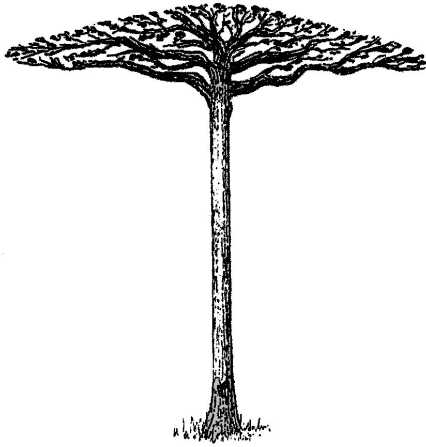


BAILLONELLA TOXISPERMA

A State of Knowledge Study undertaken for
the Central African Regional Program for the Environment

by

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1. INTRODUCTION

Baillonella toxisperma is a large lowland rain forest species that is only found from south-eastern Nigeria to the Democratic Republic of Congo. It is a valuable timber tree, that is also prized for the distinctive oil that is obtained from its fruits by local people who also use other parts of the tree for medicines. As a result of large-scale timber extraction the species is in danger of disappearing from its natural range. Conservation of the tree links in with general forest conservation issues. It is not used as a farm tree due to its size and slow growth rate, although reports of its use as a plantation shade tree occur in the literature examined for this study. Its existence and accessibility also links to issues of perpetuating traditional lifestyles because of its place in the local economy (barter or cash) of forest peoples. The species continuing existence depends on finding a balance between timber extraction and local dependence on the oil, so that it remains together with its contribution to species diversity in the Guineo-Congolian forests

This study has made a start by examining papers available in Britain, written in English, French, Spanish and Italian, in particular of studies made through the Mount Cameroon Project, the Tropenbos Programme in Southern Cameroon, the Oxford Forestry Institute, CARPE and FAO/ICRAF.

2. TAXONOMY AND LOCAL NAMES

Baillonella toxisperma Pierre is a monospecific member of the Sapotaceae occurring only in the humid tropical forests of West Central Africa. *Baillonella* was identified as a separate genus by Pierre in 1890 from a sample of seeds sent from Gabon (Pierre 1890:13-15) where it was known as 'noumgou'. The identification was debated, and was summed up by Charles Baehni in 1938:

Pierre believed that his new genus should be put in the *Lucumae*; Engler puts *Baillonella* as part of the *Mimusops*. The flowers have a structure like those of the *Euquaternaria*, but the seed is that of a *Manilkara*, and it is in this last group that Dubard classes them. It is probably a *Madhuca* (Baehni 1938).

In 1939 Lam writing of *Baillonella* in *On the System of the Sapotaceae, with some remarks on Taxonomical Methods* disagreed with Baehni saying it was 'Probably not a *Madhuca*' (Lam 1939:520).

In 1965 Baehni wrote further on identification of members of the Sapotaceae upholding the identifications of Meeuse in the differences of the testa, which is flaky, dull and tough in *Mimusops* and hard, shiny and thick in *Baillonella*. He also said: 'The distinction between *Baillonella* and the *Lecomtedoxa* classes in the *Madhuca* holds. The first always has a biserial calyx (3+3 or 4+4) whereas the latter have (4)-5-(6) sepals often sub-biseriate' (Baehni 1965:120).

Baillonella toxisperma has also been identified as: *Mimusops djave*, *Bassia djave*, *Baillonella djave/a*, *Bassia toxisperma*, *Mimusops Pierreana*, *Baillonella obovata*, *Mimusops obovata*. (Engler 1904:81-81). In Nigeria it is still known as *Mimusops djave*, and by the local name 'makoré' (Dalziel 1948:358; Ahonkai 1988; Keay 1989:390). The most widely used name used for the tree and its timber is 'moabi'.

F. White writing on the Sapotaceae of Nigeria, said of the genus, *Baillonella*:

This genus has only one species. The arrangement of the leaves and flowers is similar to that of *Butyrospermum*. *Baillonella toxisperma* is much better known in Nigeria under its old name of *Mimusops djave*. The flowers differ from those of *Mimusops* however in having undivided appendages to the corolla (White 1964:348-350).

Table 1 lists the locally used or common names for the tree found during this literature survey. In south and east Cameroon it is known as ‘karité’ (Schneemann 1995:21), which is the name more generally given to the savanna species, *Vitellaria paradoxa*, the shea butter tree. Also ‘makoré’ the timber name in Nigeria for *B. toxisperma* (there called *Mimusops djave*) is also used as a timber name for *Dumoria hekelii* A. Chev. (Sapotaceae) in Côte d’Ivoire (Centre Technique 1957:60), and for *Tieghemella heckelii* Pierre ex A. Chev. (Mabberley 1990:582).

3. DISTRIBUTION AND HABITAT

3.1 Distribution

Baillonella toxisperma has a restricted distribution, which is limited to the lowland rain forests of West and Central Africa from south-eastern Nigeria and Cameroon, to Gabon, Cabinda and Zaïre (White 1964:350; Thikakul 1985:533; Keay 1989:390; Vivien & Faure 1985:418; Laird *et al.* 1997:13). Schneemann (1995:21) believes that it is most abundant in Nigeria, Cameroon and Gabon, and is found to a ‘lesser extent’ in Congo, Angola and Equatorial Guinea.

Bertin & Meniaud (1949) restrict *B. toxisperma*’s distribution to Cameroon and Gabon, and a report from the Centre Technique (1957:61) refers to it occurring in the central part of the dense forests in Cameroon and Gabon. A later undated promotional pamphlet from the same source gives a wider distribution. ‘It occurs through the dense, wet forests from Nigeria to Gabon and the Congo and again in the interior of Zaïre. Locally it can be fairly common, (in particular, between N’Djolé and Booué, in the eastern part of Gabon’ (Centre Technique, pamphlet, n.d.).

The inland distribution of *B. toxisperma* in Equatorial Africa appears to be to the west of the Sangha River:

- ‘Its distribution extends from southern Nigeria, to Cameroon and all of Gabon. It does not appear to penetrate further to the east in the Sangha basin and the tributaries of the right bank of the Congo River. It is no longer found in Oubangui. In the south, it is still found in Mayumbe and in the Cabinda. But it is possible that this is another form, species or variety, that Pierre named instead *Baillonella obovata*. *Baillonella toxisperma* is therefore a characteristic element, particularly notable in the Cameroon-Gabonese forests, which appears to be absent from the Congolese forests’ (Aubréville 1964:48-49 in French).
- From Nigeria to Angola, a species of the Cameroon-Gabonaise primary forests not found to the east beyond the Sangha Basin (Normand & Paquis 1976:178).

Baillonella toxisperma is not a gregarious tree, described as being local in distribution, generally scattered or, ‘very rarely, in groups of several trees’ (Kennedy 1936:196-7; Centre Technique, pamphlet, n.d.), and it is not easy from the literature to assess its abundance in former times. ‘Adzap is one of the most characteristic elements of the primary forest. It is scattered, but fairly common in certain regions’ relating to Cameroon (Aubréville 1964:48-49). Debroux describes it as a relatively rare dominant tree in Central Africa’s tropical forests (Debroux *et al.* 1998:6-7). Heitz (1943:257) described it as the most beautiful tree in the forests of Gabon, with a scattered distribution, but occurring fairly frequently in primary forests.

There are some fairly detailed descriptions of its occurrence, such as this personal account from Hédin in Cameroon that pinpoints its visibility in 1928 in part of Cameroon:

B. toxisperma is particularly abundant around Douala, between Mungo and Wouri and as far as Yabassi. Along the railway line I saw it at Kaké, at Compina, and Mujaka, to Loum, to Moundeck. It is scattered throughout the Cameroonian forests, notably at Edéa, among

the Goumbas, the Boulous and the subdivision of Kribi and Ebolowa: a certain number of villages have the name ‘Adjap’ which is the name the Yaoundés and Boulous give the tree.¹ I saw it in ‘l’E’, on the road from Yokadouma to Lomié, notably at Assobam, where it is common for local people to extract the fat. On the road from Edéa to Déhane I saw young ‘njabis’ (the name given to this Sapotaceae by local people) near villages (Hédin 1928:853-854).

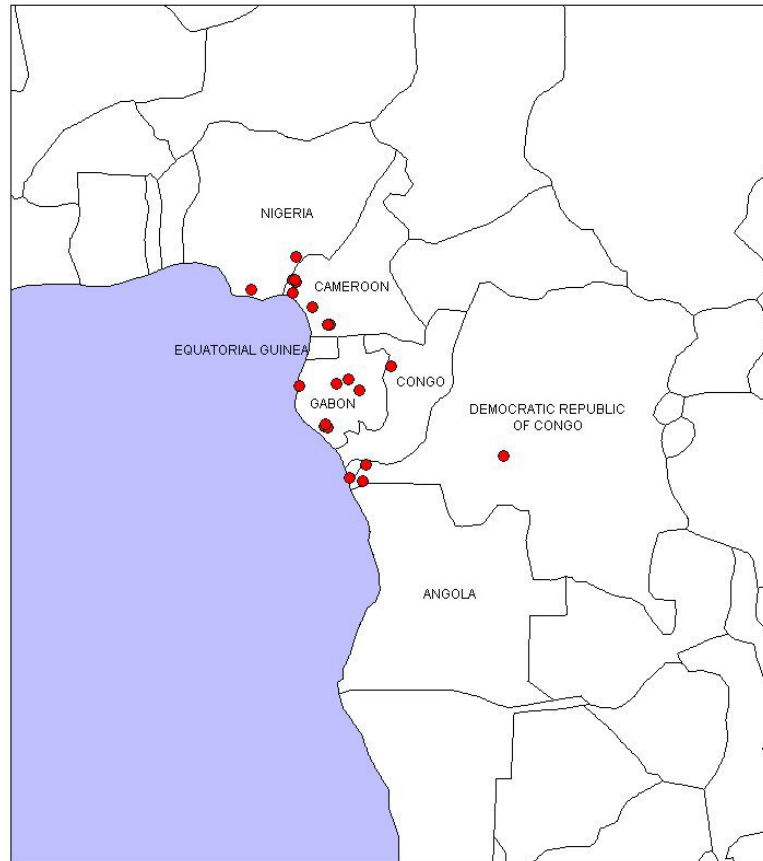


Figure 1: Collection locations of herbarium specimens of *Baillonella toxisperma* from Kew, Meise, Missouri, Oxford and Wageningen.

Other sightings from Cameroon include the following observations:

- Found almost everywhere, scattered, throughout Cameroon, except between Boumba and Sangha and in the Mbam forests, sometimes planted near to villages. Stations: Belabo (VIII), Edéa, Korup, Loum, Muyuka (VII), Nlohé, Ottotomo, Yabassi, Yanda (Vivien & Faure 1996:315).
- Absent from the forest in the Fako area, although fairly common in Mokoko, Southern Bakundu Forest Reserve, Korup National Park and other forest areas (Laird *et al.* 1997:13).
- In the district of Mbang the tree is abundantly present in one of the four “cantons”, being the one with the most dense forest vegetation (Schneemann 1995:21).

¹ See also Schneemann 1995:25.

In Southern Nigeria, where the tree is generally known as *Mimusops djave* Engler, Kennedy described it as ‘A very large tree observed at Ahoada, Obubra and other places along the Cross River. It is a type tree of the Afi Reserve. In the Kumba and Victoria divisions it is known as Djave or Njabi’ (Kennedy 1936:196-197).

Appendix 2 gives details of locations identified from herbarium specimen sheets from Angola, Cameroon, Congo, Democratic Republic of Congo, Gabon, and Nigeria.

3.2 Habitat

Baillonella toxisperma is described as a tree of the lowland rainforests (Dalziel 1948:358; White 1964:350; Chudnoff 1984:189) or, more specifically, of the wetter parts of rain forest (Nielsen 1965:143). According to Schneemann (1995:22) there is very little information on the ecological requirements of *B. toxisperma*, nor of its ecological niche, but from his studies he thought it was limited to only the most dense parts of forests. This view has been contradicted somewhat by Sunderland & Tchouto (1999:11, 27) who have found it to be a mid- to late-secondary species which is often predominant in farm bush and late-secondary forest, and it has been described as occurring ‘occasionally in cocoa plantations’ (Ntamag 1997:28). Schneemann (1995:25) claimed that villagers around Mbang planted moabi as shade trees in cocoa plantations between the years 1930-1950, and Hédin commented on a deliberate planting of moabi in Cameroon in the 1920s:

On the road from Edéa to Déhane I saw young ‘njabis’ (the name given to this Sapotacea by local people) near villages. They had been planted there on the orders of our predecessors. But it doesn’t appear that this trial is very old, nor that it has been very fruitful: these trees, which must be more than 15 years old, are a little taller than avocados, but their diameters are hardly greater. Further, a large number have disappeared. At Ebolowa germination trials have not succeeded because of insufficient shade (Hédin 1928:854).

Archaeologists in West Africa are finding that the tree acts as a marker for past settlements, presumably because of its usefulness and value to past residents of the forests. The tree’s distinctive shape and size make it easy to pick out in the canopy from the air (R. Moss, personal communication, 2000).

