ECOLOGY, UTILISATION AND CONSERVATION OF *SMILAX KRAUSSIANA* IN BWINDI IMPENETRABLE FOREST NATIONAL PARK, UGANDA

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OBUA, J., OGWAL, S. F. M. & MOSANGO, D. 2000. Ecology, utilisation and conservation of *Smilax kraussiana* in Bwindi Impenetrable Forest National Park, Uganda. *Smilax kraussiana*, a tropical forest plant with considerable economic value, is a non-timber forest product harvested by local communities living around Bwindi Impenetrable Forest National Park (BINP) and used for making baskets, trays and stretchers. In order for the managers of BINP to effectively plan, manage and control the exploitation of *S. kraussiana*, there is a need to know where the plant occurs and how much is available in the forest. This article presents the results of a study carried out on the distribution, abundance and utilisation of *S. kraussiana* in BINP. Both in-forest and household surveys were used to collect the data. It was found that forest type, canopy cover and altitude influenced the distribution and abundance of smilax in BINP. The amount of smilax decreased with increase in altitude and there were more stems in the more closed canopies. The current quantity of off-take, consisting of two head loads per household, would be unsustainable in future. Therefore, there is a need to regulate the harvesting of *S. kraussiana* in BINP in order to sustain the supply and the resource base. Furthermore, the present traditional harvesting techniques need to be maintained because it favours re-sprouting and natural regeneration of the plant.

Key words: Bwindi Impenetrable Forest National Park - *Smilax kraussiana* - distribution - abundance - ecology - conservation

OBUA, J., OGWAL, S. F. M. & MOSANGO, D. 2000. Ekologi, penggunaan dan pemuliharaan *Smilax kraussiana* di Hutan Taman Negara Tidak Ditembusi Bwindi, Uganda. *Smilax kraussiana,* sejenis tumbuh-tumbuhan hutan tropika yang mempunyai nilai ekonomi yang tinggi merupakan hasil hutan bukan-kayu yang diusahasilkan oleh penduduk tempatan yang tinggal di sekitar Hutan Taman Negara Tidak Ditembusi Bwindi (HTNB) dan digunakan untuk membuat bakul, dulang dan usungan. Bagi membolehkan pengurus di HTNB merancang, mengurus dan mengawal dengan berkesan penggunaan *S. kraussiana,* perlulah diketahui tempat pokok tersebut tumbuh dan berapa banyak pokok yang terdapat di dalam hutan. Artikel ini memberikan keputusan kajian yang dijalankan mengenai taburan, keberlebihan dan penggunaan *S. kraussiana* di HTNB. Kedua-dua kajian di dalam hutan dan kajian isi rumah digunakan untuk mengumpulkan data. Didapati bahawa jenis hutan, penutup sudur dan altitud mempengaruhi taburan dan keberlebihan smilax di HTNB. Jumlah smilax berkurangan dengan bertambahnya altitud dan terdapat lebih banyak lagi batang dalam sudur yang lebih tertutup. Kuantiti *off-take* terkini, mengandungi dua beban bagi satu isi rumah, mungkin tidak dapat dikekalkan pada masa hadapan. Oleh itu, pengusahasilan tradisi yang diamalkan sekarang perlulah dikekalkan kerana ia menggalakkan pokok bertunas semula serta mengalami pemulihan secara semula jadi.

Introduction

Tropical forests have for long been managed for timber production. At the same time the populations of developing countries have depended on the use of minor forest products for their livelihood. Ethnobotanical studies carried out in Africa and elsewhere in the world indicate that minor forest products significantly contribute to the economic well-being of local communities living close to natural forest (Hedberg & Hedberg 1968). For over a decade, the socio-economic importance and conservation of minor forest products have been the principal focus of natural forest management. Until recently, little had been done to highlight the values and conservation implications of harvesting minor forest products. As populations around protected natural forests increase and continue to rely on forest products for their livelihood, the minor forest products are likely to diminish. This will call for management interventions involving, for example, the identification and development of appropriate forest conservation strategies based on a clear understanding of the ecology, utilisation and conservation of the resource.

