections of bark from mature trees, which then die. The Forest Department/IRDP Beekeeping Survey explored this issue in the Zambia's North West Province from 1987-1992 (Claus, 1992). Here the researchers reported that the three species most used for making bark hives, *Cryptosepalum exfoliatum pseudotaxus, Brachystegia spiciformis* and *Julbernardia paniculata* were also excellent nectar species. The researchers also estimated that 3.1 trees/km^2 were destroyed by beekeepers in the whole province but this figure was later challenged by the honey trading company NWBP who believed the Beekeeping Survey had overestimated the number of beekeepers and therefore the number of trees harvested (Muzama, 1996). Despite this discrepancy researchers argued that even if the higher figure was accurate this was still well within the forests capacity to regenerate sustainably.

Serious late season fires can cause considerable damage to forests and where these are caused by honey hunters or beekeepers, it is due to carelessness in the use of fire to create smoke during honey harvest, or from campfires, as honey hunters and beekeepers always camp in the forest while they are collecting honey. However the survey undertaken in Zambia's North West Province also showed that beekeepers were strong advocates for forest conservation, as they value dense woodland and are keen to avoid damaging late fires. Clauss (1992) noted, "Beekeepers are generally worried about late fires between August and October which widely scorch the flush and above all the flower of the most important nectar species like *Cryptosepalum exfoliatum pseudotaxus, Brachystegia* spp. and *Copaifera"*. Early burning is a conventional forestry management practice that is employed to prevent late season wild fires, and it is reported that beekeepers understand and are supportive of this practice.

The beekeepers of Zambia's North West Province have managed to achieve good market access for their bee products through the company NWBP, and the prices they receive for their honey are enhanced because they have achieved organic certification. This adds further credence to the environmentally sound techniques of these beekeepers because Soil Association Organic certification inspectors deny organic certification to activities that cause forest destruction (Oxfam, 1995).

Evidence suggests that the beekeepers that have a clear financial gain from protecting the habitat of the bees are interested in forest conservation. What is not documented is the extent to which other beekeepers throughout the world are interested in and invest in forest conservation.

Forest Departments in some countries have banned people from making local-style log or bark beehives, as they perceive this to be a cause of tree destruction. This is a short sighted move as with no alternatives, this can seriously reduce the level of beekeeping which affects people's livelihoods, may reduce the potential bee population and yet local-style beehives can remain in use and productive for many years. There is often little interaction between the forestry and beekeeping sectors.

Beekeepers rarely own the land and forests where their bees forage. This is typical because in some societies, ownership of land is only secured through clearing forest and using the land to cultivate crops. Beekeeping, whilst important for income generation, does not create sufficient wealth to buy land. Rather, beekeepers recognise the value of communally owned forests or open access

[11] Ministry of Natural Resources and Tourism, Government of Tanzania (2001). National Beekeeping Programme 2001-2010.

woodland for beekeeping and take advantage of these resources. They have a stake in the maintenance of these areas of forest. Honey hunters and beekeepers are often knowledgeable about which trees are valuable for bees. Sometimes they tell that the special taste of a honey is because it comes from the nectar of a particular tree species. In many countries of Africa and Asia, trees holding wild nests of bees are regarded as valuable, and beekeeper families often have traditional ownership of such trees, even though they have no ownership of surrounding land. There are examples of beekeepers planting trees for bee forage, claiming usufruct ownership to individual trees that hold wild bee nests. Anecdotal evidence suggests that people who clear trees if they are being used to support beehives leave small clusters or strips of natural vegetation alone, and firewood and charcoal cutters may avoid areas where beehives have been sited because they are afraid of being stung. There are also examples of local-style hives acting as deterrents to elephants: on the Laikipia Plateau in Kenya, log hives were used to ‘mine’ a favourite elephant foraging area of fever tree *Acacia xanthophloea* regrowth (Vollrath, 2002).

