

# **Guide to Liberian Grasses**

**The Nimba Mountains, Bong and the Coastal Area around Buchanan**



**Pierre Poilecot**

**May 2015**

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This guide book is published jointly by ArcelorMittal Liberia Limited and CIRAD. It is derived from work commissioned by ArcelorMittal as part of the environmental and social impact assessments for its mining operations in the western range mountains of Nimba in Liberia. The detailed consideration of grasses was required to assist the company to understand the role of Gramineae in the biological environment, and to ensure that land restoration works make use of the best available species.

The work leading to this guide was undertaken by URS Scott Wilson, contracted by ArcelorMittal Liberia to produce the overall impact assessments. CIRAD acted as the specialist sub-contractor for the grass study.

The guide was produced by Pierre Poilecot with the assistance of Ouou Ouou Haba. Pierre died shortly after completing the work. He was a man of immense enthusiasm for his work, for grasses, for Africa and for life. He embodied professionalism and academic strength in all that he did. We publish this work in memory of him, and to ensure that his expertise is preserved for future generations and that the grasses of Liberia are understood and used to the betterment of the landscape, and its ecosystems and society.

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## 1. GRASSES AND THEIR STUDY IN LIBERIA

### 1.1 Overview

During October, November and December 2011, botanical surveys were carried out in the former mining sites of Northern Nimba, as well as around Greenhill Quarry in Bong and the Port of Buchanan in Grand Bassa. Mining at Nimba ceased in the 1990s due to the civil war, allowing the vegetation to recolonise the mine areas. The initial forest vegetation which covered the mountains of Northern Nimba was replaced by savannah vegetation. The plateau forests have been eroded by rainfall runoff and have also evolved towards a savannah vegetation. At Buchanan, the original swampy and woody vegetation was eliminated following clearing and spoil disposal to facilitate the port activities.

A total of 139 herbaceous species were found within 75 surveyed plots in the savannahs of the former mining sites at altitude and in the plateau savannahs of Northern Nimba. Twenty-one plots at Buchanan contained 94 herbaceous species. Finally, 31 herbaceous species were listed for two sites in the area of Greenhill Quarry in Bong County.

This recolonising vegetation has strong floristic diversity. The family of Poaceae (grasses) dominates in the herbaceous layer of the various studied sites. The herbaceous vegetation which colonised the mining sites of Northern Nimba (Old Mine, Blue Lake and Mount Tokadeh) and certain parts of the North Nimba plateaux, represents an intermediate phase before the return of forest vegetation. Grasses, such as *Anadelphia leptocoma*, *Loudetia phragmitoides*, *Melinis minutiflora*, *Hyparrhenia diplandra* var. *diplandra* and *Sporobolus dinklagei* are perennial species which ensure good ground cover. Reforestation of mine sites by soil conservation techniques will be possible once slopes have been stabilised against deeper-seated erosion and instability using civil engineering measures. Intensification of the herbaceous layer, prevention of bushfires (including slash and burn) and the introduction of woody species would facilitate a reasonably rapid return of forest cover. However, wherever there is pressure on the land for its utilisation other than for forest, for example for use as agriculture in the mine sites, construction material and railway ballast at Greenhill Quarry and port-related activities at Buchanan, then this process will be slowed or reversed.

### 1.2 Introduction

The mission was carried out in the framework of the Western Range DSO (Direct Shipping Ore) Iron Ore Project Phase 1 which will be implemented by the company ArcelorMittal. This project concerns the resumption of the mining activities in Northern Nimba of Liberia, specifically in the Yekepa region. This mission also took into account other sites such as Greenhill Quarry (quarry for ballast) and Buchanan (harbour activities) that are directly connected to the mining activities.

The “hotspot” of the Guinean forests of Western Africa, which extends from Guinea to Cameroon, is divided into two different blocks: the Block of High Guinea, which includes Liberia, and the Block of Nigeria-Cameroon. These two entities are separated by Benin and correspond to two important centres of endemism, that of High Guinea and that of the border regions of Cameroon and Nigeria. The Guinean forests include various vegetation types from the tropical wet dense forests up to the dry semi-deciduous forests. Only Liberia is completely situated in the rainforest area.

The flora richness of the Guinean Block is estimated at approximately 12,000 botanical species among which 6,400 are endemic. High Guinea is rich with 2,800 species among which 500 are endemic. Fauna figures are also spectacular and about 63 of the 320 known species of mammals are endemic to the Guinean Block.

Among the fauna, 793 species of birds include 75 endemic species and 6 genera. Although the data for reptiles and amphibians are less precise, the number of reptile species is estimated at 206 of which 52 are endemic. The number of amphibian species is estimated at 246 of which 83 are endemic. The ichthyofauna amounts to not less than 512 species amongst which approximately 35% are endemic (Mittermeier *et al.*, 2004).

The “hotspot” of the Guinean forests of Western Africa constitutes the forest ecosystem that is among the most threatened in the world. The deforestation due to forestry development, slash-and-burn cultivation, poaching, and traditional and industrial mining, results in the fragmentation of habitats and the disappearance of animal and vegetal species. Furthermore, the political instability of this vast region contributes to the destruction of the natural habitats.

The Nimba range is one of the most important areas for mammal conservation, and probably the most important in West Africa in terms of species richness and globally threatened species (Brooks *et al.*, 2001; Schipper *et al.*, 2008).

The scientific interest of Nimba, due to its geomorphological originality and the ecosystems which it shelters, drove the French researchers to launch the first botanical studies at the beginning of the 20th century, starting with botanist A. Chevalier (1909) and followed by the botanists A. Aubreville, R. Heim and R. Portere (1930s). It was only in 1942 that a true scientific exploration took place with a multidisciplinary team composed of J.-C. Lecler (Geographer), R. Schnell (Botanist), and M. Lamotte (Zoologist and Geologist). Scientific expeditions in the Nimba increased in number until 1957, mainly on the current Guinean side. The major results of studies carried out were published in various volumes of the “Mémoires de l’IFAN” of the French Institute of Black Africa (IFAN) between 1952 and 1953. Synthesised publications, for the whole massif, were produced by Curry-Lindahl and Harroy (1972) and by Lamotte in 1998.

The Mount Nimba range, for the three countries, shelters a very rich biodiversity. Approximately 700 new species were described by the scientists of IFAN between 1952 and 2003.

Recent biological inventories carried out in Liberia added 44 species of small mammals, 52 species of large mammals (among which eight are primates), 242 species of birds, 33 species of fishes, 43 species of amphibians, 824 species of insects (among which 742 are lepidoptera), 76 species of molluscs and 10 species of shellfishes (Afrique Nature International, 2009). Numerous species present a major conservation interest while some others are considered as threatened.

The studies carried out by botanists Theodor Vogel (1841) and Philipp Schoenlein (1855), along with numerous expeditions and the construction of herbariums have contributed significantly to the knowledge of the flora of Liberia. The botanical investigations carried out by Schnell (1952) and Adam (1971, 1975, 1981 and 1983) contributed to the description of numerous new species.

Many of these studies were mainly carried out in the Ivory Coast and Guinean parts of Mount Nimba, although Adam also conducted detailed investigations of the vegetation of the massif throughout the three countries. The recent works of Hawthorne and Jongkind led to an important book on the ligneous plants of this African sub-region.

The iron ore mining activities in the Liberian Nimba, started in the 1960s by the Company LAMCO (Liberian American Swedish Minerals Company) led to a massive influx of population in a region that had been sparsely populated. The extraction of the ore led to a total upheaval of the region on a socioeconomic level, as well as severe damage to the higher altitude forest vegetation and the pollution of soil and rivers. To avoid the complete destruction of the vegetation, the IUCN implemented, with the financial support of the LAMCO, a biological study of the considered region and accordingly the “Nimba Research Laboratory” was created in Grassfield. Scientific works were



carried out over several years, in particular by Xavier Coe on the reptiles and amphibians, Adames and Adam on the flora.

The scientific interest in Mount Nimba led the scientific community to mobilise for its preservation, and an area of 19,500 hectares was classified as forest in 1943, among which were 14,500 hectares on the Guinean side and 5,000 hectares on the Ivory Coast side. The Ivory Coast part was called “Strict Nature Reserve of the Mount Nimba” and was listed as a UNESCO World Heritage Site in 1983. In 1980 the Guinean side was set up as “Reserve of the Biosphere” and then became a UNESCO World Heritage Site in 1981 (with the exception of an area reserved for mining). But in 1992, because of the pressure from local populations and refugees, and by the request of the government for a license for ore exploitation, the site was defined as “Site of the World Heritage in Danger.”

The East Nimba Nature Reserve (ENNR) was created in Liberia in 2003. The Forest Development Authority (FDA), created in 1976, is working on the establishment of an agreement that allows the creation of a cross-border reserve between three countries. The East Nimba is recognised as a Key Biodiversity Area (KBA) as well as the most important Alliance for Zero Extinction (AZE) site in Africa. The Nimba Mountains were also named as an Important Bird Area (IBA) by BirdLife International in 2001.

In 2001 and 2002, a Tri-national Committee on Mount Nimba conducted a series of workshops in Man and N’Zérékoré respectively and pledged to “support natural resources conservation actions through coordination and harmonisation of their interventions in their Nimba Mountains conservation programs and through mobilisation of supplementary financing from donors.” The FDA is actively promoting the transboundary reserve and is working to prepare a final agreement to be signed by the three countries including Guinea, Ivory Coast and Liberia.

While many studies have been carried out on the forest vegetation of the Nimba region in Liberia, it is not the same with the savannah vegetation. In Liberia, there are no montane “meadows” such as those covering hillsides and summits of the north part of the Nimba range in Guinea and Ivory Coast. The savannahs of the Liberian Nimba that occur on surfaces much lower than those of the adjacent countries, are situated on the piedmont (plateau) at an altitude of 500-600 m. Adam (1971) described the flora of the savannahs of Nimba by specifying that more investigations would be necessary in the rainy season to be able to list the various species which compose the herbaceous layer. The savannah vegetation types of the Liberian Nimba thus remain largely unknown.

If the impact of the mining activities of the LAMCO/LIMINCO was harmful to the forest vegetation of the region, not enough information is available on the re-colonisation of the vegetation of the former mining sites. The destruction of the higher altitude forest cover, the levelling of rock massifs, the removal of the top soil and the disturbance caused by the mining activities also led to the degradation of the forests of the piedmont. These forest areas in the piedmont were replaced locally by vast areas of savannahs.

In this context, and because of the resumption of mining activities by ArcelorMittal, a study was undertaken to identify and evaluate these grassy formations within the mining concession in Northern Nimba, and particularly in the area around Yekepa. This mission, undertaken in two phases (20/10-06/11/11 and 25/11-17/12/11) had the following main objectives:

- To survey of the main herbaceous vegetation types, particularly grass species, which covered the former mining sites of Northern Nimba
- To determine the likely impacts of the mine and infrastructure proposals on the savannah vegetation types
- To identify appropriate mitigation measures for the mining impacts and produce practical management prescriptions to implement them.

### 1.3 Savannahs

There are no montane savannahs ("meadows") in the Liberian Nimba, as in Guinea and in Ivory Coast, but only piedmont savannahs (on foothills or low-level plains). They are located at the foot of the western hillside of Nimba with a savannah on a cuirasse at the foot of the eastern hillside, at an altitude of 640 m. A set of piedmont savannahs breaks the forest landscape in the north from Yekepa to Grassfield, to reach the foot of Mount Bele.

Certain savannahs can be considered as "Idaho-climatic" when they rest on cuirasses associated with ferruginous conglomerates. These grassy formations are isolated within the dense forest, and both formations are very sharply differentiated. The Grassfield savannah, the savannah of the eastern hillside and two savannahs situated on the forest track between Grassfield and Mount Bele belong to this savannah type. The floristic composition of the grass layer of these savannahs is more or less heterogeneous according to the density of the substratum but also according to anthropological pressure. Species such as *Loudetia simplex*, *Rhytachne rottboellioides*, *Monocymbium deightonii* and *Schizachyrium rupestre* dominate the grass layer. The cuirasse being temporarily and locally flooded during the rainy season, the vegetation contains locally numerous Cyperaceae.

Other savannahs, on more or less gravelly soils, are of more recent origin and defined as "secondary". They are not included in the dense forest but are often bordering secondary forest areas. The Yekepa-Thuo savannah, at the border with Guinea, the Yekepa savannah occupying the former airstrip, the savannah situated North of Grassfield, and the first savannah on the road going to Grassfield to the Mount Bele belong to this type.

The grass layer consists of large Andropogoneae among *Hyparrhenia diplandra*, *H. subplumosa*, *Anadelphia leptocoma* and *Andropogon macrophyllus*.

All these savannahs are generally subjected to the impact of the annual bushfires which limit, for the type, the recolonisation of the forest.

To these savannahs are added other grassy formations, of more recent origin, which cover the terraces of former mining sites or which succeeded the local destruction of the forests in the piedmont.

## 2. COMMON GRASSES OF LIBERIA

### *Anadelphia afzeliana* (Rendle) Stapf

“Thatch grass”

#### Description

Tufted *perennial* grass with erect culms, 100-200 high.

*Leaf-blades* 10-25 cm long, 2-4 mm wide. Ligule a ciliolate membrane.

*Inflorescence* compound, paniculate, lax, 25-45 cm long, composed of terminal and axillary racemes, 2 cm long, subtended and enclosed by linear spatheoles, 2-3.5 cm long, scarious. Raceme single, 1.5-2 cm long, bearing 2 fertile spikelets on each.

*Spikelets* in pairs, packing lax: 1 fertile spikelet, sessile and 1 pedicelled spikelet, sterile.

- *Fertile spikelet*, often brown, comprising 1 basal sterile floret and 1 fertile floret. Spikelet lanceolate, subterete, 5-8 mm long, with a linear and pilose callus 1.5-2.5 mm long, with a pungent base. Superior glume with an awn 10-15 mm long. Fertile floret bearing an awn, geniculate, 25-30 mm long

- *Pedicelled spikelet* sterile, well-developed, linear to lanceolate, 6-9 mm long, with coriaceous glumes and an oblong callus, 2-toothed.

#### Distribution

West Africa, from Senegal to Nigeria.

#### Ecology

In savannah, often on marshy soils: from sea-level to 1500 m.

#### Uses

*Anadelphia afzeliana* is a poor grazing grass but grazed when it is young. It is used as a thatching grass.

*Anadelphia afzeliana* could be used in soil conservation to consolidate the terraces in the former mining sites, using seeds or rooted stem cuttings.

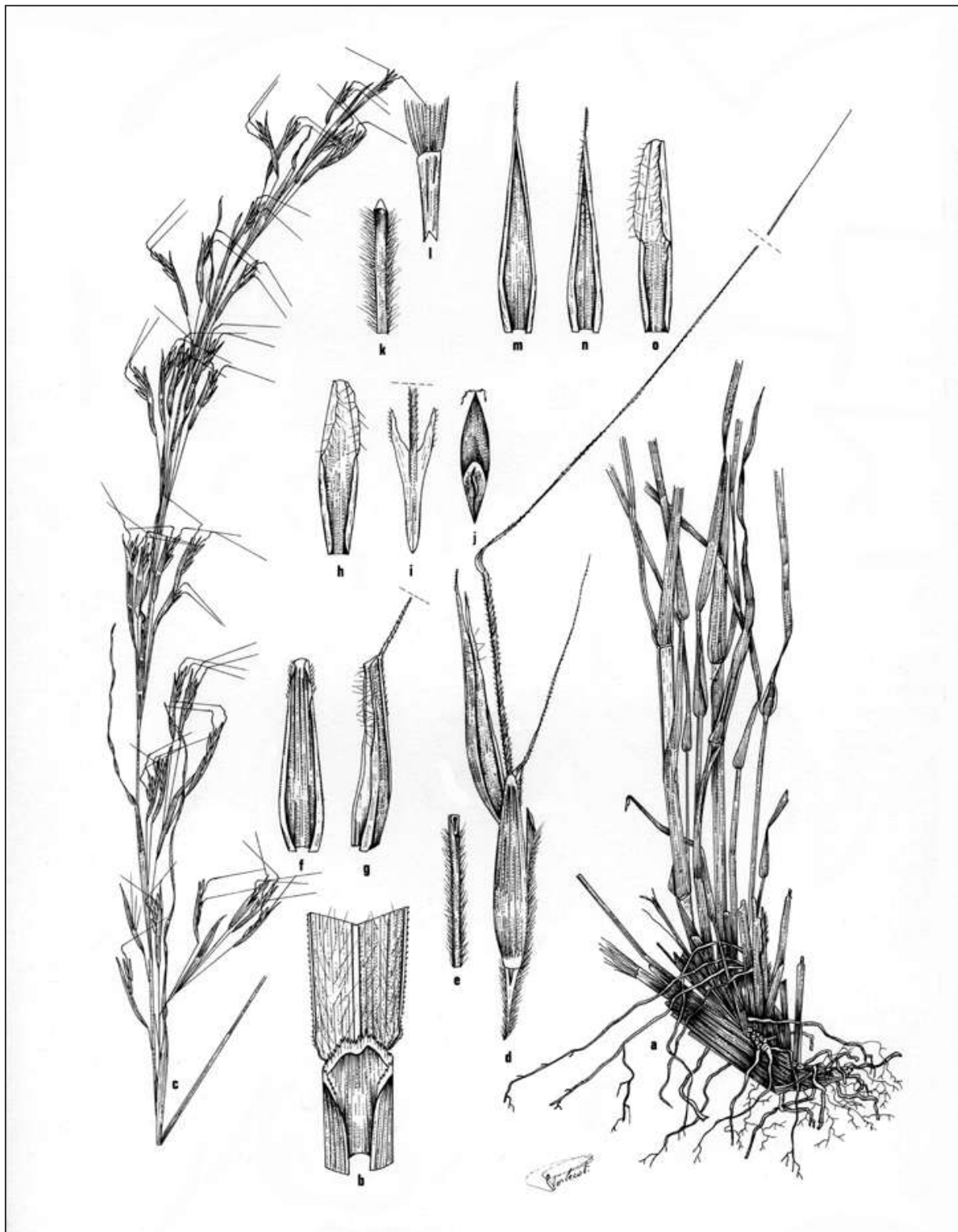
#### Other notes

*Anadelphia afzeliana* is uncommon in northern Nimba of Liberia but common in the Guinean part of the Nimba range, where it occurs especially on shallow soils.

In the Northern Province of Sierra Leone it is described as the best thatching grass and in places in the Region it is cultivated for this purpose.



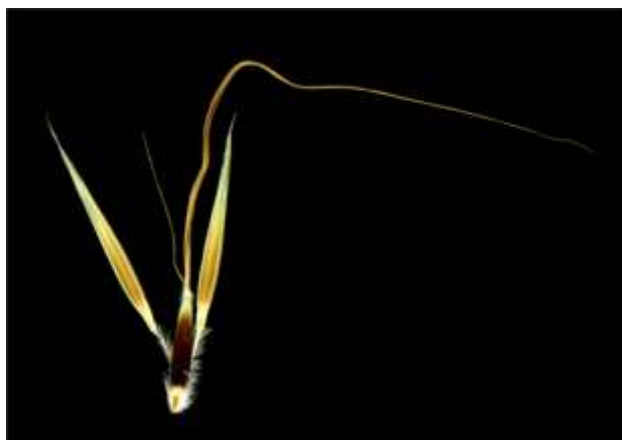
*Anadelphia afzeliana* (Rendle) Stapf



*Anadelphia afzeliana* (Rendle) Stapf

a, base of the plant (x 0.7); b, ligule; c, inflorescence (x 0.7); d, pair of spikelets and internode (x 7); e, internode (x 7); sessile spikelet (x 7): f and g; inferior and superior glumes; h, lemma of inferior floret; i, lemma of superior floret; j, caryopsis; pedicelled spikelet (x 7): k, pedicel; l, bidentate callus; m and n, inferior and superior glumes; o, lemma of lower floret.

*Anadelphia afzeliana* (Rendle) Stapf



## *Anadelphia leptocoma* (Trin.) Pilg.

“Thatch grass”

### Description

Tufted **perennial** grass, caespitose, with erect culms 100-150 cm high. The whole plant presents a red aspect.

**Leaf-blades** 15-30 cm long, 2-6 mm wide. Ligule a ciliolate membrane.

**Inflorescence** compound, paniculate, lax, 30-60 cm long, composed of terminal and axillary racemes, subtended by linear spatheoles, 1.5-2 cm long. Racemes single, 0.8-1.2 cm long, bearing 3–5 fertile spikelets on each.

**Spikelets** packing lax, in pairs: 1 fertile spikelet, sessile and 1 pedicelled spikelet, sterile.

- *Fertile spikelet* comprising 1 basal sterile floret and 1 fertile floret. Spikelet lanceolate, subterete, 4-5 mm long, with an obtuse callus base, pilose, attached obliquely. Superior glume with an awn 3-4 mm long. Fertile floret bearing an awn, geniculate, 0.7-1.7 mm long.

- *Pedicelled spikelet* sterile, represented by barren pedicels or well-developed, linear to lanceolate, as long as fertile, separately deciduous, with a cuneate callus, obtuse.

### Distribution

West tropical Africa.

### Ecology

*Anadelphia leptocoma* is a characteristic grass of low-lying savannahs, less often on shallow soils: from sea-level to 1500 m

### Uses

*Anadelphia leptocoma* is used as a thatching grass.

It can be used in soil conservation to consolidate the soil of the terraces in the former mining sites, using seeds or rooted stem cuttings.



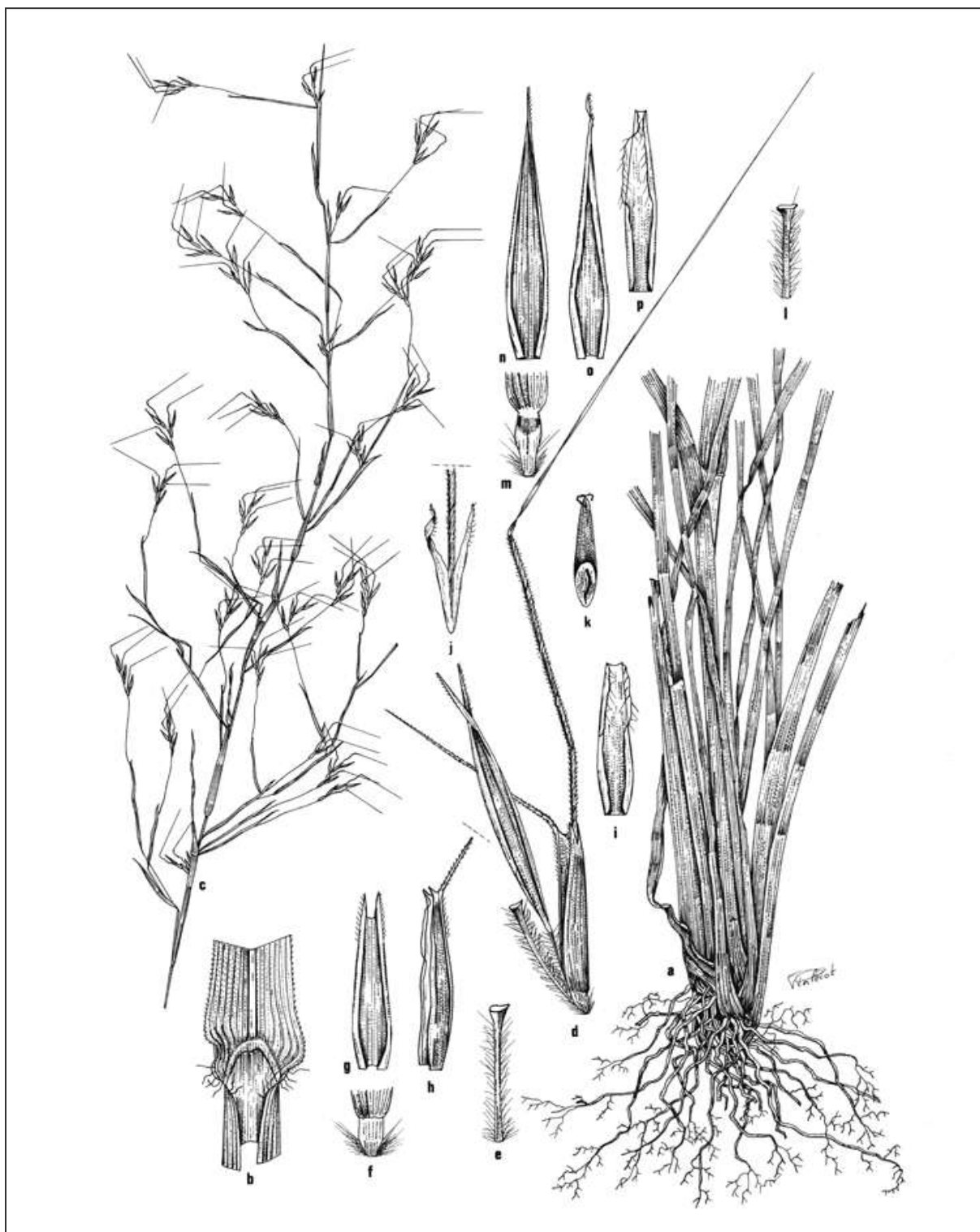
### Other notes

*Anadelphia leptocoma* is a dominant grass in the savannahs of northern Nimba. It is recognised easily by its red colour and it often dominates savannahs in almost pure populations.

*Anadelphia leptocoma* is usually an erect and tall grass in low lying savannahs. However it can become smaller on shallow soils and then stunted with narrow leaves. This second form, quite common, has been observed on the sides of the mountains in the Blue Lake site.

This species is widely used for thatching but of less good quality than *Anadelphia afzeliana*.

*Anadelphia leptocoma* (Trin.) Pilg.



*Anadelphia leptocoma* (Trin.) Pilg.

a, base of the plant (x 0.7); b, ligule; c, inflorescence (x 0.7); d, pair of spikelets and internode (x 7); e, internode (x 7); sessile spikelet (x 7); f, callus (x 8.5); g and h, inferior and superior glumes; i, lemma of lower floret; j, lemma of superior floret; k, caryopsis; pedicelled spikelet (x 7); l, pedicel; m, rounded callus (x 8.4); n and o, inferior and superior glumes; p, lemma of lower floret.



*Anadelphia leptocoma* (Trin.) Pilg.



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***Anadelphia lomaense* (A. Camus) Jacq.-Fél.****Description**

**Perennial**, caespitose, with erect culms 15-30 cm high. Basal leaf-sheaths flabellate and keeled.

**Leaf-blades** flat, or conduplicate, 4-12 cm long and 1.5-3.5 mm wide. Leaf-blade apex abruptly acute. Ligule an eciliate membrane, sharp.

**Inflorescence** compound, scanty, composed of terminal and axillary racemes, subtended by a linear spatheole. Racemes single, 2-2.5 cm long, bearing 7-8 fertile spikelets. Rhachis internodes and pedicels linear glabrous with a cupuliform tip.

**Spikelets** appressed, in pairs, 1 fertile spikelet, sessile and 1 pedicelled spikelet, sterile.

- **Fertile spikelet** comprising 1 basal sterile floret and 1 fertile floret. Spikelet lanceolate, dorsally compressed, 3-3.5 mm long, with an oblong callus 0.5 mm long, pubescent. Superior glume with an awn 2-3 mm long. Fertile floret bearing an awn 11-12 mm long.

- **Pedicelled spikelet** well-developed, lanceolate, dorsally compressed, 4-5 mm long, longer than fertile.

**Ecology**

*Anadelphia lomaense* is a characteristic grass of shallow and swampy soils: from 500 m to 1500 m

**Distribution**

West tropical Africa.

**Uses**

*Anadelphia lomaense* is a good grazing grass.

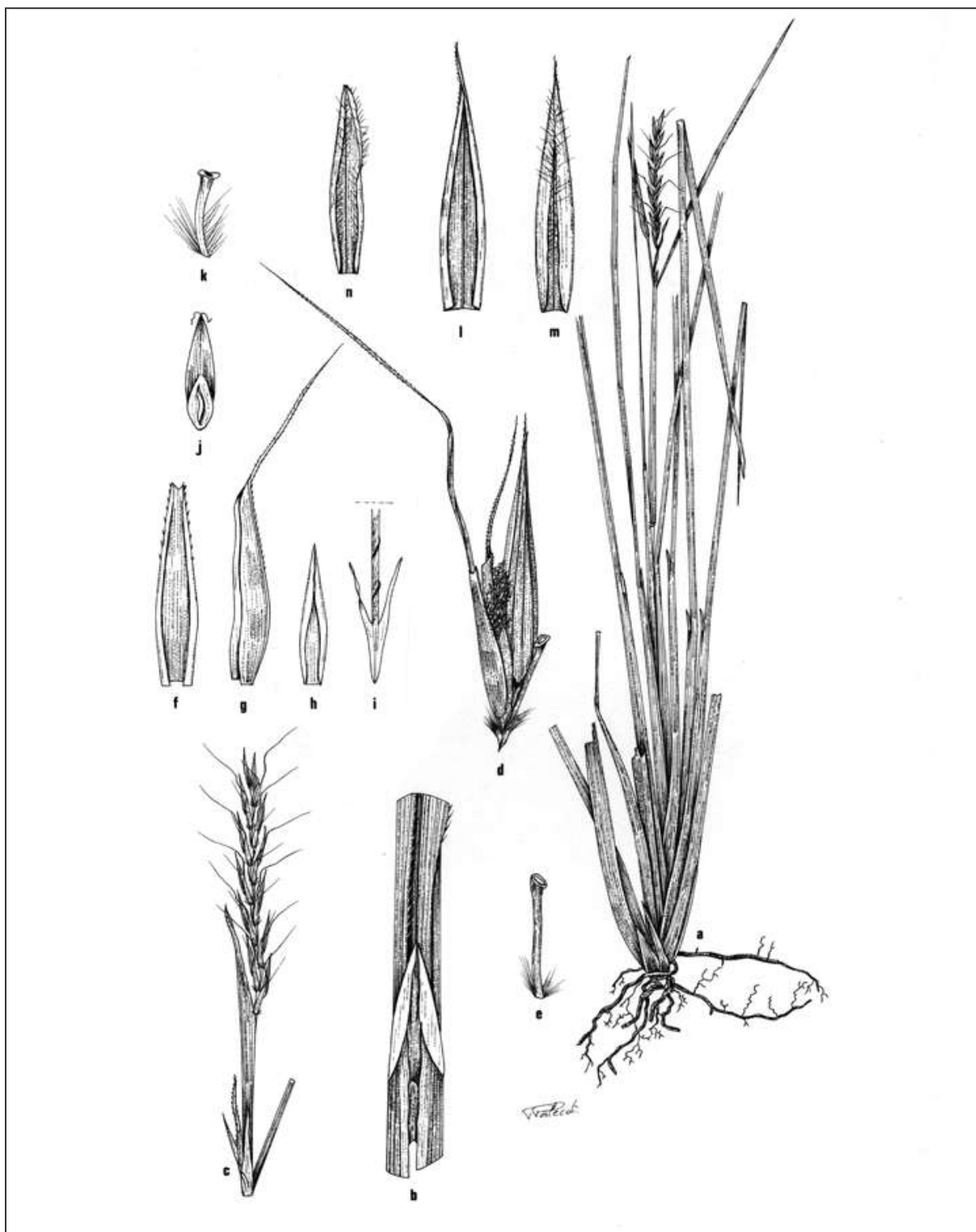
**Other notes**

*Anadelphia lomaense* is a relatively rare grass, the distribution of which is limited in western tropical Africa (Sierra Leone, Liberia, Guinea and Ivory Coast). It is a grass species of conservation interest. This species is very different from the other *Anadelphia* by its smallest size, its basal flabellate leaf-sheaths and its less supplied inflorescence, scanty panicle with red spatheoles.

It is present in the savannahs at altitude of the Guinean Nimba, in small swampy depressions. In the northern Nimba, it was collected at low altitude (500 m) in a savannah dominated by *Hyparrhenia diplandra* var. *diplandra* and *Anadelphia leptocoma*, on a lateritic carapace in the South of the Grassfield savannah.



*Anadelphia lomaense* (A. Camus) Jacq.-Fél.



*Anadelphia lomaense* (A. Camus) Jacq.-Fél.

a, base of the plant (x 0.7); b, ligule; c, inflorescence (x 1.4); d, pair of spikelets and internode (x 7); e, internode (x 7); sessile spikelet (x 9.8): f and g, inferior and superior glumes; h, lemma of lower floret; i, lemma of superior floret; j, caryopsis; pedicelled spikelet (x 7): k, pedicel; l and m, inferior and superior glumes; n, lemma of lower floret.

*Anadelphia lomaense* (A. Camus) Jacq.-Fél.



## *Andropogon gayanus* Kunth

“Blue grass, Gamba grass, Tambuki grass”

### Description

Robust and tall *perennial* tufted grass, with culms 150-250 cm high.

**Leaf-blades** variable, up to 60 cm long, 4-20 mm wide: base tapering to the midrib, with a prominent white midrib, with or without a false petiole. Ligule an eciliate membrane.

**Inflorescence** a false panicle, compound, large, lax, composed of terminal and axillary paired racemes, 4-9 cm long, subtended by lanceolate spatheoles, 6-8 cm long, herbaceous.

**Spikelets** appressed, in pairs: 1 fertile spikelet, sessile and 1 pedicelled spikelet, sterile.

- *Fertile spikelet* comprising 1 basal sterile floret and 1 fertile floret. Spikelet oblong, dorsally compressed, 5-8 mm long including a shortly oblong callus  $\pm$  1 mm, pilose. Fertile floret with an awn 10-30 mm long.

- *Pedicelled spikelet* well-developed, male, elliptic, dorsally compressed, 5-8 mm long bearing an awn 1-10 mm long.

Remark: Four varieties were defined according to the pubescence of the racemes.

### Distribution

Tropical and Southern Africa; introduced in many parts of tropical Asia, Australia and South America.

### Ecology

Deciduous woodland, wooded grassland on sandy or clayey soils. *Andropogon gayanus* is frequent in fallow fields and along roadsides: from sea level to 1700 m.

This grass was not found in savannahs covering the terraces of the former mining sites and it is better represented in the foothills.

### Uses

*Andropogon gayanus* is a good grazing grass that offers palatable grazing up to the flowering stage, after which it becomes hard. It is used as cultivated pasture and has a good production. The repeated bushfires are fatal in this species, which sees itself then replaced by others species of lesser value. It can remain green for a long time in dry season. It is one of the most productive species in western Africa.

Culms are used for thatching, fencing (palisades and enclosures), weaving (mats) and fashioned together into beehives for taking swarms.

*Andropogon gayanus* is used to consolidate river banks, embankments and dams. It could be used in soil conservation, using seeds or rooted stem cuttings, to consolidate soils.

In traditional pharmacopoeia, the plant is used as a remedy against lithiasis. An infusion of the grass after toasting is given as an aid to digestion, especially for children. Children use the culm as a toy, heating it over a fire, then breaking it across a stone when it bursts with the crack of gun-shot.

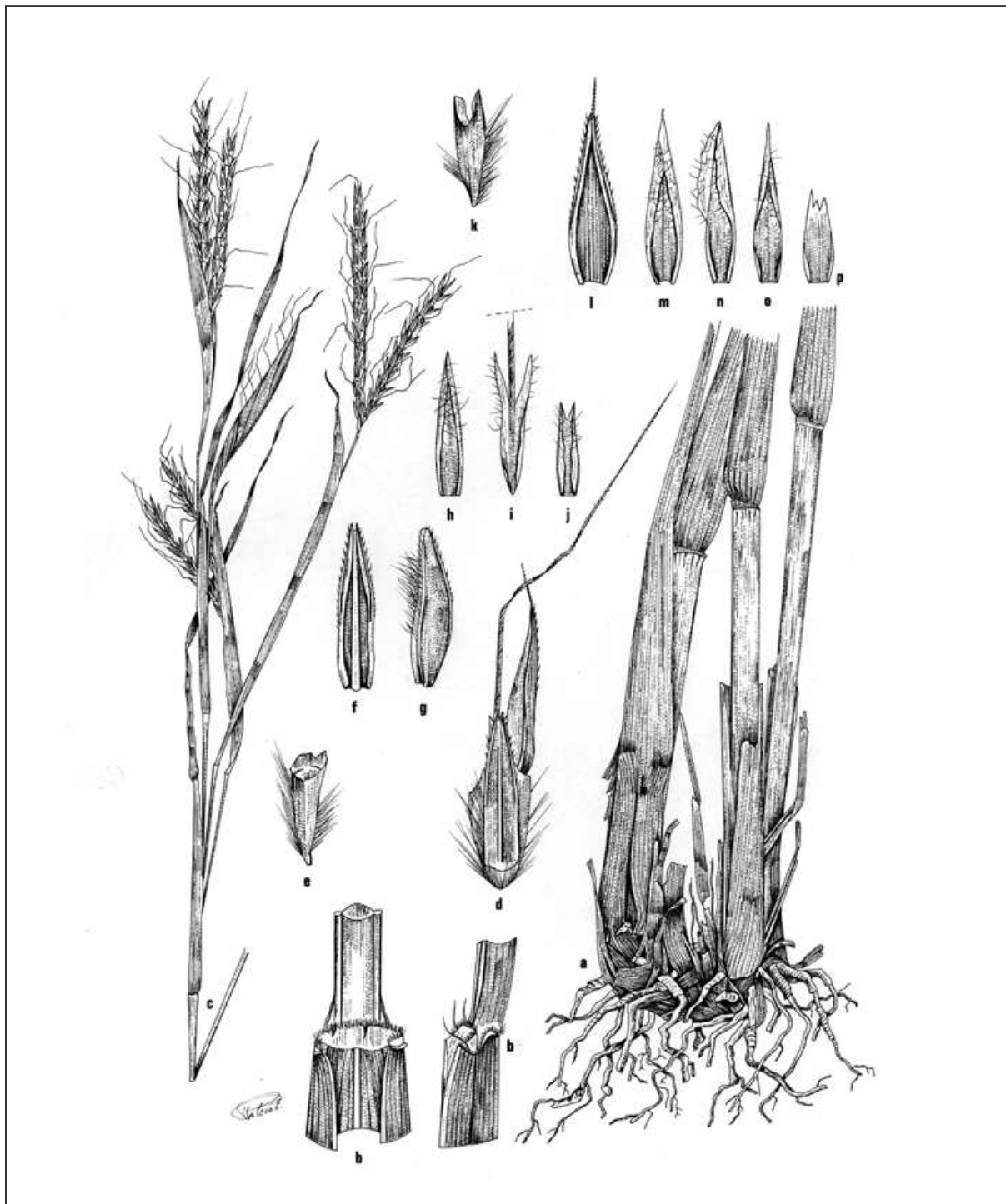
In Nigeria, Yoruba invoke the spirit of the grass dancing as a cure against bleeding eyes.

### Other notes

*Andropogon gayanus* is distinguished by erect habit to 250 cm or more, paired racemes, exert from the spatheoles.

It is usually taller than the surrounding other grasses, with a blue-green colour due to a thin layer of white wax over the entire plant. The summit of leaf-sheath often presents a brown spot. The base of the leaf blade is often very narrow and gives the appearance of a leaf stalk. The leaf blade has a prominent white midrib.

*Andropogon gayanus* Kunth



*Andropogon gayanus* Kunth

a, base of the plant (x 0.7); b, ligule; c, part of inflorescence (x 0.7); d, pair of spikelets and internode (x 5.6); e, internode (x 7); sessile spikelet (x 5.6); f and g, inferior and superior glumes; h, lemma of lower floret; i, lemma of superior floret; j, palea of superior floret; pedicelled spikelet (x 5.6); k, pedicel; l and m, inferior and superior glumes; n et o, lemmas of inferior and superior florets; p, palea of superior floret.

*Andropogon gayanus* Kunth





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***Andropogon macrophyllus* Stapf****Description**

Tall **perennial**, robust, caespitose, with erect culms, 200-350 cm high, 6-12 mm in diameter. Leaf-sheaths outer margin hairy.

**Leaf-blades** firm, coarse, 40-75 cm long, 20-40 mm wide, attenuate at apex, base tapering to the midrib at the base. Ligule a ciliolate membrane, 2-4 mm long.

**Inflorescence** a false panicle, compound, lax, 60-120 cm long, composed of terminal and axillary paired racemes subtended by lanceolate spatheoles, 6-10 cm long. Racemes 4-7 cm long;

**Spikelets** appressed: 1 fertile spikelet, sessile and 1 pedicelled spikelet, sterile.

- **Fertile spikelet** comprising 1 basal sterile floret and 1 fertile floret. Spikelet oblong, dorsally compressed, 5-6 mm, with an obtuse and pilose callus. Fertile floret with an awn 9-16 mm long, geniculate, with twisted and glabrous column.

- **Pedicelled spikelet** well-developed, male, oblong, dorsally compressed, 4-5 mm long, shorter than fertile, mucronate.

**Distribution**

West and west-central tropical Africa.

**Ecology**

*Andropogon macrophyllus* needs rich soils and is common on the forestry edge bordering savannahs. It also occurs in fallows within the forestry Guinean zone: from sea-level to 1300 m.

**Uses**

*Andropogon macrophyllus* is a good grazing grass, with a high leaf production and palatability. It can endure heavy grazing.

It is used as a thatching and weaving (Fences, mats) grass.

This robust grass could be used in soil conservation to consolidate soils and river banks, using seeds or rooted stem cuttings.

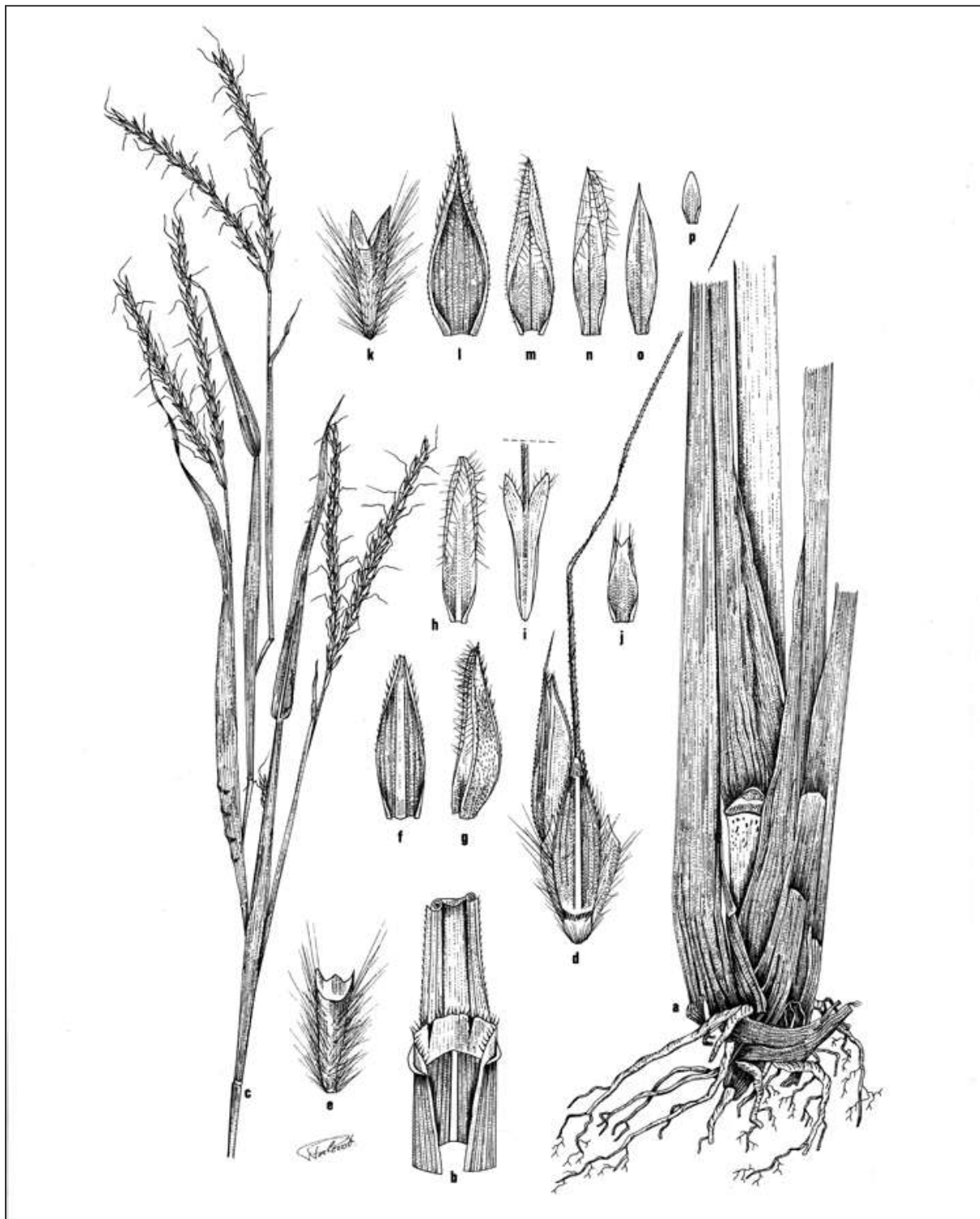
**Other notes**

*Andropogon macrophyllus* is one of the tallest grass of the region as well as *Pennisetum purpureum*. The habit is similar to that of *Andropogon gayanus* but *Andropogon macrophyllus* is much bigger with larger leaf-blades.

In northern Liberia, *Andropogon macrophyllus* can be considered as a pioneer of the forest edge bordering savannahs and riverine forests.



*Andropogon macrophyllus* Stapf



*Andropogon macrophyllus* Stapf

a, base of the plant (x 0.7); b, ligule; c, part of inflorescence (x 0.7); d, pair of spikelets and internode (x 4.2); e, internode (x 7); sessile spikelet (x 4.2); f and g, inferior and superior glumes; h, lemma of lower floret; i, lemma of superior floret; j, palea of superior floret; pedicelled spikelet (x 4.2); k, pedicel; l and m, inferior and superior glumes; n and o, lemmas of inferior and superior florets; p, palea of superior floret

*Andropogon macrophyllus* Stapf



## *Axonopus compressus* (Sw.) P. Beauv.

“American carpet grass, Blanket grass, Broadleaf carpet grass, Lawn grass, Louisiana grass”

### Description

Shallow-rooted stoloniferous and shortly rhizomatous **perennial**, mat forming, with decumbent culms 15-60 cm long, pubescent at nodes. Basal sheaths flabellate (compressed) and keeled. The plant tends to become red when becoming old and dry.

**Leaf-blades** linear or lanceolate, flat or conduplicate, 3-20 cm long, 3-12 mm wide, obtuse or abruptly acute at apex. Ligule a ciliate membrane.

**Inflorescence** composed of 2-5 spikelike racemes, pairs or sub-digitately arranged, slender, 3-10 cm long. Spikelet packing, 2-rowed.

**Spikelets** fertile, appressed, solitary, sessile, comprising 1 basal sterile floret and 1 fertile floret. Spikelets lanceolate, dorsally compressed, obtuse, 2-2.5 mm long. Fertile floret obovate, 1.5-2 mm long, indurate.

### Ecology

*Axonopus compressus* is a small grass species adapted to well to moderately drained sandy or sandy-loam soils, but also to light clays and peats. It is a characteristic species of sub-humid and humid woodland and savannah, flourishing in moist soils: from sea-level to 1300 m.

In northern Nimba, *Axonopus compressus* is a common grass in savannahs covering the terraces of the former mining sites. It is frequent, even plentiful, in small swampy depressions.

### Distribution

Native to North and South America and widely naturalised in the humid tropics and subtropics, especially west Africa and South Africa – India – Philippines – Indonesia – Australia – Pacific Islands.

### Uses

*Axonopus compressus* is used as a permanent pasture, ground cover and turf in moist, low fertility soils, particularly in shaded situations.

The plant is commonly used as a lawn grass. It spreads quickly vegetatively under favourable conditions but more slowly by seed, since it is a less prolific seed producer. It can be used in soil conservation by dibbing in stolons sets to consolidate soils. It is valuable for roadside verges and banks to curb erosion.

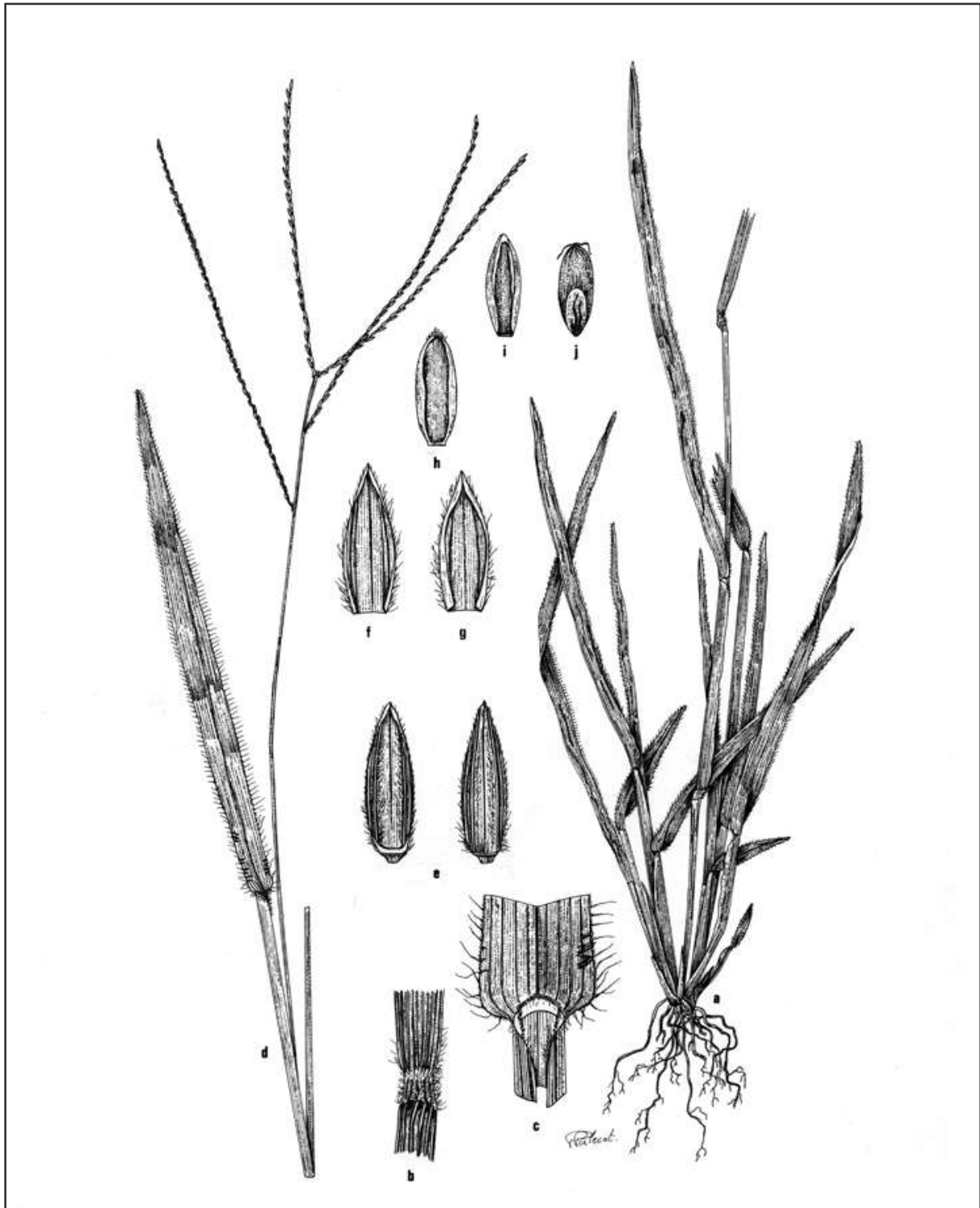
In the traditional pharmacopoeia, a decoction of the whole plant is used against the Guinean worm.

### Other notes

*Axonopus compressus* is a small-sized grass which is recognised easily by its basal flabellate leaf-sheaths, bearded nodes, short broad and obtuse leaf-blades with tubercular hairs and slender racemes. Culms are flattened, with a small groove on a side.

Due to its stoloniferous root system, *Axonopus compressus* is a gregarious grass forming often dense when mats. The plant becomes red when drying.

*Axonopus compressus* (Sw.) P. Beauv.



*Axonopus compressus* (Sw.) P. Beauv.

a, base of the plant (x 0.7); b, node (x 3.5); c, ligule; d, inflorescence (x 0.7); e, spikelet (dorsal and ventral sides, x 8.4); f, superior glumes; g, lemma of lower floret; h, superior floret; i, palea of superior floret; j, caryopsis.

*Axonopus compressus* (Sw.) P. Beauv.





***Brachiaria brizantha* (A. Rich.) Stapf**

“Bread grass, Common signal grass, Ceylon sheep grass, Large seed millet grass, Palisade grass”

**Description**

Tough and tufted *perennial*, caespitose, with erect or geniculately ascending culms, 30–200 cm high.