In the tropics, natural forests are a major source of forest products such as timber, poles, firewood, medicines and craft materials. In Uganda, the area of tropical forests has decreased in the past few years due to encroachment, illegal harvesting of timber and uncontrolled exploitation of forest products. However, one of the major conservation initiatives already undertaken by the government, in order to protect the natural forests, has been the conversion of some of the forest reserves into national parks. Bwindi Impenetrable Forest was one of the forest reserves designated as a national park in 1991 (Wild & Mutebi 1996). Since then, local communities' access to and utilisation of forest resources from the park have been limited.

Total exclusion of local people from Bwindi would, however, undermine the on-going conservation initiatives in Bwindi. It is widely accepted that the success of any conservation programme largely depends upon whether or not local communities are involved, have access to and are allowed to extract forest products from protected areas. Since 1988, the Development Through Conservation (DTC) project undertaken by CARE International (an American NGO) in collaboration with government institutions, local communities, other NGOs and donors has been attempting to reconcile local needs with conservation in Bwindi Impenetrable Forest National Park (BINP). A multiple-use programme has been established and multiple-use zones demarcated to allow limited use of resources from the forest. According to Bensted-Smith *et al.* (1995), the programme is an integral part of the park's community conservation and development initiative aimed at sustainable management of forest resources. Under the programme, communities living in Rutugunda, Nteko and Mpungu parishes are permitted to harvest minor forest products and *Smilax kraussiana* is one of them.

This article presents the results of a study carried out to assess the distribution, abundance and community utilisation of *S. kraussiana* in BINP. The aim was to provide information that would help to regulate the quantity of *S. kraussiana* off-take in BINP and assist in developing appropriate forest management strategies that take into account local community utilisation of forest resources. The distribution and abundance of *S. kraussiana* in BINP are not clearly known and it was hypothesised that they varied in all the forest types/habitats.

Materials and methods

Study species

Smilax kraussiana Meissn. (Smilacaceae) is a dioecious or glabrous shrub with roots arising from a compact rhizome. It has a slender woody stem with small prickles or thorns. The leaves are alternate while the petioles are long with a pair of firmly curled tendrils at the base.

The inflorescence is dense, solitary and shortly peduncled (Cowley 1989). The perianth segments are linear to oblong, greenish-white, brownish or yellowish and the stamens are equal to or shorter than the perianth. The anthers are oblong and much shorter than the filaments. The ovary is ellipsoid and the stigma is papillose. The berry is purple or black with one or two seeds. *Smilax kraussiana* stems are used by the local communities living around BINP for making baskets, trays and stretchers (locally known as *engozi*). The baskets are used during the harvest period for carrying and storing agricultural crops. The trays are used for winnowing crops such as millet, sorghum, beans and peas. The stretchers are used for transporting the sick to health centres and bodies for burial.

Study area

Bwindi Impenetrable Forest National Park is an afromontane forest occupying part of the Kigezi highlands in southwestern Uganda (Figure 1). It is located between latitudes 0° 45'–1° 10' and longitudes 29° 35'–29° 50'E. It covers 32 100 ha of land located 29 km northwest of Kabale town, 18 km north of Kisoro town and 40 km southeast of Lake Edward (Kamugisha *et al.* 1997). The western boundary is part of the border between Uganda and the Democratic Republic of Congo. The topography is extremely rugged, consisting of narrow steep-sided valleys that run in various directions and are bounded by emergent hill crests lying at altitudes of 1190 m in the north and 2607 m in the south.