Debroux ascribed the limitations of the species’ distribution to a preference for a more oceanic climate:

The distribution of moabi in Cameroon and its extreme rarity in the Central African Republic allows one to assume that its ecological optimum is more oceanic than *Autranella congolensis* which occurs frequently in certain regions of the Central African Republic (Debroux *et al.* 1998:6-7).

Whereas the pamphlet from the Centre Technique Forestier Tropical claims that ‘as a rule it is only found at some distance from the coastal zone’ (Centre Technique, pamphlet, n.d.).

From reports it appears that *B. toxisperma* is intolerant of heavy saturated soils preferring soils that are more freely draining and sandier (Laird *et al.* 1997:13). Chudnoff described it as being found in the dense forests of Equatorial Africa, often in small patches on dry or moist soils (Chudnoff 1984:189) and in an undated pamphlet from the Centre Technique Forestier Tropical moabi was described as a characteristic species of the undisturbed, dense equatorial forest, on both dry and wet, though not inundated soils (Centre Technique, pamphlet, n.d.).

4. PHENOLOGY

Baillonella toxisperma is deciduous and flowers after the leaves have dropped. There may be one or two flowerings in a year and fruiting may not be annual. Schneemann (1995:22) suggested that flowering and fruiting follow a cycle of one or two productions every three years with abundant production during 1 in 3 years. Many accounts are based on information from 1 or a few seasons, and relate to a very limited area, so information is patchy.

Table 1: Flowering and fruiting times of *Baillonella toxisperma* taken from the literature

<u>Country</u>	<u>Flowering</u>	<u>Fruiting</u>	<u>Source</u>
Oban, Nigeria Nigeria		July May, August	Kennedy 1936:197 White 1964:350; Keay 1989:392
Cameroon	February-April	June-August	Debroux <i>et al.</i> 1998:8
Cameroon	April (Yokadouma)	September (Douala)	Hédin 1928:853
Cameroon South Cameroon Mokoko River Forest Reserve, Cameroon		June-July July-August March-May	Thikakul 1985:533 Ntamag 1997:30 Sunderland & Tchouto 1999
Gabon	September- October		Heitz 1943:259

The 3 main areas from which information is available are Nigeria, Cameroon and Gabon.

In Nigeria:

- ‘The tree is deciduous for a very short time at Ahoada in February. At Oban the fruits are ripe in July’ (Kennedy 1936:197).
- The tree fruits in May and August (White 1964:350; Keay 1989:392).

In Cameroon, Debroux *et al.* said that flowering, if it takes place, occurs between February and April, when the main dry season moves into the little wet season. The subsequent fruiting is massive and occurs usually between June and August, just before the main wet season. There are however exceptions which qualify the apparent regularity of the cycle such as the fruiting of a few stems at the height of the dry season in 1997. They continue that ‘According to Schneeman², abundant fruiting happens about once in every three seasons. This idea has been proved during the last five years, and this pattern would be half way between the episodic and periodic types of Hecketsweiler³. A phenologic inversion is noted according to the study sites: in the east of Cameroon (Schneeman *op. cit.*), to Lopé (White, personal communication), to Mayombe (Pangou⁴). This phenologic inversion probably corresponds to the inversion of seasons either side of the equator (Debroux *et al.* 1998:8).

- The leaves are deciduous, falling at the beginning of the wet season when the tree flowers (Aubréville 1964:48; Vivien & Faure 1996:316).

² Schneemann, J. 1994. ‘Etude sur l’utilisation de l’arbre moabi dans l’Est-Cameroun, rapport final’. Yaoundé, Cameroun, SNV, 44p.

³ Hecketsweiler, P. 1992. ‘Phénologie et saisonnalité en forêt gabonaise, l’exemple de quelques espèces ligneuses’. Thèse de doctorat, Université de Montpellier II, France, 285 p.

⁴ Pangou, S.V. 1989. ‘Régénération naturelle sur 8 hectares de la forêt dense humide du Mayombe congolais, exemple de 5 espèces ligneuses pionnières, post-pionnières et forestières’. Thèse de doctorat, Université de Nancy I, France, 146 p.

- At Yokadouma in Cameroon the tree flowers in April, and fruits around Douala in September at the end of the wet season (Hédin 1928:853).
- In Cameroon, fruiting occurs in June to July (Thikakul 1985:533).
- In the Mokoko River Forest Reserve, Cameroon, seed is harvested in March, April, May, just before the beginning of the rainy season (Sunderland & Tchouto 1999: table 5).
- High collecting months in South Cameroon: July, August (end of dry season) (Ntamag 1997:30).

In Gabon the tree loses its leaves in September and flowers in September/October' (Heitz 1943:259).

Table 2: Flowering and fruiting times recorded on herbarium specimen sheets

<i>Flowering</i>	<i>Fruiting</i>	<i>Herbarium sheet ID</i>	<i>Country</i>	<i>Altitude (m above sea level)</i>
July		White, L. 14 (series 2)	Gabon	200
September		Le Testu., G. 1636	Gabon	0
November		Le Testu, G. 1441	Gabon	0
	November	Louis, A.M. <i>et al.</i> 818	Gabon	250
	January	Champluvier, D. 5314	Congo	500
	February	Thomas, D.W. <i>et al.</i> 5522	Cameroon	400

In the Herbarium specimens examined for this study, flowers were collected in Gabon in July (White 1990), September (Le Testu 1910) and November (Le Testu 1901), and fruits in November (Louis *et al.* 1983). Champluvier collected fruits in Congo in January (Champluvier 1995), and Thomas collected fruits in Cameroon in February (Thomas 1986).

5. BOTANY

Baillonella toxisperma (moabi) has been described as one of the largest trees of the closed forest (Centre Technique 1957:61) growing to about 50m (Aubréville 1964:48; Keay 1989:392; White 1964:350). White and Abernethy suggest that in Gabon the species can grow to over 70m in height (White & Abernethy 1997:184). Aubréville (1964:48) described it as 'the largest and most beautiful tree in Cameroon and perhaps in all the African tropical rainforests'. It has a distinctively shaped crown (Nielsen 1965:43) easily recognised from a distance (Aubréville 1964:48), that is umbrella shaped or tabular, very wide and flat (Kennedy 1936:197; Heitz 1943:258; Thikakul 1985:533; Vivien & Faure 1996:315), and compared by White (1964:350. See also Keay 1989:392) to that of *Terminalia ivorensis*.

The branches are more or less horizontal (Kennedy 1936:197) with dense foliage (Kennedy 1936:197; Heitz 1943:258). They are large, sinuous, ramified and whorled, with the leaves grouped in characteristic rosettes at the ends of very stout twigs marked with numerous foliar scars (Thikakul 1985:533. See also; Aubréville 1964:46; Vivien & Faure 1996:315).

5.1 Trunk and bark

The trunk is straight, cylindrical and unbranched, without buttresses, although there is slight basal swelling, especially in old trees (Thikakul 1985:533; Vivien & Faure 1996:315). This swelling in old trees is attributed by White and Abernethy, working in the Lopé Reserve in Gabon, to damage by elephants (White & Abernethy 1997:184).

In 1936 Kennedy (p.197. See also White 1964:350) described specimens in Southern Nigeria as having a 'most cylindrical bole with scarcely any buttresses' attaining heights of 160 ft with a girth of 30 ft. Keay suggested the girth of the tree could be up to 9 m (Keay 1989:392). Hédin measured one tree which at the height of a man had a circumference of 15m (Hédin 1928:853). In 1943 Heitz published a photo of a tree with a girth greater than 10m, 2m above the ground. The diameter could be greater than 3m (Heitz 1943:258; Aubréville 1964:48; Vivien & Faure 1996:315; White & Abernethy 1997:184). In the middle of the exploitable log the diameter may be 70-90 cm (Centre Technique 1957:61), or vary from 1-1.5 m to 1.6-1.7 m (Centre Technique, n.d.). The bole may be unbranched for 27 m. (Keay 1989:392). 'The length of the usable bole is from 25-30 m. or more. However, the length of the commercial logs is a function of their diameter (because of the considerable weight of the bole). moabi logs are usually of very good form, straight and cylindrical; even the butt log is a good shape, as the tree is quite free of buttressing though it may be more or less thickened depending on its age. The ends of the logs are generally fairly free of splits and not otherwise altered' (Centre Technique, n.d.).

The bark is thick (Heitz 1943:258; Centre Technique 1957:61) with abundant deep longitudinal fissures (Kennedy 1936:197; Heitz 1943:258; Aubréville 1964:48; White 1964:350; Keay 1989:392; Vivien & Faure 1996:315), and 'a flaky outer bark coming away in small, rectangular scales' (Centre Technique n.d.). The 'dark, blackish-brown bark is typically very corrugated and longitudinally split (Centre Technique n.d.). The bark colour is generally described as brown (Nielsen 1965:143), dark brown (White 1964:350; Keay 1989:392) or dark reddish brown (Heitz 1943:258; Aubréville 1964:48; Thikakul 1985:533; Vivien & Faure 1996:315). Kennedy described the bark as 'dark brown with lighter coloured patches' (1936:197).

The slash is described as mottled red (Kennedy 1937:197), red (Nielsen 1965:143), or it changes from the outer part to the inner:

- slash red-brown in the outer part, yellow-pink towards the inside (Heitz 1943:258) or, rose yellow in the inner part (Aubréville 1964:48);
- outer bark thick, dark brown: inner bark red, or red streaked with white (White 1964:350; Keay 1989:392);
- outer layer dark brown, inner layer pink-yellow, dotted with red-white (Thikakul 1985:533; Vivien & Faure 1996:315).

When slashed a white latex exudes, variously described as thick (Kennedy 1936:197; White 1964:350; Keay 1989:392) or sticky (Heitz 1943:258; Thikakul 1985:533; Vivien & Faure 1996:315), and contradictorily, as 'copious' (Kennedy 1936:197) or 'not very abundant' (Thikakul 1985:533).

Bertin & Meniaud describe the heartwood as being 'of a colour varying from old rose to reddish brown, deepening slightly on exposure to light, more or less streaked' (Bertin & Meniaud 1949). The heartwood is elsewhere described as 'pinkish-brown to old rose, sometimes fairly dark, with a lustrous appearance, especially on quartered surfaces' (Centre Technique n.d.); or as 'perfect of colour varying from old rose to reddish-brown' (Centre Technique 1957:61). Less poetically it is described as 'rich red or light reddish-brown, often figured, termite-proof, heavy and durable' (Dalziel 1948:358; White 1964:350; Keay 1989:392), or 'red to brown-red, semi-hard, heavy, siliceous, fine grain' (Thikakul 1985:533).

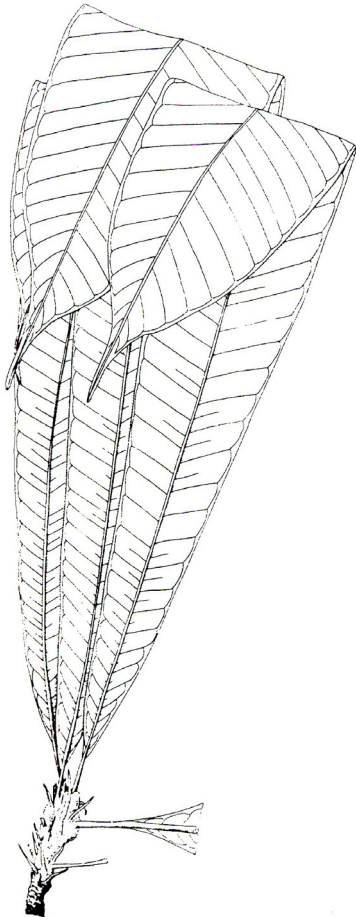
The sapwood is greyish-brown, well defined and narrow, usually between 4 and 6 cm. wide (Centre Technique n.d.), or white (Dalziel 1948:358; White 1964:350; Thikakul 1985:533; Keay 1989:392). The cambium is also described as 'pink white, 4-6 cm. wide, unusable' (Centre Technique 1957:61), and 'pale pink 1½-2½ in. thick' (Bertin & Meniaud 1949).

The wood has a fine straight grain that is very homogeneous (Centre Technique 1957:61). It has been compared to pearwood, and when it is figured may be classed for timber purposes as a light-coloured mahogany (Dalziel: 1948:358). 'Growth rings are frequently visible and give a

finely veined appearance to sawn surfaces. The texture is fine to very fine. The pores are barely visible and the vessel lines very narrow and very short. The wood is usually straight grained but sometimes the grain is wavy, undulating or curly. Interlocking is rarely present. Flat and quarter sawn surfaces are similar in appearance, with an almost uniform colour and visible growth rings, which help to distinguish moabi from makoré' (Centre Technique n.d.).

5.2 Leaves

The leaves are alternate, simple, arranged in a spiral around the end of the branches (Heitz 1943:259; Vivien & Faure 1996:315). They are also described as 'entire, grouped in rosettes at the extremities of the twigs' (Kennedy 1936:197; Aubréville 1964:46; Thikakul 1985:533), and 'clustered at the ends of very stout twigs' (White 1964:350).



Leaf length is generally given as between 20-30 cm long by 6-10 cm wide (Kennedy 1936:197; Heitz 1943:259; Aubréville 1964:46; White 1964:350; Thikakul 1985:533; Keay 1989:392; Vivien & Faure 1996:315). Nielsen said the leaves are up to 16 in long (Nielsen 1965:143). The leaf shape is most commonly described as oblanceolate with a well-defined drip tip, the apex rounded and brusquely acuminate, cuneate at the base (Kennedy 1936:197; Aubréville 1964:46; White 1964:350; Thikakul 1985:533; Keay 1989:392).