**Leaf-blades** linear or lanceolate, 10–100 cm long, 3–20 mm wide, glabrous or hairy. Ligule a fringe of hairs.

**Inflorescence** composed of (1–)2–16 racemes, 4–20 cm long, borne along a central axis 3–20 cm long. Rachis ciliate on margins. Spikelet packing, regular, 1-rowed.

**Spikelets** fertile, solitary, sessile, comprising 1 basal sterile floret and 1 fertile floret. Spikelets elliptic, slightly dorsally compressed, subacute or acute, 4–6 mm long, falling entire, supported by a short basal stalk. Inferior glume separated from the superior by a short internode.

**Distribution**

Tropical and Southern Africa, introduced elsewhere in various tropical countries.

**Ecology**

*Brachiaria brizantha* occurs in savannah woodland and grassland, especially on sandy soils. It is quite common on open grassy slopes and in woodlands clearings: from sea-level to 2300 m.

This grass is usually larger than the surrounding other grasses but is seldom dominant in the savannah: from sea-level to 2400 m.

**Uses**

*Brachiaria brizantha* is an average grazing grass, often with a high leaf production, but with hard leaves. It is used as cultivated pasture in many tropical countries and can endure heavy grazing. *Brachiaria brizantha* is very productive, drought resistant, with ability to spread and suppress weeds with ability to grow in shade. It is valuable species for permanent pasture in the Guinean zone and it makes good hay.

It can cause severe photosensitisation in sheep, goats and young cattle.

The seeds can be used for grain.

This species can be used as a lawn grass and in soil conservation using rooted stem cuttings to consolidate soils in a transitory phase of soil conservation looking forward to reforestation.

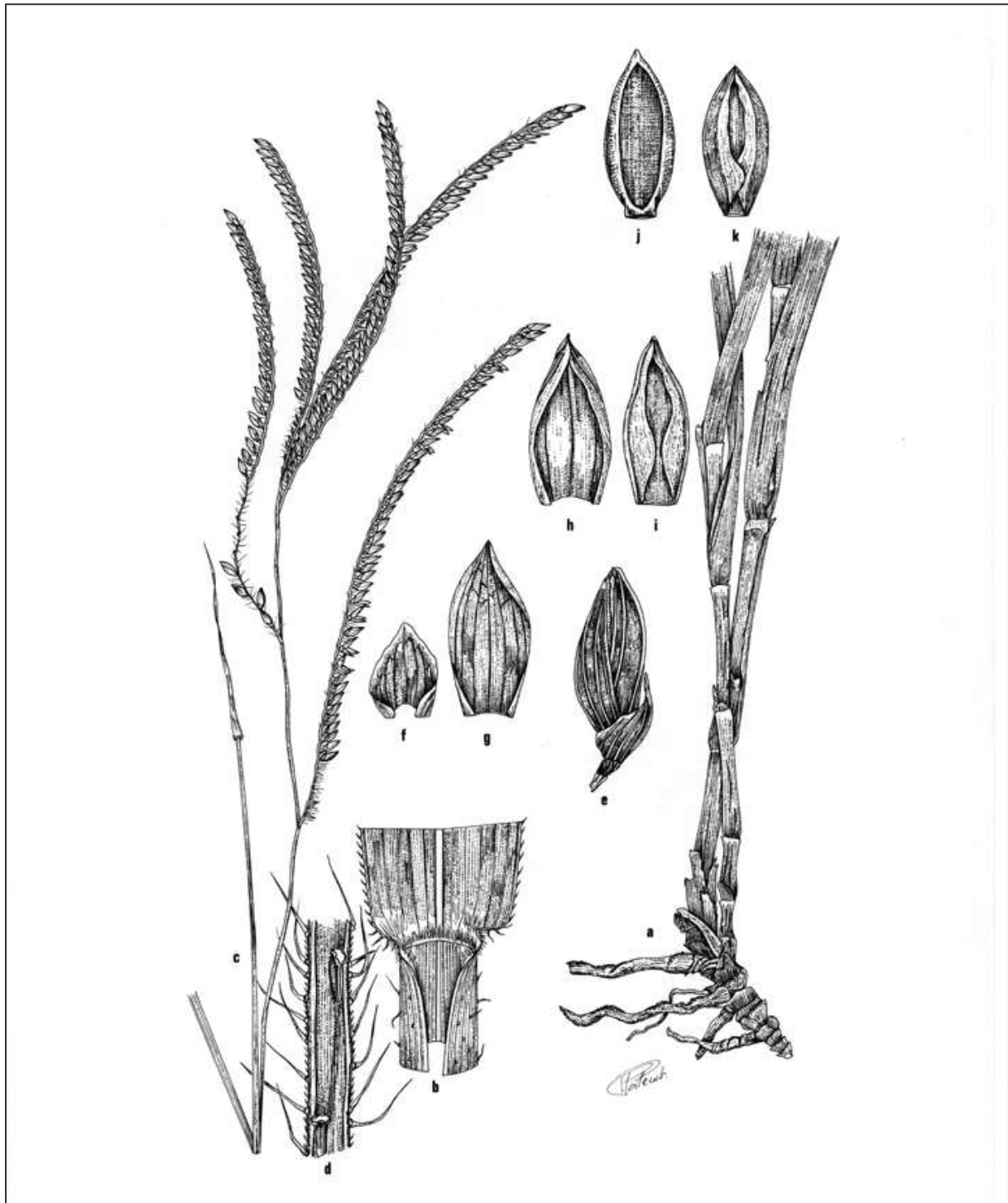
**Other notes**

*Brachiaria brizantha* was not observed in Northern Nimba but this grass species occurs in Liberia.

It is a robust grass with stout erect or sometimes geniculately ascending culms, with broadly linear or lanceolate leaf-blades and an inflorescence composed of 2–16 racemes, up to 15 cm long, bearing the spikelets singly, these typically forming a single row.



*Brachiaria brizantha* (A. Rich.) Stapf



*Brachiaria brizantha* (A. Rich.) Stapf

a, base of the plant (x 0.7); b, ligule; c, inflorescence (x 0.7); d, fragment of rachis (x 14); e, spikelet (x 7); f and g, inferior and superior glumes; h and i, lemma and palea of inferior floret; j, superior floret; k, palea of superior floret.

*Brachiaria brizantha* (A. Rich.) Stapf



## *Ctenium newtonii* Hack.

### Description

Tufted wiry **perennial**, caespitose, with erect culms up to 100 cm high, wiry.

**Leaf-blades** involute, 5-25 cm long, 2-4 mm wide, aromatic. Ligule an eciliate membrane.

**Inflorescence** composed of solitary spike (raceme) supported by a pubescent peduncle at tip.

Racemes straight, or coiled in a lax corkscrew spiral, (5-)7-20(-30) cm long. Spikelet packing broadside to rachis, crowded, regular, 2-rowed.

**Spikelets** sessile, fertile comprising 2 basal sterile florets, 1 fertile floret, with diminished florets at the apex. Spikelets cuneate, laterally compressed, 4-7 mm long.

Glumes dissimilar: lower glumes small, acuminate and upper glumes lanceolate, 4-7 mm long, hispidulous, acuminate, with a dorsal and oblique awn 1-2 mm long.

**Basal sterile florets** dissimilar, barren, one with a dorsal awn and the other with an apical awn. **Fertile floret** with an apical awn, 2.5-3 mm long

### Ecology

*Ctenium newtonii* is a common species in savannahs, mainly on the sandy soils or compact clayey soils. It occurs also in swampy savannahs: from sea-level to 1300-1500 m.

### Distribution

Tropical Africa from Senegal to Angola, extending eastwards to the Sudan.

### Uses

*Ctenium newtonii* is a poor grazing grass species: it is an aromatic plant less appreciated by livestock. It has colonised large areas as a result of over-grazing eliminating other more palatable grasses. Its presence is taken as an indicator of overgrazing.

*Ctenium newtonii* is an aggressive pioneer coloniser of shallow stony impoverished soil.

It is used as a thatching grass and, plaited to make a beehive, plastered outside with cow dung. It is also used for paper pulp.

*Ctenium newtonii* can be used in soil conservation, using rooted stem cuttings, to consolidate the soil of the terraces in the old mining sites.

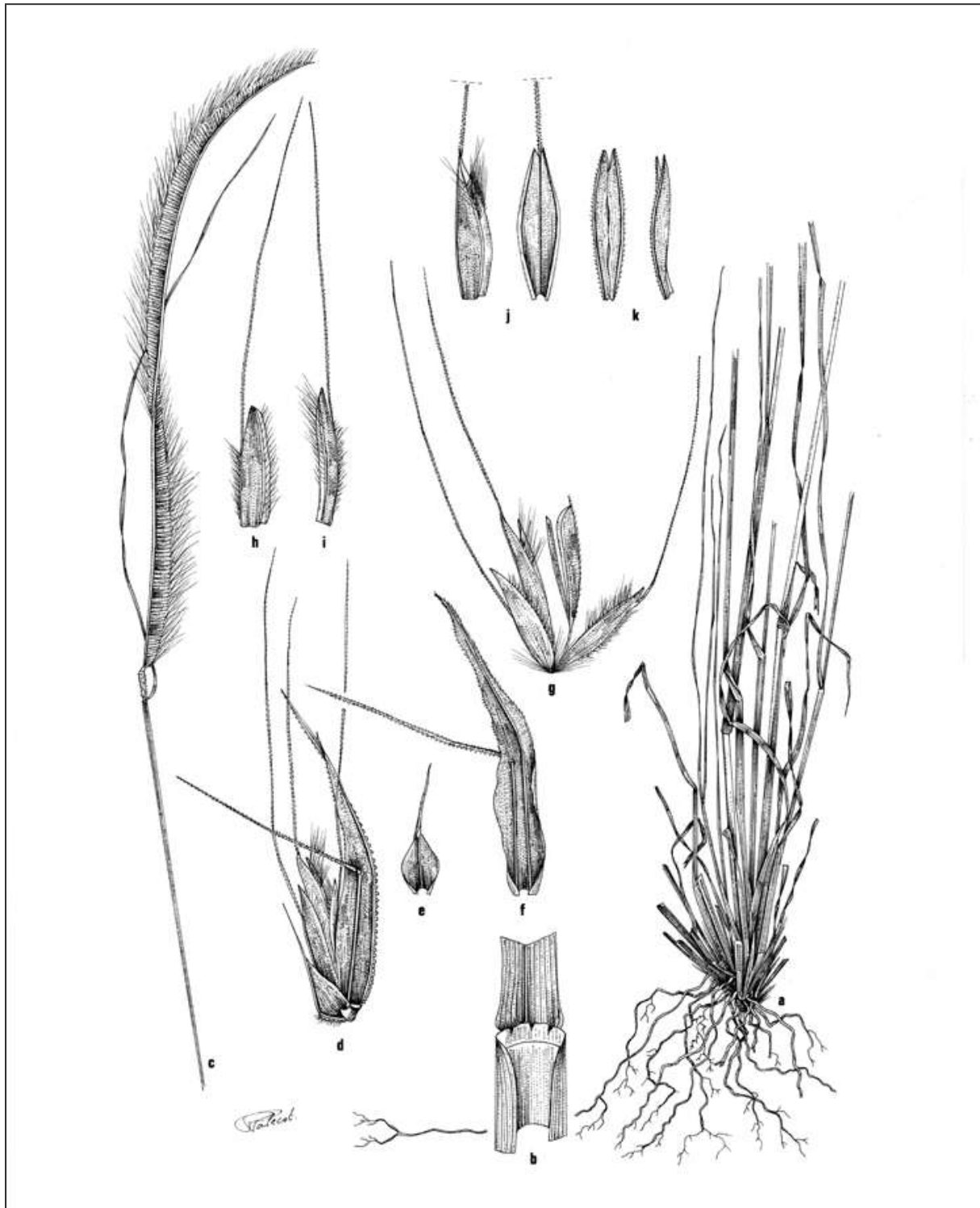


### Other notes

*Ctenium newtonii* is usually a common species in open bushland. It is a tufted wiry perennial grass, 100 cm high, easily recognisable by the solitary, straight or coiled in a lax corkscrew spiral raceme with awned spikelets.

In northern Nimba, it occurs on the terraces in the old mining sites, especially in the Blue Lake site. Because of the mineral substratum, this species is relatively little frequent and of small size.

*Ctenium newtonii* Hack.

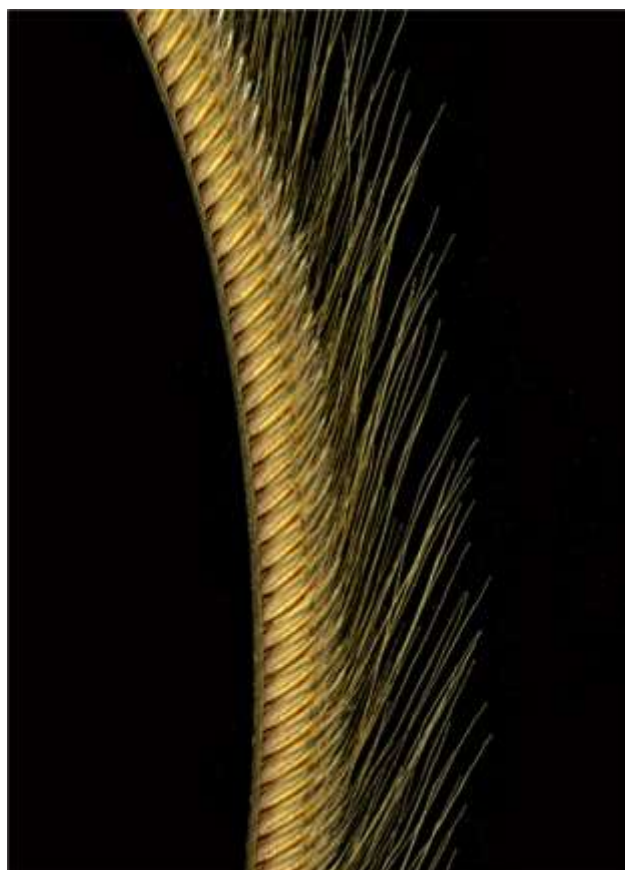


*Ctenium newtonii* Hack.

a, base of the plant (x 0.7); b, ligule; c, inflorescence (x 0.7); d, spikelet (x 10.5); e and f, inferior and superior glumes; g, flowers separated of glumes; h and i, lemmas of inferior florets; j, lemma of fertile floret (profile and ventral side); k, palea of fertile floret (ventral side and profile).



*Ctenium newtonii* Hack.



***Cynodon dactylon* (L.) Pers.**

“Bermuda grass, Couch grass, Quick grass, Star grass”

**Description**

Slender, sward-forming **perennial**, with both underground rhizomes and creeping surface stolons, with culms geniculately ascending, 8-40 cm long and 0.5–1 mm wide.

**Leaf-blades** linear, flat, sometimes almost filiform, up to 12 cm long (often much shorter), 1-4 mm wide, scaberulous, glaucous. Ligule a ciliolate membrane.

**Inflorescence** composed of a single digitate whorl of 4-6 green or purplish spikes (racemes) 1.5-6 cm long. Spikelet packing broadside to rachis; regular, imbricate in two rows.

**Spikelets** sessile, fertile, laterally compressed, ovate, 2–2.5 mm long, lanceolate in side view.

**Ecology**

*Cynodon dactylon* is an aggressive coloniser of disturbed ground as well as areas used by livestock (farms), road sides, gardens and cultivated lands. It is a sand fixer and commonly makes a short turf on stream-sides. It is also common on termitaria.

It grows on all types of soil, especially sandy soil and fertile soil, but often in damp places: from sea level to 2000 m.

**Distribution**

Throughout the world in tropical and warm temperate regions.

**Uses**

*Cynodon dactylon* is used in lawns, golf greens, tennis courts and fairways.

The roots are edible and might serve as a famine food.

It is a very popular cultivated pasture, than can endure heavy grazing. Under natural conditions it is an average to good pasture that remains green until late in the dry season.

“Star grass” is an excellent soil stabiliser, because of its rhizomes and stolons, and can be used in soil conservation, dibbling in peaces of rhizomes and stolons. Unfortunately, this characteristic causes the grass to be a serious weed which is difficult to control.

In the traditional pharmacopoeia, the whole plant is considered to be diuretic, pectoral, demulcent, astringent, haemostatic and laxative. The rhizome as used as a cardiac tonic (Nigeria). A root decoction is used to treat the inflammation of the urethra by diuresis (Gabon).

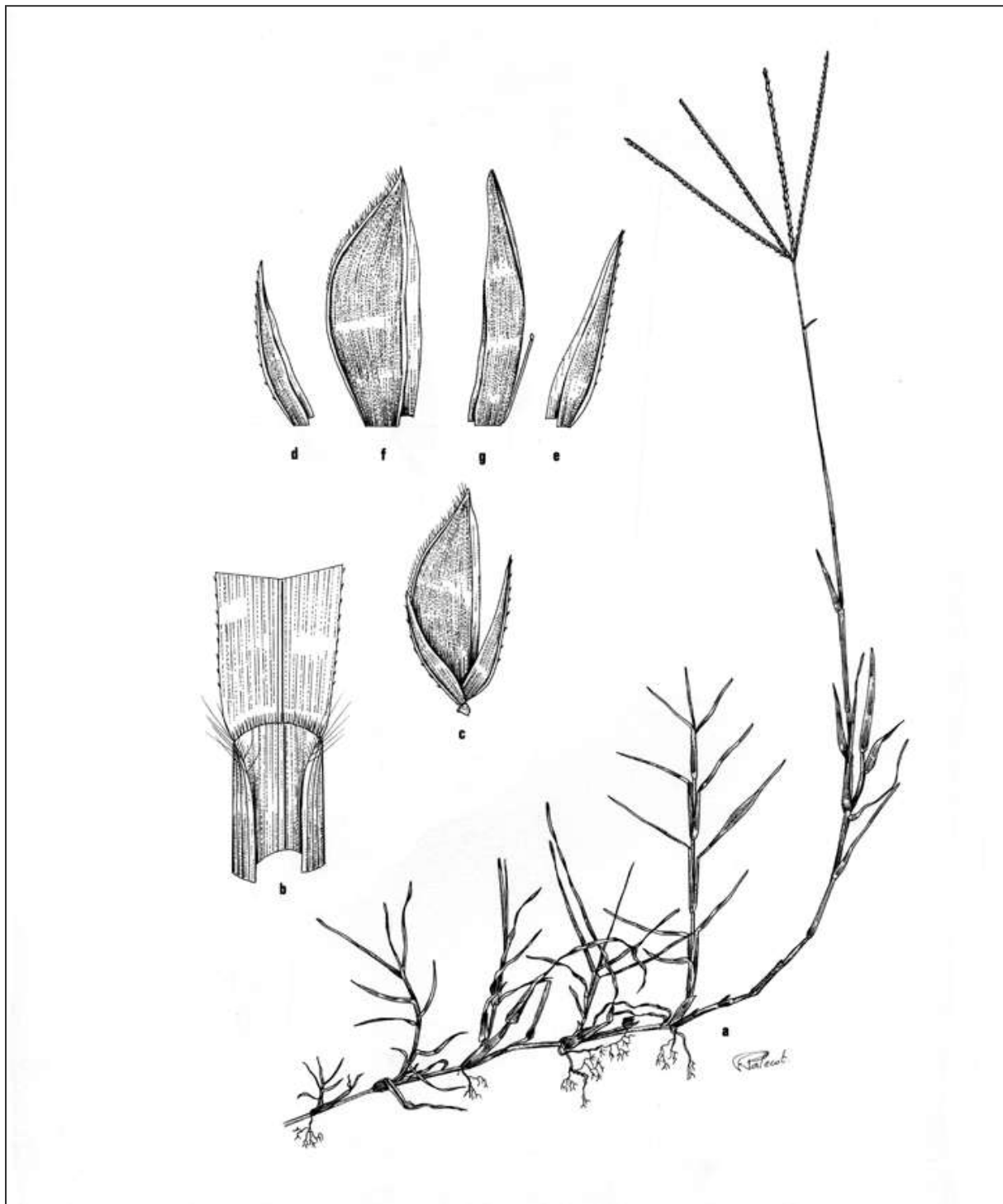
**Other notes**

*Cynodon dactylon* is a small rhizomatous, stoloniferous and mat-forming grass, easily recognisable by its Inflorescence composed of a single digitate whorl of 4-6 green or purplish spikes (racemes), 1.5-6 cm long. Spikelets are flat and awnless.

*Cynodon dactylon* was not observed in the savannahs at altitude covering the former mining sites or in the savannahs in the foothill. However this grass could be used to stabilise the fragile soil of terraces looking forward to reforestation.



*Cynodon dactylon* (L.) Pers.



*Cynodon dactylon* (L.) Pers.

a, habit (x 0.7); b, ligule; c, spikelet (x 10.5); d and e, inferior and superior glumes (x 14); f and g, lemma and palea (x 14).

*Cynodon dactylon* (L.) Pers.



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***Eragrostis atrovirens* (Desf.) Trin. ex Steud.****Description**

Tufted **perennial** with geniculately ascending or erect culms, 30-100 cm high, 1.5-3 mm wide, unbranched.

**Leaf-blades** flat or rolled, 15-30 cm long and 2-4 mm wide, glabrous or ciliate below. Ligule a fringe of hairs.

**Inflorescence** an open panicle, oblong or ovate, 4-40 cm long, contracted about primary branches which are ascending.

**Spikelets** fertile, pedicelled, solitary, comprising 6-50 fertile florets, with diminished florets at the apex. Spikelet oblong, laterally compressed, 3-20 mm long, 1.5-2.5 mm wide, breaking up at maturity, yellowish to dark green and often tinged with purple.

**Distribution**

North Africa and tropical Africa eastwards through India and Philippines.

**Ecology**

*Eragrostis atrovirens* is a characteristic species of swampy savannahs, floodplain grasslands, often in shallow water. It is a common grass in moist and swampy soils: from sea-level to 1600 m.

**Uses**

*Eragrostis atrovirens* is a good grazing species and may produce a good sound ground carpet. Culms used to make brooms and for thatching.

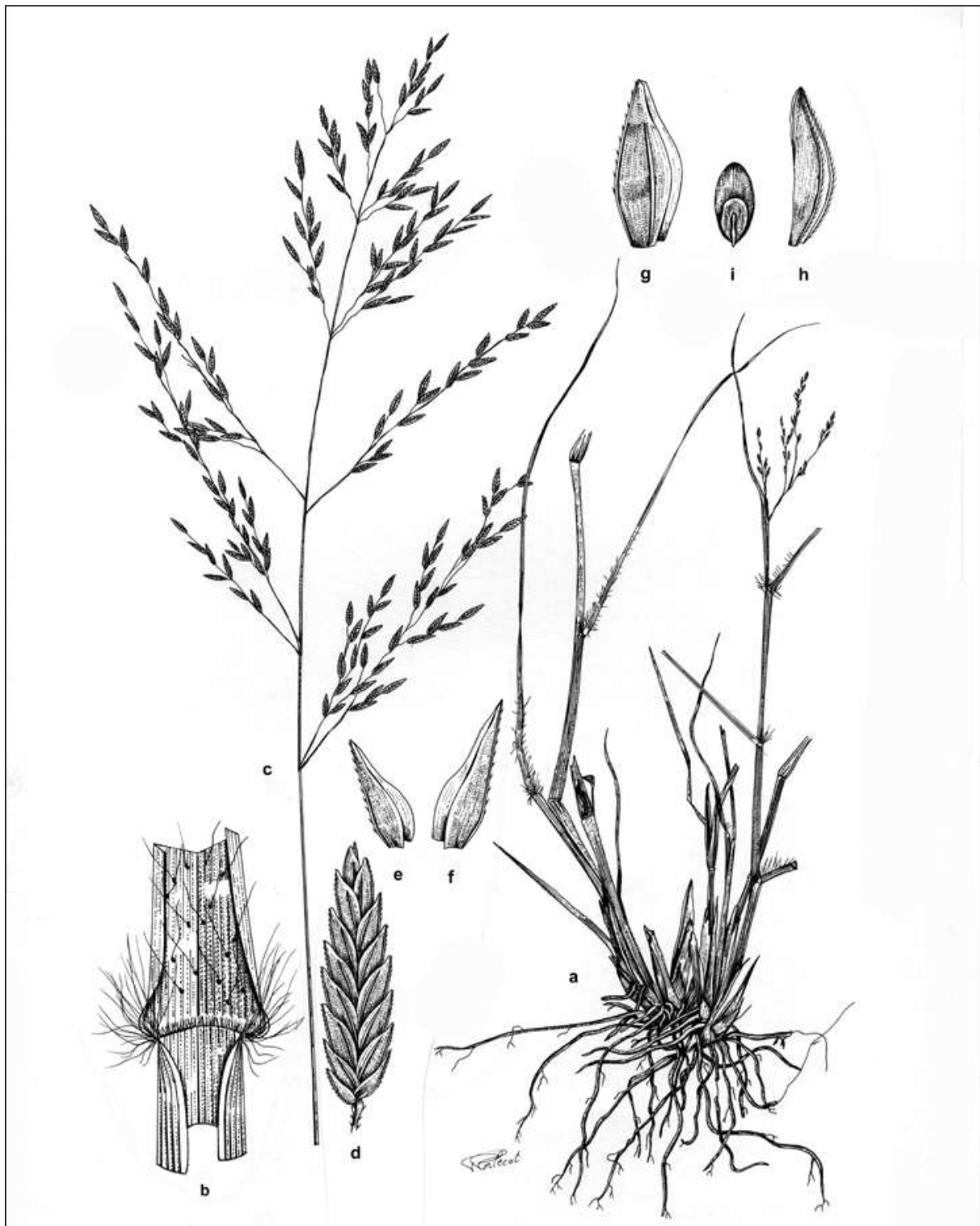
*Eragrostis atrovirens* can be used in soil conservation, with rooted stem cuttings, to consolidate soils in the mining terraces.

**Other notes**

*Eragrostis atrovirens* is a common species in the northern Nimba in the foothill as well as at altitude, on all the swampy grounds.

The plant presents usually a green grey aspect. It is a caespitose perennial with slender, erect and unbranched culms. The inflorescence, a panicle, is open with spikelets loosely contracted about the primary, branches. As for most of the *Eragrostis* species, spikelets are many-flowered.

*Eragrostis atrovirens* (Desf.) Trin. ex Steud.



*Eragrostis atrovirens* (Desf.) Steud.

a, base of the plant (x 0.7); b, ligule; c, inflorescence (x 0.7); d, spikelet (x 7); e and f, lower and superior glumes (x 17.5); g and h, lemma and palea (x 17.5); i, caryopsis (x 17.5).

*Eragrostis atrovirens* (Desf.) Trin. ex Steud.





## *Hyparrhenia diplandra* (Hack.) Stapf var. *diplandra*

### Description

Coarse, caespitose **perennial** with erect culms 200-300 cm high.

Leaf-sheaths glabrous on surface, or pilose. Ligule an eciliate membrane, 1–2 mm long.

**Leaf-blades** 20-60 cm long and 3-10 mm wide. Leaf-blade surface glabrous or sparsely hirsute.

**Inflorescence** a false panicle, compound, 20-40 cm long, usually purplish, composed of terminal and axillary racemes paired, subtended by lanceolate spatheoles 2-4.5 cm long, membranous, brown or red, glabrous. Peduncle 0.3-1.5 cm long, glabrous, or hirsute above.

Racemes 2, paired, deflexed, 1.5-2(-2.5) cm long, (3)4-6(9)-awned per pair. Rachis internodes and pedicels linear, ciliate, with an oblique tip.

**Spikelets** appressed: 1 sessile spikelet, fertile and 1 pedicelled spikelet, sterile.

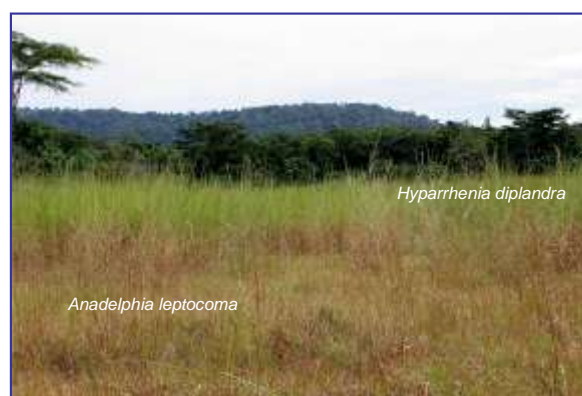
- **Fertile spikelet** comprising 1 basal sterile floret and 1 fertile floret. Spikelet lanceolate, dorsally compressed, 6-8 mm long, with a cuneate callus 1.5 mm long, pubescent. Basal floret sterile. Fertile floret linear, membranous, with an awn, geniculate, 20-55 mm long overall, with twisted and pubescent column (hairs 0.2-0.5 mm long).

- **Pedicelled spikelet** dorsally compressed, 5-7.5 mm long, acute, muticous or awned, with an awn 0-5 mm long.

### Ecology

Habitat very variable, favouring damp places in savannahs, and extending onto stony hillsides and into areas of cultivation: from sea-level to 2000 m.

In northern Nimba, *Hyparrhenia diplandra* var. *diplandra* is very common in the foothill savannahs, in particular in Grassfield and in the savannah of Yekepa-Thuo on the Guinean border. In these savannahs, it forms practically pure stands, associated with *Anadelphia leptocoma*. It is rather frequent in the savannahs at altitude, on the terraces of the former mining sites, on the relatively wet grounds.



### Distribution

Throughout tropical Africa – South Asia.

### Uses

Excellent grazing species, especially when young; offers palatable grazing up to the flowering stage.

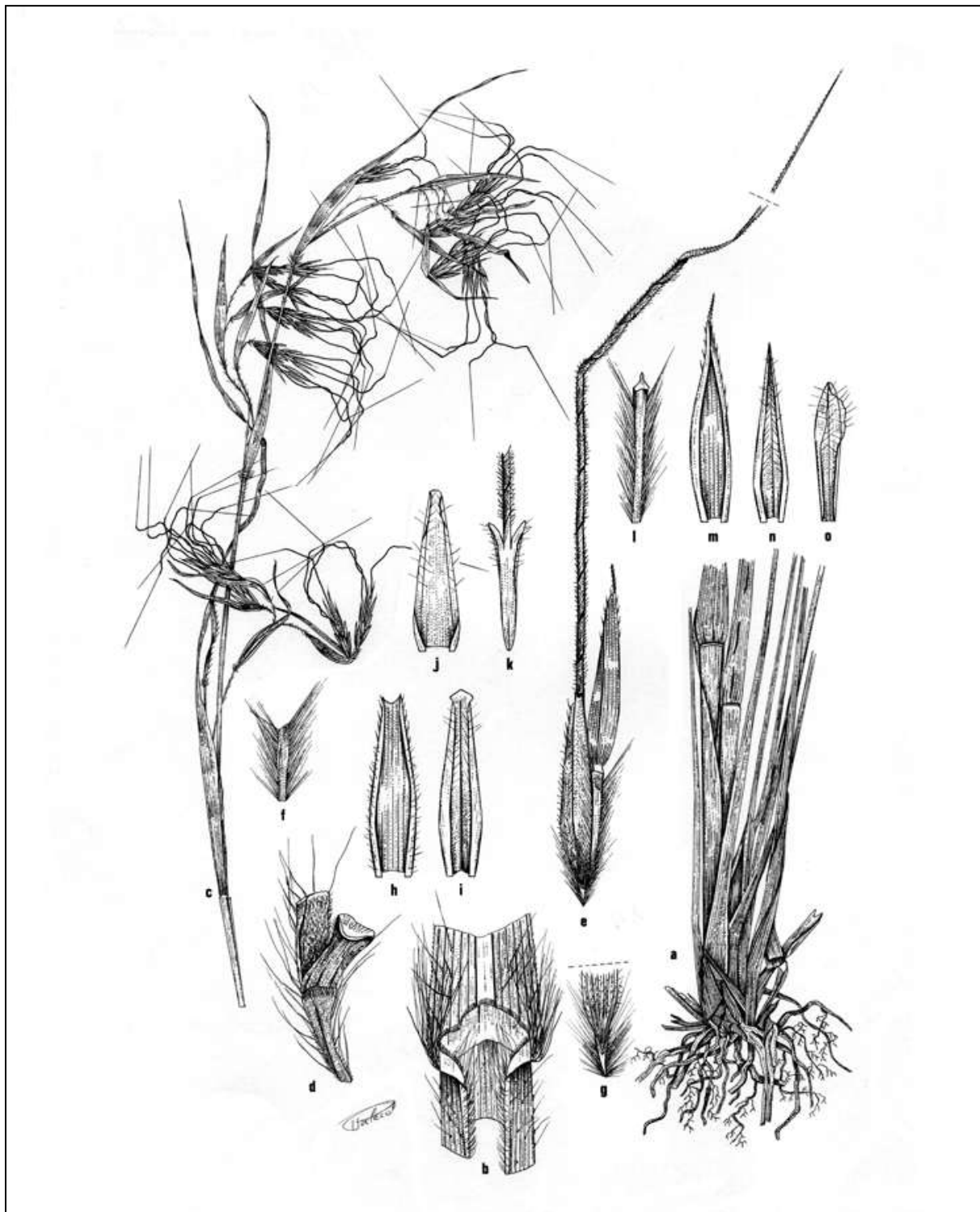
*Hyparrhenia diplandra* var. *diplandra* can be used to stabilise fragile soils, using rooted stem cuttings, and can be planted to mark plot borders.

It is also used as a thatching grass.

### Other notes

*Hyparrhenia diplandra* var. *diplandra* is a tall robust perennial, often forming pure stands. The inflorescence, a false panicle, is green or purplish and composed of raceme paired at the base of which sterile spikelet form an involucre. Racemes bearing geniculate awns, 20-55 mm long, with white or fulvous hairs. The base of the leaf-blade is usually hairy.

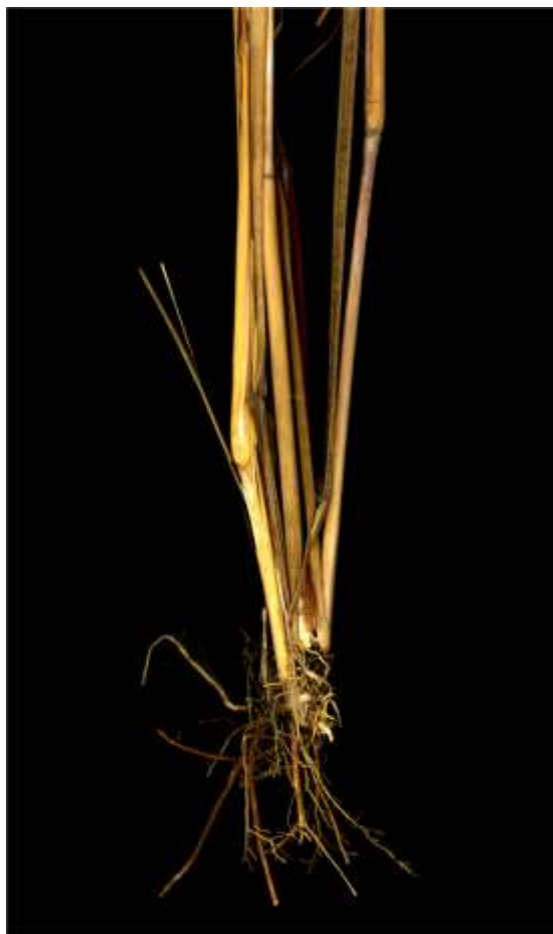
*Hyparrhenia diplandra* (Hack.) Stapf var. *diplandra*



*Hyparrhenia diplandra* (Hack.) Stapf var. *diplandra*

a, base of the plant (x 0.7); b, ligule; c, part of inflorescence (x 0.7); d, base of raceme pairs and peduncle (x 10.5); e, pair of spikelets and internode (x 5); f, internode (x 5); g, callus of sessile spikelet (x 7); sessile spikelet (x 5); h and i, inferior and superior glumes; j, lemma of lower floret; k, lemma of superior floret; pedicelled spikelet (x 5); l, pedicel; m and n, inferior and superior glumes; o, lemma of inferior floret.

*Hyparrhenia diplandra* (Hack.) Stapf var. *diplandra*



## *Imperata cylindrica* (L.) Raeusch.

“Cottonwool grass, Spear grass”

### Description

**Perennial**, with elongated and scaly rhizomes, with erect culms 10-120 cm high.

Basal leaf-sheaths are smooth and break up into fibres when they mature.

**Leaves** mostly basal. Leaf-blades erect flat or convolute, 3-100 cm long, 2-20 mm wide, stiff, with sharp tip and scabrous margins. Leaves are red-brown during the dry season. Ligule a ciliate membrane.

**Inflorescence** a panicle, spiciform, linear, 3-22 cm long, silver-white. Primary panicle branches accrescent to a central axis, with evident branchlets on axis. Racemes bearing few fertile spikelets.

**Spikelets** in pairs, fertile, with unequal and filiform pedicels. Spikelets comprising 1 basal sterile floret and 1 fertile floret. Spikelets lanceolate, subterete, 2.2-6 mm long, enveloped in long white hairs, with a truncate callus.

### Ecology

*Imperata cylindrica* is a common weed in cultivation. It grows in poorly drained, damp soil such as low grounds and river banks where it can form dense stands: from sea-level to 2100 m.

*Imperata cylindrica* is a little frequent grass in savannahs recovering the terraces at altitude in the northern Nimba. It is more common in the foothill, in the lands having been cultivated.

### Distribution

Tropical and warm temperate regions.

### Uses

The young foliage is tender and stock will browse it but old leaves become tough and develop razor-sharp margins and then become unpalatable.

The raw rhizomes can be eaten.

It is used for thatching, weaving (mats, baskets), for paper, for fuel and ornamental purposes. The flossy flowers are collected for stuffing cushions and pillows.

This species is a very important soil stabiliser in many tropical parts of the world.

*Imperata cylindrica* is considered as a weed in lands where rice, cotton, coffee and tea are cultivated.

It can be used in soil conservation, locally and on certain types of soils.

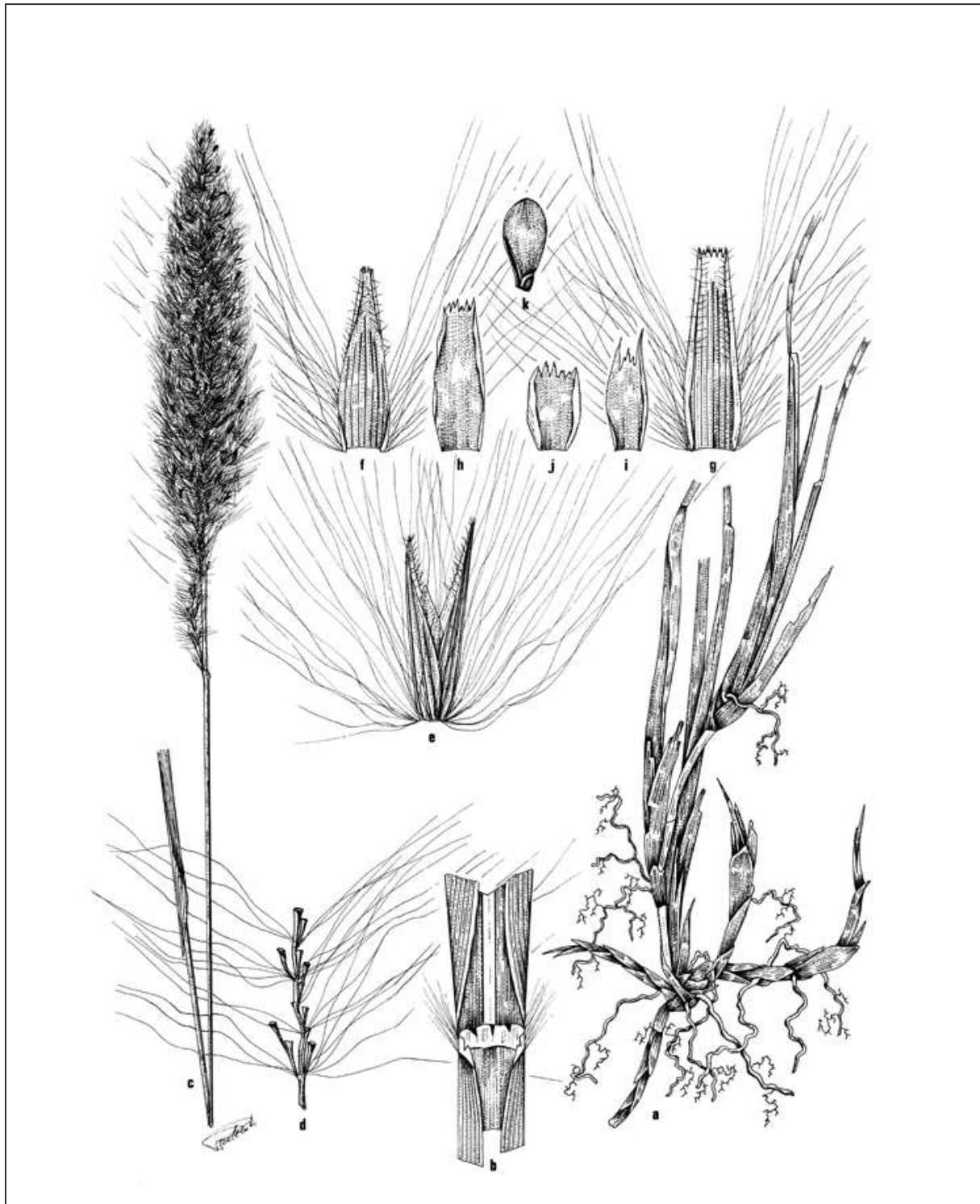
In the traditional pharmacopoeia this species is recognised for its astringent, diuretic and febrifuge properties. It is used to look after the venereal diseases. The decoction of leaves allows treating the rheumatisms, the mucous candida and the abscesses. The aqueous soaked of roots serves to treat the high blood pressure and the measles. The root is held to be galactogenic and is given to suckling women (Congo). The plant is invoked in a Yoruba incantation to make a husband fight with his wife (Nigeria).

### Other notes

*Imperata cylindrica* is very easy to recognise with its unbranched culms, its spiciform, silky and white panicle. It is a strong, water-loving grass which spreads with long rhizomes and can form dense stands in disturbed lands. Leaves are hard, stiff, with a sharp tip and a prominent midrib: they become red during the dry season.



*Imperata cylindrica* (L.) Raeusch.



*Imperata cylindrica* (L.) Raeusch.

a, base of the plant (x 0.7); b, ligule; c, inflorescence (x 0.7); d, fragment of ramification with spikelets (x 2.8); e, spikelet (x 7); f and g, lower and superior glumes; h, lemma of inferior floret; i and j, lemma and palea of superior floret; k, caryopsis.



*Imperata cylindrica* (L.) Raeusch.



## *Loudetia phragmitoides* (Peter) C.E. Hubb.

“Erapo grass”

### Description

Tall **perennial** tussock grass, clumped densely with culms erect 200-400 cm high, smooth or hirsute.

**Leaf-blades** linear, flat, or convolute, up to 100 cm long, 10-20 mm wide, stiff. Ligule a fringe of hairs.

**Inflorescence** a contracted panicle, narrowly oblong, dense, 40–60 cm long.

**Spikelets** solitary, fertile, pedicelled, comprising 1 basal sterile floret and 1 fertile floret. Spikelets linear, laterally compressed, 6-7 mm long, yellowish brown, glabrous or tuberculate-setose. Fertile floret loosely hirsute, prolonged by an awn 10-20 mm long.

### Ecology

*Loudetia phragmitoides* is a characteristic grass species of swampy and marshy places: from sea-level to 2000 m.

It is a very common in the northern Nimba. This species is dominant in the foothill savannahs which surround the site of Blue Lake. It is also very frequent on the terraces at altitude, very often in swampy grounds but also on the sides of terraces when the slope is not too steep. *Loudetia phragmitoides* is often associated with *Anadelphia leptocoma*.

### Distribution

Throughout tropical Africa.

### Uses

*Loudetia phragmitoides* is a medium grazing species, mainly when young.

Culms used to build huts. Inflorescence can be tint to produce colored bouquets.

The stout pithy culms become hollow, used for arrow-shafts or whistles.

The leaves are sometimes used for scrubbing out utensils such as calabashes.

*Loudetia phragmitoides* can be used in soil conservation, with rooted stem cuttings, to consolidate soils of old mining terraces.

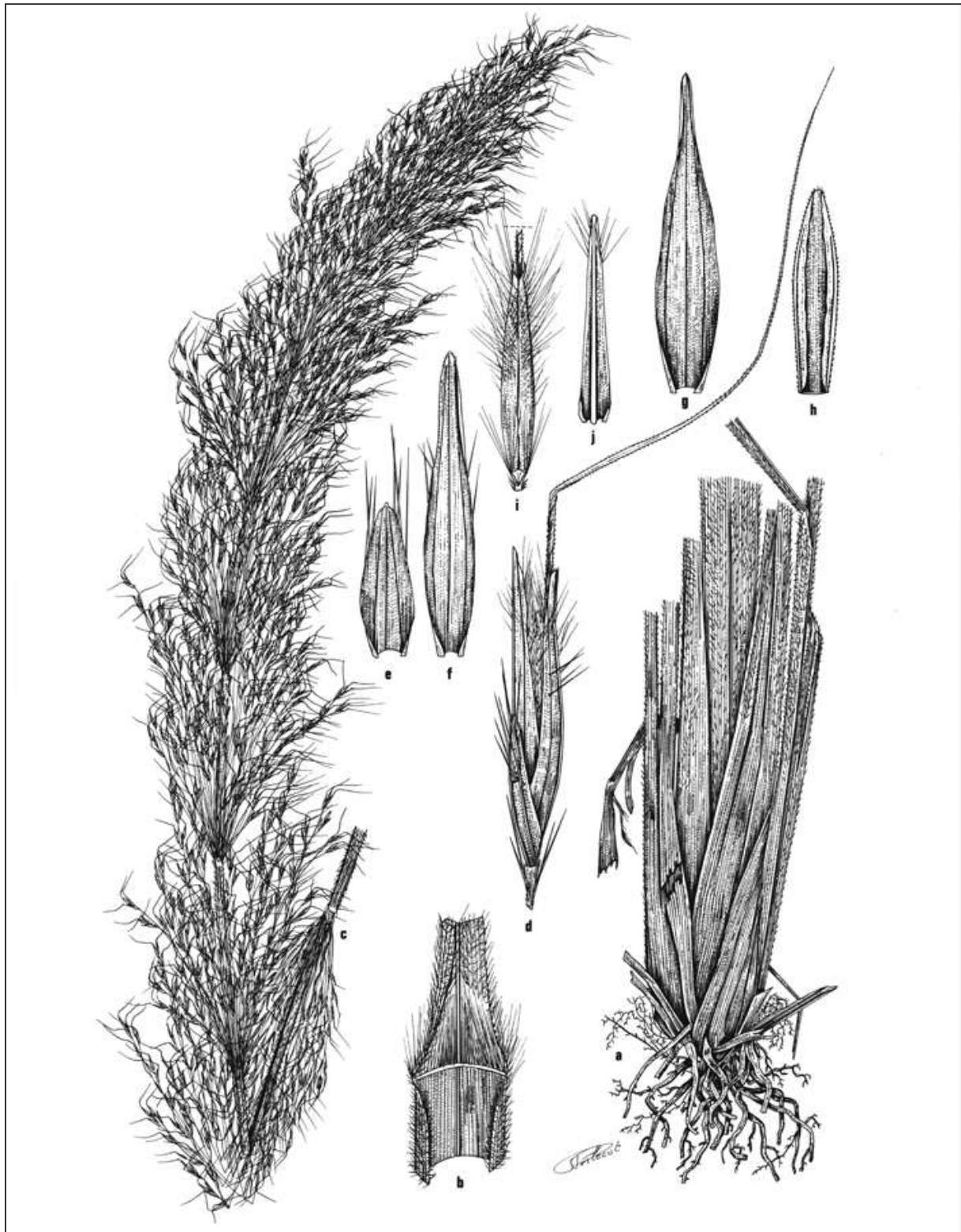


### Other notes

*Loudetia phragmitoides* is a robust perennial with a reed-like habit. It is easily recognisable by the narrowly oblong, dense, contracted and yellow-brown panicle, 40-60 cm long. Culms can be smooth or hirsute. The fertile flower is loosely hirsute with silky hairs. 1-2 mm long

This grass is characteristic of the grassy swampy savannahs.

*Loudetia phragmitoides* (Peter) C.E. Hubb.



*Loudetia phragmitoides* (Peter) C.E. Hubb.

a, base of the plant (x 0.7); b, ligule; c, inflorescence (x 0.7); d, spikelet (x 7); e and f, lower and superior glumes; g and h, lemma and palea of inferior floret; i, superior floret; j, palea of superior floret.

*Loudetia phragmitoides* (Peter) C.E. Hubb.





## *Loudetia Simplex* (Nees) C.E. Hubb.

“Common Russet Grass”

### Description

Tufted **perennial** with erect culms 30-150 cm high. Basal leaf-sheaths usually becoming fibrous, typically woolly tomentose but sometimes silky pubescent or glabrescent. Culm-nodes pallid or black, glabrous or bearded.

**Leaves** mostly basal. Leaf-blades flat or convolute, 10–30 cm long and 2-5 mm wide. Ligule a fringe of hairs.

**Inflorescence** a panicle, linear to narrowly ovate, or loosely diffuse and open, 5-30 cm long, the branches contracted or loose but seldom markedly whorled. Spikelets solitary, pedicelled.

**Spikelets** comprising 1 basal sterile floret and 1 fertile floret. Spikelets lanceolate; laterally compressed, 8-14 mm long, glabrous or tuberculate setose.

Fertile floret oblong, 4-7 mm long, coriaceous, pubescent, bidentate at apex, with a callus evident, 0.8–1 mm long, pubescent, narrowly oblong, 2-toothed. Floret with an awn 2-4 cm long with a twisted column.

### Ecology

*Loudetia simplex* is a variable grass species which occurs in wooded grassland, grassy hillsides on both stony and seasonally waterlogged soils: from seal-level to 2700 m. It usually grows on poor and coarse sandy soils.

It is probably an indicator of poor soil and/or overgrazing.

In northern Nimba, *Loudetia simplex* is a characteristic grass of savannahs resting on lateritic carapaces. It dominates in the savannah of Grassfield, associated with *Schizachyrium rupestre* and *Rhytachne rottboellioides*.



This species meets in the savannah of Geipa (Eastern Nimba) and constitutes the main part of the grass layer recovering outcrops (Greenhill area).

### Distribution

Widespread in tropical and South Africa – Madagascar.

### Uses

*Loudetia simplex* is a good grazing grass when young, with a good regrowth during the dry season. It is an important grass for preventing surface erosion after heavy rainfall.

This grass is also used for thatching. The culms are tied together and used as hand brooms or weaved to make baskets.

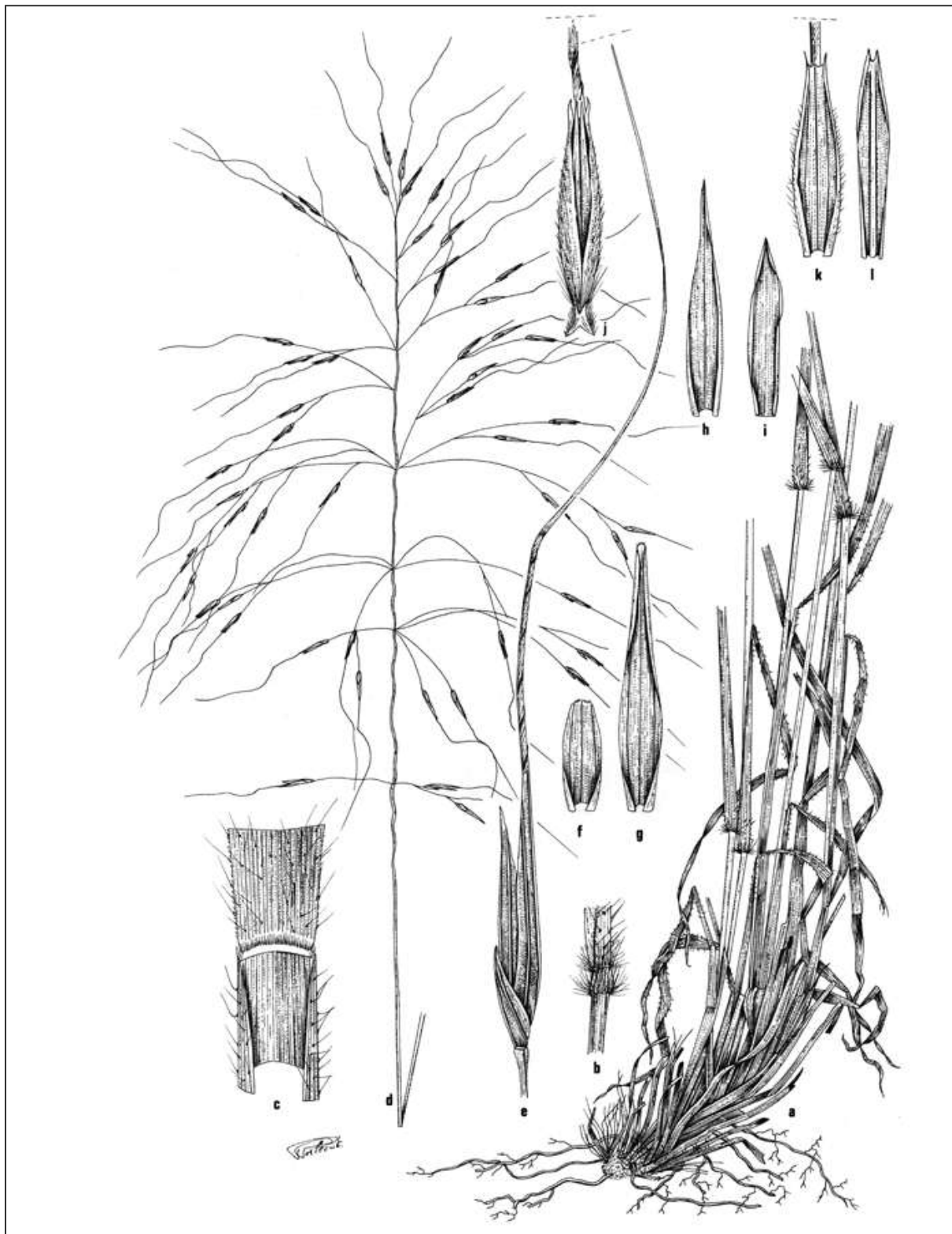
### Other notes

As with *Loudetia phramitoides*, *Loudetia simplex* is a gregarious grass, preferring seasonally waterlogged soils.

