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What is left of rattan in Burundi?

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ABSTRACT: Non-timber forest products are sources of income for rural populations. This is the case in Burundi for bamboo and until a few years ago for rattan. The latter is threatened by clearing of its habitats for agricultural purposes. This study presents an overview of rattan in Burundi. A mapping of the sites still hosting rattan and hosted it some six to thirty years ago was carried out and the areas covered were measured. In total, rattan covered, in 2015, an area of 1.04 ha on various sites in southern Burundi and mainly in the Kigwena Forest Natural Reserve. The analysis of the anatomical features of rattan stems from this forest confirmed that the species present in Burundi is *Eremospatha haullevilleana* De Wild.

Keywords: *Eremospatha haullevilleana*, habitats, area, anatomical features.

INTRODUCTION

With an estimated population in 2016 of 11,215,000 inhabitants on an area of 27,834 km² (ISTEEBU, 2017), Burundi is one of the most densely populated countries. It is experiencing a severe degradation of its natural resources mainly due to demographic pressure. The sharp increase in population is accompanied by an increase in the need for natural resources for the livelihood of this population. Land use for agricultural purposes even affects very steep slopes that would otherwise be reserved for forests or plantations. The disruption of the protected area monitoring system due to the successive socio-political crises (from 1993 to 2005) has also opened the door to illegal harvesting and over-exploitation of natural resources.

The fragmentation or the complete disappearance of the habitats of certain plant resources puts them in serious danger of extinction. This is the case of rattan. However, it was a source of income for a large rural population who collected canes for sale (Nzigidahera, 2000). This is also the case in neighboring countries hosting this species as the Democratic Republic of Congo (Kahindo *et al*., 2011).

The situation of rattan in Burundi is all the more worrying because current knowledge indicates that it is represented only by a genus *Eremospatha* represented by a single species *Eremospatha haullevilleana*. The purpose of this article is to draw up an inventory of rattan ecology in Burundi, what remains of this non-wood forest product and to authenticate the botanical classification of the present species by an analysis of its anatomical features. Suggestions to safeguard this plant have been proposed.

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MATERIAL AND METHODS

Location of rattan habitats in Burundi

Based on previous work on natural resources in Burundi (Nzigidahera, 2000; Nzigidahera and Habonimana, 2016), information from the guards of the Kigwena Natural Reserve and the communal agronomists from different provinces in the south and north-west of Burundi, a study was carried out in 2015 with the aim of inventorying and locating the sites that have hosted rattan or where it can still be found. The geographic coordinates of these sites have been taken with a GPS and a distribution map developed using the QGIS Version 2.18 Software. Leaf samples were collected for botanical identification of the species. At each site where rattan still exists, the area covered was measured with a measuring tape but in some places where only a few stems remained, the latter were counted.

Analysis of the anatomical features

The anatomical identification of living rattan in Burundi has just been carried out from samples of stems harvested in the Kigwena peri-guinean forest in southern Burundi. Four randomly stem sections of *Eremospatha haullevilleana* were selected. The stem was brown reddish and without shine, the diameter between 0.7 - 1.2 mm.

The methods used for the preparation were proven with the Asian species (Weiner & Liese, 1988). For preparation, approx. 1 cm long stem sections were placed in glycerine. The samples were boiled in distilled water embedded in polyethylene glycol (PEG) 2000 M W. Transverse and longitudinal sections were double-stained with acridin/chrysoidin red and astra-blue. The detection of lipid-containing substances such as waxes and cutin was performed by staining with Sudan III and Sudan.

