RICINODENDRON HEUDELOTII

A State of Knowledge Study undertaken for

the Central African Regional Program for the Environment

by

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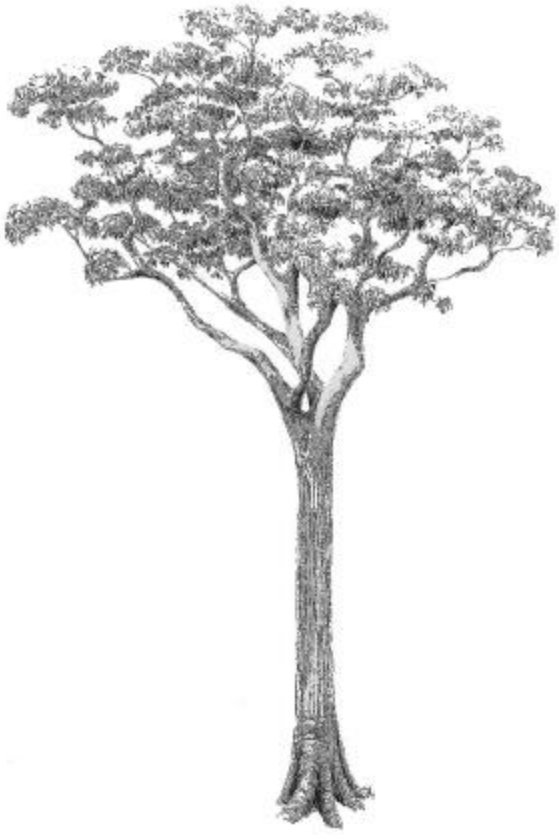

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Cover illustration from White and Abernethy (1997)

1. Introduction

Ricinodendron heudelotii is a fast-growing late secondary forest tree found in the Guinean-Congolean humid forests of West and Central Africa. It is valued for its distinctively-flavoured seeds, most commonly called 'njansang', which are dried and ground and used as a flavouring and thickening agent in food. The seeds are exported in the region, and to European cities with West African populations. The tree also has many medicinal uses, some of which are highly localised, and it is grown by farmers as a soil improver, for forage, shade, poles, and light woodwork. It is mainly found in secondary forest and on the fringes of settlements, but in the future, management of the species on farms may be necessary as forest extent diminishes and agriculture spreads with population growth. *Ricinodendron heudelotii* has been planted on the compound farms of Nigeria, and in plantations as a fast-growing shade tree. Research is being carried out on vegetative propagation of the species to make it more productive and reduce the length of time it takes for a sapling to begin fruiting.

The material gathered together in this survey relies heavily on work carried out by CARPE, ICRAF, the Tropenbos programme in Southern Cameroon, and in the Mount Cameroon Project, and is therefore not representative of knowledge and use of the species throughout its area of distribution. There is also reliance on material gathered from Anglophone and Francophone countries and published in Europe. This study should therefore not be considered as definitive but as a starting point for increasing the state-of-knowledge of the uses and importance of *Ricinodendron heudelotii* in Africa, and its place in the local economy and potential for commercialisation.

2. Taxonomy

Ricinodendron heudelotii (Baill.) Pierre ex Heckel, Ann. Inst. Col. Marseille, V.2, p.40 (1898) p.p.

Table 1 Identification of subspecies of *Ricinodendron heudelotii* as defined by Léonard (1961)

Plant part	subsp. *heudelotii*	subsp. *africanum*
Petiole	Without glands at the top on the upper surface, or occasionally with 1-2 glands. The base has (1)2-4(6) large glands, or exceptionally there are no glands. There are 3 or 5 stipules.	Generally with (1)2 large glands at the top on the upper surface, or fairly often without glands. The base lacking glands, or exceptionally with 1(4) gland(s). Generally 5 stipules, rarely 3-4, fairly often (6)7.
Flower	Female flowers with 3-locules and 3 styles.	Female flowers with 2-locules, very rarely 3, and 2, or very rarely, 3 styles.
Fruit	3-locules, 3-lobed, from 1.5-2 cm long and 2.4-3.4 cm in diameter, when dried. Sometimes 2-lobed or without lobes resulting from the abortion of 1 or 2 seeds.	2-locules, 2-lobed, from 1.3-2.5 cm in length and breadth , and 2.4-3.5 cm in width when dried, sometimes unlobed resulting from abortion of a seed, and very rarely 3-celled.

In 1961 J. Léonard proposed identifying *Ricinodendron heudelotii* (Baill.) Pierre ex Heckel based on *Jatropha heudelotii* Baill. 1860, and *R. africanum* Müll. Arg. 1864, as 2 closely-related subspecies originating from two distinct areas (Léonard 1961:396-401): *Ricinodendron heudelotii* subsp. *africanum*, and *Ricinodendron heudelotii* subsp. *heudelotii*. The main identifying features of the two subspecies proposed by Léonard, apart from their distribution, was that generally, but not invariably, subspecies *heudelotii* has ovaries divided in 3, 3 styles, and 3-seeded fruits, whilst subspecies *africanum* generally but not invariably, has ovaries divided in 2, 2 styles, and 2-seeded fruits (Table 1).

3. Distribution

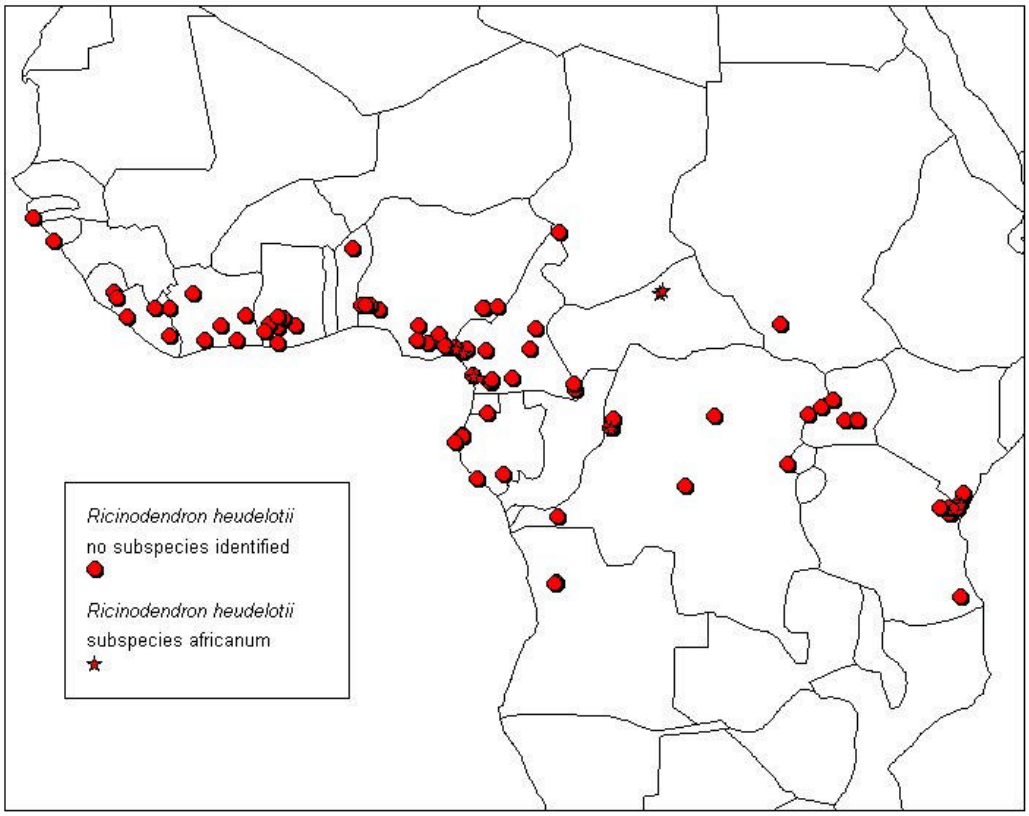

Figure 1 Collection locations of herbarium specimens from Kew, Meise, Missouri, Oxford and Wageningen, of *R. heudelotii*

Ricinodendron heudelotii is found from Senegal (Laird *et al.* 1997) in West Africa to Sudan (Keay 1989:152), Uganda (Normand & Paquis 1976:67; Keay 1989:152; Chudnoff 1984:270) and Tanzania (Léonard 1961:400; Hall & Swaine 1981:275; Keay 1989:152; Laird *et al.* 1997), and from Sudan down the western coast of sub-Saharan Africa to Angola (Léonard 1961:397; Normand & Paquis 1976:67; Keay 1989:152; Vivien & Faure 1996; Laird *et al.* 1997). The species has also been reported occurring in Mozambique (Léonard 1961:400; Normand & Paquis 1976:67; Keay 1989:152), but the earliest reference found – by Léonard in 1961 – describes the occurrence as 'ex. bibliogr.'

Léonard proposed a distribution of the two subspecies as: *R. heudelotii* subsp. *africanum* found in Nigeria, Cameroon, Equatorial Guinea, Congo, Angola, Central African Republic, Sudan, Democratic Republic of Congo, Uganda, Tanzania, and Mozambique (Léonard 1961:397-398), and *R. heudelotii* subsp. *heudelotii* occurring in Guinea-Bissau, Equatorial Guinea, Sierra Leone, Liberia, Côte d'Ivoire, and Ghana (Léonard 1961:399-400). The generally accepted distribution for the two subspecies therefore is Ghana and westwards for *R. heudelotii* subsp. *heudelotii*, and Nigeria and eastwards for *R. heudelotii* subsp. *africanum*.

4. Habitat

Ricinodendron heudelotii is a light-demanding species occurring most frequently in fringing, deciduous and secondary forests (Taylor 1960:164-5; Burkill 1994:130-132). It is common throughout the semi-dry wooded-savanna zone of Central and West Africa, and is found throughout south west Cameroon in forest, fallow, and cocoa and other farms, in drier types of

forest and in secondary regrowth (Laird *et al.* 1997). In Ghana in the 1960s it was observed throughout the high forest zone and in the riverain forest of the southern savannah-woodland, but was less common in the rain forest than in the moist semi-deciduous forest (Taylor 1960:164-5).

Table 2: Léonard (1961) separation of subspecies *heudelotii* and *africanum*.

Ricinodendron heudelotii (Baill.) Pierre ex Heckel., Ann. Inst. Col. Marseille, V.2, p.40 (1898) p.p.

~subsp. *heudelotii*
Portuguese Guinea (Fulacunda, S. Joâo, Mato de Poncom); Guinea (Fouta Djallon); Sierra Leone (Bagroo River); Liberia (Dukwia R.); Ivory Coast (Dabou, Danané, 60km N. of Sassandra); Ghana (Sikamang, Kumasi).

~subsp. *africanum*
Nigeria (Imperial Institute; Calabar River Division; Ishagama-Ibadan); Fernando Po; Cameroon (Babua; Duala; Bipinde); Spanish Guinea (Nkolentangam); Gabon (Libreville); Congo Republic (Congo); Cabinda (Chiluango); Angola (Loanda - Cazengo, Luanda - Ambriz); Central African Republic (Boukoko); Sudan (Bendere - Zande District); Congo (Eala, Yangambi); Uganda (Semliki Forest); Tanganyika (Korogwe, Eastern Usambaras, Tanga District [1 location?]); Mozambique (ex bibliogr.).

The area for subsp. *africanum* is very different from that of subsp. *heudelotii*. These 2 distributions constitute a new and fine example of geographical distribution, underlying the necessity of establishing a phytogeographic boundary between the western and eastern regions of the Guinea-Congolese area.

Source: Léonard 1961: 396-401. For Guinea-Congolese phytogeographic zones, see also Léonard 1963: Carte 1, facing p. 634.

It is described as a lower-altitude species, not found in montane forests (Vivien & Faure 1996) although many of the observations in this study are from above 1000 m. (See Appendix 1, p.28). In Uganda it grows scattered throughout the lower altitude rain forests in gaps, at forest edges, and in secondary scrub and thickets. It is common in the Budongo Forest (Katende *et al.* 1995:536). In the Mount Cameroon region it grows in lower forest areas, such as Mabeta-Moliwe and along the West Coast to Idenau (Laird *et al.* 1997), but in the Mbalmayo Forest Reserve, in Cameroon observations were made in secondary semi-deciduous moist forest at 640m above sea level (Musoko *et al.* 1994). Fondoun *et al.* collected their data from trees occurring up to 1030 m in southern Cameroon (Fondoun, Tiki Manga & Kengue 1999:1-6).

In the South Province of Cameroon, an average density of 2.1 stems/ha. was observed in secondary forest, with a maximum density of 4.1 stems/ha. (Van Dijk 1999:42), and in the Mbalmayo Forest Reserve (3º31´ N, 11º30´ E), a higher density of 5 individuals/ha was observed (Musoko *et al.* 1994). Van der Linden measured the following relative densities of *R. heudelotii* in the Dja Fauna Reserve, East Cameroon (Van der Linden 1994):

- Altitude 3,000 m, dbh >10 cm, 0.7 stems/ha; dbh >70 cm, 0.3 stems/ha.
- Altitude 2,850 m, dbh >10 cm, 1 stem/ha; dbh >70 cm, 0.3 stems/ha.
- Altitude 1,650 m, dbh >10 cm, 2.4 stems/ha; dbh >70 cm, 0.5 stems/ha.

In Cameroon, where it is planted to shade coffee and cocoa plantations, it is planted at a density of 0.4 trees/ha in coffee plantations, and 0.2 trees/ha in cocoa plantations (Mapongmetsem & Tchiegang 1996:18).

5. Botany

Ricinodendron heudelotii is a fast-growing tree, reaching up to 50 m in height and 2.7 m in girth, or a diameter of 150 cm (Heitz 1943:80; Leeuwenberg 1958: herb. spec.; Latilo 1959: herb. spec.; Keay *et al*. 1960:257; Keay 1989:152; Adjanohoun 1991:147; Shiembo 1994:21; ICRAF 1999) with a widely spreading crown (Chapman 1977: herb. spec.) which is low, rounded and frequently reminiscent of a candelabrum (Taylor 1960:164). The tree is deciduous (Katende *et al*. 1995:536; Kennedy 1936:78; Vivien & Faure 1996:153) with flowers and young leaves appearing together (Kennedy 1936:78; Thomas 1984: herb. spec.) and has 'sticky gum' (Thomas 1984: herb. spec.). It is not a long-lived tree; dead standing specimens are not uncommon (Taylor 1960:164).