It is a hard tufted grass, with unbranched culms with a light brown, open (sometimes contracted) panicle. Inflorescence is drooping when dry.



*Loudetia Simplex* (Nees) C.E. Hubb.



*Loudetia simplex* (Nees) C.E. Hubb.

a, base of the plant (x 0.7); b, node (x 1.4); c, ligule; d, inflorescence (x 0.7); e, spikelet (x 2.8); f and g, lower and superior glumes (x 2.8); h and i, lemma and palea of inferior floret (x 2.8); j, superior floret (x 5.6); k and l, lemma and palea of superior floret (x 5.6).

*Loudetia Simplex* (Nees) C.E. Hubb.



## ***Melinis minutiflora* P. Beauv.**

“Molasses Grass, Stink grass, Wynne grass”

### **Description**

Tufted **perennial**, with geniculate ascending culms, 60-100 cm high. Culm-nodes bearded. Leaf-sheaths viscid, pilose.

**Leaf-blades** 5-20 cm long, 3-11 mm wide, flat, pilose, viscid, sticky with a strong smell of linseed oil. Ligule a fringe of hairs.

**Inflorescence** an open panicle, oblong, dense, 10-30 cm long, with capillary and scaberulous branches.

**Spikelets** solitary, fertile, oblong, laterally compressed, symmetrical, 1.5-2(-2.4) mm long, with filiform pedicels 0.5-2 mm long, scaberulous, glabrous or bearing a few hairs. Basal sterile floret barren, awnless or with an awn up to 14 mm long.

### **Ecology**

Grassland to woodland at higher altitude often at anthropogenic sites: from 300 to 2300 m.

In northern Nimba, *Melinis minutiflora* is a dominant grass in the savannahs at altitude where it recovers sometimes completely the terraces of the old mining sites. It is also common on the contact forest / savannah in the foothill savannahs as Grassfield for example.



### **Distribution**

Tropical Africa – Introduced throughout the tropics as a fodder plant.

### **Uses**

*Melinis minutiflora* is a good grazing grass but very sensitive to fire. It is appreciated by the cattle in dry season because it remains green. It produces very good hay. It is sometimes used as plant cover or to sow the fragile grounds.

The whole plant is held to be insecticidal and used to take away mosquitoes and tsetse flies. In the traditional pharmacopoeia, the root is used as a purgative and as a diarrhoea remedy.

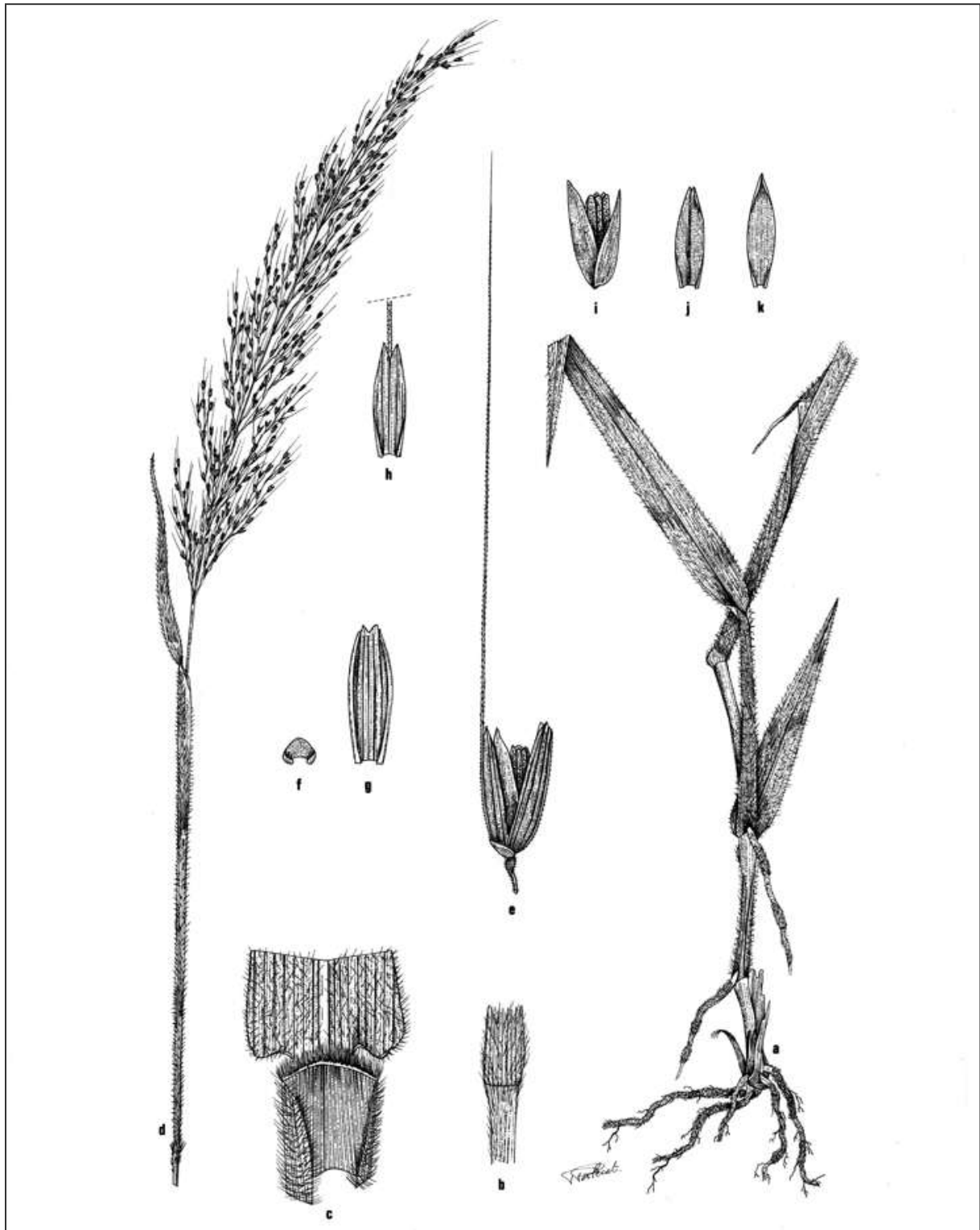
The plant is said to be a favourite sleeping place for pythons (Sierra Leone).

### **Other notes**

*Melinis minutiflora* is a gregarious grass, easily recognisable in the dry season because it remains green. It becomes a beautiful grass at the flowering time with pink purple panicles.

The whole plant is covered with viscous hairs which kick away a strong smell of linseed oil. These hairs make dirty clothes when crossing the dense stands composed of this grass.

*Melinis minutiflora* P. Beauv.



*Melinis minutiflora* P. Beauv.

a, base of the plant (x 0.7); b, node (x 1.4); c, ligule; d, inflorescence (x 0.7); e, spikelet (x 10.5); f and g, lower and superior glumes; h, lemma of inferior floret; i, superior floret (x 5.6); j and k, lemma and palea of superior floret.

*Melinis minutiflora* P. Beauv.





***Paspalum scrobiculatum* L.**

“Bastard millet, Dirch millet, Koda millet, Kodomillet, Scrobic paspalum”

**Description**

**Perennial**, mat forming or caespitose with erect or geniculate ascending culms, 10-150 cm high, 1-6 mm in diameter, rooting or not from lower nodes.

**Leaf-blade** linear, 5-40 cm long, 3-15 mm wide, tapering to a filiform tip. Ligule an eciliate membrane.

**Inflorescence** composed of 1-20 racemes, digitate or borne along a central axis, 2-15 cm long. Spikelets borne singly on a ribbon-like rachis 1-2.5 mm wide.

**Spikelets** solitary, fertile, with oblong pedicels, comprising 1 basal sterile floret and 1 fertile floret. Spikelets obovate or orbicular, dorsally compressed, obtuse, 1.4–3 mm long, green becoming brown.

**Ecology**

*Paspalum scrobiculatum* favours swampy and muddy ground but sometimes in drier, weedy or lightly shaded places: from sea-level to 2900 m. It mostly grows in sandy and loam soil and is a weedy species associated with some degree of trampling, grazing or cultivation.

In northern Nimba, *Paspalum scrobiculatum* is a common species on the wet soil that forms on the terraces of the former mining sites. This grass is also common in the foothill, in the disturbed wet places and along the roadsides.

**Distribution**

*Paspalum scrobiculatum* occurs in the tropical and subtropical parts of Africa and Asia – Introduced in Australia.

**Uses**

*Paspalum scrobiculatum* is a good grazing species, very palatable and highly digestible but this grass has a short life time. Some forms produce toxic seeds which cause digestive trouble: in India elephants died as a result of eating the grains.

The wild perennial plant is in general not edible on account of toxicity. In India, it is grown as a edible minor cereal (*Kodo millet*) and used to prepare alcoholic beverages

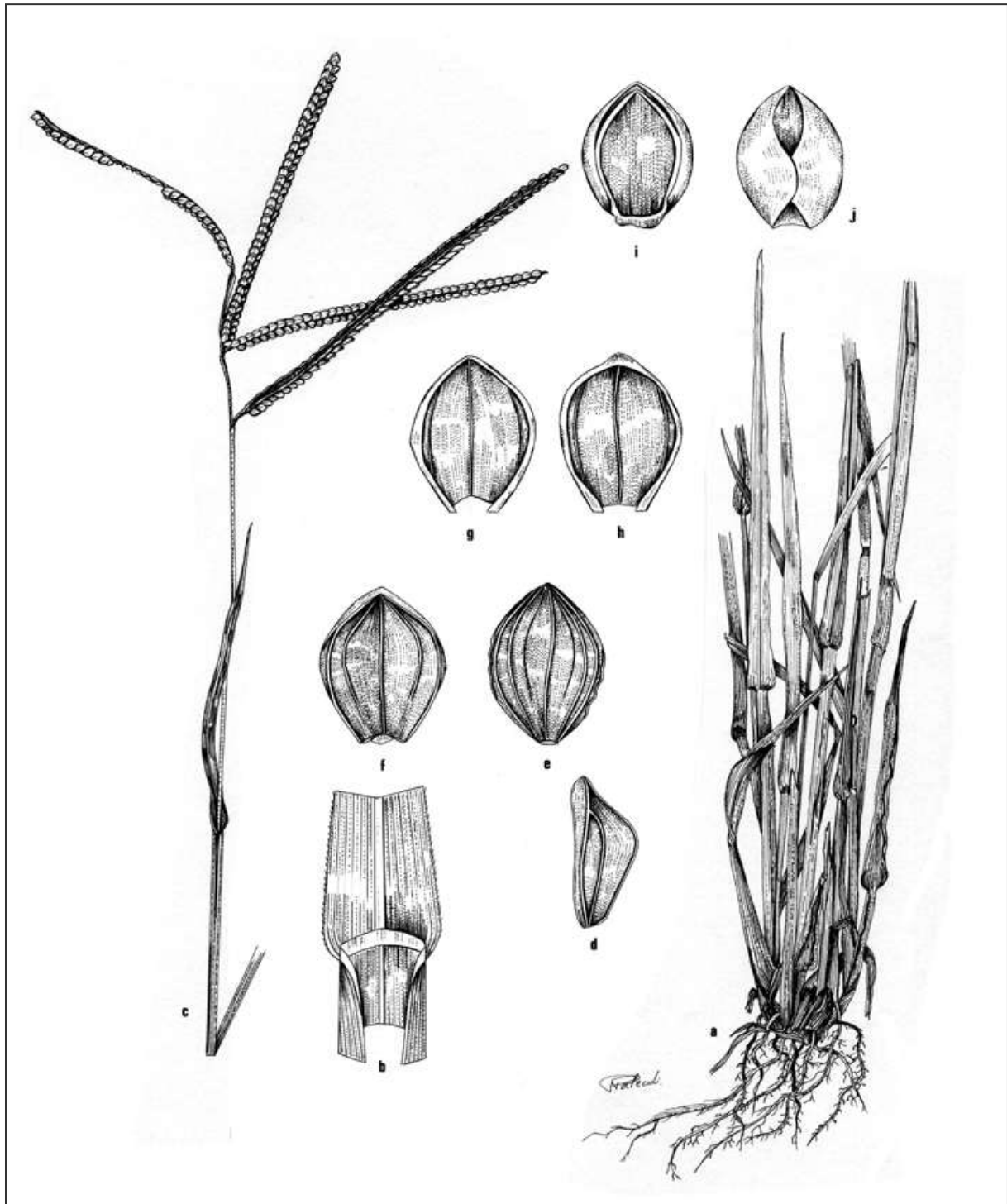
In the traditional pharmacopoeia, the cooked leaves allow looking after the cardiac affections and the decoction of leaves is used to look after the bruises. The juice of the plant, mixed in some salt, serves to treat the traumatism of the eye. Added to some palm oil, it forms pomade used as remedy against the headaches and the intercostal pains. Leaves are lavished in steam bath for the feverish patients. The plant is an excellent purge for dogs and cats. In India, *Paspalum scrobiculatum* is in use as medicine for Diabetes.

**Other notes**

*Paspalum scrobiculatum* is a very variable grass species in terms of vegetative and flowering parts.

It is a perennial tufted grass with light green leaves, sometimes tinged with purple. The obovate or orbicular, dorsally compressed spikelets are arranged in two overlapping rows along the broad thickness axis of the raceme.

*Paspalum scrobiculatum* L.



*Paspalum scrobiculatum* L.

a, base of the plant (x 0.7); b, ligule; c, inflorescence (x 0.7); d and e, spikelet (dorsal and ventral sides, x 7); f, superior glume; g, lemma of inferior floret; h, superior floret; i, palea of superior floret; j, caryopsis.

*Paspalum scrobiculatum* L.



## ***Pennisetum polystachion* (L.) Schult.**

“Mission grass, Bara grass, Matting grass, Golden grass”

### **Description**

**Annual** or **perennial**, caespitose, with erect or geniculately ascending culms, 30-200 cm high, copiously branched.

**Leaf-blades** 10-40 cm long and 3-16 mm wide. Ligule a ciliate membrane.

**Inflorescence** a spiciform panicle, linear, straight or curved, 3-25 cm long, 0.8-1(-1.5) cm wide (excluding bristles).

**Spikelets** subtended by an involucre composed of bristles, deciduous with the fertile spikelets, oblong, 4-12 mm long, with an obtuse base: bristles numerous, terete, flexible, antrorsely scaberulous, glabrous or ciliate, tawny to purple, the longest 6-25 mm long,

Fertile spikelet sessile, 1 in the cluster, comprising 1 basal sterile floret and 1 fertile floret. Spikelets lanceolate, dorsally compressed, 2-5 mm long,

### **Ecology**

Old farmland, roadsides and disturbed places: from sea-level to 2400 m.

### **Distribution**

Throughout the tropics.

### **Uses**

*Pennisetum polystachion* is a good grazing grass when young but the regrowth is very slow after grazing and the plant is, however, killed off rapidly by too heavy grazing. It can produce good hay.

The presence of the grass in the bush is held to indicate potential good farm land.

The plant resists badly the drought.

The culms are used for thatching and weaved to make mats.

Ears enter the decoration of tam-tams.

This grass has an excellent seeding capacity, rapid germination and good early production. It can be used in soil conservation to stabilise the fragile soils of the terraces in the old mining sites, using seeds as well as rooted stem cuttings.

The brass is calcined to yield a vegetable salt.

In the traditional pharmacopoeia, the cooked seeds applied in cataplasms calm the internal pains, the intercostal pains and the luxations of shoulder. The juice of the plant is used as disinfectant of the wounds and to look after conjunctivitis.

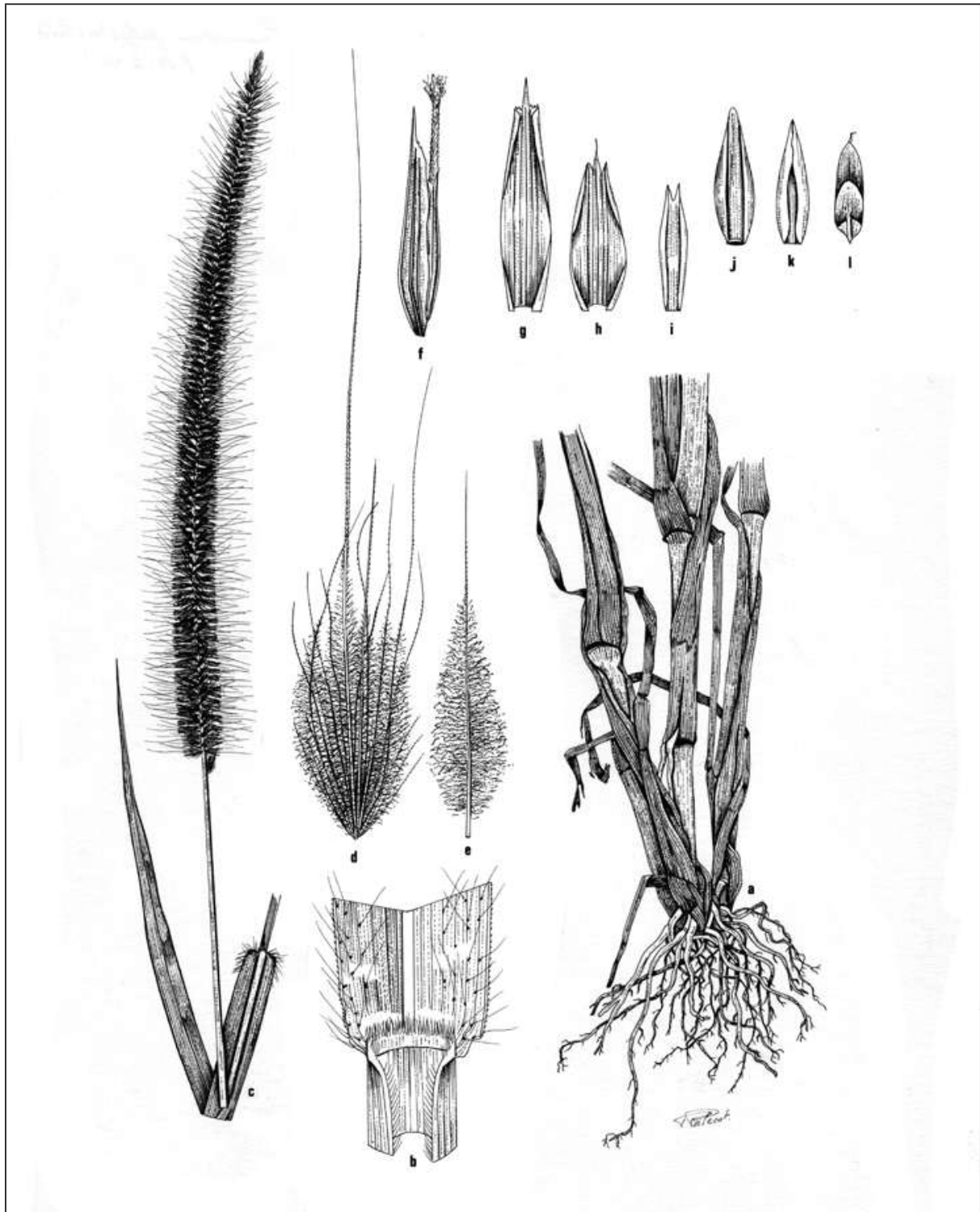
The plant is held to have medico-magical powers, particularly with a corn cob in treating impotence (Senegal).

### **Other notes**

*Pennisetum polystachion* is an annual or perennial grass, to 200 cm tall, recognisable by its seedheads, 25 cm long and 1.5-2 cm wide, cylindrical, compact, yellow or purple. Spikelets are surrounded by numerous bristles to 2.5 cm long, and often hairy in the lower part.

*Pennisetum polystachion* is a widespread species, varying in vigour, duration (annual or perennial) and in bristle length and colour.

*Pennisetum polystachion* (L.) Schult.

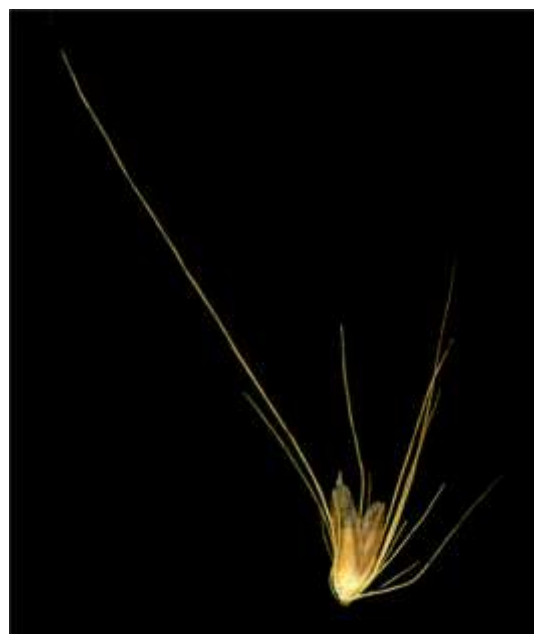


*Pennisetum polystachion* (L.) Schult.

a, base of the plant (x 0.7); b, ligule; c, inflorescence (x 0.7); d, spikelet and involucre of bristles (x 8.4); e, bristle (x 8.4); f, spikelet (x 8.4); g, superior glume; h and i, lemma and palea of inferior floret; j, superior floret; k, palea of superior floret; l, caryopsis.



*Pennisetum polystachion* (L.) Schult.



## ***Pennisetum purpureum* Schumach.**

“Elephant Grass, Napier Grass, Marker grass, Uganda grass”

### **Description**

**Robust perennial**, with erect culms, 100-600 cm long, often bloomy and pubescent.

**Leaf-blades** 30-120 cm long and 20-40 mm wide, with cartilaginous and scaberulous margins. Ligule a fringe of hairs, 3-5 mm long.

**Inflorescence** a panicle with the peduncle pubescent above. Panicle spiciform, linear, 7-30 cm long, 1-3 cm wide. Involucres enclosing 1-5 spikelets, one of them sessile and bisexual, the others pedicelled and male. Bristles terete, flexible, glabrous, the longest 10-40 mm.

**Fertile spikelet** comprising 1 basal sterile floret and 1 fertile floret. Spikelet lanceolate, dorsally compressed, 4.5-7 mm long,

**Sterile spikelets** are well-developed, male, lanceolate, dorsally compressed, 4.5-7 mm long.

### **Ecology**

Riversides, valley bottoms, forest margins and other disturbed sites on fertile soils. It is sometimes considered as a weed in grassland, agricultural land and disturbed habitats: from sea-level to 2500 m.

It is very deep-rooted and has a beneficial effect on soil fertility.

*Pennisetum purpureum* forms large bamboo-like clumps, sometimes producing stolons. In northern Nimba, this grass is common in the foothills along river sides, in fallows and various disturbed places.

### **Distribution**

Tropical Africa – Introduced to most other tropical countries.

### **Uses**

*Pennisetum purpureum* is a valuable pasture and fodder grass, widely cultivated throughout the tropics and subtropic areas of sufficient rainfall, especially for cattle. It is a heavy fodder-producer. It is also cut for hay and fermented for silage.

Split stems are used to make wickerwork baby cots and ordinary covered baskets.

Leaves are used for roofing and culms are made into fences, screens and used to reinforce the mud walls of huts. The can be used for thatching and making paper-pulp. The dried culms as used as pipe stems.

The young leaves and young shoots are eaten in soups and stews. The seeds are eaten by birds.

*Pennisetum purpureum* can be used in soil conservation to stabilise fragile soils using seeds or rooted stem cuttings. It is planted as hedgerows for erosion protection and forage production in the alley cropping system of agroforestry. It is also effective as a windbreak for agricultural crops and planted on riverbanks to prevent erosion. Lines of plants are used to mark boundaries between plots and properties.

In the traditional pharmacopoeia extract of the plant is used as diuretic: it is also used in a number of other herbal remedies. A root decoction as well as ash from the calcined culms is given to treat blennorrhoea. A leaf-infusion constitutes a gargle and mouthwash for buccal infections, gingivitis and Thrush. Clumped of the grass are sometimes grown near houses to prevent entry of evil spirits.

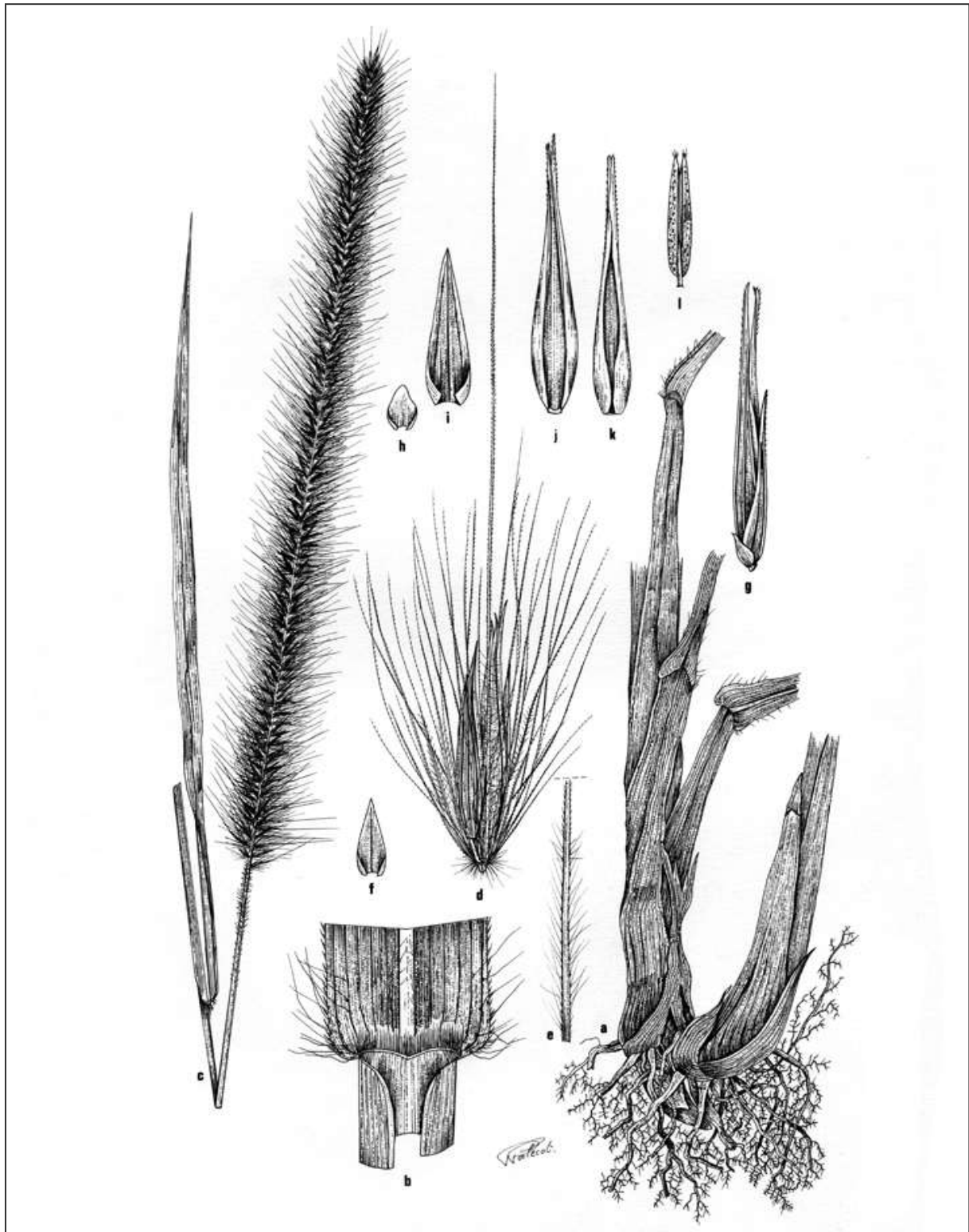
### **Other notes**

*Pennisetum purpureum* is the tallest grass of Africa, mostly found in large stands. It is a robust grass reaching 600-800 cm, producing short creeping rhizomes, with large leaf-blades and a spiciform panicle, yellow, reaching 30 cm. Spikelets are enclosed in an involucre of bristles.

The older culms may branch several times. Leaves of new, vigorous growth have wide, robust leaves but older culms have finer, narrow leaves



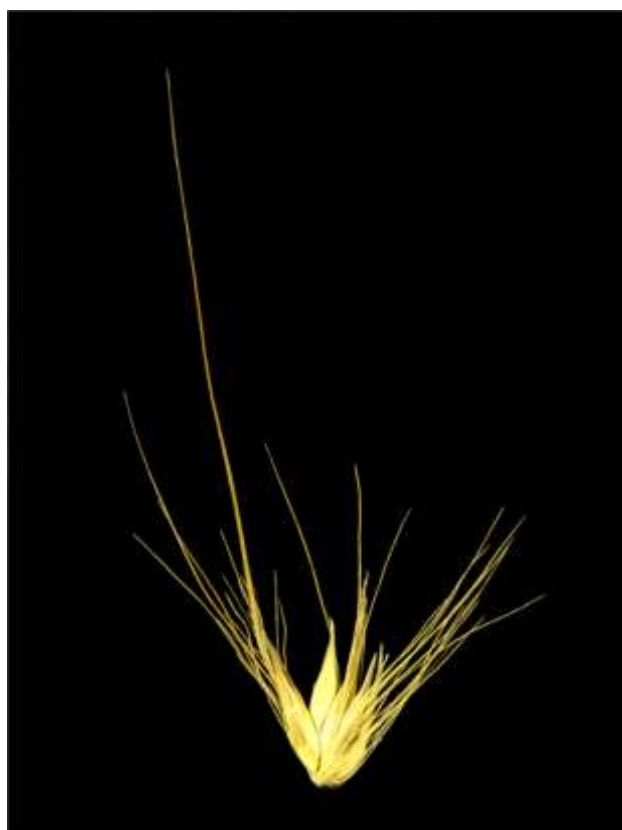
*Pennisetum purpureum* Schumach.



*Pennisetum purpureum* Schumach.

a, base of the plant (x 0.7); b, ligule; c, inflorescence (x 0.7); d, involucre of bristles (x 7); e, base of the main bristle (x 8.4); f, superior glume of a pedicelled spikelet (x 7); g, sessile spikelet (x 7); h, superior glume; i, lemma of inferior floret; j, superior floret; k, palea of superior floret; l, anthers.

*Pennisetum purpureum* Schumach.





## *Rhytachne rottboellioides* Desv.

### Description

**Perennial**, forming dense tussocks, with erect culms 20-100 cm high. Basal sheaths persistent and investing base of culms, with compacted dead sheaths. Ligule a ciliolate membrane.

**Leaf-blades** setaceous, involute, 5-25 cm long and 0.5-1 mm wide.

**Inflorescence** composed of a single terminal raceme, cylindrical, 2-20 cm long. Internodes clavate  $\pm$  equal to the spikelet and the pedicels curved, subfoliaceous.

**Spikelets** in pairs, 1 fertile spikelet, sessile and 1 pedicelled spikelet, sterile

- *Fertile spikelet* comprising 1 basal sterile floret and 1 fertile floret. Spikelet narrowly ovate to oblong, dorsally compressed, 2-5(-6) mm long, with a truncate and glabrous callus.

Lower glume surface smooth (rarely), variously rugose or muricate rugose, acuminate or bidenticulate, with or without an awn up to 5 mm long.

- *Pedicelled spikelet* suppressed or almost so, represented by a curve pedicel sometimes surmounted by an awn up to 5 mm long.

### Ecology

*Rhytachne rottboellioides* is a characteristic grass of swampy and seasonally wet grasslands: from sea-level to 2000 m.

In northern Nimba, *Rhytachne rottboellioides* is not a common species in the old mining sites. It is more common in the foothill savannahs, on the lateritic caparaces, associated with *Loudetia simplex*, *Anadelphia leptocoma* and *Schizachyrium rupestre*.

The grass can become a weed of paddy field margins.



### Distribution

Tropical Africa – Natal – Madagascar – Also in the West Indies and Brazil.

### Uses

*Rhytachne rottboellioides* is of average grazing value.

The culms are weaved to make fancy baskets and fine light straw hats.

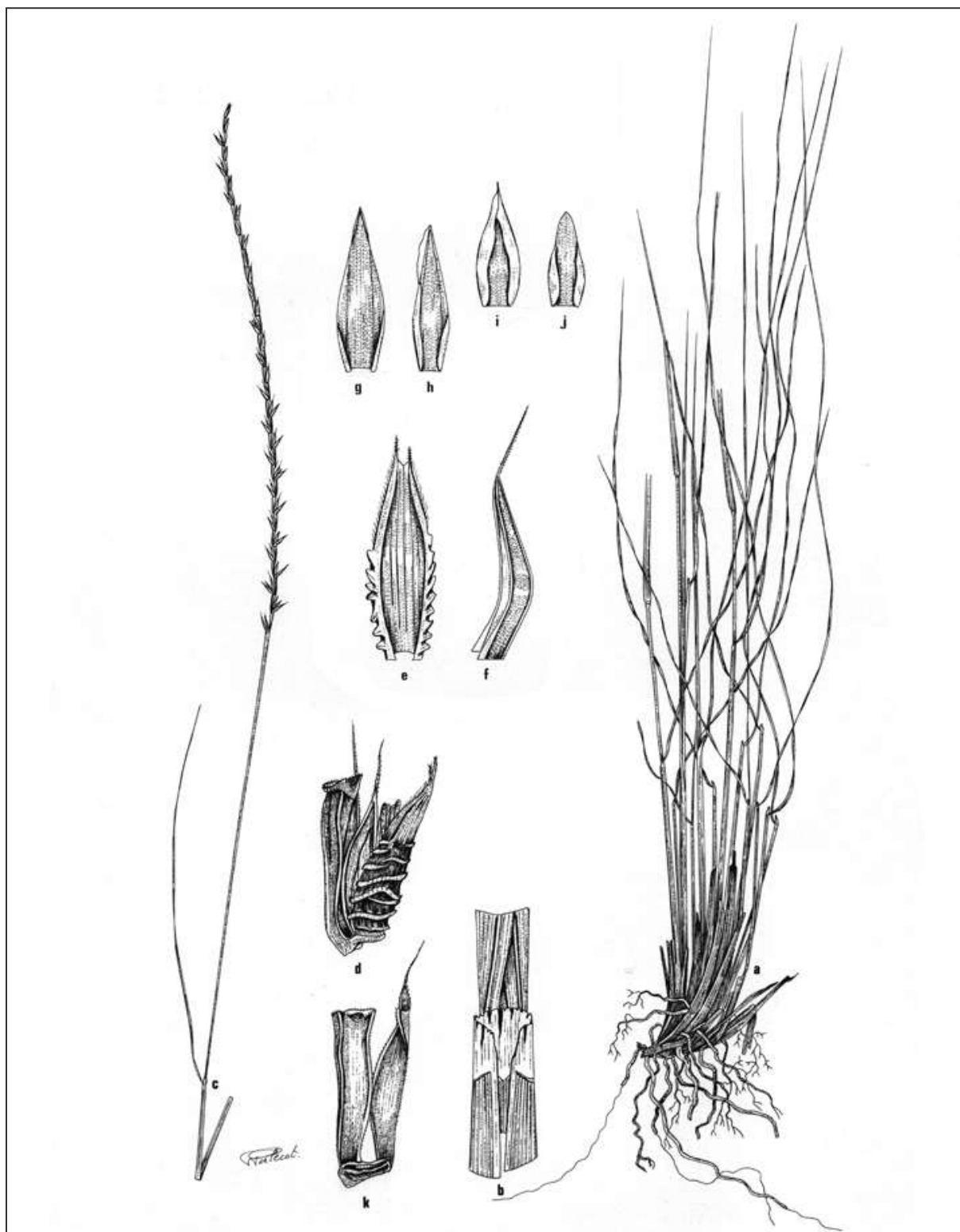
This grass species can be used in soil conservation to stabilise fragile soils in the terraces of the old mining sites, using rooted stem cuttings.

### Other notes

*Rhytachne rottboellioides* is not easy to recognise in the wild. It forms large green tussocks with numerous setaceous leaves. Inflorescence is a slender raceme up to 20 cm long bearing small spikelets, usually rugose or muricate, awned or awnless.



*Rhytachne rottboellioides* Desv.



*Rhytachne rottboellioides* Desv.

a, base of the plant (x 0.7); b, ligule; c, inflorescence (x 0.7); d, pair of spikelets and internode (x 7); sessile spikelet (x 7); e and f, inferior and superior glumes; g and h, lemma and palea of inferior floret; i and j, lemma and palea of superior floret; k, pedicelled spikelet and internode (x 7).

*Rhytachne rottboellioides* Desv.



## *Schizachyrium brevifolium* (Sw.) Büse

### Description

Delicate **annual**, with creeping or rambling culms, slender, 5-60 cm long and 1-2 mm in diameter. Leaf-sheaths mostly shorter than adjacent culm internode. Ligule a ciliolate membrane.

**Leaf-blades** 1-6 cm long and 1-7 mm wide, obtuse at apex.

**Inflorescence** scanty, composed of terminal and axillary racemes, subtended by a linear spatheole. Racemes single, 1-2.5 cm long, fragile, inconspicuous: internodes and pedicels linear to narrowly clavate, 2-4 mm long.

**Spikelets** in pairs, squeezed between internodes and pedicels.

- **Fertile spikelet** comprising 1 basal sterile floret and 1 fertile floret. Spikelet lanceolate, laterally compressed, 2-4 mm long, with an obtuse and pilose callus. Fertile floret with an awn 7-12 mm long, geniculate.
- **Pedicelled spikelet** sterile, rudimentary, lanceolate, dorsally compressed, 1-1.5 mm long; shorter than fertile, with an awn 3-6 mm long.

### Ecology

*Schizachyrium brevifolium* occurs in marshy places, often as an understorey beneath taller grass. It is frequent on shallow and wet soils: from sea-level to 2100 m. It becomes a weed of abandoned cultivations and a roadside ruderal.

*Schizachyrium brevifolium* appears among dominant grass species in savannahs occupying the terraces of the former mining sites. It is also frequent on the mineral ground of terraces with then a reduced size. This species is also very common in the foothill savannahs where it occupies lateritic carapaces.

### Distribution

Throughout the tropics.

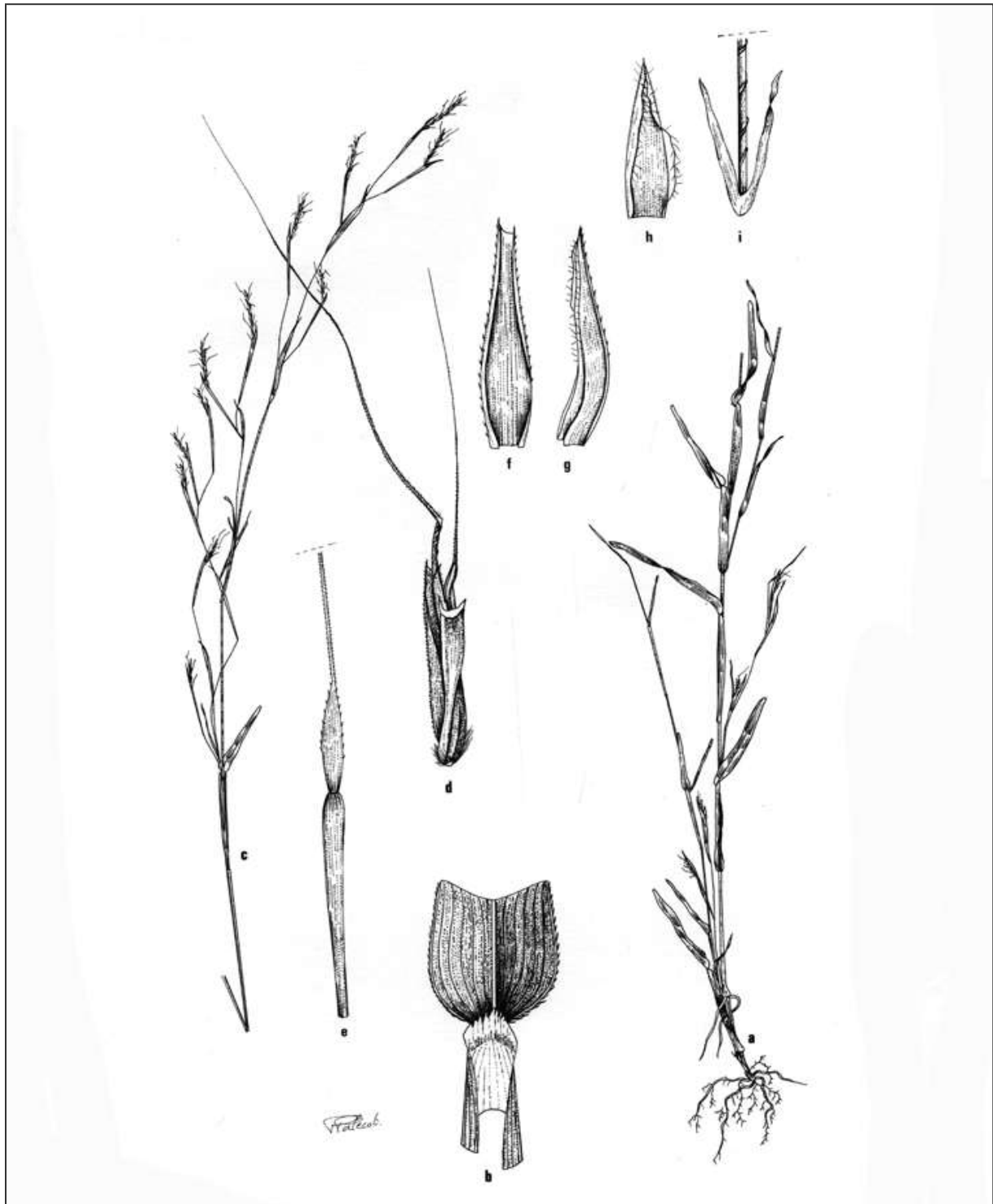
### Uses

*Schizachyrium brevifolium* is a good grazing grass but which disappears rapidly with the dry season. The leafage can be used as a stuffing for beds.

### Other notes

*Schizachyrium brevifolium* is a delicate straggling annual, usually found growing beneath taller grass species, or in shaded sites on damp grounds. It often forms one dominated stratum under the cover of *Melinis minutiflora*. It is also particularly plentiful in certain savannahs composed by *Loudetia phragmitoides* in the foothill where it forms a low dominated stratum very dense, to see exclusive.

*Schizachyrium brevifolium* (Sw.) Büse



*Schizachyrium brevifolium* (Sw.) Büse

a, base of the plant (x 0.7); b, ligule; c, part of inflorescence (x 0.7); d, pair of spikelets and internode (x 8.4); e, pedicelled spikelet (x 8.4); sessile spikelet (x 8.4); f and g, inferior and superior glumes; h, lemma of inferior floret; i, lemma of superior floret.

*Schizachyrium brevifolium* (Sw.) Büse





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***Schizachyrium rupestre* (K. Schum.) Stapf****Description**

**Tufted perennial**, with erect culms 30-150 cm high, slightly compressed at the base. Roots often black. Basal leaf-sheaths glabrous or sparsely pubescent. Ligule a ciliate membrane.

**Leaf-blades** 15-30 cm long and 1-5 mm wide, acute.

**Inflorescence** a panicle, composed of terminal and axillary racemes, long-exserted, subtended by a linear spatheole. Racemes single, delicate, 3-5 cm long: internodes and pedicels clavate to almost linear, long-ciliate on the margins.

**Spikelets** appressed, in pairs, comprising 1 fertile spikelet, sessile and 1 pedicelled spikelet, sterile.

- **Fertile spikelet** comprise 1 basal sterile floret and 1 fertile floret. Spikelet narrowly elliptic, dorsally compressed, 4-6.5 mm long, pilose below, with a pilose callus (base obtuse). Fertile floret with an awn 10-16 mm long, geniculate, with a twisted column 3.5-7 mm long.

- **Pedicelled spikelet** well-developed, lanceolate; dorsally compressed, 3-6.5 mm long, acuminate or with an awn-point up to 2 mm long.

**Ecology**

*Schizachyrium rupestre* is a characteristic grass of shallow, stony soils: from sea-level to 1500 m.

**Distribution**

West, East tropical Africa and South Africa (rare).

**Uses**

*Schizachyrium rupestre* is a poor grazing grass which can be used by cattle when it is still young.

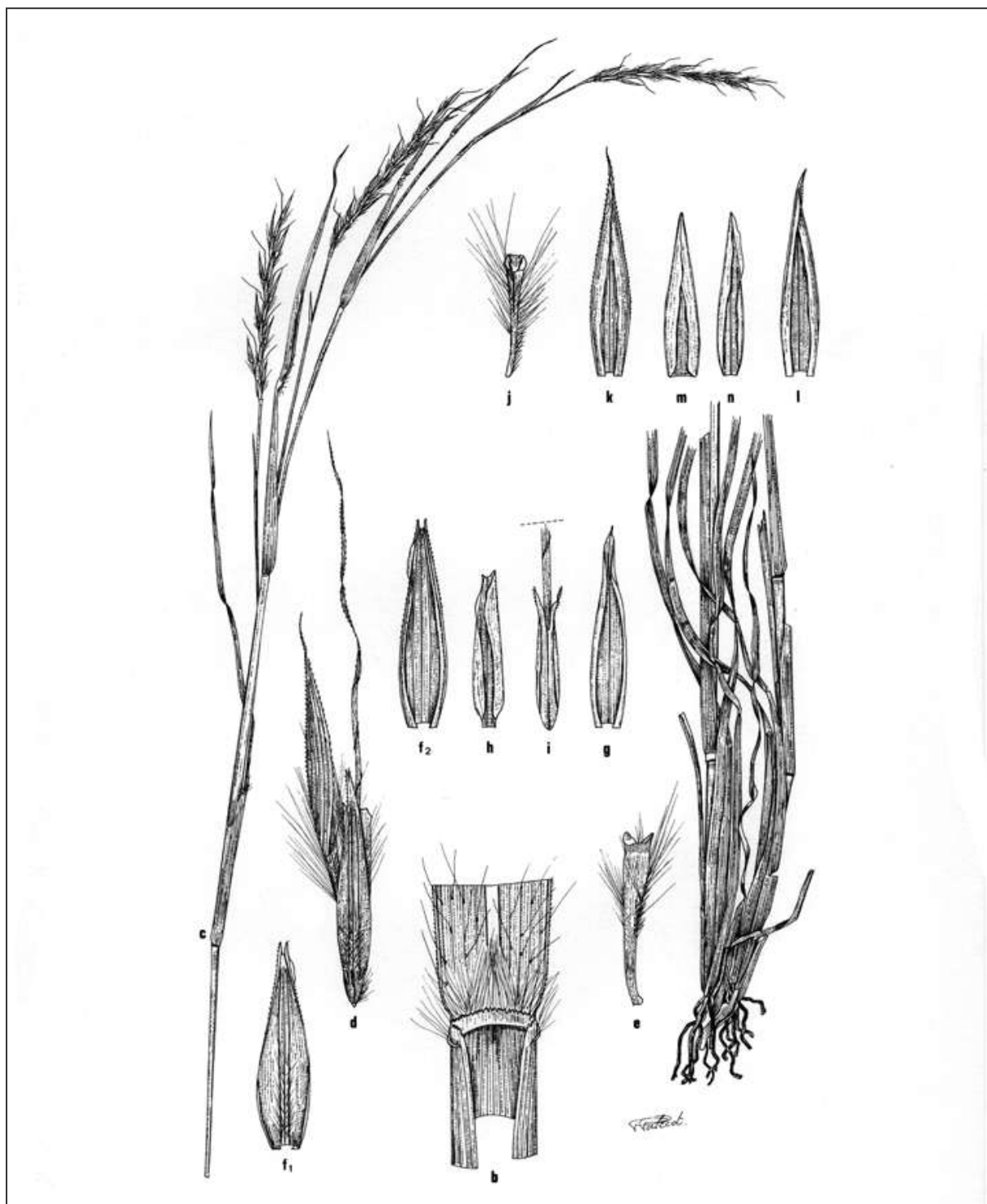
It is an indicator of shallow soils. It can be used to stabilise fragile soils, using rooted stem cuttings.

**Other notes**

In northern Nimba, *Schizachyrium rupestre* occurs in savannahs resting on lateritic carapaces. This species is common in the savannah of Grassfield associated with *Loudetia simplex*, *Rhytachne rotboellioides* and *Monocymbium cerasiiforme*.

It occurs also in the same type of habitat in the savannah of Geipa in the eastern Nimba.

*Schizachyrium rupestre* (K. Schum.) Stapf



*Schizachyrium rupestre* (K. Schum.) Stapf

a, base of the plant (x 0.7); b, ligule; c, inflorescence (x 0.7); d, pair of spikelets and internode (x 5); e, internode (x 5.6); sessile spikelet (x 5): f and g, inferior and superior glumes; h, lemma of inferior floret; i, lemma of superior floret; pedicelled spikelet (x 5): j, pedicel; k and l, inferior and superior glumes; m and n, lemmas of inferior and superior florets.

*Schizachyrium rupestre* (K. Schum.) Stapf



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***Sporobolus dinklagei* Mez****Description**

**Perennial**, caespitose with erect culms 60-120 cm long.

**Leaf-blades** flat, 15-25 cm long and 3-7 mm wide. Ligule a fringe of hairs.

**Inflorescence** an open panicle, linear, 20-40 cm long, contracted about primary branches. Primary panicle branches ascending (incurved), distant (their own length apart), whorled at most nodes (10-20 whorls), 1-2 cm long, bearing spikelets almost to the base.

**Spikelets** solitary, lanceolate, subterete, 2-2.2 mm long, almost black, comprising 1 fertile floret.

**Ecology**

Sandy soils and roadsides: from sea-level to 1500 m.

**Distribution**

West tropical Africa: Sierra Leone to Ivory Coast.

**Uses**

*Sporobolus dinklagei* is of average grazing value.