The upper surface of the leaf-blade is hairless and glossy (Heitz 1943:259), the lower surface with minute hairs on the nerves (Keay 1989:392). Young leaves are hairy russet, the leaf-blade is initially hairy beneath, but rapidly hairless except for some russet hairs persisting on the midrib (Aubréville 1964:46; White 1964:350; Thikakul 1985:533).

There are about 25-30 pairs of lateral veins in widely spaced pairs which join forming loops just within the margin of the leaf; the midrib is prominent on the under surface (Kennedy 1936:197; Heitz 1943:259; White 1964:350; Aubréville 1964:46; Thikakul 1985:533; Keay 1989:392; Vivien & Faure 1996:315).

Figure 2: Leaves of *Baillonella toxisperma* are clustered at the end of the branches (Laird *et al.* 1997)

The sturdy leaf stalk is 3-4 cm. long, downy russet in young leaves (Kennedy 1936:197; Heitz 1943:259; Aubréville 1964:46; Thikakul 1985:533; Vivien & Faure 1996:315), with lanceolate stipules, about 0.5 in. long, persisting for a long time (Heitz 1943:259; Aubréville 1964:46; White 1964:345).

5.3 Flowers

The long-stalked whitish flowers are grouped in rounded heads at the end of the branches (Kennedy 1936:197; Heitz 1943:259; Aubréville 1964:46; Nielsen 1965:143; Thikakul 1985:533), clustered among the leaves (White 1964:350; Keay 1989:392). Thikakul described them as 'fairly large green flowers' (Thikakul 1985:533). The flowers (1 cm) are monoecious, with 4-8 stamens and an 8-celled ovary (Vivien & Faure 1996:315; Debroux *et al.* 1998:7).

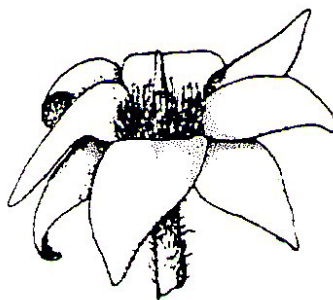


Figure 3: Flowerhead of *Baillonella toxisperma* (Laird *et al.* 1997).

- Calyx with 8 sepals, 4 exterior and 4 interior, about 1 cm. long, pubescent on the outside and slightly so on the inside. The corolla has 8 lobes, each furnished with 2 dorsal appendages longer than the lobes; total height about 8 mm.; lobes about 4 mm; appendices about 5.5 mm. The tube of the corolla is hairy on the outside. There are 8 stamens, with short filaments 1.5-2 mm., inserted slightly above the base of the lobes of the corolla, and 8 staminodes, longer than the stamens, about 5 mm., strongly hairy on the outside at the base, on the internal face slightly concave and slightly pubescent. Shaggy ovary with 8 uni-ovular cells. Short hairless style (Aubréville 1964:46).
- Each flower is complex and only about $\frac{2}{3}$ in. across. It has 4 + 4 sepals, 8 petals with 16 petaloid appendages and 8 staminodes alternating with 8 stamens (Nielsen 1965:143).
- Flowers $\frac{1}{2}$ in. diameter, 4 sepals, 4 petals, anthers open by apical pores (Kennedy 1936:197).
- The calyx has 5 sharp downy sepals; the corolla is tubular with very small lobes; stamens with threads inserted in the middle of the corolla tube; arched hairy spatulate staminodes; downy ovoid ovary with 8 cells (Heitz 1943:259). The flowers differ from those of *Mimusops* in having undivided appendages to the corolla (White 1964:348).
- Sepals 1 cm long, pubescent, not persistent in the fruit (White 1964:350; Keay 1989:392).
- *Baillonella* 'always has a biserial calyx (3+3 or 4+4)' (Baehni 1965:119; Letouzey 1986:281).

The flower stalks (pedicels) are pubescent, about 2-3 cm. long (Aubréville 1964:46; White 1964:350; Thikakul 1985:533; Keay 1989:392; Vivien & Faure 1996:315). Heitz described the pedicels as downy russet, about 3 cm. long (Heitz 1943:259).

5.4 Fruits and Seeds

Baillonella toxisperma is a zoochore species with fleshy fruit whose large and very hydrated seeds are protected by a thin lignified integument, about 1 mm thick (Debroux *et al.* 1998:17).

The fruit has been described as being the size of a fist (Dalziel 1948:358). In shape it is described as being globose, with the remains of the calyx at the base, and a short point at the other end (Kennedy 1936:197), or globular with a small point (Vivien & Faure 1996:315), or sub-globular and briefly apical (Heitz 1943:259-60). Aubréville described the fruit as spherical, about 6.5 cm in diameter, with a short very thick peduncle, 1.5 cm long (Aubréville 1964:47-48).

In colour the fruit is glaucous green, grey or pale green (Kennedy 1936:197; Aubréville 1964:47-48; White 1964:350; Keay 1989:392; Thikakul 1985:533; Schneemann 1995:21; Vivien & Faure 1996:315). The texture has been described as both rough (Kennedy 1936:197) and smooth (Dalziel 1948:358).

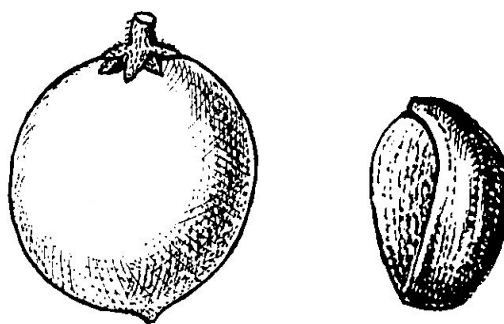


Figure 4: Fruit and seed of *Baillonella toxisperma* (Letouzey 1986).

The pulp has a sticky latex when unripe (Kennedy 1936:197; Dalziel 1948:358) and is mealy, slightly acid and edible when ripe (Kennedy 1936:197; White 1964:350; Keay 1989:392). In colour the pulp is described as yellow-white or yellow (Aubréville 1964:47-48; White 1964:350; Keay 1989:392; Schneemann 1995:21; Vivien & Faure 1996:315), and it has a strong smell (Schneemann 1995:21; Vivien & Faure 1996:315).

Embedded in the pulp are between 1-3 hard-shelled ellipsoid seeds (Kennedy 1936:197; Heitz 1943: 259-60; Aubréville 1964:47-48; White 1964:350; Keay 1989:392; Schneemann 1995:21; Vivien & Faure 1996:315). The fruits have also been said to contain 6 seeds (Debroux *et al.* 1998:7) or even 8 seeds (Nielsen 1965:143).

When Pierre examined the seeds in 1890 he was told they yielded a butter similar to that from *Vitellaria paradoxa*. He described the seed thus:

The fruits and flowers of *Baillonella toxisperma* are still unknown. It has a seed 6 cm. long. The widest part of its diameter, from beneath the middle of the ventral face to the dorsal face, is 36 mm. tapering to 15 mm. near the top. It measures 25 mm. transversally. Elliptic, slightly compressed, subgibbous in the part bordering the micropyle, and rounded at both ends, on the dorsal face as well, it has a ventral cicatrice 56 mm. long covering a little less than half its surface. This is slightly rough with a dull look, and the thickness of its integument (about 1 mm.) is almost the same as in the other parts of the seed. The shiny part of the seed is dark brown or chocolate. Its omphalodium (4 x 4 mm.) is at the upper end of the cicatrice, which is also the natural apex of the seed. The line of its raphe across the testa is consequently almost rectilinear. The second integument is firmly attached to the outer surface and is hard to detach. The vascular system, although well developed, has no external expression. The embryo appears to be surrounded with nucellus and a thin coat of albumen. The elliptical cotyledons are entirely free, lie close to each other, and are not rounded, in spite of their thickness. The point at which they join is turned towards the hilum. They end at the base in a short tigella, bent like a fish-hook and directed towards the micropyle. The shape of this seed is very distinct from the 'Lucumées', and particularly of *Vitellaria*. The curve of its tigella is slightly reminiscent of those of the *Radlkofereella*. It is one of the rare genera of the tribe without starch (Pierre 1890:14).

Other authors have described the seeds as follows:

- The seeds are oval, 2¼ in. long x 1¼ in. x 1 in. thick. In shape they resemble a laden canoe and are three-quarters encased in a hard, shiny light brown shell. The remaining quarter is the hilum which is oval, rough and whitish (Kennedy 1936:197).
- The seeds are fusiform, lightly flattened laterally, 5-6 cm. long by 2 cm. wide, almost exactly resembling the seeds of douka (*Mimusops africana* (Pierre) H. Lec.); the testa is glossy light chestnut brown; the scar grey, matt, rough, reaching over almost all the length of the seed (whereas the scar of the douka seed only covers two-thirds the length of the seed) (Heitz 1943: 259-60).

- The seeds are ellipsoid, about 4.2 cm. long and 2.5 cm. wide and 2 cm. thick. Ventral scar occupying almost the whole of the ventral face very rounded. The omphalodium about 4 x 4 mm. Thin integument (Aubréville 1964:47-48).
- The seed is more or less ellipsoid, about 5 cm. long by 3 cm. wide, and has a thin testa and a large scar covering nearly the whole of one face of the seed (White 1964:350; Keay 1989:392).
- In *Baillonella* the testa is hard, shiny and thick (Baehni 1965:119).
- The seeds (5-7 x 3-2.25 cm) are brown, hard and shiny with a cicatrice occupying almost the whole of the ventral surface (Vivien & Faure 1996:315).
- The seeds are 4 x 7 cm in size with a thin woody integument 1 mm thick. The endosperm is absent, and the bulky cotyledons contain the oil (Debroux *et al.* 1998:7).

Baillonella toxisperma seeds are parasitised by the larvae of *Carpophilus* sp. (Coleoptera *Nitidulidae*) and *Musseidia* sp. (Lepidoptera *Phycitidae*). Fruits are attacked on the tree before they fall. An examination of 600 seeds distributed under 15 trees, found on average that 12.8% of seeds are perforated. This rate of parasitism is very variable from tree to tree (0-53%). Parasite attack slows the development of the seedling significantly and jeopardises germination if the larva reaches the embryo (Debroux *et al.* 1998:8).

6. DISPERSAL, GERMINATION, GROWTH RATES AND DENSITY

6.1 Dispersal

Although the fruits of *Baillonella toxisperma* are known to be eaten by several different animals there is no certainty of their role in the dispersal and germination of the seed. White and Abernethy consider that *B. toxisperma* is dependent on forest elephants for seed dispersal as they consume the whole fruit excreting the seed complete in their dung (White & Abernethy 1997:184). Other animals known to eat the fruit, but not necessarily without damaging or discarding the seeds, are wild pigs, porcupines (WCMC Tree Conservation Database 1999), duiker (Kennedy 1936:197) and gorillas. Schneemann said that the gorilla only eats the pulp of the fruit, whilst animals such as wild pigs and porcupines eat the seeds (thereby damaging them and decreasing seed availability), and that elephants play an important role in dissemination by leaving the entire seeds elsewhere in their excrement. Schneemann also pointed out that people affect reproduction potential by gathering seeds for oil extraction and by logging trees for timber (Schneemann 1995:22).

In a study made by Voysey *et al.* (1999) gorillas were found to be effective dispersers of seed through their gut. However, no evidence has been provided that they swallow *B. toxisperma* seeds, perhaps because the seeds are too large for easy passage through the gorilla's gut.

6.2 Germination and Early Growth

Baillonella toxisperma is not currently in cultivation on any large scale because the seeds are difficult to germinate (Sunderland & Tchouto 1999: 38, table 14), but tests have been carried out that gave optimistic results, for example, the comparative study made of *B. toxisperma* and *Austranella congolensis* in the Dja Wildlife Reserve, in Cameroon, testing germination and development of seeds under nursery conditions (Debroux *et al.* 1998:5-17). These nursery germination tests found that moabi has a short latent germination period, germination rate is very high, and seedling growth is fast.

Germination starts quickly (latent period = 7 days) and is staggered over 6 weeks. The germination rate is very high ($T_{\text{control}} = 87.9\%$). The seeds swiftly lost their germinative power: T - 4.0% after 2 months dry conservation. But cold storage of the seeds prolonged the viability period resulting in 53% germination of seeds stored for 48 weeks. The seedlings grow fast, first drawing on the cotyledon's reserves ($h_{\text{moy}} = 43$ cm at 3 months)

and then by photosynthesis ($h_{\text{moy}} = 150$ cm at 18 months). In nurseries the mortality rate is very low (7.8% in 18 months) (Debroux *et al.* 1998:8-9).

Debroux *et al.* considered that even though seeds germinate in total darkness, introduction into the digestive system of elephants was not necessary for germination to occur (Debroux *et al.* 1998:10). Vivien and Faure recommended that seeds should not be buried too deep (half the height of the seed), and that the cicatrice should be placed facing down (Vivien & Faure 1996:316).