5.1 Trunk and Bark

The trunk is generally described as being straight and cylindrical (Heitz 1943:80; Versteegh & Outer 1969: herb. spec.; Chapman, J.D. 1977: herb. spec.; Katende *et al.* 1995:536; ICRAF 1999), but also it may be slightly sinuous or twisted (Thikakul 1985:305; Vivien & Faure 1985:202; 1996:153). Adjanohoun describes *R. heudelotii* as having a stocky trunk (Adjanohoun 1991:147), as does Taylor (1960:164) who says the bole is frequently short and often very twisted and fluted to the crown.. The buttresses are variously described as:

- Short buttresses on straight bole (Chapman, J.D. 1974: herb. spec.)
- Short broad buttresses, some of which extend up to 20 ft from the tree as big surface roots (Chapman, J.D. 1977: herb. spec.).
- Broad rounded buttresses (Letouzey 1986:153).
- Short buttresses at the base (Katende *et al*. 1995:536).
- Thick buttresses extending into large horizontal roots (Vivien & Faure 1996:153).

Patrick Shiembo observes that hitting the bole of the tree with the back of a cutlass produces a characteristic hollow sound (Shiembo 1994:21).

The branches are sappy, with branchlets conspicuously arranged in whorls of five (Kennedy 1926:78; Leeuwenberg 1958: herb. spec). They are more or less horizontal, arching upwards in young trees, whilst old trees have widely spreading, crooked branches, (Keay *et al.* 1960:257; Keay 1989:152; Katende *et al.* 1995). Branches may break off suddenly (Taylor 1960:164). The branchlets are up to 1 cm thick, and are densely brown hairy when young (Katende *et al.* 1995:536). The foliage is dense and dull-green (Heitz 1943:80).

Descriptions of the colour of the bark range from light grey, almost white, (Heitz 1943:80; Vivien & Faure 1996:153) to grey-brown (Leeuwenberg 1980: herb. spec.; Katende *et al*. 1995:536), to brownish (Thikakul 1985:305; Keay *et al.* 1960:257; Keay 1989:152), to a herbarium specimen described as having a dark brown bark (Chapman 1977). In old trees the bark is grey, and higher up the bole the bark is green and smooth (Kennedy 1936:78).

The texture of the outer bark is said to be smooth at first, becoming scaly with ageing (Keay *et al*. 1960:257; Keay 1989:152; Katende *et al*. 1995:536; ICRAF 1999), and finely and regularly fissured (Heitz 1943:80; Letouzey 1986:153). Two herbarium specimens collected in 1974 and 1978 have contradictory descriptions of the bark, but there is no indication of which part of the tree is being described. One tree which was 'well over 100 ft tall' had a scaly bark (Chapman, J.D., 1977) and the other, slightly smaller ('tree up to 90 ft tall') had a smooth bark (Chapman, H.M., 1974).

Leeuwenberg describes the inner bark as being 'brownish-creamy, 3 mm. thick' (Leeuwenberg 1980: herb. spec.). For a more vivid account, there is the herbarium specimen collected by Versteegh and Outer: 'Rhytidoma 2 mm; living bark 4 mm, white with orange and wine-red tang. [sic?] stripes and turning brown on exposure; with bloody-red sap' (Versteegh & Outer 1969: herb. spec.), or the literal translation from Vivien and Faure: 'Light-grey (1-1.5 cm), smooth, with

a surface marked with [lit.] pustulous lenticels, often horizontally streaked' (Vivien & Faure 1996:153).

In herbarium specimens of *R. heudelotii* from Nigeria, Côte d'Ivoire and Liberia the slash is described as reddish (Chapman 1974: herb. spec.; Chapman, J.D. 1977: herb. spec.; Leeuwenberg 1980: herb. spec.) or reddish-brown (Latilo 1959: herb. spec.), or pale red, juicy and soft (Voorhoeve 1962: herb. spec.). Wood collected from the branches however appears to have a light brown slash (Binuyo 1959: herb. spec.). The slash is also described as granular (Keay *et al.* 1960:257; Keay 1989:152) and secreting drops of red liquid (Vivien & Faure 1996:153). The ICRAF description of the slash is 'Dark red, densely mottled with scattered pits and orange stone-cell granules' (ICRAF 1999).

It is not clear whether differences between *Ricinodendron heudelotii* subsp. *heudelotii* and subsp. *africanum* can be seen in the sap, but in 1936 Kennedy wrote of *R. africanum* Muell. Arg. in Southern Nigeria having a reddish slash, but continued:

> 'The writer is of the opinion that there is a second species of *Ricinodendron* whose slash constantly shows drops of blood red juice. The leaves, flowers and fruits however are quite the same although the natives differentiate between the two.' (Kennedy 1936:79. See also Léonard 1961 for distribution of the two subspecies.)

The wood of *R.heudelotii* is soft and white (Keay *et al.* 1960:257; Voorhoeve 1962: herb. spec.; Chapman 1974: herb. spec.; Letouzey 1986:153; Keay 1989:152). Burkill (1994:131) describes it as dull, white, fibrous, soft, light and perishable, with a density of 0.327[1], and for Dalziel (1948:159), 'The wood is dull white or brownish with compact fibres, but soft, not durable, and one of the light woods, easily mistaken for that of *Ceiba pentandra*.'

5.2 Leaves

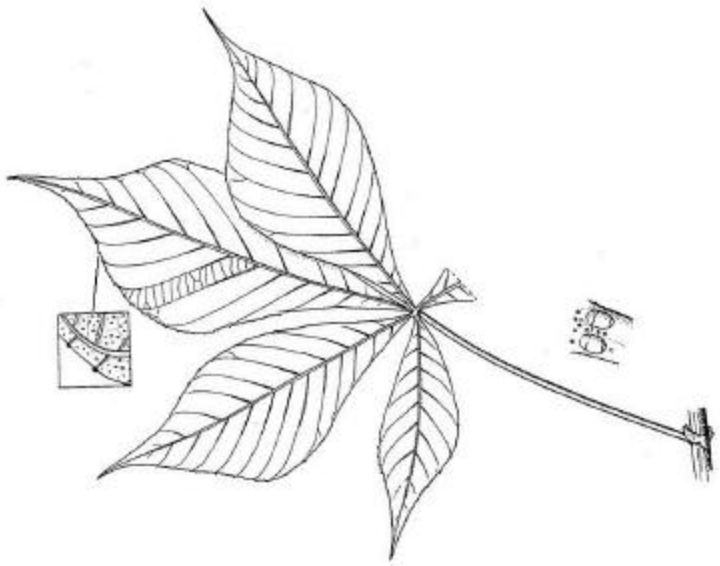

Figure 2 Leaf of *Ricinodendron heudelotii* showing margin with small glandular teeth and petiole glands (from Hawthorne 1990)

Euphorbiaceae leaves are always stipulate, simple, entire, and dentate (or more or less deeply palmately lobed), and are only digitately compound in *Ricinodendron heudelotii* (Letouzey 1986:153).

[1] Schnell 1950, b: 258, as *R. africanum*. Quoted in Burkill 1994:131.

The large soft leaves (Heitz 1943:80) are alternate, with 3-5 leaflets (Keay *et al.* 1960:257; Dale & Greenway 1961:217 line drawing; Keay 1989:152; Adjanohoun 1991:146 line drawing, 147; Shiembo 1994:21; ICRAF 1999). Six (Katende *et al.* 1995:536) or 7 leaflets (Heitz 1943:80) have been observed, though most commonly there are 5.

The largest central leaflets are 10-30 cm long (Katende *et al.* 1995:536). Lateral leaflets are often smaller, generally 6-20 cm long and 3-12 cm broad (Adjanohoun 1991:147; ICRAF 1999). The leaflets are subsessile to sessile, obovate to obovate-elliptic, with the apex long-acuminate and narrow at the base, with edges spiked with small glandular teeth (Heitz 1943:80), often white-felted on the underside at first with stellate pubescent hairs, becoming glabrous (Adjanohoun 1991:147; Katende *et al*. 1995:536; ICRAF 1999).[2]

Young leaves are pale green, slightly shining (Leeuwenberg 1959: herb. spec.), and mature leaves are smooth, slightly shiny, subcoriaceous, dark green, somewhat paler beneath (Leeuwenberg 1959: herb. spec.; Meer 1968: herb. spec.), or medium green (Breteler & Lemmens 1986: herb. spec.).

There are between 10 and 16 lateral nerves in pairs (Kennedy 1936:78; Adjanohoun 1991:147). The midrib is dark green at the base and pale green at the apex beneath, and the main nerves are pale green beneath. Secondary nerves are raised on both sides, with reticulation of the veins faintly distinct, and dark green beneath (Meer 1968: herb. spec.). The leaf margins have small glandular teeth (Hawthorne 1990:157).

The petiole is 20 cm long (Keay *et al.* 1960:257; Keay 1989:152; Adjanohoun 1991:147), and may be up to 40 cm in length, glandular at the base (Malaisse & Claes 1995: herb. spec.; Vivien & Faure 1996:153). The petiole is very dark green with medium green patches, blackish at the base, and the glands are dark grey green (Meer 1968: herb. spec.).

At the base of the leaf stalk are fan-shaped leafy stipules, 2.5 cm long, with deeply toothed edges (Keay *et al.* 1960:257; Beghen 1978: herb. spec.; Keay 1989:152; Adjanohoun 1991:147; Katende *et al.* 1995:536). Heitz described the stipules as broad with a striking network of veins (Heitz 1943:80), which were 'obvious' in a voucher sample collected by Breteler and Lemmens (Breteler & Lemmens 1986: herb. spec.).

5.3 Flowers

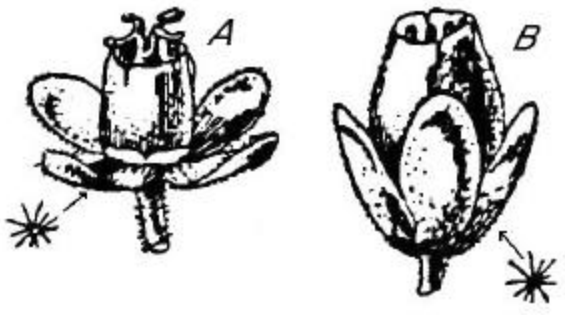

Figure 3 Female (A) and male (B) flowers (from Keay, 1989)

Ricinodendron heudelotii is monoecious (Taylor 1960:164) (wrongly described in Shiembo as dioecious (1997:515), with the tomentose inflorescence in panicles. Male flowers are grouped in loosely branched terminal panicles (15-40 cm long) of small white flowers (0.7 cm diameter) on

[2] See also: Kennedy 1936:78; Keay *et al.* 1960:257; Dale & Greenway 1961:217; Chapman 1974: herb. spec.; Beghen 1978: herb. spec.; Keay 1989:152; Malaisse & Claes 1995: herb. spec.; Vivien & Faure 1996:153.

short flower stalks. They have 5 sepals, a 5-lobed corolla tube and 10-14 stamens. Female flowers are grouped in stouter and shorter panicles. They are white and the same size as male flowers, with a stellate tomentose ovary and 2 styles which are slender and bipartite (Keay *et al.* 1960:257; Keay 1989:152; Vivien & Faure 1996:153; ICRAF 1999. See also Léonard's definition, Table 2). The ovary is superior (Kennedy 1936:78).

Variations in describing the flower colour range from white (Vivien & Faure 1996:153) to whitish (Adjanohoun 1991:147), to yellow (Kennedy 1936:78; ICRAF 1999). There frequently appears to be a greenish tinge too (Andoh 1951: herb. spec.; Leeuwenberg 1959: herb. spec.; Breteler & Lemmens 1986: herb. spec.; Katende *et al.* 1995:536). The calyx is described as 'rusty' (Leeuwenberg 1959: herb. spec.). The peduncle and pedicel are very dark green (Meer 1968: herb. spec.).

5.4 Fruits and Seeds

The fruit is an indehiscent drupe weighing about 20 g., flattened at the apex and the base, yellow-green in maturity, turning black, with 2 or 3 lobes, a fleshy exocarp and a woody endocarp containing 2-3 seeds (Ambe 1997: herb. spec.; Vivien & Faure 1996:154). The fruits smell of over-ripe apples (Burkill 1994:132; Katende *et al.* 1995:536; ICRAF 1999).

Table 3: Herbarium specimens of *Ricinodendron heudelotii* examined for this study, relating subspecies to seed number and altitude (where given)

Collector	Subspecies	Country	Altitude	Seed no	Year / Herbarium
Dechamps-Murta & Da Silva 1529	*africanum*	Angola	680 m	2	1974 BELG
Mildhaer 9266	*africanum*	Cameroon	900 m	2	1914 KEW
A.J.M. Leeuwenberg 5970	*africanum*	Cameroon	670 m	2 seeds	1965 MISS
Louis, J. 10319	*africanum*	DR Congo	-	1 & 2	1938 KEW
Léonard, J. 901	*africanum*	DR Congo	-	2	1946 KEW
Donis, C. 3227	*africanum*	DR Congo	-	2	1951 KEW
Gossweiler, J. 151	*africanum*	Gabon	-	2	1919 KEW
		* * * * *			
G. Proctor Cooper 457	*heudelotii*	Liberia	-	3	1929 FHO
Leeuwenberg, A.J. 2594	*heudelotii*	Côte d'Ivoire	100m	3	1959 WAGEN
P.P.C. van Meer 829	*heudelotii*	Nigeria	-	3	1968 WAGEN
Versteegh, Chr. & den Outer, R.W. 596	*heudelotii*	Côte d'Ivoire	-	3 & 2 seeded	1969 WAGEN
H.M. Chapman 165	*heudelotii*	Nigeria	233 m.	3 (in spirit: 2 + 1 aborted)	1974 FHO
A. Gentry & G. Pilz 32657	*heudelotii*	Nigeria	150 m.	2 seeded (with 1 aborted)	1981 BELG / WAGEN.
D. Thomas 3477	*heudelotii*	Cameroon	150 m.	2	1984 BELG / MISS
Malaisse & Claes 14866	*heudelotii*	Guinea-Bissau	20m	3	1995 BELG
M. Merello *et al.* 1251	*heudelotii*	Ghana	400m	2 seeds	1995 MISS
G-A. Ambe 223	*heudelotii*	Côte d'Ivoire	-	(in notes) 2 or 3 seeded	1997 BELG

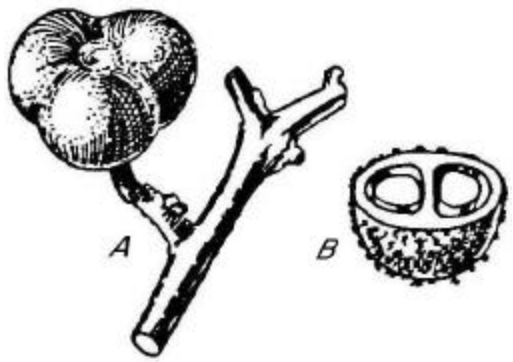

Figure 4: Fruit (A) and cross section of ovary (B) (adapted from Keay, 1989)

Type specimens from herbaria give the range in coloration of the fruits as they mature: immature fruits are green (Thomas 1991: herb. spec.) and mature fruits are yellow green (Versteegh & Outer 1969: herb. spec.). Other descriptions include: greyish green fruits (Latilo 1959: herb. spec.); globose, pale green, pale pruinose (Leeuwenberg 1958: herb. spec.); greenish brown pubescent, powdery fruits (Breteler & Lemmens 1986: herb. spec.); medium green (Meer 1968: herb. spec.). The size of the fruits is about 2.5-4.5 cm by 3-5 cm.(Taylor 1960:164; Adjanohoun 1991:147; Katende *et al*. 1995:536; Vivien & Faure 1996:154).