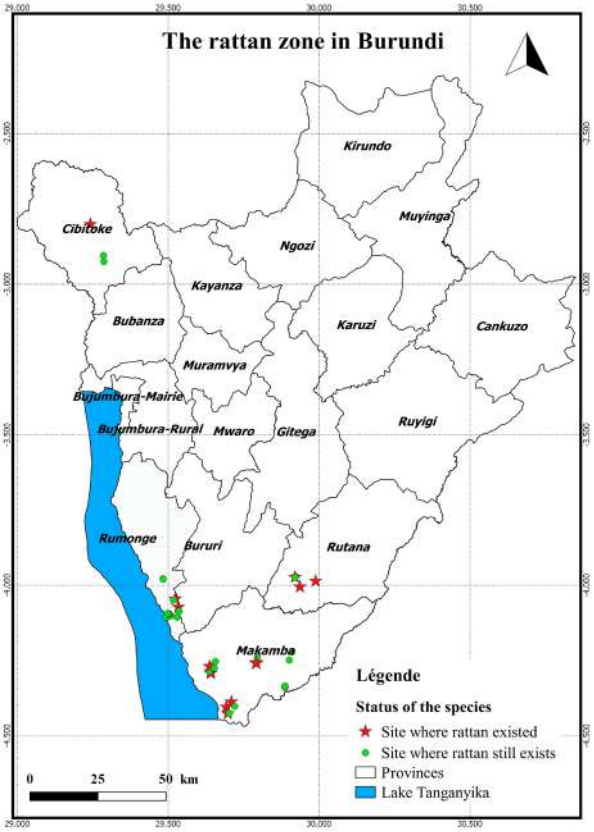


Figure 1: The rattan zone in Burundi (2015)

RESULTS AND DISCUSSION

Rattan habitats in Burundi

Rattan in Burundi is growing at low to medium altitude. The inventoried sites have altitudes between 777 - 1500m. They are mainly in the south of the country: Kigwena Forest Natural Reserve, forest galleries, bordering marshy areas in flooded valleys or along rivers where there are supporting trees and in the Natural Reserve Forest of Vyanda. The Cibitoke province in northwestern Burundi still contains some remnants (Fig. 1).

Area covered by rattan in 2015

A total of 85 sites have been identified of which 71 are still home to rattan. On 14 other sites, the farmers reported reallocation of land at periods ranging from 6 to 38 years depending on the locality where rattan still exists, areas vary from 2m² to 3200m². The sites where only a few stems were found here and there in the crop fields were not included in the calculation of the total area. The latter covers 1.04 ha (Table 1).

Table 1: Sites and areas covered by rattan in 2015

Provinces	Commune	Site	Area (m²)	Area (ha)
Makamba	Nyanza-Lac	Kabonga	35	0.0035
Makamba	Nyanza-Lac	Kabo	600	0.06
Makamba	Nyanza-Lac	Zingure	1200	0.12
Makamba	Mabanda	Mivo-Kibimba	4	0.0004
Makamba	Mabanda	Kibimba-Mabanda	3	0.0003
Makamba	Kibago	Nyarutuntu-Nyabigina	6	0.0006
Rumonge	Rumonge	Cabara-Rwamvura	500	0.05
Rumonge	Rumonge	Gashasha	2	0.0002
Rumonge	Rumonge	Gatanganika	6	0.0006
Rumonge	Rumonge	Kigwena Forest-Kamango	1800	0.18
Rumonge	Rumonge	Kigwena Forest-Mibango	3200	0.32
Rumonge	Rumonge	Kigwena Forest- Gitamba 1	3000	0.30
Rumonge	Rumonge	Rukengwe	13	0.0013
Rutana	Gitanga	Gashawe-Mugongo	12	0.0012
Rutana	Gitanga	Gatwaro	9	0.0009
Cibitoke	Bukinanyana	Murengera	10	0.0010
Total			**10413**	**1.04**

When analyzing the availability of the rattan by province (Fig. 2), Rumonge has 0.85 ha of rattan (82 %), of which 0.80 ha is located in the Kigwena forest. In Makamba, rattan occupies about 0.2 ha spread over the Nyanza-Lac, Mabanda and Kibago communes, mainly in the forest galleries. In the provinces of Rutana and Cibitoke, there are some remnants, respectively in Gitanga Commune and Bukinanyana. There are also some stems in Bururi province in the Vyanda Forest Natural Reserve.