CASE STUDY 7 - BEE TREES IN MALAYSIA

In the tropical forests of Malaysia, the so-called ‘giant honeybees’ *Apis dorsata* build their single comb nests high in tall trees such as *Koompassia excelsa* which have few horizontal branches. The lowest branches are at least 30 metres above the ground, and the trunk is smooth and without climbing plants and epiphytes. The main predators of these bees are bears and man. One such ‘bee tree’ may contain up to 200 colonies. In Sarawak, people from the Iban and the Kelabit tribes mention special trees as host trees for wild bees: *Alstonia scholaris*, *Hopea pentanervia*, *Shorea plantyclados* and other *Shorea* species, and *Ficus* sp. In many places in South East Asia, spirits were believed to live in the bee trees that protected the trees against being felled (Christensen, 2002).

Loss of trees has only negative implications for beekeepers: loss of food for bees, loss of nesting sites for bees, loss of materials for building hives, loss of places to keep hives. However, there has been little research to investigate how beekeepers make deliberate and conscious efforts to protect and conserve forests in which their bees forage, despite their dependency on these resources. This is an area of investigation that has been neglected and yet holds significant potential for future sustainable forest management initiatives.

BEES ADD TO THE VALUE OF TREES AND FORESTS

The multipurpose value of trees and forests is increasingly well appreciated, and beekeeping provides one of the most benign ways of obtaining a harvest from natural forests. Apiculture’s unique feature as an activity is the fact that its continuation, through pollination, fosters the maintenance of an entire ecosystem, and not just a single crop or species. Beekeeping is practised by a variety of different techniques that can be selected and adapted depending upon the situation of resource-poor farmers. Honey and beeswax are products that people can harvest which can be of world quality, and for which there are significant local and international markets. A significant proportion of honey produced in Africa is used to make beer and is valued for its medicinal and cultural properties. Beekeeping should always be taken into account when the economic importance of trees and forests are being calculated.

The financial outcome of forest beekeeping will, however, depend upon many variables including the skills of the practitioners, the markets available to them, as well as the botanical resources available, climate and other variables. The difficulty of making this calculation, the multiplicity of beekeeping practises and the widespread and small-scale nature of the activity means that there is little research data that can be quoted here. Furthermore, in many communities, the honey that is produced is consumed by family and neighbours, bartered for food and other goods or used to make beer for home use or sale. This makes it difficult to assign a market value to the honey. In some communities honey is used for medicinal purposes in which case the economic value could only be calculated if there were available equivalent medicines for sale. However, these medicines often have social and cultural values that are impossible to quantify.

The only route towards valuing forest beekeeping is to measure the income earned from the sales of bee products. The Tanzanian National Beekeeping Programme[11] describes beekeeping in Tanzania as a dynamic forest-based industry that is currently threatened by forest resource depletion but has the potential to earn foreign exchange. Table 6 shows the income earned over a 12-year period.

The Tanzania National Beekeeping Programme explains that at prevailing costs and profit margins, an ordinary beekeeper keeping an average of 150 local-style beehives can earn more than US$200 a year. This figure is comparable with income earned from beekeepers in Zambia (IFAD, 1997). Other site-specific figures of income are available but these rarely incorporate the costs of production.

TABLE 6
Beeswax and honey exports from Tanzania

Year	Beeswax		Honey	
	Metric Tons	Value US$	Metric Tons	Value US$
1988/89	326	324 070	20	14 727
1989/90	203	328 353	33	20 487
1990/91	234	378 495	38	23 591
1991/92	696	2 088 000	123	221 400
1992/93	569.5	1 522 739	32	31 216
1993/94	124	237 883	78	71 540
1994/95	120	371 625	19	25 837
1995/96	226	7 82 662	56	74 459
1996/97	326	1 359 843	310	370 094
1997/98	449	1 523 544	190	237 175
1998/99	403	1 440 678	39	35 533
1999/2000*	462	1 863 387	135	148 808

* Up to March 31, 2000.