There are 2 or 3 seeds to a fruit. They are rounded with a flat side (Kennedy 1936:78; Keay *et al.* 1960:257; Taylor 1960:164; Keay 1989:152; Katende *et al*. 1995:536; ICRAF 1999). According to Vivien and Faure (1996:154) there may be only one seed per fruit, but this appears to be unusual, two seeds is the most frequently cited number. However, Léonard (1961) proposed that the number of seeds per fruit is one of the ways of identifying the two subspecies: the fruits of subspecies *heudelotii* having 3 seeds, with frequently 1 aborted, and those of subspecies *africanum* having 2 seeds (Table 1). From a small sample of herbarium voucher samples (Table 3) there is evidence for this differentiation, although Fondoun *et al*. (1999:5), in their study from southern Cameroon, have proposed that it is altitude that affects seed production, with fruits from low altitude localities bearing 1 or 2 seeded fruits. The small selection in Table 3 does not appear to bear this theory out, but more data is needed.

Descriptions of the colours of the seeds range from red-brown-black (Katende *et al.* 1995:536; ICRAF 1999), black (Taylor 1960:164; Adjanohoun 1991:147; Vivien & Faure 1996:154), to dirty brownish-grey (Imperial Institute 1908:367).

The seed shell is thick and hard with a bright white internal coating (Imperial Institute 1908:367; Adjanohoun 1991:147). The kernels are white (Dalziel 1948:159) and soft, and cannot be freed easily from the shells. By weight the kernels form 29% and the shells 71% of the whole seeds (Imperial Institute 1908:367).

There are about 17 seeds to an ounce[3] (Taylor 1960:164-165), and a seed weighs an average of 1.6 g (Kyereh, Swaine and Thompson 1999:776; Fondoun *et al*. 1999:4, Table 2) .The size of the seeds has been given as about 1 cm in diameter (Katende *et al.* 1995:536; Vivien & Faure 1996:154), or, about 0.9 in.[4] long and 0.75 in. across the flat face (Taylor 1960:164). The water content of fresh seed of *Ricinodendron heudelotii* is 10% of the fresh mass (Kyereh, Swaine and Thompson 1999:774, table 1).

[3] 1 ounce = 28.35 grams.
[4] 1 inch = 2.54 centimetres.

6. Dispersal and Germination

Fruits are produced in large quantities, and most of them remain dormant for about 6 months. They are said to be dispersed by bats and also by hornbills and rodents (Taylor 1960:164-5). But human intervention harvesting fruits of species such as *Ricinodendron heudelotii* from the forest may be having an impact on the species' population structure. Sunderland and Tchouto have found some evidence that over-gathering of fruits, combined with the length of time needed for the seed to reach germination point, is having an impact on natural regeneration rates (Sunderland and Tchouto 1999:35).

After the pulp has rotted the stony endocarp may lie for more than two years if it does not germinate or get carried away by rodents (Shiembo 1994:24). Katende suggested that seed could be collected from the forest ground after the seed capsules had broken open and scattered the seeds (Katende *et al.* 1995:536). This is the only suggestion in the literature examined that the endocarp opens spontaneously and explosively rather than rotting away. The fruits are frequently described as being indehiscent (Kennedy 1936:78; Nielsen 1965:101-3; Letouzey 1986:153; Adjanohoun 1991:146-7; ICRAF 1999).

Germination of *R. heudelotii* seeds is fairly slow, with only a 40 per cent success rate that decreases rapidly with time (Vivien & Faure 1996). Taylor estimated that about 78 per cent of planted seed would germinate and the germination period averaged 12 days (Taylor 1960:164-5). Katende recommends soaking the seed to hasten germination (Katende *et al*. 1995:536). Shiembo found germination unpredictable and it seemed to be governed by the decomposition of the stony endocarp. He found that pretreatments such as scarification, partial burning under a thin layer of grass, or cycles of soaking and drying were ineffective in promoting germination (Shiembo 1994:24).

Recent research by Mapongmetsem, Duguma, Nkongmeneck and Selegny into techniques for improving germination in 8 tree species indigenous to Cameroon forests found that manual scarification was the most efficient treatment for all species (Mapongmetsem *et al.* 1999:679-683). One specific object of the study was to overcome the dormancy of *R. heudelotii*. Five pretreatments of seeds were tried: hot water, ordinary water, hand scarification, sulphuric acid, and an untreated control group. Results for *R. heudelotii* germination were:

> Hot water 1.3%; ordinary water 0%; hand scarification 61.6%; sulphuric acid (98%) 3.30%; control 0%.

It was also found that germination of *R. heudelotii* seeds increased as sowing depth increased. The best germination (60%) took place at 10 cm depth after a period of two weeks.

Germination is epigeal. The hypocotyl is about 3½ in. long and stout. Fibrous roots are formed and not a tap root. The cotyledons become foliaceous and are broadly cordate, about 2½ ins long and broad, entire and veined. The slender petioles are about 1¼ in long. The leaves are alternate and the first ones are simple, palmate, about 2½ in. long and 1¾ in broad, with a slender petiole about ¾ in long. The leaves and stem are covered with a dense mass of white stellate hairs, and the margins of the cotyledons and leaves bear conspicuous black glandular dots (Taylor 1960:164-5).

In Ghana the seedlings appear in abundance in March-April, germinating from 6-month old fruits. They progress rapidly where they have plenty of overhead light. A natural sapling growing in a taungya plantation in the Pra-Anum F.R. was 32 ft high when 4 years old (Taylor 1960:164-165).

In the forest there is mass germination under the parent female tree when regrowth is cleared at the start of the rainy season. The seedlings are then attacked by psyllids or smothered by regrowth, but seeds will germinate that are carried away from the parent tree. Wildings can be collected and potted out in the nursery (Shiembo 1994:24).

The effect of light on the germination of forest trees was studied in Ghana (Kyereh, Swaine and Thompson 1999) to test whether West African forest trees have gap-dependent germination, or if their failure to establish is due to a negative carbon balance in young seedlings. The seeds of *Ricinodendron heudelotii* were found not to be responsive to light, and *R. heudelotii* stood out among the species tested for its rather inconsistent responses. It was not photoblastic in the light/dark experiment, was unaffected by reduced R:FR light (low red : far-red ratio), but responded strongly to differences in irradiance: germination in *Ricinodendron* was enhanced by high irradiance.

> Viability of ungerminated *Ricinodendron* seeds: 91% at 2% irradiance; 67% at 30% irradiance; 30% at 65% irradiance. (p.778, table 4).

However, a high proportion (91%) of the *Ricinodendron* seeds that failed to germinate in 2% irradiance remained viable, suggesting that the ungerminated seeds had some requirement for radiant energy for germination.

A further set of tests were undertaken on seedlings of 16 West African timber tree species, including *Ricinodendron heudeloti*, to derive a light response index (Agyeman, Swaine & Thompson 1999). The seedlings were grown in 6 neutral shade-houses with irradiances of 2%, 6%, 10%, 28%, 44% and 66% of unshaded values. Two species, *Guarea cedrata* and *R. heudelotii*, represented extremes of response to irradiance, with *R. heudelotii* showing a negative growth rate at 2% irradiance. Unit leaf rate values suggested that leaves of *R. heudelotii* were most efficient at 44% irradiance.

Relative height growth showed marked variation in *Ricinodendron*. There was a positive height increment at 2% irradiance, and height growth was maximum at 6% but declined to an asymptote from about 28%. Its rapid height growth in shade was probably due to etiolation.

In *Ricinodendron* specific leaf area increased markedly with exposure to increased irradiance, resulting in much larger, thinner leaves at high irradiance. The relative diameter growth (a useful non-destructive indicator) indicated negative growth in 2%, maximum growth in 44% and inhibition in 66% irradiance. *Ricinodendron* maintained a higher leaf production rate than *Guarea* at all irradiances but also had consistently much higher mortality rate, i.e. production and mortality were similar at low irradiance but production exceeded mortality at higher irradiance.

7. Phenology and Ecology

7.1 Phenology

In Ghana *Ricinodendron heudelotii* is deciduous in December and January and sometimes in early February. Flowering takes place at the end of the deciduous period but is usually coincident with the flushing of the new leaves (Taylor 1960:164-5). In Southern Nigeria *Ricinodendron africanum* Muell. Arg. flowers in January and July (Kennedy 1936:78). In Nigeria and Cameroon it flowers from March – May (Keay *et al.* 1960:257; Thikakul 1985:305). In Nigeria *R. heudelotii* flowers in September and March, and there is a long bare period (October/November – February/March) with bud break occurring in March (Lawton & Lawton 1971:189). See Appendix 1: Flowering and fruiting times for *Ricinodendron heudelotii* as recorded in herbarium specimens and Appendix 2: Flowering and fruiting times for *Ricinodendron heudelotii* as recorded in the literature

In Cameroon and Nigeria *Ricinodendron heudelotii* fruits from May – October (Keay *et al.* 1960:257; Thikakul 1985:305). The high production period for the fruits in Nyangong, Cameroon, is between July and September, on a two-year cycle (Ntamag 1997:71), and from August to November in the South West Province (Gordon & Fereday 1997:19, fig.2). According to Ambrose, in Southern Cameroon the Bakweri harvest *Ricinodendron heudelotii* fruits from January to March (Ambrose 1994:21, table 3).

Kennedy reported that at Olokemeji in Southern Nigeria *R.. africanum* Muell. Arg. fruited in September and October, and at Illah near the Niger, ripe fruits were collected in August (Kennedy 1936:78). Taylor said that mature fruits were available from about the end of July until the middle of October in Ghana, being produced in large quantities. They were evident because of their smell, which resembles over-ripe apples (Taylor 1960:164-5). In Côte d'Ivoire production is from June-October (Gautier-Béguin 1992:277, fig.72).

Ricinodendron heudelotii was one of the species selected for research to determine seasonal variations in secondary phloem of selected forest trees growing in disturbed land at the edge of the moist semi-deciduous forest zone, using samples taken from the Botanical Garden, Ibadan, Nigeria (Lawton & Lawton 1971; Lawton 1972). The greatest amount of the active phloem coincided in all cases with some part of the rainy season. Bud break generally occurred at some time during the dry season, normally at the very end, and this coincided with the lowest amount of 'active' phloem, although it was rapidly followed by an increase in the amount of 'active' phloem. This was most clearly marked in *Ricinodendron.* Only 2 genera studied, *Ricinodendron* and *Tectona grandis*, showed a cessation of cambial activity during the dry season, as indicated by the lack of 'active' phloem. In all other cases active phloem was present throughout the dry season.

7.2 Nutrient Take Up

Ricinodendron heudelotii was one of ten deciduous tree species sampled in an investigation into the retranslocation of nutrients from leaves as a means of retaining nutrients in deciduous forest trees before leaf abscission, and to discover the concentration of nutrients in forest floor litter before further decomposition. The mobility of nutrients under study was classified into two groups: mobile elements comprising potassium, phosphorus and nitrogen; and the immobile elements calcium and magnesium. Potassium was the most mobile element found in all the sampled deciduous trees, while the relative mobility of phosphorus and nitrogen varied according to species. Not all of the sampled tree species retranslocated calcium and magnesium since the concentrations in the litter were greater than the content in green leaves (Oyefesobi 1983).

7.3 Mycorrhizae

Ricinodendron heudelotii growing in semi-evergreen forest in Tanzania was examined for mycorrhizal associations (Högberg 1982). The species was found to be endomycorrhizal (Redhead 1960; de Alwis & Abeynayake 1980; Högberg 1982:410-411), the most common type of association found in the tropics. Further work in secondary semi-deciduous moist tropical forest at Mbalmayo, Cameroon (lat. 3º 31' N; long. 11º 30' E) to determine the effects of different types of site preparation for reforestation on mycorrhiza populations (Musoko *et al.* 1994) looked at 90 tree species, of which *R. heudelotii* was one of the most numerous with a density of 5 trees/ha. No separate information on *R. heudelotii* mycorrhiza was given.

7.4 Lichens

One major factor responsible for availability and distribution of plants is moisture, and the humid conditions of tropical rain forests create a suitable environment for germination of the spores of lichens. An examination was made of bark flora of 12 rainforest trees in Nigeria, including a specimen of *Ricinodendron heudelotii* on which the following flora were observed (Akinsoji 1991:181-185):

- Green, red and white fruticose lichens, but not crustose or foliose lichens.
- Three types of algae: *Pleurococcus, Chlorococcum* and *Physolinum* in the Chlorophyta.
- *Entophysalis* and *Gleocapsa* of the Cyanobacteria.
- *Bacillus* species were the only bacteria found.
- No Bacillariophyta were present.

Most species appear to be specific in the kind of lichens that they support, but their presence does not seem to be governed by bark texture, because both smooth-barked trees like *Bosqueia angolensis* and *Triplochiton scleroxylon* and rough-barked ones like *Ricinodendron heudelotii* and *Chlorophora excelsa* showed extensive lichen growth. There may be several colours or several shades of a particular colour of a lichen incrustation on the same bark. e.g. *R. heudelotii* had green, red and white incrustations of the fruticose type. The different colours of the lichens observed in the study may be due to the aspect of their position on the tree barks, and Akinsoji concludes that moisture rather than bark texture is a critical factor for lichen growth.

7.5 Pathogens

Three studies from Ghana found:

1. Susceptibility in *Ricinodendron heudelotii* seedlings to an aphid which causes the leaves to curl and may kill the plant. These attacks are only apparent on seedlings in their first year (Taylor 1960:164-5).
2. Reports of infection of *Ricinodendron heudelotii* include a susceptibility to yellow mosaic and vein clearing disease. The infection was said to be transmissible by grafting, but it was sometimes difficult to distinguish damage due to disease from the psyllid feeding-damage prevalent in some areas (Deighton & Tinsley 1954:6).
3. *R. heudelotii* trees felled during clear felling of shade trees in cacao plantings were virus infected, but the identity and vector of the virus were not conclusively established. The virus was readily transmitted by grafting 2 bark patches from naturally infected trees or graft-infected seedlings to each healthy *R. heudelotii* seedling. When the graft-inoculated seedlings grew well, symptoms appeared within about 7 weeks of grafting, but symptom appearance was delayed under sub-optimal growth conditions. The leaf symptoms produced on infected seedlings were very similar to those found on infected trees (Brunt 1963:326-327), and were similar to those in cassava (*Manihot utilissima* Pohl.) – a closely related species – infected with cassava mosaic virus (CsMV). Attempts to link these two infections were inconclusive. The virus was not transmitted by *Aphis gossypii* Glov., or by mealybugs *Planococcoides njalensis* (Laing) and *Ferrisiana virgata* Ckll., or by unidentified jassids collected from an infected tree. Nor was it transmitted by sap inoculation using infected leaves (Brunt 1963:327).