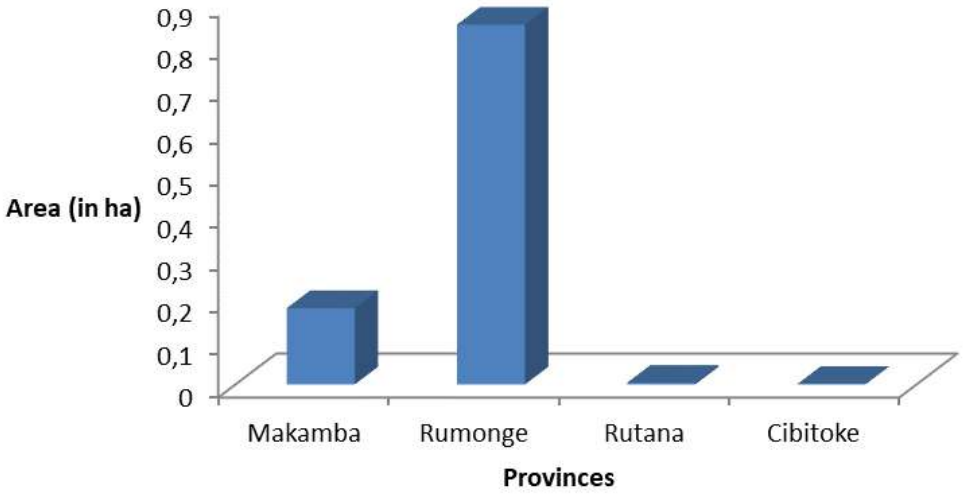


Figure 2: Provinces hosting rattan in Burundi (2015)

Despite a disturbing destruction of this resource (Nzigidahera and Habonimana, 2016), it is interesting to note that in the Kigwena forest, rattan is in full expansion and that the flowering and fruiting stages that had become rare until recently in 2017 could be observed again (Fig. 3). It is in the open and semi-open environments of this forest that the plant is more abundant. This was also reported for this species in the Yoko Forest Reserve in the Democratic Republic of Congo (Shalufa *et al.,* 2015).

Figure 3: *Eremospatha haullevilleana* fruits in the Kigwena forest

Anatomical features

The stem anatomy of the rattan *Eremospatha haullevilleana* corresponds to the general structure of the monocotyledons, represented by collateral vascular bundles embedded in ground parenchyma (Weiner, 1992). The stem cross-section (fig. 4) showed a division into three zones: Epidermis, cortex and central cylinder.