The pollination services of bees are widely understood to be of immense value to natural and agricultural systems but putting a figure on this value is difficult. Some recent studies have however broken new ground by showing the gains in coffee yields and profit margins caused by the proximity of coffee bushes to natural forests that provide a habitat for bees. A study exploring the economic benefits of native ecosystems in Costa Rica found that forest-based pollinators increased coffee yields by 20 percent within approximately one kilometre of forest (Ricketts, 2004). The quality of the coffee near to the forest also improved as the frequency of "pea berries" (i.e. small misshapen seeds) was reduced by 27 percent. The economic value of the pollination services of the bees in two natural forest fragments (46 and 111 hectares) during 2000-2003, translated into US$60 000 per year for one Costa Rican farm. This works out to be $389 per hectare per year although this figure would rise if the benefits to other farms was also included, or it was found that a smaller area provided the same level of services. This value exceeds conservation incentive payments, where landowners are paid in the region of US$42 to conserve forest, as well as some non-forest land uses such as pasture for beef cattle that yield on average US$151 per hectare per year. These findings show that investment in maintaining the habitat of wild bees with an agricultural landscape yield significant economic benefits for coffee production. This study also supports the earlier findings of Roubik (2002) who also demonstrated that bees could augment pollination and boost coffee crop yields by over 50 percent. He concluded that coffee plants would benefit from being grown in habitats that are suitable for sustaining valuable pollinators.

The paucity of robust quantitative data about the value of forests for beekeeping and their contribution to livelihoods in financial terms, is one reason why beekeeping remains in the margins of development planning.

CASE STUDY 8 - BEE RESERVES IN TANZANIA

Yves Hausser, President of ADAP and Jean-Félix Savary, Head of Inyonga Project 2002[12]

The forests of Inyonga area are some of the least disturbed, wild ecosystems in Africa. They are located between the protected areas of Katavi National Park, Rukwa-Lukwati Game Reserve and Ugalla Game Reserve. Beekeeping is traditionally practiced in the area. However, immigration and environmentally destructive activities are posing a threat to these valuable ecosystems. Those responsible for protecting the area were attempting to disallow beekeepers access to the protected area, which in the meantime was being expanded. The Association for the Development of Protected Areas (ADAP) stepped in to assist the Government of Tanzania to tackle the problem and a multi-stakeholder workshop was held to explore some opportunities for improvement.

A major outcome of the workshop was a much clearer appreciation that beekeeping is environmentally friendly and contributes directly to the effective protection of the whole ecosystem by ensuring the long-term protection of the forests, whilst generating income for local communities and it relies on local knowledge and skills. Given the existing links between the beekeepers and ‘Goldapis’, a Tanzanian company that is marketing bee products, beekeeping also offers a highly viable income stream to local people.

This consequently led to the creation of Bee Reserves within the forests that would be protected and managed by beekeepers for their purposes. This provides them with a strong incentive to maintain and manage these forests.

BIODIVERSITY AND WILDLIFE

Efforts to encourage beekeeping inside wildlife parks and reserve areas are beneficial for the livelihoods of nearby communities. For example, in Nyika National Park, Malawi the Department of National Parks and Wildlife encouraged local people to place beehives in suitable foraging locations within the park. This allows local people to gain benefits from the park and therefore have a vested interest in its protection. It also has the added advantage that the beekeepers will engage in controlled early burning near their hives to protect them from later destructive wildfires. This activity also benefits naturally regenerating trees from the damaging effect of fires. Furthermore during the honey harvest periods, the beekeepers spend time in the park and can act as additional eyes and ears for the Departmental staff, and help to see and report poachers.

The National Beekeeping Policy of Tanzania includes the creation of bee reserves: this is a main component of the strategy to continue to promote beekeeping within the country. This development is taken in recognition of the positive relationship between beekeeping and forest protection, and that without adequate forest protection the bee industry could collapse.

[12] Hausser, 2002.

FLORAL CALENDARS

For any forest supporting populations of bees, it is possible to compile a flowering calendar which shows the times of year when important bee forage species flower. Typically, it is possible to compile lists of the most important bee trees as well as complementary or supplementary species. Complementary plants are those which "fill the gaps" in the flowering calendar of the important species, and supplementary species are those which can help to compensate fluctuations in main nectar flows. Complementary and supplementary species are therefore extremely important for bee habitats.

It is difficult to identify the causes of periodic fluctuations of flowering of important bees trees. Beekeepers interviewed in the NW province of Zambia during the Beekeeping Survey stated that good flowering of trees and shrubs is dependant on good rainy seasons and that fluctuations are normal. Studies on selected tree species undertaken by the Beekeeping Survey suggested additional factors that have effect upon flowering intensity such as hydrological conditions, heat waves, frost, fires and pests. In trees, the effect of these influences can persist for one year or longer masking cause and effect. Constantly interacting factors like soil conditions, genetic dispositions of single specimens as well as whole populations and biological characteristics also add to flowering fluctuations.