An examination of *Ricinodendron heudelotii* wood carried out in the Congo in the 1960s found that all parts of the wood were susceptible to fungal attacks which stained the wood shades of grey-blue, brown or pink (Fouarge & Gérard 1964:364-365). Local people throughout the region benefit from this susceptibility to fungal attack – see 'Uses' – by eating mushrooms that grow on dead trunks (Burkill 1994 – in Gabon; Mapongmetsem & Tchiegang 1996, and Laird 1999 – in Cameroon; Latham 1999a:27 – in DR Congo).

8. Management and Uses

8.1 Silviculture

Ricinodendron heudelotii is a light-demanding species which thrives in late secondary forest and farm fallows (Sunderland & Tchouto 1999:17). It was retained when land was cleared, and is common on abandoned farmland (Chudnoff 1984). Dalziel described it as 'A quick-growing tree, shooting readily from the stump and coming up freely in old farms. Trees growing spontaneously from seed are often preserved in the neighbourhood of villages in the forest' (Dalziel 1948:159; Burkill 1994:130-132).

In Ghana in the 1960s Taylor described it as 'one of the commonest seedlings seen in the more open parts of the forest, such as along timber-extraction routes and in areas opened up for natural regeneration. It is abundant in new farm clearings. Often the seedlings are grouped in 3s – the product of an entire fruit.' (Taylor 1960:164-5).

Ricinodendron heudelotii is able to grow in hot, humid climates with as much as 2,800 mm rainfall/year, and also to withstand drought. It will survive well in soils with a pH as high as 7.7, and can thrive across a range of soil, moisture and drainage conditions if not subject to heavy competition for light (Anigbogu 1996:18). In open light spaces it will bear fruit in the seventh to tenth year (Dalziel 1948:159).

The species is widely valued by farmers as a multi-purpose tree, and for the cash value of the seeds, which are widely traded in local markets. In the Kisantu area of Bas Congo, *R. heudelotii* was often planted on burial sites so that Mvinsu caterpillars (probably *Imbrasia ertli*) that live on the tree, and which are a valued food, could be guarded by the family whose tree it was (Latham 1999b).

The versatility of the tree was illustrated in a letter sent to *Economic Botany* in 1959:

> Travelling from Stanleyville northward through the rainforest of the Congo basin toward Buta I noticed that the telegraph line parallel to the road was attached to living trees all of the same species, *Ricinodendron heudelotii*, and regularly spaced. The poles were 'planted by cutting a 6-10 m. pole from the forest and putting it in a hole at the desired place. During the rainy season the pole quickly strikes root and begins to put out branches and foliage. The telegraph wires are placed on the poles some six or more metres above the ground as soon as they are firm. The branches, which sprout at the summit of the poles, rarely interfere with the line' (Williams 1959:150).

The species is one of the non-leguminous tree species used in hedgerows by farmers on compound farms in Nigeria for soil enrichment, and to provide useful products such as fodder, stakes for yams, fuelwood, and leafy vegetables (Okafor & Fernandes 1987:163. Photo p.164, Fig.3; Okafor 1999:127). Its deep rooting system is good for erosion control and improving degraded soils, whilst not competing directly with adjacent crop roots in the upper soil layers (Anigbogu1996:18: Latham 1999:27).

Because the stump growth has a high biomass, producing many shoots and broad leaves, it is a good source of organic manure and mulch (Shiembo 1994:22). Waste from fermented leaf pulp is also an excellent manure, and ashes from nutshells, which are rich in potassium etc., make an excellent fertiliser (Mapongmetsem & Tchiegang 1996). The leaves are an important source of high-quality fodder for sheep and goats in the dry season. Green foliage collected from the plant has an average protein content of 16%, and no known toxicity (Anigbogu 1996:18; Latham 1999:27). Residues from processing seeds for oil can also contribute to plant and soil nutrients. In Ghana the seed cake is used for green manure (Abbiw 1990:255), but is not recommended for feeding to livestock as it contains traces of an alkaloid and because of the nature of the oil (Dalziel 1948). ICRAF also does not recommend its use as cattle feed as the seeds contain small amounts of a toxic substance said to be a resin (ICRAF 1999).

In the 1940s Heitz wrote that *Ricinodendron africanum* was frequently found in plantations in Gabon (Heitz 1943:80) where it would provide shade. In West Africa it was believed that 'collar crack' disease would occur if the tree was cut down on a cocoa farm (Dalziel 1948). *Ricinodendron* trees are intentionally left in cacao plantations, plantain and cocoyam food crop fields, as a soil fertility improver. 'Farmers stated that cocoyam (*Xanthosoma* spp.) and plantains (*Musa* spp.) cropped in the vicinity of *Ricinodendron* trees give better yields' (Fondoun *et al.* 1999:6). In compound farms of south eastern Nigeria it grows in the plantain/banana zone (3-6m) and is usually pollarded (Okafor & Fernandes 1987:162).

The tree is suited to alley farming or intercropping (Okafor & Fernandes 1987:165-166; Okafor & Lamb 1992). It coppices well, and is an integral part of traditional farming systems in Anambra State, in eastern Nigeria, where the tree is propagated from stem cuttings, and from seed, and planted in cropping fields (Anigbogu 1996:18). However, integration of *Ricinodendron heudelotii* into farming systems is variable across its range. Shiembo reported that farmers in Cameroon

seldom plant the species – in spite of the high foliage production that makes it a useful mulch crop – because planting stocks are not readily obtainable as the seeds are difficult to germinate (Shiembo 1994).

In spite of these drawbacks, *Ricinodendron heudelotii* has potential for increased use by farmers. Sunderland and Tchouto believe that prospects for domestication or incorporation into agroforestry systems are 'good'. They rate the species a 'high-value resource' which would benefit more from better management, such as retaining individuals on farmland, than from domestication (Sunderland & Tchouto 1999:35, 38). Surveys carried out by ICRAF and partners to find farmers' preferences for multipurpose trees ranked *R. heudelotii* third of species considered useful for domestication in the West African humid lowlands (Leakey & Tomich 1999:327, table 4), and it was ranked fourth most valued multipurpose tree species (MPTS) in a survey by ICRAF/IITA/OSU that screened over 100 MPTS at their Ibadan, Onne (Nigeria) and Mbalmayo (Cameroon) sites (Adeola 1995).

In order to facilitate on-farm use of *Ricinodendron heudelotii* improvements in reproduction and in attributes useful to farmers are needed. For example, farmers who took part in the surveys carried out by ICRAF in Nigeria, Cameroon and Ghana, said the attributes they required to make the species more acceptable were, precocity, reduced tree height, increased biomass, larger seeds, and larger fruit with a longer shelf life (Adeola 1995; Mollet *et al.* 1995:16).

The most stable means of improving *R. heudelotii* for on-farm use is by vegetative propagation, a process which can rapidly overcome the limitations to domestication and improvement imposed by long generation times, irregular fruiting/flowering and outbreeding. Identification of the critical factors determining adventitious root development is crucial to sustained, cost-effective propagation. Propagation trials of *Ricinodendron* have been carried out at the Institute of Terrestrial Ecology, Edinburgh (Leakey, Newton & Dick 1992:73, Table 1. Results for individual species not given) without leading to a continuing programme. *Ricinodendron heudelotii* appears often to be in competition for domestication with *Irvingia gabonensis*, on which current ICRAF research is focussing, and for which there are already many high-yielding and improved cultivars available.

Experiments on vegetative propagation of *Ricinodendron heudelotii* were also undertaken at the Forest Research Station of the Agronomic Research Institute, Kumba, Cameroon, (P. Shiembo 1994; Leakey & Newton 1994:67-68) to determine appropriate treatments for mass production of clonal planting stock of *R. heudelotii*. In particular, the trials assessed the effect of variation in the propagation medium, auxin concentration, and leaf area on the rooting of leafy stem cuttings. Maximum rooting percentages of over 80% were achieved in all 3 experiments. The highest rooting percentages were achieved in sawdust. None of the leafless cuttings rooted. It is suggested that optimum leaf area for propagation of *R. heudelotii* is >80 cm^2. The main cause of cutting mortality in these experiments was stem rotting following leaf abscission (Shiembo *et al.* 1997). Experiments were also designed to test the suitability of a low technology non-mist propagation system for propagating this species. Using improved low-technology, high humidity polythene propagators it was found that rooting by day twenty-one was best without mist (75% *v* 50% under mist) (Leakey *et al.* 1990:255). Patrick Shiembo has also written that in experiments to find the optimal rooting percentage of *R. heudelotii* stock plants, rooting declined with increasing pollard height – the highest rooting was obtained at 1.5 m (Shiembo 1994:v).

Farmers in the region would benefit from such breeding programmes because of the market potential for the seeds, as well as the species' multiple uses. There is evidence that market supplies of njangsang are shrinking due to the reduction of forests and to increasing demand for the condiment. Perez suggests that this demand could be met if, for example, *R.. heudelotii* was purpose planted in plantations (Pérez *et al.* 1999). Katende recommends that the tree should be either planted in pure stands, intercropped with coffee, cocoa or banana, or as individual shade and avenue trees (Katende *et al.* 1995:536).

The reduction in forests across the region is putting pressure on remaining forest resources, such as *Ricinodendron heudelotii*, and in addition, the decline of traditional social structures and observance of customary rights across the region is resulting in these resources becoming common property managed on a 'first-come first-served' basis leading to over-harvesting and a decline in species' populations. In some places there may be a reaction under way. For example, in the Mokoko Forest Reserve, Cameroon, where the current harvesting impact on *R. heudelotii* is rated as 'high' (Sunderland & Tchouto 1999:35, Table 13), some farmers are retaining valuable NWFP resources, such as *R. heudelotii*, on their farms in order to ensure a regular supply of fruits (Sunderland & Tchouto 1999:37).

8.2 Uses

All parts of the tree are used to some extent, not just the coppice growth and the leaves. The wood is light and easily carved; the bark and roots have therapeutic properties; and the seeds contribute to the local cuisine both as a condiment and in soups and stews. The tree also provides a host for edible caterpillars, mushrooms and bees.

8.2.1 Non-Food Uses

The wood of *R. heudelotii* is white and light, often compared with balsa (Forest 1934; Fouarge & Gérard 1964; Chudnoff 1984). It is suitable for fishnet floats and lifebelts, toys and models, for sound-proofing, heat-proofing, electrical insulation, and for reducing vibration as wrappings, paddings or fillings. It also can be used for crude joinery such as boxes and crates, or as plywood core stock (Dalziel 1948; Burkill 1994:130-132; Laird *et al.* 1997) but it is seldom used for general construction purposes (Shiembo 1994).

In Côte d'Ivoire (Gautier-Béguin 1992), Nigeria (Anigbogu 1996:18), and Cameroon (Mapongmetsem & Tchiegang 1996:19), *Ricinodendron* wood is valued as firewood, but other reports claim it is an indifferent fuel as it burns too quickly (Burkill 1994:130-132; ICRAF 1999). The ash is used in Guinea for the preparation of a vegetable-salt in soap making and in indigo dyeing (Burkill 1994:130-132; ICRAF 1999), and the Mende in Sierra Leone also use the wood ash as a source of potash in soap making (Burkill 1994:131), as do the Ghanaians (Abbiw 1990:228). In Ghana (Abbiw 1990:49) and Bas Congo (Latham 1999:27) the wood ash, but not the root or leaf, is used as a cooking salt. On the borders of Liberia and Côte d'Ivoire hunters cover their faces with bark ash, which they believe enables them to kill all elephants they see (Burkill 1994:132).

R. heudelotii wood is easy to carve and traditionally has both household and ceremonial uses. Household uses include spoons, ladles, plates, platters, bowls, dippers, stools, and mortars for pounding yams. It is also used for carving fetish masks and dolls. Because it is said to be very 'sonorous' it is used for the resonant parts of musical instruments in the Democratic Republic of Congo, Southern Nigeria, Gabon and Angola (Dalziel 1948; Abbiw 1990:107-109; Shiembo 1994:22; Laird *et al.* 1997). In the Lower Niger and Cross Rivers area of Southern Nigeria a log may be carved out to make a giant xylophone called in Mbe: *ogbang* (Burkill 1994:131). 'Wood of other trees is attached to give a variety of tones: *mankwaro* (*Mangifera indica*, Anacardiaceae) for high notes, *ntweno* (sp.?) for middle notes and *nkomni* (sp.?) for bass notes.'

In studies made in the Congo of African carvings R. Dechamps found extensive use of the wood of *R. heudelotii*. It was used in the Central Basin for carving the shell of drums (Dechamps 1972). Out of 351 drums examined, 142 were made from *Ricinodendron* spp. (137 from *R. heudelotii*, and 5 from *R. rautanenii*) – 39% of the total.

Dechamps examined 279 carved wooden articles made by the Kuba[5] in the Congo (Dechamps 1970:76-84) and found that they had used *Crossopteryx febrifuga* for 67% of all the articles, but 65% of the masks examined were carved from *Ricinodendron heudelotii* subsp. *africanum*.

[5] NB in the Congo there are Kuba peoples and Luba peoples – see other Dechamps articles.

Dechamps concluded that the preference for making masks from *R. heudelotii* rather than *C. febrifuga* was that the latter being a small tree with dense wood limited the size of mask that could be carved, whereas in using *R. heudelotii* a diameter of more than one metre could be attained and the wood is light and easy to work.

A study of Luba carvings found that 31% of the 364 carvings examined were made from *Ricinodendron* species: statuettes 22%; seats 65%; masks 68%; and bowl carriers 75% (Dechamps 1974:14-21). Use of *Ricinodendron* for carvings by the Luba is logical because it grows near to the villages, in old cultivated land, multiplies easily from cuttings, and has rapid growth. Use of *Ricinodendron* for making seats is surprising because it would not appear to have sufficient strength. A photo of a cup carrier (Dechamps 1974:20, Fig.6) demonstrates that although the wood carves well it is liable to chip and scratch easily. The figure's nose has lost a chip. The Museum[6] has beautiful carvings made from this wood which have obviously been used. Dechamps remarked on the fact that very beautiful carvings with a fine patina could be made from wood as soft as *Ricinodendron* in spite of its tendency for movement and fragility.