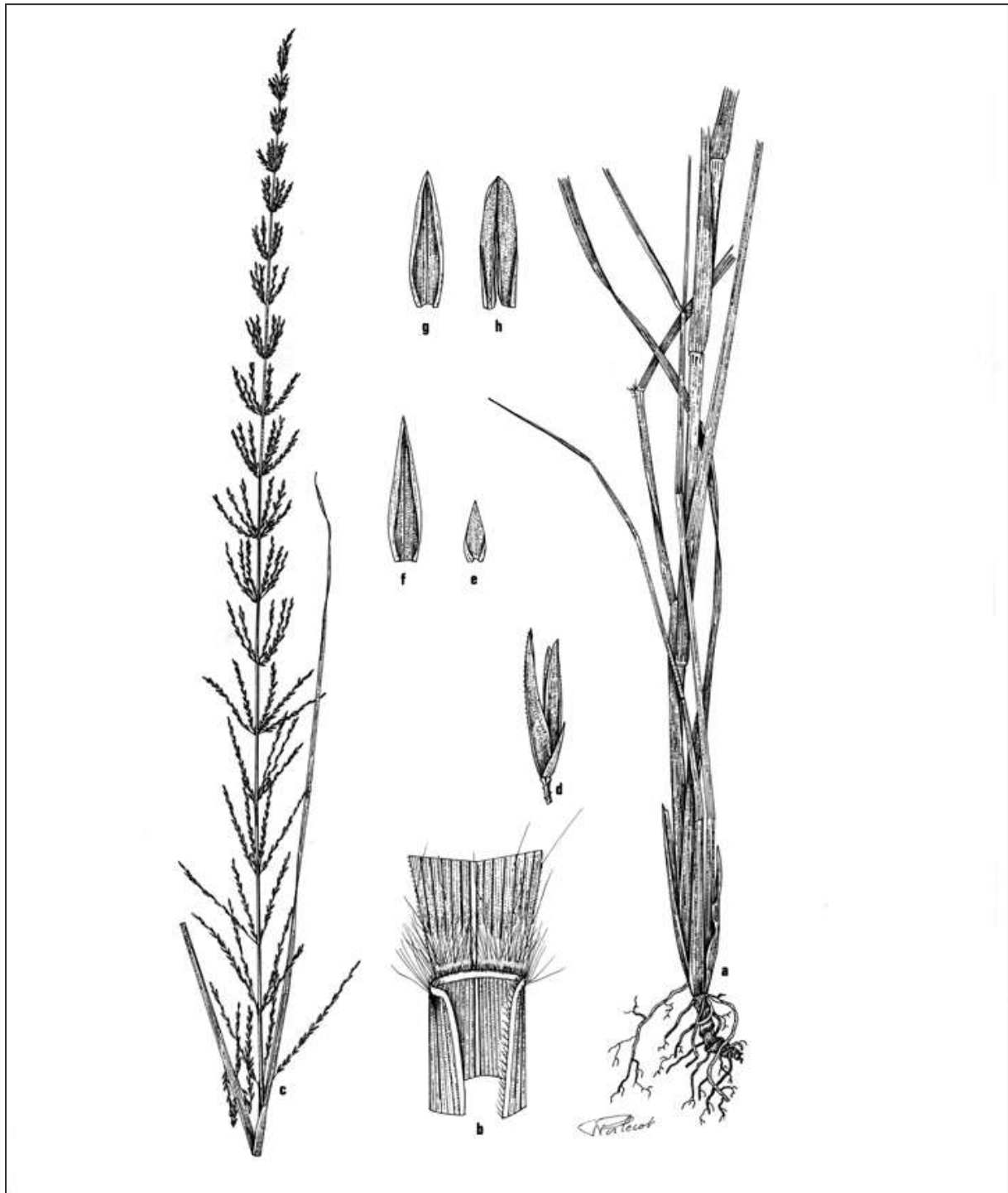
This grass can be used to stabilise fragile soils, using rooted stem cuttings.

**Other notes**

*Sporobolus dinklagei* is one of grasses the best represented in the former mining sites of Northern Nimba. It presents a powerful root system which allows it to settle solidly on the superficial grounds of terraces.

This grass is easily recognisable by its inflorescence composed of successive whorls of racemes.

*Sporobolus dinklagei* Mez



*Sporobolus dinklagei* Mez.

a, base of the plant (x 0.7); b, ligule; c, inflorescence (x 0.5); d, spikelet (x 10.5); e and f, inferior and superior glumes; g and h, lemma and palea.



*Sporobolus dinklagei* Mez



## ***Sporobolus pyramidalis* P. Beauv.**

“Catstail dropseed, Rat’s tail grass”

### **Description**

Tufted **perennial**, with erect culms, 90-160 cm long and 2-5 mm in diameter at the base. Basal sheaths herbaceous. Ligule a fringe of hairs.

**Leaf-blades** flat, or convolute; up to 50 cm long and 3-10 mm wide, tapering to a flexuous filiform tip.

**Inflorescence** a panicle, open, narrowly pyramidal, 20-45 cm long. Primary panicle branches spreading, the lowest 5-10 cm long, bearing spikelets almost to the base. Spikelets are small and packed tightly together.

**Spikelets** pedicelled, lanceolate, subterete, 1.7-2 mm long, green or purplish, comprising 1 fertile floret.

### **Ecology**

*Sporobolus pyramidalis* grows in disturbed, often damp places: from sea-level to 2500 m.

### **Distribution**

A widespread species throughout tropical Africa, extending into South Africa, Madagascar, Mauritius and Yemen – Also (probably introduced) in French Guiana and Brazil.

### **Uses**

*Sporobolus pyramidalis* is a tough, unpalatable grass that is seldom grazed by livestock but can provide forage for stock when young and tender. It is better used by wildlife.

It is an indicator of trampled and overgrazed habitats and it plays an important role in protecting such places against erosion. This grass is a persistent weed in perennial pastures and areas under cultivation.

The culms are used for weaving hats, bowls, baskets and women’s skirts. They are also roved into rope and cord or bundled together to make brooms. The plant is sometimes used to fill mattresses and in house-building when mixed with mud.

Grains can be used as cereal in period of drought and time of famine. The plant is sometimes burnt to produce vegetal salt.

*Sporobolus pyramidalis* is of a graceful habit and can be used in garden borders as an ornamental.

It is difficult to pull out of the ground due to its strong root system. This grass species can be used in soil conservation to stabilise fragile soils, using rooted stem cuttings.

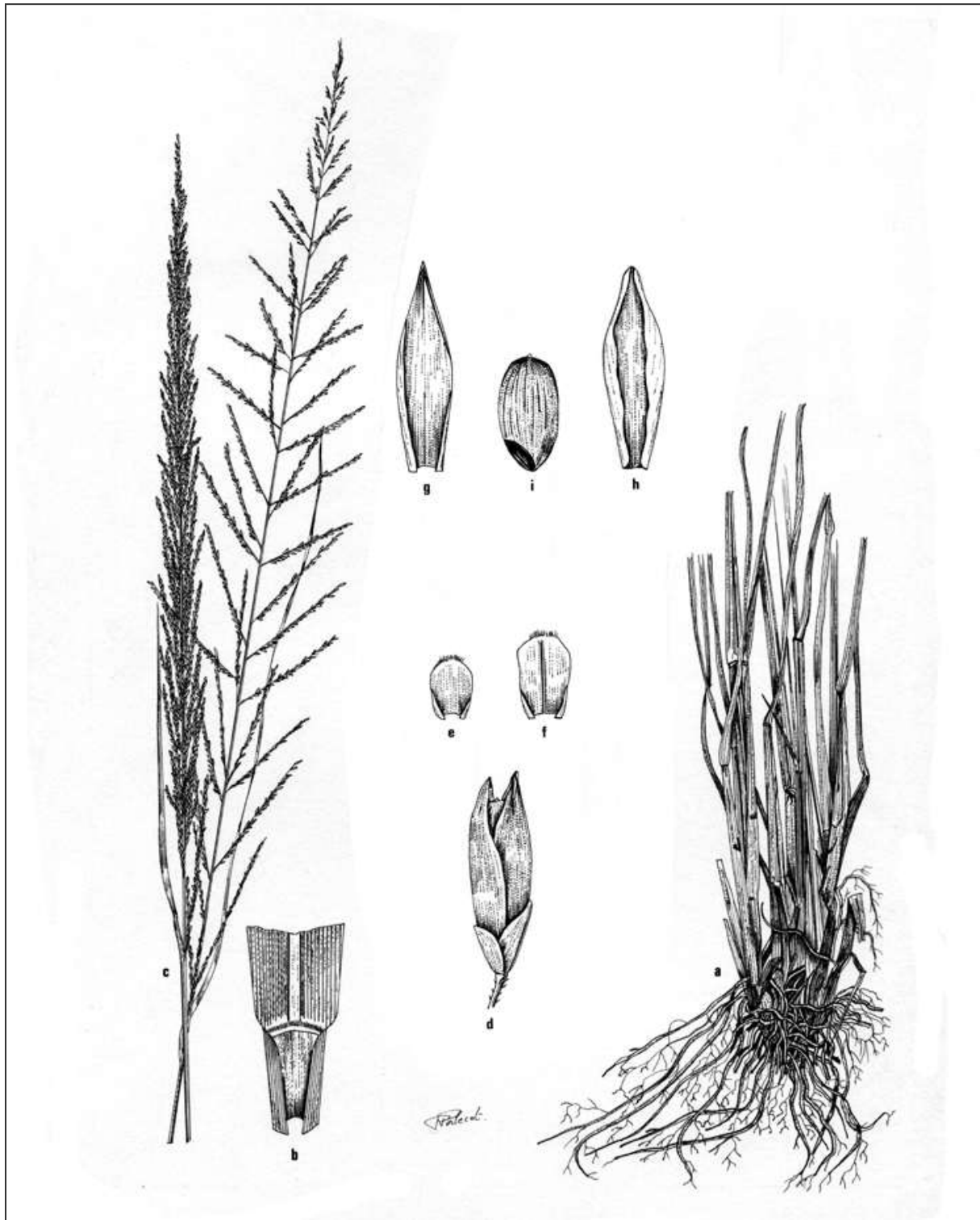
In the traditional pharmacopoeia, the powder of roots is used external to calm stitch. It is a fetish plant to some West African people. The whole plant is used as a styptic and as a snake-bit antidote. A decoction of the whole plant is given in draught as a counter-poison. A prescription, with other medicines, is applied with charms, amulets and magic to make babies strong.

Birds eat the seeds.

### **Other notes**

*Sporobolus pyramidalis* is not very frequent in the old mining sites of the northern Nimba, at altitude, but very common in the foothillt. It is of a graceful habit and is recognisable by its open and pyramidal inflorescence with small grey spikelets packed tightly together.

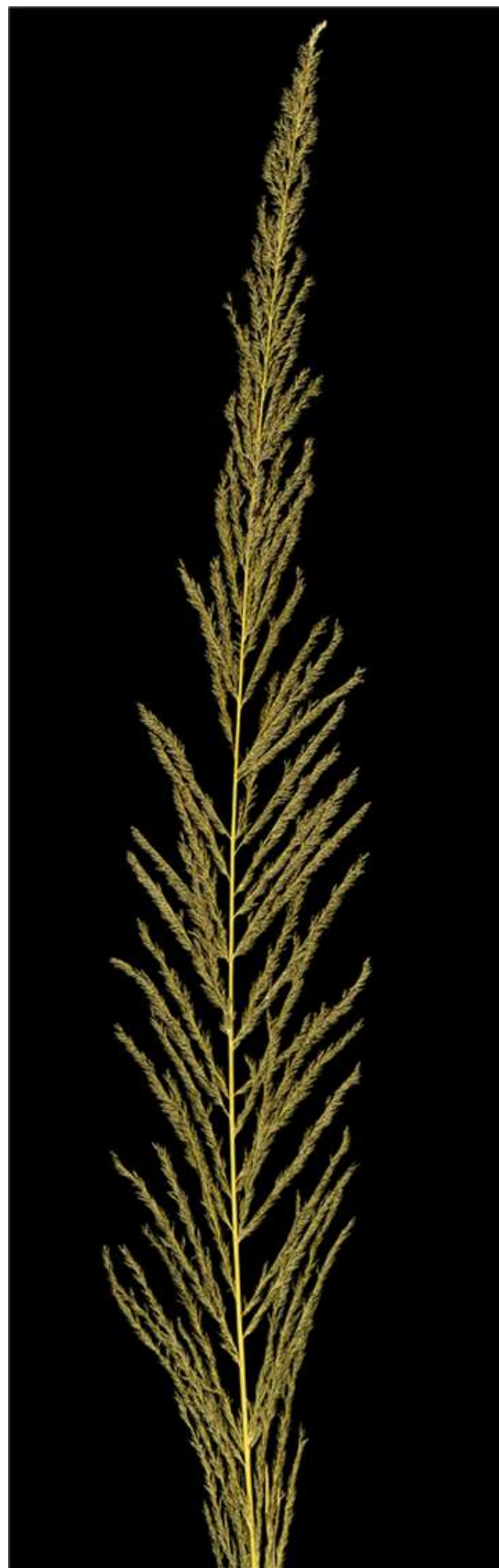
*Sporobolus pyramidalis* P. Beauv.



*Sporobolus pyramidalis* P. Beauv.

a, base of the plant (x 0.7); b, ligule; c, inflorescence (x 0.5); d, e and f, spikelet (profile, dorsal and ventral sides, x 14); g and h, inferior and superior glumes (x 17.5); i and j, lemma and palea (x 14), k, caryopsis (x 10.5).

*Sporobolus pyramidalis* P. Beauv.





## 3. INVENTORIES OF GRASSES IN DIFFERENT AREAS

### 3.1 Grasses of Northern Nimba

**List of the herbaceous species observed, with their families and biological type, in the grassy vegetation of Northern Nimba**

Ch, chamaephyte – G, geophyte – H, hemicryptophyte – Hel, helophyte – Hyd, hydrophyte – L, liane – np, nanophanerophyte – P, parasite – Rh, rhizomatous – St, stoloniferous – Th, therophyte

| Species  | Family           | Biological |
|--|------------------|------------|
| <i>Abildgaardia congolensis</i> (De Wild.) Lye                   | Cyperaceae       | Th         |
| <i>Abildgaardia densa</i> (Wall.) Lye                            | Cyperaceae       | Th         |
| <i>Abrus canescens</i> Welw. ex Bak.                             | Fabaceae         | L/H        |
| <i>Aedesia glabra</i> (Klatt) O. Offm.                           | Asteraceae       | H          |
| <i>Aframomum albobolaceum</i> (Ridley) K. Schum.                 | Zingiberaceae    | G          |
| <i>Ageratum conyzoides</i> L.                                    | Asteraceae       | Th         |
| <i>Alectra sessiliflora</i> (Vahl) Kuntze                        | Scrophulariaceae | Th/Hel     |
| <i>Anadelphia leptocoma</i> (Trin.) Pilg.                        | Poaceae          | H          |
| <i>Anadelphia lomaense</i> (A. Camus) Jacq.-Fél.                 | Poaceae          | H/Hel      |
| <i>Andropogon curvifolius</i> Clayton                            | Poaceae          | H          |
| <i>Andropogon fastigiatus</i> Sw.                                | Poaceae          | Th         |
| <i>Andropogon gayanus</i> Kunth                                  | Poaceae          | H          |
| <i>Andropogon macrophyllus</i> Stapf                             | Poaceae          | H/Rh       |
| <i>Aristolochia embergeri</i> Nozeran & Hallé                    | Aristolochiaceae | L/H        |
| <i>Aspilia africana</i> (Pers.) Adams                            | Asteraceae       | H          |
| <i>Aspilia helianthoides</i> (Schum. & Thonn.) Oliv. &           | Asteraceae       | H          |
| <i>Axonopus compressus</i> (Sw.) P. Beauv.                       | Poaceae          | H/St       |
| <i>Blumea adamsii</i> J.P. Lebrun & Stork                        | Asteraceae       | Th         |
| <i>Blumea heudelotii</i> (Adams) Lisowski                        | Asteraceae       | Th         |
| <i>Brachycorythis paucifolia</i> Summerh.                        | Orchidaceae      | G          |
| <i>Burmannia madagascariensis</i> Martius                        | Burmanniaceae    | Th/Hel     |
| <i>Calopogonium mucunoides</i> Desv.                             | Fabaceae         | L/Th       |
| <i>Canscora diffusa</i> (Vahl) R. Br. ex Roem. & Schult.         | Gentianaceae     | Th         |
| <i>Chamaecrista mimosoides</i> (L.) Greene                       | Caesalpiniaceae  | Th         |
| <i>Chromolaena odorata</i> (L.) R. King & H. Robinson            | Asteraceae       | np         |
| <i>Clerodendrum umbellatum</i> Poir.                             | Verbenaceae      | L/H        |
| <i>Conyza bonariensis</i> (L.) Cronquist                         | Asteraceae       | Th         |
| <i>Crassocephalum rubens</i> (Juss. ex Jacq.) S. Moore           | Asteraceae       | Th         |
| <i>Crotalaria cylindrocarpa</i> DC.                              | Fabaceae         | Th         |
| <i>Crotalaria lathyroides</i> Guill. & Perr.                     | Fabaceae         | Th         |
| <i>Crotalaria retusa</i> L.                                      | Fabaceae         | Th         |
| <i>Ctenium newtonii</i> Hack.                                    | Poaceae          | H          |
| <i>Cuphea carthagenensis</i> J.F. Macbr.                         | Lythraceae       | Th         |
| <i>Cyperus difformis</i> L.                                      | Cyperaceae       | Th/Hel     |
| <i>Cyperus haspan</i> L.   | Cyperaceae       | Th/Hel     |
| <i>Cyperus tenuiculmis</i> Böck. var. <i>guineensis</i> (Nelmes) | Cyperaceae       | Th/Rh      |
| <i>Cyphostemma rubrosetosum</i> (Gilg & Brandt.)                 | Vitaceae         | L//G       |
| <i>Desmodium hirtum</i> Guill. & Perr.                           | Fabaceae         | H          |
| <i>Desmodium ramosissimum</i> G. Don                             | Fabaceae         | H          |
| <i>Desmodium velutinum</i> (Willd.) DC.                          | Fabaceae         | H          |
| <i>Dicranopteris linearis</i> (Burm.f.) Underw.                  | Gleicheniaceae   | L/Ch       |



| Species  | Family         | Biological |
|--|----------------|------------|
| <i>Dioscorea minutiflora</i> Engl.                               | Dioscoreaceae  | G/L        |
| <i>Droogmansia scaettaiana</i> A. Chev. & Sillans                | Fabaceae       | H          |
| <i>Drosera madagascariensis</i> DC.                              | Droseraceae    | Th/Hel     |
| <i>Elionurus tripsacoides</i> H. & B. ex Willd.                  | Poaceae        | H          |
| <i>Elymandra androphila</i> (Stapf) Stapf                        | Poaceae        | H          |
| <i>Emilia coccinea</i> (Sims) G. Don                             | Asteraceae     | Th         |
| <i>Eragrostis atrovirens</i> (Desf.) Steud.                      | Poaceae        | H/Hel      |
| <i>Eragrostis gangetica</i> (Roxb.) Steud.                       | Poaceae        | Th         |
| <i>Eriosema glomeratum</i> (Guill. & Perr.) Hook.f.              | Fabaceae       | H          |
| <i>Euphorbia</i> sp.   | Euphorbiaceae  | Th         |
| <i>Fimbristylis albobiridis</i> C.B. Clarke                      | Cyperaceae     | Th         |
| <i>Fuirena stricta</i> Steud.                                    | Cyperaceae     | H/Rh/Hel   |
| <i>Habenaria genuflexa</i> Rendle                                | Orchidaceae    | G          |
| <i>Hibiscus diversifolius</i> Jacq.                              | Malvaceae      | Th         |
| <i>Hyparrhenia diplandra</i> (Hack.) Stapf var. <i>diplandra</i> | Poaceae        | H          |
| <i>Hyparrhenia diplandra</i> var. <i>mutica</i> (Clayton) Cope   | Poaceae        | H          |
| <i>Hyparrhenia rufa</i> (Nees) Stapf                             | Poaceae        | H/Th       |
| <i>Imperata cylindrica</i> (L.) Raeusch.                         | Poaceae        | G/Rh       |
| <i>Indigofera dendroides</i> Jacq.                               | Fabaceae       | Th         |
| <i>Ipomoea eriocarpa</i> R. Br.                                  | Convolvulaceae | L/H        |
| <i>Ipomoea involucrata</i> P. Beauv.                             | Convolvulaceae | L/H        |
| <i>Lipocarpa chinensis</i> (Osbeck) J.Kern                       | Cyperaceae     | H/Hel      |
| <i>Liparis rufina</i> Rchb.f. ex Rolfe                           | Orchidaceae    | G          |
| <i>Loudetia phragmitoides</i> (Peter) C.E. Hubb.                 | Poaceae        | H          |
| <i>Loudetia simplex</i> (Nees) C.E. Hubb.                        | Poaceae        | H          |
| <i>Ludwigia abyssinica</i> A. Rich.                              | Onagraceae     | Th         |
| <i>Ludwigia erecta</i> (L.) H. Hara                              | Onagraceae     | Th         |
| <i>Lycopodiella affinis</i> (Bory) Pic.Serm.                     | Lycopodiaceae  | Ch         |
| <i>Mariscus rubrotinctus</i> Cherm.                              | Cyperaceae     | H/Rh       |
| <i>Melinis minutiflora</i> P. Beauv.                             | Poaceae        | H          |
| <i>Mimosa pudica</i> L.  | Mimosaceae     | L/Th/H     |
| <i>Monocymbium deightonii</i> C.E. Hubb.                         | Poaceae        | H          |
| <i>Nemum spadiceum</i> (Lam.) Desv. ex Ham.                      | Cyperaceae     | Th/Hel     |
| <i>Nephrolepis undulata</i> (Afzel ex Sw.) J.Sm.                 | Davalliaceae   | H          |
| <i>Neurotheca loeselioides</i> (Spruce ex Progel) Baillon        | Gentianaceae   | Th/Hel     |
| <i>Oldenlandia corymbosa</i> L.                                  | Rubiaceae      | Th         |
| <i>Oldenlandia herbacea</i> (L.) Roxb.                           | Rubiaceae      | Th         |
| <i>Otomeria guineensis</i> Benth.                                | Rubiaceae      | H          |
| <i>Panicum congoense</i> Franch.                                 | Poaceae        | H/Hel      |
| <i>Panicum dinklagei</i> Mez                                     | Poaceae        | Ch         |
| <i>Panicum glaucocladum</i> C.E. Hubb.                           | Poaceae        | Th         |
| <i>Panicum griffonii</i> Franch.                                 | Poaceae        | Th         |
| <i>Panicum hochstetteri</i> Steud.                               | Poaceae        | H/Ch       |
| <i>Panicum laxum</i> Sw.   | Poaceae        | Th/Hel     |
| <i>Panicum nervatum</i> (Franch.) Stapf                          | Poaceae        | H          |
| <i>Panicum parvifolium</i> Lam.                                  | Poaceae        | H/Hyd/Hel  |
| <i>Panicum sadinii</i> (Vanderyst) Renvoize                      | Poaceae        | H          |
| <i>Paspalum conjugatum</i> Berg                                  | Poaceae        | H/St       |
| <i>Paspalum scrobiculatum</i> L.                                 | Poaceae        | H/Hel      |
| <i>Passiflora foetida</i> L.                                     | Passifloraceae | L/Th       |
| <i>Pennisetum hordeoides</i> (Lam.) Steud.                       | Poaceae        | Th         |

| Species   | Family           | Biological |
|---|------------------|------------|
| <i>Pennisetum polystachion</i> (L.) Schult.               | Poaceae          | H/Th       |
| <i>Pennisetum purpureum</i> Schumach.                     | Poaceae          | H/Rh       |
| <i>Phyllanthus alpestris</i> Beille                       | Euphorbiaceae    | Ch/nph     |
| <i>Phyllanthus</i> sp.                                    | Euphorbiaceae    | Th         |
| <i>Phyllanthus</i> sp.                                    | Euphorbiaceae    | H          |
| <i>Plectranthus monostachyus</i> (P. Beauv.) B.J. Pollard | Lamiaceae        | Th         |
| <i>Polygala multiflora</i> Poir.                          | Polygalaceae     | Th         |
| <i>Pteridium aquilinum</i> (L.) Kuhn                      | Dennstaedtiaceae | G/Rh       |
| <i>Pueraria phaseoloides</i> (Roxb.) Benth.               | Fabaceae         | L/H        |
| <i>Pycnus capillifolius</i> (A.Rich.) C.B. Clarke         | Cyperaceae       | Th/Hel     |
| <i>Pycnus lanceolatus</i> (Poir.) C.B. Clarke             | Cyperaceae       | H/Rh/Hel   |
| <i>Pycnus polystachyos</i> (Rottb.) P. Beauv.             | Cyperaceae       | H/Rh       |
| <i>Rhynchospora corymbosa</i> (L.) Britton                | Cyperaceae       | H/Rh/Hyd   |
| <i>Rhynchospora perrieri</i> Cherm.                       | Cyperaceae       | Th/Hel     |
| <i>Rhytachne rottboellioides</i> Desv.                    | Poaceae          | H/Hél      |
| <i>Rottboellia cochinchinensis</i> (Lour) Clayton         | Poaceae          | H          |
| <i>Sauvagesia erecta</i> L.                               | Ochnaceae        | H          |
| <i>Schizachyrium brevifolium</i> (Sw.) Büse               | Poaceae          | Th         |
| <i>Schizachyrium delicatum</i> Stapf                      | Poaceae          | Th         |
| <i>Schizachyrium rupestre</i> (K.Schum.) Stapf            | Poaceae          | H          |
| <i>Schwenckia americana</i> L.                            | Solanaceae       | Th         |
| <i>Scleria aterrima</i> (Ridl.) Napper                    | Cyperaceae       | H/Rh       |
| <i>Scleria flexuosa</i> Boeckeler                         | Cyperaceae       | Th/Hel     |
| <i>Scleria lagoensis</i> Boeckeler                        | Cyperaceae       | H/Rh/Hel   |
| <i>Scleria naumanniana</i> Boeckeler                      | Cyperaceae       | H/Rh/Hel   |
| <i>Scleria spiciformis</i> Benth.                         | Cyperaceae       | H/Rh       |
| <i>Sida acuta</i> Burm. f.                                | Malvaceae        | Th         |
| <i>Sida linifolia</i> Juss. ex Cav.                       | Malvaceae        | Th         |
| <i>Smilax kraussiana</i> Meisn.                           | Smilacaceae      | L/G/H      |
| <i>Sopubia ramosa</i> (Hochst.) Hochst.                   | Scrophulariaceae | Th         |
| <i>Spermacoce ruelliae</i> DC.                            | Rubiaceae        | Th         |
| <i>Spermacoce verticillata</i> L.                         | Rubiaceae        | H          |
| <i>Sporobolus dinklagei</i> Mez                           | Poaceae          | H/Rh       |
| <i>Sporobolus paniculatus</i> (Trin.) T. Durand & Schinz  | Poaceae          | Th         |
| <i>Sporobolus pyramidalis</i> P. Beauv.                   | Poaceae          | H          |
| <i>Stachytarpheta angustifolia</i> (Mill.) Vahl           | Verbenaceae      | Th         |
| <i>Striga asiatica</i> (L.) Kuntze                        | Scrophulariaceae | Par        |
| <i>Striga macrantha</i> (Benth.) Benth.                   | Scrophulariaceae | Par        |
| <i>Tephrosia flexuosa</i> G. Don                          | Fabaceae         | Th         |
| <i>Thunbergia chrysops</i> Hook.                          | Acanthaceae      | L/H        |
| <i>Triumfetta tomentosa</i> Bojer                         | Tiliaceae        | Th         |
| <i>Urena lobata</i> L.                                    | Malvaceae        | H          |
| <i>Vigna racemosa</i> (G.Don) Hutch. & Dalziel            | Fabaceae         | L/Th       |
| <i>Xyris decipiens</i> N.E.Br.                            | Xyridaceae       | H/Hel      |
| <i>Xyris straminea</i> N.A. Nilsson                       | Xyridaceae       | Th/Hel     |
| <i>Zehneria thwaitesii</i> (Schweinf.) C. Jeffrey         | Cucurbitaceae    | Th         |
| <i>Zornia latifolia</i> Sm.                               | Fabaceae         | H          |

## 3.2 Grasses of Greenhill, Bong

**List of the herbaceous species observed, with their families and biological type, in the grassy vegetation of Greenhill Quarry area, Bong County**

Ch, chamephyte – G, geophyte – H, hemicryptophyte – Hel, helophyte – Hyd, hydrophyte – L, liane – Rh, rhizomatous – Th, therophyte

| Species   | Family           | Biological Type |
|---|------------------|-----------------|
| <i>Abildgaardia congolensis</i> De Wild.) Lye         | Cyperaceae       | Th              |
| <i>Aeollanthus pubescens</i> Benth.                   | Lamiaceae        | Th/Hel          |
| <i>Afrotrilepis pilosa</i> (Boeckeler) J.Raynal       | Cyperaceae       | Ch              |
| <i>Astraea lobata</i> (L.) Klotzsch                   | Euphorbiaceae    | Th              |
| <i>Chamaecrista kirkii</i> (Oliv.) Standl.            | Caesalpinaceae   | Th              |
| <i>Chromolaena odorata</i> (L.) R. King & H. Robinson | Asteraceae       | nph             |
| <i>Crotalaria lathyroides</i> Guill. & Perr.          | Fabaceae         | Th              |
| <i>Cyperus difformis</i> L.                           | Cyperaceae       | Th/Hél          |
| <i>Cyperus haspan</i> L.                              | Cyperaceae       | Th/Hél          |
| <i>Dolichos dinklagei</i> Harms                       | Fabaceae         | Ch              |
| <i>Eragrostis atrovirens</i> (Desf.) Steud.           | Poaceae          | H/Hél           |
| <i>Eragrostis gangetica</i> (Roxb.) Steud.            | Poaceae          | Th/Hél          |
| <i>Eriocaulon</i> sp.                                 | Eriocaulaceae    | Th/Hél          |
| <i>Fimbristylis littoralis</i> Gand.                  | Cyperaceae       | Th              |
| <i>Fuirena umbellata</i> Rottb.                       | Cyperaceae       | G/He/Rh         |
| <i>Lipocarpa filiformis</i> (Vahl) Kunth              | Cyperaceae       | Th/Hél          |
| <i>Loudetia simplex</i> (Nees) C.E. Hubb.             | Poaceae          | H               |
| <i>Panicum glaucocladum</i> C.E. Hubb.                | Poaceae          | Th/Hél          |
| <i>Panicum griffonii</i> Franch.                      | Poaceae          | Th              |
| <i>Panicum laxum</i> Sw.                              | Poaceae          | Th/Hél          |
| <i>Pennisetum hordeoides</i> (Lam.) Steud.            | Poaceae          | Th              |
| <i>Pennisetum polystachion</i> (L.) Schult.           | Poaceae          | H/Th            |
| <i>Polygala multiflora</i> Poir.                      | Polygalaceae     | Th              |
| <i>Pteridium aquilinum</i> (L.) Kuhn                  | Dennstaedtiaceae | G/Rh            |
| <i>Pycreus capillifolius</i> (A. Rich.) C.B. Clarke   | Cyperaceae       | Th/Hél          |
| <i>Pycreus polystachyos</i> (Rottb.) P. Beauv.        | Cyperaceae       | H/Rh            |
| <i>Rottboellia cochinchinensis</i> (Lour) Clayton     | Poaceae          | H               |
| <i>Schizachyrium brevifolium</i> (Sw.) Büse           | Poaceae          | Th              |
| <i>Sida linifolia</i> Juss. ex Cav.                   | Malvaceae        | Th              |
| <i>Spermacoce verticillata</i> L.                     | Runiaceae        | H               |
| <i>Spigelia anthelmia</i> L.                          | Loganiaceae      | Th              |

## 3.3 Grasses of Buchanan, Grand Bassa

### List of the herbaceous species observed, with their families and biological type, in the grassy vegetation of the Buchanan area

Ch, chamephyte – G, geophyte – H, hemicryptophyte – Hel, helophyte – Hyd, hydrophyte – L, liane – nph, nanophanerophyte – P, parasite – Rh, rhizomatous – St, stoloniferous – Th, therophyte

| Species   | Family          | Biological Type |
|---|-----------------|-----------------|
| <i>Abildgaardia congolensis</i> (De Wild.) Lye          | Cyperaceae      | Th              |
| <i>Aechynomene indica</i> L.                            | Fabaceae        | Th/Hel          |
| <i>Anadelphia leptocoma</i> (Trin.) Pilg.               | Poaceae         | H               |
| <i>Aspilia africana</i> (Pers.) Adam                    | Asteraceae      | H               |
| <i>Astraea lobata</i> (L.) Klotzsch                     | Euphorbiaceae   | Th              |
| <i>Axonopus compressus</i> (Sw.) P. Beauv.              | Poaceae         | H/St            |
| <i>Brachiaria brizantha</i> (Hochst. ex A. Rich.) Stapf | Poaceae         | H               |
| <i>Bulbostylis laniceps</i> (K.Schum.) C.B.Clarke ex    | Cyperaceae      | Th              |
| <i>Burmannia liberica</i> Engl.                         | Burmanniaceae   | Th/Hel          |
| <i>Calopogonium mucunoides</i> Desv.                    | Fabaceae        | L/Th            |
| <i>Chamaecrista mimosoides</i> (L.) Greene              | Caesalpiniaceae | Th              |
| <i>Chromolaena odorata</i> (L.) R. king & Robinson      | Asteraceae      | Nph             |
| <i>Courtoisina cyperoides</i> (Roxb.) Soják             | Cyperaceae      | Th/Hel          |
| <i>Crotalaria retusa</i> L.                             | Fabaceae        | Th              |
| <i>Cuphea carthagenensis</i> J.F. Macbr.                | Lythraceae      | Th              |
| <i>Cuscuta australis</i> R.Br.                          | Convolvulaceae  | L/Par           |
| <i>Cyclocarpa stellaris</i> Afzel. ex Baker             | Fabaceae        | Th              |
| <i>Cynodon dactylon</i> (L.) Pers.                      | Poaceae         | G               |
| <i>Cyperus difformis</i> L.                             | Cyperaceae      | Th/Hel          |
| <i>Cyperus haspan</i> L.                                | Cyperaceae      | Th/Hel          |
| <i>Desmodium ramosissimum</i> G. Don                    | Fabaceae        | H               |
| <i>Desmodium triflorum</i> (L.) DC.                     | Fabaceae        | H               |
| <i>Digitaria argyrotica</i> (Andersson) Chiov.          | Poaceae         | Th/H            |
| <i>Digitaria horizontalis</i> Willd.                    | Poaceae         | Th/H            |
| <i>Dissotis rotundifolia</i> (Sm.) Triana               | Melastomataceae | Th              |
| <i>Echinochloa colona</i> (L.) Link                     | Poaceae         | Th/H            |
| <i>Eclipta prostrata</i> (L.) L.                        | Asteraceae      | Th              |
| <i>Eleocharis geniculata</i> (L.) Roem. & Schult.       | Cyperaceae      | Th/Hel          |
| <i>Emilia coccinea</i> (Sims) G. Don                    | Asteraceae      | Th              |
| <i>Eragrostis atrovirens</i> (Desf.) Steud.             | Poaceae         | H               |
| <i>Eragrostis gangetica</i> (Roxb.) Steud.              | Poaceae         | Th/H            |
| <i>Eragrostis unioides</i> (Retz.) Nees ex Steud.       | Poaceae         | Th/H            |
| <i>Fimbristylis littoralis</i> Gand.                    | Cyperaceae      | Th/Hel          |
| <i>Fuirena umbellata</i> Rottb.                         | Cyperaceae      | G/Hel           |
| <i>Habenaria genuflexa</i> Rendle                       | Orchidaceae     | G               |
| <i>Hibiscus physaloides</i> Guill. & Perr.              | Malvaceae       | Th              |
| <i>Imperata cylindrica</i> (L.) Raeuschl.               | Poaceae         | G/Rh            |
| <i>Ipomoea aquatica</i> Forssk.                         | Convolvulaceae  | L/H/Hyd/Hel     |
| <i>Ipomoea cairica</i> (L.) Sweet                       | Convolvulaceae  | L/H             |
| <i>Ipomoea involucrata</i> P. Beauv.                    | Convolvulaceae  | L/H             |
| <i>Isachaemum afrum</i> (J.F. Gmel) Dandy               | Poaceae         | H/Rh            |
| <i>Kyllinga peruviana</i> Lam.                          | Cyperaceae      | H/Rh            |
| <i>Lasiorhiza senegalensis</i> Schott                   | Araceae         | G/Hel           |

| Species  | Family           | Biological Type |
|--|------------------|-----------------|
| <i>Lipocarpa chinensis</i> (Osbeck) J. Kern                  | Cyperaceae       | H/Hel           |
| <i>Liparis rufina</i> Rchb. ex Rolfe                         | Orchidaceae      | G               |
| <i>Loudetia phragmitoides</i> (Peter) C.E. Hubb.             | Poaceae          | H/Rh            |
| <i>Ludwigia erecta</i> (L.) H. Hara                          | Onagraceae       | Th              |
| <i>Lycopodiella affinis</i> (Bory) Pic.Serm.                 | Lycopodiaceae    | Ch/Hel          |
| <i>Mesanthemum radicans</i> (Benth.) Körn.                   | Eriocaulaceae    | H               |
| <i>Mimosa pudica</i> L.                                      | Mimosaceae       | L/Th/H          |
| <i>Neurotheca loeselioides</i> (Spruce ex Progel) Baill.     | Gentianaceae     | Th/Hel          |
| <i>Oldenlandia corymbosa</i> L.                              | Rubiaceae        | Th              |
| <i>Panicum dinklagei</i> Mez                                 | Poaceae          | Ch              |
| <i>Panicum glaucocladum</i> C.E. Hubb.                       | Poaceae          | Th/Hel          |
| <i>Panicum griffonii</i> Franch.                             | Poaceae          | Th              |
| <i>Panicum laxum</i> Sw.                                     | Poaceae          | Th/Hel          |
| <i>Panicum maximum</i> Jacq.                                 | Poaceae          | H               |
| <i>Panicum parvifolium</i> Lam.                              | Poaceae          | H/Hel           |
| <i>Panicum repens</i> L.                                     | Poaceae          | G/Rh/Hyd        |
| <i>Paspalum scrobiculatum</i> L.                             | Poaceae          | H/Hel           |
| <i>Passiflora foetida</i> L.                                 | Passifloraceae   | Th              |
| <i>Pennisetum polystachion</i> (L.) Schult.                  | Poaceae          | H/Th            |
| <i>Phyllanthus</i> sp.                                       | Euphorbiaceae    | Th              |
| <i>Phyllanthus</i> sp.                                       | Euphorbiaceae    | H               |
| <i>Plecthranthus monostachyus</i> (P. Beauv.) B.J. Pollard   | Lamiaceae        | Th              |
| <i>Polygonum limbatum</i> Meisn.                             | Polygonaceae     | G/Hyd           |
| <i>Pteridium aquilinum</i> (L.) Kuhn                         | Dennstaedtiaceae | G               |
| <i>Pueraria phaseoloides</i> (Roxb.) Benth.                  | Fabaceae         | L/H             |
| <i>Pycreus capillifolius</i> (A. Rich.) C.B. Clarke          | Cyperaceae       | Th/Hel          |
| <i>Pycreus polystachyos</i> (Rottb.) P. Beauv.               | Cyperaceae       | Th/Hel          |
| <i>Sauvagesia erecta</i> L.                                  | Ochnaceae        | H               |
| <i>Schizachyrium brevifolium</i> (Sw.) Büse                  | Poaceae          | Th              |
| <i>Schizachyrium maclaudii</i> (Jacq.-Fél.) S.T. Blake       | Poaceae          | Th              |
| <i>Schwenckia americana</i> L.                               | Solanaceae       | Th              |
| <i>Scleria achtenii</i> De Wild.                             | Cyperaceae       | H/Rh            |
| <i>Scleria spiciformis</i> Benth.                            | Cyperaceae       | H/Rh            |
| <i>Scoparia dulcis</i> L.                                    | Scrophulariaceae | Th              |
| <i>Sida acuta</i> Burm. f.                                   | Malvaceae        | Th              |
| <i>Sida linifolia</i> Juss. ex Cav.                          | Malvaceae        | Th              |
| <i>Sorghum bicolor</i> subsp. <i>arundinaceum</i> (Desv.) de | Poaceae          | Th              |
| <i>Spermacoce verticillata</i> L.                            | Rubiaceae        | H               |
| <i>Spigelia anthelmia</i> L.                                 | Loganiaceae      | Th              |
| <i>Sporobolus dinklagei</i> Mez                              | Poaceae          | H               |
| <i>Sporobolus pyramidalis</i> P. Beauv.                      | Poaceae          | H               |
| <i>Stachytarpheta angustifolia</i> (Mill.) Vahl              | Verbenaceae      | Th              |
| <i>Striga asiatica</i> (L.) Kuntze                           | Scrophulariaceae | Par             |
| <i>Stylosanthes erecta</i> P. Beauv.                         | Fabaceae         | H               |
| <i>Urena lobata</i> L.                                       | Malvaceae        | H               |
| <i>Xyris decipiens</i> N.E.Br.                               | Xyridaceae       | H/Hel           |
| <i>Xyris rubella</i> Malme                                   | Xyridaceae       | Th/Hel          |
| <i>Xyris straminea</i> N.A. Nilsson                          | Xyridaceae       | Th/Hel          |
| <i>Zornia latifolia</i> Sm.                                  | Fabaceae         | H               |



## 4. GRASS ASSOCIATIONS

This section gives examples of the grass associations found in the surveys in Liberia.

### 4.1 Savannahs Developed on Old Mine Sites in Northern Nimba

The former mining sites of Nimba Old Mine, Blue Lake and Tokadeh were studied together because they form a very different group from the other sites situated in the piedmont. Over several decades, the mining activities modified the landscape and reduced mountains covered with dense forests to bare terraced slopes. Approximately two decades after the abandonment of the mining activities, these slopes have become colonised with savanna species.

Ninety-three herbaceous species were found in these three sites, within 33 plots surveyed, including 27 Poaceae, 15 Cyperaceae and 51 species belonging to diverse families.

The herbaceous layer which covers these terraces, mainly composed of grasses, supplies a good vegetation cover for the soil. The majority of grasses observed in these savannahs are perennial and so play an essential role in the fixation and the preservation of soils. The main species include *Anadelphia leptocoma*, *Axonopus compressus*, *Loudetia phragmitoides*, *Melinis minutiflora*, *Schizachyrium brevifolium* (annual) and *Sporobolus dinklagei*. These species are not distributed in a homogeneous way between the various sites:

- *Anadelphia leptocoma* is a dominant Poaceae in the three sites but is represented locally in Tokadeh Site (Site IV)
- *Axonopus compressus* is abundant in the Old Mine Site (Site I) but less so than that of Blue Lake (Site II) and locally represented on Mount Tokadeh (Site IV).
- *Loudetia phragmitoides* and *Schizachyrium brevifolium* are the two species that are distributed on all the three sites.
- *Melinis minutiflora* is abundant in the sites of Old Mine and Blue Lake.

Certain other grasses, although represented only locally, are of significant interest for the revegetation of terraces. They are: *Andropogon macrophyllus*, *Hyparrhenia diplandra* var. *diplandra*, and *Paspalum scrobiculatum*. Their presence in the various sites of Northern Nimba could mean an evolution of the grass layer of the terraces by the installation of strong perennial and typically savanna grasses (with the exception of *Paspalum scrobiculatum* which can be common in human disturbed ground). Another long-lasting grass, *Imperata cylindrica*, is locally abundant, in particular in the Site of Blue Lake (Site II). This rhizomatous grass often appears in the disturbed soil, after cultivation, and becomes an invasive and annoying species because of its resistance and difficulty to control. Its presence in the surveyed sites is very localised.

It could be the same with *Melinis minutiflora* which covers a large part of the mountain slopes in the sites of Old Mine (Site I) and Blue Lake (Site II). This species can be used as a cover plant and to stabilise soil but can become an invasive harmful plant and, as *Imperata cylindrica*, difficult, even impossible, to control. It is practically absent in the Site of Mount Tokadeh (Site IV). *Panicum griffonii*, an annual, is also a frequent Poaceae in the three sites. Some grasses as *Panicum sadinii*, *P. dinklagei*, and *P. hochstetteri* are more sciaphilous and occupy the border of thickets adjacent to ravines or areas shielded by rocks.

The Cyperaceae family is well-represented in all the sites, but the species are never abundant. These plants occupy the small swampy depressions which persist on the mineral ground of terraces. Certain species such as *Abildgaardia congolensis*, *Cyperus tenuiculmis* var. *guineensis*, *Pycneus capillifolius*, *P. polystrachyos* or *Scleria flexuosa* can be frequent locally. These species are often associated with some grasses occupying the same habitats such as *Eragrostis atrovirens*, *Paspalum scrobiculatum* and *Panicum laxum*.

Other herbaceous species are spread in the grass layer, but not abundant, with the exception of *Chromolaena odorata* in the sites of Blue Lake (Site II) and Mount Tokadeh (Site IV).

The soil and environmental conditions favour the growth of some of the species, such as *Neurotheca loeselioides* and *Canscora diffusa* on the very shallow soils.

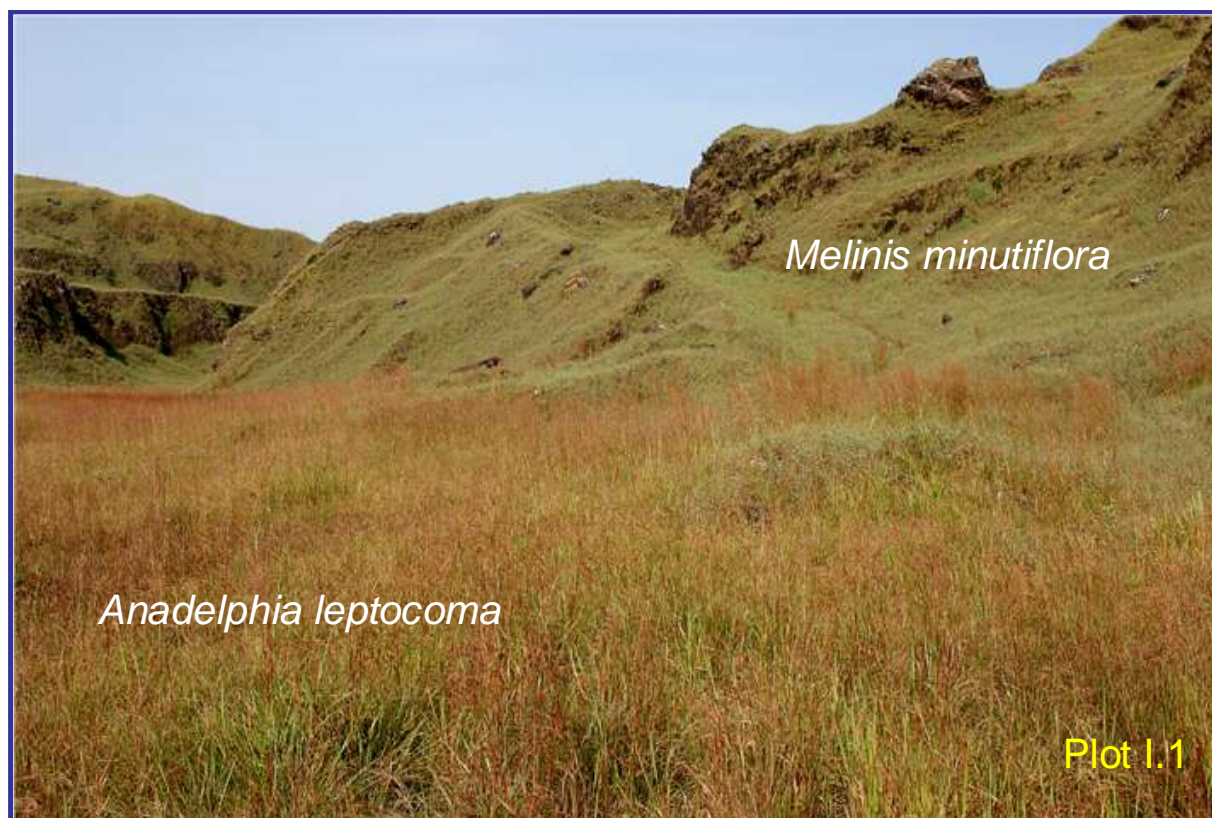
Mining activities transformed these mountain habitats into an environment hostile to the development of trees and shrubs. Few woody species at the stage of regeneration are present in the various sites. Islands of forests persist in the Site of Blue Lake (Site II), shielded from ravines which protect them from bush fires. The revegetation of terraces with herbaceous species constitutes, however, only a transitory stage before the imminent recolonisation of the environment by forest species.

## 4.2 Savannahs Developed on Old Mine Sites on Nimba Ridge above 1200 metres

### Example Plot I.1: N07°31'58.8 – W008°30'10.0 – Altitude: 1245 m

Plot I.1 corresponds to a plateau situated on the border of a crest in the west and is dominated by a rock massif in the east. Two species dominate widely in the herbaceous layer: *Melinis minutiflora*, which also colonises the slopes of the mountain on which it forms the totality of the herbaceous layer, and *Anadelphia leptocoma* which forms a more or less homogeneous population on the shelf.

These two grasses are associated with other Poaceae, such as *Sporobolus dinklagei*, *Schizachyrium brevifolium* and varied Cyperaceae including in particular *Abildgaardia congolensis*, *Cyperus tenuiculmis* var. *guineensis*, *Pycnus capillifolius*, *P. polystachyos* and *Scleria flexuosa*. Some dicotyledons, such as *Neurotheca leoeselioides* are very often present but represent an unimportant biomass. Most of these species are helophilous plants which thrive in wet substrata. On the edge of the crest, which forms a rough cliff, *Melinis minutiflora* is associated with *Aspilia africana*, *Panicum sadinii* and secondarily to *Emilia coccinea* and *Crassocephalum rubens*.



## Example Plot I.2: N07°31'56.7 – W008°30'15.0 – Altitude: 1251 m

Plot I.2 also corresponds to a plateau (shelf), limited by the crest in the east and by a rocky bar to the South. The herbaceous cover is widely dominated by *Melinis minutiflora* whereas *Anadelphia leptocoma* appears only by some tussocks where the soil is thicker.

The rocky substratum makes the herbaceous layer quite varied. Species such as *Schizachyrium brevifolium*, *Sporobolus dinklagei*, *Neurotheca loeselioides*, *Oldenlandia herbacea* are found on the shallower soils.



Plot I.2

## Example Plot I.3: N07°31'30.2 – W008°30'46.1 – Altitude: 1291 m

This plot, situated on a flat slope, contains a heterogeneous swampy savannah.. *Loudetia phragmitoides*, on the wettest and the thickest parts of the ground, *Melinis minutiflora* and *Axonopus compressus* constitute the dominant species. Other common species include *Anadelphia leptocoma*, *Schizachyrium brevifolium*, *Paspalum scrobiculatum* and *Abildgaardia congolensis*. Some shrubby *Dissotis thollonii* is spread in the herbaceous layer.



Plot I.3



## Example Plot I.4: N07°31'14.6 – W008°30'58.4 – Altitude: 1332 m

Plot I.4 is situated on a gentle slope, on each side of the track, and includes locally swampy ground. It is characterised by a dense patch of *Panicum glaucocladum* which contrasts with the surrounding landscape. This species, on this wet substratum, is associated with *Axonopus compressus*, *Paspalum scrobiculatum*, *Anadelphia leptocoma*, *Sporobolus dinklagei* and *Neurotheca loeselioides*. The best drained parts of soil are colonised by *Melinis minutiflora*.

The vegetation on the mountainsides lining this track is poor; however, *Dicranopteris linearis* grows abundantly on the rock.



## Example Plot I.5: N07°30'54.9 – W008°31'26.7 – Altitude: 1334 m

Plot I.5 comprises a savanna on a plateau, crossed by the track, and lined by ravines. *The Poaceae* *Anadelphia leptocoma* dominates the herbaceous layer associated with, among others, *Paspalum scrobiculatum*, *Schizachyrium brevifolium*, *Loudetia phragmitoides*, *Spermacoce verticillata* and *Scleria spiciformis*. Other less frequent species include *Cyperus tenuiculmis* var. *guineensis*, *Lipocarpa chinensis*, *Eragrostis atrovirens*, *Burmannia madagascariensis* (locally abundant): most of these species prefer the swampy ground. To the left of the track, the contact with the ravine is vegetated by a dense thicket composed of *Dissotis* sp., *Hibiscus diversifolius*, *Ipomoea involucrata*, *Aspilia africana* and *Panicum hochstetteri*. To the right, on better drained soil, the bank of the road is colonised by a small stand of *Hyparrhenia diplandra* var. *diplandra* and another stand of *Imperata cylindrica*.



## Example Plot I.6: N07°31'37.7 – W008°30'39.5 – Altitude: 1317 m

The herbaceous layer of Plot I.6, situated on a flat step, is dominated by *Melinis minutiflora* and *Sporobolus dinklagei*. The flora, relatively poor on this mineral ground, also includes *Schizachyrium brevifolium*, *Cyperus tenuiculmis* var. *guineensis* and *Neurotheca loeselioides*.

On the rocky side of the terrace, the vegetation is similar except for small tufts of *Ctenium newtonii*.



## Example Plot I.7: N07°31'31.2 – W008°30'45.0 – Altitude: 1305 m

This plot close to the entrance of the mining site occupies a sloping terrace at the foot of which persist small swamps. The herbaceous layer, rather heterogeneous, is dominated by *Melinis minutiflora* and *Sporobolus dinklagei* associated with *Cyperus tenuiculmis* var. *guineensis*, *Pennisetum polystachion*, *Blumea adamsii* and *Phyllanthus* sp. The wet zones are occupied by *Loudetia phragmitoides*, *Anadelphia leptocoma* and secondarily by *Paspalum scrobiculatum*, *Rhynchospora perrieri*, *Scleria spiciformis*, *Axonopus compressus*, *Eragrostis atrovirens* and *Desmodium ramosissimum*.

Some woody plants, at the stage of regeneration and belonging to *Dissatisfy thalami*, *D. Jacques* and *Hiragana madagascariensis*, are spread in the grassy layer.