MELLIFEROUS TREE SPECIES

Beekeepers are always interested to observe the herbaceous plants, shrubs and trees that are especially important for bees, and will often know whether the bees are collecting nectar and/or pollen. Often beekeepers will recognise, from the colour of pollen being carried by workers arriving at the hive, which plant species the bee has been visiting. The following tables give details of nectar-producing tree species that may have other uses too, and are reproduced with kind permission from Bees and Trees (Svensson, 1991). As Svensson points out, these lists are not complete, but provide a stating point for further studies.

Other good nectar producers in lowland rainforest: *Acacia farmesiana*, *Alstonia bovrei*, *Combretum smeathmanii*, *Dalbergia kisantuensis*, *Erythrophleum guineense*, *Gaertnera paniculata*, *Gilbertiondendron dewevreii*, *Harungana madagascariensis*, *Mimosa pudica*, *Pentaclathra eetveldeana*, *Phyllanthus nivosus*, *Prosopis chilensis* and *Virectaria multiflora*.

TABLE 7
Nectar-producing tree species

Terms used	Abbrev.	Explanation
Vegetation zone		Divisions between vegetation zones have been made as simple as possible. Some tree species are represented in many different zones (e.g. *Citrus* spp., *Coffea* spp., *Cordia* spp., *Eucalyptus* spp.).
Pollen	P	The tree is reported by at least one author as a major pollen source for bees.
	(P)	The tree is reported to give pollen of value to bees.
	-	No information.
Food	Fo	Food for humans can be prepared from flowers, fruit, seeds, leaves, bark, etc.
Fodder	Fd	The tree provides fodder for at least one kind of animal.
Fuel	Fu	The tree has value for firewood production.
Timber	Ti	The tree has value as timber.
Land	La	The tree has a value for land use, land conservation or land development such as windbreaks, shade, forestation, land reclamation, living fences, fire belts, soil conservation, nitrogen fixation, organic mulch, weed control, erosion control, or sand stabilization.
Ornamental	Or	The tree has a value for amenities.
Others	+1	Other uses such as medicinal, insecticidal, oil, wax, gas, fibres, tannin, or dyes. The number given indicates number of other uses.

TABLE 8
Nectar-producing species in lowland rainforest

Tree name	Pollen	Food	Fodder	Fuel	Timber	Land	Ornamental	Others
Anacardium occidentale	(P)	Fo		Fu	Ti			+4
Brachystegia laurentii	-							
Coffea spp.	(P)	Fo	Fd			La		
Cordia alliodora	(P)							
Cynometra alexandrii								
Eugenia spp.								
Gymnopodium antigonoides	-			Fu				
Haematoxylum campechianum	P				Ti		Or	+1
Hevea brasiliensis	-							+2
Ilex spp.	-							
Inga spp.	(P)					La		
Litsea glabberima	P							
Lonchocarpus spp.	-							
Musa spp.	P	Fo						+1
Nephelium lappaceum	(P)	Fo						+1
Pithecellobium spp.	P	Fo	Fd	Fu	Ti	La	Or	+3
Syzygium spp.	(P)	Fo	Fd	Fu	Ti	La	Or	+4
Terminalia spp.	(P)			Fu	Ti	La	Or	+3