According to Cunningham (1996), Bwindi forest is a Pleistocene refugium containing not only plants typical of an afromontane forest but also representatives of the Guineo-Congolian flora such as the secondary forest tree *Musanga leo-erreae* (Cecropiaceae), the shrub *Agelea pentagyna* (Connaraceae), herbs such as *Ataenidia* and *Marantochloa* (Marataceae) and parasitic plants such as *Thonningia sanguinea* (Balanophoraceae). The area has a population of nearly one million, the population density is about 230 persons per km^2, and the growth rate is 2.7%. There are three ethnic groups; the Bakiga (90%) and Bafumbira (9.5%) are mainly agriculturalists, while the Batwa (0.5%), previously forest dwellers, depend in part on hunting and gathering.

Methods

Altitudinal distribution, abundance and local community utilisation of *S. kraussiana* were assessed in BINP between November 1996 and July 1997. In-forest sampling was used to assess the abundance and distribution of *S. kraussiana* in four forest habitats in BINP, namely forest gap, early secondary succession forest, late secondary succession forest and mature forest. A semi-structured questionnaire was used to solicit information on how local communities harvest and utilise the plant.

In-forest sampling

Systematic sampling (Kent & Coker 1996) was used to collect information on the occurrence, distribution and abundance of *S. kraussiana.* One hundred and twenty alternating square sample plots (400 m^2) were established along 10 transects, each 1.2 km long, oriented in a hill-top to down-slope direction in the forest. In each sample plot, the presence of smilax was noted and the number of stems (horizontal runners and vertical climbers) per clump counted and recorded. The amount of canopy cover was estimated using a spherical crown densiometer, altitude was determined using a pocket altimeter and slope was measured using a Suunto tandem compass clinometer.

Household survey

Community utilisation of *S. kraussiana* was assessed by administering a semi-structured questionnaire to 90 households living in Kashasha, Kitojo and Rutugunda parishes (Figure 1). Two villages in each parish were selected for the household interviews. The questions focussed on where local communities harvested smilax, frequency of harvesting, number of bundles/stems they removed per visit, items made from smilax and whether they would be willing to grow the plant in their gardens.

Data analysis

Chi-square tests (Fowler & Cohen 1988) were used to test the association between type of forest/habitat and the occurrence of *S. kraussiana.* Kruskall-Wallis single factor analysis (Zar 1984) was used to test variations in the number of *S. kraussiana* stems in the different forest types/habitats. Mann-Whitney test (Fowler & Cohen 1988) was used to test the difference in the number of vertical stems and horizontal runners and SPSS was used to summarise information from the household survey into percentages.

Results

Distribution and abundance of Smilax kraussiana

The presence of *S. kraussiana* was recorded in 26 plots (10 400 m^2) representing 22% of the total study area. The stem density varied in the different forest types/habitats. Table 1 shows that *S. kraussiana* was more abundant in the early secondary successional (mean = 1130±47 stems per hectare) and late secondary successional (mean = 800±36