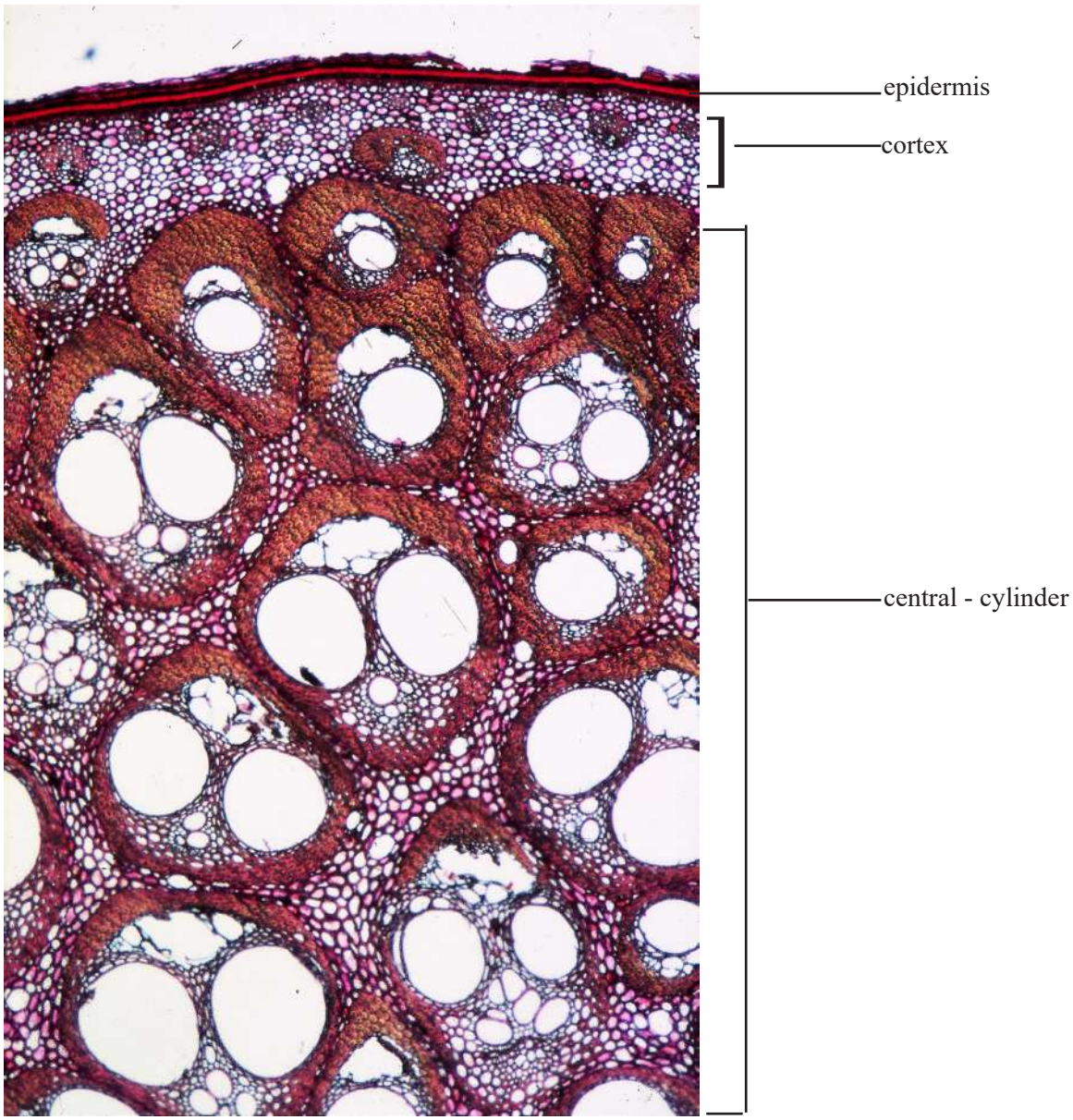


Figure 4: Transverse section of *Eremospatha haullevilleana* stem with epidermis, cortex and central cylinder

The epidermis consisted of a single uniform, unlignified cell layer. The shape and lumen of the epidermal cells were quadarartic. The outer epidermal cell wall has a wax layer. The stomata complexes were tetracytic. The cortex, i.e. area between epidermis and first vascular bundles of the central cylinder consisted of parenchyma cells and incomplete vascular bundles or 'leaf traces' (Tomlinson & Zimmermann, 1967). *Ereomospatha haullevileana* showed two – three fibre rows below the epidermis which is typical for this endemic African genera. In the second and third sections up-to 16 parenchyma rows with incomplete vascular bundles and clusters of fibres were observed (fig. 5).

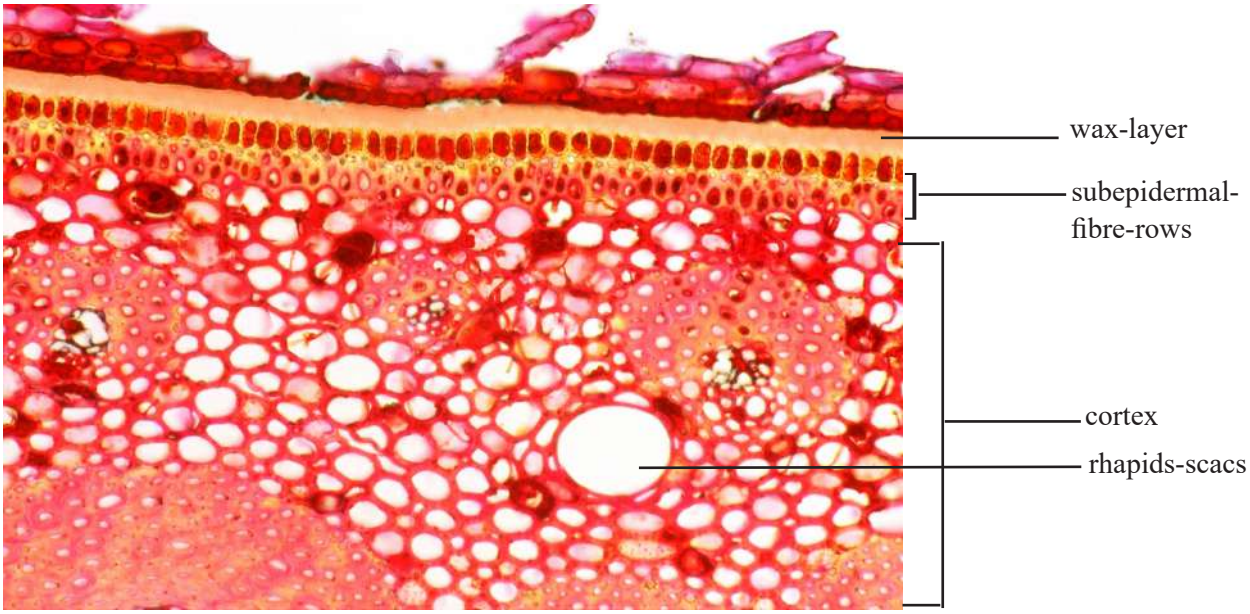


Figure 5: Epidermis and Cortex; Wax layer and subepidermal fibre rows and 'rhapids sacs'