TABLE 9
Nectar-producing species in highland forests

Tree name	Pollen	Food	Fodder	Fuel	Timber	Land	Ornamental	Others
Acacia polyphylla	-							
Aesculus spp.	P		Fd	Fu	Ti	La	Or	+1
Calcophyllum Candidissimum	-				Ti	La		
Castanea sativa	P	Fo			Ti		Or	
Citrus spp.	P	Fo					Or	+3
Correa spp.	(P)	Fo	Fd			La		
Cordia spp.	(P)	Fo			Ti	La		
Croton spp.	(P)							
Dombeya rotundifolia	P				Ti		Or	+1
Erica arborea	P				Ti		Or	+1
Eriobotrya japonica	P	Fo					Or	
Eucalyptus spp.	P		Fd	Fu	Ti	La	Or	+6
Gleditsia triacanthos	(P)	Fo	Fd	Fu	Ti	La	Or	
Gliricidia sepium	-	Fo	Fd	Fu	Ti	La	Or	+3
Grevillea robusta	(P)			Fu	Ti	La	Or	
Inga spp.	(P)					La		
Musa spp.	P	Fo						+1
Olea africana	(P)	Fo	Fd	Fu	Ti			+1
Robinia pseudoacacia	P	Fo	Fd	Fu	Ti	La	Or	
Tilia spp.	(P)				Ti	La	Or	+2
Tipuana tipu	-				Ti			
Trichilia glabra	-				Ti			
Vernonia polyanthus	(P)							
Vitex spp.	-	Fo						+3
Ziziphus jujube	(P)	Fo					Or	

Other good nectar producers in highland forest: *Albizia* spp., *Cupania* spp., *Matayba apetala*, *Ricinus communis*, *Rosa abyssinica* and *Triumfetta rhomboidoea*.

TABLE 10
Nectar-producing species in wooded grassland (savannah)

Tree name	Pollen	Food	Fodder	Fuel	Timber	Land	Ornamental	Others
Acacia spp.	(P)	Fo	Fd	Fu	Ti	La	Or	+5
Azadirachta indica	(P)	Fo	Fd	Fu	Ti	La	Or	+4
Brachystegia spp.	(P)	Fo		Fu	Ti	La	Or	+4
Calycophyllum candidissimum	-				Ti	La		
Ceiba pentandra	P	Fo	Fd		Ti	La	Or	+1
Cochlospermum spp.	(P)					La		
Combretum spp.	-			Fu	Ti			+5
Cordia spp.	(P)	Fo			Ti	La	Or	
Cryptosepalum pseudotaxus	-							+1
Dialium engleranum	-	Fo						+1
Dombeya rotundifolia	P				Ti		Or	+1
Eucalyptus spp.	P		Fd	Fu	Ti	La	Or	+6
Faurea saligna	(P)				Ti			+2
Gilibertia spp.	-							
Isoberlina spp.	-				Ti			+2
Julbernardia spp.	-				Ti			+5
Leucas aspera	(P)							
Lonchocarpus spp.	-							
Madhuca longifolia	(P)	Fo						+2
Marquesia macroura	-				Ti			+1
Parkia biglobosa	-	Fo	Fd		Ti	La		+2
Prosopis spp.	P	Fo	Fd	Fu	Ti	La	Or	+2
Pterocarpus spp.	(P)				Ti			
Sclerocarya caffra	(P)	Fo	Fd					+2
Syzygium spp.	(P)	Fo	Fd	Fu	Ti	La	Or	+4
Terminalia spp.	(P)			Fu	Ti	La	Or	+3

Other good nectar producers in wooded grassland: *Adansonia digitata*, *Albizia* spp., *Bauhinia* spp., *Burkea* spp., *Commiphora* spp., *Copaifera guineense*, *Erythrina* spp., *Erythrophleum*, spp., *Euphorbia* spp., *Ficus sycamorus*, *Grewia* spp., *Hymenocardia* spp., *Jacaranda mimosifolia*, *Lannea* spp., *Parianari* spp., *Protea* spp., *Pseudolachnos tylois*, *Schinus molle*, *Schwartzia madagascariensis* and *Vernonina* spp.