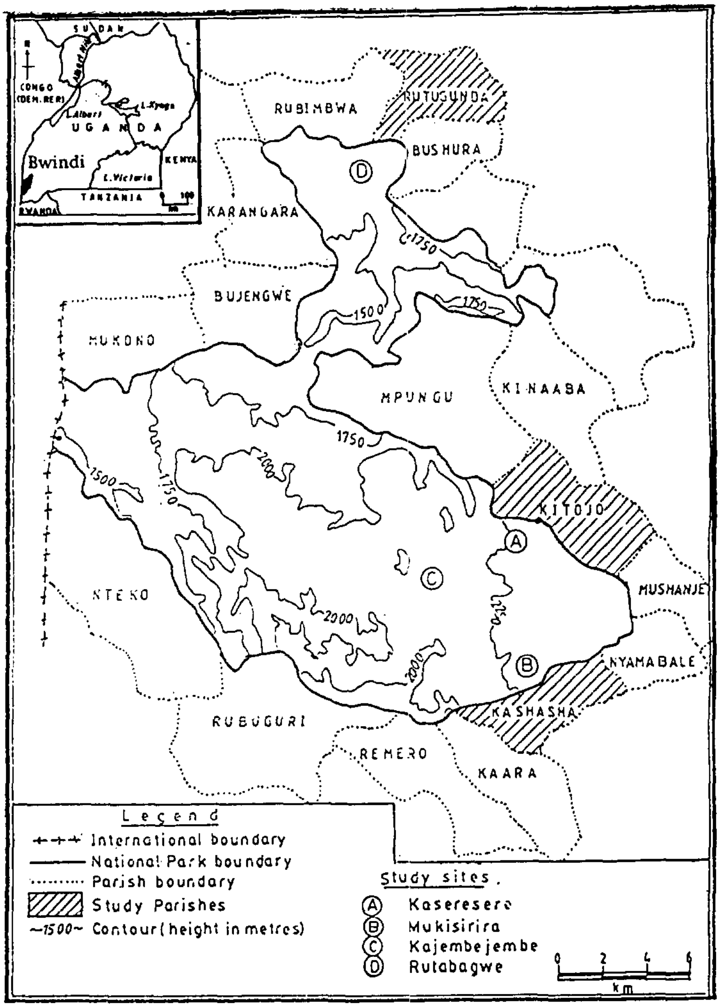

Figure 1. Map of Bwindi Impenetrable Forest National Park showing the location of study parishes

stems per hectare) forests than in the gaps (mean = 726 ± 31 stems per hectare) and mature forests (mean = 312 ± 18 stems per hectare). There was a significant association between forest type/habitat and the distribution and abundance of *S. kraussiana* in BINP (chi square test: $\chi^2 = 38.4$, $p \leq 0.05$) and no significant variation in the number of *S. kraussiana* stems in the four forest types/habitats (Kruskall-Wallis test: H=0.90, $p \geq 0.05$). Furthermore, there was no significant difference in the number of vertical stems and horizontal runners (Mann-Whitney test: U=16, $p \geq 0.05$). In all the sites, the number of vertical stems was about three times higher than the horizontal runners (Table 2).

Table 3 shows that there were many stems of smilax in the diameter classes 4.0–4.99 mm and 5.0–5.99 mm in all the forest types whilst small diameter stems were found in gaps. The distribution and abundance of *S. kraussiana* decreased with increase in altitude. No stems of *S. kraussiana* were found on the lower slopes (< 10%) and at the foot of the hills (Table 4). Of the 26 plots where *S. kraussiana* were

Table 1. Estimated densities of *Smilax kraussiana* in different forest types/habitats in BINP

Site	Habitat	Area (m²)	Canopy cover (%)	No. of stems	Stem density (No. per ha.)
Kaseresere	Gap	400	0–25	25	625
	ESSF	800	26–50	141	1763
	LSSF	400	51–75	41	1025
	MF	400	>75	19	475
Mukisirira	ESSF	400	25–50	37	925
	LSSF	400	51–75	52	1300
Kajembejembe	ESSF	400	25–50	52	1300
	LSSF	400	51–75	10	250
Rutabagwe	Gap	400	0–25	33	825
	ESSF	2400	26–50	130	542
	LSSF	2000	51–75	127	635
	MF	2000	>75	30	150

Key: ESSF = early secondary successional forest, LSSF = late secondary successional forest, MF = mature forest.

Table 2. Number of vertical stems and horizontal runners of *S. kraussiana* recorded at four sites in BINP

Site	Vertical stems	%	Horizontal runners	%	Number of clumps	Total No. of stems
Kaseresere	171	75.7	55	24.3	79	226
Mukisirira	64	71.9	25	28.1	26	89
Kajembejembe	46	74.2	16	25.8	20	62
Rutabagwe	232	72.5	88	27.5	102	320
Total	513	-	184	-	227	697
Mean	128.5	-	46	-	56.7	174.3

Table 3. Number of stems and diameter classes of *S. kraussiana* recorded in different forest types/habitats in BINP