Growing *B. toxisperma* seedlings in nurseries helps to avoid causes of death in natural conditions, but it does have two drawbacks: the best time for replanting seedlings is at 6 months at the beginning of the little rainy season, but fruiting is not annual and seed dormancy is short, so to maintain a supply of seeds they need to be kept in a low-temperature seed bank (Debroux *et al.* 1998).

The work of Hladik and Miquel (1990) defines the seedlings of *Baillonella toxisperma* as ‘type 2’. These are phanerocotylar⁵ (with exposed cotyledons) and epigeal (with cotyledons above ground level), with fleshy food-storing cotyledons – a type found in 25% of 210 tree species examined in the evergreen Makokou forest in Gabon. ‘Type 2’ seedlings have sufficient energy reserves for long resting stages and a large plasticity in light requirements. They could be considered potential animal food. However, when the fleshy cotyledons escape animal predation, they have sufficient energetic reserves for long resting stages in the understorey, and these species often become the giant trees of the Makokou forest.

Although the seeds germinate rapidly, later stages of growth are slower and there is also evidence that there is heavy mortality in the early stages of growth. In the Afi Reserve in southern Nigeria Kennedy remarked that natural regeneration was good, but during the second year when seedlings were about 4 ft. high the majority of promising saplings died back (Kennedy 1936:197).

A more recent study of chemicals present in *B. toxisperma* stems by Ohigashi *et al.* in Cameroon suggested a reason for this die-back. The growing area of saplings in the vicinity of a mature tree of about 50m height and 1.9m dbh, is very restricted under the crown of the mature tree (about 30m diameter) and saplings growing there only survive till they reach about 1.6m height (Ohigashi *et al.* 1989:1365-1368). Eight hundred grams of dried stems were selected for investigating the possible inhibitor, which was isolated as a colourless resin and identified as 3-hydroxyuridine. Under experimental conditions, the methanolic extracts of both the aerial part and root of the tree strongly inhibited germination of cucumber (*Cucumis sativus*) and radish (*Raphanus sativus*) seed. The strong plant growth inhibitory activity, together with the occurrence of 3-hydroxyuridine in most parts of the tree at high levels, indicated that 3-hydroxyuridine may be involved in the allelopathy of the tree.

In a study conducted on a test plantation in the Ekouk forest of Gabon comparing the regeneration performance of 13 indigenous forest trees, two methods of land preparation were compared: clear-cutting and underbrush cutting (Zaou *et al.* 1998:21-32). It was found that *Baillonella toxisperma* grew better in a forest environment provided by the underbrush cutting method, both after 1 year (90.7% survival in the clear cut system compared with 99% in the underbrush cut system) and, particularly, after 6 years, when there was 78.7% survival in the clearcut system and 93.5% in the underbrush cut system. After 6 years the average height of the saplings was 8 m in the clearcut system and 9.9 m in the underbrush cut system.

6.3 Density

Baillonella toxisperma has a low density. Van Dijk found this to be a common feature of marketable NWFP species whose average densities could be considered low, with the large majority of these species not achieving densities greater than 5 stems/ha with a dbh greater than 10

⁵ A term introduced by J.A. Duke in ‘Keys of the identification of seedlings of some prominent woody species in eight forest types in Puerto Rico’, *Annals of the Missouri Botanical Garden*, 1965, 52:314-50.

cm in any part of the Bipindi-Akom II region in Cameroon. Some species, such as the high-value oleaginous seed-bearing trees *B. toxisperma* and *Poga oleosa*, could be classified as being rare, with less than 1 tree/ha greater than 10 cm dbh (Van Dijk 1999:41). *Baillonella toxisperma* grows slowly and does not start flowering until it reaches an average dbh of 70 cm (Debroux 1996⁶, quoted in Van Dijk 1999:41), so its productivity per unit of area is low.

In an inventory of marketable trees in two coupes exploited by GWZ in southern Cameroon, there were only 5 *B. toxisperma* trees in a 2,500 ha coupe (density of less than 0.01 trees/ha), and 9 trees in a 2,600 ha coupe (also less than 0.01 trees/ha), giving an estimated total volume of 91m³ (Nef 1997:18, Table 6). Schneemann (1995:21) estimated the density of *B. toxisperma* to be between 0.01 stems/ha and 0.08 stems/ha. in the Mbang subdistrict, East Cameroon.

7. USES

7.1 Timber

Baillonella toxisperma is a hardwood described as having a beautiful satiny lustre that is remarkably fine grained and very homogeneous. Without ribbon figure, moabi is lightly and irregularly veined (Bertin and Meniaud 1949). The texture of the wood is described as fine and even, with a straight or sometimes wavy grain, and an attractive figure (Chudnoff 1984:189). In a comparison with douka (*Tieghemella africana*) which was described as medium-hard and medium-heavy, moabi is characterised as harder and denser and rather more fibrous (Bertin and Meniaud 1949). However, according to Ninin, *Baillonella* can be classified as a fairly light and soft wood (Ninin 1969:68). Chudnoff classed it as a hard, sometimes moderately hard, wood, 6.8 on the Chalais-Meudon scale.

Ahonkai classed moabi as a 'strong and heavy' wood, and in an analysis made of several African hardwoods of commercial interest observed an apparent link between wood density and the Ca²⁺ content measured in the ash (Ahonkhai & Nwokoro 1987⁷). However, a further set of tests, this time on *Afrormosia elata*, *Antiaris africana*, *Baillonella toxisperma* (here called *Mimusops djave*, local name 'makoré'), *Celtis mildbraedii*, *Daniella ogea*, *Entandrophragma cylindricum*, *Mitragyna ciliata*, and *Terminalia superba* (Ahonkhai 1988:227-229) resulted in a weak correlation being found between the densities of African hardwoods and the Ca²⁺ content of their ash (Table 3). Analysis of ash from *Baillonella toxisperma* gave the following results: Density (seasoned) 640 kg/m³; Ash content 0.56 %; Soluble base, as K₂CO₃ in ash, 6.80; Concentration of ions in ash, ppm: Na⁺ 0.85; K⁺ 5.80; Ca²⁺ 14.70; Mg²⁺ 3.80.

The wood is durable: the heartwood is rated as very durable, resistant to termite attack, and is reported to be rarely attacked by marine borers (Chudnoff 1984:189). In exposure trials in the Tagus estuary in Portugal, testing the wood for its natural resistance to attack by marine borers, it gave promising results after 18 months' exposure (Brown 1977:21-22). This resistance may be due to the silica content of the timber, to toxic substances in the wood, or a combination of both. Descriptions of general characteristics of moabi wood refer to saponins in the dust affecting the mucous membranes (Bertin & Meniaud 1949; Chudnoff 1984:189; Centre Technique, n.d. See also section 7.5.5) and which may contribute to its resistance to attack. However, the wood generally has a fairly high silica content (Centre Technique, n.d.). In investigations in France and Belgium of four tropical timber species, *Entandrophragma angolense*, *Virola* spp., *Baillonella toxisperma*, and *Azelia bipindensis*, *B. toxisperma* was found to be the most durable of the four with a silica percentage about 100 times greater than *Entandrophragma* (Ninin 1969:91-94). *Baillonella* had the

⁶ Debroux, L. 1996. 'La régénération naturelle et la gestion de populations d'arbres: l'étude du moabi (*Baillonella toxisperma*) dans la forêt du Dja, Cameroun'. Belgium: Faculté Universitaire des Sciences Agronomiques de Gembloux, 20p.

⁷ Ahonkhai, S.I. & Nwokoro, W.I. 1987. 'The chemical characterisation of the ashes of some African hardwoods.' *Wood Science Technology* 21:257-260.

highest percentage of silica, representing more than half the weight of the ashes; the cellulose and lignin percentages are normal.

Table 3: Ash content, soluble base and ion concentration of samples studied

Species	Density, seasoned kg/m ³	Ash content %	Soluble base, as K ₂ CO ₃ , in ash	Concentration of ions in ash, ppm			
				Na ⁺	K ⁺	Ca ²⁺	Mg ²⁺
<i>Afrormosia elata</i>	700	0.51	6.52	0.85	5.50	15.80	4.20
<i>Celtis mildbraedii</i>	780	0.87	9.20	0.80	7.20	15.50	3.70
<i>Baillonella toxisperma</i>	640	0.56	6.80	0.85	5.80	14.70	3.80
<i>Entandrophragma cylindricum</i>	640	0.74	8.06	0.75	6.00	15.40	3.20
<i>Mitragyna ciliata</i>	560	0.83	8.10	0.80	7.40	15.20	2.70
<i>Terminalia superba</i>	480-640	0.71	8.32	0.80	7.60	13.40	3.50
<i>Daniella ogea</i>	420-580	0.85	7.65	0.67	7.00	13.40	2.40
<i>Antiaris africana</i>	420	0.66	7.45	0.80	7.70	14.20	3.00

Source: Ahonkhai 1988:228 Table 2.

The silica content was used in tests of the use of scanning electron microscopes (SEM) and energy dispersive X-ray analysers (EDXA) for studying wood anatomy (Berti 1980). Species used in the tests were moabi (*Baillonella toxisperma* Pierre), iroko (*Chlophora excelsa* Benth-Hook) and odoko (*Scotellia coriacea* A. Chev.).

No crystals were detected for *Baillonella toxisperma*, but close examination revealed the presence of an abundance of silica, found almost exclusively in the square and upright ray cells of the rays that also contained dark viscous inclusions often looking like granules. Besides these granules of silica and silicates there were granules formed mainly of potassium and sulphur (Berti 1980:47).

Many timber trees have wood with similar appearance and properties. Knowledge of these similarities is of potential interest to conservationists because slow-growing and endangered species such as *Baillonella toxisperma* with a high timber value may be replaced in the market by other species that do not have NWFP value and/or are more widespread and replaceable. For example, moabi is often confused with douka (*Tieghemella africana*) and makoré (*Dumoria hekelii* A. Chev. (Sapotaceae) (Centre Technique 1957:62), and is not unlike *Manilkara* species in appearance, except that it is rather lighter in weight (Brown 1977).

Certain market species coming from different continents are sometimes practically identical in aspect (Fouquet 1984:43-45), though the author warns that their mechanical and physical properties and behaviour do not always enable them to be used for identical purposes. A comparison was made between moabi (*Baillonella toxisperma* Pierre, Sapotaceae. Provenance: primary forests in Cameroon), and Balata Pomme (*Ragala sanguinolenta* Pierre, Sapotaceae. Provenance: Guyana and Surinam), which concluded that generally moabi had mechanical properties, such as finish, that were superior to those of Balata Pomme.

The wood is suitable for furniture making, cabinetwork, decorative flooring, decorative veneers, joinery, store fittings (Chudnoff 1984; Laird *et al.* 1997). As it is fine grained and without stripe it could be used for sculpture, engraving and turnery (Bertin & Meniaud 1949). There is also a recommendation that it is suitable for external carpentry and heavy woodworking (Centre Technique 1957:13-14), but this is contradicted by Bertin and Meniaud who maintain that the wood is sensitive to moisture variation, and should only be used for interior joinery, cabinet work and large panels (preferably in the form of veneers). The timber is also weak on impact so it should not be used for structures subject to movement (Bertin and Meniaud 1949).

7.2 Non-wood uses

The value of *Baillonella toxisperma* to local communities is as a multipurpose forest tree visited to collect the fruits, bark, or other parts of the tree used for food, medicines etc. (Adeola 1995; Vivien & Faure 1996). In a series of surveys carried out in Ghana, Nigeria and Cameroon, respondents in Cameroon gave *B. toxisperma* a rank order value of 6.0 (77 % of respondents mentioned the tree) when asked their preferred species. The uses mentioned were timber, medicine, firewood, and oil (Adeola 1995).

7.2.1 Medicinal

The seeds, seed oil, bark (Schneemann 1995:23) and latex are, or have been all used for medicinal treatment. For example, in the Mount Cameroon region of Cameroon a decoction made from the bark (by drying in the sun or boiling) is used to prepare a woman for childbirth. The bark is also used to treat infertility and other gynaecological problems (Laird *et al.* 1997). In the same region seed oil is used for mixing local plant medicines, particularly when heated, and is rubbed on joints for rheumatic pains and on skin inflammations. In the South West Province of Cameroon a bark decoction is used as a mouthwash to reduce pain (Esukutan), and as an enema for groin abscesses (Ekon1). Seed oil is rubbed on abscesses and the baked seeds are ground with *Aframomum* species and rubbed on swellings behind the ears (Mbu).

In Gabon, leaves of *Rauvolfia vomitoria* are cooked with djave nut butter (*Baillonella toxisperma*) and applied as an ointment to inflammations, dislocated joints and limbs affected by rheumatism (Burkill 1985:174-176). Also in Gabon it was recorded that local people used the latex for dressing wounds (Heitz 1943:260).

In Gabon⁸ and Equatorial Guinea oil from the seeds is used as a medicine against rheumatism (Moss 1995:112; Sunderland 1999:214).

7.2.2 Ritual

In Cameroon the seeds are used in the manufacture of foot-rattles used in traditional dances and celebrations (Sunderland & Tchouto 1999:11). The seeds are also said to be used in a poison ordeal in some parts of Cameroon, and the bark is used in native medicine to ensure strength (Dalziel 1948:358). In the subdistrict of Mbang, Cameroon, the Baka use a part of the bark to become invisible for elephant hunting (Schneemann 1995:23).