TABLE 11
Nectar-producing species in arid and semi-arid land

Tree name	Pollen	Food	Fodder	Fuel	Timber	Land	Ornamental	Others
Acacia spp.	(P)	Fo	Fd	Fu	Ti	La	Or	+5
Adansonia digitata	-	Fo	Fd		Ti	La		+4
Balanites aegyptiaca	-	Fo	Fd	Fu	Ti			+3
Combretum spp.	-			Fu	Ti			+5
Commiphora spp.	-		Fd	Fu	Ti			+2
Cordia spp.	(P)	Fo			Ti	La	Or	
Dombeya rotundifolia	P				Ti		Or	+1
Eucalyptus spp.	P		Fd	Fu	Ti	La	Or	+6
Euphorbia spp.	P	Fo				La		+1
Guaiacum officinale		-			Ti		Or	+2
Gymnopodium antigonoides		-		Fu				
Khaya senegalensis			Fd		Ti			
Leptospermum spp.	(P)				Ti	La		
Parkinsonia aculeate	(P)	Fo	Fd	Fu		La	Or	
Prosopis spp.	P	Fo	Fd	Fu	Ti	La	Or	+2
Terminalia spp.	(P)	Fu			Ti	La	Or	+3
Ziziphus spp.	(P)	Fo	Fd	Fu	Ti	La		+3

TABLE 12
Nectar-producing species in coastal plains

Tree name	Pollen	Food	Fodder	Fuel	Timber	Land	Ornamental	Others
Acacia spp.	(P)	Fo		Fu	Ti	La	Or	+5
Anacardium occidentale	(P)	Fo		Fu	Ti			+4
Antigonon leptopus	P	Fo					Or	
Bombax ceiba	P	Fo	Fd		Ti	La		+2
Bucida buceras	(P)				It		Or	
Ceiba pentandra	P	Fo	Fd		Ti	La	Or	+1
Citrus spp.	P	Fo					Or	+3
Coccoloba uvifera	-	Fo						
Cocus nucifera	P	Fo	Fd		Ti		Or	+3
Cordia spp.	(P)	Fo			Ti	La		
Durio zibethinus	(P)	Fo						
Ehretia acuminata	(P)		Fd		Ti		Or	
Eucalyptus spp.	P		Fd	Fu	Ti	La	Or	+6
Haematoxylon campechianum	(P)				Ti		Or	+1
Litchi chinensis	(P)	Fo						
Mangifera indica	P	Fo				La	Or	
Melicoccus bijuga	-	Fo				La		
Musa spp.	P	Fo						+1
Nephelium lappaceum	(P)	Fo						+1
Parkinsonia aculeata	(P)	Fo	Fd	Fu		La	Or	
Persea americana	(P)	Fo						
Pithecellobium arboreum	(P)				Ti			
Psidium guajava	P	Fo			Ti			+3
Roystonea regia	P		Fd			La	Or	
Schinus terebinthifolius	-	Fo	Fd		Ti	La	Or	+3
Syzygium spp.	(P)	Fo	Fd	Fu	Ti	La	Or	+4
Triplaris surinamensis	-				Ti		Or	

TABLE 13
Nectar-producing species in mangrove

Tree name	Pollen	Food	Fodder	Fuel	Timber	Land	Ornamental	Others
Avicennia spp.	(P)	Fo	Fd	Fu	Ti			
Nyssa spp.	-	Fo			Ti		Or	
Rhizophora mangle	-			Fu	Ti	La		+4
Serenoa repens	(P)							

Other good nectar producers: *Actinidia chinensis*, *Agave sisalana*, *Albizia* spp., *Aleurites* spp., *Annona* spp., *Averrhoa carambola*, *Bauhinia purpurea*, *Cola* spp., *Cydonia oblonga*, *Eugenia* spp., *Feijoa sellowiana*, *Ficus* spp., *Jacaranda mimosifolia*, *Macadamia integrifolia*, *Malpighia* spp., *Phoenix dactylifera*, *Pistacia vera*, *Pyrus* spp. and *Ricinus communis*.

TABLE 14
Nectar-producing species for agricultural land, roadside plantings and urban areas