	Site							
Diameter class (mm)	Gap		ESSF		LSSF		MF	
	No. of stems	%	No. of stems	%	No. of stems	%	No. of stems	%
1.00–1.99	9	4	-	-	-	-	-	-
2.00–2.99	29	12.8	-	-	6	9.6	5	1.6
3.00–3.99	63	27.9	5	5.6	8	12.9	45	14.4
4.00–4.99	81	35.8	15	16.9	27	43.5	70	21.9
5.00–5.99	37	16.4	16	18	16	25.8	98	30.6
6.00-6.99	7	3.1	19	21.3	3	4.8	59	18.4
7.00–7.99	-	-	18	20.2	1	1.6	28	8.8
8.00–8.99	-	-	15	16.9	1	1.6	14	4.4
9.00–9.99	-	-	1	1.1	-	-	1	0.3
>10.00	-	-	-	-	-	-	-	-
Total	226	100	89	100	62	100	320	100

Key: ESSF = early secondary successional forest, LSSF = late secondary successional forest, MF = mature forest.

Table 4. Altitudinal distribution of *S. kraussiana* in BINP

Site	Altitude range (m)	Slope range (%)	Number of stems
Mukisirira	2300–2340	20–42	62
Kajembejembe	2200–2280	20–30	89
Kaseresere	2100–2150	13–33	226
Rutabagwe	1320–1340	10–26	320

Table 5. Number of respondents harvesting *S. kraussiana* and willing to grow the plant in their gardens (N=90)

Parish	Village	Number harvesting	Number willing to grow smilax
Kashasha	Ndego	12(3)	14(3)
	Kiriba	10(5)	8(5)
Kitojo	Katoma	8(4)	1(16)
	Rwesansiro	6(12)	6(7)
Rutugunda	Kitariro	15(0)	1(14)
	Kazuru	15(0)	0(15)
Total		90	90

Values in parentheses are numbers of respondents not harvesting and unwilling to grow smilax in their gardens.

enumerated, 16 were under sparse (>50%) canopy cover and these were mainly in the early and late secondary successional forests.

Community utilisation of Smilax kraussiana

The household survey revealed that only 32% of the households were willing to plant *S. kraussiana.* Furthermore, *S. kraussiana* was exclusively harvested by men, mostly from Kashasha and Rutugunda parishes (Table 5). Of the 90 households interviewed, 72% said they harvested *S. kraussiana* twice a year from the forest. This finding is consistent with a report by Ogwal (1998) that *S. kraussiana* in BINP is harvested in two seasons: June–July and November–December. Generally, households living around BINP were allowed into the forest once in every season in order to harvest two bundles/headloads of *S. kraussiana.* One bundle/headload of fresh *S. kraussiana* weighed about 5 kg and consisted of about 130 stems each 1–3 metres long. The stems were cut using a traditional knife known as *omuhoro* and a stub of about 5 cm long was left at the base from which new shoots sprouted. Stems less than 3 mm in diameter were considered to be immature, weak and unsuitable for making trays, baskets and stretchers and were therefore not harvested.

Discussion and conclusion

This study has highlighted the major forest types/habitats where *S. kraussiana* is found in Bwindi Impenetrable Forest National Park. Before planning for effective management and exploitation of forest resources, forest managers need to know where the resources occur. According to Peters (1994), information on the occurrence and density of forest plants is important for the sustainable management and utilisation of non-timber forest resources. This is because the populations of forest plants commonly exploited by local communities often decline and become extinct with each successive harvest. In this regard, it was felt necessary to provide information on the distribution, abundance and utilisation of *S. karussiana* in BINP. Such knowledge helps to guide the planning and decision-making process on resource management and exploitation in protected forests.