7.2.3 Fruit and seed

The fruit is harvested when it has fallen, and some of the seeds are more or less damaged. According to various local people one can hope to find 15-20 kg. of nuts at the foot of a tree. However, the harvest varies greatly from year to year. (Hédin 1928: 853-55).

The people in the village of Nyangong, Cameroon, use four products from *Baillonella toxisperma*: fruits, seeds, bark and wood (Ntamag 1997:72-73). It is also a source of income. Fruits can be eaten fresh, or can be processed to produce a highly valued oil. This very expensive viscous oil is exclusively processed by women for household consumption. It is so prized and so scarce that it is rarely sold in markets since local communities prefer to keep what they can collect for their own use, though it is traded throughout the Central African region when there is a surplus (Ntamag 1997:72-73; Sunderland & Tchouto 1999:11; Laird 1999:53). One of its advantages is that it provides an 'easily stored and transported commodity' (Moss 1994:448).

The most highly valued product to local communities is the oil that is extracted from the fruits of *Baillonella toxisperma*. This oil, described as similar to shea butter (Keay 1989), is said to be preferred above all other oils in communities where it is available.

⁸ Walker, A. & Sillans, R. 1961. *Les plantes utiles du Gabon*. Paris, France: Editions Paul Lechevalier.

- In Cameroon in the 1920s Hédin learnt that the local people preferred the oil of *B. toxisperma* to palm oil (Hédin 1928).
- In Gabon, the main traditional use for mimusops (*B. toxisperma*) is for the production of an edible fat or oil from the seeds. The oil is highly appreciated and is considered of higher quality than other vegetable oils (Moss 1994:448).
- In Cameroon, seeds produce a highly-valued oil used in cooking and eaten as a butter (Laird *et al.* 1997; Sunderland & Tchouto 1999; Agom & Ogar 1994:10).

The tree provides an essential food supplement for hunting and gathering groups in Equatorial Africa's forests where it is used to supplement game meat: 'the wild mango (*Irvingia gabonensis*), *Baillonella toxisperma* seeds and *Antrocaryon* and *Panda* fruit are also picked or gathered for their kernels, which provide flavour for sauces and are high in fat and protein' (Anon 1995:2).

In his study of Baka and Bantu groups in the subdistrict of Mbang, Cameroon, Schneemann (1995:23-25) described how whole family groups would go on a collecting trip into the forest when the trees were in fruit:

'For many generations the oil of moabi has been the only source of edible oil for the forest-dependent communities. As an inhabitant of Mbang stated: "moabi is a tradition for us. Since our grandparents, we go to stay in the forest to eat its succulent fruits and to extract its oils." Collection of fruit starts in July-August, when Bantu and Baka families may stay for 2-8 weeks near a moabi place in the forest. The women gather the fruits, take out the seeds, dry them, pound the kernels, extract the oil, and transport it to the village. The men build the camp and the drying installations and they may help in taking out the seeds and breaking them. Besides they do a lot of hunting in the surroundings of the camp. The oil is pressed by hand or with a wooden press fabricated on the spot. The wood press takes less time, while the output is nearly the same.'

Schneemann (1995:25) also points out that an indication of its cultural value to the Baka and Bantu is that local names for moabi are used in many place-names in South and East Cameroon.

Cameroon, in particular, exports large quantities of whole seeds to Gabon and Equatorial Guinea (Yembi, in press). In their surveys of the markets of Equatorial Guinea, Sunderland and Obama (1999:218) found evidence that the need for this trade from Cameroon was because forest use in general in Rio Muni had diminished to such an extent that Guineans had 'lost' their knowledge of how to use the forest. This was corroborated by other research carried out in the region (Dounias 1997⁹; Serrano 1997¹⁰; Cogels 1997¹¹).

Observations of oil preparation have been made by Hédin, Dalziel and Moss:

- Women crush the seeds between two stones or pound them in a mortar, generally made from the wood of *Alstonia congensis* Engl. The paste that is obtained is put into a pot with water and the fat that surfaces is recovered. (Hédin 1928: 853-55).
- 'The method of preparation is more or less as follows: after thoroughly drying the nuts the shells are removed for use as fuel for the operation; the kernels are ground finely on a stone, then spread out and moistened frequently with boiling water; the mass is then manipulated with added water into lumps or balls until the fat appears dark in colour. Sometimes the residue after a first extraction is dried again for a day or two and treated a second time. The final residue contains a considerable amount of oil and is used as a fire-

⁹ Dounias, E. 1997. *Mission d'expertise ethno-sociologique dans le cadre du Programme CUREF*. CUREF, Guinea Ecuatorial.

¹⁰ Serrano, N.C. 1997. *Etude de terroir coutumier de village de Engombegombe à la Reserve Forestière di Ndote*. CUREF, Guinea Ecuatorial.

¹¹ Cogels, S. 1997. *Etude du terroir du village d'Ayamiken (Reserve Forestier Rio Ntem / Rio Campo)*. CUREF, Guinea Ecuatorial.

lighter (like the fibre of palm-nuts), or is thrown in streams or pools to stupefy fish, the effect being probably due to the saponin contained. The extraction may be made by mechanical means, the smoothly-ground mass being put in a press; the oil so expressed soon thickens, and is said to have a pleasant taste free from the bitterness of the residue' (Dalziel 1948:358).

- In Gabon 'The main traditional use for *mimusops* is for the production of an edible fat or oil from the seeds. The oil is highly appreciated and is considered of higher quality than other vegetable oils. Old informants in the villages claimed that, before the introduction of peanuts, *mimusops* was an important source of quality vegetable oil for the Fang people. The traditional method for extraction of oil from the inedible pulp (observed during the study) involves a process of manual grinding, heating and expulsion of the oil through sacking. This method is very time consuming, and extraction rates appear low. *Mimusops* oil is prepared only in small volumes by older women used to this task since childhood. The difficulties involved in processing were repeatedly cited by villagers as the key reason for the decline in the production of *mimusops* oil' (Moss 1994/5:448-449).

7.2.4 Use of residues

After extraction of the oil from the seeds an oily residue is left that has been described by various authors as being poisonous to animals (Keay 1989:390; Offem 1990), and for which the best documented use is as a fish poison (Neuwinger 1994:269).

- Local people know the toxicity of the seed for they take care that the residue, emptied of fat, is not consumed by domestic animals. This residue is sometimes used to poison rivers for fishing, as are the leaves of *Tephrosia vogelii*, grown near the huts, or the fruits of a forest tree, *Pachyelasma tasmanii* Harms, that the Yaoundes call 'eyec' (Hédin 1928:854).
- The residue after extraction of the fat (by expression) is poisonous to fowls and animals in general and has been found to contain saponin. It could be used as a worm-killer on lawns, or as a fertiliser. The final residue contains a considerable amount of oil and is used as a fire-lighter (like the fibre of palm-nuts), or is thrown in streams or pools to stupefy fish, the effect being probably due to the saponin contained (Dalziel 1948:358).

Fishing with the aid of plant poisons has a long tradition world-wide. Over a period of 25 years Neuwinger gathered information on 258 fish-poisoning plants used in tropical Africa (Neuwinger 1994:263-270). The main active compounds found in these plant poisons were saponins, rotenoids and diterpene esters. Such biologically active plants are of interest in various disciplines, for some of these plants provide important insecticides, many play an important part in traditional medicine and in the preparation of arrow poisons. The use of seed residues from the production of *B. toxisperma* oil to poison fish has been documented (see above), and Offem (1990) has recorded the presence of saponins in these residues. Neuwinger concluded that the effect of these saponins on the fish may be due to a pathological increase of permeability in the gill epithelial cells. The essential electrolytes dissolved in plasma, e.g. potassium ions, go into the surrounding water, and this irreversible leakage of ions leads to the death of the fish.

Offem analysed seeds from *Mimusops djave* [*Baillonella toxisperma*] for nutritional, toxic and other components, including fat, protein, ash, fibre and minerals (Offem 1990:207-210). He found that whole seeds contain about 613 g. crude fat/kg, whilst the defatted seeds contain 219.6 g. crude protein/kg, corresponding to 85 g/kg whole seeds. The silica-free ash and crude fibre contents were 73.8 and 34.6 g/kg of the defatted seed meal, respectively. A methanol extract of the defatted seeds produced 100% mortality within 72 hours of feeding to chicks. Aflatoxin B₁ was detected at 3 µg/100g of dried and defatted seed and G₁ in only trace amounts, plus low levels of lead and cyanide, but these were too low to account for the chick deaths. The methanol extract was purified, analysed and found to contain two compounds with the spectral characteristics of saponins. The Liebermann-Burchard test on this methanol extract was positive.

The toxicity of *Baillonella toxisperma* extends beyond the saponins contained in the residues from oil extraction and may give it a competitive advantage against other plants in the forest environment (See 6.2, investigation by Ohigashi *et al.* into allelopathy).

8. MARKETS AND BENEFIT SHARING

8.1 Timber

As one of the prized tropical timbers exported from West Africa, *Baillonella toxisperma* has been over-exploited. By volume, it was the tenth most important commercial timber species exported from Cameroon in 1997: 27,944 m³ were exported in January-September 1997 (SGS Cameroun, S.A. 1997, quoted in Laird 1999:53). From 1990-1993 *B. toxisperma* constituted 2.6-3.7% of the total volume of logs (all species) exported from Cameroon (Schneemann 1995:27). According to ITTO 25,000 m³ of *B. toxisperma* logs were exported from Cameroon in 1994 at an average price of US\$ 385.00/m³, and 10,000 m³ of sawn timber were also exported at an average price of US\$ 700.00/m³.

Table 4: Exports of *Baillonella toxisperma* timber from Cameroon and Gabon in 1994 and 1995

Exporter	Year	Commodity	Quantity (m ³)	Average Price/m ³ (US\$)
Cameroon	1994	logs	25,000	385.00
Cameroon	1994	sawn timber	10,000	700.00
Gabon	1994	logs		70.40
Gabon	1994	sawnwood	82	63.13
Total	1994		32,572.065	
Total	1995		44,390.331	

The stumpage value of moabi to a concessionaire in Cameroon has been quoted as follows:

- Export price CFA/m³ 91,653; stumpage value/m³ CFA 77,653; stumpage value/ha CFA 2,718; stumpage value/tree CFA 784,295. (Nef 1997:20, table 8).

The export price in Cameroon between 1990-1993 for *Baillonella toxisperma* logs averaged 62,500 CFA (US\$ 250) /m³ (f.o.b. Douala). This export value was between 20-34 million French francs, 3.4-3.5% of the total export value for logs of all species (Schneemann 1995:28). Also in Cameroon, Nef (Nef 1997:17, table 5) quoted the following figures from GWZ : 1993-94 log export sales for *B. toxisperma* – 172 logs (1287 m³), total value CFA (x10⁶)118, were 2.78 % of total export value, with a price/m³ of CFA 91,653. Laird (Laird *et al.* 1997:13) described the timber value as ‘mercurial’. At that time it was 40,000 CFA/m³.

In 1987, 55,884 m³ moabi timber were exported from Gabon at an average price of CFA 60,000 /m³ (US\$ 91 /m³) and 59,891 m³ were exported in 1989 (Wilks 1990, quoted in Moss 1994:112).

8.2 Oil

There are many reports of the preference people have for the flavour of the oil obtained from *Baillonella toxisperma* seeds where they have access to it (Amadi 1993:22; Agom & Ogar 1994:10; Laird *et al.* 1997:15; Nef 1997:32), and Okafor and Lamb (1992:38) suggest that it is a species whose fruits with their high fat and oil content would be suitable for commercial production of cooking oil and margarine, use in soap manufacture and pharmaceutical preparations etc.

In addition to local preference for the oils, the seeds of *Baillonella toxisperma* were in the past imported into Europe where there was a market for the fats and oils:

‘The lack of fats from which certain of our industries suffer has led us to import from our colonies all the fats and oils that can be economically exploited. It is important to re-examine the seeds of *Baillonella toxisperma* Pierre (1890) which has already been part of a by no means negligible trade with England and Germany.’ ... ‘In the time of our predecessors Hamburg regularly purchased the *Baillonella* nut harvest; production was greater or smaller according to the year. In 1907 it was 15 t; in 1908 183 t. representing a value of 20,000 marks. In 1911 exports reached a value of 32,000 M. It is still the Hamburg market that offers an outlet for shelled njabi nuts. So, in the region of Yabasse in 1920, 14 t. were exported, in 1921 28 t. But transport presented difficulties: the seeds in bags arrived broken and partly pulverised. There is no doubt that industry would be more interested in the fat itself’ (Hédin 1928:853-55).

‘The nuts were formerly exported from Portuguese Equatorial Africa to Germany, possibly along with those of *Mimusops Pierreana* Engl. which yield a similar product’ (Dalziel 1948:358).

The trade in the unprocessed seeds ceased, and now consumption of the fats is documented as being limited to within the West and Central African regions where the species is endemic.

Current research into use of NWFPs indicates that the markets are very restricted due to limited availability of the oil. In his recent study of NWFPs available in Paris Tabuna (1999) did not record the oil as being sold in the Paris markets, despite the fact that the source countries for these NWFPs were those of the Congo Basin and the clientele in Paris were primarily African or Caribbean in origin. This may be for a variety of reasons such as the limited availability of the oil which is kept for personal use if imported and there is no surplus to sell, rather than that there is no demand. Sunderland and Obama (1999:218) in their market survey found that most NWFP sold in markets in Equatorial Guinea were imported from Cameroon because of loss of knowledge of forest use by the local people. This could be another contributing factor to its absence from appropriate markets.