## Example Plot I.8: N07°32'03.8 – W008°30'11.1 – Altitude: 1284 m

This plot is situated on a terrace with a shallow soil and locally wet rock. *Malines minutiflora*, dominant in the herbaceous layer, is mainly associated with *Abildgaardia congolensis*, *Axonopus compressus* and *Schizachyrium brevifolium*. Other frequent species include *Panicum griffonii*, *Anadelphia leptocoma*, *Sporobolus paniculatus*, *S. dinklagei*, *Pennisetum polystachion* and *Paspalum scrobiculatum*.



## Example Plot I.9: N07°32'04.1 – W008°30'06.5 – Altitude: 1259 m

Plot I.9, situated on a terrace with a gentle slope, is rather similar to the previous one but with a denser herbaceous cover. *Melinis minutiflora* forms the main part of the herbaceous layer associated mainly with *Sporobolus dinklagei*, *S. paniculatus*, *Pennisetum polystachion*, *Cyperus tenuiculmis* var. *guineensis*, *Anadelphia leptocoma* and *Abildgaardia congolensis*. Some new species appear in this plot such as *Plectranthus monostachyus* (more frequent on the rock) and *Schwenckia americana*. On the edge of the terrace, forming the crest of a ravine grows *Clerodendrum umbellatum*.



## Example Plot I.10: N07°32'06.2 – W008°30'05.8 – Altitude: 1299 m

This plot is situated at the top of a mountain summit, at an altitude of approximately 1,300 m. The vegetation is dominated by *Melinis minutiflora* associated with *Hyparrhenia diplandra* var. *diplandra*, and *Sporobolus dinklagei*. These three species form the bulk of the herbaceous biomass while the other species are less frequent. Among these are *Schizachyrium brevifolium*, *Anadelphia leptocoma*, *Loudetia phragmitoides*, *Cyperus tenuiculmis* var. *guineensis* and *Hibiscus diversifolius*.



## Example Plot I.11: N07°32'04.4 – W008°30'02.6 – Altitude: 1246 m

Plot I.11, situated under the previous summit, occupies the side of the mountain on a steep slope. Three species, *Anadelphia leptocoma*, *Melinis minutiflora* and *Sporobolus dinklagei*, dominate in the herbaceous stratum associated in particular with *Dicranopteris linearis*, *Lycopodiella affinis*, *Scleria spiciformis*, *Loudetia phragmitoides* and *Plectranthus monostachyus*; also, *Ctenium newtonii* was observed on the walls of previous plots.





## Conclusions on Old Mine Sites on the Nimba Ridge above 1200 metres

Table I synthesises the information collected on Site I of Old Nimba Mine. The whole site, since the end of the mining activities of LAMCO, was recolonised by vegetation. The surveys, comprising eleven plots, listed sixty-five (65) species among which many prefer the wet, even swampy, ground.

The perennial grasses dominate in the herbaceous layer of the plots inventoried with in particular: *Melinis minutiflora*, *Anadelphia leptocoma*, *Axonopus compressus* and *Sporobolus dinklagei*, to which is added an annual, *Schizachyrium brevifolium*. The first one is a strong plant which can be invasive if the environmental conditions suit it. It is often associated with *Schizachyrium brevifolium*, which occupies the dominated stratum. The second characterizes wet ground and often dominates on the superficial soils. *Loudetia phragmitoides*, a strong perennial Poaceae, is rather frequent in particular in the swampy depressions. Although abundant, some other long-lived grasses are of interest in the evolution of the vegetation of this site, for example, *Hyparrhenia diplandra* var. *diplandra*, which is frequent in the savannas of the Guinean Nimba. Some other species are locally abundant, such as *Panicum glaucocladum* and *Paspalum scrobiculatum*.

The Cyperaceae family is represented by several abundant species such as *Abildgaardia congolensis*, *Pycnus capillifolius*, *P. polystachyos*, *Scleria spiciformis*, *Scleria flexuosa*, and *Rhynchospora perrieri*. These species are more or less heliophytic plants which give evidence of the wet, even swampy state, of the various plots.

It is interesting to note the quasi-absence of *Chromolaena odorata* as this species is very common along the access road to the former mining site. This strong Asteraceae is a pioneer of disturbed habitats and often behaves as an invasive plant.

Some species, frequent but not abundant, are more sciaphilous and found in the contact of savannas with the crests of ravines. They are in particular: *Aspilia africana*, *Panicum sadinii*, *Ipomoea involucrata* where they are associated with various shrubs forming a dense thicket.

The sides of terraces can be practically bare if they are very steep or covered by vegetation similar to those of the terraces that are colonised by the fern *Dicranopteris linearis*.

Other species were observed outside the surveyed plots such as *Crotalaria lathyroides*, *Polygala multiflora* and *Striga asiatica*.

**Table I. List of the herbaceous species, with their abundance/dominance, observed in Site I: dominant species are highlighted in green and locally abundant species in yellow.**

| Site I: Old Mine Sites on Nimba Ridge above 1200 metres |      |      |      |      |      |      |      |      |      |      |       |       |
|---|------|------|------|------|------|------|------|------|------|------|-------|-------|
| Species   | Plot | PI.1 | PI.2 | PI.3 | PI.4 | PI.5 | PI.6 | PI.7 | PI.8 | PI.9 | PI.10 | PI.11 |
| <i>Abildgaardia congolensis</i>                         |      | 3    | +    | 1    | 1    | 1    | .    | +    | 3    | 1    | +     | .     |
| <i>Abildgaardia densa</i>                               |      | +    | +    | .    | .    | .    | .    | .    | .    | .    | .     | .     |
| <i>Ageratum conyzoides</i>                              |      | +    | .    | .    | .    | .    | .    | .    | .    | .    | .     | .     |
| <i>Alectra sessiliflora</i>                             |      | +    | +    | +    | +    | .    | .    | .    | .    | .    | +     | .     |
| <i>Anadelphia leptocoma</i>                             |      | 4    | +    | 2    | 2    | 4    | .    | 1    | +    | +    | +     | +     |
| <i>Andropogon gayanus</i>                               |      | +    | .    | .    | .    | .    | .    | .    | .    | .    | .     | .     |
| <i>Aspilia africana</i>                                 |      | +    | .    | +    | +    | 1    | .    | +    | .    | .    | .     | .     |
| <i>Axonopus compressus</i>                              |      | +    | 1    | 4    | 4    | 3    | .    | 2    | 3    | +    | .     | .     |
| <i>Blumea adamsii</i>                                   |      | 1    | +    | .    | .    | .    | .    | +    | .    | .    | +     | .     |
| <i>Brachycorythis paucifolia</i>                        |      | +    | +    | +    | .    | .    | .    | .    | .    | .    | .     | +     |
| <i>Burmannia madagascariensis</i>                       |      | .    | .    | .    | .    | 1    | .    | .    | .    | .    | .     | .     |
| <i>Canscora diffusa</i>                                 |      | +    | .    | .    | .    | .    | .    | .    | .    | +    | .     | .     |
| <i>Chromolaena odorata</i>                              |      | +    | .    | .    | .    | .    | .    | .    | .    | .    | .     | .     |
| <i>Clerodendrum umbellatum</i>                          |      | .    | .    | .    | .    | .    | .    | .    | .    | +    | .     | .     |
| <i>Conyza bonariensis</i>                               |      | .    | .    | .    | .    | .    | +    | .    | .    | .    | .     | .     |
| <i>Crassocephalum rubens</i>                            |      | +    | .    | .    | .    | .    | .    | +    | +    | +    | +     | .     |
| <i>Ctenium newtonii</i>                                 |      | .    | .    | .    | .    | .    | +    | .    | .    | +    | +     | +     |
| <i>Cyperus tenuiculmis</i>                              |      | +    | +    | +    | +    | +    | +    | +    | +    | 1    | +     | .     |
| <i>Desmodium hirtum</i>                                 |      | .    | .    | +    | .    | .    | .    | .    | .    | .    | +     | .     |
| <i>Desmodium ramosissimum</i>                           |      | .    | .    | .    | .    | .    | +    | .    | .    | +    | .     | .     |
| <i>Dicranopteris linearis</i>                           |      | +    | .    | .    | 2    | .    | .    | .    | .    | .    | .     | 1     |

| Site I: Old Mine Sites on Nimba Ridge above 1200 metres |      |     |     |     |     |     |     |     |     |     |      |      |
|---|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|
| Species   | Plot | PL1 | PL2 | PL3 | PL4 | PL5 | PL6 | PL7 | PL8 | PL9 | PL10 | PL11 |
| Emilia coccinea   |      | +   | .   | .   | .   | .   | .   | .   | .   | .   | .    | .    |
| Eragrostis atrovirens                                   |      | .   | .   | +   | +   | +   | .   | +   | +   | .   | +    | .    |
| Habenaria genuflexa                                     |      | +   | +   | +   | +   | 1   | +   | +   | +   | .   | +    | .    |
| Hibiscus diversifolius                                  |      | +   | +   | +   | .   | +   | .   | .   | .   | +   | +    | .    |
| Hyparrhenia diplandra                                   |      | .   | +   | .   | .   | 1   | .   | .   | .   | .   | 1    | .    |
| Imperata cylindrica                                     |      | +   | .   | .   | .   | +   | .   | .   | .   | .   | .    | .    |
| Indigofera dendroides                                   |      | .   | .   | .   | .   | .   | .   | .   | +   | .   | .    | +    |
| Ipomoea involucrata                                     |      | .   | .   | .   | .   | +   | .   | .   | .   | .   | .    | .    |
| Loudetia phragmitoides                                  |      | .   | +   | 2   | +   | 1   | .   | 1   | +   | .   | +    | +    |
| Lycopodiella affinis                                    |      | .   | .   | +   | .   | .   | +   | .   | .   | .   | .    | 1    |
| Lipocarpa chinensis                                     |      | .   | .   | .   | .   | +   | .   | .   | .   | .   | .    | .    |
| Melinis minutiflora                                     |      | 5   | 4   | 3   | 2   | 3   | 4   | 3   | 4   | 5   | 4    | 3    |
| Nephrolepis undulata                                    |      | +   | +   | .   | .   | .   | .   | .   | +   | .   | .    | .    |
| Neurotheca loeselioides                                 |      | +   | +   | +   | +   | .   | .   | .   | .   | .   | .    | .    |
| Oldenlandia herbacea                                    |      | +   | +   | +   | .   | .   | .   | .   | +   | +   | +    | .    |
| Otomeria guineensis                                     |      | .   | .   | +   | .   | .   | +   | .   | .   | +   | +    | .    |
| Panicum dinklagei                                       |      | +   | +   | .   | .   | .   | .   | .   | .   | .   | .    | .    |
| Panicum glaucocladum                                    |      | .   | .   | .   | 4   | .   | .   | .   | .   | .   | .    | .    |
| Panicum griffonii                                       |      | 1   | +   | .   | +   | .   | .   | .   | +   | .   | .    | .    |
| Panicum hochstetteri                                    |      | .   | .   | .   | .   | +   | .   | +   | .   | .   | .    | .    |
| Panicum nervatum  |      | .   | .   | .   | +   | 2   | .   | .   | .   | .   | .    | .    |
| Panicum sadinii   |      | +   | .   | .   | .   | .   | .   | .   | +   | .   | .    | +    |
| Paspalum scrobiculatum                                  |      | .   | .   | +   | 1   | 3   | .   | +   | +   | .   | +    | .    |
| Pennisetum polystachion                                 |      | +   | 1   | .   | .   | .   | .   | +   | +   | +   | +    | .    |
| Phyllanthus sp.   |      | +   | +   | 1   | +   | .   | .   | +   | .   | .   | .    | .    |
| Plectranthus monostachyus                               |      | .   | .   | .   | .   | .   | .   | .   | .   | +   | +    | +    |
| Pteridium aquilinum                                     |      | .   | +   | .   | .   | .   | .   | .   | .   | .   | .    | .    |
| Pycneus capillifolius                                   |      | 1   | .   | +   | +   | +   | .   | .   | .   | .   | .    | .    |
| Pycneus polystachyos                                    |      | +   | +   | +   | .   | +   | +   | .   | .   | .   | .    | .    |
| Rhynchospora perrieri                                   |      | +   | .   | .   | .   | .   | .   | +   | .   | .   | .    | .    |
| Rhytachne rottboellioides                               |      | .   | .   | .   | .   | .   | .   | +   | .   | +   | +    | .    |
| Schizachyrium brevifolium                               |      | 1   | 2   | 1   | +   | 1   | 1   | .   | 1   | 2   | 1    | .    |
| Schwenckia americana                                    |      | .   | .   | .   | .   | .   | .   | .   | +   | +   | .    | .    |
| Scleria flexuosa  |      | 1   | .   | 1   | +   | 3   | .   | 1   | +   | .   | .    | +    |
| Scleria spiciformis                                     |      | +   | .   | .   | .   | .   | .   | +   | +   | .   | .    | +    |
| Spermacoce ruelliae                                     |      | .   | +   | .   | .   | .   | .   | .   | .   | .   | .    | .    |
| Spermacoce verticillata                                 |      | +   | .   | 1   | 1   | 1   | .   | 1   | .   | .   | .    | .    |
| Sporobolus dinklagei                                    |      | +   | 2   | 3   | 3   | 1   | 4   | 3   | +   | 1   | +    | 2    |
| Sporobolus paniculatus                                  |      | +   | .   | .   | .   | .   | .   | .   | +   | 1   | .    | .    |
| Sporobolus pyramidalis                                  |      | .   | .   | .   | .   | .   | .   | .   | .   | +   | +    | .    |
| Stachytarpheta angustifolia                             |      | .   | .   | .   | +   | .   | .   | .   | .   | .   | .    | .    |
| Triumfetta tomentosa                                    |      | .   | +   | .   | .   | .   | .   | .   | .   | .   | .    | .    |
| Xyris straminea   |      | .   | .   | +   | 1   | +   | .   | .   | .   | .   | .    | .    |
| Zornia latifolia  |      | .   | .   | .   | .   | .   | .   | +   | .   | +   | +    | .    |

## 4.3 Savannahs Developed on Old Mine Sites on Nimba Ridge below 1100 metres

### Example Plot II.1: N07°32'32.4 – W008°29'43.1 – Altitude: 961 m

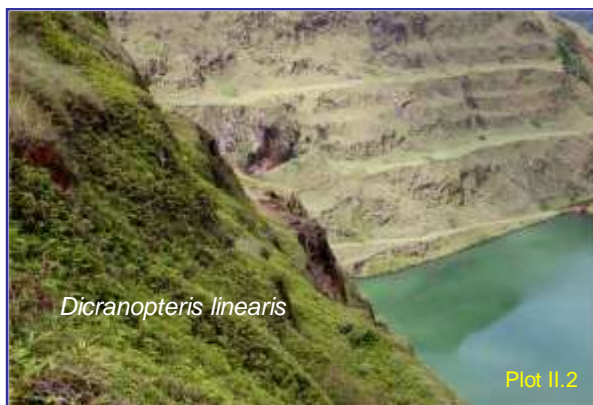
Plot II.1, close to the track giving access to the site, is situated on a terrace between the mountain and the ravine lining Blue Lake on the eastern side. Species such as *Imperata cylindrica*, *Calopogonium mucunoides*, *Chromolaena odorata*, *Mimosa pudica* or *Chamaecrista mimosoides* testify to a state of strong degradation of the environment. The most frequent Poaceae, with *Imperata cylindrica*, are *Melinis minutiflora*, *Schizachyrium brevifolium*, *Andropogon macrophyllus* (locally), *Hyparrhenia diplandra* var. *diplandra*, *Pennisetum polystachion* and *Panicum griffonii* associated secondarily with *Paspalum scrobiculatum* and *Pennisetum polystachion*.

Some woody plants, at the regeneration stage, are spread in the herbaceous layer such as *Albizia zygia*, *A. adianthifolia*, *Harungana madagascariensis* and *Psidium guajava* (exotic species).



### Example Plot II.2: N07°32'20.7 – W008°29'45.4 – Altitude: 1016 m

This plot is situated on a terrace overlooking the lake on the southeast. The herbaceous layer, heterogeneous because of rocky patches not colonised by the vegetation, is mainly constituted by *Anadelphia leptocoma*, *Loudetia phragmitoides*, *Schizachyrium brevifolium* and *Abildgaardia congolensis*. Other grasses such as *Eragrostis atrovirens*, *Pennisetum polystachion* and *Panicum griffonii* are present but less frequent, with *Chromolaena odorata* (Asteraceae). The very abrupt rocky slope, located down from the terrace towards the lake, is covered with a stand of *Dicranopteris linearis*. Over the terrace, the rocky mass not having undergone mining activities is covered with a savanna composed of *Anadelphia leptocoma*, *Loudetia phragmitoides* and *Schizachyrium brevifolium*.





## Example Plot II.3: N07°32'23.2 – W008°29'39.4 – Altitude: 1011 m

This plot, occupying a terrace which also overlooks the Blue Lake on the southeast, is situated on a gentle slope. The herbaceous stratum is composed of perennial grass species including *Anadelphia leptocoma*, *Melinis minutiflora*, and *Hyparrhenia diplandra* var. *diplandra*: the annual *Schizachyrium brevifolium* is rather abundant. The composition of the herbaceous layer of this whole terrace is widely variable and characterised locally by *Loudetia phragmitoides* on a swampy soil (N07°32'13.2 – W008°29'53.6) or *Hyparrhenia diplandra* var. *diplandra* on better drained parts of ground (N07°32'20.2 – W008°29'41.0) or by *Loudetia phragmitoides*, *Panicum griffonii* and *Abildgaardia congolensis* (N07°32'12.1 – W008°29'54.6).



## Example Plot II.4: N07°32'04.5 – W008°29'43.1 – Altitude: 1098 m

Plot II.4 is situated on a gently sloping terrace on a southern hillside of the Blue Lake, limited by a ravine on one side and the side of a mountain on the other. The Poaceae *Anadelphia leptocoma*, *Loudetia phragmitoides*, *Schizachyrium brevifolium* and *Melinis minutiflora* form the major parts of the herbaceous layer. *Loudetia phragmitoides* and *Melinis minutiflora* are more abundant on the side of the massif than on the terrace.



## Example Plot II.5: N07°32'03.8 – W008°29'45.7 – Altitude: 1094 m

This plot is a continuation of the previous one, on a shelf, and is lined by a small ravine forest. The grass layer is composed of *Melinis minutiflora*, *Imperata cylindrica*, *Panicum griffonii* and *Schizachyrium brevifolium*. The ground is rockier and *Anadelphia leptocoma* and *Loudetia phragmitoides* are represented only by some individuals. *Chromolaena odorata* forms transition between the herbaceous layer and the forest species.



## Example Plot II.6: N07°32'02.4 – W008°29'49.6 – Altitude: 1097 m

This plot follows the previous ones on the same terrace with a grass layer composition similar to that of the Plot II.5 in which *Anadelphia leptocoma*, *Loudetia phragmitoides*, *Schizachyrium brevifolium* and *Melinis minutiflora* are the dominant species.





## Example Plot II.7: N07°32'01.0 – W008°29'52.6 – Altitude: 1094 m

Plot II.7 marks the end of the terrace which joins a wide grassy road. A small depression, still in water, modifies the composition of the herbaceous vegetation and species such as *Eragrostis atrovirens*, *Panicum laxum*, *Xyris decipiens*, *Abildgaardia congolensis*, *Nemum spadiceum*, *Axonopus compressus*, *Pycnus capillifolius* and *Paspalum scrobiculatum* comprise the main part of the grass layer. On the neighbouring better-drained soil appear *Anadelphia leptocoma*, *Melinis minutiflora* and *Schizachyrium brevifolium*: this last species thriving in this wet substratum is relatively abundant. The crest of the ravine and the side of the mountain are occupied by *Loudetia phragmitoides* and *Melinis minutiflora*.



## Example Plot II.8: N07°32'04.3 – W008°29'53.1 – Altitude: 1095 m

This plot on the south side of the Lake is at a crossroad between a wide road in the course of recolonisation by vegetation, and the former mining terraces. The grassy cover is less homogeneous with rocky and relatively bare patches of soil.

*Anadelphia leptocoma*, *Sporobolus dinklagei* and *Schizachyrium brevifolium* are the three best represented grasses. *Loudetia phragmitoides* appears under the form of a small stand while *Melinis minutiflora* occupies mainly roadsides bordering the sides of terraces.



## Example Plot II.9: N07°32'09.7 – W008°29'58.5 – Altitude: 1094 m

This plot occupies a gently sloping terrace on the western side of the Blue Lake. *Anadelphia leptocoma* forms a grass layer, in association with *Melinis minutiflora* and *Schizachyrium brevifolium*. *Loudetia phragmitoides* is still present and *Sporobolus paniculatus* appears under rock shelter.



## Example Plot II.10: N07°32'04.0 – W008°29'57.3 – Altitude: 1136 m

This plot, which overlooks the previous one, is widely dominated by *Melinis minutiflora* and *Schizachyrium brevifolium*, this second species becoming abundant in low grass stratum. Some other species are present on this stony soil, among which are *Pennisetum polystachion* and *Loudetia phragmitoides*, without being abundant.





## Example Plot II.11: N07°32'01.7 – W008°30'01.8 – Altitude: 1098 m

After Plot II.10, the terrace which continues on a slight slope was partially filled by earth from a collapse in the terrace situated above. Species such as *Loudetia phragmitoides*, *Schizachyrium brevifolium* and *Panicum griffonii* took advantage of this substratum to occupy the ground, as did *Droogmansia scaettaiana* (Fabaceae) and some Cyperaceae, such as *Pycnus polystachyos* and *Scleria flexuosa*.

A stand of *Loudetia phragmitoides*, associated with a dense carpet of *Schizachyrium brevifolium*, was observed on the same terrace at the point N07°32' 07.0 – W008°29'58.2, altitude: 1122 m. At the end of this terrace, the side of the mountain not having been subjected to mining, is covered with a pure stand of *Anadelphia leptocoma* which presents a different physiognomy (lower and thicker) from that observed on terraces (N07°32'13.8 – W008°30'05.3).



## Example Plot II.12: N07°32'13.8 – W008°30'05.3 – Altitude: 1081 m

This plot is situated downstream from Plot II.8 on the previously described main road. A beautiful population of *Anadelphia leptocoma* forms a high cover, although patches of soil are bare soils occur locally. This species is associated with *Sporobolus dinklagei*, *Schizachyrium brevifolium*, and secondarily with *Hyparrhenia diplandra* var. *diplandra* and *Melinis minutiflora* (which is more abundant on sides lining this terrace). The ground remained wet for a long time and has allowed the presence of small annual species such as *Abildgaardia congolensis*, *Pycnus capillifolius*, *Scleria flexuosa*, *Neurotheca loeselioides* and *Xyris straminea*.



## Example Plot II.13: N07°32'38.1 – W008°29'44.2 – Altitude: 1035 m

Plot II.13 is situated on a terrace in the northeast side of the Blue Lake. It forms a small plateau bordered in the east by a ravine. *Anadelphia leptocoma* remains a dominant species, with secondarily, *Melinis minutiflora*, *Schizachyrium brevifolium* and *Loudetia phragmitoides*.



## Example Plot II.14: N07°32'34.0 – W008°29'40.7 – Altitude: 1052 m

This plot is situated on a terrace which overlooks the previous one. The dense herbaceous stratum is mainly constituted by *Melinis minutiflora* and *Schizachyrium brevifolium*, associated with *Loudetia phragmitoides*. Other grasses, such as *Anadelphia leptocoma* and *Hyparrhenia diplandra* var. *diplandra*, are represented only by some individuals.





## Example Plot II.15: N07°32'17.5 – W008°29'25.4 – Altitude: 1055 m

This plot is situated downstream of a woody slope, on a stony and superficial soil, on the southeast side above the lake. The herbaceous layer is dominated by *Loudetia phragmitoides*, *Anadelphia leptocoma* and *Schizachyrium brevifolium*. The still locally wet ground explains the presence of species such as *Abildgaardia congolensis*, *Scleria flexuosa*, *S. spiciformis*, *Canscora diffusa* and *Burmattia madagascariensis*. The foot of the terrace is lined with scattered tufts of *Melinis minutiflora* and with some areas of *Blumea adamsii*.



## Example Plot II.16: N07°32'14.2 – W008°29'33.5 – Altitude: 1084 m

Plot II.16 occupies a gravelly terrace on a flat slope, bordered by a ravine, which overlooks the lake in the southeast. *Loudetia phragmitoides* (more abundant on the bank) and *Anadelphia leptocoma* dominate in the herbaceous layer, associated with the most common species found in this site such as *Schizachyrium brevifolium*, *Abildgaardia congolensis*, *Panicum griffonii* and *Melinis minutiflora*.



## Example Plot II.17: N07°32'35.2 – W008°29'30.7 – Altitude: 1123 m

Plot II.17 is situated at a higher altitude than the previous one, on a terrace on which the ground is locally shallow. *Anadelphia leptocoma* remains the dominant grass species, associated with *Melinis minutiflora*, *Abildgaardia congolensis* and secondarily with *Schizachyrium brevifolium*. Rarer species such as *Plectranthus monostachyus* and *Dragomans scaettaiana* appear in the grassy layer. A collapse, on a higher terrace, provoked a mudslide of clay on which *Scleria aterrima* is quite common.



## Example Plot II.18: N07°32'27.3 – W008°29'30.5 – Altitude: 1159 m

The herbaceous layer of this terrace varies in its floristic composition with regard to the previous ones, because of the presence of more mineral-rich soils. *Loudetia phragmitoides* constitutes the main part of the grass stratum associated with *Melinis minutiflora*, and some other uncommon species such as *Ctenium newtonii*, *Rhynchne rootboellioides*, *Drosera madagascariensis* (carnivorous plant) or *Lycopodiella affinis*. Higher up, the vegetation of a narrow rocky terrace is characterised by *Pennisetum polystachion*, *Loudetia phragmitoides*, *Anadelphia leptocoma*, *Panicum sadinii* and *Dicranopteris linearis* (N07°32'27.7 - W008°29'29.0, altitude: 1176 m).





## Example Plot II.19: N07°32'31.3 – W008°29'26.3 – Altitude: 1207 m

This plot, overlooking the Blue Lake in its eastern part, also occupies a terrace bordered by a ravine. The vegetation changes little and is still dominated by *Anadelphia leptocoma* and *Melinis minutiflora*. A mudslide from an upper level has created a clayey and wet soil that promotes species such as *Axonopus compressus* and *Sopubia ramosa*.

Further upslope, in the direction of the summit of the massif which dominates the Blue Lake in the south and on a terrace with relatively strong slope, grows a population of *Pennisetum polystachion*, as well as on the projecting ledge of the terrace and its flank. (N07°32'28.8 - W008°29'21.8; altitude: 1242 m).



## Example Plot II.20: N07°32'29.0 – W008°29'18.7 – Altitude: 1265 m

This plot is the continuation of the previous one toward the summit. *Anadelphia leptocoma* and *Pennisetum polystachion* form a high and open grass layer, associated with *Schizachyrium brevifolium* and *Melinis minutiflora* at the foot of the terrace.



## Example Plot II.21: N07°32'38.5 – W008°29'17.2 – Altitude: 1297 m

Note that this plot is higher than the others in this section.

This plot is situated below the summit of the mountain which overlooks the Blue Lake in the east. *Rhytachne rottboellioides*, relatively uncommon on the site, forms at this level a dense stand on the terrace as well as on its flank. *Anadelphia leptocoma* and *Melinis minutiflora* are the two other main species.



## Example Plot II.22: N07°32'14.8 – W008°29'31.2 – Altitude: 1042 m

This plot is situated at a crossroads, east of Blue Lake. It occupies a terrace forming a light swampy depression in which *Anadelphia leptocoma* and *Loudetia phragmitoides* are associated with miscellaneous helophilous plants, more or less abundant, such as *Lipocarpa chinensis*, *Pycnus capillifolius*, *P. lanceolatus*, *Eragrostis atrovirens*, *Burmannia madagascariensis* or *Paspalum scrobiculatum*.

There is no photograph of this site.

## Conclusions on Old Mine Sites on Nimba Ridge below 1100 metres

As with Site I, vegetation practically covers the terraces of Site II but it is less dense: 72 herbaceous species were listed within this site (Table II). The dominant grasses are the same as those in Site I, i.e. *Anadelphia leptocoma*, *Melinis minutiflora* and *Schizachyrium brevifolium*; *Panicum griffonii* is also rather abundant. The substratum of terraces seems more mineral-rich than in Site I, and the perennial grasses, with the exception of *Melinis minutiflora*, occur locally there where the ground allows it. Species such as *Loudetia phragmitoides*, *Hyparrhenia diplandra* var. *diplandra* and *Imperata cylindrica* (rhizomatous perennial) occur locally in small practically monospecific stands on terraces. Poaceae such as *Sporobolus dinklagei*, *Pennisetum polystachion* or *Rhynchacne rothboelliioides* are frequent also locally. Although little abundant, *Chromolaena odorata* is present everywhere while this Asteraceae was practically absent in the previous site.

Cyperaceous species such as *Abildgaardia congolensis*, *Pycnus polystachyos*, *P. lanceolatus*, and *Scleria flexuosa* appear within small swampy depressions where they are associated with heliophilous grasses comprising *Eragrostis atrovirens*, *Paspalum scrobiculatum*, *Panicum congoense* and with diverse herbaceous plants such as *Burmannia madagascariensis* and *Xyris decipiens*.

**Table II. List of the herbaceous species, with their abundance/dominance, observed in Site II, on old mine sites below 1100 metres: dominant species are highlighted in green and the locally abundant species in yellow.**

|                                   |      | Site II: Old Mine Sites on Nimba Ridge below 11 metres |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |
|-----------------------------------|------|--|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Species                           | Plot | 1  | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
| <i>Abildgaardia congolensis</i>   |      | +  | 2 | 1 | 3 | + | 3 | 3 | 2 | 1 | 2  | 1  | 3  | 2  | 2  | 2  | 3  | 2  | .  | 2  | .  | .  | 2  |
| <i>Anadelphia leptocoma</i>       |      | +  | . | + | 4 | + | 3 | 3 | 4 | 5 | 1  | 3  | 4  | 5  | +  | 3  | 4  | 4  | 1  | 5  | 4  | 2  | 4  |
| <i>Andropogon macrophyllus</i>    |      | +  | . | . | . | . | . | . | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  |
| <i>Aspilia africana</i>           |      | .  | . | . | . | . | . | . | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | +  | .  |
| <i>Axonopus compressus</i>        |      | .  | . | . | . | . | . | + | . | . | .  | .  | .  | .  | .  | 1  | +  | .  | +  | +  | .  | .  | 3  |
| <i>Blumea adamsii</i>             |      | +  | . | + | + | 1 | . | . | . | . | .  | .  | .  | .  | .  | .  | +  | .  | .  | 1  | .  | +  | .  |
| <i>Blumea heudelotii</i>          |      | .  | . | . | + | + | + | . | . | . | .  | +  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  |
| <i>Brachycorythis paucifolia</i>  |      | .  | + | . | . | . | . | . | . | . | .  | .  | .  | .  | .  | +  | .  | .  | .  | .  | .  | .  | .  |
| <i>Burmannia madagascariensis</i> |      | .  | . | . | . | . | . | . | . | . | .  | .  | .  | .  | +  | .  | .  | +  | .  | .  | .  | .  | +  |
| <i>Calopogonium mucunoides</i>    |      | 3  | . | . | . | . | . | . | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  |
| <i>Canscora diffusa</i>           |      | +  | . | . | + | + | . | . | 1 | . | .  | .  | 1  | .  | .  | +  | .  | .  | +  | .  | .  | +  | +  |
| <i>Chamaecrista mimosoides</i>    |      | +  | . | . | . | . | . | . | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  |
| <i>Chromolaena odorata</i>        |      | +  | + | 2 | . | 1 | + | + | + | . | .  | +  | .  | +  | 1  | .  | +  | .  | +  | +  | +  | +  | +  |
| <i>Crassocephalum rubens</i>      |      | .  | . | + | . | . | . | . | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  |
| <i>Crotalaria cylindrocarpa</i>   |      | .  | . | . | . | . | . | . | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | +  | .  | .  |
| <i>Ctenium newtonii</i>           |      | .  | . | . | . | . | . | . | . | . | .  | .  | .  | .  | .  | .  | .  | +  | 3  | .  | .  | .  | .  |
| <i>Cyperus difformis</i>          |      | .  | . | . | . | . | . | + | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  |
| <i>Cyperus tenuiculmis</i>        |      | +  | + | . | + | + | + | + | . | + | +  | +  | .  | .  | +  | .  | .  | .  | .  | .  | .  | +  | .  |
| <i>Desmodium ramosissimum</i>     |      | .  | . | . | . | . | . | + | . | . | .  | +  | .  | +  | .  | +  | .  | +  | .  | +  | .  | .  | .  |
| <i>Dicranopteris linearis</i>     |      | .  | 2 | . | . | . | . | . | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  |
| <i>Droogmansia scaettaiana</i>    |      | .  | . | . | . | . | . | . | . | . | .  | 2  | .  | .  | .  | .  | .  | +  | .  | .  | .  | .  | .  |
| <i>Drosera madagascariensis</i>   |      | .  | . | . | . | . | . | . | . | . | .  | .  | .  | .  | .  | .  | .  | .  | +  | .  | .  | .  | .  |
| <i>Emilia coccinea</i>            |      | .  | . | . | . | . | . | . | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | +  |
| <i>Eragrostis atrovirens</i>      |      | .  | + | . | . | . | . | 4 | . | . | .  | .  | .  | .  | .  | +  | .  | .  | .  | .  | .  | .  | 2  |
| <i>Eriosema glomeratum</i>        |      | .  | . | . | . | . | . | . | . | . | .  | .  | .  | .  | +  | .  | .  | .  | .  | .  | .  | .  | .  |
| <i>Fimbristylis alboviridis</i>   |      | .  | . | . | . | + | . | . | + | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  |
| <i>Habenaria genuiflexa</i>       |      | +  | . | . | + | . | . | + | . | + | .  | +  | +  | +  | +  | .  | .  | .  | .  | .  | .  | .  | .  |
| <i>Hyparrhenia diplandra</i>      |      | 1  | . | 4 | + | . | 4 | . | . | . | .  | .  | 1  | 1  | +  | .  | .  | .  | .  | .  | .  | .  | .  |
| <i>Hyparrhenia rufa</i>           |      | 1  | . | . | . | . | . | . | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  |
| <i>Imperata cylindrica</i>        |      | 4  | . | 1 | . | 3 | . | . | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  |
| <i>Ipomoea eriocarpa</i>          |      | .  | . | . | . | . | . | . | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | +  |
| <i>Lipocarpha chinensis</i>       |      | .  | . | . | . | . | . | . | . | . | .  | .  | .  | .  | .  | +  | .  | .  | .  | .  | .  | .  | 3  |
| <i>Liparis rufina</i>             |      | .  | . | . | . | . | . | . | + | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | 1  |
| <i>Loudetia phragmitoides</i>     |      | .  | 2 | + | 3 | + | . | + | 1 | 2 | 1  | 4  | +  | +  | 3  | 4  | 3  | +  | 4  | .  | .  | .  | 4  |
| <i>Lycopodiella affinis</i>       |      | .  | . | . | . | . | . | . | . | . | .  | .  | .  | .  | .  | +  | .  | +  | 3  | .  | .  | .  | 1  |
| <i>Melinis minutiflora</i>        |      | 3  | 2 | + | 3 | 4 | 3 | 1 | 3 | 3 | 4  | 2  | 1  | +  | 4  | +  | 2  | 4  | 3  | 3  | 3  | 2  | 1  |

| Site II: Old Mine Sites on Nimba Ridge below 11 metres |      |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |
|--|------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Species  | Plot | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
| <i>Mimosa pudica</i>                                   |      | 1 | . | . | . | . | . | + | . | . | .  | .  | .  | .  | .  | +  | .  | .  | .  | .  | .  | .  | .  |
| <i>Nemum spadiceum</i>                                 |      | . | . | . | . | . | . | + | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  |
| <i>Nephrolepis undulata</i>                            |      | . | . | . | . | . | . | . | . | . | .  | +  | .  | .  | .  | .  | .  | .  | .  | .  | .  | +  | .  |
| <i>Neurotheca loeseloides</i>                          |      | + | . | . | . | . | . | . | + | . | .  |    | 1  | .  | .  | .  | .  | .  | .  | .  | +  | +  | .  |
| <i>Oldenlandia corymbosa</i>                           |      | . | . | . | . | + | . | . | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  |
| <i>Oldenlandia herbacea</i>                            |      | . | . | . | . | . | . | . | . | . | .  | .  | .  | .  | .  | .  | .  | +  | .  | .  | .  | .  | .  |
| <i>Panicum congoense</i>                               |      | . | . | . | . | . | . | . | . | . | .  | .  | .  | .  | .  | 1  | .  | .  | .  | .  | .  | .  | .  |
| <i>Panicum griffonii</i>                               |      | + | + | + | . | 3 | . | 3 | 2 | . | 2  | 3  | .  | .  | .  | 2  | 3  | .  | .  | 1  | .  | .  | .  |
| <i>Panicum laxum</i>                                   |      | . | . | . | . | . | . | 2 | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  |
| <i>Panicum sadinii</i>                                 |      | . | . | . | . | . | . | . | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | +  | .  | .  |
| <i>Paspalum scrobiculatum</i>                          |      | + | + | . | + | 1 | + | + | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | 3  |
| <i>Pennisetum polystachion</i>                         |      | + |   |   |   |   |   | + | + | 1 | 2  | 1  | +  | +  | +  | .  | +  | .  | +  | +  | 4  | +  | +  |
| <i>Pennisetum purpureum</i>                            |      | . | . | . | . | . | . | . | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  |
| <i>Plectranthus monostachyus</i>                       |      | . | . | . | . | . | . | . | . | . | .  | .  | .  | .  | .  | .  | .  | +  | .  | .  | .  | .  | .  |
| <i>Pueraria phaseoloides</i>                           |      | . | . | . | . | . | . | 1 | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  |
| <i>Pycreus capillifolius</i>                           |      | . | . | . | . | . | . | 2 | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | 1  |
| <i>Pycreus lanceolatus</i>                             |      | . | . | . | . | . | . | . | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | 2  |
| <i>Pycreus polystachyos</i>                            |      | + | . | . | . | . | . | . | . | . | .  | +  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  |
| <i>Rhynchachne rotboelliioides</i>                     |      | . | . | . | . | + | . | . | + | . | +  | +  | .  | .  | +  | +  | +  | .  | +  | .  | +  | 5  | .  |
| <i>Schizachyrium brevifolium</i>                       |      | 1 | 3 | 2 | 4 | 3 | 4 | . | 3 | 2 | 4  | 4  | 2  | 3  | 4  | 3  | 3  | 1  | +  | 2  | 3  | +  | 3  |
| <i>Scleria aterra</i>                                  |      | . | . | . | . | . | . | . | . | . | .  | .  | .  | .  | .  | .  | .  | +  | .  | .  | .  | .  | +  |
| <i>Scleria flexuosa</i>                                |      | . | . | . | . | . | . | . | . | . | .  | +  | 1  | .  | .  | 2  | 1  | .  | .  | .  | .  | .  | 1  |
| <i>Scleria melanotricha</i>                            |      | . | . | . | . | . | . | . | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | +  |
| <i>Scleria spiciformis</i>                             |      | . | . | . | . | . | . | . | . | . | .  | .  | .  | .  | .  | +  | .  | .  | 1  | .  | .  | .  | +  |
| <i>Sopubia ramosa</i>                                  |      | + | . | . | . | . | + | . | . | . | .  | .  | .  | .  | 1  | .  | .  | +  | .  | +  | .  | .  | .  |
| <i>Spermacoce ruelliae</i>                             |      | . | . | + | . | . | . | . | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  |
| <i>Spermacoce verticillata</i>                         |      | . | . | . | . | . | . | . | + | . | .  | .  | .  | +  | .  | +  | .  | .  | .  | .  | 1  | .  | +  |
| <i>Sporobolus dinklagei</i>                            |      | . | . | . | . | . | . | . | 3 | . | .  | .  | 3  | .  | .  | 1  | .  | 1  | 1  | .  | 1  | .  | .  |
| <i>Sporobolus paniculatus</i>                          |      | . | . | . | . | . | . | . | 1 | 1 | .  | +  | 1  | .  | 1  | .  | +  | .  | .  | +  | 1  | +  | 1  |
| <i>Sporobolus pyramidalis</i>                          |      | . | . | . | . | + | . | . | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  |
| <i>Striga asiatica</i>                                 |      | . | + | . | . | . | . | . | . | . | .  | .  | .  | +  | .  | .  | .  | .  | .  | .  | .  | .  | .  |
| <i>Vigna racemosa</i>                                  |      | . | . | . | . | . | . | . | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | +  | .  |
| <i>Xyris anceps</i>                                    |      | . | . | . | . | . | . | . | + | . | .  | .  | +  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  |
| <i>Xyris decipiens</i>                                 |      | . | . | . | . | . | . | 2 | . | . | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | .  | +  |
| <i>Zornia latifolia</i>                                |      | + | . | . | . | . | + | . | . | . | .  | .  | .  | +  | +  | .  | .  | .  | .  | .  | .  | .  | .  |



#### 4.4 Savannahs Developed on Old Mine Sites on Mount Tokadeh below 1000 metres

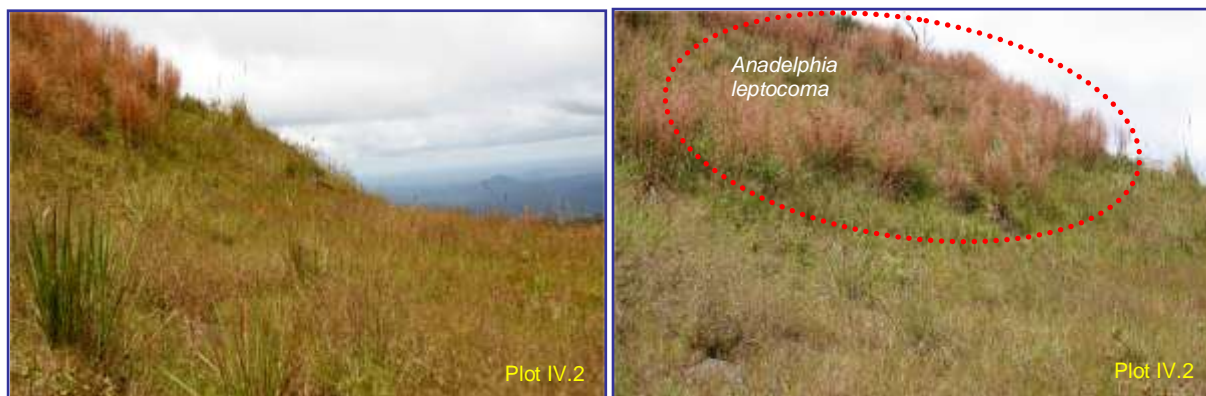
##### Example Plot IV.1: N07°27'02.0 – W008°40'21.4 – Altitude: 872 m

This plot corresponds to a terrace, more or less swampy, of which the herbaceous mat mainly consists of *Loudetia phragmitoides*, *Anadelphia leptocoma*, *Sporobolus dinklagei* and *Schizachyrium brevifolium*. *Sporobolus dinklagei* is abundant, locally, on the best drained soils. Small, wet depressions are invaded by helophilous species including *Cyperus haspan*, *Lipocarpha chinensis*, *Axonopus compressus*, *Eragrostis atrovirens* and *Panicum laxum*. The flanks of the terrace carry the same dominant species with the exception of *Anadelphia leptocoma*. *Dissotis jacquesii* is a frequent shrub at the base of the terraces where it sometimes forms dense stands, associated with *Chromolaena odorata*.



##### Example Plot IV.2: N07°26'58.4 – W008°40'23.8 – Altitude: 955 m

The Plot IV.2 occupies the summit of Mount Tokadeh, at approximately 955 m. *Loudetia phragmitoides*, *Sporobolus dinklagei*, *Schizachyrium brevifolium* and *Panicum griffonii* form the main part of the herbaceous layer. The summit of the mount is covered with a small population of *Anadelphia leptocoma*. Among the other frequent species are *Chromolaena odorata*, *Pennisetum polystachion* P. *hordeoides*, *Cyperus tenuiculmis* var. *guineensis* and *Nephrolepis undulata*. *Dissotis jacquesii* forms a thicket at the base of a rock outcrop.



## Example Plot IV.3: N07°27'00.0 – W008°40'21.3 – Altitude: 927 m

The herbaceous layer of Plot IV.3, situated also on a terrace below the summit of the mount, is widely dominated by *Sporobolus dinklagei* and *Schizachyrium brevifolium*. The presence of *Lipocarpa chinensis*, *Panicum laxum*, *P. griffonii*, *Fuirena stricta*, *Eragrostis atrovirens* and *Axonopus compressus* is due to a small swampy depression. Asteraceae *Chromolaena odorata* also appears in this plot but most of it is withering at the foot of the mount.



## Example Plot IV.4: N07°26'52.0 – W008°40'14.5 – Altitude: 897m

This plot is represented by a terrace with a relatively substantial herbaceous cover. Annual Poaceae *Andropogon fastigiatus* dominates the grass layer associated mainly with *Sporobolus dinklagei*. Other species, such as *Abildgaardia congolensis*, *Loudetia phragmitoides*, *Pennisetum hordeoides* or *Schizachyrium brevifolium* are present but with a very low biomass.

The side of this terrace is colonised by *Dicranopteris linearis* with some woody plants at the stage of regeneration among which are *Dissotis brazzae*, *Albizzia adianthifolia*, *A. zygia*, *Gaertnera paniculata* and *Alchornea cordifolia*.





## Example Plot IV.5: N07°26'53.6 – W008°40'14.5 – Altitude: 896 m

The Plot IV.5 is very similar to the previous one, with a herbaceous layer consisting mainly of *Andropogon fastigiatus*, but *Loudetia phragmitoides*, *Schizachyrium brevifolium*, *Sporobolus dinklagei* and *Pennisetum polystachion* are more abundant because of the presence of a small but deep wet depression.



## Conclusions on Old Mine Sites at Mount Tokadeh

The terraces of Mount Tokadeh were colonised by a savannah vegetation that is very different from that observed in the Sites of Old Mine (Site I) and Blue Lake (Site II). Among thirty five (35) listed species, *Loudetia phragmitoides*, *Sporobolus dinklagei*, *Schizachyrium brevifolium* and in a less important way *Panicum griffonii* are the best represented. *Anadelphia leptocoma* appears only in two plots, as well as *Andropogon fastigiatus* but this last one is dominant in the herbaceous layer by forming an almost monospecific population (Table III).

*Melinis minutiflora* is practically absent in this site though this grass dominated in the two other former mining sites.

The soil characterising the terraces of Mount Tokadeh is deeper and better drained. On other terraces, with a similar herbaceous stratum composition, species such as *Pennisetum polystachion* can be locally abundant. Some Cyperaceae were observed but are much less numerous than in the two other sites: they are located in small wet depressions. The flanks of the terraces carry similar vegetation to that of the terraces but often less dense because of the slope which is usually steep. The steepest rock faces are colonised by the fern *Dricranopteris linearis*.

Another difference with the previous sites lies in the presence of woody plants in the state of regeneration, among which are: *Funtumia africana*, *Lophira alata*, *Harungana madagascariensis*, *Dissotis brazzae*, *Anthocleista nobilis*, *Albizia adianthifolia*, *A. zygia*, *Gaertnera paniculata*, *Alchornea cordifolia* and *Eugenia leonensis*.

**Table III. List of the herbaceous species, with their abundance/dominance, observed in Site IV: dominant species are highlighted in green and the locally abundant species in yellow.**

| Site IV: Old Mine Sites at Mount Tokadeh |      |       |       |       |       |       |
|--|------|-------|-------|-------|-------|-------|
| Species                                  | Plot | PIV.1 | PIV.2 | PIV.3 | PIV.4 | PIV.5 |
| <i>Abildgaardia congolensis</i>          |      | .     | .     | .     | 2     | .     |
| <i>Ageratum conyzoides</i>               |      | .     | .     | .     | .     | +     |
| <i>Alectra sessiliflora</i>              |      | .     | +     | .     | .     | +     |
| <i>Anadelphia leptocoma</i>              |      | 2     | 2     | .     | .     | .     |
| <i>Andropogon fastigiatus</i>            |      | .     | .     | .     | 4     | 4     |
| <i>Axonopus compressus</i>               |      | 1     | .     | 2     | .     | .     |
| <i>Blumea heudelotii</i>                 |      | .     | .     | .     | .     | +     |
| <i>Chromolaena odorata</i>               |      | 2     | 1     | +     | +     | 1     |
| <i>Crassocephalum rubens</i>             |      | .     | .     | .     | .     | +     |
| <i>Cyperus haspan</i>                    |      | +     | .     | .     | .     | .     |
| <i>Cyperus tenuiculmis</i>               |      | .     | 1     | 2     | +     | +     |
| <i>Emilia coccinea</i>                   |      | +     | +     | .     | +     | .     |
| <i>Eragrostis atrovirens</i>             |      | +     | .     | +     | .     | .     |
| <i>Conyza bonariensis</i>                |      | .     | +     | .     | .     | .     |
| <i>Fuirena stricta</i>                   |      | .     | .     | +     | .     | .     |
| <i>Habenaria genuflexa</i>               |      | .     | .     | .     | .     | +     |
| <i>Lipocarpa chinensis</i>               |      | 1     | .     | .     | .     | .     |
| <i>Liparis rufina</i>                    |      | .     | .     | .     | .     | +     |
| <i>Loudetia phragmitoides</i>            |      | 4     | +     | 1     | +     | 2     |
| <i>Lycopodiella affinis</i>              |      | 1     | .     | .     | .     | .     |
| <i>Melinis minutiflora</i>               |      | .     | +     | .     | .     | .     |
| <i>Nephrolepis undulata</i>              |      | +     | 1     | 2     | .     | .     |
| <i>Neurotheca loeselioides</i>           |      | 1     | +     | 2     | +     | 1     |
| <i>Oldenlandia herbacea</i>              |      | +     | +     | .     | .     | +     |
| <i>Otomeria guineensis</i>               |      | .     | +     | .     | .     | .     |
| <i>Panicum dinklagei</i>                 |      | .     | +     | .     | .     | +     |
| <i>Panicum griffonii</i>                 |      | 2     | 2     | 2     | .     | .     |
| <i>Panicum laxum</i>                     |      | +     | .     | +     | .     | .     |
| <i>Pennisetum hordeoides</i>             |      | +     | +     | 1     | +     | .     |
| <i>Pennisetum polystachion</i>           |      | .     | +     | .     | .     | 1     |
| <i>Polygala multiflora</i>               |      | .     | .     | .     | +     | +     |
| <i>Schizachyrium brevifolium</i>         |      | 1     | 3     | 3     | +     | 2     |
| <i>Scleria lagoensis</i>                 |      | .     | .     | +     | .     | .     |
| <i>Spermacoce verticillata</i>           |      | .     | +     | +     | +     | +     |
| <i>Sporobolus dinklagei</i>              |      | 4     | 4     | 4     | 3     | 2     |



## 4.5 Savannahs on Mounts Gangra and Yuelliton

Mounts Gangra and Yuelliton are situated at approximately 11 km to the West of Yekepa. The clearing of the forest vegetation at the time of the activities of the LAMCO, then the opening of roads and the construction of buildings left a clearing which was invaded by herbaceous vegetation. One single plot was surveyed in this site because of its small surface area.

### Example Plot V.1: N07°33'32.3 – W008°37'55.2 – Altitude: 706 m

Plot V.1 is represented by a small savannah situated between Mount Gangra and Mount Yuelliton at an altitude close to 700 m. It is lined by two roads at the intersection of which was constructed a building where the activities of LAMCO were recorded. This savannah, formed mainly by a population of *Anadelphia leptocoma* and *Hyparrhenia diplandra* var. *diplandra*, is much degraded and vulnerable to encroachment. A total of thirty-two (32) herbaceous species was listed in this site (Table IV).



The initial forest vegetation seems to reconquer the site. As everywhere, after the elimination of the forest, *Anadelphia leptocoma* is again the dominant species in the herbaceous layer.

This is associated locally with *Hyparrhenia diplandra* var. *diplandra* and *Pennisetum polystachion*. Species such as *Chromolaena odorata* and *Aspilia africana*, rather abundant, form thickets on the border of the forest and participate in the encroachment of the environment.

Numerous ruderal plants are spread in the grass layer and on the eroded patches of soil comprising among others, *Ageratum conyzoides*, *Calopogonium mucunoides*, *Mimosa pudica*, *Passiflora foetida*, *Pennisetum hordeoides*, *Sida acuta*, *Zornia latifolia*, *Sporobolus pyramidalis*, *Spermacoce verticillata* and *Stachytarpheta angustifolia*.