The central cylinder started with a closed vascular bundle ring. The further distribution of the vascular bundles over the stem cross section was dense to loose and scattered. The vascular bundles were characterized by one phloem field and two metaxylem vessels. The phloem field was adversal/ opposite to the metaxylem vessel. The phloem consisted of sieve tubes with companion cells. Simple or transitional sieve plates mixed with very oblique compound ones were seen (Parthassarathy (1968). The five to ten screen tubes with conductive cells were arranged in several rows in the field. The sieve tubes were among the largest with a tangential diameter of 55-68 µm (Weiner 1992). The two metaxylem vessels had a tangential diameter of 245-372µ mm. The vessels perforations were simple. The cell walls exhibited oval, half-bordered pits in an opposite arrangement (fig. 6).

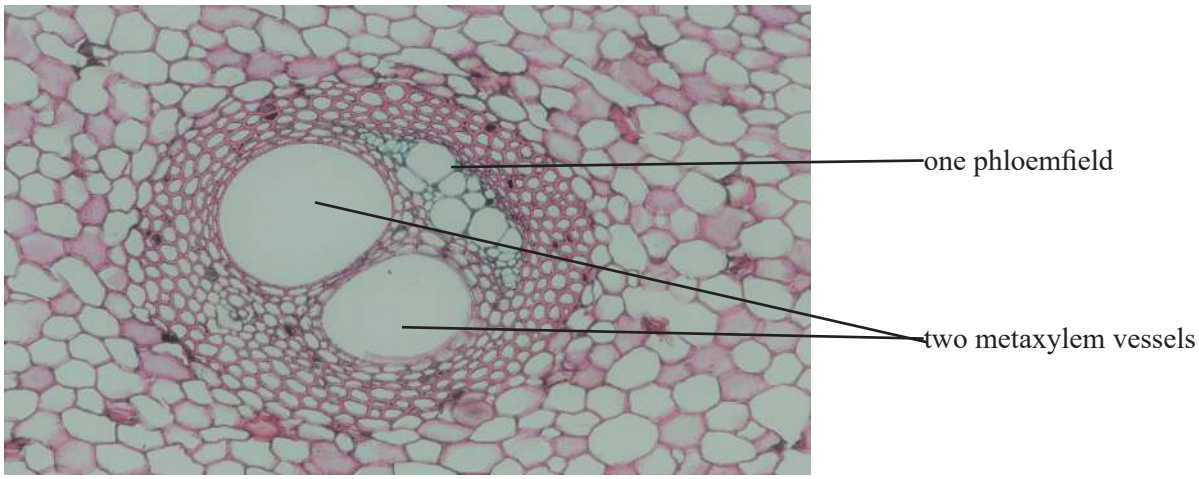
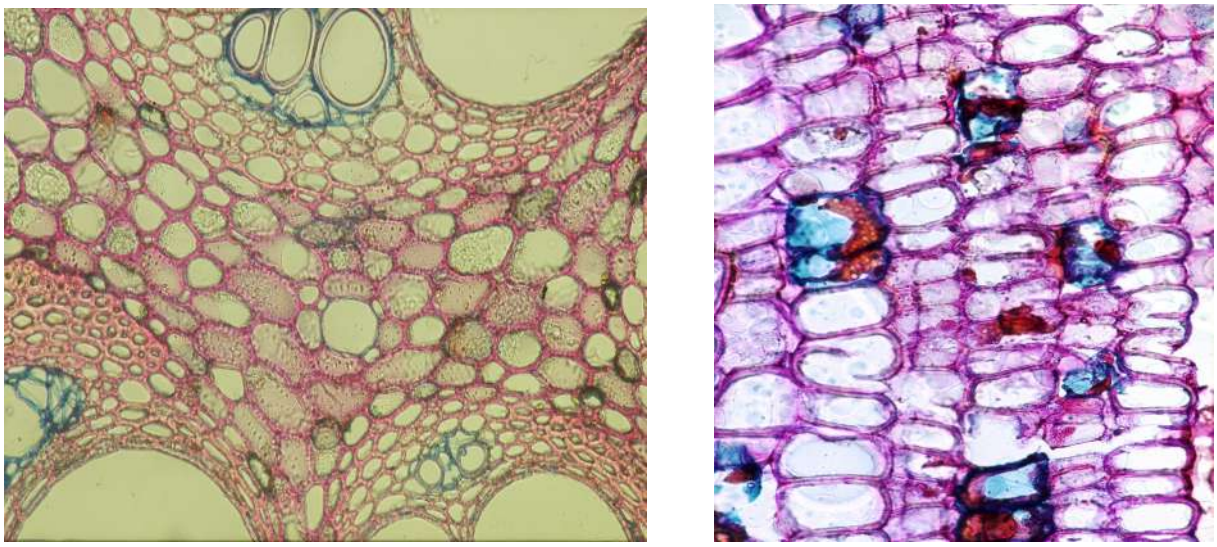