Marked seasonality noted ‘in the collection of and benefits accrued from a number of NTFPs targeted during this survey’ such as *B. toxisperma* (Sunderland and Tchouto 1999:17).

The oil is high-priced indicating its value and scarcity. Looking at prices of the oils in markets in the Congo region and West Africa prices and values found for the oil or seeds are:

- In Nigeria *Baillonella toxisperma* has very high NTFP value. The oil presently sells at N 30 /beer bottle (70 cl.) and is used like any other vegetable oil. An average sized tree is able to produce 170 bottles of oil per season, which is annually. A single tree is thus worth about N 5,100 a year (Agom & Ogar 1994:10).
- In Northern Gabon very little mimusops oil is marketed and prices are variable. However, most is sold for a least CFA 3,000 (US\$ 3.3) /litre compared with CFA 995 (US\$ 0.75) /litre for peanut oil. Oil sold in 5 cl. bottles as medicine receives as much as CFA 20,000 (US\$ 15.1) /litre (Moss 1994:449).
- In East Cameroon demand for moabi oil exceeds availability. ‘Prices vary from 400 CFA (US\$1.6) /litre in far-off production areas (e.g. Lomié) to 2,000 or 3,000 CFA (US\$ 8 or 12) in Douala and Yaoundé.’ ‘Extrapolation of inventory results showed that in 1992 Baka and Bantu women in the subdistrict of Mbang would have extracted approximately 6,200 litres of oil, with a local value of 4.6 million CFA (approximately US\$ 18,400). They would have sold 2,100 litres of oil for 1.6 million CFA (US\$ 49,600)’ (Schneemann 1995:28).

- Recorded prices in 1996, 1997 and 1998: Sangmelima market 1,000 CFA/litre oil; Abong-Mbang market 1,733 CFA/litre oil; average of two markets 1,367 CFA/litre oil (CIFOR 2000).

8.3 Comparison of a tree's potential NWFP value and its timber value

The value of the timber from *Baillonella toxisperma* (moabi) to those countries where it is found is as a single one-off asset benefiting mainly the national government, whereas until recently, a tree's value to local communities was its availability for repeated harvesting. Today, however the timber value of a tree to a local community may outweigh its NWFP values. For example, in Nigeria communities that own forest that is exploited are given a royalty of 50% of the permit money that loggers pay to the Forestry Department (Agom & Ogar 1994:11). The value of this to the community per tree extracted is about N 1,125 for first grade trees. *Baillonella toxisperma* is classified as Group A, a high value species (Schneemann 1995:27), so the timber value to a community of logging moabi may far exceed its value as a back-up resource at any one point in time.

Schneemann, however, compared the economic benefits to the 'manager' of a moabi tree of extracting the oils, and selling them periodically, to those of logging a single mature tree at its peak economic value (Schneemann 1995:29).

He based his estimations on the data he had collected (labour costs are not included), using a starting time of flowering and fruiting at 50-70 years. However, from the age of 50-70 years a tree will not have consistent annual production because over the tree's lifetime production will increase and then decrease. Peak fruiting does not occur until the tree is 90-100 years old, and furthermore there is a cycle of one or two fruitings every three years, so from any one tree communities will not harvest a consistent amount during the tree's productive lifetime. A tree is logged when it has a dbh of 100 cm (135-150 years at the estimated average growth rate of 0.7 cm/yr) – the Minimum Diameter of Exploitation determined by the Cameroon Forestry Department, but not always observed.

He found that the timber value, once every 140 years, was about 462,500 CFA (approx. US\$ 1,850). The value of the oil, estimated at a rate of 135-165 litres oil from one tree every 3 years, would be 300,000 CFA (approx. US\$ 1,200). With a discount rate of 10% the value of the oil production 4.5 years after year x would be 455,000 CFA (approx. US\$ 1,820), and after 7.5 years the total revenues would be CFA 602,000 CFA (US\$ 2,408), discounted to year x.

Schneemann concluded that, comparing the 2 scenarios 'after 4.5 years the benefits of oil extraction are almost equal to those of the timber revenue of a tree with a diameter of 100 cm. Moreover, after 7.5 years the discounted oil revenues do largely exceed the timber revenues' (Schneemann 1995:29) so the economic value of NWFP gathering could be promoted as providing long-term benefits to a community compared to a tree's timber value.

9. INSTITUTIONAL ISSUES

The survival of *Baillonella toxisperma* in its natural habitat is affected by a country's logging legislation, conservation legislation (national and international laws), and customary laws and rights. Investment and strength of infrastructure are critical accessories to these laws and rights for ensuring their implementation, and for providing opportunities within the species natural range for its *in situ* conservation, and to enable research into managed plantings in suitable accessible locations.

Baillonella toxisperma is a particularly vulnerable species because of its slow rate of regeneration and lateness to fruit, and its high timber value as a diminishing resource in an increasingly demanding market. On the IUCN Red List it has a status of 'Vulnerable', i.e. facing a very high risk of extinction in the wild in the immediate future (Oldfield *et al.* 1998). It has been declared by the World Conservation Monitoring Centre (1994) to be vulnerable in Cameroon, uncertain in Gabon and Nigeria, and not threatened in Congo. A draft Cites Proposal in 1991 expressed concern about illegal trade in moabi in some countries (referred to in WCMC Tree Conservation Database 2000).

Figure 5: World Conservation Centre assessment of *Baillonella toxisperma*

Moabi is restricted to areas of primary evergreen and old secondary rainforest. The species is overexploited for its timber and is seriously declining in large parts of its range. It is the second most important exported wood in Gabon. Amongst other local uses the tree produces edible oil which can fetch high market prices. Maturation rates are slow: 90-100 years, and regeneration occurs only under a closed canopy. Minimum exploitable diameters have been set in several countries. *Baillonella* is a monotypic genus endemic to the Guinea-Congolian Regional Centre of Endemism.

Source: WCMC Tree Conservation Database, 2000.

Whilst there may be forms of legal protection that could help its conservation, weak government and infrastructure failings are factors mitigating against this. It is well-documented that the oil is a valued resource to local communities in Central Africa, but it seems likely that as it becomes rarer, the push to protect it will weaken because of loss of knowledge of its uses and substitution in local diets by other more freely accessible oils. Therefore the sooner that effective forms of protection are devised for the species the greater the chances will be that it continues to be a valued resource to the indigenous peoples of the region.

Protection needs to be directed towards balancing the timber value to countries in the region and local needs, including those of forest biodiversity. In 1928 Hédin wrote of the strength of logging companies in influencing government policy in Cameroon when the ban on felling moabi in logging coupes was altered, and the felling of trees not used by local people was permitted (Hédin 1928:854-855):

Felling *Baillonella*, considered to be a useful tree that provides edible fat to the local users of the forests, was forbidden to loggers in Cameroon. Yet it is known that this species provides wood that is much appreciated for cabinet making, and the ban has been lifted as a result of pressure by loggers, to exploit trees not used by local people. There is no doubt that very old trees produce fewer and smaller fruits.

This is still the case where commercial pressures influence governments against the interests of local communities or override their practices. The Baka are also affected by insecurity of tenure and usage rights because they lack *de jure* control over forest lands they inhabit and resources they use. Conflicts with logging companies have already arisen over Baka harvesting of fruit from *Baillonella toxisperma* (Ambrose 1994:28). Furthermore, for the Baka this loss of a resource is extending beyond its availability. It is a symptom of a threat to their whole lifestyle:

'More important is the lack of *de jure* control the Baka have over forest lands and resources, for example, conflicts with logging companies have already arisen over Baka harvesting of oil rich fruit from the *moabi* tree (*Baillonella toxisperma*), a species felled by commercial operators despite concession agreements to the contrary.' (Ambrose 1994:28)

A vivid example of the impact of the timber companies on the lifestyle of the Baka peoples of Cameroon is given by Horta:

Another formidable skill is the Baka's sense of orientation within the forest. They are able to walk for hundreds of kilometers and many weeks through the forest while maintaining a precise sense of their location. Now that logging roads are penetrating and criss-crossing the forest in many areas, Baka people are becoming disoriented and lost in their ancestral forest lands¹². The disorientation is leading to a loss of cultural and spiritual identity which is closely tied to the forest. In addition, the traditional exchange relations between Baka people and Bantu villages have become eroded. For example, logging companies, such as the French company Pallisco in the Lomié region, are specializing in extracting the very tree, the moabi (*Baillonella toxisperma*), whose existence is essential to maintaining the traditional balance of local trade, in which the Baka exchange food (cooking oil) and medicinal products derived from the moabi for metallic goods and starchy foods planted by the Bantu villagers (Horta 1997:70).

The clash between local usage rights and logging pressures on *B. toxisperma* is most accessible through studies carried out in Cameroon (Ambrose 1994; Schneemann 1995; Horta 1997; Ntamag 1997; Sunderland & Tchouto 1999).

9.1 Cameroon

Ambrose (1994:47-48) provided an overview of forest legislation in Cameroon. Relevant points are:

- Use of natural resources within the country are covered by legislation embedded largely within Law No. 81-13, and its implementing Decrees 83-169/170/171, which establishes a framework for control over concessionaire activity and the long-term management of forests.
- Concessionaire payment is through stumpage fees and a series of contractual obligations ('Cahier de charges') which specify extraction rules, required infrastructural developments and the level of compensation to be paid to communities affected by logging.
- Land Tenure Act Articles 14, 16, and 17 'create possibilities for indigenous people to defend land rights and privileges and involvement in natural environment'. Anyone clearing land for cash crops such as coffee or cocoa obtains *de facto* possession of the land, 'mise en valeur', for 30 years, but the position regarding agroforestry and clearing land or planting trees around forest margins or on fallow land is less clear.
- Creation of Community Forests as part of the non-permanent forest domain. Such forests offer opportunities for protecting standing trees of NWFPA value and for planting schemes planned according to the wishes of the community, but their legal status is ill-defined in the law (Sunderland & Tchouto 1999:25).

Schneemann (1995:23-27) has also written of the clash between logging companies and local communities in South and East Cameroon:

- 'The people living in South and East Cameroon have a tradition of communal ownership of land and forest resources.' For example, for moabi, 'the man who discovers the tree obtains the right to use it during his life, together with his family. The discoverer consolidates his right by marking the tree and by cleaning the surroundings of the tree. The tree is heritable and becomes a family's property. The obtainment of ownership has taken place many decades ago by the Bantu, who were the first to settle in villages. Nowadays the Baka complain that the Bantu have "taken" all the moabi and bush mango trees nearby the villages, and that they (the Baka) have to penetrate far into the forest to collect fruits and nuts from "free" trees. Though the

¹² Personal communication to Korinna Horta from Georges Mouchourou, IUCN Project in Lomie, May 1997.

preceding concerns customary right, the State is the legal owner of all natural resources, including forest resources.’

- ‘Logging started around 1900 at the coast of Cameroon and has expanded towards the East province between 1950-1960. From 1971/72 moabi has been exploited in the East province, in particular in the districts Kadey and Haut-Nyong. In order to assure forest regeneration the forestry department has determined a certain “Minimum Diameter of Exploitation” (DME) for each timber species. It is forbidden to log moabi trees with a diameter of less than 100 cm; a rule which is however not always respected. Logging companies qualify moabi trees as suitable for logging if they: (i) have a diameter of at least 100 cm; (ii) are not situated near a ravine, and (iii) have a straight and healthy stem.’
- ‘Up to 1981 logging companies were obliged to assist local communities by building infrastructure such as classrooms, health centres etc. From 1981 the companies no longer have direct obligations towards the population, as they pay a “communal tax” in Yaoundé, meant to finance local infrastructure building. Now local communities are only informed about the arrival of a logging company, their licence etc.’ Local communities have ‘often expressed the desire that logging companies would not log the moabi trees they use for oil extraction... logging companies and government have not given any guarantee of conserving moabi trees for the local communities’ (Schneemann 1995:26).

Ntamag also observed this dissatisfaction. ‘During our stay in Nyangong, there was a logging company for timber exploitation. From informal discussions and some observations, we realise that local people were not satisfied with the realisations carried out so far by the logging company, based on the agreements signed on the matters. Also, some people complained about the disappearance of some trees which provide very highly valued NTFPs such as *B. toxisperma* (*adjap*), exploited by the logging company’ (Ntamag 1997:63).

Sunderland and Tchouto in their survey of timber and NTFPs in the Mokoko River Forest Reserve in the South West Province of Cameroon found that even where a company may have an agreement with a local community there is no certainty that this will be honoured:

In the Mokoko Forest Reserve ‘the majority of preferred timber species do not have any particular non-timber uses regarded as valuable by the Mokoko-based communities’, except for *B. toxisperma* and *Poga oleosa*. ‘The recovery of timber by Cameroon Development Corporation during its expansion has led to the felling of a number of taxa of some importance to local people. The worst example of this is that of *B. toxisperma*, the nuts of which have been harvested from many individuals for many years and contribute significantly to some household incomes. Protests by villagers have led to negotiations with CDC to retain some valuable NTFP species on plantation land. At the time of writing no agreement had been reached on this. However, it is important to note that this issue does not affect the Mokoko Reserve itself, and is an issue on CDC land only, as yet’ (Sunderland & Tchouto 1999:19).