**Table IV. List of herbaceous species, with their abundance/dominance, observed in the savannah of Site V: dominant species are highlighted in green and locally abundant species in yellow.**

| Site V: Gangra-Yuelliton Savannah    |      |      |
|--------------------------------------|------|------|
| Species                              | Plot | PV.1 |
| Abildgaardia congolensis             |      | +    |
| Abildgaardia densa                   |      | +    |
| Ageratum conyzoides                  |      | +    |
| Anadelphia leptocoma                 |      | 4    |
| Aristolochia embergeri               |      | +    |
| Aspilia Africana                     |      | 2    |
| Axonopus compressus                  |      | +    |
| Calopogonium mucunoides              |      | 1    |
| Chromolaena odorata                  |      | 3    |
| Cuphea carthagenensis                |      | +    |
| Cyperus haspan                       |      | +    |
| Cyperus tenuiculmis                  |      | +    |
| Desmodium ramosissimum               |      | +    |
| Euphorbia sp.                        |      | +    |
| Hyparrhenia diplandra var. diplandra |      | 3    |
| Mimosa pudica                        |      | 1    |
| Neurotheca loeselioides              |      | +    |
| Panicum griffonii                    |      | 3    |
| Paspalum scrobiculatum               |      | +    |
| Passiflora foetida                   |      | +    |
| Pennisetum hordeoides                |      | +    |
| Pennisetum polystachion              |      | 3    |
| Schizachyrium brevifolium            |      | 3    |
| Scleria spiciformis                  |      | +    |
| Sida acuta                           |      | +    |
| Spermacoce verticillata              |      | 1    |
| Sporobolus dinklagei                 |      | +    |
| Sporobolus pyramidalis               |      | +    |
| Stachytarpheta angustifolia          |      | +    |
| Thunbergia chrysops                  |      | +    |
| Vigna racemosa                       |      | +    |
| Zornia latifolia                     |      | +    |

## 4.6 Piedmont Savannahs in Northern Nimba

The main piedmont savannahs in Northern Nimba are situated in the region of Yekepa or extend around the sites of Old Mine and Blue Lake. Other savannahs, situated in the southwest of the mining sites, are included in the wet, dense forest. These grassy formations, at an altitude between 500 and 700 m, are formed following degradation of the forest's natural environment due to the past mining activities.

### Site III: Grassfield area savannahs

The Grassfield Site includes three very different types of savannahs, situated southwest of the site of Old Mine. Eleven plots were surveyed in these savannahs which were and are still sometimes subjected to human pressures.

#### Example Plot III.1: N07°29'11.3 – W008°34'46.6 – Altitude: 513 m

Large Andropogoneae dominate widely in the grass layer setting of this plot, in particular: *Anadelphia leptocoma*, then *Hyparrhenia diplandra* var. *diplandra*. Strong perennial *Andropogon macrophyllus* is present in the form of a) dense patches, often associated with *Aspilia africana*, or b) a compact fringe along the forest borders. The high density of the grass layer limits the development of the other herbaceous species.



## Example Plot III.2: N07°29'19.1 – W008°34'52.5 – Altitude: 503 m

This plot, continuing on from the previous one, is very similar with the dominance of *Anadelphia leptocoma*. However, the opening of a road for the training of ArcelorMittal drivers led to a degradation of the environment. The strong grass *Imperata cylindrica* quickly colonised this clearing, but *Anadelphia leptocoma* seems to supplant it gradually. Ruderal plants such as *Neurotheca loeselioides*, *Eragrostis gangetica*, *Axonopus compressus*, *Schwenckia americana* and *Zornia latifolia* have taken root on the roadsides.

*Andropogon macrophyllus* is always present, associated with *Aspilia africana*, *Chromolaena odorata* and *Urena lobata*, forming dense thickets within the *Anadelphia leptocoma* layer or along the forest border.



## Example Plot III.3: N07°29'28.2 – W008°34'57.6 – Altitude: 502 m

This plot concerns an environment which was more degraded by roads and the construction of buildings. However large Andropogoneae, and in particular *Anadelphia leptocoma*, have colonised the site. Ruderal species, more numerous, such as *Zornia latifolia*, *Sida acuta*, *Spermacoce verticillata* or *Calopogonium mucunoides* appear on the roadsides and in certain small clearings within the grass layer.





## Plots PIII.4 and PIII.5

These two plots include a large savannah, situated more in the south-east, developed on a lateritic cuirasse with a mostly compact ferruginous conglomerate and crossed by a road going to Mount Bele. The transition between the herbaceous vegetation and the neighboring forest is clear except for a transition thicket formed by tall grasses and some shrubs. Small woody islands are spread in the savannah, sometimes in swampy depressions.

### Example Plot III.4: N07°27'49.4 – W008°34'56.0 – Altitude: 522 m

The savannah of Plot III.4 is very different from that studied previously, both by structure and floristic composition. The strong Andropogoneae *Hyparrhenia diplandra* var. *diplandra* dominates the herbaceous layer associated with *Anadelphia leptocoma* when the cuirasse appears on more swampy patches of soil. This last species forms virtually monospecific stands. *Andropogon macrophyllus* is present without being abundant, in the form of patches and on the forest border which lines the savannah. It is also present in the woody islands that spread in the savannah.

The dense grass cover limits the development of other species except for some Dicotyledons such as *Indigofera dendroides* and *Vigna racemosa*. The small clearings formed by the cuirasse, when it is at soil level, allow the development of *Panicum griffonii*, *P. glaucocladum*, *Striga asiatica*, *Nemum spadiceum* or *Neurotheca loeselioides* which take advantage of the soil humidity.



## Example Plot III.5: N07°27'59.4 – W008°35'01.3 – Altitude: 507 m

This plot, situated on the west side of the road, features an herbaceous layer of floristic composition similar to that of Plot III.4. The same species dominate in the grass layer but *Hyparrhenia diplandra* var. *diplandra* and *Anadelphia leptocoma* are more mixed. The second species is dominant when the ground becomes swampy, associated with *Panicum griffonii*, *P. glaucocladum*, *P. parviflorum*. *Anadelphia lomaense*, a rare perennial grass species, appears locally on the wet cuirasse.



## Plots III.6 to III.11

These six plots were surveyed in the Grassfield savannah. This savannah, included in the dense forest, constituted an important site when LAMCO carried out its mining activities with the creation of the Nimba Research Laboratory. The objective of the laboratory was to study the biological richness of Nimba. The construction of buildings, diverse infrastructure and roads had disturbed this environment with, furthermore, the introduction of exotic botanical species to decorate gardens around dwellings. During the last two decades, the vegetation of this savannah was reconstituted and the buildings, for the most part, collapsed and are practically no longer visible.



## Example Plot III.6: N07°29'14.8 – W008°34'08.6 – Altitude: 576 m

This plot is situated in the north-east part of the savannah and rests on a lateritic carapace and a gravelly soil. The herbaceous stratum, very dense, consists mainly of *Loudetia simplex* associated with *Anadelphia leptocoma*, locally in border of the forest, *Schizachyrium rupestre* and *Rhytachne rottboellioides*, and secondarily to *Chromoalena odorata*. Some shrubs are spread in the savannah, among others *Alchornea cordifolia* and *Margaritaria discoidea*, as well as some shrubs belonging to the exotic species *Allamanda catarthica*. On the wet and bare cuirasse appear some small annual plants as *Neurotheca loeselioides* and *Nemum spadiceum*.



## Example Plot III.7: N07°29'12.9 – W008°34'14.6 – Altitude: 572 m

This plot is similar to the previous one, but situated on a gentle slope, with the dominance of *Loudetia simplex* associated mainly with *Anadelphia leptocoma* (at the top of the slope), *Schizachyrium rupestre* and secondarily, very locally, with *Hyparrhenia diplandra* var. *diplandra* and *Pennisetum polystachion*.

Species such as *Andropogon macrophyllus*, *Aspilia africana*, *Melinis minutiflora* and *Indigofera dendroides* are associated with the forest border or on the edge of the woody thickets isolated in the savannah.



## Example Plot III.8: N07°29'15.9 – W008°34'16.5 – Altitude: 573 m

A stand of *Elymandra androphila*, *Hyparrhenia diplandra* var. *diplandra* and *Hyparrhenia diplandra* var. *mutica* contrasts with the surrounding savannah. The first species occupies the top of a small slope, with *Anadelphia leptocoma*, while the two others colonised a small depression where the soil, black, is thicker. *Loudetia simplex* is always present, but less abundant, on a shallow soil forms by the carapace.



## Example Plot III.9: N07°29'16.7 – W008°34'16.7 – Altitude: 575 m

This plot, adjacent to the previous one, is again situated on the carapace with the return of *Loudetia simplex*, *Rhytachne rottboellioides*, *Monocymbium deightonii* and *Andropogon curvifolius*. Small rivelets on the bare carapace are occupied by *Nemum spadiceum* and *Neurotheca loeselioides*. The same species that previously line the border of the forest are, among others, *Andropogon macrophyllus*, *Melinis minutiflora*, *Chromolaena odorata* as well as *Crotalaria retusa*, *Desmodium velutinum* and *Mikania scandens*. *Phyllanthus alpestris* appears under the shade of a small shrub within the grass layer.





## Example Plot III.10: N07°29'12.9 – W008°34'26.7 – Altitude: 572 m

The herbaceous stratum of this plot does not change with *Loudetia simplex*, *Andropogon curvifolius*, *Rhytachne rottboellioides* and *Monocymbium deightonii* as the main grasses. *Chromolaena odorata* is still present, spread in the grassy layer.



## Example Plot III.11: N07°29'16.9 – W008°34'29.1 – Altitude: 561 m

This plot in the Western border of the dense forest consists of two very different grass populations. One of *Loudetia simplex*, with *Schizachyrium rupestre*, *Anadelphia leptocoma* and *Monocymbium deightonii*, occupies the cuirasse while big Andropogoneae including *Hyparrhenia diplandra* var. *diplandra*, *H. diplandra* var. *mutica* and *Elymandra androphila* develop on a deeper soil.

On the other side of the track crossing the savannah, not far from this plot, *Elymandra androphila* forms a practically pure stand, associated with *Hyparrhenia diplandra* var. *mutica*, in a small depression with a black soil (N07°29'14.2 - W008°34'28.5).



## Conclusions on the Grassfield Piedmont Savannahs

The site called Grassfield consists of three types of savannah in which 57 herbaceous species were observed (Table V). The distribution of the dominant grasses is not homogeneous in the different plots studied:

- *Anadelphia leptocoma* and *Hyparrhenia diplandra* var. *diplandra* are the species best represented on the whole site;
- *Andropogon macrophyllus* is little frequent in the savannah of Grassfield while this strong grass is abundant in the other savannahs;
- *Loudetia simplex*, *Andropogon curvifolius*, *Monocymbium deightonii*, *Rhytachne rottboellioides* and *Schizachyrium rupestre* are the dominant grasses of the savannah of Grassfield but are absent in the other studied formations.

The first savannah represents a recolonisation of a forest environment cleared to establish the Grassfield airstrip: *Anadelphia leptocoma* is dominant, associated locally with *Hyparrhenia diplandra* var. *diplandra* and *Andropogon macrophyllus*. The presence of a stand of *Imperata cylindrica* and numerous ruderal species such as *Calopogonium mucunoides*, *Chamaecrista mimosoides*, *Chromolaena odorata*, *Schwenckia americana*, *Sida acuta* or *Spermacoce verticillata* is representative of the environmental degradation.

Some woody plants are spread in the savannah such as *Dissotis brazzae*, *Dichrostachys cinerea*, *Virectaria multiflora* and *Margaritaria discoidea*, or have grown around the former buildings, such as *Alchornea cordifolia*.

The second savannah is a natural grassy formation in which are spread woody islands or thickets consisting of species such as *Ficus sur*, *Alchornea cordifolia*, *Anthocleista nobilis*, *Margaritaria discoidea*, or *Rauvolfia vomitoria* in the swampy depressions. This savannah is situated on a lateritic cuirasse with ferruginous conglomerates and certainly lateritic clays drained in depth. The transition with the surrounding forest is very clear.

The large Androponeae *Hyparrhenia diplandra* var. *diplandra* constitutes the main part of the grass layer, particularly dense in Plot III.4.

The savannah is more associated with *Anadelphia leptocoma* in Plot III.5. The flora changes when the cuirasse is on the ground surface with the appearance of annuals such as *Panicum glaucocladum*, *P. griffonii*, *Anadelphia lomaense* (rare), *Neurotheca loeselioides* and *Nemum spadiceum*.

The third savannah - Grassfield savannah - has grown on a dense lateritic cuirasse. The variations in the structure and density of the soil influence the composition of the grass layer with species such as *Loudetia simplex* and *Rhytachne rottboellioides* on the shallow soil while *Hyparrhenia diplandra* var. *diplandra*, *Hyparrhenia diplandra* var. *mutica* and *Elymandta androphila* occupy deeper and more clayey soils.

The contact between the forest and savannah is defined by a dense shrubby thicket lined with an association of different species comprising *Andropogon macrophyllus*, *Melinis minutiflora*, *Pteridium aquilinum*, *Aspilia africana*, *Panicum scandens*, *Mikania scandens* and *Chromolaena odorata*. This last species, represented by isolated individuals in the savannah is very frequent and even dominant in certain parts of the forest edge. Plants in the forest border that have withstood previous human occupation are now combined with strong Asteraceae *Tithonia diversifolia* and various exotic shrubs or trees such as *Allamanda catarthica*, *Lantana camara*, *Gmelina arborea*, *Tectona grandis* or *Lagerstroemia speciosa*.

**Table V. List of herbaceous species, with their abundance/dominance, observed in the savannahs of Site III: dominant species are highlighted in green and locally abundant species in yellow.**

| Site III: Grassfield area piedmont savannahs |      |       |       |       |       |       |       |       |       |       |        |        |
|--|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------|--------|
| Species                                      | Plot | III.1 | III.2 | III.3 | III.4 | III.5 | III.6 | III.7 | III.8 | III.9 | III.10 | III.11 |
| Abildgaardia congolensis                     |      | +     | +     | +     | .     | .     | .     | .     | .     | .     | .      | .      |
| Anadelphia leptocoma                         |      | 5     | 5     | 4     | 2     | 2     | 2     | 1     | 1     | +     | .      | 2      |
| Anadelphia lomaense                          |      | .     | .     | .     | .     | +     | .     |       | .     | .     | .      | .      |
| Andropogon curvifolius                       |      | .     | .     | .     | .     | .     | 1     | .     | 3     | 3     | 3      | .      |
| Andropogon macrophyllus                      |      | 3     | 2     | 2     | 2     | 2     | .     | +     | +     | +     | .      | .      |
| Aspilia Africana                             |      | 1     | 1     | +     | .     | .     | +     | .     | .     | .     | .      | .      |
| Axonopus compressus                          |      | .     | +     | +     | .     | .     | .     | .     | .     | .     | .      | .      |
| Burmannia madagascariensis                   |      | .     | .     | .     | .     | .     | .     | .     | +     | +     | .      | .      |
| Calopogonium mucunoides                      |      | .     | +     | .     | .     | .     | .     | .     | .     | .     | .      | .      |
| Chamaecrista mimosoides                      |      | .     | .     | .     | .     | .     | .     | .     | .     | .     | +      | .      |
| Chromolaena odorata                          |      | +     | +     | 1     | +     |       | 2     | .     | +     | 1     | +      | .      |
| Crotalaria lathyroides                       |      | .     | .     | .     | .     | +     | .     | .     | .     | +     | .      | +      |
| Crotalaria retusa                            |      | .     | .     | .     | .     | .     | .     | .     | .     | +     | .      | .      |
| Cuphea carthagenensis                        |      | .     | .     | .     | .     | .     | .     | .     | .     | .     | .      | +      |
| Desmodium ramosissimum                       |      | .     | +     | +     | .     | .     | +     | +     | .     | .     | .      | .      |
| Desmodium velutinum                          |      | .     | .     | .     | .     | .     | .     | .     | .     | +     | .      | .      |
| Elymandra androphila                         |      | .     | .     | .     | .     | .     | .     | .     | 3     | .     | .      | 2      |
| Eragrostis gangetica                         |      | .     | +     | +     | .     | .     | .     | .     | .     | .     | .      | .      |
| Eriosema glomeratum                          |      | .     | .     | .     | +     | .     | +     | .     | .     | +     | .      | +      |
| Fimbristylis albiviridis                     |      | .     | .     | .     | .     | .     |       | +     | .     | .     | .      | .      |
| Habenaria genuflexa                          |      | .     | .     | .     | .     | .     | +     | .     | .     | .     | .      | .      |
| Hyparrhenia diplandra var. Diplandra         |      | 2     | 2     | 1     | 5     | 5     | +     | +     | 3     |       | .      | 4      |
| Hyparrhenia diplandra var. Mutica            |      | .     | .     | .     | .     | .     | .     | .     | 3     | +     | 1      | 1      |
| Imperata cylindrica                          |      | .     | 3     | .     | .     | .     | .     | .     | .     | .     | .      | .      |
| Indigofera dendroides                        |      | .     | .     | .     | +     | +     | +     | +     | .     | +     | 1      | .      |
| Ipomoea involucrata                          |      | .     | +     | .     | .     | .     |       |       | .     | .     | .      | .      |
| Loudetia simplex                             |      | .     | .     | .     | .     | .     | 4     | 5     | 2     | 5     | 4      | 4      |
| Melinis minutiflora                          |      | .     | .     | .     | .     | .     | .     | 1     | .     | .     | 1      | .      |
| Monocymbium deightonii                       |      | .     | .     | .     | .     | .     | .     | +     | .     | 2     | 2      | 2      |
| Nemum spadiceum                              |      | .     | .     | .     | +     | .     | +     | .     | .     | 1     | .      | .      |
| Neurotheca loeselioides                      |      | +     | +     | +     | +     | +     | +     | +     | .     | .     | +      | .      |
| Oldenlandia herbacea                         |      | .     | +     | +     | .     | .     | .     | .     | .     | .     | .      | .      |
| Panicum congoense                            |      | .     | .     | .     | .     | +     | .     | .     | .     | .     | .      | .      |
| Panicum dinklagei                            |      | .     | .     | .     | .     | +     | .     | .     | .     | .     | .      | .      |
| Panicum glaucocladum                         |      | .     | .     | .     | +     | +     | .     | .     | .     | .     | .      | .      |
| Panicum griffonii                            |      | .     | .     | .     | +     | +     | .     | +     | .     | .     | .      | .      |
| Panicum parviflorum                          |      | .     | .     | .     | .     | +     | .     | .     | .     | .     | +      | .      |
| Paspalum scrobiculatum                       |      | +     | +     | .     | .     | .     | .     | +     | .     | .     | .      | .      |
| Pennisetum polystachion                      |      | .     | .     | .     | .     | .     | .     | +     |       | +     | .      | .      |
| Phyllanthus alpestris                        |      | .     | .     | .     | .     | .     | .     | .     | .     | +     | .      | .      |
| Rhytachne rottboelliodes                     |      | .     | .     | .     | .     | .     | 3     | .     | +     | 2     | 3      | .      |
| Rottboellia cochinchinensis                  |      | .     | .     | .     | .     | .     | .     | .     | +     | .     | .      | .      |
| Sauvagesia erecta                            |      | .     | +     | +     | .     | .     | .     | .     | .     | .     | .      | .      |
| Schizachyrium brevifolium                    |      | .     | .     | .     | .     | .     | .     | .     | +     | .     | .      | .      |
| Schizachyrium rupestre                       |      | .     | .     | .     | .     | .     | 3     | 2     | .     | 1     | +      | +      |
| Schwenckia Americana                         |      | +     | +     | +     | .     | .     | .     | .     | .     | .     | .      | .      |
| Scleria flexuosa                             |      | .     | .     | .     | +     | +     | +     | .     | .     | +     | +      | .      |
| Scleria naumanniana                          |      | .     | .     | .     | .     | .     | +     | .     | .     | .     | .      | .      |
| Sida acuta                                   |      | .     | +     | +     | .     | .     | .     | .     | .     | .     | .      | .      |
| Spermacoce ruelliae                          |      | .     | .     | .     | .     | .     | .     | +     | .     | +     | .      | .      |
| Spermacoce verticillata                      |      | .     | +     | +     | .     | .     | .     | .     | .     | .     | .      | .      |
| Striga asiatica                              |      | +     | .     | .     | +     | .     | +     | .     | .     | .     | .      | .      |
| Striga macrantha                             |      | .     | .     | .     | +     | .     | .     | .     | .     | .     | .      | .      |
| Tephrosia flexuosa                           |      | .     | .     | .     | .     | .     | .     | .     | .     |       | +      | .      |
| Urena lobata                                 |      | .     | +     | .     | .     | .     | .     | .     | .     | .     | .      | .      |
| Vigna racemosa                               |      | .     | .     | .     | .     | +     | .     | .     | .     | +     | .      | .      |
| Zornia latifolia                             |      | .     | +     | +     | .     | .     | .     | .     | .     | .     | .      | .      |



## Piedmont Savannah close to the Northern Side of Mount Tokadeh

Site VI is represented by a piedmont savannah included in the forest and situated at the foot of Mount Tokadeh in the North. This savannah is lined in the South by a small river which is polluted by the muddy flows caused by the mining of Mount Tokadeh. Four plots were surveyed in this savannah.

### Example Plot VI.1: N07°27'28.5 – W008°40'15.2 – Altitude: 650 m

This plot, in the western part of the savannah, is situated at the top of slope, at the level of a break which announces a plateau. This plateau ends, following a gentle slope, at the border with the gallery forest of the river. *Anadelphia leptocoma*, *Imperata cylindrica*, *Schizachyrium brevifolium* and *Pennisetum polystachion* are dominant Poaceae in the herbaceous layer, associated with *Pteridium aquilinum*: *Panicum griffonii* is locally abundant. The cuirasse, locally wet, allows species such as *Paspalum scrobiculatum* or *Eragrostis atrovirens* to remain in the grass stratum.

Some woody species such as *Margaritaria discoidea*, *Holarrhena africana*, *Trema orientalis*, *Albizia zygia* and *Dichrostachys cinerea* are common in this part of the savannah.





## Example Plot VI.2: N07°27'30.7 – W008°40'12.0 – Altitude: 635 m

Plot VI.2 is also situated at the top of a slope, and the dense herbaceous layer is dominated by *Anadelphia leptocoma*, associated locally with *Schizachyrium brevifolium*. Because of the dense cover, the grass layer presents less floristic diversity than the previous plot. The same woody species are still present, including *Alstonia boonei*.



## Example Plot VI.3: N07°27'29.1 – W008°40'06.8 – Altitude: 619 m

This plot is characterised by an almost pure stand of *Anadelphia leptocoma*. Only annual Poaceae *Schizachyrium brevifolium* is associated with it locally. Other species are less numerous because of the density of the grass cover.





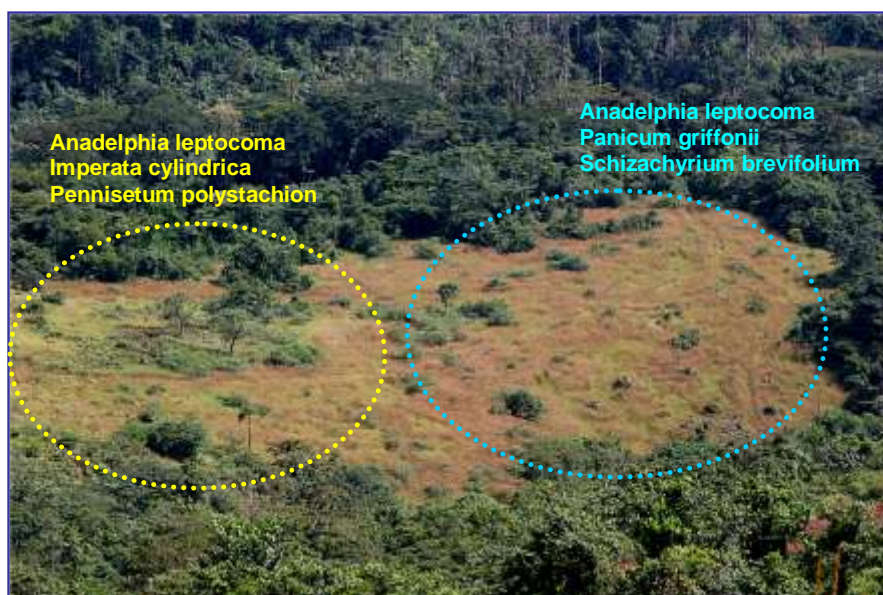
## Example Plot VI.4: N07°27'27.4 – W008°40'05.5 – Altitude: 623 m

This plot, sloping gently towards the small forest gallery of the river, is again dominated by *Anadelphia leptocoma* associated with *Panicum griffonii* and *Schizachyrium brevifolium*. Some small woody thickets are spread in this part of the savannah, formed in particular by *Dalbergia saxatilis*, *Aspilia africana* and *Ipomoea involucrata*.



## Conclusions on the Savannah close to the Northern Side of Mount Tokadeh

The vegetation surveys carried out in Site VI list 29 species (Table VI). If *Anadelphia leptocoma* is the dominant species in the herbaceous layer, the vegetation of the western part of the savannah, situated on a slope, where *Imperata cylindrica* and *Pennisetum polystachion* are locally abundant, differs from that of the eastern part, on a plateau, where *Panicum griffonii* and *Schizachyrium brevifolium* are both main grasses associated with *Anadelphia leptocoma*. The fern *Pteridium aquilinum* also appears only in the western part of the site where an encroachment is modifying the physiognomy of the savannah.



**Table VI. List of herbaceous species, with their abundance/dominance, observed in the savannah of Site VI: dominant species are highlighted in green and locally abundant species in yellow.**

| Site VI: Tokadeh piedmont        |      |       |       |       |       |
|----------------------------------|------|-------|-------|-------|-------|
| Species                          | Plot | PVI.1 | PVI.2 | PVI.3 | PVI.4 |
| <i>Abrus canescens</i>           |      | .     | .     | +     | .     |
| <i>Anadelphia leptocoma</i>      |      | 4     | 5     | 5     | 5     |
| <i>Andropogon fastigiatus</i>    |      | .     | .     | +     | .     |
| <i>Aspilia Africana</i>          |      | +     | .     | .     | +     |
| <i>Calopogonium mucunoides</i>   |      | +     | .     | .     | .     |
| <i>Chromolaena odorata</i>       |      | +     | .     | .     | +     |
| <i>Crassocephalum rubens</i>     |      | +     | .     | .     | .     |
| <i>Cyphostemma rubrosetosum</i>  |      | .     | .     | .     | +     |
| <i>Desmodium ramosissimum</i>    |      | .     | .     | .     | +     |
| <i>Dioscorea minutiflora</i>     |      | .     | +     | .     | .     |
| <i>Eragrostis atrovirens</i>     |      | +     | .     | .     | .     |
| <i>Eriosema glomeratum</i>       |      | .     | .     | +     | .     |
| <i>Habenaria genuflexa</i>       |      | .     | .     | .     | +     |
| <i>Hyparrhenia diplandra</i>     |      | +     | .     | .     | .     |
| <i>Imperata cylindrica</i>       |      | 3     | .     | .     | .     |
| <i>Ipomoea involucrata</i>       |      | .     | .     | .     | +     |
| <i>Lipparis rufina</i>           |      | +     | .     | .     | .     |
| <i>Nephrolepis undulata</i>      |      | +     | +     | .     | .     |
| <i>Neurotheca loeselioides</i>   |      | +     | +     | .     | .     |
| <i>Panicum griffonii</i>         |      | 3     | +     | +     | 2     |
| <i>Paspalum scrobiculatum</i>    |      | +     | .     | .     | .     |
| <i>Pennisetum polystachion</i>   |      | 3     | .     | .     | 1     |
| <i>Pteridium aquilinum</i>       |      | 3     | .     | .     | .     |
| <i>Schizachyrium brevifolium</i> |      | 3     | 2     | 3     | 3     |
| <i>Scleria spiciformis</i>       |      | 1     | +     | .     | +     |
| <i>Sida acuta</i>                |      | +     | .     | .     | .     |
| <i>Spermacoce verticillata</i>   |      | +     | .     | .     | .     |
| <i>Striga asiatica</i>           |      | +     | +     | +     | +     |
| <i>Zehneria thwaitesii</i>       |      | .     | .     | +     | .     |

## Savannah in the Nimba Piedmont East of the Blue Lake

Site XI is located in a large savannah situated on the piedmont to the east of the Blue Lake. Degradation of the terrace walls upstream has caused collapses of the ravines. During the rainy season, heavy water flow transports voluminous and heavy rocky materials which have destroyed part of the forest situated in the piedmont. A river established itself in this forest massif and has transformed the landscape to a mosaic of forest and savannah.



### Example Plot XI.1: N07°31'11.4 – W008°29'32.0 – Altitude: 584 m

This plot corresponds to a band of narrow savannah which extends through the forest and is lined by a small river flowing down from the mountain. The floristic composition of the herbaceous layer is mainly dominated by *Loudetia phragmitoides*, *Anadelphia leptocoma* and *Melinis minutiflora*. These species occupy ground covered with blocks of granite. The drainage banks are lined by *Pennisetum purpureum*.





## Example Plot XI.2: N07°31'08.5 – W008°29'06.8 – Altitude: 497 m

The savannah which characterizes this plot is situated slightly north-eastwards, and joins the vast zone degraded by the flows from the mountain. This savannah, composed of *Rhynchospora corymbosa*, *Loudetia phragmitoides* and of various ferns, is in fact a swamp. It was not possible to penetrate into it because of the thickness of the mud, and only some species situated on the border such as *Pycreus lanceolatus*, *Panicum parvifolium*, *Cyperus difformis*, *C. distans* were able to be observed. *Chromolaena odorata* is also relatively well-represented in this habitat.



## Example Plot XI.3: N07°31'13.9 – W008°29'02.4 – Altitude: 510 m

Plot XI.3 is situated on the border of the forest in the contact zone of flow which opened a breach in the original forest massif. The vegetation, resting on a wet ground strewn with blocks of granite, is dominated by *Loudetia phragmitoides* and *Lycopodiella affinis*; this last species forming a very dense dominated stratum. Some other species such as *Cyperus distans*, *Pycreus lanceolatus*, *Mimosa pudica*, *Desmodium ramosissimum*, *Chromolaena odorata* and *Pennisetum polystachion* are present without being abundant.



## Example Plot XI.4: N07°31'19.7 – W008°28'58.7 – Altitude: 527 m

Plot XI.4 is situated in the center of the zone of flow coming down from the mountain. The vegetation here is very poor because of the intensity of the flows during rainy season. The ground is sandy and covered with big pieces of granite. The species observed in this habitat, widely spread between the rocks, are *Loudetia phragmitoides*, *Pennisetum polystachion*, *Paspalum scrobiculatum*, *P. conjugatum*, *Panicum laxum*, *Sporobolus dinklagei* and *Mimosa pudica*.



## Example Plot XI.5: N07°31'43.7 – W008°29'06.5 – Altitude: 616 m

This plot is situated in the high part of the savannah, on ground covered with blocks of granite. The herbaceous layer, dense, is dominated by *Loudetia phragmitoides*, *Schizachytium brevifolium* and *Imperata cylindrica* (locally). *Schizachyrium brevifolium* forms a very dense and dominant stratum which masks the ground. Among other most frequent species are *Melinis minutiflora*, *Pennisetum polystachion*, *Chromolaena odorata*, *Sopubia ramosa*, *Lycopodiella affinis*, and *Panicum parvifolium* in small swampy ponds.





**Example Plot XI.6: N07°31'43.6 – W008°29'01.3 – Altitude: 605 m**

**Example Plot XI.7: N07°31'42.3 - W008°28'57.9 - Altitude: 588 m**

**Example Plot XI.8: N07°31'40.8 – W008°28'52.1 - Altitude: 570 m**

**Example Plot XI.9: N07°31'38.7 – W008°28'46.8 - Altitude: 552 m**

**Example Plot XI.10: N07°31'37.4 – W008°28'44.8 - Altitude: 552 m**

These five plots are situated at the middle-slope of the savannah limited on both sides by forest formations. They are very similar to Plot XI.5 with *Loudetia phragmitoides* and *Schizachyrium brevifolium* which form the main part of the herbaceous biomass. Only Plot XI.10 differs from the others by the fact that *Loudetia phragmitoides* is abruptly replaced by *Pennisetum polystachion* until the end of the savannah at the bottom of slope at the edge of the forest.

The density of the *Schizachyrium brevifolium* stratum made the observation of the other species very difficult. These less numerous species, because of the herbaceous cover, are of only minor interest as to the biomass of this savannah.



## Conclusions on the Savannah in the Nimba Piedmont East of the Blue Lake

With the exception of Plot XI.2, represented by a swamp, the whole savannah is very homogeneous. The herbaceous stratum, and especially the grass layer, is widely dominated by *Loudetia phragmitoides* and *Schizachyrium brevifolium*, this second species forming a particularly dense grassy mat. *Pennisetum polystachion*, at the bottom of the slope, *Chromolaena odorata*, *Melinis minutiflora* and *Imperata cylindrica* (locally) represent the other best-represented species. Thirty-seven herbaceous species were listed in this savannah (Table VII).

The physiognomy of the ground level and the structure of this savannah reveal past human pressure and collapses of terraces upstream. Transported gravels and boulders were deposited in this area at the time of the mining activities conducted by LAMCO. The forest would then have been eliminated for mining, and savannah vegetation would then have colonised these large areas. The torrential river flows from the mountain facilitated the colonisation of savannah species by destroying the surrounding forests.

**Table VII. List of herbaceous species, with their abundance/dominance, observed in the savannah of Site XI: dominant species are highlighted in green and locally abundant species in yellow.**

| Site XI: Piedmont to the East of the Blue Lake |      |      |      |      |      |      |      |      |      |      |       |
|--|------|------|------|------|------|------|------|------|------|------|-------|
| Species  | Plot | XI.1 | XI.2 | XI.3 | XI.4 | XI.5 | XI.6 | XI.7 | XI.8 | XI.9 | XI.10 |
| Abildgaardia congolensis                       |      | 1    | .    | .    | +    | +    | +    | +    | .    | .    | .     |
| Abrus canescens                                |      | .    | .    | .    | .    | +    | .    | .    | .    | .    | .     |
| Anadelphia leptocoma                           | 2    | .    | .    | .    | .    | .    | .    | .    | .    | .    | .     |
| Axonopus compressus                            |      | .    | .    | +    | +    | .    | .    | .    | .    | .    | .     |
| Canscora diffusa                               |      | .    | .    | .    | .    | +    | .    | +    | .    | .    | .     |
| Chromolaena odorata                            | 2    | 1    | +    | +    | 2    | .    | +    | .    | +    | .    | +     |
| Cyperus difformis                              |      | .    | 1    | .    | .    | .    | .    | .    | .    | .    | .     |
| Cyperus distans                                |      | .    | 1    | 1    | .    | .    | .    | .    | .    | .    | .     |
| Cyperus haspan                                 |      | .    | +    | .    | .    | .    | .    | .    | .    | .    | .     |
| Desmodium ramosissimum                         | +    | .    | .    | 1    | +    | .    | +    | .    | +    | .    | .     |
| Elionurus tripsacoides                         |      | .    | .    | .    | .    | +    | .    | .    | .    | .    | .     |
| Eragrostis atrovirens                          |      | .    | .    | .    | .    | .    | .    | .    | .    | +    | +     |
| Fimbristylis alboviridis                       |      | .    | .    | .    | +    | .    | .    | .    | .    | .    | .     |
| Hibiscus diversifolius                         |      | .    | .    | .    | .    | .    | +    | .    | .    | .    | .     |
| Imperata cylindrica                            |      | .    | .    | .    | .    | 3    | .    | .    | .    | .    | .     |
| Liparis rufina                                 |      | .    | .    | .    | .    | .    | +    | +    | .    | +    | .     |
| Loudetia phragmitoides                         | 4    | .    | .    | .    | +    | 3    | 4    | 4    | 4    | .    | .     |
| Ludwigia erecta                                |      | .    | .    | .    | .    | .    | +    | .    | .    | .    | .     |
| Lycopodiella affinis                           |      | .    | .    | 4    | .    | 1    | .    | .    | .    | .    | .     |
| Melinis minutiflora                            | 3    | .    | .    | .    | .    | 2    | +    | .    | .    | .    | .     |
| Mimosa pudica                                  | 1    | .    | .    | 2    | .    | .    | .    | .    | .    | .    | .     |
| Neurotheca loeselioides                        |      | .    | .    | .    | .    | +    | .    | +    | +    | +    | .     |
| Oldenlandia herbacea                           |      | .    | .    | .    | .    | .    | .    | +    | .    | +    | .     |
| Panicum laxum                                  |      | .    | .    | +    | +    | .    | .    | .    | .    | .    | .     |
| Panicum parvifolium                            |      | .    | .    | .    | .    | +    | .    | .    | .    | .    | .     |
| Paspalum conjugatum                            |      | .    | .    | .    | +    | .    | .    | .    | .    | .    | .     |
| Paspalum scrobiculatum                         |      | .    | .    | +    | +    | .    | .    | .    | .    | .    | .     |
| Pennisetum polystachion                        | +    | .    | .    | +    | +    | +    | +    | .    | .    | .    | 4     |
| Pennisetum purpureum                           | 2    | .    | .    | .    | .    | .    | .    | .    | .    | .    | .     |
| Phyllanthus alpestris                          |      | .    | .    | .    | .    | .    | .    | .    | +    | .    | .     |
| Pycreus capillifolius                          |      | .    | .    | +    | .    | .    | .    | .    | .    | .    | .     |
| Pycreus lanceolatus                            |      | .    | 3    | 2    | .    | .    | .    | .    | .    | .    | .     |
| Rhynchospora corymbosa                         |      | .    | 4    | .    | .    | .    | .    | .    | .    | .    | .     |
| Rhynchospora perrieri                          |      | .    | 1    | .    | .    | .    | .    | .    | .    | .    | .     |
| Schizachyrium brevifolium                      | 4    | .    | .    | .    | .    | 4    | 5    | 5    | 5    | 4    | 4     |
| Sopubia ramose                                 |      | .    | .    | .    | +    | .    | 1    | .    | .    | .    | .     |
| Sporobolus dinklagei                           |      | .    | .    | .    | +    | .    | .    | .    | .    | .    | .     |

## Savannah in the Nimba Piedmont West of the Blue Lake

### Example Plot XII.1: N07°32'39.7 – W008°30'39.0 – Altitude: 695 m

Plot XII.1 corresponds to a savannah situated in the piedmont to the west of the Blue Lake. It is crossed by a torrent coming down from the lake and lined in the West by the Seka River. This savannah results from the same phenomenon of erosion as that of Site XI from the terraces of Blue Lake situated upstream. Because of its homogeneity, only one single plot was surveyed in this savannah. This savannah is characterised by a beautiful population of *Anadelphia leptocoma* which differentiates it from the savannah of Site XI. At the bottom of slope, the swampy ground was colonised by *Loudetia phragmitoides*. These two Poaceae form the main part of the herbaceous biomass associated secondarily with *Schizachyrium brevifolium* and *Abildgaardia congolensis*. The banks of the torrent are lined with small stands of *Pennisetum purpureum*. *Dichrostachys cinerea*, a thorny shrub, forms a small thicket within the savannah, associated with *Chromolaena odorata*. The swampy bottom of the slope, bordering the forest, is occupied by a regeneration of *Hallea stipulosa* (Rubiaceae). Eleven herbaceous species were listed in this savannah (Table VIII).



## Savannah in the Nimba Piedmont West of the Blue Lake



**Table VIII.** List of herbaceous species, with their abundance/dominance, observed in the savannah of Site XII: dominant species are highlighted in green and locally abundant species in yellow.

| Piedmont to the West of the Blue Lake |      |       |
|---------------------------------------|------|-------|
| Species                               | Plot | XII.1 |
| Abildgaardia congolensis              |      | 1     |
| Anadelphia leptocoma                  |      | 5     |
| Chromolaena odorata                   |      | +     |
| Loudetia phragmitoides                |      | 3     |
| Melinis minutiflora                   |      | +     |
| Otomeria guineensis                   |      | +     |
| Pennisetum polystachion               |      | +     |
| Pennisetum purpureum                  |      | 2     |
| Schizachyrium brevifolium             |      | 3     |
| Scleria lagoensis                     |      | +     |
| Spermacoce verticillata               |      | +     |

## Savannahs in the Yekepa Area

The savannahs of Yekepa are represented by:

- the savannah which colonised the former airstrip of the city;
- the big savannah of Yekepa-Thuo, close to the Guinean border; and
- the savannah situated above the Saint Joseph Catholic Mission.

Six plots were surveyed for Site XIII.

### Plots XIII.1 to XIII.4

These four plots are situated on the former airfield constructed by LAMCO after having eliminated the forest vegetation. This savannah, of secondary origin, is lined by the Yâh River on the western side and by a series of swampy depressions of the eastern side. The herbaceous vegetation has recolonised the site, but the site is subjected to diverse human pressures: charcoal production, bushfires (part of this savannah had already burned at the beginning of November), and extraction of sand on the edge of the river. Some woody thickets are spread in this savannah formed by among others, *Ficus sur*, *Margaritaria discoidea*, *Morinda geminata*, *Dichrostachys glomerata* and *Harungana madagascariensis*.

### Example Plot XIII.1: N07°32'46.7 – W008°34'14.0 – Altitude: 488 m

This plot is situated in the south-western extremity of the savannah, at the foot of the small hill and bordering a swampy depression. *Anadelphia leptocoma* and *Loudetia phragmitoides* are both dominant species in the herbaceous layer. The density of the grass layer limits the development of the other species among which were observed *Schizachyrium brevifolium*, *Lycopodiella affinis*, *Polygala multiflora*, *Scleria flexuosa*, *S. lagoensis*, *Rhynchospora perrieri* and *Sopubia ramosa*.





**Example Plot XIII.2:** N07°32'58.1 – W008°33'51.0 – Altitude: 500 m

This plot is situated in the continuation of the previous plot towards the north-east. The grass *Anadelphia leptocoma* forms close to a monospecific population on a compact soil with ferruginous conglomerates. Some rare species were observed in the herbaceous layer such as *Hyparrhenia diplandra* var. *diplandra*, *Striga asiatica*, *Spermacoce verticillata*, *Ipomoea involucrata* and *Desmodium ramosissimum*. Part of the savannah had been burned in November. Close to this plot is a stand of *Imperata cylindrica* (N07°32'51.8 – W008°34'05.1, altitude: 493 m).



**Example Plot XIII.3:** N07°33'15.2 – W008°33'35.8 – Altitude: 499 m

Plot XIII.3 is a continuation of the previous plot in the northeast direction. The herbaceous layer is strictly identical to that of Plot XIII.2 with the exception of a small puddle colonised by Poaceae such as *Panicum congoense*, *P. laxum*, *Eragrostis atrovirens*, *E. gangetica* and diverse Cyperaceae among which are *Nemum spadiceum* and *Cyperus haspan*.



## Example Plot XIII.4: N07°33'21.5 – W008°33'28.5 – Altitude: 505 m

This plot is situated at the other extremity of the airstrip and includes a small hill lined by the forest. The grass layer is always dominated by *Anadelphia leptocoma*. On the shallow soil, where the cuirasse appears, *Sporobolus dinklagei*, *Neurotheca loeselioides*, *Striga asiatica*, *Zornia latifolia* and *Spermacoce verticillata* develop. On the hill appear *Pennisetum polystachion*, and in the shade of a thicket appear *Margaritaria discoidea* and *Morinda geminata*, which facilitated the installation of *Clerodendrum umbellatum*, *Aspilia africana*, *Ipomoea involucrata* and *Aedesia glabra*.



## Example Plot XIII.5: N07°34'30.3 – W008°33'27.8 – Altitude: 573 m

Plot XIII.5 is situated above the Saint Joseph's Catholic Mission. The vegetation is comprised of a very dense herbaceous layer lined by forest patches and crops. This vast “savannah” results from forest clearings, and *Anadelphia leptocoma*, *Imperata cylindrica* and *Pennisetum polystachion* are the three dominant grasses that have colonised this disturbed milieu. They are associated with *Chromolaena odorata* and *Pteridium aquilinum* which become more and more abundant as they get closer to the forest borders, with *Andropogon gayanus*.

It seems difficult to attribute the term of “savannah” to such an herbaceous formation. It is more a grassy formation in which pioneer savannah grasses are associated with species which characterize an evolving environment.





## Example Plot XIII.6: N07°35'22.5 – W008°30'42.2 – Altitude: 557 m

Plot XIII.6 is situated near the Guinean border and is similar to the big savannah of Yekepa-Thuo. It is the continuation of the south part of the vast piedmont savannahs which characterize the north-western part of Mount Nimba in Guinea.

This savannah, occupying a deep, gravelly and argilo-sandy soil, under the cuirasse, is formed by a very dense population of *Hyparrhenia diplandra* var. *diplandra* and of *Anadelphia leptocoma*. The density of the grass cover limits the establishment of the other species with the exception of *Aframomum albobolaceum*, *Ipomoea involucrata* or *Stachytarpheta angustifolia*. On the bare cuirasse *Oldenlandia corymbosa*, *Neurotheca loeselioides* and *Schizachyrium delicatum* have developed.



## Conclusions on Savannahs in the Yekepa Area

Site XIII, around Yekepa, comprises three very different types of savannah in which forty- six (46) herbaceous species were listed (Table IX).

The first one is an *Anadelphia leptocoma* savannah, similar to the one which occupies the former airfield of LAMCO near Grassfield.

The second concerns a savannah, the origin of which is linked with previous cultivations. It occupies a deeper soil in which *Anadelphia leptocoma* is always part of the dominant species but is associated locally with grasses such as *Imperata cylindrica*, *Pennisetum polystachion*, which are abundant locally, and *Andropogon gayanus* on the forest border. The other species such as *Pteridium aquilinum* and *Chromolaena odorata* are also abundant and reflect the degradation of the area.

The third type of savannah, the Yekepa-Thuo savannah, rests on gravelly, argilo-sandy ground, derived from weathered granite. This savannah is characterised by *Hyparrhenia diplandra* var. *diplandra*, associated again with *Anadelphia leptocoma*. This savannah is similar, by its floristic composition, to that studied in the South of Grassfield (PIII.4 and PIII.5), on the road leading to Mount Bele.

The savannahs found in the Yekepa region are recent savannahs, resulting from the destruction or the degradation of the forest formations due to the construction of infrastructure or for cultivation. The annual bushfires prevent the recolonisation of forest vegetation.

**Table IX. List of herbaceous species, with their abundance/dominance, observed in the savannah of Site XIII: dominant species are highlighted in green and locally abundant species in yellow.**

| Site XIII: Yekepa savannahs |      |        |        |        |        |        |        |
|-----------------------------|------|--------|--------|--------|--------|--------|--------|
| Species                     | Plot | XIII.1 | XIII.2 | XIII.3 | XIII.4 | XIII.5 | XIII.6 |
| Abildgaardia congolensis    |      | .      | .      | .      | .      | .      | +      |
| Aedesia glabra              |      | .      | .      | .      | +      | .      | .      |
| Aframomum albobiolaceum     |      | .      | .      | .      | .      | .      | +      |
| Alectra sessiliflora        |      | .      | .      | .      | .      | +      | .      |
| Anadelphia leptocoma        |      | 4      | 5      | 4      | 4      | 4      | 4      |
| Andropogon gayanus          |      | .      | .      | .      | .      | 3      | .      |
| Aspilia Africana            |      | .      | .      | .      | +      | +      | .      |
| Aspilia helianthoides       |      | .      | .      | .      | .      | +      | .      |
| Blumea heudelotii           |      | .      | .      | .      | .      | +      | .      |
| Chromolaena odorata         |      | +      | 1      | .      | +      | 3      | .      |
| Clerodendrum umbellatum     |      | .      | .      | .      | +      | .      | .      |
| Cyperus haspan              |      | .      | .      | 1      | .      | .      | .      |
| Desmodium ramosissimum      |      | +      | +      | .      | .      | .      | .      |
| Eragrostis atrovirens       |      | .      | .      | .      | .      | .      | .      |
| Eragrostis gangetica        |      | .      | .      | 2      | .      | .      | .      |
| Fimbristylis alboviridis    |      | +      | .      | .      | .      | .      | +      |
| Hyparrhenia diplandra       |      | .      | +      | .      | .      | +      | 5      |
| Imperata cylindrica         |      | .      | .      | .      | .      | 4      | .      |
| Ipomoea involucrata         |      | .      | +      | .      | +      | .      | +      |
| Loudetia phragmitoides      |      | 4      | .      | .      | .      | .      | .      |
| Lycopodiella affinis        |      | 3      | .      | .      | .      | .      | .      |
| Nemum spadiceum             |      | .      | .      | +      | .      | .      | .      |
| Nephrolepis undulata        |      | +      | .      | .      | .      | +      | .      |
| Neurotheca loeselioides     |      | .      | .      | .      | +      | +      | +      |
| Oldenlandia herbacea        |      | +      | .      | .      | .      | .      | +      |
| Panicum congoense           |      | .      | .      | 3      | .      | .      | .      |
| Oldenlandia corymbosa       |      | .      | .      | .      | .      | .      | +      |
| Panicum griffonii           |      | +      | .      | .      | .      | 1      | +      |
| Panicum laxum               |      | .      | .      | 1      | .      | .      | .      |
| Paspalum scrobiculatum      |      | .      | .      | .      | .      | +      | .      |
| Pennisetum polystachion     |      | +      | .      | .      | +      | 3      | .      |
| Phyllanthus sp.             |      | +      | .      | .      | .      | .      | .      |
| Polygala multiflora         |      | +      | .      | .      | +      | .      | .      |
| Pteridium aquilinum         |      | .      | .      | .      | .      | 3      | .      |
| Rhynchospora perrieri       |      | +      | .      | .      | .      | .      | .      |
| Schizachyrium brevifolium   |      | 2      | .      | .      | .      | .      | .      |
| Schizachyrium delicatum     |      | .      | .      | .      | .      | .      | +      |
| Scleria flexuosa            |      | +      | .      | .      | .      | .      | .      |
| Scleria lagoensis           |      | +      | .      | +      | .      | .      | .      |
| Sida linifolia              |      | +      | .      | .      | .      | .      | .      |
| Sopubia ramose              |      | +      | .      | .      | .      | +      | .      |
| Spermacoce verticillata     |      | +      | +      | 1      | +      | .      | .      |
| Sporobolus dinklagei        |      | .      | .      | .      | .      | +      | .      |
| Stachytarpheta angustifolia |      | .      | .      | .      | .      | .      | +      |
| Striga asiatica             |      | +      | +      | .      | +      | .      | .      |
| Zornia latifolia            |      | .      | .      | .      | +      | .      | .      |

## Savannah in the Nimba Piedmont North-east of the Blue Lake

This large savannah occupies the piedmont which extends in the north-east of the Site of Blue Lake. It touches the foot of the mountain and slopes slightly toward the Yâh River. This savannah has a physiognomy similar to that of all the piedmont savannahs surrounding the old mining site. Terrace subsidences have caused collapses, and voluminous and heavy stony materials carried away downstream by the rainwater forms torrents from the summit. It results in the destruction of the forest massif of the piedmont which forms breaches crossed by rivers.

### Example Plot XIV.1: N07°34'16.9 – W008°29'36.4 – Altitude: 578 m.

This plot is situated at the bottom of a slope bordering the Yâh River. The flat ground is occupied by a savannah in which *Anadelphia leptocoma* forms the main part of the herbaceous and grass layer. A small swampy depression facilitates the development of helophilous species such as *Panicum laxum*, *Eragrostis gangetica* or *Cyperus difformis*. Asteraceae *Chromolaena odorata*, associated with the scandent shrub *Combretum racemosum*, is abundant in the border of the forest which lines this savannah, opposite the Yâh River. *Pennisetum purpureum*, *Hyparrhenia diplandra* var. *diplandra* and *Imperata cylindrica* form patches on the bank of the river.



### Example Plot XIV.2: N07°34'05.1 – W008°29'30.8 – Altitude: 592 m

This second plot is situated at the bottom of a slope and features very different herbaceous vegetation. The “Elephant Grass”, *Pennisetum purpureum*, associated with *Loudetia phragmitoides* and *Chromolaena odorata* forms a dense herbaceous bush in which creepers *Pueraria phaseoloides* and *Mimosa pudica* are mixed in a dominated and impenetrable herbaceous layer. Only the bed of a small river crossing the stand of *Pennisetum* allows the installation of species such as *Eragrostis atrovirens*, *Pycnus polystachyos* and *Panicum laxum*.





## Example Plot XIV.3: N07°33'52.0 – W008°29'32.2 – Altitude: 616 m

Plot XIV.3 is situated approximately at the middle-slope of the savannah, on a sandy soil covered with big pieces of granite. The dense herbaceous cover consists of *Loudetia phragmitoides*, *Hyparrhenia diplandra* var. *diplandra*, and *H. rufa* associated with *Schizachyrium brevifolium*, which forms a low dominated grass layer. Some other species such as *Chromoalena odorata* are well represented.