Tree name	Pollen	Food	Fodder	Fuel	Timber	Land	Ornamental	Others
Anacardium occidentale	(P)	Fo		Fu	Ti			+4
Antigonon leptopus	P	Fo					Or	
Azadirachta indica	(P)	Fo	Fd	Fu	Ti	La	Or	+4
Carica papaya	(P)	Fo						+3
Cassia siamea	(P)		Fd	Fu	Ti	La	Or	+1
Castanea spp.	P	Fo			Ti		Or	
Ceiba pentandra	P	Fo	Fd		Ti	La	Or	+1
Citrus spp.	P	Fo					Or	+3
Cocos nucifera	P	Fo	Fd		Ti		Or	+3
Correa spp.	(P)	Fo	Fd			La		
Diospyros spp.	-	Fo			Ti			+3
Durio zibethinus	(P)	Fo						
Elaeis guineensis	P	Fo	Fd	Fu				+2
Eucalyptus spp.	P		Fd	Fu	Ti	La	Or	+6
Euphoria longana	-	Fo						
Gliricidia sepium	-	Fo	Fd	Fu	Ti	La	Or	+3
Grevillea spp.	(P)			Fu	Ti	La	Or	
Litchi chinensis	(P)	Fo						
Malus spp.	P	Fo						
Mangifera indica	P	Fo				La	Or	
Melicoccus bijuga	-	Fa				La		
Moringa oleifera	P	Fo				La	Or	+3
Musa spp.	P	Fa						+1
Nephelium lappaceum	(P)	Fo						+1
Persea americana	(P)	Fa						
Prosopis spp.	P	Fo	Fd	Fu	Ti	La	Or	+2
Prunus spp.	(P)	Fo					Or	
Psidium guajava	P	Fo			Ti			+3
Roystonea regia	P		Fd			La	Or	
Sapindus detergens	(P)					La	Or	+3
Schinus terebinthifolius	-	Fo	Fd		Ti	La	Or	+3
Syzygium spp.	(P)	Fo	Fd	Fu	Ti	La	Or	+4
Tamarindus indica	P	Fo	Fd	Fu	Ti	La	Or	+3
Terminalia arjuna	(P)			Fu	Ti	La	Or	+3
Tilia spp.	(P)				Ti	La	Or	+2
Toona ciliata	(P)		Fd		Ti		Or	+2
Ziziphus spp.	(P)	Fo	Fd	Fu	Ti	La		+3

TABLE 15
Nectar-producing species for commercial plantation

Tree name	Pollen	Food Fodder		Fuel	Timber	Land	Ornamental-	Others
Anacardium occidentale	(P)	Fo		Fu	Ti			+4
Ceiba pentandra	P	Fo	Fd		Ti	La	Or	+1
Citrus spp.	P	Fo					Or	+3
Cocos nucifera	P	Fo	Fd		Ti		Or	+3
Coffea spp.	(P)	Fo	Fd			La		
Dalbergia sissoo	-		Fd	Fu	Ti	La	Or	
Elaeis guineensis	P	Fo	Fd	Fu				+2
Eucalyptus spp.	P		Fd	Fu	Ti	La	Or	+6
Gmelina arborea	P			Fu	Ti			+1
Hevea brasiliensis	-							+2
Manihot glaziovii	(P)					La	Or	+1
Musa spp.	P	Fo						+1

Other good nectar producers for possible plantation use: *Albizia falcataria*, *Balanites aegyptiaca*, *Cordia* spp., *Leucaena leucocephala*, *Melia azadirachta*, *Sclerocarya caffra*, *Shorea robusta*, *Tamarindus indica*, and *Ziziphus abyssinica.*

BEEKEEPING IN MANGROVES

Mangrove is highly specialized coastal forest growing only in brackish or salt water in tropical and subtropical regions, and covering more than 70 percent of the tropical and subtropical coastlines. Different mangrove species form zones in the inter-tidal region or even beyond, they protect and stabilize low-lying coastal land and provide protection and food sources for estuarine and coastal fishery food chains. Mangroves serve as feeding, breeding, and nursery grounds for a variety of fish, shellfish, birds and other wildlife. In America and West Africa, the red mangrove (*Rhizophora mangle*) forms the outermost zone. These red mangrove trees have prop roots that provide attachment surfaces for oysters and other organisms, and protection for crabs and fish. Other mangrove species are the white mangrove (*Laguncularia racemosa*), black mangrove (*Avicennia germinans*), and buttonwood (*Conocarpus erectus*). These species are distantly related and are only grouped based on their similar ecological functions within mangroves. In Asia, the red mangrove is formed by *Rhizophora mucronata* and *Rhizophora conjugate*. The black mangrove (*Avicennia nitida*) forms a zone nearer the shore, with its roots sticking up vertically above the mud. Here the soils are exposed to the air at low tide, but covered at high tide. The highest trees in the mangrove can be over 40 metres tall, but usually mangrove trees rarely exceed 10 metres.