Figure 6: Vascular bundle with one phloem-field and two metaxylem-vessel

The protoxylem tracheids had annular or helical secondary wall structures. The diameter of the protoxylem tracheids was 30-80µm, i.e. much smaller than that of the metaxylem vessels. The phloem and xylem were surrounded by fibre and parenchyma sheaths. Fibre sheaths were located above the phloem field and consisted of three to five fibre rows. The fibres were thin-walled in two samples of *Eremospatha haullevilleana*, but thick-walled in the other samples. The thickness of the fibre walls was an indicator for origin of the sample within the stem. Thin-walled fibre existed in the top of the stem, thick-walled in the bottom.

Ground tissue – consisted of isodiametric parenchyma cells with simple pits which surround the vascular bundles. The investigated species showed smaller, rounded cells with irregular shaped spaces. These were similar to the ground parenchyma Type B according to Weiner & Liese (1988) and Weiner (1992). In the longitudinal section (fig. 7) the ground parenchyma cells appeared like 'stacks of coins'. These were identical to the basic parenchyma Type B. as designated according to Weiner & Liese (1988). However, the cells were slightly more elongated than in the Asian genera.



Type B (cross section) Type AB (longitudinal section)

Figure 7: Ground parenchyma by *Eremospatha haullevilleana*

'Rhapide sacs' the raphide bundles were present in thin-walled, unlignified mucilage-filled cells which were also called sacs Tomlinson (1961). In monocotyledons such sacs are typical. They were solitary in both the cortex and central cylinder, their tangential diameter was 32 to 63 µm. Further 'silica bodies' or 'stegmata' were present in *Eremospatha haullevilleana* Tomlinson (1968).

Suggestions for safeguarding rattan in Burundi

Even though *Eremospatha haullevilleana* is classified as non-threatened species on the IUCN Red List (Cosiaux *et al*., 2017), given the decline in the area occupied by rattan, this is not the case in Burundi. The domestication of *Eremospatha haullevilleana* could be a solution to restore it. For this purpose, we conducted experiments around the Kigwena Forest Natural Reserve and Nyanza-Lac in 2016 under oil palms. Vegetative propagation from suckers has shown that it is possible to grow *Eremospatha hullevilleana*. A survival rate of 91% and an average height growth of 3cm have been observed after 98 days. However, despite these interesting results on the growing and multiplication of rattan, the risk of non-adoption by the Burundian farmers due to the scarcity of the arable lands is a limitation.

A salutary measure is to strengthen the protection of the Kigwena Forest Natural Reserve, the main habitat of *Eremospatha haullevilleana*. This species could also be restored to the Vyanda Forest Natural Reserve and protection could be enhanced. Exploitation has to be regulated that rapidly leads to the degradation of this resource, as was the case in Côte d'Ivoire for *Eremospatha macrocarpa* and *Laccosperma secundiflorum* (Kouakou *et al*., 2015).

CONCLUSION

The four randomly examined *Eremospatha haullevilleana* stem samples were taxonomically similar to Weiner & Liese 1993, 1994) herbarium studies on west African Rattan palms: stem anatomy of samples were shown identical structure of *Eremospatha* with one phloem field, two metaxylem vessels, plus ground parenchyma type B and the subepidermal fibre rows as well as the wax layer on the epidermis. According to Dransfield (oral communication, 1990), the African rattan palms are less specialized but referring to the history of development elder plants.

Regarding its habitat in Burundi, results showed that in 2015, *Eremospatha haullevillean* was still relatively abundant in the south in Rumonge province, mainly in the Kigwena Forest Natural Reserve, a peri-Guinean forest. It was also found in Makamba, Rutana, Cibitoke and Vyanda provinces where it was represented by a few stems. The total area spanned 1.04 ha. Given this situation, the restoration of the species is urgent. Strengthening the protection measures of the Kigwena Forest Natural Reserve seems to be the most promising solution.

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