The fruits of *R. heudelotii* are not eaten by humans, but the fallen fruits are attractive to animals of the forest so hunters use the tree to guide them to game (Dalziel 1948:159; Burkill 1994; Laird *et al*. 1997). The seeds, on the other hand, have a multiplicity of uses, and are processed in various ways once the outer fruit has been removed. The seeds are used in Sierra Leone in rattles for bundu dances (Burkill 1994:132), and in Cameroon the stony seeds are used as 'rattlers in gourds to produce musical sounds' (Shiembo 1994: personal observation) for percussion and other instruments (Abbiw 1990:117). They are used in Nigeria by the Igbo in a game called 'okwe', which is also the Igbo name for the tree, and in Cameroon for 'songo', both games are forms of mancala (Burkill 1994:132; Mapongmetsem & Tchiegang 1996; ICRAF 1999).

The seeds and husks can be processed to obtain oil. In 1907 and 1908 samples of *R. africanum* seeds were received at the Imperial Institute in London where they were tested for their oil content (Imperial Institute 1907). 'The seeds were found to contain 45.2% oil, which dried in a day on exposure to air at atmospheric temperature, and left a wax-like residue.' A second consignment of nuts was subsequently tested:

> 'The kernels, which were white and soft and could not be freed easily from the shells, formed 29%, and the shells 71%, by weight, of the whole seeds. The yield of oil was 47% on the kernels and 14% on the entire nuts. It was light yellow in colour, with a pleasant taste resembling that of ground-nut oil, and dried to a film in a few hours.' (Imperial Institute 1908).

The chemical composition of the oil was found to be like Chinese wood oil (t'ung oil) which is obtained from two species of Aleurites, also in the Euphorbiaceae family, growing in China: *Aleurites fordii* and *A. cordata*. In the early twentieth century t'ung oil was mainly sold in the USA. In Britain it was used in the manufacture of linoleum, lacquer and varnish.

A later analysis of the seeds yielded an oil content from the whole nuts of 13.4%, or, calculated on air-dry kernels, 48.8%. This was broken down as follows:

> *Analysis*: Unsaponifiable matter 0.5%; saturated fatty acids 9.7%; 9· oleic acid 16%; 9:12-linoleic acid 11%; linolenic acid 10%; elaostearic acid 46%; glycerol residue 4.4%; volatile 1.2%. (Steger & van Loon 1935: 319).

As part of their ethnobotanical survey in southern Cameroon Fondoun and colleagues extracted the oil from the kernels of *R. heudelotii* (Fondoun *et al*. 1999:6). The total oil content found in their analysis varied from 49.25% to 63.18%. Similar oil content has been reported by Tchiengang *et*

[6] Le Musée Royal de l'Afrique Centrale, Tervuren, Belgium.

al.[7] Pieraerts (1917)[8] found up to 67.13% oil content in *R. heudelotii* seeds from Congo and Gabon provenances while Heim *et al.* (1919)[9] reported 57.58% of oil content from Madagascar provenances. This compares favourably to the oil content of cotton nuts (35-40%) and soyabean (15-25%) found by Cheftel and Cheftel[10].

Although this oil is said to be inedible (Laird *et al.* 1997), Steger and van Loon, writing in the *Quarterly Journal of Pharmacy and Pharmacology* in 1935, claimed that people on the West Coast of Africa used essango oil for food purposes (Steger & van Loon 1935:319). And more recent commentators have suggested that the high fat and oil content of the fruits of *Ricinodendron heudelotii* indicates their suitability for commercial production of cooking oil and margarine, as well as use in the manufacture of soaps and pharmaceutical preparations (Okafor & Lamb 1992:38; Mapongmetsem & Tchiegang 1996; Latham 1999:27).

8.2.2 Food

Obtaining the seeds from the fruits of *Ricinodendron*, which are used in cooking, is extremely labour intensive. The large green kidney-shaped fruits drop towards the end of the rainy season and are collected into piles under the tree, usually by the women and children of the village. The piles signify both ownership of the fruits as well as allowing the pulp to rot, revealing the yellow nuts. It takes about 3-4 weeks for the fruit to decompose when the fleshy parts are taken off and the nuts are given a long boiling to crack them. The kernels are then dried in the sun or in an oven. Removal of the nuts from the fruit is undertaken by women and children over a period of six weeks to two months. It takes approximately two days processing to fill a 10 litre basket. The dried kernels can be kept for several years and may be sold throughout the year in urban markets (Gautier-Béguin 1992:206; Vivien & Faure 1996; Gordon & Fereday 1997:11; Ntamag 1997:71; Sunderland & Tchouto 1999:17). The kernels are easily damaged in cracking the nut, but this is avoided by boiling before cracking (Dalziel 1948).

The yellow seeds are crushed and used as a condiment for soups and fresh fish. Crushed njangsang has a spicy/peppery taste and acts as a thickening agent (Gordon & Fereday 1997:11; Sunderland & Tchouto 1999:17). The ground seeds are used to thicken and flavour pepe soup, fish stews and other dishes. They are also cooked with fish, chicken, vegetables, or eaten directly (Amadi 1993:22; Mapongmetsem & Tchiegang 1996; Brocklesby & Ambrose-Oji 1997; Laird *et al.* 1997; Ndoye *et al.* 1997/98:12). The kernels may be roasted and made into a paste and used for making a sauce similar to peanut sauce (Ake Assi 1991; Fondoun *et al.* 1999:6; ICRAF 1999).

In Zougoussi village in Côte d'Ivoire, 'akpi sauce', made from *R. heudelotii* seeds cooked with smoked pigs' trotters and onions, is a highly favoured food, which is so appreciated by the men of the village that there is a saying one should not wash one's hands after eating the sauce in order to retain its odour (Gautier-Béguin 1992:206; Herzog 1992[11]). Akpi seeds, added to other sauces, are used also as a spice. Because this sauce was so greatly appreciated in Zougoussie, special efforts were made by the villagers to harvest and process the fruits. In the author's experience this village was atypical, perhaps because it was near a reserve so the villagers still had easy access to traditional gathered foods, and because traditional practices were still being strongly maintained and passed down the generations. The author had found that such traditional knowledge was weak in Agbaille, a village about 60 km west of Abidjan surrounded by oil palm and rubber plantations

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[7] Tchiengang, C., Kapseu, C., Njounkeu, R. & Ngassoum, M. 1997. 'Les amandes de *Ricinodendron heudelotii* (Bail.): matière première potentielle pour les huileries tropicales' (in press). Quoted in Fondoun *et al*. 1999:6.

[8] Pieraerts 1917. 'Contribution à l'étude chimique des noix de Sanga-Sanga on *Ricinodendron africanum*'. *Bull. Agence Générale des Colonies* 10:28-37. Quoted in Fondoun *et al.* 1999:6.

[9] Heim, F., Garrigue, E. & Husson, M. 1919. 'Un nouvel oléagineux de Madagascar: "Le Betrata" *Jatropha mahafalensis* Jum. (Euphorb.)'. *Bull. Agence Générale des Colonies*, 12:679-691. Quoted in Fondoun *et al*. 1999:6.

[10] Cheftel, J.C. & Cheftel, H. 1977. *Introduction à la biochimie et à la technologie alimentaire.* Vol. I, Lavoisier, Paris. 381 pp. Quoted in Fondoun *et al*. 1999:6.

[11] Herzog, F.M. 1992. *Etude biochimique et nutritionnelle des plantes alimentaires sauvages dans le Sud du V-Baoulé, Côte d'Ivoire.* Doctoral thesis, Ecole polytechnique Fédérale Zurich, 122p.

where the men were employed in the plantations and villagers had less time and opportunity to gather food (Gautier-Béguin 1992:292).

In Gabon (Yembi 1998:235) and Equatorial Guinea (Sunderland & Obama 1998:213) the seeds are used as a condiment. Sunderland and Obama found that there was no strong tradition of African-style cooking in Equatorial Guinea and attributed recent increased use of forest condiments and local ingredients to the influence and tastes of recent immigrants from Ghana, Nigeria and Cameroon (1998:219). In Uganda where *R. heudelotii* is most common in the Budongo Forest region, the seeds are cooked and eaten by the Baamba peoples (Katende *et al.* 1995:536).

In the Democratic Republic of Congo, there are over 40 different kinds of edible caterpillars, which are a significant source of protein in the local diet. Many of these caterpillars are specific to certain trees. *Ricinodendron* is a host plant for at least 5 different varieties of edible caterpillars in Bas Congo (Latham 1996) such as, Minsendi (*Imbrasia oyemensis* Rougeot), Mvinsu (*Imbrasia ertli* Rebel (Diverse Emperor)), Mimpemba [scientific name not given], Kaba (*Lobobunaea phaedusa* Drury – Blotched Emperor), and Bisumbi [scientific name not given] (Latham 1999:27).

In Gabon people of the interior relish a small white mushroom *dibindi* (Eshira) which grows on the dead trunk of *R. africanum* Müll.-Arg. (Walker & Sillans 1961:175-76). The mushroom is also eaten or sold in parts of Cameroon (Mapongmetsem & Tchiegang 1996:18; Laird *et al.* 1997:62), and Bas Congo (Latham 1999:27).

Honey can be obtained from the flowers by placing beehives in the trees (Mapongmetsem & Tchiegang 1996).

8.2.3 Medicinal Uses

Ricinodendron heudelotii has widespread medicinal use. The parts of the tree commonly used in medicines or treatments are the trunk, stem bark and roots, the leaves, seeds and/or kernels, and the latex. The bark appears to be the most efficacious and frequently used part of the tree, although little is known of the therapeutic ingredients of the parts used. In Burkill's summary of medicinal uses of *R. heudelotii* in central and western tropical Africa (Burkill 1994:131-132), Adegoke *et al.*[12] in 1968 could find no alkaloid present in the bark of material from Nigeria, and no active principle was found in material from the Congo examined by Bouquet[13] in 1972. However, Willaman and Li[14] in 1970 reported an unnamed alkaloid found in the leaves and stems. The unnamed toxic resins found in the seeds may be the active ingredient of West African treatments for gonorrhoea and diarrhoea which use the seed, husk and latex (Burkill 1994:132).

Bark extract of *R. heudelotii* is used against coughs, and as an antidote to poison (Kimbu *et al.* 1991; Burkill 1994:132).

Fankankun and Loto made a characterisation of ashes from *R. heudelotii* to determine the cations and anions which may be active ingredients in compounds used in Nigeria in the treatment of different ailments. The concentration of ions in parts per million (ash 4.63%; pH 9.65) were found to be:

> Na^{+} 810; K^{+} 5,359; Ca^{2+} 6.4; Mg^{2+} 2.4; Mn^{2+} 0.1; Fe^{2+} 1.2; Cu^{2+} 0.1; Cl^{-} 63.81; SO^{2-}_{4} 658; PO^{3-}_{4} 43.7 (Fakankun & Loto 1990:306).

In another analysis to find the active ingredients in bark extract used against coughs and as an antidote, Kimbu *et al.* isolated 2 dinoditerpenoids (heudelotinone and 1,2-dihydroheudelotinol) and

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[12] Adegoke, E.A., Akisanya, A. & Naqvi, S.H.Z. 1968. 'Studies of Nigerian medicinal plants 1: A preliminary survey of plant alkaloids.' *J. W. Afr. Sci. Ass.* 13:13-33. Quoted in Burkill 1994.

[13] Bouquet, A. 1972. 'Plantes médicinales du Congo-Brazzaville: Uvariopsis, Pauridiantha, Diospyros etc.' *Trav. Doc. O.R.S.T.OM.* 13. Quoted in Burkill 1994.

[14] Willaman, J.J. & Li, H.-L. 1970. 'Alkaloid-bearing plants and their contained alkaloids.' *Lloydia* 33 (3A). Quoted in Burkill 1994.

3 known compounds (*E*-ferulic acid octacosylate, 3-methylmethylorsellinate and lupeol) from stem bark and roots of *R. heudelotii* obtained from Mbankomo, Centre Province, Cameroon (Kimbu *et al.* 1991:619).

In Western Nigeria a decoction is prepared from 'the stem barks of *Terminalia glaucescens* (Combretaceae), *Bridelia ferruginea* (Euphorbiaceae), *Nauclea latifolia* (Rubiaceae), *R. heudelotii* (Euphorbiaceae), *Vitex doniana* (Verbenaceae), *Ekebergia senegalensis* (Meliaceae), *Pterocarpus erinaceus* (Papilionaceae), *Anacardium occidentale* (Anacardiaceae), and root of *Phyllanthus muellerianus* (Euphorbiaceae) to ease insomnia. A shot (hot drink cup) for adults and half a shot for children may be taken, whereupon the patients will feel lighter and healthier' (Adjanohoun 1991:333).

The roots, or root-bark are also used as a laxative, mixed with bush pepper and salt, in Ghana (Abbiw 1990:178) and Nigeria (Burkill 1994:131). Also in the Mount Cameroon region (Laird *et al.* 1997:62), and in Ghana (Abbiw 1990:146), an infusion of the bark or root bark is taken to treat diarrhoea, and as an anti-dysenteric in Côte d'Ivoire (Burkill 199 4:132).

In the Congo a bark decoction is used in lotions and baths to strengthen rachitic children and premature babies. It is also used against rheumatism (Burkill 1994:132). To combat anaemia and 'increase blood' the bark is boiled with *Eremomastax* (Laird *et al.* 1997:62). In Gabon and Congo a bark-decoction is used to treat anaemia and blennorrhoea, and a stem-bark decoction is used to wash and cicatrise sores (Burkill 1994:132).

For treating oedema a bark-decoction may be used in lotions and baths to relieve the swelling (Burkill 1994:132), and elephantiasis is treated by local application of bark which has been pounded and warmed (Dalziel 1948:159; Abbiw 1990:150; Fakankun & Loto 1990:306; Burkill 1994:131; Laird *et al.* 1997:62).

The use of *Ricinodendron heudelotii* for leprosy cases was reported by Wome Bokemo who spent four years with traditional healers and practitioners in Kisangani, Haut-Zaïre, studying plants used in the treatment of leprosy (Wome 1984:305-311). It was found that 43 plants were used, of which the dominant family was the Euphorbiaceae. Of these 43 plants, three were used only in Kisangani, and *R. heudelotii* was the one best represented. The tree was reported by 27 subjects interviewed to be of use against leprosy, a claim that has not been made in other regions of Africa. Leprosy is treated in Kisangani with an infusion made from the trunk bark of *Ricinodendron heudelotii* which is used as a local/topical bath to disinfect and heal the skin (Wome 1984:307).

Treatments made from *Ricinodendron* bark are widely used for sexual and fertility problems, as well as to ease pain associated with menstruation or childbirth. Decoctions made from bark are taken in the Congo to ease painful menstruation (Burkill 1994:132), and in Liberia women take a bark-liquor to kill a worm in the bowels that prevents them from conceiving (Burkill 1994:131-132).

In Côte d'Ivoire stem-bark is taken by enema to prevent abortion (Burkill 1994:132). Pulp bark and wood are also used in Ghana and Nigeria to prevent abortion (Fakankun & Loto 1990:306; Abbiw 1990:126).