## Example Plot XIV.4 (Station XIV.4): N07°33'34.7 – W008°29'39.6 – Altitude: 654 m

Plot XIV.4 is situated on approximately 2/3 of the slope, not far from the summit of the savannah in sight of the mountain. The ground is similar to that of the previous plot, but sandier, and the vegetation is less dense with the appearance of *Andropogon fastigiatus*, an annual Poaceae. The same species dominates the high grass stratum with *Loudetia phragmitoides* and *Anadelphia leptocoma*.





## Conclusions on the Savannah in the Nimba Piedmont North-east of the Blue Lake

Three types of savannah characterise this site in which 33 species were listed (Table X).

The first is an *Anadelphia leptocoma* savannah in the Yâh River valley which is close to the second type characterised by a dense “bush” rather than a savannah, formed by *Pennisetum purpureum* and *Loudetia phragmitoides* at the bottom of slope, on wet ground. These two species are strong perennial Poaceae.

The third and less-diverse savannah extends over the slope and on up to its summit. The grass layer consists of *Loudetia phragmitoides* and *Hyparrhenia diplandra* var. *diplandra* to which is added the annual *Andropogon fastigiatus*.

With the exceptions of *Anadelphia leptocoma* and *Loudetia phragmitoides*, which are found in all the plots surveyed, the other species are distributed in a heterogeneous way and are abundant only locally.

The savannah, crossed by a wide river bed, ends in a gorge with a waterfall.

**Table X. List of herbaceous species, with their abundance/dominance, observed in the piedmont savannah to the north-east of the Blue Lake: dominant species are highlighted in green and locally abundant species in yellow.**

| Piedmont North-east of the Blue Lake |      |       |       |       |       |
|--------------------------------------|------|-------|-------|-------|-------|
| Species                              | Plot | XIV.1 | XIV.2 | XIV.3 | XIV.4 |
| Abildgaardia congolensis             |      | +     | .     | .     | .     |
| Anadelphia leptocoma                 |      | 5     | .     | 1     | 2     |
| Andropogon fastigiatus               |      | .     | .     | 3     | .     |
| Blumea heudelotii                    |      | +     | .     | .     | .     |
| Chromolaena odorata                  |      | 3     | 3     | 3     | 2     |
| Cyperus difformis                    |      | +     | .     | .     | .     |
| Desmodium ramosissimum               |      | +     | .     | .     | +     |
| Eragrostis atrovirens                |      | .     | +     | .     | .     |
| Eragrostis gangetica                 |      | +     | .     | .     | .     |
| Eriosema glomeratum                  |      | .     | .     | .     | +     |
| Fimbristylis alboviridis             |      | +     | .     | .     | .     |
| Hyparrhenia diplandra                |      | .     | .     | 3     | .     |
| Hyparrhenia rufa                     |      | +     | .     | 3     | .     |
| Imperata cylindrica                  |      | 1     | .     | .     | .     |
| Lipocarpha chinensis                 |      | +     | .     | .     | .     |
| Loudetia phragmitoides               |      | .     | 3     | 4     | 4     |
| Ludwigia erecta                      |      | +     | .     | .     | .     |
| Lycopodiella affinis                 |      | .     | 2     | .     | +     |
| Melinis minutiflora                  |      | .     | .     | +     | .     |
| Mimosa pudica                        |      | +     | 3     | 1     | +     |
| Panicum laxum                        |      | 3     | 1     | .     | .     |
| Paspalum scrobiculatum               |      | +     | .     | .     | .     |
| Pennisetum polystachion              |      | .     | 1     | .     | 1     |
| Pennisetum purpureum                 |      | 1     | 4     | .     | +     |
| Pueraria phaseoloides                |      | .     | 4     | .     | .     |
| Pycreus capillifolius                |      | +     | +     | .     | .     |
| Pycreus polystachyos                 |      | +     | +     | .     | .     |
| Schizachyrium brevifolium            |      | .     | .     | 3     | 4     |
| Smilax kraussiana                    |      | +     | .     | .     | .     |
| Sopubia ramose                       |      | .     | .     | +     | .     |
| Spermacoce verticillata              |      | +     | .     | +     | 1     |
| Striga asiatica                      |      | +     | .     | .     | .     |
| Zornia latifolia                     |      | .     | .     | +     | .     |

## Eastern Nimba: the Geipa savannah

A quick survey was carried out in a savannah situated north of Geipa in Eastern Nimba. This savannah, sloping gently in a north-south direction, rests on a lateritic cuirasse with a very hard ferruginous conglomerate. The superficial and rocky ground is wet in rainy season and dries out quickly in the dry season. It was difficult to attribute a coefficient of abundance/dominance for every main species because of the density of the herbaceous layer and the interweaving of the diverse species between them. The herbaceous vegetation of this savannah, practically at the end of cycle in this time of the year, consists of a very dense grass stratum in which *Loudetia simplex*, *Monocymbium cerasiiforme*, *Schizachyrium rupestre* are dominant species associated with *Rhytachne rottboellioides* (often in the form of monospecific patches), *Andropogon curvifolius* and *Panicum glaucocladum* (dominated stratum). Some other species were observed, in particular: *Polygala lecardii* (growing under the cover of grass species), *Indigofera dendroides*, *Abrus canescens*, *Neurotheca loeselioides*, *Scleria flexuosa*, *Chromolaena odorata*, *Vigna racemosa* and *Dolichos dinklagei*. Woody thickets, infrequent, are spread in the grassy vegetation: they are mainly comprised of *Holarrhena africana*, *Morindia geminata* and *Albizia zygia*. Some individuals of *Phyllanthus alpestris* were also observed within the grass layer.

On the borders, the contact with the forest is not sharply differentiated but defined by a dense belt of *Melinis minutiflora* (N°07°28'27.0 - W008°31'26.0, altitude: 621 m) associated with *Pteridium aquilinum*, then of a shrubby undergrowth consisting of *Cassia podocarpa*, *Allophylus africanus*, *Harungana madagascariensis*, *Holarrhena africana* and *Spathodea campanulata*, with creepers such as *Mikania scandens*, *Ipomoea involucrata*, *I. eriocarpa* and *Scleria barteri*. Some grasses more or less sciaphilous such as *Rottboellia cochinchinensis*, *Oplismenus hirtellus*, *Pseudechinolaena polystachya*, *Cenotheca lappacea* and *Cyrtococcum chaetophoron* develop sheltered from the undergrowth.

This savannah's structural and floristic composition is similar to Grassfield (Plots SIII.6 to SIII.11). The Grassfield savannah is floristically richer because of the more varied conditions of ground which allow the establishment of big *Andropogoneae* such as *Hyparrhenia diplandra*, *Elymandra androphila* and *Anadelphia leptocoma*. This savannah has undergone, furthermore, a strong human pressure during the activities of LAMCO, while that of Geipa, of large homogeneity, constitutes a habitat little affected by man with the exception of the bushfires (PG.1 (N°07°28'36.0 - W008°31'35.5, altitude: 659 m), PG.2 (N°07°28'33.2 - W008°31'33.9, altitude: 649 m), PG.3 (N°07°28'30.6 - W008°31'31.4, altitude: 639 m), PG.4 (N°07°28'27.0 - W008°31'26.0, altitude: 621 m), PG.5 (N°07°28'28.9 - W008°31'36.6, altitude: 638 m) and PG.6 (N°07°28'34.2 - W008°31'36.9, altitude: 648 m).

## Conclusions on the Piedmont Savannahs in Northern Nimba

Liberian Mount Nimba has no natural montane savannahs on hillsides and crests compared to the north-eastern continuation of the Nimba ridge in Guinea and Ivory Coast. The naturally-occurring savannahs are situated in the piedmont at an altitude of between 500 and 700 m. They are mostly on the western hillside of the massif and are more extensive near Guinea than in the south.

Savannahs not formed on lateritic cuirasses but rather on gravelly soils, are of secondary origin and tend to expand in area because of human influences, namely the clearings for cultivation and annual bushfires. The secondary forests are regularly damaged and do not allow, or allow very slowly, a stage of recolonisation of the forest vegetation on the savannah.

Savannahs formed on lateritic and ferruginous cuirasses, more or less dense with hard conglomerates, are edaphic. The Grassfield savannah that is situated more in the south on the road to Mount Bele (Site III) and the savannah to the north of Geipa (Eastern Nimba) belong to this category. These savannahs are exposed to minimal damage due to human activity, with the exception of the annual bushfires.

In the 37 surveyed plots, some 114 herbaceous species were listed. These species include 37 Poaceae, 17 Cyperaceae and 60 herbaceous plants belonging to diverse families.

On more or less gravelly soils, the dominant Poaceae is *Anadelphia leptocoma*, associated mainly with *Hyparrhenia diplandra* var. *diplandra* and secondarily with *Andropogon macrophyllus* in certain piedmont plots near Mount Tokadeh.

The composition of the grass layer changes on the lateritic cuirasse, with a more or less compact conglomerate. *Loudetia simplex*, *Rhytachne rottboellioides*, *Monocymbium deightonii*, *Andropogon curvifolius* and *Schizachyrium rupestre* become the main species.

The piedmont savannahs, recent and stemming from the destruction of the forest formations due to mining activities and situated below the sites of Old Mine and Blue Lake, are dominated either by *Anadelphia leptocoma* (SXII.1) or by *Loudetia phragmitoides* (Sites XI and XIV).

Other Poaceae, associated with dominant species, are well-represented locally. Some are common such as *Pennisetum polystachion*, *Panicum griffonii* while others, among which is *Imperata cylindrica*, appear in small practically monospecific stands.

Some species are dependent on the particular edaphic conditions of the small swampy depressions such as *Eragrostis atrovirens*, *E. gangetica*, *Panicum congoense* and *P. laxum*.

Cyperaceae, often characteristic of the wet zones, are not present as dominant species in the studied sites. Only *Rhynchospora corymbosa* in Site XI, which characterizes swampy areas, makes an exception. On the other hand, certain species such as *Abildgaardia congolensis*, *Pycreus capillifolius* or *Scleria flexuosa* are relatively common.

It is the same for some other herbaceous species. Only *Chromolaena odorata*, which becomes a shrub, is present in the whole of the studied sites. This plant has a strong power of scattering and it is sometimes considered as an invasive plant harmful to agriculture and livestock. However, it can contribute to the recolonisation of the forest on the savannah by the protective screen against the bushfires that it creates where the forest and savannah interface.

### Overall Conclusions on the Savannah Vegetation in Northern Nimba

Vegetation surveys carried out in 75 plots within the savannahs of Northern Nimba, in the former mining sites and the piedmont, identified 139 herbaceous species among which are 41 Poaceae, 20 Cyperaceae and 78 plants belonging to diverse families (Table XI).

The flora of the studied sites is rich. The radical modification of the natural environment due to mining activities suggests that recolonising vegetation comprises common species including numerous ruderal plants. It is possible that this was the case in the first years which followed the cessation of mining activities. After several decades, the resultant vegetation is savannah with a strong proportion of perennial species.

Certainly this vegetation remains herbaceous, with an absence of woody regeneration, but the current composition of the herbaceous layer suggests that it is always evolving. Although the substratum is mineral, the zones where the mining was implemented comprise relatively porous soils, i.e. generally less dense than the soil cover in non-mined areas.

**Table XI. List of the herbaceous species observed in the grassy savannahs of Northern Nimba.**

| Poaceae                    |                             | Cyperaceae                |                             |
|----------------------------|-----------------------------|---------------------------|-----------------------------|
| Anadelphia leptocoma       | Panicum glaucocladum        | Abildgaardia congolensis  |                             |
| Anadelphia lomaense        | Panicum griffonii           | Abildgaardia densa        |                             |
| Andropogon curvifolius     | Panicum hochstetteri        | Cyperus difformis         |                             |
| Andropogon fastigiatus     | Panicum laxum               | Cyperus distans           |                             |
| Andropogon gayanus         | Panicum nervatum            | Cyperus haspan            |                             |
| Andropogon macrophyllus    | Panicum parvifolium         | Cyperus tenuiculmis       |                             |
| Axonopus compressus        | Panicum sadinii             | Fimbristylis albobiridis  |                             |
| Ctenium newtonii           | Paspalum conjugatum         | Fuirena stricta           |                             |
| Elionurus tripsacoides     | Paspalum scrobiculatum      | Lipocarpha chinensis      |                             |
| Elymandra androphila       | Pennisetum hordeoides       | Nemum spadiceum           |                             |
| Eragrostis gangetica       | Pennisetum polystachion     | Pycnus capillifolius      |                             |
| Hyparrhenia diplandra      | Pennisetum purpureum        | Pycnus lanceolatus        |                             |
| Hyparrhenia mutica         | Rhynchne rottboellioides    | Pycnus polystachyos       |                             |
| Hyparrhenia rufa           | Rottboellia cochinchinensis | Rhynchospora corymbosa    |                             |
| Imperata cylindrica        | Schizachyrium brevifolium   | Rhynchospora perrieri     |                             |
| Loudetia phragmitoides     | Schizachyrium delicatum     | Scleria aterrima          |                             |
| Loudetia simplex           | Schizachyrium rupestre      | Scleria flexuosa          |                             |
| Melinis minutiflora        | Sporobolus dinklagei        | Scleria lagoensis         |                             |
| Monocymbium deightonii     | Sporobolus paniculatus      | Scleria naumanniana       |                             |
| Panicum congoense          | Sporobolus pyramidalis      | Scleria spiciformis       |                             |
| Panicum dinklagei          |                             |                           |                             |
| Others                     |                             |                           |                             |
| Abrus canescens            | Crotalaria lathyroides      | Ludwigia abyssinica       | Sida linifolia              |
| Aedesia glabra             | Crotalaria retusa           | Ludwigia erecta           | Smilax kraussiana           |
| Aframomum albviolaceum     | Cuphea carthagenensis       | Lycopodiella affinis      | Sopubia ramosa              |
| Ageratum conyzoides        | Cyphostemma rubrosetosum    | Mimosa pudica             | Spermacoce ruelliae         |
| Alectra sessiliflora       | Desmodium hirtum            | Nephrolepis undulata      | Spermacoce verticillata     |
| Aristolochia embergeri     | Desmodium ramosissimum      | Neurotheca loeselioides   | Stachytarpheta angustifolia |
| Aspilota africana          | Desmodium velutinum         | Oldenlandia corymbosa     | Striga asiatica             |
| Aspilota helianthoides     | Dicranopteris linearis      | Oldenlandia herbacea      | Striga macrantha            |
| Blumea adamsii             | Dioscorea minutiflora       | Otomeria guineensis       | Tephrosia flexuosa          |
| Blumea heudelotii          | Droogmansia scaettaiana     | Passiflora foetida        | Thunbergia chrysops         |
| Brachycorythis paucifolia  | Drosera madagascariensis    | Phyllanthus alpestris     | Triumfetta tomentosa        |
| Burmannia madagascariensis | Emilia coccinea             | Phyllanthus sp.           | Urena lobata                |
| Calopogonium mucunoides    | Eriosema glomeratum         | Phyllanthus sp.           | Vigna racemosa              |
| Canscora diffusa           | Euphorbia sp.               | Plectranthus monostachyus | Xyris decipiens             |
| Chamaecrista mimosoides    | Habenaria genuflexa         | Polygala multiflora       | Xyris straminea             |
| Chromolaena odorata        | Hibiscus diversifolius      | Pteridium aquilinum       | Zehneria thwaitesii         |
| Clerodendrum umbellatum    | Indigofera dendroides       | Pueraria phaseoloides     | Zornia latifolia            |
| Conyza bonariensis         | Ipomoea eriocarpa           | Sauvagesia erecta         |                             |
| Crassocephalum rubens      | Ipomoea involucrata         | Schwenckia americana      |                             |
| Crotalaria cylindrocarpa   | Lipparis rufina             | Sida acuta                |                             |

Certain Poaceae are present, even dominant, in the whole of the studied sites. They are *Anadelphia leptocoma*, *Loudetia phragmitoides*, *Schizachyrium brevifolium* (annual), *Melinis minutiflora* and *Sporobolus dinklagei*: Others are less frequent, such as *Hyparrhenia diplandra* var. *diplandra*. The first three species, as well as *Hyparrhenia diplandra*, occur in the piedmont savannahs on gravelly soils. On the other hand, *Melinis minutiflora* is becoming scarce in the piedmont savannahs where it plays a role of transition between the forest and the savannah formed on lateritic cuirasse.

The edaphic piedmont savannahs formed on lateritic cuirasse are dominated by three perennials and strong grasses: *Loudetia simplex*, *Rhynchne rottboellioides* and *Schizachyrium rupestre*. The savannah of Grassfield (Site III) was formerly occupied and subjected to strong human activities. This formation was not directly affected by the works of mining exploitation and only the bushfires constitute at present a factor of degradation. The situation is the same with the Geipa savannah in Eastern Nimba.



It is not the same for the savannahs of secondary origin adjacent to the sites of Old Mine, Blue Lake and Mount Tokadeh. They are dominated either by *Anadelphia leptocoma* (Sites VI, XII, and XIV), or by *Loudetia phragmitoides* (Sites XI, XIV). These two grasses, of Guinean affinities, prefer wet ground. *Loudetia phragmitoides* is a strong characteristic grass of the swampy savannahs. *Anadelphia leptocoma* occurs in the plant communities dominated by *Loudetia phragmitoides* and also on superficial ground which remains wet during a part of the dry season. It is thus not surprising to find these two species together in the piedmont savannahs. They are frequent, also, at high altitude as well as in small swampy depressions. Their presence and abundance testify to a relatively deep wet soil.

The abundance of *Melinis minutiflora* at altitude in the sites of Old Mine and Blue Lake, results from the impact of the mining activities. This heliophilous species likes dry habitats and often behaves as a ruderal plant to become invasive. This grass, resistant to the drought, resists the bushfires and the clogging of the ground. Its presence in the montane savannahs is explained by the mineral environment which succeeded the mining activities and the exposure of the ground. Although this grass is sometimes considered to be a "plague", because of the competition which it can engender with the other species, it also provides soil binding and soil cover protection, especially on steep slopes. *Melinis minutiflora* is infrequent in the piedmont savannahs with the exception of the formations on lateritic cuirasse. It often forms dense populations in the forest border areas. In association with other diverse species and with the shrubs, it can participate, in the absence of bushfires, along with *Chromolaena odorata* (Asteraceae), in the reconolisation of forest in areas of savannah.

*Sporobolus dinklagei* is a long-living grass represented well at high altitude, especially in the Old Mine Site. Also of Guinean affinity, this species, preferring the shallow soils, found an environment convenient to its growth on the terraces of the mining sites.

The presence of *Hyparrhenia diplandra* var. *diplandra* in the grassy vegetation at altitude is not surprising. This strong grass is common in the whole of Nimba. While *Anadelphia leptocoma* and *Loudetia phragmitoides* could be considered as "pioneer" species in the reinstatement of vegetation as well in the montane savannahs and those of the piedmont, *Hyparrhenia diplandra* is relatively infrequent in these former mining sites. It is likely that its growth is recent. These species constitute the main part of the biomass of savannah. Others occurring less frequently, but nonetheless important, are *Andropogon macrophyllus*, *Ctenium newtonii*, *Paspalum scrobiculatum*, *Pennisetum polystachion*, *P. purpureum* and *Rhytachne rottboellioides*. These grasses are strong perennial grasses which contribute to the revegetation of the terraced ground.

No rare or threatened species were found in the studied sites. However, some species are of conservation interest because of their limited distribution in the mountain massifs of Western Africa. They are:

- *Anadelphia lomaense* (Poaceae): montane savannah, also collected in piedmont savannah. It is present in Mounts Loma and Tingi in Sierra Leone and in Mount Nimba.
- *Monocymbium deightonii* (Poaceae): savannah, between 450 m and 1470 m in Mount Nimba.
- *Droogmansia scaettaiana* (Fabaceae): montane savannah of Mount Nimba.
- *Brachycorythis paucifolia* (Orchidaceae): ground species, from 1000 to 1750 m on Mount Loma and Mount Nimba.

## 4.7 Greenhill Area, Bong County

### Greenhill, near Palala in Bong County

Site VII corresponds to an outcrop in the region of Greenhill, situated 5 km to the south-east of Palala (on the way to Sokopa-Palala, to approximately 13 km of Sokopa). Four plots were surveyed on this outcrop. The perennial *Loudetia simplex* forms a very dense and homogeneous grass layer which occupies the slopes and the summit of the hill. Only the presence of patches of bare, wet rock, allow some other species to develop in such a habitat. The herbaceous layer, at the top of the mountain, is in direct contact with a forest massif.



#### Example Plot VII.1: N06°59'05.9 – W009°14'40.1 – Altitude: 286 m

This plot is situated on a relatively strong slope on which patches of dripping rock (granite) interrupt the grass layer dominated by *Loudetia simplex*. This perennial grass is associated mainly with *Panicum glaucocladum*, *P. griffonii* and *Afrotrilepis pilosa* (Cyperaceae). Other species such as *Albidgaardia congolensis* are less frequent. A woody thicket, composed of *Sterculia tragacantha*, *Ficus exasperata*, *Sarcocephalus latifolius* and *Holarrhena floribunda*, raises itself within the herbaceous vegetation, allowing *Chromolaena odorata* to occupy the border.



**Example Plot VII.2:** N06°59'07.5 – W009°14'41.5 – Altitude: 292 m

Plot VII.2 is similar to the previous one, and *Loudetia simplex* remains the dominant species. Some new species appear in the grass layer such as *Dolichos dinklagei* and *Pteridium aquilinum* (in the form of a small population associated with the woody, thorny liana, *Mezoneuron benthamianum*). The rock layer is colonised by *Pennisetum hordeoides* while *Aeollanthus pubescens* develops on small patches of organic matter dispersed on the rocky surfaces.



**Example Plot VII.3:** N06°59'11.2 – W009°14'38.2 – Altitude: 305m

This plot is close to the top of the hill. *Loudetia simplex* forms a very dense grass stratum which absorbs a swampy ground. *Panicum griffonii* and *P. glaucocladum* are relatively abundant, always associated with *Afrotrilepis pilosa*. Few other species are spread in the herbaceous mat with *Polygala multiflora* and *Chromolaena odorata* while *Eriocaulon* sp. appears on the wet patches of rock. On the border of the forest develop *Setaria megaphylla* and *Chromolaena odorata*.





## Example Plot VII.4: N06°59'07.6 – W009°14'33.9 – Altitude: 291m

Plot VII.4 is rather similar to the previous one. The swampy ground favours the installation of *Panicum glaucocladum* which becomes more abundant. The floristic composition of the herbaceous layer does not vary and only a patch of *Pennisetum hordeoides* appears along an old trunk of *Ceiba pentandra* in a state of decomposition.



## Conclusions on the Greenhill Area in Bong County

The grassy vegetation, homogeneous and very dense, which covers this outcrop, is rich with 15 species (Table XII). The herbaceous layer is constituted by a population of *Loudetia simplex* which also occupies the slopes and the summit of the hill. Only the presence of patches of bare, wet rock allows some other species to develop in this habitat.

*Loudetia simplex* is mainly associated with *Panicum glaucocladum*, *P. griffonii* and *Afrotrilepis pilosa*. If the first species occurs on the site with a very high cover, the others are abundant according to the edaphic conditions, the soil being more or less swampy. Nevertheless the grassy layer is largely homogeneous.

The study of the vegetation of this savannah shows the impact of quarrying activities on the savannahs. However, it allows the vegetation history of the Greenhill quarry to be traced.



## Greenhill Quarry

This site, situated approximately 49 km from Gbloyee south toward Buchanan, occupies the granite quarry of Greenhill, recently put back in operation by ArcelorMittal for the production of ballast.

### Example Plot VIII.1: N06°50'31.6 – W009°10'59.1 – Altitude: 305 m

The original environment was similar to the savannah on outcrop described in Site VII with a grassy vegetation, essentially composed of grasses and dominated by *Loudetia simplex*. The extraction of the granite profoundly modified the site, levelling the outcrop and destroying the vegetation. *Loudetia simplex* lives precariously, especially on the crest of the cliff, but also, locally, on the plateau. This one presents numerous small swampy depressions or small puddles, on the banks of which develop species which characterize the muddy substratum. Most of the species belonging to the Cyperaceae family, are common in this type of disturbed habitat with, among others, *Cyperus haspan*, *C. difformis*, *Panicum laxum*, *Fuirena umbellata*, *Pycnus polystachyos*, *P. capillifolius* or *Eragrostis gangetica*. Other ruderal plants such as *Spigelia anthelmia*, *Astraea lobata* and *Sida linifolia* are found on the driest parts of ground.

The foot and the walls of the cliff are colonised by *Chromolaena odorata* and *Pennisetum polystachion*.



Twenty herbaceous species were observed in this site (Table XII). The vegetation is evolving and the population of *Loudetia simplex* begins to reconquer the basin of the quarry. The initial grassy formation can never be reconstituted because of the destruction of the outcrop. It is possible to imagine an evolution toward a mixed vegetation type with a heterogeneous population of *Loudetia simplex* within which will remain small puddles fed by rainwater and in which will remain helophytes.

## Conclusions on the Greenhill Quarry sites

*Loudetia simplex* is a characteristic grass of this type of habitat in which it often forms practically monospecific populations. The nature of the substratum, the strong slopes and the intense heat limit the growth of plants. Numerous species, among which are woody species, take advantage to develop in the humus accumulated in small depressions or cracks of the rock.

A total of 31 species was listed during the vegetation surveys (Table XII). The species observed on the first outcrop characterize well this type of material. *Afrotrilepis pilosa* is a strong pioneer Cyperaceae on this type of substratum. Annual grasses such as *Panicum griffonii* and *P. glaucocladum* occur very often in savannahs formed on weak soil, which retain humidity during the dry season.

On the site of the quarry, most of the observed plants are ruderal species which can be found frequently in the disturbed places subjected to human activities. It is also, for the greater part, helophytes which benefit from the swampy depressions or wet areas scattered in the basin.

**Table XII. List of herbaceous species, with their abundance/dominance, observed in Sites VII and VIII: dominant species are highlighted in green and locally abundant species in yellow.**

| Species                            | Plot | Greenhill Area |       |       |       | Greenhill Quarry |
|------------------------------------|------|----------------|-------|-------|-------|------------------|
|                                    |      | VII.1          | VII.2 | VII.3 | VII.4 | VIII.1           |
| <i>Abildgaardia congolensis</i>    |      | +              | 1     | +     | .     | 1                |
| <i>Aeollanthus pubescens</i>       |      | .              | 1     | .     | .     | .                |
| <i>Afrotrilepis pilosa</i>         |      | 1              | 2     | 1     | +     | 1                |
| <i>Astraea lobata</i>              |      | .              | .     | .     | .     | +                |
| <i>Chamaecrista kirkii</i>         |      | +              | .     | .     | .     | .                |
| <i>Chromolaena odorata</i>         |      | +              | .     | +     | .     | 3                |
| <i>Crotalaria lathyroides</i>      |      | +              | .     | .     | .     | .                |
| <i>Cyperus difformis</i>           |      | .              | .     | .     | .     | 1                |
| <i>Cyperus haspan</i>              |      | .              | .     | .     | .     | 1                |
| <i>Dolichos dinklagei</i>          |      | .              | 1     | .     | .     | .                |
| <i>Eragrostis atrovirens</i>       |      | .              | .     | .     | +     | +                |
| <i>Eragrostis gangetica</i>        |      | .              | .     | .     | .     | +                |
| <i>Eriocaulon</i> sp.              |      | .              | .     | +     | .     | .                |
| <i>Fimbristylis littoralis</i>     |      | .              | .     | .     | .     | +                |
| <i>Fuirena umbellata</i>           |      | .              | .     | .     | .     | 2                |
| <i>Lipocarpa filiformis</i>        |      | .              | .     | .     | .     | +                |
| <i>Loudetia simplex</i>            |      | 5              | 5     | 5     | 5     | 3                |
| <i>Panicum glaucocladum</i>        |      | 2              | 3     | 3     | 3     | .                |
| <i>Panicum griffonii</i>           |      | 1              | 1     | 3     | 1     | .                |
| <i>Panicum laxum</i>               |      | .              | .     | .     | .     | +                |
| <i>Pennisetum hordeoides</i>       |      | .              | 2     | .     | +     | .                |
| <i>Pennisetum polystachion</i>     |      | .              | .     | .     | .     | 1                |
| <i>Polygala multiflora</i>         |      | .              | .     | +     | .     | .                |
| <i>Pteridium aquilinum</i>         |      | .              | 1     | .     | .     | .                |
| <i>Pycneus capillifolius</i>       |      | .              | .     | .     | .     | +                |
| <i>Pycneus polystachyos</i>        |      | .              | .     | .     | +     | .                |
| <i>Rottboellia cochinchinensis</i> |      | +              | +     | .     | .     | .                |
| <i>Schizachyrium brevifolium</i>   |      | .              | .     | .     | .     | +                |
| <i>Sida linifolia</i>              |      | .              | .     | .     | .     | +                |
| <i>Spermacoce verticillata</i>     |      | .              | .     | .     | .     | +                |
| <i>Spigelia anthelmia</i>          |      | .              | .     | .     | .     | +                |

## 4.8 Savannahs in the Coastal Belt around Buchanan, Grand Bassa

The city of Buchanan is situated approximately 100 km to the south-east of Monrovia. Sites studied in this region, for the vegetation surveys, are included in a vast industrial complex created when LAMCO was active. The clearing of the woody vegetation and the filling of large areas of grounds, more or less swampy, by a contribution of diverse solid materials (stones, gravels, laterite,) had been carried out so as to be able to undertake construction or to store residues of the treatment of the ore. Certain zones of deposits of materials, not built, have been colonised by herbaceous vegetation which assimilates them to “savannahs”.

### Site IX

Site IX is situated to the east of the ArcelorMittal Hospital, the fenced areas of the industrial complex. It is represented by a large savannah composed of *Anadelphia leptocoma* relatively homogeneous, limited by swampy woody thickets which form small, winding galleries in the grassy vegetation. Seven plots were surveyed in this site.





## Example Plot IX.1: N05°52'05.1 – W010°01'34.1 – Altitude: 18 m

Plot IX.1 corresponds to a grassy savannah composed of *Anadelphia leptocoma*, on white sand, associated mainly with *Panicum glaucocladum*. Although situated on a sandy soil, certain species such as *Xyris decipiens*, *Mesanthemum radicans*, *Burmanna liberica* and diverse Cyperaceae testify of a wet ground. Small swampy depressions, even small puddles, are colonised by helophytes among which *Cyperus haspan*, *Panicum laxum* and *Fuirena umbellata*. No woody species are present in this savannah with the exception of some feet of *Virectaria multiflora* and *Clappertonia ficifolia*. The woody thicket which lines this savannah is very dense and species such as *Anthostema senegalense*, *Heisteria parviflora*, *Ixora laxiflora* or *Smeathmannia pubescens* are frequent.



## Example Plot IX.2: N05°52'08.7 – W010°01'31.5 – Altitude: 17 m

This plot is very similar to the previous one although more swampy. *Anadelphia leptocoma* forms a very dense grass cover, without the sandy beaches that were found in the previous plot. The herbaceous layer consists of the same main species but *Mesanthemum radicans* and *Xyris decipiens* are more abundant because of the more pronounced hydromorphy of the soil. Cyperaceae as *Rhynchospora rubra* and *Pycnus polystachyos* are common without being abundant.





## Example Plot IX.3: N05°52'09.1 – W010°01'34.9 – Altitude: 10 m

This plot, identical to the previous ones, is very swampy in isolated places. *Anadelphia leptocoma* again forms a very dense grass layer, and only some sandy patches allow *Panicum glaucocladum* to appear in the herbaceous mat. A small, shallow pool is plentiful with *Fuirena umbellata* while feet of *Lasiorhiza senegalensis* develop in a small but deep hole filled with water. A small population of *Rhynchospora holoschoenoides* occupies an isolated, swampy patch of ground.

No woody species is present within this plot with the exception, as in Plot IX.1, of *Virectaria multiflora* and *Clappertonia ficifolia* bordering the swampy thicket.



## Example Plot IX.4: N05°52'12.8 – W010°01'31.0 – Altitude: 16 m

Plot IX.4 presents a similar structure to that of previous plots. The composition differs little from them by a lesser floristic diversity. *Anadelphia leptocoma* remains the dominant grass and some wet depressions allow in places, the growth of *Panicum glaucocladum*, *Mesanthemum radicans* and *Xyris decipiens*.



## Example Plot IX.5: N05°52 ' 14.2 - W010°01 ' 32.9 – Altitude: 16 m

*Anadelphia leptocoma* is always the dominant grass in this plot. However, this plot includes white sand patches on which this species is less abundant. It is then associated with species such as *Schwenckia americana*, *Astraea lobata*, *Pennisetum polystachion* which are ruderal plants evident of a poor and degraded ground. *Anthostema senegalense*, a small, characteristic tree of the woody thicket which lines the savannah, penetrates the herbaceous layer.



## Plot IX.6: N05°52'19.2 – W010°01'29.3 – Altitude: 15 m

This plot differs from the previous ones and the population of *Anadelphia leptocoma* is not so dense or homogeneous because of an extensive, white sandy soil. Most of the species cited in the previous plots are still present, and the increased density and moisture in the ground, support areas of *Loudetia phragmitoides*, *Clappertonia ficifolia* (more abundant) and *Panicum parvifolium*, to develop in a small swamp bordering the woody thicket. Species such as *Xyris rubella* and *Schwenckia americana* are common. This part of the savannah is in the course of encroachment with dead *Elaeis guineensis* and *Alchornea cordifolia*. These woody islands are surrounded by a dense fringe of *Pteridium aquilinum* associated with *Aspilia africana*, *Panicum dinklagei*, *Hibiscus physaloides* and *Ipomoea involucrata*.



## Example Plot IX.7: N05°52'16.9 – W010°01'29.0 – Altitude: 9 m

This plot is similar to the previous one but shows signs of degradation due to human activities. The population of *Anadelphia leptocoma* is also less dense and dissipates on the parts of white sand where this grass is comprised of *Schwenckia americana*, *Zornia latifolia*, *Chamaecrista mimosoides*, *Pennisetum polystachion* and areas of *Sporobolus dinklagei*. The presence of woody thickets, as in Plot IX.6, and the abundance of *Pteridium aquilinum*, are evidence of the encroachment of the milieu.



## Conclusions on Site IX

The savannah described for Site IX is relatively homogeneous. Forty-one species were listed in the various surveyed plots among which 15 Poaceae, 7 Cyperaceae and 19 species belonging to diverse families. The perennial grass *Anadelphia leptocoma* dominates in the whole of the herbaceous layer with a generally dense cover, associated mainly with *Panicum glaucocladum* (dominated stratum), *Mesanthemum radicans* and *Xyris decipiens* which are evidence of the hydromorphy of the ground (Table XIII).

The variations in the ground structure, currently sandy and dense, and the presence of small swampy depressions, modify parts of the structure and the floristic composition of the herbaceous vegetation. Cyperaceae as *Rhynchospora holoschonoides*, *Scleria spiciformis*, *Pycnus polystachyos* and Poaceae such as *Loudetia phragmitoides* occur in areas within the herbaceous layer. Other species, such as *Schwenckia americana*, *Chamaecrista mimosoides*, *Zornia latifolia*, *Spermacoce verticillata* are ruderal, more or less abundant. Crossed by several pedestrian tracks, this savannah is subject to human distress by the production of charcoal and the presence of bushfires.

This savannah is surrounded by a very dense, swampy, woody thicket, consisting of, among others, *Anthostema senegalense*, *Elaeis guineensis*, *Gaertnera paniculata*, *Anthocleista nobilis*, *Alchornea cordifolia*, *Smeathmannia pubescens* and *Heisteria parvifolia*. *Clappertonia ficifolia* is frequent in the borders of this thicket. Plots IX 6 and IX7 differ from the others by the presence of woody thickets surrounded by ferns. The fern *Pteridium aquilinum* is particularly abundant there and seems to contribute to the encroachment of this part of the savannah.



**Table XIII. List of herbaceous species, with their abundance/dominance, observed on the Site IX: dominant species are highlighted in green and locally abundant species in yellow.**

| Buchanan, east of the ArcelorMittal Hospital |      |      |      |      |      |      |      |      |
|--|------|------|------|------|------|------|------|------|
| Species                                      | Plot | IX.1 | IX.2 | IX.3 | IX.4 | IX.5 | IX.6 | IX.7 |
| <i>Poaceae</i>                               |      |      |      |      |      |      |      |      |
| <i>Anadelphia leptocoma</i>                  |      | 5    | 5    | 5    | 5    | 5    | 4    | 4    |
| <i>Axonopus compressus</i>                   |      | +    | .    | .    | .    | .    | .    | .    |
| <i>Eragrostis atrovirens</i>                 |      | +    | .    | .    | .    | .    | .    | .    |
| <i>Eragrostis gangetica</i>                  |      | +    | .    | .    | .    | .    | .    | .    |
| <i>Eragrostis unioides</i>                   |      | +    | .    | .    | .    | .    | .    | .    |
| <i>Loudetia phragmitoides</i>                |      | .    | .    | .    | .    | +    | 1    | +    |
| <i>Panicum dinklagei</i>                     |      | .    | .    | .    | .    | .    | +    | 1    |
| <i>Panicum glaucocladum</i>                  |      | 4    | 3    | 2    | 1    | 3    | 1    | 1    |
| <i>Panicum laxum</i>                         |      | +    | .    | +    | .    | +    | .    | .    |
| <i>Panicum maximum</i>                       |      | .    | .    | .    | .    | .    | .    | +    |
| <i>Panicum parvifolium</i>                   |      | .    | .    | +    | .    | +    | 1    | .    |
| <i>Panicum repens</i>                        |      | +    | .    | .    | .    | .    | .    | .    |
| <i>Paspalum scrobiculatum</i>                |      | .    | .    | .    | .    | .    | .    | +    |
| <i>Pennisetum polystachion</i>               |      | .    | .    | .    | .    | +    | 1    | 1    |
| <i>Sporobolus dinklagei</i>                  |      | .    | .    | .    | .    | .    | .    | 1    |
| <i>Cyperaceae</i>                            |      |      |      |      |      |      |      |      |
| <i>Cyperus haspan</i>                        |      | +    | .    | .    | .    | .    | .    | .    |
| <i>Fuirena umbellata</i>                     |      | +    | .    | +    | .    | +    | .    | .    |
| <i>Pycnus capillifolius</i>                  |      | 1    | +    | 1    | .    | .    | .    | .    |
| <i>Pycnus polystachyos</i>                   |      | 1    | +    | .    | 2    | 1    | 1    | +    |
| <i>Rhynchospora holoschoenoides</i>          |      | 1    | .    | 3    | .    | .    | .    | .    |
| <i>Rhynchospora rubra</i>                    |      | 1    | +    | .    | .    | .    | .    | .    |
| <i>Scleria spiciformis</i>                   |      | +    | .    | .    | .    | .    | .    | .    |
| <i>Others</i>                                |      |      |      |      |      |      |      |      |
| <i>Astraea lobata</i>                        |      | .    | .    | .    | .    | +    | .    | +    |
| <i>Burmannia liberica</i>                    |      | +    | +    | +    | .    | +    | .    | .    |
| <i>Chamaecrista mimosoides</i>               |      | +    | .    | .    | .    | .    | .    | +    |
| <i>Hibiscus physaloides</i>                  |      | .    | .    | .    | .    | .    | +    | .    |
| <i>Ipomoea involucre</i>                     |      | .    | .    | .    | .    | .    | .    | 1    |
| <i>Lasimorpha senegalensis</i>               |      | .    | +    | .    | .    | .    | .    | .    |
| <i>Lipparis rufina</i>                       |      | +    | .    | .    | .    | .    | .    | .    |
| <i>Lycopodiella affinis</i>                  |      | .    | .    | .    | +    | .    | .    | .    |
| <i>Mesanthemum radicans</i>                  |      | 1    | 2    | 2    | 1    | 2    | +    | +    |
| <i>Neurotheca loeseloides</i>                |      | 1    | +    | +    | +    | +    | .    | 1    |
| <i>Oldenlandia corymbosa</i>                 |      | .    | .    | .    | .    | .    | +    | +    |
| <i>Pteridium aquilinum</i>                   |      | .    | .    | .    | .    | .    | 2    | 3    |
| <i>Sauvagesia erecta</i>                     |      | +    | .    | .    | +    | +    | +    | +    |
| <i>Schwenckia Americana</i>                  |      | +    | .    | .    | +    | 1    | 2    | 1    |
| <i>Spermacoce verticillata</i>               |      | +    | .    | .    | +    | +    | +    | +    |
| <i>Striga asiatica</i>                       |      | .    | .    | .    | .    | .    | +    | +    |
| <i>Xyris decipiens</i>                       |      | 1    | 2    | 1    | 1    | +    | 1    | .    |
| <i>Xyris rubella</i>                         |      | .    | .    | .    | .    | +    | +    | +    |
| <i>Zornia latifolia</i>                      |      | +    | .    | .    | +    | .    | 1    | +    |



## Site X

Site X is represented by a set of 14 plots surveyed in three different areas within the industrial complex. Three plots, X.1, X.2 and X.3, are situated on the former airfield, abandoned after the activities of LAMCO ceased, east of the Buchanan Site. Five plots, X.4 to X.8, occupy a vast savannah bordering the sea south of the site. Finally six plots, X.9 to X.14, in the west of the site near the harbour, relate to a vast, degraded zone which cannot be likened to a "savannah". A former logging park is also included in these last plots.

### Plots X.1 to X.3

The three plots X1, X.2 and X.3 are situated on the former airstrip which had been constructed when LAMCO was active. Originally wooded and partially swampy, this zone was cleared before being spread over with sand and laterite. This area was transformed into savannah vegetation, limited on both sides by a swampy, woody thicket.

#### Example Plot X.1: N05°51'18.8 – W010°01'23.6 – Altitude: 31 m

Plot X.1 is dominated by *Panicum repens* and includes *Sporobolus dinklagei*: these two species indicate a hydromorphy of the soil in depth. The other species are spread in the herbaceous layer with the exception of *Panicum dinklagei* and *Schizachyrium maclaudii* which form small, monospecific patches, the first one on a sandy mound and the second in a small depression. With the exception of *Virectaria multiflora* and *Indigofera sp.*, no other woody plant developed in this savannah.



**Example Plot X.2:** N05°51'28.3 – W010°01'13.0 – Altitude: 28 m

Plot X.2 is rather similar, but *Sporobolus dinklagei* becomes the dominant species over *Panicum repens*. A small depression, bordering the woody thicket, creates a group of new species among which *Neurotheca loeselioides*, *Xyris straminea*, *Cyperus haspan*, *Abildgaardia congolensis*, *Bulbostylis laniceps*, *Panicum glaucocladum* and *P. laxum*. Certain ruderal species, such as *Schwenckia Americana*, are very common.

The woody thicket, framing this savannah on each side, consists mainly of *Terminalia catappa* (exotic species), *Elaeis guineensis*, *Rauvolfia vomitoria*, *Xylopia aethiopica* and *Alchornea cordifolia*.



**Example Plot X.3:** N05°51'37.0 – W010°01'00.9 – Altitude: 24 m

This plot is situated at the end of the airstrip, toward the northeast, in the contact with the mangrove swamp. The structure and the composition of the herbaceous mat vary little and *Panicum repens* and *Sporobolus dinklagei* remain dominant; however, the appearance of *Anadelphia leptocoma* and *Pennisetum polystachion* become more abundant. The small shrub *Indigofera sp.* is more abundant in this part of the plot in addition to some feet of *Virectaria multiflora*.



## Conclusions on Plots X.1 to X.3

Thirty-seven herbaceous species were listed in these three plots (Table XIV). The herbaceous and grass layer is dominated by perennials among which *Panicum repens* and *Sporobolus dinklagei*: *Anadelphia leptocoma* are abundant, in areas, only in Plot X.3. These species characterize a hydromorphy of the soil in depth which is confirmed by the composition of the ligneous undergrowth which lines the savannah on both sides and along the mangrove swamp.

Ruderal species including *Schwenckia americana*, *Astraea lobata*, *Spermacoce verticillata*, *Chamaecrista mimosoides* or *Chromolaena odorata* confirm a state of degradation of the milieu. The presence of such species in this savannah is not surprising especially since this area has human habitation and is used by United Nations for the training of helicopter pilots.

**Table XIV. List of the observed herbaceous species, with their abundance / dominance, in the plots SX.1 to SX.3 of the Site X in Buchanan: dominant species are highlighted in green and the locally abundant ones in yellow.**

| Buchanan Airstrip               |      |     |     |     |
|---------------------------------|------|-----|-----|-----|
| Species                         | Plot | X.1 | X.2 | X.3 |
| <i>Abildgaardia congolensis</i> |      | +   | 1   | .   |
| <i>Anadelphia leptocoma</i>     |      | .   | +   | 3   |
| <i>Astraea lobata</i>           |      | .   | +   | .   |
| <i>Axonopus compressus</i>      |      | 1   | 1   | +   |
| <i>Bulbostylis laniceps</i>     |      | .   | +   | .   |
| <i>Burmannia liberica</i>       |      | .   | +   | .   |
| <i>Calopogonium mucunoides</i>  |      | +   | .   | .   |
| <i>Chamaecrista mimosoides</i>  |      | +   | +   | .   |
| <i>Chromolaena odorata</i>      |      | +   | +   | +   |
| <i>Cuscuta australis</i>        |      | +   | .   | .   |
| <i>Cyperus haspan</i>           |      | .   | +   | .   |
| <i>Eragrostis atrovirens</i>    |      | .   | +   | .   |
| <i>Eragrostis unioides</i>      |      | +   | +   | .   |
| <i>Ipomoea aquatica</i>         |      | .   | .   | +   |
| <i>Ipomoea involucrata</i>      |      | .   | +   | .   |
| <i>Neurotheca loeselioides</i>  |      | .   | +   | .   |
| <i>Panicum dinklagei</i>        |      | 2   | .   | .   |
| <i>Panicum glaucocladum</i>     |      | .   | 1   | +   |
| <i>Panicum laxum</i>            |      | .   | +   | .   |
| <i>Panicum parvifolium</i>      |      | .   | +   | .   |
| <i>Panicum repens</i>           |      | 5   | 3   | 4   |
| <i>Pennisetum polystachion</i>  |      | +   | +   | 2   |
| <i>Pycnus capillifolius</i>     |      | +   | .   | .   |
| <i>Pycnus polystachyos</i>      |      | +   | +   | .   |
| <i>Sauvegesia erecta</i>        |      | +   | +   | +   |
| <i>Schizachyrium maclaudii</i>  |      | +   | .   | .   |
| <i>Schwenckia americana</i>     |      | 1   | 2   | 1   |
| <i>Scleria spiciformis</i>      |      | .   | +   | .   |
| <i>Scoparia dulcis</i>          |      | .   | +   | +   |
| <i>Sida linifolia</i>           |      | .   | +   | +   |
| <i>Spermacoce verticillata</i>  |      | 1   | 1   | 1   |
| <i>Sporobolus dinklagei</i>     |      | 3   | 5   | 4   |
| <i>Striga asiatica</i>          |      | .   | .   | +   |
| <i>Stylosanthes erecta</i>      |      | +   | .   | .   |
| <i>Urena lobata</i>             |      | .   | +   | +   |
| <i>Xyris straminea</i>          |      | .   | +   | .   |
| <i>Zornia latifolia</i>         |      | +   | +   | +   |



## Plots X.4 to X.8

Plots X.4 to X.8 belong to a mud savannah situated in the south of the industrial complex. As for the previous plots, this zone was used for disposal of solid materials derived from residues of the treatment of rocks from the mining sites. This savannah, close to the ocean, has also formed on wet ground and is partially encroached by woody species consisting of the vegetation of the surrounding area.

### Example Plot X.4: N05°51'13.4 – W010°02'24.0 – Altitude: 13 m

The herbaceous stratum of Plot X.4 is dominated by a combination including *Schizachyrium maclaudii*, *Panicum repens* and *P. griffonii*. These grasses form a dense grass layer and are secondarily combined with *Eragrostis atrovirens*, *Axonopus compressus*, and *Abildgaardia congolensis* and, in areas, with *Cyclocarpa stellaris*. Annual *Panicum glaucocladum* is also well represented under the cover of the dominant grasses.



### Example Plot X.5: N05°51'06.3 – W010°02'18.6 – Altitude: 11 m

As the previous one, this plot has a very dense herbaceous layer. If *Schizachyrium maclaudii* remains a dominant grass, *Panicum repens* and *P. griffonii* are absent. *Panicum glaucocladum* is always abundant in the dominated stratum. Some species such as *Mimosa pudica*, *Phyllanthus sp.*, and Cyperaceae species including *Kyllinga peruviana*, *Rhynchospora rubra* and *Fuirena umbellata* are relatively abundant.





## Example Plot X.6: N05°51'08.8 – W010°02'16.5 – Altitude: 11 m

*Schizachyrium maclaudii* always forms the main part of the herbaceous biomass in this plot. Another Poaceae, *Imperata cylindrica*, appears in some areas in the form of a monospecific stand. These two grasses are present with other diverse species among which in particular are *Paspalum scrobiculatum* and *Cyclocarpa stellaris*.



## Example Plot X.7: N05°51'09.9 – W010°02'11.0 – Altitude: 16 m

This plot is similar to the previous one, but *Schizachyrium maclaudii*, always dominant in the grassy layer, is strictly associated with *Scleria achtenii* which forms wide tussocks. The grass layer is more diverse and includes *Panicum glaucocladum*, *P. griffonii*, *P. repens*, *Eragrostis atrovirens*, *Paspalum scrobiculatum* and *Pennisetum polystachion*. A dense population of *Aeschynomene indica* and *Clappertonia ficifolia*, close to the plot, underlines the swampy tendency of the site.



## Example Plot X.8: N05°51'15.5 – W010°02'09.7 – Altitude: 18 m

Plot X.8 differs from the previous ones in that the dominant grasses are absent although *Axonopus compressus*, *Panicum griffonii* and *P. glaucocladum* are still well represented. Other species become more abundant in the herbaceous mat such as *Phyllanthus sp.*, *Panicum laxum* and *Scleria achenii*. Not far from this plot, patches of *Saccharum officinarum* (sugar cane) and a small mat of *Chrysopogon aciculatus* (grass used to make lawns) are evidence of the former human occupation of the site (N05°51'18,5 – W010°02.21.2). A population of *Imperata cylindrica* is also very close to the plot (N05°51'22.4 - W010°02'.10.9).



## Conclusions on Plots X.4 to X.8

This large savannah in which these five plots were surveyed, is relatively rich because 36 species were listed there (Table XV). Although various plots inventoried present differences in their floristic composition, the herbaceous stratum is widely dominated by some grasses i.e. *Schizachyrium maclaudii*, *Panicum griffonii*, *P. glaucocladum*, *Axonopus compressus*, *Eragrostis atrovirens* and secondarily *Pennisetum polystachion*. Two other species, *Panicum repens* and *Imperata cylindrica*, are abundant in some areas. Other numerous species are present in the herbaceous layer, more or less frequent according to the soil conditions and especially its hydromorphy.

Woody thickets, more or less important, are spread throughout the savannah and tend to indicate a phase of recolonisation by the swampy forest vegetation. Species such as *Alchornea floribunda*, *Anthocleista nobilis* and *Ficus sur* are prominent. These areas are sometimes surrounded by a dense fringe of ferns which ensures the detachment from the savannah, and a dense herbaceous cover, bush-resistant to fires, favour the regeneration of the ligneous layer. *Chromolaena odorata* is present everywhere but is scarce (a widely distributed species is not always an abundant species).