9.2 Nigeria

It has already been mentioned that in Nigeria communities that own forests that are exploited are paid royalties from the money earned by the government: 50% of the permit money paid to the Forestry Department Royalty per tree extracted is paid to the community and is about N1,125 for first grade trees (Agom & Ogar 1994:11).

9.3 Equatorial Guinea

In Equatorial Guinea forestry is a major contributor to the country’s GDP, yet only about 1% of the earnings from forestry taxes is channelled back into forest administration, and a big gap can be noted between forest policy, legislation and the actual situation in the forest (van Breugel & Parren

1997:82). The 1997 forestry law (Ley No. 1/1997) set a maximum concession size of 50,000 ha. 'effective harvestable area' (concessions in mountainous areas, for example, could be larger) valid for fifteen years. However, good timber quality in the coastal zone, where most logging activity has been concentrated, is declining whilst the number of enterprises is increasing and all potential land has been handed out. 'This surface includes other land use types apart from forest lands. Of the present concessions about 960,000 ha are exploited or have been exploited, while at the same time logging takes place in community forests (*reservas de poblados*) and on private land.' There is a felling interdiction for fruit trees useful for human consumption (van Breugel & Parren 1997:79), which could be used to protect taxa such as *Baillonella toxisperma* if supervision and management of forests were effective.

There is in existence a project, the EC-funded CUREF (Conservación y Utilización de Ecosistemas Forestales de Guinea Ecuatorial) which should result in the 'determination of a permanent forest domain, with the production forests, protection forests and the protected areas', plus social studies to find out the present extent of human activities and the future needs of the local population' (van Breugel & Parren 1997:80).

10. TOWARDS A SUSTAINABLE POPULATION OF *BAILLONELLA TOXISPERMA*

10.1 Contributory factors to the species' decline

The factors which make *B. toxisperma* a vulnerable species are:

- its habit (slow growth and large size, late maturity, irregular fruiting, low density);
- restricted range;
- loss of habitat resulting from forest clearance and changing land uses;
- high timber value;
- the political weakness of forest peoples who collect and process the fruits,
- a growing preference for more easily accessed sources of oil (processing is slow and hard work).

Baillonella toxisperma grows within a limited region of tropical Africa that is under global pressure from the world timber industry. As logging encroaches further and further inland from more easily accessible forests the species is losing its habitat for regeneration and is not replacing itself as the forests are logged and primary forests give way to more transitory forms of vegetation cover – secondary forest or agriculture. *B. toxisperma* is a slow-growing, long-living species with a replacement time of more than half a century (Vivien & Faure 1996:316; Schneemann 1995:22), and it is disappearing from the more accessible parts of its habitat. Because of its vulnerable regeneration and the exploitation which occurs without (sufficient) restrictions, the species will probably disappear from a large part of its original area of distribution.

There are conflicting interests in the region which need to be resolved concerning traditional forest-based lifestyles, and the opportunities for Central African countries to earn maximum revenues from the world timber market as other tropical timber producing countries introduce export controls, or their forests are logged out and the industry seeks alternative timber sources.

The principal conflict of interest affecting the *in situ* conservation of *B. toxisperma* is between local communities and logging companies. Communities who until recently had been dependent on NWFPs to supplement their dietary and other needs have found that their access to and use of the forests are being curtailed by the encroachment of loggers, who not only remove valued trees but also ignore customary ownership and rights to forest products. Changes in the social structure of cleared forests as land is opened to agriculture also are insensitive to these rights and to traditional knowledge and use of NWFPs.

Logging operations have a serious effect on local communities' use of NWFPs particularly where both commercial value and local value are high. The extent to which these values correspond determines the level of opposition that may arise (Nef 1997:20). *Baillonella toxisperma* is an excellent example of the conflict of interests between the commercial sector and local communities. Its density/ha is low; it is commercially valued for its fine timber; and the oil from the fruits is valuable to local communities and is in increasingly scarce supply (Laird 1999:53).

Extraction of *Baillonella toxisperma* affects peoples such as the Baka and Bantu in East Cameroon for whom the fruits have been their only source of edible oil. They sold or exchanged surpluses not needed for their own consumption (Schneemann 1995), and loss of the trees has resulted in conflicts between them and the logging companies.

In a study in southern Cameroon of 31 timber species exploited by the Dutch logging company, GWZ, 19 were also used by local communities, and sixty per cent of the local people interviewed cited *B. toxisperma* as a NWFP that was seriously affected by logging (Laird 1999:54). In the Bipindi-Ekom II area of southern Cameroon the local community considered that *B. toxisperma* was by far the most important species in need of protection of the ten NWFP species they listed (Nef 1997:20).

For a report to the UK Overseas Development Administration Damian Agom and David Ogar surveyed a concession area of 170 km² in the Afi River Forest Reserve, Cross River State, Nigeria, to estimate the impact of logging on the forest and on the communities living there (Agom & Ogar 1994). The concession area was next to a village, Abo Ogbabante, and the villagers used the forest regularly for collecting NWFPs. However, some of these products were being destroyed by logging, notably *B. toxisperma* and *Brachystegia eurycoma*. *B. toxisperma* constituted 37.8% of the species extracted by the loggers (Table 5) – the extraction percentages reflected orders received by the company.

Table 5: Species extraction distribution from the Afi River Forest Reserve, Nigeria

Species	%
<i>Baillonella toxisperma</i>	37.8
<i>Lophira alata</i>	29.5
<i>Brachystegia eurycoma</i>	21.1
<i>Piptadeniastrum africanum</i>	07.4
<i>Entandrophragma</i> spp.	02.1
<i>Afzelia africana</i>	01.1
<i>Lovoa</i> spp.	01.1

Source: Agom and Ogar 1994:10, Table 2.

The impact of logging on communities has also been witnessed by Cécile Ntamag during her research into the collection of non-timber forest products in Nyangong, Cameroon. The local people complained that particular trees they depended on for very highly valued NWFPs, such as *B. toxisperma*, were being logged out (Ntamag 1997:63). And Sunderland and Tchouto have written of the conflict in the Mokoko River Forest Reserve (Chapter 9.1 in this paper) between the timber company and local people.

It is not only commercial logging companies that are exploiting the timber resource. In the roadside settlements of the Korup Forest, Cameroon, where poorer groups sell NWFPs, their access to forest resources is diminishing as forest is converted to farmland, as reported by Malleson:

New farming methods have been adopted by elites which entail clearing large areas of land to make way for the cultivation of yams, cassava and other crops. These methods are not only used to earn cash from farm sales, but also to generate income from the timber trees

felled during clearing. Some of these valuable tree species, such as *B. toxisperma*, also provide economically important forest products for less wealthy households (Malleon 1999:121).

There are other factors contributing to the decline in use of *B. toxisperma* oil that are a more general reflection of social change. For example, one consequence of the declining availability of oil from *B. toxisperma* is that people turn to more easily obtained products, such as palm oil, and the taste and quality of the oil is in time forgotten.

This consequence was touched on in 1928 by Hédin referring to changing practices influencing traditional uses:

It must not be forgotten that whatever the abundance of *Baillonella* in the forest, its nuts are a product of harvesting whose value is limited compared with cultivated products. Moreover, local people prefer to cultivate the land rather than to search for their food or income in the forest. This explains, for example, why in spite of the abundance of groundnut vines in the forests of Niohé or Nyombe, local people devoted to cacao cultivation are not interested in this source of wealth (Hédin 1928:855).

Indigenous fruit-producing trees contribute significantly to the species diversity of tropical forests, yet the availability and consumption of native fruits is declining (Okafor & Lamb 1992) as the trees become more rare. Chikudze found that the affordability to buy food lessens the need to collect forest foods, and that the more field crops are harvested and sold, the less is the reliance on NWFPs (Chikudze 1995¹³) as introduced fruits gain a market foothold and greater attention is given to research, development and marketing of exotic fruits.

With decreasing reliance on NWFPs other constraints on collecting forest fruits were given to Henkemans, such as: lack of time; lack of knowledge of fruit locations in the forest; the weight of the load; fear of getting lost in the forest; storage without loss of quality (Henkemans 1995¹⁴). Research in Equatorial Guinea has found that processing skills, such as oil extraction, are also being lost in a general decline of gathering and use of non-wood forest products (Sunderland & Obama 1999:218; Moss 1995).

Another contributing factor to the decline in NWFP use is that communities have no control over these trees because their customary rights over either the land or the trees themselves are ineffectual (Horta 1997:70; Ambrose 1994:28). Sunderland and Tchouto have examined the impact on conservation that results from lack of land tenure and long-term security. They found that where people had long-term control over their land and the species growing there, and as they became more aware of the market value of certain products beyond the subsistence level, farmers were retaining valuable NWFP resources, such as *Irvingia gabonensis*, *Baillonella toxisperma* and *Ricinodendron heudelotii* on their lands.

‘Whilst some levels of traditional management and control exist for these species, the reality is that the lack of coherent social structure is leading to many forest resources to become common property and they are being managed on a ‘first-come first-served’ basis. Growing, or maintaining these products on farmland is viewed by many farmers as a means of ensuring access to a regular supply and hence a share of the market’ (Sunderland & Tchouto 1999:37).

¹³ Chikudze, J. 1995. *Economic importance of minor forest products in rural areas of Zimbabwe: a case study on Mafungabusi Forest, Gokwe South district*. MSc thesis, Forestry Department, Wageningen Agricultural University. 97pp. Quoted in Ntamag 1997:14.

¹⁴ Henkemans, A.B. 1995. *Forest products are a free gift of nature: gender issues in the exploitation and trade of Non-Timber Forest Products in the Korup Project Area, Southwest Province Cameroon*. MSc thesis. Wageningen Agricultural University. 123 pp. Quoted in Ntamag 1997:14.

10.2 Ways of conserving the species *ex situ* as well as *in situ*

Because of the increasing human impacts on tropical forests species such as *Baillonella toxisperma* no longer have time or space to reproduce in sufficient quantities *in situ*. New methods have to be adopted to conserve valuable multipurpose trees in landscapes that are permanently changed. Alternative rapid methods of propagation need to be developed to supplement *in situ* conservation. This could be achieved by bringing moabi into the community environment which would enable farmers and community members to retain control over *Baillonella* products.

The objections of farmers interviewed in the ICRAF Cameroon survey to planting *B. toxisperma* were that the trees take too long to begin bearing fruit (over 15 years) and then do so only every 2-3 years; that the fruits are quite small; that the natural stock is declining; and that artificial propagation techniques have not been developed that they can use or benefit from (Mollet *et al.* 1995:16). These are all indicators of approaches that could be taken towards increasing the species' appeal and improving its non-wood values.

It has been shown that dispersal, germination and early growth are uncertain processes in *Baillonella* (White & Abernethy 1997; Schneemann 1995; Sunderland & Tchouto 1999; Debroux *et al.* 1998) due to the short period that the seeds retain viability; seed predation (including removal by humans) and the species possible dependence on one dispersal agent (the forest elephant); seedling damage and allelopathy; and the species' low density (van Dijk 1999). Using such traditional horticultural techniques as vegetative propagation and clonal selection (Leakey & Maghembe n.d., p.7) early growth can be accelerated by bypassing the dispersal and germination stage, and farmers can have access to saplings rather than searching for wildings. Trials on vegetative propagation of *Baillonella toxisperma* have been carried out at the Institute of Terrestrial Ecology, Edinburgh (Leakey, Newton & Dick 1992:73, Table 1). As well as enabling material to be selected and multiplied from superior genotypes, and the conservation of genetic variety, vegetative propagation for fruit trees can achieve early fruiting and fruit set in slow-maturing species by using mature adult budwood (Okafor and Lamb 1992).

The literature shows that *Baillonella toxisperma* has been planted in the past, and has been left as a shade tree when land was cleared for plantations (Sunderland & Tchouto 1999; Ntamag 1997; Schneemann 1995; Hédin 1928). Okafor and Lamb have written that programmes to incorporate forest fruit trees into traditional agricultural systems have been tried in Nigeria and included *B. toxisperma* in their list of recommended species (Okafor & Lamb 1992:38). And in Gabon *B. toxisperma* is one of 6 species of wild fruit trees being researched by the Ministère des Eaux et Forêts and the Institut de Recherche Agronomique et Forestière (IRAF) for their potential for reforestation to augment timber production. IRAF is also investigating the biology of wild fruit trees because of their importance to the local population (Bourobou-Bourobou 1999:3). Trials are also being carried out of mixed plantings of large trees such as *Baillonella toxisperma* with faster growing medium trees such as *Irvingia gabonensis*, and plants with rapid growth such as Macaranga species (Bourobou-Bourobou 1999:19, 20, quoting Hladik & Miquel 1984¹⁵).

10.3 Conserving the species and increasing its use

Factors which would help conservation and promotion of *Baillonella toxisperma* would include earlier fruiting (and smaller trees); *in situ* conservation (forbidding logging in protected areas); alternative sources of germplasm (*ex situ* conservation in seed banks, nurseries); improved or more secure access to and use of trees for NWFP harvesters; improved oil processing techniques; enlarged markets and promotion of the oil as a quality product.