In Nigeria (Fakankun & Loto 1990:306), Ghana (Abbiw 1990:126) and Liberia (Dalziel 1948:159; Burkill 1994:131) a bark infusion is used by pregnant women to relieve labour pains and to prevent miscarriage.

In Côte d'Ivoire the roots are considered an aphrodisiac (Burkill 1994:132), but in Nigeria the bark is used as a cure for gonorrhoea (Fakankun & Loto 1990:306), and in Ghana root, or root-bark decoction is used to treat venereal disease (Abbiw 1990:197; Laird *et al.* 1997:62). The root-bark is also made into a drink in Côte d'Ivoire to ease stomach ache after childbirth (Gautier-Béguin 1992:316).

In the Mount Cameroon region the seeds are used in soups to stimulate the appetite of invalids and build their strength, and also in a mixture with palm oil as a treatment for stomach and 'bile' (Laird *et al.* 1997:62).

In the Mount Cameroon region, ground kernels are mixed with palm kernel oil (manyanga) into a lotion and massaged on the soft spot of babies with fever (Laird *et al.* 1997:62), whilst in a recipe from Côte d'Ivoire, the kernels are braised with the heads of a smoked fish and 'uaka' bird, pounded to a powder and mixed with palm oil (*Elaeis guineensis*). Sipping the mixture calms a child's cough (Gautier-Béguin 1992:319).

In Cameroon and Ghana the leaves are used in baths, vapour baths, or in medicinal drinks to treat fever (Abbiw 1990:154; Mapongmetsem & Tchiegang 1996:18; Laird *et al.* 1997:62).
In the Congo bark and leaves are pulped and 'applied to fungal infections and to maturate abscesses, furuncles and buboes' (Burkill 1994:132). In Cameroon leaves are also mashed and applied to fungal ailments and abscesses (Mapongmetsem & Tchiegang 1996).

The latex and leaves are also used in West Africa as a purgative, and for guinea-worm extraction (Laird *et al.* 1997:62).

In the Congo the expressed sap is instilled in the eye for filaria and ophthalmias (Burkill 1994:132).

In southern Cameroon the dried bark is used to ferment palm wine (Fondoun *et al.* 1999:6).

9 Markets and Trading

9.1 The trade in *Ricinodendron heudelotii* in Central and West Africa

Non-wood forest products make a significant contribution to village incomes in West and Central Africa where local people have access to forest environments, and where the tradable value of forest products are known to them. In theory efficient markets for tree products may:

- encourage conservation by increasing the value of forests as a productive asset;
- provide an incentive for improved land-use practices;
- provide a means of expanding rural employment opportunities;
- improve the supply of rural produce to urban markets;
- provide raw materials for the development of small and medium scale industry.

However, these factors are still largely untested, and market theory does not offer ways of pricing environmental goods whose future value may be greater than the current value (Gordon & Fereday 1997:6). This is true of products such as njansang which has a wider global market than is currently reached, and which would increase in value with wider education on the uses and cultivation of the tree, and with investment in improved means of processing the fruits.

Cameroon's forests offer a large supply of non-wood forest products used for subsistence, medicines and trading. The trade is an important part of the rural economy, especially for poorer traders, many of them women. *Ricinodendron* together with *Cola, Dacryodes* and *Irvingia* are major traded species, representing the bulk of the NWFP sales at marketplaces in the Humid Forest Zone of Cameroon (Pérez *et al.* 1999:14). Another survey of villages inside and bordering the Korup National Park of Cameroon (Amadi 1993:22-23) showed that hunting, and the collecting and processing of non-wood forest products, were the enterprises undertaken in the communities which were of greatest importance in terms of their contribution to the village economy. Condiments such as njansang (*R. heudelotii*), bush mango (*Irvingia* spp.) – which is mainly sold to Nigerians – and country onion (*Afrostyrax lepidophyllus*), accounted for 25-50% of overall village incomes.

Research for the Tropenbos programme also revealed that some species, such as *R. heudelotii*, providing valuable NWFPs, were still little known by the local villagers (Ntamag 1997:63). Some NWFPs were collected by a few people who had learned about them from outside the village. A study undertaken by Van Dijk in the South Province of Cameroon (van Dijk 1999:37-49) found that only 2 out of 30 families were involved in trading *R. heudelotii* products, of which two families undertook extraction, and one family engaged in trade. The revenue from this activity over four months was CFA 5,800.

Wherever *Ricinodendron heudelotii* fruits are harvested and processed, they are reported to be in the domain of women's activities, whereas bush mango may be gathered by men or women, or as a group or family activity (Ntamag 1997:43; Vabi & Tchamou 1999:173). In the Mokoko River Forest Reserve, Cameroon, even though njansang (*R. heudelotii*) is regarded as one of the more valuable non-wood forest products available, it is an 'open access' resource, so njansang fruits are exploited by the women (Sunderland & Tchouto 1999:9).

The marketing of most non-wood forest products and agricultural products reflects their seasonal nature. Prices are low at harvesting, and tend to increase as supplies diminish. The harvest is sold through the home and village markets. In the villages surveyed in the north and north-east of the Korup Project Area, South-West Cameroon, November to January is a period of boom when cocoa, coffee, oranges, bush pepper, njansang and smoked bush mango are sold (Vabi & Tchamou 1999:177). There was no clear pattern for marketing most women's agricultural produce, but in the same region bush mango and njansang were generally sold between October and November, even though the peak period for njansang harvesting for women was August-October, with the peak marketing period lasting from October-March (Vabi & Tchamou 1999:177, 180). During October and November the roads leading into the suburban centres of the support zone of the Korup Project Area are almost impassable, which has a negative effect on the marketing of non-wood forest products collected, and therefore on the prices paid to collectors (Vabi & Tchamou 1999:177). For *Ricinodendron heudelotii* nuts the limitations of the wet season to marketing NWFPs are somewhat mitigated because the dried kernels will store for several years, enabling them to be stored and sold throughout the year in urban markets (Vivien & Faure 1996:154; Laird *et al*. 1997:61-62) from Cameroon to Congo Brazzaville, Equatorial Guinea and Gabon (Sunderland & Tchouto 1999:17).

Most of the processing of *Ricinodendron heudelotii* is done where the fruits drop (Gordon & Fereday 1997:24). This reduces the labour cost of carrying fruits to the village and increases value for weight. Processing also increases the seeds' durability. Well-dried seeds can last for up to two years. Consumers prefer to buy njansang dried but not ground because grinding reduces storage life. Most storage is undertaken by the wholesalers who buy in bulk in the harvesting season and then sell when the prices are higher in the off-season.

9.2 Estimations of the value of the trade in *Ricinodendron heudelotii* products

The information available on market prices for *Ricinodendron heudelotii* mainly relates to the seeds, although the bark and roots are also sold in markets. No prices were found for wood products – such as poles or carved items – either for local use or export. In Africa western medicines are still very expensive and traditional use of medicinal plant matter such as the bark and root of *R. heudelotii* is still widespread. Yembi listed the bark, root and seeds of *R. heudelotii* as among the most commonly sold products in Libreville markets in Gabon, and *R. heudelotii* products (bark, root and seeds) were included in the list of most commonly sold items in the Libreville markets (Yembi 1998:234), but they were not a major item in Kisangani and Beni markets (Yembi 1998:229).

Table 4: Value of the 4 main NWFPs traded in 25 markets of the humid forest zone of Cameroon

Species	*Estimated half-year value of sales (CFA 1,000*[15]*)*	*Net margin as % of total sales value*
Dacryodes edulis	388,479	17
Ricinodendron heudelotii	229,052	26
Irvingia spp.	135,376	27
Cola spp.	129,578	19

Source: Pérez *et al.* 1999:14.

In Cameroon it was found that *Ricinodendron heudelotii* (njansang) is important in both local and regional markets with 1 kg (average of 250 nuts) selling for US$ 1.30-1.50 (1996 prices) (Mapongmetsem & Tchiegang 1996:18). An extrapolation from market surveys in Cameroon suggests that the trade of 4 indigenous fruits (*Ricinodendron heudelotii*, *Irvingia gabonensis*, *Dacryodes edulis* and *Cola acuminata*) from the humid forest zone over the 6-month period January-July 1995 was valued at $1.2m of which the share for *R. heudelotii* was US$ 460,200 for 172 tonnes traded at US$2.7/kg[16] (Leakey & Tomich 1999:323, Table 2). A marketing survey of *Ricinodendron heudelotii* (njansang) carried out in 1995, reported sales value and net margins for marketing *R. heudelotii* in 28 markets of the Humid Forest Zone of Cameroon as follows:

Njangsang is traded in 15 litre buckets and 300 ml cups with the number of cups/bucket varying from 60-65 cups for bush mango to 100-110 for njangsang. Wholesalers' views of a full bucket differs from that of the farmer/producer (Gordon & Fereday 1997:21). The fruits of *R. heudelotii* are not as lucrative as those of bush mango, but the yields are more reliable (Laird *et al.* 1997:61-62).The survey carried out by Gordon and Fereday found revenues to wholesalers and retailers were greater for *R. heudelotii* than for *Irvingia gabonensis*.

From Table 6 it appears that the value added down the market chain is of greater benefit to wholesalers and retailers for *R. heudelotii* than for *Irvingia gabonensis*, but the price received by farmers only differs marginally. This probably reflects the storage capacity of njansang which enables wholesalers to wait until demand rises before selling, and the greater availability of *Irvingia* products which have two seasons in a year.

Table 5: Comparison of sales and margins for R. heudelotii and Irvingia spp traded in 28 markets in Cameroon

	R. heudelotii	*Irvingia spp.*
Total net margin for all traders and markets combined	CFA 10,193,800	CFA 12,987,900
Total value of sales	CFA 42,694,700	CFA 34,633,100
Average weekly net margin/trader (surveyed over 29 weeks)	CFA 4,200	CFA 3,800
Net margin as % of total value of sales	23%	30%

Source: Ndoye *et al.*1997/98:11, Table 1

The market surveys undertaken in the Korup region of Cameroon appear to indicate a buoyant market for *Ricinodendron heudelotii* products, with no discernible decline in demand for non-wood forest products. Prices of all products sold by women from the Korup region of Cameroon were reported to have been increasing over the past 5 years, whereas those sold by men had fluctuated, but were generally on the decline (Vabi & Tchamou 1999:177).

[15] Average of 2 seasons 1995 and 1996. US$1 = CFA 500.
[16] US$1 = CFA 600 (1999 rate of exchange).

Table 6: Comparison of selling prices and monthly gross margins for *Ricinodendron heudelotii* and *Irvingia gabonensis* in South West Cameroon

	Selling prices[17] (CFA/bucket)		Monthly gross margins[18]	
	Ricinodendron heudelotii	*Irvingia gabonensis*	*Ricinodendron heudelotii*	*Irvingia gabonensis*
Farmer	10 - 13,000	10 - 13,500	–	–
Wholesaler	13 - 18,000	13 - 15,000	CFA 67,300 (24 buckets)	CFA 40,100 (24 buckets)
Retailer	17,500 - 25,000	16,250 – 19,500	CFA 18,700 (3 buckets)	CFA 23,200 (4 buckets)

Source: Gordon & Fereday 1997:26-27.

The studies undertaken in the South Province of Cameroon for the Tropenbos Cameroon Programme found that where *Ricinodendron heudelotii* products were traded, one hundred per cent of the harvest was sold, with a revenue over 4 months of CFA 5,800. In this region the seeds and bark of *Ricinodendron heudelotii* were sold in the markets for medicinal purposes, indicating that the culinary value of the seeds was either unknown or not appreciated (van Dijk 1999:37-49).

Market value for *Ricinodendron* not only varies with season, but with availability and demand. Ndoye *et al.* found a clear difference in the percentage net marketing margin of *Ricinodendron* between the largest markets, with the value in markets in the Littoral province of Cameroon (35-40%) being about double that in the Centre province. This is a reflection of the source of supply. *Ricinodendron* is readily available in the Centre-South provinces, but is relatively scarce in the Littoral province. In addition, demand is high in the Littoral province because fish is an important staple there and *Ricinodendron* is a popular condiment for use with fish (Ndoye *et al.* 1997/98:12).

As has been described in chapter 8.2.1, the nuts from *Ricinodendron heudelotii* produce a high-quality oil. Mapongmetsem and Tchiegang suggest the tree could become a major producer of cooking oil, comparable with that of cotton, soya or peanut (Mapongmetsem & Tchiegang 1996:18). The oil is also suitable for other non-food uses. The possibilities of manufacturing oil from nsa-sana seeds (*Ricinodendron heudelotii*) investigated in the early twentieth century by the Imperial Institute, London, and an unnamed firm of varnish makers (Imperial Institute 1907 1908). The price for t'ung oil in London in 1907 was £32-33/ton, and a suggested price for nsa-sana oil was £18-20/ton. The varnish makers were reported as being positively disposed towards adding nsa-sana oil to their list of oils and selling it at an equivalent price to linseed oil, for which the 1908 price was £21 12s.6d to £21 17s.6d /ton. The problems blocking commercial development of the oil were the same in 1908 as today. (i) the low oil yield from the entire nuts (14%); (ii) the low proportion of kernel in the nut and the great difficulty of separating the kernels; (iii) the cake had no value except as manure; and (iv) the cost of collection would probably not be covered by the expected market price in Britain compared to t'ung oil. The search is still on for a quick, cheap and efficient method of separating the kernels from the nut.

9.3 The chain of trade from village to town

Markets for *Ricinodendron heudelotii* are concentrated in the vicinity of the large urban centres of Cameroon. Wholesale traders buy from local markets and villages and sell to larger urban centres and for export (Laird *et al.* 1997:61-62). Wholesalers help to stabilise prices, at the same time earning a considerable premium by storing the more durable processed products such as cola, bush mango and njangsang. The premiums earned more than compensate for storage costs and losses due to insect damage. The more durable products can be stored for years. (Gordon & Fereday 1997:20)

[17] Range of selling prices over 12 months. Retailers sell in smaller units such as cups and bowls, but for ease of comparison prices here are given in the unit used by wholesalers and farmers.

[18] Gross margins and volumes traded in the four weeks prior to the survey. Data from Muea and Limbe, Cameroon. In gross margin accounting only the variable costs are shared out to individual enterprises.

In the Remote Settlements[19] of the Korup Forest there are few income-generating opportunities for the young women, so they have become involved in trading forest spices, such as bush mango (*Irvingia* spp.) and njansang (*R. heudelotii*). They buy the seeds from women in Remote Settlements and sell them to traders in Roadside Settlements. These items provide the main source of cash for women in the Remote Settlements (Malleson 1998:120) and the products form a value-adding chain from the communities to the main marketplace. Many pygmy communities in Uganda have formed a similar association at the lower end of the commercial marketing chain, providing non-wood forest products such as *Pausinystalia johimbe* bark, *Gnetum* leaves, forest tubers (e.g. *Dioscorea* yams), and forest fruits (e.g. *Irvingia, Ricinodendron heudelotii* etc.) to timber loggers, or "protein for starch exchanges" with agriculturists (Cunningham 1998).