It was estimated that there were about 1000 stems of *S. kraussiana* per hectare in BINP, and in all the sites the number of vertical stems was about three times higher than the number of horizontal runners. This finding suggests that local communities could be allowed to harvest larger quantities of the vertical stems since they are more abundant than the horizontal runners. However, the rate of off-take should be regulated in the different forest types in order to ensure minimum disturbance to the forest ecosystem. For instance, more stems of *S. kraussiana* could be exploited from the early and late secondary successional forests that have high stem density.

According to Grubb (1987), forest type/habitat influences the distribution and abundance of climbers and vines. As noted earlier, more stems of *S. kraussiana* were found mainly in the early and late secondary successional forests with relatively sparse canopy cover. The early and late secondary successional forests were created by human disturbance mainly through pitsawing and cultivation of agricultural crops by the local communities. This observation is consistent with Putz's (1984) report that logged and secondary successional forests often have open canopies that support the growth of lianas and other climbers. The same observation could be used to explain why *S. kraussiana* was more abundant in the early and late secondary successional forest in BINP. It was also noted that there were many stems of *S. kraussiana* in the diameter classes 4.0–4.99 and 5.0–5.99 mm in all the forest types whilst small diameter stems were mainly found in gaps. Since gaps generally receive higher light intensities, this finding suggests that there were other environmental factors that could have influenced the distribution and abundance of *S. kraussiana* in BINP and this could be investigated in another study in future.

The distribution and abundance fo *S. kraussiana* decreased with increase in altitude. Although not examined in this study, it can be said that differences in environmental factors such as soil nutrients and moisture could have influenced the altitudinal variations in the distribution and abundance of *S. kraussiana* in BINP. Much of the forest canopy in Bwindi was opened up mainly by natural tree falls, pitsawing and cultivation by local communities.

Generally, canopies that permit high light intensities to reach the forest floor support the growth of plants underneath them. In the context of this study, it can be said that the relatively more open canopies, except the gaps, supported the growth of *S. kraussiana* in BINP. Considering that *S. kraussiana* is a vine, the finding corroborates with an observation by Peters (1994) that forest vines and climbers easily adapt, grow and reproduce under sparse canopies receiving high light intensities. The low abundance of *S. kraussiana* in gaps can be attributed to the dense growth of pioneer plants such as ferns and mimulopsis noted during in-forest sampling and lack of trellises to provide support especially for the vertical stems (Putz 1984, Cunningham 1996).

It was also noted that local communities harvested mainly stems of *S. kraussiana* that had diameters of about 3–7 mm. Ideally, there should have been fewer stems of

S. kraussiana within this diameter range since larger stems were mostly harvested. In contrast, many stems within this range were recorded because *S. kraussiana* tends to re-sprout after cutting or when damaged. On this basis, therefore, it can be said that the harvesting of *S. kraussiana* could be sustainable in BINP for two major reasons. First, the traditional harvesting method that involves leaving a stub on the clump encourages re-sprouting. Such a method is appropriate and supports the conservation of the plant. In a related study, Gotllieb (1979) noted that local resource users often know how forest products can best be harvested and use techniques that help to conserve the resources. Secondly, *S. kraussiana* is harvested only twice a year. This time period between harvests therefore allows the harvested stems to re-sprout, and according to Hegarty and Caballe (1991), this usually takes place three months after cutting. Since two thirds of the respondents were unwilling to plant *S. kraussiana* in their gardens, it means that the conservation of Bwindi forest will largely depend on the use of appropriate methods of resource extraction and regulation of resource exploitation by local communities. These will require proper planning based on adequate information collected from the field on the availability, distribution and abundance of the resources. Therefore a significant lesson that can be learned from this study is that forest conservation can be achieved through a good knowledge of the ecology and use of plant resources by local communities. In this respect, the Integrated Conservation and Development (ICD) model can be used to ease the burdens of conservation on local communities. The model has been successfully used in BINP (Wild & Mutebi 1996) and could be adopted in other protected areas to reconcile the goals of conservation with those of development.

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