Lawson has recommended co-ordinating breeding programmes through national germplasm collections, and breeding native hardwood trees through a regional hardwoods improvement programme using a range of timber and multipurpose species such as *Baillonella toxisperma*, *Garcinia kola* and *Prunus africana* (Lawson 1992). Such programmes could provide stock for

¹⁵ Hladik, A. and Miquel, S. 1984. 'Sur le concept d'agroforesterie: exemple d'expériences en cours dans la région de Makokou (Gabon).' *Bulletin d'Ecologie* 15(3)163-173.

planting in and near to villages and farms. Local people who still use *B. toxisperma* products would be able to indicate superior trees from which to obtain planting stock as they would know the characteristics of mature trees from which products were gathered.

As the quality and quantity of fruits declines when a tree is old (Hédin 1928) people with rights over trees could sell the tree for timber when it is considered to be past its prime fruit-bearing age. Such small-scale production of timber could be marketed through specialist outlets promoting sustainable wood use and production at premium prices.

The problems of processing oil-producing fruits like *B. toxisperma* were addressed by Amadi (1993 in Cameroon) and Moss (1994 in Gabon). Amadi recommended that surveys to establish the problems and potential for the further development of NTFPs as sustainable income generating activities should be carried out, including studies on the potential to facilitate processing NTFPs such as njabe where traditional methods of oil extraction from the seed kernels are lengthy and laborious (Amadi 1993:26).

Table 6: Suggestions for further areas of study of *Baillonella toxisperma*

- The tree is not currently suitable for agroforestry because of its slow growth rate and size. Possible option is plantation approach. Moabi has been planted as a shade tree.
- The seeds are recalcitrant and fruiting is irregular – this limits seed supply for planting as seeds quickly lose viability. Investigation into vegetative and clonal propagation of the species is needed to speed up the reproductive process.
- There is very little information on the ecological requirements of *Baillonella toxisperma*, nor of its ecological niche. Is it limited to only the most dense parts of the forests, or is it a mid- to late-secondary species that survives in farm bush and late-secondary forest?
- If elephants are the main dispersers of the seeds, is *B. toxisperma* wholly dependent on forest elephants for dispersal? To increase understanding of the species' ecological niche further studies need to be made on seed dispersal and regeneration and also whether the limiting factor to the species' range is linked to the range of the forest elephant in the Congo Basin.
- Investigation into the role of predation, disease/parasitism and allelopathy in seedling survival in the forest may also contribute to overcoming high sapling mortality.
- Would widespread education programmes on the uses and potential of such NTFPs as *B. toxisperma* create sufficient popular pressure to influence forest policy and law enforcement?

Moss found that because the traditional processing method was so laborious, *B. toxisperma* fruits often went uncollected despite high oil prices. However, this process, which involves pounding, heating and pressing, could easily be mechanised using improvised, locally made equipment (Moss 1994), and if the kernels collected a good price, villagers would be encouraged to resume gathering, even from trees deep in the forest. Moss recommended that a pilot buying and processing scheme should be initiated, with the aim of setting up individual entrepreneurs – or perhaps village groups – to buy and process the seeds themselves.

Programmes for enlarging markets for the oil and familiarising people with its flavour and usefulness could be promoted, and developing alternative uses for the oil. Leakey and Newton recommend investigating *B. toxisperma* for commercial production of cooking oil and margarine, manufacture of soaps, or pharmaceutical preparations etc. (Leakey & Newton 1994:62).

Schneemann made recommendations for conserving *B. toxisperma* balancing the exploitation for oil and timber in such a way that sufficient regeneration is guaranteed. His suggestions follow (Schneemann 1995:31):

- Conservation of good quality ‘mother trees’;
- A higher Minimum Diameter of Exploitation;
- Restriction of logging trees used by local communities;
- A thorough analysis of national forest inventories, and supplementary research in order to determine the sustainable exploitation levels;
- Research on the influence of seed gathering on the regeneration of moabi;
- Improved control of logging operations;
- Equal involvement of all parties in the development of management plans for particular areas;
- Investigation of the possibilities of planting moabi;
- Investigation of potential new applications of moabi oil, e.g. for cosmetics.

Strategies suggested by Okafor and Lamb (1992) for promoting diversity and conservation included investing intravarietal diversity – using phenological and geographical variation – to extend fruiting periods. They also recommended encouraging people to cultivate local forest species in their farming systems, and the development of commercial products, such as the oil. Forest reserves, strict natural reserves, and protected fetish groves should be used as reservoirs of the species.

This State of Knowledge study has revealed the imbalance in information on *Baillonella toxisperma*. There is much information on timber aspects of the tree – both recent and older – and some indications in recent literature of the important role the species has for communities with a dependence on Non-Wood Forest Products, and the impact logging is having on those communities, as well as in bringing the species to near extinction. Papers written more than fifty years ago show that the seeds were exported to Germany and Britain to obtain the oil (Hédin 1928; Dalziel 1948). But there must be much more information in libraries in Germany, France and Belgium, as well as Spain and Italy, which would add to this body of knowledge.

APPENDIX 1: VERNACULAR NAMES FOR *BAILLONELLA TOXISPERMA*

<i>Local or common name</i>	<i>Place</i>	<i>Source</i>
adjab	Balundu, Duala etc. (West Cameroon)	Dalziel 1948
adzap	Fang (Equatorial Guinea); south Cameroon; Yaoundé, Boulou (south Cameroon); Boulou/Ewondo (Centre) (Cameroon)	Sunderland 1998; Sunderland & Obama 1998; Berti 1982; Nef 1997; Hédin 1928; Schneemann 1994:3
adjap, ayap	Cameroon, Equatorial Guinea	Centre Technique n.d
adza	Gabon	Chudnoff 1984; Centre Technique n.d.
adzap	Yaoundé (Cameroon)	Aubréville 1964:49
African pearwood (timber)		Brown 1977
aghanokpe, aganokwe	Benin (South Nigeria)	Dalziel 1948
bojie	Boki (Nigeria)	Dalziel 1948; Keay 1989
dimpampi	Congo	Chudnoff 1984
djabi	Douala (Cameroon)	Aubréville 1964
djabo	Bakola Pygmies (South) (Cameroon)	Schneemann 1994:3
djap	Bassa (Littoral-Centre) (Cameroon)	Schneemann 1994:3
djave (seeds), moabi (wood)	West Africa	Mabberley 1990
djave, ndjabe, njave (fruit)	Gabon	Dalziel 1948
ebondo	Kota (Congo)	Champluvier 1995
efam	Efik (South Nigeria)	Dalziel 1948
ጠmi-igbó (shea of the forest)	Yoruba (South Nigeria)	Dalziel 1948
gyabo	Bakola (south Cameroon)	Nef 1997
karité	South and East Cameroon	Schneemann 1995
mabè	Baka Pygmies (Est) (Cameroon)	Schneemann 1994:3
makoré	Nigeria	Ahonkai 1988
maniki (fruit)	Cameroon	Engler 1904
mimusops	Gabon	Moss 1994
moabi	Bapunu (Gabon); Baka (Cameroon/Gabon)	Centre Technique 1957; Horta 1997
moabi (wood)	Gabon, Cameroon, Congo, Zaire, Angola	Engler 1904; Fouquet 1984; Laird 1998; Centre Technique n.d.
mwabi	Congo, Zaire, Angola	Centre Technique n.d.; Normand & Paquis 1976
ngiari	Mayouka (Cameroon)	Aubréville 1964
n'jabi	Douala (Cameroon)	Centre Technique 1957
n'jave (tree)	Gabon	Engler 1904
niabi	Gabon	Centre Technique n.d.
njab	Balundu, Duala etc. (West Cameroon)	Dalziel 1948
njabe, njabé	Cameroon	Malleson 1998; Sunderland & Tchouto 1999
njabi	Balundu, Duala etc. (South Cameroon) (Nigeria)	Dalziel 1948; Chudnoff 1984; Schneemann 1994:3
numgu (tree)	Cameroon	Engler 1904
nungu	South Cameroon	Dalziel 1948
nyam	Efik (South Nigeria)	Dalziel 1948 (also Kennedy 1936)
oat	Itung (South Nigeria)	Dalziel 1948
oabé	Gabon	Centre Technique n.d.
ode	Ogoja / Okoja (South Nigeria)	Dalziel 1948; Keay 1989
odjoh	Kozimé (Haut-Nyong) (Cameroon)	Schneemann 1994:3
ofor	Kiaka (Nigeria)	Keay 1989
ofri	Ogoja / Okoja (South Nigeria)	Dalziel 1948; Keay 1989
ojv	Boki (South Nigeria)	Dalziel 1948

<i>Local or common name</i>	<i>Place</i>	<i>Source</i>
oko	Ibo, Ow. etc. (South Nigeria)	Dalziel 1948
oko uku	Igbo (Nigeria)	Keay 1989
orere (tree)	Gabon	Dalziel 1948
oreré (fruit)		Engler 1904
oréré, orèrè	N'Komi, Gabon	Centre Technique 1957; Centre Technique n.d.
osat	Itung (Nigeria)	Keay 1989
osso	Mézimé/Bangantou (Mbang) (Cameroon)	Schneemann 1994:3
oyabi	Mboko (Congo)	Champluvier 1995
shellnut	Nigeria ?	Okafor & Lamb 1992
ube, uku	On (Bonny, South Nigeria)	Dalziel 1948

APPENDIX 2: *BAILLONELLA TOXISPERMA*: LOCATIONS IDENTIFIED FROM HERBARIUM SPECIMEN SHEETS

<u>Herbarium sheet ID</u>	<u>Year of collection</u>	<u>Country</u>	<u>Other location information</u>	<u>Altitude</u>
Dawe, M.T. 252	1921	Angola	Cabinda	0
Annet, E. 530	1918	Cameroon	Edea	0
de Wilde, J.J.F.E. 8373	1975	Cameroon	Zingui, ca. 21km on the rd. from Ebolowa to Kribi (counted from the cross at Ebolawa). Cacao plantations south of the village	580
de Wilde, J.J.F.E. 8475A	1975	Cameroon	N'Koemvone, ca. 14km on road from Ebolowa to Ambam. Cacao plantation around the village. Seedlings of no. 8373.	0
Ejiofor. FHI 15115	1946	Cameroon	Kumba district. On base line near line 10. S. Bakundu Forest Reserve, closed H.F.	0
Nemba, J. <i>et al.</i> 887	1988	Cameroon	SW Prov., Secondary forest & scrub around Baro village. Seedling.	240
Thomas, D.W. <i>et al.</i> 5522	1986	Cameroon	SW Prov. Farms & secondary vegetation at Banyu. Fruit only	400
Thomas, D.W. <i>et al.</i> 7649	1988	Cameroon	SW Prov. Korup National Park, between Ikenge & Esukutang, ca. 6kms W of Ikenge. Seedling	200
Champluvier, D. 5314	1995	Congo	District de Mbomo, Region de la Cuvette. P.N. Odzala. Kekele a env. 45km NW de Mbomo, sur la piste vers Mekambo(a mi-chemin entre Mbomo et Oloba.)	500
Hombert, J. 218	1956	Congo	Ineac-Luki, Lukula territory, Leopoldville province	0
Hombert, J. 293	1956	Congo	Leopoldville. Tshela. Route de Maduda-Kai Mbaku.	0
Hombert, J. 429	1957	Congo	Ineac-Luki, Lukula territory, Leopoldville province	0
Hombert, J.Hombert, J. 431	1957	Congo	Ineac-Luki, Lukula territory, Leopoldville province	0
Matton, 3	1957	Congo	Luki, Lukula, Leopoldville	0
Dechamps, 84	1958	Democratic Republic of Congo	Bena Longo, Mweka territory, Kasai province	535
Briey, C. de, 227	1910	Gabon	Mayombo	0
Gentrey, A. 33231	1981	Gabon	Ogooue-Ivindo, M'Passa Field station near Makokou on Riviere l'Ivindo. Treetlet	480
Klaine, R.P. 1735	1899	Gabon	Libreville	0

Klaine, R.P. 6650 or 717	1897	Gabon	Libreville	0
Le Testu, G. 1441	1901	Gabon	Issala	0
Le Testu., G. 1636	1910	Gabon	Tchibanga	0
Lecomte, H. 66	1895	Gabon	Loango	0
Louis, A.M. <i>et al.</i> 818	1983	Gabon	"Deforestation Eurotrag" ca. 20 km N of Lastoursville	250
Louis, A.M., F.J. Breteler <i>et al.</i> 818	1983	Gabon	Deforestation Eurotrag, ca. 20km N of Lastoursville	250
McPherson, G. 13792	1989	Gabon	Ogooue-Ivindo : Reserve de la Lope, au sud d'Ayem; chantier SOFORGA	200
White, L. 14 (series 2)	1990	Gabon	Ogooue-Ivindo .Reserve de Lope-Okanda. SOFORGA (?)	200
Jones, A.P.D. & C.F. Omichie 18604	1946	Nigeria	E. boundary of Boje enclave. On banks of stream in old H.F.	0
Latilo, M.G. 30935	1952	Nigeria	Boshi-Okwangwo FR, Obudu district, Ogoja province	0
Sherriff, J.W.	1906	Nigeria	Degema	0

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