In Nyangong, Cameroon, even though the use of *Ricinodendron heudelotii* as a condiment is known, it is little-used in the village, and the nuts are mostly collected and processed for sale in the cities, where they are very highly valued, by women native to Nyangong who live in the cities (Ntamag 1997:71). For these women the nuts provide high revenues, even though their extraction is a very difficult and time consuming task.

Processing and transport are the main marketing functions provided in the market chain for njansang, with processing carried out by the initial gatherer. Most farmers sell immediately after processing to meet cash needs, which also saves them transport costs. Market traders buy small quantities throughout the year, and most storage is undertaken by wholesalers who buy in bulk during the harvesting season and sell during the off-season when prices are higher. Wholesalers also perform arbitrage, moving product from areas where abundance is high and prices are low, to areas where there is demand but not supply (Gordon & Fereday 1997:25).

9.4 Export

Ricinodendron seeds, and to a lesser extent the bark and roots, are widely traded within West and Central Africa, both within countries and across borders. Pérez *et al.* gave three reasons why cross-border trade should thrive in the region (Pérez *et al.* 1999:16-17):

> i) Ecophysiological. Production periods in adjacent countries differ, particularly either side of the Equator, with the production season running from June to November in Cameroon and Nigeria, and from November to April in Angola, the Congo, The Democratic Republic of Congo, and Gabon. Trade will therefore change direction seasonally.
> ii) Differences in consumer appreciation for a given product encourage bidirectional trade.
> iii) It is common to find related ethnic groups living on both sides of a given frontier, often consuming similar products and trading with each other.

The authors estimated that exports from markets they had studied in Cameroon to neighbouring countries in 1996 amounted to at least US$ 980,000 (Pérez *et al.* 1999:17). Cameroon exports to its neighbouring countries of Nigeria, Equatorial Guinea, Gabon, and the Central African Republic (Ndoye 1998:4), with 30% of the trade going to Gabon and Equatorial Guinea. Farmers sell NWFPs to acquire cash for the basic needs of their household (74%), to pay for school fees (9%), and for 'other needs' (17%) (Leakey & Tomich 1999:322).

The seeds of *R. heudelotii* are sold widely in markets throughout the South West of Cameroon and larger West Africa (Laird *et al.* 1997:61-62). Demand is great within Cameroon, and there is an export market to Nigeria from villages such as Otu. Otu is an important cross-border trade centre that shares the same socio-cultural history with the other Ejagham villages in the Cross River State of Nigeria. Most, if not all the cocoa, non-wood forest products and other agricultural products

[19] 'Remote Settlements are surrounded by relatively intact high forest, but poor market access limits the range of livelihoods. For this reason Remote Settlements are largely socially homogenous. Many people have moved to Roadside Settlements in search of a better standard of living. Remote Settlements are distinguishable by their access to high forest.' (Malleson 1998).

from Otu, in the Korup Project Area, Cameroon, are either sold in Nigeria or bought by Nigerian traders in the village (Vabi & Tchamou 1999:177). This may be a very localised trade that doesn't penetrate deep into Nigeria because Gordon and Fereday in their study based in the region of Mount Cameroon held that njansang is not exported to Nigeria (Gordon & Fereday 1997:17, footnote 16).

In Equatorial Guinea almost all condiments are imported from Cameroon, and due to transport costs and customs duty (official and unofficial) they are almost twice as expensive as in Cameroon. *R. heudelotii* seeds are sold in small wrapped polythene packets, costing CFA 50 each (Sunderland & Obama 1999:215).

There is also trade in non-wood forest products between Cameroon and some large European cities such as Paris and Brussels where there are large numbers of immigrants from West and Central Africa (Pérez *et al.* 1999:16-17), and the trade in African non-wood forest products is known to employ several hundred persons in France and Belgium. In Paris a survey listed djansang (*R. heudelotii*) among the most frequently imported non-wood forest products to France, although the size of the trade and volume traded was difficult to quantify (Tabuna 1999:251-259). The markets are diverse because national origins tend to influence customers' purchases. For example, djansang (*R. heudelotii*) is bought only by people from Cameroon.

In Congo-Brazzaville the potential of many high value non-wood forest products, such as the seeds of *R. heudelotii* are not fully exploited despite the international market demand for these products being high (Kimpouni 1998).

10. Institutional Issues

Ricinodendron heudelotii is not on the World Conservation Monitoring Centre's list of endangered species in West Africa, even though it is reported that individual trees in the forest are not as common as they once were (Laird *et al.* 1997).

National land use laws may present an opportunity for conservation by offering long-term security to users of the land. For example, the 1994 Cameroon Land Tenure Act (Articles 14, 16 and 17) created opportunities for indigenous people to defend land rights and privileges (Ntamag 1997:12). Within the categories of forest land established in the legislation, 'National Forests' are areas of non-permanent forest that are not State, Council or Private forests, and forest products remain the property of the State, unless they are subject to management agreements as in Community Forests. 'Community Forests' are formed from forested land within 'National Forests' and are likely to be under relatively intense exploitation already (Ambrose 1994:48). This may be as much as 50-60% of national forest territory but it has little legal protection (See also Sunderland & Tchouto 1999:25).

Cameroon Land Tenure Act, Articles 14, 16 and 17, creates 'possibilities for indigenous people to defend land rights and privileges' (Ambrose 1994:47). Clearing forest land and planting cash crops, such as cocoa or coffee, grants *de facto* possession of the land for 30 years, although whether this includes clearing land and planting trees around forest margins or fallow land is not clear. Ambrose reported that even though such usufruct rights to forest land in Cameroon exist under State and National forest land classifications, legal title can not be obtained to 'virgin' forest, so, for example, many of the Bakweri people living in the Mount Cameroon Project area in South-west Cameroon do not hold *de jure* ownership of the land they farm (Ambrose 1994:19-20).

Furthermore, Fereday *et al.* point out that under Cameroon law there is a potential for conflict because the 'existing forest resource classification means that the harvesting of NWTPs for commercial purposes could be interpreted as illegal' (Fereday, Gordon & Oji 1997:22).

Awarding people long-term control over their land gives them an interest in retaining valuable NWFP resources, such as *R. heudelotii*, because their horizons are longer and the benefits of long-term earnings from trees are seen as accruing to them (Sunderland & Tchouto 1999:37).

Table 7 Suggestions for further study to increase the productivity of *Ricinodendron heudelotii* and perpetuate the use of its products

- Improved planting stock for farmers either by improving seed germination, or further work on vegetative propagation and clonal reproduction.
- Analysis of the two subspecies for breeding improvements that will give a better ratio of seed to fruit. Are there differences between them in, for example, seed size, seed flavour and oil content?
- Provenance studies using local farmers to find superior trees from which improved stock could be bred.
- Ecology: Seeds are dispersed by bats, hornbills and rodents, but they are removed by collectors. As forest area shrinks, is overcollection of fruits causing a reduction in the regeneration of natural/wild populations?
- Extending fruit production to meet potential market demand, through large-scale or local-based planting programmes.
- Improved local-based methods of seed extraction and processing are needed.
- Improved market access for farmers: local-based co-operatives that could share processing and distribution.

Customary laws governing who has rights over products from a tree are the main vehicle for ensuring a tree's protection (Sunderland & Tchouto 1999:35), but as rights over trees are often distinct from rights over the land, a clear distinction needs to be made between tree tenure and land tenure (Ntamag 1997:12). In the Bas Congo region of the Democratic Republic of Congo planting a tree confers ownership of that tree, and *R. heudelotii* was often planted on or near graves (Latham 1999 manual:15, 27). In Cameroon *Ricinodendron heudelotii* is commonly planted to mark farm boundaries (Mapongmetsem & Tchiegang 1996). However, if trees are on land which is in the public domain use of the fruits is often on a first-come-first-served basis. Ownership of the harvest is asserted by piling up the fruits.

In Nyangong, in the south of Cameroon, even though the State is the highest authority with respect to the forests and the trees, it is accepted that the people have the property rights on those lands that have been 'given to their ancestors by God' (Ntamag 1997:31-37). The villagers recognise categories of land tenure that include virgin forest lands without 'ancestral claims', and forest lands with user rights for local people that are based on ancestral customs (Ntamag 1997:31-37; Malleson 1999:119). This ownership system extends to trees and limits usage of the trees, although forest lands are an open-access resource. *Ricinodendron heudelotii* is not a well-known tree in this village so the nuts may be collected without limitation because of the limited demand.

11. Conclusion

Ricinodendron heudelotii is a useful multi-purpose tree that has been taken into agricultural systems in parts of its range, but not in others. The species has been left when land is cleared to provide shade for crops. It is also grown as a shade tree in plantations. It is a non-leguminous species which acts as a soil improver, and its deep rooting system does not compete with the roots of crops. It is coppiced or pollarded and used as a hedging species to provide browse and poles. It has both medicinal and cultural importance throughout its range, and the condiment derived from the seeds is a valued flavouring in many places.

Women gather and process the fruits to obtain the seeds which are sold in local markets. The market chain extends to urban centres, across adjacent borders, and the seeds are exported to cities with sizeable expatriate communities in Europe (Tabuna 1999:252).

Farmers interviewed in Ghana, Nigeria and Cameroon in a survey for the ICRAF/IITA/OSU project, ranked the species fourth most important out of 15-25 multi-purpose trees they had selected. There were aspects of the species' performance the farmers would like improved, that would encourage them to utilise *R. heudelotii* in their farming systems. These included: less time to produce fruit (precocity), reduced tree height, increased biomass, larger seeds, and larger fruit with a longer shelf life (Adeola 1995; Mollet *et al.* 1995:16). Table 7 suggests further areas of research which could contribute to continuing productive and profitable use of the species in the CARPE region.

Breeding programmes to realise these farmers' suggestions would benefit from greater understanding of the species and the importance of habitat to the growth of superior trees. For example, Fondoun *et al.* (1999) have suggested, based on their observations, that in Cameroon altitude may govern the numbers of seed per fruit. On the other hand, Léonard proposed in 1961 that seed number per fruit was one of the distinguishing characteristics of two subspecies with different areas of distribution – a West African subspecies, *R. heudelotii*, subsp. *heudelotii*, and a Central West African subspecies, *R. heudelotii*, subsp. *africanum*. Many descriptions of the fruits mention undeveloped or aborted seeds, and herbarium samples provide the evidence. Further investigation to confirm the existence and distribution of the two subspecies, and the role of habitat in seed development would help the development of superior cultivars for use on farms.

Germination of the seeds can be unpredictable. Taylor (Taylor 1960:388-389) stated that germination occurred in 12 days, with 78% success, but Shiembo found the seeds difficult to germinate (Shiembo 1994) and this acted as a deterrent to farmers, though they may transplant wildings. Development of clonal propagation techniques and the provision of nursery-grown saplings to farmers would decrease the time before a tree is harvestable. Work on germination and propagation techniques are cited in this study (Shiembo 1994 1997; Kyereh, Swaine & Thompson 1999; Agyman, Swaine & Thompson 1999).

As well as improvements to the species' performance there is a need to make processing the fruits an easier exercise. At present extracting and drying the seeds is a time-consuming task undertaken by women, and the prices they receive when they sell their produce to traders, or in local markets, are unlikely to reflect the labour involved. The formation of co-operative ventures may be a means to improve this situation. For example, production and marketing co-operatives for such forest produce as *Ricinodendron* have been formed, which give women a stronger bargaining position, helping them to obtain better prices for their produce (Arrey 1999:4).

The most intractable issue relating to NWFPs is that of tenure and usage rights. Where a species such as *Ricinodendron heudelotii* is still undomesticated and its products are gathered both the law and customary rights may inhibit the development of sizeable markets. The law limits control over land use very often by retaining land ownership in the government's hands. Thus, even if a farming is renting his land there is little incentive to invest in long-term resources such as trees. Customary rights may act as an aid to sustainability by limiting usage of a resource but this limitation also acts as a brake on increasing revenues.

Appendix 1: Flowering and fruiting times for *Ricinodendron heudelotii* as recorded in herbarium specimens

Country	Flowering	Fruiting	Collector & collector number	Altitude (m)
Subspecies *heudelotii*				
Côte d'Ivoire		January	Leeuwenberg, A.J.M. 2594	100
Côte d'Ivoire	March		Leeuwenberg, A.J.M. 2982	370
Ghana		July	Merello, M. *et al.* 1251	400
Ghana	February		Vigne, C. 1801	900
Ghana	March		Vigne, C. 281	133
Ghana	March		Vigne, C. 79	133
Guinea Bissau		November	Malaisse, F. & V. Claes 14866	20
Subspecies *africanum*				
Angola		March	Dechamps, R.-F. Murta et M. Da Silva 1529 28.196	680
Cameroon	February		Thomas, D. 3059	850
Cameroon	March		Thomas, D. 3269	200
Cameroon		May	Thomas, D. 3477	150
Cameroon		May	Mildhaer 9266	900
Cameroon		May	Thomas, D. 3477	150
Cameroon		June	Leeuwenberg, A.J.M. 5970	670
Central African Republic	March		Harris, D.J. & J.M.Fay 317	350
Central African Republic		November	Fay, J.M. & D. Harris 8682	385
Dem. Republic of Congo	March		Louis, J. 8308	470
Equatorial Guinea	April		Tessmann, G. 357	450
Gabon		November	Louis, A.M., F.J. Breteler *et al.* 818	250
Kenya		March	Faden, R.B. & A.J. 74/312	450
Nigeria	January		64	63
Nigeria	April		Chapman, J.D. 5330	260
Nigeria		June	Gentry, A. & G. Pilz 32657	150
Nigeria		August	Chapman, H.M. 165	233
Tanzania	January		Greenway, P.J. 4843	4000
Uganda	March		Harris, C.M. 634	1000
Uganda	November		Dummer, R.A. 4444	1000
Uganda		October	Dawe, M..J. 637	800

Appendix 2: Flowering and fruiting times for *Ricinodendron heudelotii* as recorded in the literature

Country	Flowering	Fruiting	Source
Côte d'Ivoire		June-October	Gautier-Béguin 1992:277, fig.72
Ghana	February/March	July-October	Taylor 1960:164-5
Southern Nigeria	January & July	August, September-October	Kennedy 1936:78
Nigeria	March & September		Lawton & Lawton 1971:189
Nigeria & Cameroon	March-May	May-October	Keay *et al.* 1960:257; Thikakul 1985:305
Cameroon		August-November	Gordon & Fereday 1997:19, fig.2
Cameroon		August-December	Sunderland & Tchouto 1999:18, table 5.
Southern Cameroon		January-March	Ambrose 1994:21, table 3