The ecological importance of the mangrove is huge. It prevents coastal erosion, and mangroves produce significant leaf litter that benefits estuarine food chains: many depend upon the continuously dropped evergreen leaves from the mangrove vegetation. Mangrove creates an important protection, foraging and breeding area for birds, fish, mussels, crabs, manatees and dugongs. Mangrove vegetation is threatened by man. Every year the world area of mangrove is diminished because the vegetation is cut for termite resistant timber and firewood and to give room for rice fields, shrimp farms, tourism and other human activities. Destruction of mangrove has been one of the factors, along with removal of coral reefs and coastal dunes, which lead to the massive coastal destruction and loss of life in South India, Sri Lanka, Thailand and Indonesia following the December 2004 Tsunami.

The black mangrove *Avicennia germinans* is also known as the honey mangrove. It has small white flowers that produce abundant nectar. There is little research on the relationship between bees and mangrove, however from observation of the type of pollen, nectar and scent, it appears that mangrove species are dependent upon bee pollination, and mangrove provides excellent forage for bees and significant honey crops (Hogarth, 1999; Lacerda, 2002). In Florida the main species for pollen and nectar production are the black mangrove *Avicennia germinans*, buttonbush (*Conocarpus erectus*), and white mangrove (*Laguncularia racemosa*) (Stanford, 1983). Local beekeepers also regard the red mangrove (*Rhizophora mangle*) as contributing to the nectar producing species of importance for beekeeping. Many beekeepers in Florida migrate their hives between the citrus growing areas in central Florida and the mangrove areas, with the mangrove honey season extending from mid May to early August. Average honey production from the mangrove is 35-40 kilogram per colony (Hamilton and Snedaker, 1984). In Cuba, there is a tradition of moving thousands of bee colonies to mangrove during its long blooming season. Mangrove areas have high potential for honey production: this can be seen also from the high numbers of honey hunters visiting mangrove in some countries, unfortunately often using destructive methods of harvesting, for example as seen in the Sundarbans of Bangladesh (Burgett, 2000).

When mangrove occurs near dry areas, for example such as in West Africa where the Rivers of Gambia and Senegal are lined with mangrove vegetation and extend inland for 150 kilometres, the mangrove provides some of the best flowering forage available to bees. In this area, mangrove is considered by local beekeepers to be one of the best types of vegetation for beekeeping.

Termites and specially adapted ants existing on and in mangrove trees are not a great problem compared to termite and ant problems in the savannah. Hives placed in mangrove are well protected against seasonal bushfires, although they can be difficult to protect from thieves. Between the mangrove trees is black, sticky mud, and it can be a problem to transport and place hives in the area. The hives must be situated above the highest spring tide level, and above the highest level of the river following heavy rain.

CASE STUDY 9 - BEEKEEPING IN THE MANGROVE OF BIJAGOS ISLANDS, GUINEA BISSAU

Ole Hertz

The easiest way to achieve sustainable beekeeping in mangrove is just to harvest the biggest honeycombs from a wild and free-building colony. The necessary equipment is protective clothing, a smoker, a knife, a bucket and some type of bee brush. This type of beekeeping developed as a result of the Danish supported beekeeping project in Bijagos Islands west of Guinea Bissau. The beekeepers look for wild bee colonies in the mangrove and when a new one is found, it is marked as a sign that it belongs to a beekeeper. Because of the protective clothing, the beekeeper (or honey hunter) does not have to kill the bee colony as happened previously. The smoker can be used to move most of the bees away from the honeycombs, which are then carefully cut off, brushed free from the last bees, and transported home to be pressed. One beekeeper can in this way, without any high investment, become the owner of 30 or more bee colonies.

Beekeeping provides one of the few sustainable ways to use mangrove. If the beekeeping is done without harming the bees, it has no negative impact. On the contrary, because of pollination of the trees by foraging bees, beekeeping may exert a positive influence on the forest, and beekeeping extension can be used as a way to protect the mangrove vegetation against being cut. By making the local people aware of the economical potential in mangrove beekeeping, it is easier to protect the vegetation against total destruction from cutting and burning.