**Table XV. List of the observed herbaceous species, with their abundance / dominance, in Plots X.4 to X.8 in the Site X in Buchanan: dominant species are highlighted in green and the locally abundant ones in yellow.**

| Buchanan, Mud Savannah South of the Industrial Area |      |     |     |     |     |     |
|---|------|-----|-----|-----|-----|-----|
| Species   | Plot | X.4 | X.5 | X.6 | X.7 | X.8 |
| Abildgaardia congolensis                            |      | 3   | +   | 1   | +   | +   |
| Aechynomene indica                                  |      | 1   | .   | +   | +   | +   |
| Anadelphia leptocoma                                |      | +   | +   | .   | .   | .   |
| Aspilia africana                                    |      | .   | .   | .   | .   | .   |
| Axonopus compressus                                 |      | 3   | 3   | .   | .   | 3   |
| Chamaecrista mimosoides                             |      | .   | .   | +   | .   | .   |
| Chromolaena odorata                                 |      | +   | .   | +   | +   | .   |
| Cyclocarpa stellaris                                |      | 3   | .   | 1   | .   | .   |
| Cyperus haspan                                      |      | .   | +   | +   | .   | .   |
| Desmodium ramosissimum                              |      | 1   | 1   | +   | 1   | +   |
| Emilia coccinea                                     |      | +   | .   | .   | .   | .   |
| Eragrostis atrovirens                               |      | 3   | 1   | .   | 2   | +   |
| Fuirena umbellata                                   |      | +   | 1   | 1   | +   | +   |
| Habenaria genuflexa                                 |      | +   | 1   | +   | +   | +   |
| Imperata cylindrica                                 |      | .   | .   | 4   | .   | .   |
| Kyllinga peruviana                                  |      | .   | 2   | +   | .   | .   |
| Lipparis rufina                                     |      | .   | .   | .   | .   | +   |
| Ludwigia erecta                                     |      | +   | +   | +   | .   | .   |
| Mimosa pudica                                       |      | +   | 3   | .   | 1   | 1   |
| Panicum glaucocladum                                |      | 2   | 2   | +   | 2   | 3   |
| Panicum griffonii                                   |      | 4   | +   | .   | 2   | 3   |
| Panicum laxum                                       |      | +   | +   | .   | +   | 2   |
| Panicum repens                                      |      | 4   | .   | .   | 2   | .   |
| Paspalum scrobiculatum                              |      | 1   | +   | 2   | 1   | +   |
| Passiflora foetida                                  |      | +   | .   | .   | .   | .   |
| Pennisetum polystachion                             |      | +   | +   | +   | 1   | +   |
| Phyllanthus sp.                                     |      | +   | 2   | .   | 1   | 3   |
| Pycreus polystachyos                                |      | +   | .   | +   | 1   | +   |
| Rhynchospora rubra                                  |      | .   | 1   | .   | .   | .   |
| Sauvagesia erecta                                   |      | .   | .   | .   | +   | .   |
| Schizachyrium maclaudii                             |      | 4   | 4   | 5   | 4   | .   |
| Scleria achtenii                                    |      | .   | +   | +   | +   | 2   |
| Spermacoce verticillata                             |      | +   | +   | .   | 1   | 1   |
| Sporobolus pyramidalis                              |      | +   | .   | .   | +   | .   |
| Xyris decipiens                                     |      | .   | .   | .   | .   | +   |
| Zornia latifolia                                    |      | +   | .   | .   | .   | .   |

## Plots X.9 to X.11

These three plots, as the previous ones, occur on deposits of residues resulting from the treatment of iron ore from the mining sites. They were surveyed within depressions which are separated by banks and lined by a swampy, woody thicket. The sites may be considered as shallow tailings ponds from the former LAMCO washplant.

### Example Plot X.9: N05°51'40.3 – W010°02'50.6 – Altitude: 18 m

Two species, *Schizachyrium maclaudii* and *Panicum repens*, constitute the major part of the dense herbaceous layer. Another grass, *Ischaemum afrum*, forms a small, monospecific patch in some areas. A population of *Imperata cylindrica* and *Schizachyrium maclaudii* is adjacent to the plot (N05°51'43.7 – W010°02'52.2). Numerous species are common with previous plots but scarce: others are new as *Pueraria phaseoloides* (ruderal species), *Plectranthus monostachyus* and *Digitaria argyrothrica*.



### Example Plot X.10: N05°51'47.0 – W010°02'50.5 – Altitude: 19 m

Plot X.10 is adjacent to the previous one, from which it is separated by a bank. *Schizachyrium maclaudii* remains the dominant grass in addition to *Panicum repens*, *Pennisetum polystachion*, *Eragrostis atrovirens* and *Paspalum scrobiculatum*: *Anadelphia leptocoma* is present only in some areas, as well as *Loudetia phragmitoides*. In the neighborhood of the bank, *Brachiaria brizantha* develops. A small, swampy depression allows the growth of *Panicum glaucocladum*, *Panicum laxum*, *Aeschynomene indica* and diverse Cyperaceae including *Fuirena umbellata*.





## Example Plot X.11: N05°51'51.5 – W010°02'45.4 – Altitude: 21 m

Plot X.11 is adjacent to Plot X.10 from which it is also separated by a bank. The grass layer is rather similar but *Schizachyrium maclaudii* dominates widely, and is combined with *Axonopus compressus*, *Panicum glaucocladum*, *Paspalum scrobiculatum* and *Panicum laxum*.

*Imperata cylindrica* is again present in the form of a near monospecific population, whereas *Loudetia phragmitoides* and *Anadelphia leptocoma* appear only in some patches in some areas.



## Conclusions on Plots X.9 to X.11

These three plots are rather similar in regard to the structure and the composition of the herbaceous mat, although certain grasses are more or less abundant. Forty-two species were identified and the floristic composition varies little with regard to previous plots (Table XVI). The soil moisture constitutes a major element in the distribution of the species. *Schizachyrium maclaudii*, *Panicum repens* and *Axonopus compressus* are grasses that are best represented with *Anadelphia leptocoma* and *Imperata cylindrica* in some areas. The presence of small swampy depressions influences the floristic diversity of the plots with the local appearance of Cyperaceae such as *Courtoisina cyperoides*, *Fuirena umbellata* or *Kyllinga peruviana*.

**Table XVI. List of the observed herbaceous species, with their abundance/dominance, in Plots P X.9 to P X.11 in the Site X in Buchanan: dominant species are highlighted in green and the locally abundant ones in yellow.**

| Buchanan, LAMCO Washplant Tailings Ponds |      |     |      |      |
|--|------|-----|------|------|
| Species                                  | Plot | X.9 | X.10 | X.11 |
| Abildgaardia congolensis                 |      | +   | +    | .    |
| Aeschynomene indica                      |      | .   | 1    | .    |
| Anadelphia leptocoma                     |      | .   | 2    | +    |
| Aspilia africana                         |      | +   | .    | .    |
| Astraea lobata                           |      | .   | .    | +    |
| Axonopus compressus                      |      | .   | 2    | 3    |
| Brachiaria brizantha                     |      | +   | .    | .    |
| Chamaecrista mimosoides                  |      | +   | .    | .    |
| Chromolaena odorata                      |      | 1   | +    | .    |
| Courtoisina cyperoides                   |      | .   | .    | +    |
| Cyclocarpa stellaris                     |      | .   | +    | .    |
| Cyperus haspan                           |      | .   | .    | +    |
| Desmodium ramosissimum                   |      | +   | +    | +    |
| Digitaria argyrorhiza                    |      | +   | +    | .    |
| Eragrostis atrovirens                    |      | +   | 2    | +    |
| Fuirena umbellata                        |      | .   | +    | +    |
| Habenaria genuflexa                      |      | .   | +    | 1    |
| Imperata cylindrica                      |      | .   | .    | 2    |
| Ipomoea involucrata                      |      | .   | +    | .    |
| Ischaemum afrum                          |      | 3   | .    | .    |
| Kyllinga peruviana                       |      | .   | .    | +    |
| Lipparis rufina                          |      | .   | .    | +    |
| Loudetia phragmitoides                   |      | +   | 1    | +    |
| Ludwigia erecta                          |      | .   | .    | +    |
| Mimosa pudica                            |      | .   | +    | +    |
| Panicum dinklagei                        |      | .   | +    | .    |
| Panicum glaucocladum                     |      | .   | 1    | 2    |
| Panicum griffonii                        |      | .   | +    | .    |
| Panicum laxum                            |      | .   | 1    | 2    |
| Panicum maximum                          |      | +   | .    | .    |
| Panicum repens                           |      | 4   | 3    | .    |
| Paspalum scrobiculatum                   |      | 1   | 1    | 1    |
| Pennisetum polystachion                  |      | 1   | 3    | +    |
| Plectranthus monostachyus                |      | +   | .    | .    |
| Pueraria phaseoloides                    |      | +   | +    | .    |
| Pycreus polystachyos                     |      | +   | .    | +    |
| Schizachyrium maclaudii                  |      | 4   | 4    | 4    |
| Scleria achenii                          |      | .   | +    | .    |
| Spermacoce verticillata                  |      | +   | .    | .    |
| Sporobolus pyramidalis                   |      | .   | .    | 1    |
| Urena lobata                             |      | .   | .    | +    |
| Xyris decipiens                          |      | .   | .    | +    |

## Plots X.12 to X.14

These three plots are situated near the harbour, in the south-west of Buchanan, and near an old logging park with abandoned rough timber. It is difficult to consider this environment as a “savannah” but rather as a waste ground colonised by heterogeneous herbaceous vegetation due to occasional swampy soil. This zone was severely affected by the creation of the logging park and the construction of various buildings.

### Example Plot X.12: N05°51'58.8 – W010°03'13.2 – Altitude: 4 m

This plot is adjacent to the logging park. The herbaceous stratum is dominated by *Eragrostis atrovirens* and *Ischaemum afrum*, this last species forming a monospecific population. Most of the other species are helophytes isolated in small muddy depressions. Species such as *Eragrostis gangetica*, *Fuirena umbellata*, *Abildgaardia congolensis*, *Pycnus capillifolius*, *P. polystachyos*, *Panicum laxum*, *Mimosa pudica*, *Aeschynomene indica* or *Echinochloa colona* are frequent and distributed in the grass layer in a very heterogeneous manner, often in confined areas.



### Example Plot X.13: N05°52'00.4 – W010°03'11.4 – Altitude: 4 m

Plot X.13, although adjacent to the previous one, is very different and crossed by wide drainage ditches. The herbaceous stratum, very dense, consists mainly of *Ischaemum afrum*, which forms an almost monospecific population, combined in some areas with *Schizachyrium maclaudii*. Some other grasses, as *Paspalum scrobiculatum*, *Eragrostis gangetica*, *Panicum laxum* and *Pennisetum polystachion*, occupy spaces in which the grassy layer is less high and less dense. Most of the other species are less abundant, spread within the plot or sometimes more or less intrusive as lianas *Mimosa pudica* and *Calopogonium mucunoides*.





## Example Plot X.14: N05°51'53.4 – W010°03'18.5 – Altitude: 9 m

Though Plots X.12 and X.13 contain well-marked grass layers, Plot X.14, next to the harbour and to the former warehouses, is fundamentally very different. The vegetation is constituted of intrusive plants, confirming a severe degradation of the environment. Grasses are practically absent, and the herbaceous vegetation is mainly made up of *Ipomoea cairica*, *Passiflora foetida*, *Pueraria phaseoloides* combined with *Chromolaena odorata*. The only rare present grasses are *Panicum maximum*, *P. laxum*, *Ischaemum afrum*, and *Sorghum bicolor* subsp. *arundinaceum*.

*Lantana camara*, an exotic, invasive shrub, grows at the base of buildings.



## Conclusions on Plots X.12 to X.14

Plots X.12, X.13 and X.14 are located in an environment which was disturbed by the activities of the harbour and which remain subjected to a strong human influence. While previous studied plots were colonised during the last two decades by savannah herbaceous plant species, the present 3 plots should be more accurately defined as "waste grounds" without reference to any vegetation type. With a total of fifty (50) species listed, this environment presents a rather strong floristic diversity but most of the plants are ruderal species (Table XVII).

Only *Schizachyrium maclaudii*, *S. brevifolium* and *Ischaemum afrum* present a substantial growth. The last species, introduced from Asia, is now naturalised in numerous tropical countries and is relatively well represented in the industrial complex where it occupies depressions by forming monospecific populations there.

Some species, locally abundant, such as *Pueraria phaseoloides*, *Mimosa pudica* or *Calopogonium mucunoides*, are herbaceous lianas which are intrusive in this type of habitat.



**Table XVII. List of the observed herbaceous species, with their abundance/dominance, in the plots X.12 to P X.14 in the Site X in Buchanan: dominant species are highlighted in green and the locally abundant ones in yellow.**

| <b>Buchanan, near the Harbour</b> |             |             |             |             |
|-----------------------------------|-------------|-------------|-------------|-------------|
| <b>Species</b>                    | <b>Plot</b> | <b>X.12</b> | <b>X.13</b> | <b>X.14</b> |
| Abildgaardia congolensis          |             | 1           | +           | .           |
| Aechynomene indica                |             | 2           | +           | .           |
| Anadelphia leptocoma              |             | +           | .           | .           |
| Calopogonium mucunoides           |             | 3           | 1           | .           |
| Chamaecrista mimosoides           |             | .           | +           | .           |
| Chromolaena odorata               |             | .           | +           | 4           |
| Courtoisina cyperoides            |             | +           | .           | .           |
| Crotalaria retusa                 |             | 1           | +           | .           |
| Cuphea carthagenensis             |             | .           | .           | +           |
| Cynodon dactylon                  |             | +           | +           | .           |
| Cyperus difformis                 |             | +           | .           | .           |
| Cyperus haspan                    |             | +           | .           | .           |
| Cyperus podocarpus                |             | +           | 1           | .           |
| Dactyloctenium aegyptium          |             | +           | .           | .           |
| Desmodium triflorum               |             | +           | .           | .           |
| Digitaria horizontalis            |             | .           | +           | .           |
| Dissotis rotundifolia             |             | .           | .           | +           |
| Echinochloa colona                |             | +           | .           | .           |
| Eclipta prostrate                 |             | +           | .           | .           |
| Eleocharis geniculata             |             | 1           | .           | .           |
| Eragrostis atrovirens             |             | 4           | +           | .           |
| Eragrostis gangetica              |             | 1           | +           | .           |
| Eragrostis unioloides             |             | +           | +           | .           |
| Fimbristylis littoralis           |             | 1           | .           | .           |
| Fuirena umbellata                 |             | 3           | +           | .           |
| Ipomoea aquatica                  |             | .           | +           | .           |
| Ipomoea cairica                   |             | .           | .           | 2           |
| Ischaemum afrum                   |             | 3           | 4           | 1           |
| Lipocarpa chinensis               |             | +           | .           | .           |
| Ludwigia recta                    |             | 1           | +           | 2           |
| Mimosa pudica                     |             | 1           | 1           | 1           |
| Panicum laxum                     |             | 2           | 2           | 3           |
| Panicum maximum                   |             | +           | +           | 2           |
| Paspalum scrobiculatum            |             | 1           | 2           | +           |
| Passiflora foetida                |             | .           | .           | 3           |
| Pennisetum polystachion           |             | .           | 1           | 1           |
| Polygonum limbatum                |             | .           | +           | .           |
| Pueraria phaseoloides             |             | .           | .           | 3           |
| Pycnus capillifolius              |             | +           | .           | .           |
| Pycnus polystachyos               |             | +           | .           | .           |
| Schizachyrium brevifolium         |             | .           | +           | .           |
| Schizachyrium maclaudii           |             | .           | 2           | .           |
| Sida acuta                        |             | +           | .           | .           |
| Sorghum bicolor                   |             | .           | +           | +           |
| Spermacoce verticillata           |             | +           | +           | .           |
| Spigelia anthelmia                |             | +           | .           | .           |
| Sporobolus pyramidalis            |             | +           | +           | .           |
| Stachytarpheta angustifolia       |             | 1           | +           | .           |
| Urena lobata                      |             | .           | .           | +           |
| Zornia latifolia                  |             | .           | +           | .           |

### Conclusions on the vegetation surveys in the Buchanan sites

The vegetation surveys carried out in the plots of Sites IX and X in the Buchanan area and in the industrial complex, produced ninety-four (94) herbaceous species, among which are 27 Poaceae, 16 Cyperaceae and 51 species belonging to diverse families (Table XVIII).

With the exception of Site IX, the vegetation plots surveyed in the Buchanan complex reveal very "artificial" vegetation formations. Site IX, adjacent to the complex, is represented by *Anadelphia leptocoma* savannah, slightly degraded in its northwest part. This grass dominates widely in all plots studied, combined with species such as *Mesanthemum radicans*, *Xyris decipiens*, *Panicum glaucocladum*, *Pycnus polystachyos*, *Rhynchospora holoschoenoides* and secondarily with *Loudetia phragmitoides* which give evidence to the soil moisture. This savannah, lined and crossed by small woody galleries in the form of swampy thickets, is free from encroachment, except in its northwest part where woody thickets are often surrounded by the fern *Pteridium aquilinum*.

Although the studied vegetation types seem different, a group of common grass species can be defined including especially *Axonopus compressus*, *Eragrostis atrovirens*, *Panicum glaucocladum*, *P. laxum*, *P. repens*, *Pennisetum polystachion* and *Schizachyrium maclaudii*. Most of these species are indicators of a deep, wet soil. Other grasses, abundant in some areas, confirm this wet, even swampy state of the ground, and include *Imperata cylindrica*, *Panicum griffonii* and *Sporobolus dinklagei* to which it is necessary to add numerous Cyperaceae with, among others, *Abildgaardia congolensis*, *Cyperus difformis*, *haspan C.*, *Eleocharis geniculata*, *Fimbristylis littoralis*, *Fuirena umbellata*, *Kyllinga peruviana*, *Lipocarpa chinensis*, *Scleria achtenii*, *Pycnus capillifolius* and *P. polystachyos*.

The floristic composition of these "savannahs" is not surprising because the original vegetation, constituted for the greater part by swampy thickets, was modified by clearing and backfilling. Plots X.4 to X.8 are indicative because the vegetation tends to be reconstituted locally within the grass layer.

It is important to note the abundance of the ruderal species, indicators of disturbed areas, such as *Calopogonium mucunoides*, *Chamaecrista mimosoides*, *Chromolaena odorata*, *Mimosa pudica*, *Passiflora foetida*, *Pueraria phaseoloides*, *Schwenckia americana*, *Stylosanthes erecta* and *Zornia latifolia* which are very abundant in some areas.

**Table XVIII. List of the observed herbaceous species, with their abundance / dominance, in Sites IX and X in Buchanan: dominant species are highlighted in green and the locally abundant species in yellow.**

| Savannahs in the Coastal Belt around Buchanan, Grand Bassa |      |      |      |      |      |      |      |      |    |    |    |    |    |    |    |    |    |     |     |     |     |     |  |
|--|------|------|------|------|------|------|------|------|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|--|
| Species  | Plot | IX.1 | IX.2 | IX.3 | IX.4 | IX.5 | IX.6 | IX.7 | X1 | X2 | X3 | X4 | X5 | X6 | X7 | X8 | X9 | X10 | X11 | X12 | X13 | X14 |  |
| Poaceae  |      |      |      |      |      |      |      |      |    |    |    |    |    |    |    |    |    |     |     |     |     |     |  |
| Anadelphia leptocoma                                       |      | 5    | 5    | 5    | 5    | 5    | 4    | 4    | .  | +  | 3  | +  | +  | .  | .  | .  | .  | 2   | +   | +   | .   | .   |  |
| Axonopus compressus  |      | +    | .    | .    | .    | .    | .    | .    | 1  | 1  | +  | 3  | 3  | .  | .  | 3  | +  | 2   | 3   | .   | .   | .   |  |
| Brachiaria brizantha                                       |      | .    | .    | .    | .    | .    | .    | .    | .  | +  | .  | .  | .  | .  | .  | .  | +  | .   | .   | .   | .   | .   |  |
| Cynodon dactylon   |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | .  | .  | .  | .  | .  | .  | .   | .   | +   | +   | .   |  |
| Digitaria argyrothrica                                     |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | .  | .  | .  | .  | .  | +  | +   | .   | .   | .   | .   |  |
| Digitaria horizontalis                                     |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | .  | .  | .  | .  | .  | +  | +   | .   | +   | +   | .   |  |
| Echinochloa colona   |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | .  | .  | .  | .  | .  | .  | .   | .   | +   | .   | .   |  |
| Eragrostis atrovirens                                      |      | +    | .    | .    | .    | .    | .    | .    | .  | +  | .  | 3  | 1  | .  | 2  | +  | +  | 2   | +   | 4   | .   | +   |  |
| Eragrostis gangetica                                       |      | +    | .    | .    | .    | .    | .    | .    | .  | .  | .  | .  | .  | .  | .  | .  | .  | .   | .   | 1   | +   | .   |  |
| Eragrostis unioides  |      | +    | .    | .    | .    | .    | .    | .    | +  | +  | .  | .  | .  | .  | .  | .  | .  | .   | .   | +   | +   | .   |  |
| Imperata cylindrica  |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | .  | .  | 4  | .  | .  | .  | .   | 2   | .   | .   | .   |  |
| Ischaemum afrum  |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | .  | .  | .  | .  | .  | 3  | .   | .   | 3   | 4   | 1   |  |
| Loudetia phragmitoides                                     |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | .  | .  | .  | .  | .  | +  | 1   | +   | .   | .   | .   |  |
| Panicum dinklagei  |      | .    | .    | .    | .    | .    | .    | .    | 2  | .  | .  | .  | .  | .  | .  | .  | .  | +   | .   | .   | .   | .   |  |
| Panicum glaucocladum                                       |      | 4    | 3    | 2    | 1    | 3    | 1    | 1    | .  | 1  | +  | 2  | 2  | +  | 2  | 3  | .  | 1   | 2   | .   | .   | .   |  |
| Panicum griffonii  |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | 4  | +  | .  | 2  | 3  | .  | +   | .   | .   | .   | .   |  |
| Panicum laxum  |      | +    | .    | +    | .    | +    | .    | .    | .  | +  | .  | +  | +  | .  | +  | 2  | .  | 1   | 2   | 2   | 2   | 3   |  |
| Panicum maximum  |      | .    | .    | .    | .    | .    | .    | +    | .  | .  | .  | .  | .  | .  | .  | .  | +  | .   | .   | +   | +   | 2   |  |
| Panicum parvifolium  |      | .    | .    | +    | .    | +    | 1    | .    | .  | +  | .  | .  | .  | .  | .  | .  | .  | .   | .   | .   | .   | .   |  |
| Panicum repens   |      | +    | .    | .    | .    | .    | .    | .    | 5  | 3  | 4  | 4  | .  | .  | 2  | .  | 4  | 3   | .   | .   | .   | .   |  |
| Paspalum scrobiculatum                                     |      | .    | .    | .    | .    | .    | .    | +    | .  | .  | .  | 1  | +  | 2  | 1  | +  | 1  | 1   | 1   | 1   | 2   | +   |  |
| Pennisetum polystachion                                    |      | .    | .    | .    | .    | +    | 1    | +    | +  | +  | 2  | +  | +  | +  | 1  | +  | 1  | 3   | +   | +   | 1   | 1   |  |
| Schizachyrium brevifolium                                  |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | .  | .  | .  | .  | .  | .  | .   | .   | .   | +   | .   |  |
| Schizachyrium maclaudii                                    |      | .    | .    | .    | .    | .    | .    | .    | +  | .  | .  | 4  | 4  | 5  | 4  | .  | 4  | 4   | 4   | +   | 2   | .   |  |
| Sorghum bicolor  |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | .  | .  | .  | .  | .  | .  | .   | .   | .   | +   | +   |  |
| Sporobolus dinklagei                                       |      | .    | .    | .    | .    | .    | .    | 1    | 3  | 5  | 4  | .  | .  | .  | .  | .  | .  | .   | .   | .   | .   | .   |  |
| Sporobolus pyramidalis                                     |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | +  | +  | .  | .  | +  | .  | .  | .   | 1   | +   | +   | .   |  |
| Cyperaceae   |      |      |      |      |      |      |      |      |    |    |    |    |    |    |    |    |    |     |     |     |     |     |  |
| Abildgaardia congolensis                                   |      | .    | .    | .    | .    | .    | .    | .    | +  | 1  | .  | 3  | +  | 1  | +  | +  | +  | +   | .   | 1   | +   | .   |  |
| Bulbostylis laniceps                                       |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | +  | .  | .  | .  | .  | .  | .  | .   | .   | .   | .   | .   |  |
| Courtoisina cyperoides                                     |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | .  | .  | .  | .  | .  | .  | .   | +   | +   | .   | .   |  |
| Cyperus difformis  |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | .  | .  | .  | .  | .  | .  | .   | .   | +   | .   | .   |  |
| Cyperus haspan   |      | +    | .    | .    | .    | .    | .    | .    | .  | +  | .  | .  | +  | +  | .  | .  | .  | .   | +   | +   | .   | .   |  |
| Eleocharis geniculata                                      |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | .  | .  | .  | .  | .  | .  | .   | .   | 1   | .   | .   |  |
| Fimbristylis littoralis                                    |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | .  | .  | .  | .  | .  | .  | .   | .   | 1   | .   | .   |  |
| Fuirena umbellata  |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | +  | 1  | 1  | +  | +  | .  | +   | +   | 3   | +   | .   |  |
| Kyllinga peruviana   |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | .  | .  | +  | .  | .  | .  | .   | +   | .   | .   | .   |  |
| Lipocarpha chinensis                                       |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | .  | .  | .  | .  | .  | .  | .   | .   | +   | .   | .   |  |
| Pycreus capillifolius                                      |      | +    | .    | .    | .    | .    | .    | .    | .  | +  | .  | .  | .  | .  | .  | .  | .  | .   | .   | +   | .   | .   |  |
| Pycreus polystachyos                                       |      | .    | .    | .    | .    | .    | .    | .    | .  | +  | +  | .  | +  | .  | +  | 1  | +  | +   | .   | +   | .   | .   |  |
| Rhynchospora holoschoenoides                               |      | 1    | .    | 3    | .    | .    | .    | .    | .  | .  | .  | .  | .  | .  | .  | .  | .  | .   | .   | .   | .   | .   |  |
| Rhynchospora rubra   |      | 1    | +    | .    | .    | .    | .    | .    | .  | .  | .  | .  | .  | .  | .  | .  | .  | .   | .   | .   | .   | .   |  |
| Scleria achtenii   |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | .  | +  | +  | +  | 2  | .  | +   | .   | .   | .   | .   |  |
| Scleria spiciformis  |      | +    | .    | .    | .    | .    | .    | .    | .  | +  | +  | .  | .  | .  | .  | .  | .  | .   | .   | .   | .   | .   |  |
| Others   |      |      |      |      |      |      |      |      |    |    |    |    |    |    |    |    |    |     |     |     |     |     |  |
| Aechynomene indica   |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | 1  | .  | +  | +  | +  | .  | 1   | .   | 2   | +   | .   |  |
| Aspilia africana   |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | .  | .  | .  | .  | .  | +  | .   | .   | .   | .   | .   |  |
| Burmannia liberica   |      | +    | +    | +    | .    | +    | .    | .    | .  | +  | .  | .  | .  | .  | .  | .  | .  | .   | .   | .   | .   | .   |  |
| Calopogonium mucunoides                                    |      | +    | .    | .    | .    | .    | .    | +    | +  | .  | .  | .  | .  | .  | .  | .  | .  | .   | .   | 3   | 1   | .   |  |
| Chamaecrista mimosoides                                    |      | .    | .    | .    | .    | .    | .    | .    | +  | +  | .  | .  | .  | +  | .  | .  | +  | .   | .   | .   | +   | .   |  |
| Chromolaena odorata  |      | .    | .    | .    | .    | .    | .    | .    | +  | +  | +  | +  | .  | +  | +  | .  | 1  | +   | .   | .   | +   | 4   |  |
| Crotalaria retusa  |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | .  | .  | .  | .  | .  | .  | .   | .   | 1   | +   | .   |  |
| Croton lobatus   |      | .    | .    | .    | .    | +    | .    | +    | .  | +  | .  | .  | .  | .  | .  | .  | .  | .   | .   | +   | .   | .   |  |

| Savannahs in the Coastal Belt around Buchanan, Grand Bassa |      |      |      |      |      |      |      |      |    |    |    |    |    |    |    |    |    |     |     |     |     |     |
|--|------|------|------|------|------|------|------|------|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|
| Species  | Plot | IX.1 | IX.2 | IX.3 | IX.4 | IX.5 | IX.6 | IX.7 | X1 | X2 | X3 | X4 | X5 | X6 | X7 | X8 | X9 | X10 | X11 | X12 | X13 | X14 |
| Cuphea carthagenensis                                      |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | .  | .  | .  | .  | .  | .  | .   | .   | .   | .   | +   |
| Cuscuta australis  |      | .    | .    | .    | .    | .    | .    | .    | +  | .  | .  | .  | .  | .  | .  | .  | .  | .   | .   | .   | .   | .   |
| Cyclocarpa stellaris                                       |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | 3  | .  | 1  | .  | .  | .  | +   | .   | .   | .   | .   |
| Desmodium ramosissimum                                     |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | 1  | 1  | +  | 1  | +  | +  | +   | +   | .   | .   |     |
| Desmodium triflorum  |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | .  | .  | .  | .  | .  | .  | .   | .   | +   | .   |     |
| Dissotis rotundifolia                                      |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | .  | .  | .  | .  | .  | .  | .   | .   | .   | .   | +   |
| Eclipta prostrata  |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | .  | .  | .  | .  | .  | .  | .   | .   | +   | .   | .   |
| Emilia coccinea  |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | +  | .  | .  | .  | .  | .  | .   | .   | .   | .   | .   |
| Habenaria genuflexa  |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | +  | 1  | +  | +  | +  | .  | +   | 1   | .   | .   | .   |
| Hibiscus physaloides                                       |      | .    | .    | .    | .    | .    | +    | .    | .  | .  | .  | +  | .  | .  | .  | .  | .  | .   | .   | .   | .   | .   |
| Ipomoea aquatica   |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | +  | .  | .  | .  | .  | .  | .  | .   | .   | .   | +   | .   |
| Ipomoea cairica  |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | .  | .  | .  | .  | .  | .  | .   | .   | .   | .   | 2   |
| Ipomoea involucrata  |      | .    | .    | .    | .    | .    | .    | 1    | .  | +  | .  | .  | .  | .  | .  | .  | .  | +   | .   | .   | .   | .   |
| Lasimorpha senegalensis                                    |      | .    | +    | .    | .    | .    | .    | .    | .  | .  | .  | .  | .  | .  | .  | .  | .  | .   | .   | .   | .   | .   |
| Liparis rufina   |      | +    | .    | .    | .    | .    | .    | .    | .  | .  | .  | .  | .  | .  | .  | +  | .  | .   | +   | .   | .   | .   |
| Ludwigia erecta  |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | +  | +  | +  | .  | .  | .  | .   | .   | 1   | +   | 2   |
| Lycopodiella affinis                                       |      | .    | .    | .    | +    | .    | .    | .    | .  | .  | .  | .  | .  | .  | .  | .  | .  | .   | .   | .   | .   | .   |
| Mesanthemum radicans                                       |      | 1    | 2    | 2    | 1    | 2    | +    | +    | .  | .  | .  | .  | .  | .  | .  | .  | .  | .   | .   | .   | .   | .   |
| Mimosa pudica  |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | .  | 3  | .  | 1  | 1  | .  | +   | +   | 1   | 1   | 1   |
| Neurotheca loeselioides                                    |      | 1    | +    | +    | +    | +    | .    | 1    | .  | +  | .  | .  | .  | .  | .  | .  | .  | .   | .   | .   | .   | .   |
| Oldenlandia corymbosa                                      |      | .    | .    | .    | .    | .    | +    | +    | .  | .  | .  | .  | .  | .  | .  | .  | .  | .   | .   | .   | .   | .   |
| Passiflora foetida   |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | +  | .  | .  | .  | .  | .  | .   | .   | .   | .   | 3   |
| Phyllanthus sp. (annuelle)                                 |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | .  | .  | .  | .  | .  | .  | .   | .   | +   | .   | .   |
| Phyllanthus sp. (p  renne)                                 |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | +  | 2  | .  | 1  | 3  | .  | .   | .   | .   | .   | .   |
| Plectranthus monostachyus                                  |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | .  | .  | .  | .  | .  | +  | .   | .   | .   | .   | .   |
| Polygonum limbatum   |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | .  | .  | .  | .  | .  | .  | .   | .   | .   | +   | .   |
| Pteridium aquilinum  |      | .    | .    | .    | .    | .    | 2    | 3    | .  | .  | .  | .  | .  | .  | .  | .  | .  | .   | .   | .   | .   | .   |
| Pueraria phaseoloides                                      |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | .  | .  | .  | .  | .  | +  | +   | .   | .   | .   | 4   |
| Sauvagesia erecta  |      | +    | .    | .    | +    | +    | +    | +    | +  | +  | +  | .  | .  | .  | +  | .  | .  | .   | .   | .   | .   | .   |
| Schwenckia americana                                       |      | +    | .    | .    | +    | 1    | 2    | 1    | 1  | 2  | 1  | .  | .  | .  | .  | .  | .  | .   | .   | .   | .   | .   |
| Scoparia dulcis  |      | .    | .    | .    | .    | .    | .    | .    | .  | +  | +  | .  | .  | .  | .  | .  | .  | .   | .   | .   | .   | .   |
| Sida acuta   |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | .  | .  | .  | .  | .  | .  | .   | .   | +   | .   | .   |
| Sida linifolia   |      | .    | .    | .    | .    | .    | .    | .    | .  | +  | +  | .  | .  | .  | .  | .  | .  | .   | .   | .   | .   | .   |
| Spermacoce verticillata                                    |      | +    | .    | .    | +    | +    | +    | +    | 1  | 1  | 1  | +  | +  | .  | 1  | 1  | +  | .   | .   | .   | .   | .   |
| Spigelia anthelmia   |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | .  | .  | .  | .  | .  | .  | .   | .   | +   | .   | .   |
| Stachytarpheta angustifolia                                |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | .  | .  | .  | .  | .  | .  | .  | .   | .   | 1   | +   | .   |
| Striga asiatica  |      | .    | .    | .    | .    | .    | +    | +    | .  | .  | +  | .  | .  | .  | .  | .  | .  | .   | .   | .   | .   | .   |
| Stylosanthes erecta  |      | .    | .    | .    | .    | .    | .    | .    | +  | .  | .  | .  | .  | .  | .  | .  | .  | .   | .   | .   | .   | .   |
| Urena lobata   |      | .    | .    | .    | .    | .    | .    | .    | .  | .  | +  | +  | .  | .  | .  | .  | .  | .   | .   | +   | .   | +   |
| Xyris decipiens  |      | 1    | 2    | 1    | 1    | +    | 1    | .    | .  | .  | .  | .  | .  | .  | .  | .  | .  | .   | +   | .   | .   | .   |
| Xyris rubella  |      | .    | .    | .    | .    | +    | +    | +    | .  | .  | .  | .  | .  | .  | .  | .  | .  | .   | .   | .   | .   | .   |
| Xyris straminea  |      | .    | .    | .    | .    | .    | .    | .    | .  | +  | .  | .  | .  | .  | .  | .  | .  | .   | +   | .   | .   | .   |
| Zornia latifolia   |      | .    | .    | .    | .    | .    | .    | .    | +  | +  | +  | +  | .  | .  | .  | .  | .  | .   | .   | .   | +   | .   |



## 5. GROWING GRASSES

### 5.1 Propagation of Grasses

#### (a) Introduction

This and the next section describe how grasses can be propagated in nurseries for mass plantation programmes. They have been added by John Howell of ArcelorMittal Liberia, based mainly on his experience in the use of grasses for soil conservation in South and South-east Asia between 1986 and 2012. Grass revegetation techniques were introduced to Liberia by ArcelorMittal in 2009, and some examples are shown in section 5.4.

Grasses for soil conservation works are often collected direct from existing large savannahs, where the removal of some plants will not affect the local ecology. However, the production of very large volumes is best done by bulking up the planting materials in nurseries. This section gives the details on how to do so in simple soil beds.

#### (b) How to estimate the requirement for grass beds in a nursery

Grass slips are produced in nursery beds from cuttings made from either a portion of root and stem, or just stem. They are planted in nursery beds at a density of 100 per sq. m.

Soil conservation nurseries have to produce more grass slips than any other plants. It is therefore important to estimate the quantity of grass slips required, and the nursery space they need, early on. This is done in two stages: determining the number of slips per planting drill, which depends on the type of grass; and then calculating the multiplication factor for the production of the grass.

**Number of grass slips per planting drill.** A planting drill consists of different numbers of slips, depending on the type of grass, the nature of its rooting and the parts used for vegetative propagation. Rhizomatous grasses<sup>1</sup> require only one slip per planting drill. Fibrous rooting grasses, require two slips per drill. Grasses grown from single or double-node stem cuttings require only one slip per planting drill.

**Calculation of grass slip multiplication in the nursery.** The nursery multiplication of grasses by slips produces a three to seven times increase in the number of plants each time the grass clumps are split out, depending on the species and time of planting in the nursery.

The table below summarises this information.

| Propagation method   | Species   | Cuttings planted in nursery | Number to plant                     |
|----------------------|---|-----------------------------|-------------------------------------|
| Rooted slip cuttings | Any grasses   | November to February        | Final site number $\times 2 \div 7$ |
|                      |   | March to May                | Final site number $\times 2 \div 3$ |
| Stem cuttings        | <i>Andropogon macrophyllus</i><br><i>Cynodon dactylon</i><br><i>Imperata cylindrical</i><br><i>Loudetia phragmitoides</i><br><i>Pennisetum purpureum</i><br><i>Sporobolus dinklagei</i> | January-February            | Final site number $\times 0.25$     |

<sup>1</sup> Some grasses, especially bamboos, grow with a form of underground stem called a rhizome. Roots and shoots form from nodes on the rhizome.

## (c) Introduction: the methods of grass production

Perennial grasses usually form the main part of a soil conservation scheme. Propagating these grasses vegetatively (*i.e.* from cuttings) is not difficult technically and various vegetative methods of propagation are highly successful. However, the reason for using a particular propagation method in the nursery is often related to the availability of material.

There are three methods for propagating grasses in soil conservation, as described in Figure SH 4.6. Some grasses (*e.g.* *Cynodon dactylon*) can also be propagated from [stolon](#) cuttings<sup>2</sup>, but these are not normally used in soil conservation. Seed is a cheap means of propagating grasses, but requires much longer growing in the nursery before the plants can be used on site.

Grasses from cuttings always grow much faster than those produced from seed. Also, they are tougher and do not go through such a delicate stage as seedlings.

**Propagation methods for soil conservation grasses.**

| Propagation method | Description   |
|--------------------|---|
| Slip cuttings      | The main method of propagating grasses for soil conservation. Rooted cuttings are made by splitting out grass clumps grown in the nursery. If the grass is rhizomatous, then the slip consists of a section of the rhizome and some shoots, and must include root buds. |
| Stem cuttings      | Propagation by planting a section of the stem, usually with two nodes and a section of culm. This is carried out either in the nursery for transplanting as a rooted cutting, or directly on site.  |
| Seeds              | Grass plants are grown up from seeds. This is carried out either in the nursery for transplanting as a rooted plant, or directly on site.   |

## (d) Propagation of grasses from slip and rhizome cuttings

All of the soil conservation grasses can be propagated by this method. It is by far the most widely used method of propagation in soil conservation.

Take a clump of the grass, cut the shoots off about 100 to 150 mm above the ground and then split the whole clump carefully into sections. Each section should include several old shoots, any new buds that are visible and as much root as possible. You need to balance getting the maximum number of transplants from one clump while making sure each is a viable plant.

When you are planting the slips, bury the root parts carefully into loose, moist soil, trying to keep them as straight as possible and about 20 mm below the surface. If they are more shallow they may dry out. The tops can be either at an angle or vertical. After planting, lay a sheet of hessian over the tops of the cuttings to give shade. Keep it there until the new shoots are about 50 mm long and then remove it in stages, starting by removing the hessian for a few hours a day.

**Rhizome cuttings.** Some grasses have a rhizome system (*e.g.* *Andropogon macrophyllus*, *Imperata cylindrical*, *Pennisetum purpureum*). The method involves making a slip, which includes part of the rhizome.

Take a clump of the grass and cut off the shoots above the first or second node above the ground. Separate the clump, taking care not to damage the rhizomes and fine roots. Keep at least 50 mm of the rhizome, or horizontal part, per cutting. Each cutting should have some buds at the nodes on the rhizome, but often these are difficult to see. The new growth will come from these buds. When you plant the slip, keep the level of the soil as it was originally, making sure the rhizome is well covered. The method of planting and covering is similar to that of other slip cuttings.

<sup>2</sup> A stolon is a stem that grows along the ground, producing at its nodes new plants with roots and upright stems.

### (e) Propagation of grasses from culm or stem cuttings

This is most suitable for grasses that have heavy branching. Usually, a piece of stem with at least two or three nodes is used, but the most vigorous species, such as *Pennisetum purpureum*, can be propagated from single-node cuttings if material is scarce.

Select material that is between one and two years old. Cut the stem horizontally about 30 mm above the higher node and at 45° about 30 mm below the lower node. The different cuts help you to tell at a glance which way up the cutting should be planted.

Insert the cutting into loosened, moist soil, so that it is two-thirds buried. Cuttings can be inserted at an angle of about 45° but vertical insertion is also acceptable. Many plants survive equally well if cuttings are planted horizontally. Often the upper node gives shoots and the lower node gives roots, but a large, strong shoot may also emerge from the lower node.

After planting, lay a sheet of hessian over the tops of the cuttings to give shade. Keep it in place until the new shoots are about 50 mm long, and then remove it in stages, starting by removing the hessian for a few hours a day.

**Stolon cuttings.** If the grass produces a stolon, it is usually possible to make cuttings from the individual nodes. This is particularly easy with *Cynodon dactylon*.

Often, roots grow naturally from the nodes on the stolon. This is called “layering”. If this happens you only have to cut the stolon mid-way between the nodes and carefully transplant it with its roots and shoots intact. It is already a new plant. If roots have not yet appeared, you can cut off a node and plant it not more than 10 mm below the surface. Keep any leaves attached to it and plant the cutting with them above the ground. Avoid damaging any shoots or buds that exist. The node will shoot and root very quickly.

### (f) Collecting and treating grass seeds

In soil conservation it is normal to collect and use the whole seed head of grasses. The procedure is as follows.

- Collect seed heads when they are ripe. Bring them back to the nursery in baskets or hessian sacks. If you use polythene bags, empty them out as soon as possible so that they do not go mouldy.
- Spread the seed heads out to dry in sheltered, sunny places, on a clean concrete or hard earth floor.
- Separate them from stems and other unwanted parts in the ways normally used for grains. Since the seeds of soil conservation grasses are mostly very fine, take great care when winnowing.
- Store them in hessian or polythene bags in a dry, well ventilated place. If you use polythene bags, make sure that the heads are completely dry or they will go mouldy.
- Most grass seeds will remain viable<sup>3</sup> for several years, but you should use them within one year if possible.

### (g) Propagation of grasses from seeds

Sow the whole remains of the seed heads on the surface of a recently cultivated bed. Dense sowing is usually the best method (i.e. 25 g of seed per 1 sq. m of bed), so that several thousand seeds germinate per square metre.

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<sup>3</sup> Viability is the length of time that the majority of seeds remain able to germinate. After a certain period of storage, seeds will not germinate once sown. This varies for each species.

Very young grass seedlings can be scorched by the sun and killed if they do not have enough shade. Avoid this problem by placing a sheet of dampened hessian jute over newly sown seeds. Keep the jute damp as much as possible, because very intense sun can dry out the surface even underneath it. Remove the hessian in stages once the seedling stems are about 10 mm long. First remove it for a few hours during the early morning and late afternoon, then for longer, and finally completely. Thin the seedlings heavily from time to time.

#### **(h) Management of grasses in the nursery**

Keep grass beds well watered and weeded. Replant any gaps where plants have failed as soon as possible. Grass seedlings will need to be thinned heavily every week or so, to allow clumps to develop. Eventually you should aim to have 100 plants per square metre.

When grasses grown from slips have grown up and completely filled the beds, there are two options. The usual one is to cut the shoots off about 150 mm above the soil, to encourage the development of new shoots. However, if the planting season is a long time off, you can lift the grasses out, split them up and replant them. One bed of large plants ready for splitting usually fills three to seven beds after transplantation.

#### **(i) Preparing and packing grass slips for transport**

Lift grass clumps carefully, keeping the root ball intact so that the roots are not damaged. Wrap the root ball in wet hessian. Split them out on site. Trim the roots and stems to length, as for nursery planting. Wrap bundles of slips in wet hessian until they are needed for planting by the site labourers. Do not let them get exposed to direct sun because this will dry out the grass slips rapidly. At every stage, encourage labourers to treat the grasses as if they are slips of rice which are being transplanted.



## 5.2 Species of Grasses for Soil Conservation in Liberia

| Species                         | Status  | Mean of planting                           | Other uses   |
|---------------------------------|---|--|--|
| <i>Anadelphia leptocoma</i>     | Common, caespitose  | Seeds, rooted stem cuttings or grass slips | Thatching  |
| <i>Andropogon gayanus</i>       | Common, caespitose, strong                                | Seeds, rooted stem cuttings or grass slips | Fixation of river banks<br>Good forage value<br>Thatching, weaving (fence, mat)<br>Pharm.: Remedy against lithiasis  |
| <i>Andropogon macrophyllus</i>  | Common, caespitose, strong, rhizomatous                   | Seeds, rooted stem cuttings or grass slips | Excellent forage value<br>Thatching, weaving (fence, mat)  |
| <i>Axonopus compressus</i>      | Common, stoloniferous                                     | Rooted stem cuttings or grass slips        | Forage value<br>Lawn grass<br>Pharm.: Plant decoction used against the Guinean worm  |
| <i>Ctenium newtonii</i>         | Uncommon, caespitose                                      | Rooted stem cuttings or grass slips        | Thatching  |
| <i>Cynodon dactylon</i>         | Rhizomatous, stoloniferous                                | Rooted stem cuttings or grass slips        | Good forage value<br>Lawn grass<br>Pharm.: Emollient and diuretic properties, remedy against venereal diseases, and the fatigue<br>Weed difficult to control                               |
| <i>Eragrostis atrovirens</i>    | Common, caespitose, helophyte                             | Rooted stem cuttings or grass slips        | Good forage value<br>Thatching   |
| <i>Hyparrhenia diplandra</i>    | Common, caespitose, strong                                | Seeds, rooted stem cuttings or grass slips | Good forage value<br>Thatching   |
| <i>Hyparrhenia rufa</i>         | Uncommon, sensitive to fire                               | Seeds, rooted stem cuttings or grass slips | Good forage value<br>Thatching<br>Weaving (fence, mat)   |
| <i>Imperata cylindrica</i>      | Unommon, geophyte, rhizomatous                            | Rooted stem cuttings or grass slips        | Thatching<br>Weaving (fence, basket)<br>Inflorescences used for mattress<br>Pharm.: Astringent, diuretic, febrifuge, galactagogue, antirheumatic properties                                |
| <i>Loudetia phragmitoides</i>   | Uncommon, caespitose, strong, rhizomatous/helophyte       | Rooted stem cuttings or grass slips        | Indicator plant of ground favourable to the breeding<br>Culms used to make arrows  |
| <i>Melinis minutiflora</i>      | Abundant, sensitive to fire                               | Seeds, rooted stem cuttings or grass slips | Good forage value<br>Good cover plant<br>Used to repel mosquitoes and tsetse flies   |
| <i>Paspalum scrobiculatum</i>   | Common, caespitose, helophyte                             | Seeds, rooted stem cuttings or grass slips | Good forage value<br>Seeds used in period of scarcity, cereal of complement<br>Pharm.: see <i>P. conjugatum</i>  |
| <i>Pennisetum polystachion</i>  | Common, caespitose, strong, sensitive to fire and drought | Seeds, rooted stem cuttings or grass slips | Good forage value (young)<br>Pharm.: Cooked seeds used to treat intercostal pains and luxations<br>Plant juice used as an antiseptic   |
| <i>Pennisetum purpureum</i>     | Common, caespitose, strong, rhizomatous                   | Seeds, rooted stem cuttings or grass slips | Excellent forage value<br>Thatching, building of huts and fences<br>Pharm.: remedy for treatment of cataracts, wounds, fractures, inflammation of the gums, ulcers, stomach pains, oedemas |
| <i>Rhynchne rottboellioides</i> | Frequent, caespitose                                      | Rooted stem cuttings or grass slips        | Average forage value<br>Weaving (hats)   |
| <i>Schizachyrium rupestre</i>   | Frequent, caespitose                                      | Rooted stem cuttings or grass slips        | Average forage value   |
| <i>Sporobolus dinklagei</i>     | Common, caespitose, rhizomatous                           | Rooted stem cuttings or grass slips        | Average forage value   |
| <i>Sporobolus pyramidalis</i>   | Common, caespitose  | Rooted stem cuttings or grass slips        | Weaving (hats)<br>Cereal of complement<br>Pharm.: roots used to treat stitch   |

## 5.3 Planting Grasses for Soil Conservation

Revegetation techniques should normally be used to cover bare soil slopes, to begin the process of restoring the natural habitat, to control soil erosion or to stabilise or prevent shallow landslips (i.e. where the depth to the sliding surface is shallow, up to 0.5 m).

Among the various techniques, the planting of grasses on bare slopes gives a quick cover and complete protection against erosion.

Grass slips are small sections of a grass plant, made by splitting up a large clump. The stems are cut down to a height of 100 to 200 mm and the roots cut back to 40 to 80 mm. There should be 2 or 3 stems per slip.

Grass slips (rooted cuttings), rooted stem cuttings or clumps grown from seed are planted in lines on the slope. This form of revegetation uses large clump grasses.



Grasses planted in contour or horizontal lines protect the slope with their roots and, by providing a surface cover, reduce the speed of runoff and catch debris, thereby armouring it.

Grasses planted in diagonal lines protect the slope with their roots and by providing a surface cover, while at the same time helping to drain surface water. They have limited functions of catching debris and draining surface water. The main engineering functions are to armour and reinforce the soil surface, with secondary functions to catch debris and drain moisture. This technique offers the best compromise of the grass line planting systems in many situations.

### Sites

Almost any slope less than 50°.

Contour or horizontal lines are used on all slopes less than 35°. Also on steep (35° to 50°) dry sites, where moisture needs to be conserved. They are most widely used on well-drained materials where increased infiltration is unlikely to cause problems. On cultivated slopes, horizontal lines of grass planted at intervals across a field can be used to avoid loss of soil and to help conserve moisture, as a standard soil conservation measure.

Diagonal lines are used on poorly drained materials on steep slopes (35° to 50°) where an increase in infiltration can lead to liquefaction of the soil. It is also useful on damp sites, where moisture needs to be shed.

### Timing

Planting work should only be done in the wet season. The slope should be moist when the planting is done. If it does not rain within 24 hours of the work being done, water the plants every day until it does rain. On small sites this may be done by hand but on large sites it will require a water truck and spray cannon.

## Spacing of plants

Line spacing depends largely on the steepness of the slope.

Within rows: plants at 100-mm centres.

Row spacings: rows at 500-mm centres for diagonal lines;  
for contour lines: slope < 30°: 1000 mm;  
slope 30-45°: 500 mm;  
slope > 45°: 300 mm.

## Materials

Grass slips are small sections of a grass plant, made by splitting up a large clump. The stems are cut down to a height of 100 to 200 mm and the roots cut back to 40 to 80 mm. There should be 2 or 3 stems per slip. The clumps must be obtained locally (i.e. from similar terrain within 15 km of the planting site) where their loss will not cause soil erosion to start. The source location should have similar environmental characteristics (altitude and soil particularly) to the destination site. The material must be between 6 and 18 months old. Grass clumps must be dug up and brought to site on the same day that the slips are made and planted, and kept cool and moist.

## Construction

Prepare the site well in advance of planting. Slopes should be trimmed to an even grade that meets the engineering standard. Trimming should achieve a slope that meets the appropriate design for the material. If there is no design, it should be cut or finished with a straight profile, without undulations that give over-steep portions that are steeper than the grade appropriate for the material.

After slope trimming, remove all debris and either remove or fill in surface irregularities so that there is nowhere for erosion to start. If the site is on backfill material, it should be thoroughly compacted, preferably when moist.

Always start grass planting at the top of the slope and work downwards.

Mark out the lines with string, using a tape measure and spirit level. Make sure the lines run exactly as required by the specification.

Split the grass plants out to give the maximum planting material. Trim off long roots and cut the shoots off at about 100-mm above ground level. Wrap the plants in damp hessian to keep them moist until they are planted.

With a planting bar (typically a 500-mm section of re-bar with a flattened end), make a hole just big enough for the roots. Place the grass into the hole, taking care not to tangle the roots or have them curved back to the surface. Fill the soil in around them, firming it gently with your fingers. Take care to avoid leaving an air pocket by the roots.

If it looks dry and there is no prospect of rain for a day or two, consider watering the plants by hand.

Grass slips are planted in lines across the slope. The best results usually come from lines that are at 45° to the maximum slope. Start from the top and work downwards.

Mark out the lines on the slope and then plant the grass slips to the original depth and gently firm the soil back around them.



## 5.4 Examples of Revegetation using Grasses in Liberia

Grass planted to stop erosion of the road cutting on the approach to Tokadeh Mine.



Grass trial at Mount Gangra, July 2009





Railside slope being planted, 12 km from Buchanan, July 2009



Railside slope being planted, 12 km from Buchanan, July 2009





Dense lines of planted grass slips starting to shoot a few weeks after planting



Tokadeh drill pad rehabilitated, October 2010, 4 months after planting





Tokadeh Mine, Area F, April 2013, eight months after planting



Northern sediment pond, Tokadeh Mine, January 2014, six months after planting



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## EPILOGUE

Pierre Poilecot, who identified and illustrated the grasses of Nimba, Bong and Grand Bassa, was a man of enormous enthusiasm, energy and talent. Everyone who worked with him also loved him as a person. We miss him, but his work and wisdom live on in these pages, the first guidebook on grasses in Liberia. We – his colleagues in CIRAD and ArcelorMittal – are proud to have worked with him and to have the honour to publish his work posthumously.