Appendix 3: *Ricinodendron heudelotii* – vernacular names

Vernacular name	*Language / Country*	*Source*
African nut tree, African wood, African wood-oil nut tree, cork wood	English	ICRAF 1999
African wood oil nut tree		Adjanohoun 1991
akin	Baule (Côte d'Ivoire)	Burkill 1994
akpi	Ngban, Abe, Akan-Asante, Akye, Baule (Côte d'Ivoire)	Gautier-Béguin 1992; Burkill 1994
akporo	Baule (Côte d'Ivoire)	Burkill 1994
akwi	Akye, Anyi (Côte d'Ivoire)	Burkill 1994
alokpo	Ghana	Burkill 1994
andjo cos yogos	Tanda (Guinea Bissau)	Malaisse & Claes 1995
anwarma		Fouarge & Gérard 1964
api	Anyi, Brong, Kulango (Côte d'Ivoire)	Burkill 1994
asoma	Anyi, Nzema (Ghana)	Burkill 1994
awama, awoma, owama	Akan-Asante, Fante (Ghana)	Burkill 1994
bofeko	Zaïre	Fouarge & Gérard 1964; Chudnoff 1984
bo-gboho	Kissi (Guinea)	Burkill 1994
bonjasanga	Kundu (Cameroon)	Burkill 1994
bonjaosao	Duala (Cameroon)	Burkill 1994
bõn kuõforo	Manding-Mandinka (Senegal)	Burkill 1994
boroï	Toma (Guinea)	Burkill 1994
bosisang	Lundu (Cameroon)	Burkill 1994
bu kenkare, bu makureg, bu makurèn	Diola (Senegal)	Burkill 1994
bukombola	Kitembo (DR Congo)	Troupin 1957
corkwood	English	Forest 1958; ICRAF 1999
djansang		Tabuna 1998
egobo	Central African Republic	herbarium
eho, ého	Abe (Côte d'Ivoire)	Fouarge & Gérard 1964; Burkill 1994
eke	Urhobo (Nigeria)	Keay *et al.* 1960; Keay 1989; Burkill 1994
ekku	Yoruba (Nigeria)	Burkill 1994
ekobo	Central African Republic	herbarium
ekpedi	Adangme-Krobo (Ghana)	Burkill 1994
engwanle	Nzema (Ghana)	Burkill 1994
epi	Akan-Asante (Ghana)	Burkill 1994
epo	Edo (Nigeria)	Burkill 1994
epui, epuwi	Anyi, Anufo (Ghana)	Burkill 1994
erimado, erín madò	Zaïre; Yoruba (Nigeria)	Pieters 1977; ICRAF 1999; herbarium; Chudnoff 1984; Fouarge & Gérard 1964
erinmado, erinmadu	Yoruba, Edo (Nigeria)	Keay *et al.* 1960; Keay 1989; Burkill 1994
esangasanga	Kpe (Cameroon)	Burkill 1994
esesang	Fang (Equatorial Guinea)	Sunderland 1998
essandaille, esseng ndaye	Adyukru (Côte d'Ivoire)	Burkill 1994
essesang, essessang	Fang (Equatorial Guinea); Gabon; Cameroon; Zäire	Fouarge & Gérard 1964; Chudnoff 1984; Sunderland & Obama 1998; Yembi 1998; Pieters 1977
ewama, enwany(e), nwuama	Anufo (Ghana)	Burkill 1994
ezan	Cameroon	Bates 1921

ezezang, ezang	Cameroon	Anigbogu 1996
flekpo	Ghana	Burkill 1994
gbo	Kissi (Sierra Leone)	Burkill 1994
gboe	Kono (Sierra Leone)	Burkill 1994
gbore	Koranko (Sierra Leone)	Burkill 1994
gbolei, gbolo, gboloi,	Mende (Sierra Leone);	Burkill 1994
gbolei, kpolei, kpolo	Mende (Liberia)	
gbolo	Kpelle (Guinea)	Burkill 1994
gboloba-bulu	Manding-Maninka (Guinea)	Burkill 1994
gboloye	Toma (Guinea)	Burkill 1994
gbuho-ba	Dioula (Côte d'Ivoire)	Ambe 1997
gbwoye	Kono (Sierra Leone)	Burkill 1994
goodi	Dan (Côte d'Ivoire)	Burkill 1994
gporo	Toma (Guinea)	Burkill 1994
groundnut tree	English (Cameroon)	Anigbogu 1996
groundnut tree	Nigeria [check]	Okafor & Lamb 1992
hacbiuagpi, haipi	Anyi (Côte d'Ivoire)	Burkill 1994
haipi	Kulango (Côte d'Ivoire)	Burkill 1994
hakpiwaka	Anyi (Ghana)	Burkill 1994
hobo hapi	Abe (Côte d'Ivoire)	Burkill 1994
irinmado	Nigeria	Fakankun & Loto 1990
irranguila [?]	Zambia	herbarium
isain	Akye (Côte d'Ivoire)	Burkill 1994
isange	Koosi (Cameroon)	Burkill 1994
issanguila	Gabon	Klaine 1895
ka-kino, ka-sigboro	Temne (Sierra Leone)	Burkill 1994
karro-tu	Guere (Liberia)	Burkill 1994
karatu	Kru-Grebo (Côte d'Ivoire)	Burkill 1994
katotu	'Kru' (Côte d'Ivoire)	Burkill 1994
kô, koo	Mano (Guinea); Mano (Liberia); Gagu, Guere, Kweni (Côte d'Ivoire)	Burkill 1994
ko	Dan (Liberia)	Burkill 1994
kohué, kotué, ko-ué	Kru-Grebo, Guere (Côte d'Ivoire)	Burkill 1994
koor	Ktu-Basa (Liberia)	Burkill 1994
kpedi	Vhe (Ghana)	Burkill 1994
kpo	Kissi (Sierra Leone)	Burkill 1994
kua	Guere (Côte d'Ivoire)	Burkill 1994
kingela	Kicongo (Bas Congo)	Latham 1999, 1999b
kishongo	Uganda	Chudnoff 1984
kisongo	Kuamba	Forest 1958
matondoo	Tanzania	Zimmerman 1917
mbob, nbob	Adyukru, 'Kru' (Côte d'Ivoire)	Burkill 1994
mille[20]	Ngban (Côte d'Ivoire)	Gautier-Béguin 1992
mlindi	Kishamba (Tanzania)	herbarium
muawa	Swahili	ICRAF 1999
mughele	Bapounou (Gabon)	Yembi 1998
mulela	Zaïre	Pieters 1977
munguella	Angola	Gossweiler 1908; Fouarge & Gérard 1964; Chudnoff 1984
musodo	Lunyoro (Uganda)	Forest 1934; Forest 1958
ngwama, ngwani	Nzema (Ghana)	Burkill 1994
njansang, njangsang	Kundu (Cameroon)	van Dijk 1998; Vabi 1998; Malleson 1998; Sunderland & Tchouto 1998; Burkill 1994
nsasana	Efik (Nigeria)	Burkill 1994
nwuama	Anufo (Ghana)	Burkill 1994
ode, odede	Igala (Nigeria)	Burkill 1994
okao koodo	Ghana	Burkill 1994

[20] The author doesn't have information on the meaning of this name.

okengbo	Ijaw, Ijo-Izon (Nigeria)	Keay *et al.* 1960; Keay 1989; Burkill 1994
okhuen, okhuen-nebo, okhuen-n'fua, okhuen-seva	Bini, Benin, Edo (Nigeria)	Smith 1931; Keay *et al.* 1960; Chudnoff 1984; Keay 1989; Burkill 1994
okponum	Abua (Nigeria)	Burkill 1994
okue	Itsekiri (Nigeria)	Keay *et al.* 1960; Keay 1989; Burkill 1994
okwar	Mbe (Nigeria)	Burkill 1994
okwe	Ibo (eastern Nigeria); Igbo (Nigeria)	Keay *et al.* 1960; Anigbogu 1996; Keay 1989; Burkill 1994
olóbò igbó	Yoruba (Nigeria)	Burkill 1994
omodan, omodon, oromodon	Yoruba (Nigeria)	Adjanohoun 1991; Burkill 1994
omwama, onwama	Twi (Ghana)	Burnett 1926; Burkill 1994
ovovo	Ijo-Izon (Nigeria)	Burkill 1994
plo	Kono (Guinea)	Burkill 1994
poposi	Abure (Côte d'Ivoire)	Burkill 1994
popossi, popossi ya, propossi	Kyama (Côte d'Ivoire)	Burkill 1994
poto poto, putu putu, putu putu funfun	Yoruba (Nigeria)	Burkill 1994
sanga-sanga	Democratic Republic of Congo	Fouarge & Gérard 1964; Pieters 1977
sesamga	Angola	Dawe1921
sosahu	Nzema (Côte d'Ivoire)	Burkill 1994
tonta	Susu, Sosso (Guinea)	Burkill 1994; Malaisse & Claes 1995
tsain	Akye (Côte d'Ivoire)	Burkill 1994
tondoro	Tanzania	herbarium
uama, wamba	Akan-Asante (Côte d'Ivoire); Ahanta, Wasa (Ghana)	Burkill 1994
wama, wamba, wamma	Wasa (Ghana)	Vigne 1926; Vigne 1927; Chudnoff 1984; Burkill 1994; Abbiw 1990
wawankurmi, wawan kurmi	Hausa, Bassa (Nigeria)	Chapman 1974; Keay *et al.* 1960; Burkill 1994
wawanputu kurmi	Hausa (Nigeria)	Keay 1989
wawan kormi	Hausa (Nigeria)	herbarium
webango	Zaïre	Pieters 1977
wongasanga, wonjasanga, wonjangasanga	Kpe (Cameroon)	Burkill 1994

Appendix 4: Recorded distribution of *Ricinodendron heudelotii*, subsp. *heudelotii* and subsp. *africanum* (taken from literature sources).

Species	*Country*	*Distribution*	*Source*
Ricinodendron heudelotii (Baill.) Pierre ex Pax, FWTA, ed.2, 1:393, fig.137. Synonym: *R. africanum* Muell. Arg. FWTA ed.1, 1:294	Benin	Sapoba, *Mitchell* FHI 2614	Keay *et al.* 1960:257
Ricinodendron heudelotii (Baill.) Pierre ex Heckel., Ann. Inst. Col. Marseille, V.2, p.40 (1898) pp. ~subsp. *heudelotii*	Guinea-Bissau; Equatorial Guinea; Sierra Leone; Liberia; Côte d'Ivoire; Ghana	Portuguese Guinea (Fulacunda, S. Joâo, Mato de Poncom); Guinea (Fouta Djallon); Sierra Leone (Bagroo River); Liberia (Dukwia R.); Côte d'Ivoire (Dabou, Danané, 60km N. of Sassandra); Ghana (Sikamang, Kumasi).	Léonard 1961
Ricinodendron heudelotii (Baill.) Pierre ex Heckel., Ann. Inst. Col. Marseille, V.2, p.40 (1898) pp. ~subsp. africanum	Nigeria; Malabo (Equatorial Guinea); Cameroon; Equatorial Guinea; Congo; Cabinda; Angola; Central African Republic; Sudan; Democratic Republic of Congo; Uganda; Tanzania; Mozambique (?)	Nigeria (Calabar River Division; Ishagama-Ibadan); Fernando Po; Cameroon (Babua; Duala; Bipinde); Spanish Guinea (Nkolentangam); Gabon (Libreville); Congo Republic (Congo); Cabinda (Chiluango); Angola (Loanda – Cazengo, Luanda – Ambriz); Central African Republic (Boukoko); Sudan (Bendere – Zande District); Congo (Eala, Yangambi); Uganda (Semliki Forest); Tanganyika (Korogwe, Eastern Usambaras, Tanga District [1 location?]); Mozambique (ex bibliogr.).	Léonard 1961
R. heudelotii (Baill.) Pierre ex Heckel subsp. *heudelotii*	Guinea-Bissau to Ghana	Portuguese Guinea to Ghana	Léonard 1965:635
R. heudelotii (Baill.) Pierre ex Heckel subsp. *africanum* (Müll. Arg.) J. Léonard		Guinea-Congo region	Léonard 1965:630-631
Ricinodendron Müller d'Argovie: *R. heudelotii,* subsp. *africanum*		Nigeria to Angola and from Uganda to Mozambique.	Normand & Paquis 1976:67
Ricinodendron Müller d'Argovie: *R. heudelotii,* subsp. *heudelotii*		Western part of the Guinéo-Congolaise forests	Normand & Paquis 1976:67

Species	***Country***	***Distribution***	***Source***
Ricinodendron heudelotii (Baill.) Pierre ex Heckel subsp. *africanum* (Müll. Arg.) J. Léonard.	Democratic Republic of Congo	Mayumbe, Bas-Zaïre, Central Forests of Zaïre, Bas-Shaba, Kasai, Ubangi-Uele.	Pieters 1977:213-214
Ricinodendron heudelotii (Baill.) Pierre ex Pax, FWTA 1:393. Euphorbiaceae		Guinea Bissau to Angola and Tanzania; (Guineo-Congolian wide)	Hall & Swaine 1981:275
Ricinodendron heudelotii		West tropical Africa from Guinea to Angola and eastward to Uganda	Chudnoff 1984:270
Ricinodendron heudelotii (Baill.) Heckel, subsp. *africanum* (Müll. Arg.) J. Léonard 1961; FWTA, ed.2, 1:393, fig. 137		Southern Nigeria eastwards to Sudan, Uganda, Tanzania, Angola and Mozambique	Keay 1989:152
Ricinodendron heudelotii (Baill.), subsp. *heudelotii*		Guinea-Bissau to Ghana only	Keay 1989:152
Ricinodendron heudelotii (Baill.) Pierre. ssp. *heudelotii*		Ghana and westwards:	Burkill 1994:131
Ricinodendron heudelotii (Baill.) Pierre. ssp. *africanum*		Nigeria and eastwards	Burkill 1994:131
Ricinodendron heudelotii	Cameroon	Mbalmayo Forest Reserve (lat. 3°31`N; long. 11°30`E	Musoko *et al*. 1994
Ricinodendron heudelotii		Tropical Africa from Guinea to Angola and in east Africa. Stations: Kaka (III), Linté (IX), Matomb (IV), Nguila (IX-X), Yangafok.	Vivien & Faure 1996
Ricinodendron heudelotii		Senegal to Cameroon and Bioko, across to Zaïre and Tanzania and Angola. Mount Cameroon region in lower forest areas, such as Mabeta-Moliwe and along the West Coast to Idenau.	Laird et al 1997
Ricinodendron heudelotii	Cameroon	Southern Bakundu Forest Reserve, Southwest Province, Cameroon (4°12` – 5°29` N, 9° – 9°55` E), approx. 230 m above mean sea level	Shiembo *et al.* 1997

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