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The impacts of bark harvesting on a population of *Encephalartos transvenosus* (Limpopo cycad), in Limpopo Province, South Africa

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Abstract. *Bamigboye SO, Tshisikhawe MP. 2020. The impacts of bark harvesting on a population of* Encephalartos transvenosus *(Limpopo cycad), in Limpopo Province, South Africa. Biodiversitas 21: 8-13.* Cycads are the most threatened group of plants in the world and there are a wide range of ecological and anthropological forces responsible for the extinction risk of these taxa. South Africa is a global hotspot of cycad diversity and the country's cycads are facing high extinction risk. In this study, we sampled a population (n=34) of *Encephalartos transvenosus* Stapf & Burtt Davy, a cycad species endemic to Limpopo Province, South Africa. The population was located on the Soutpansberg mountain range in the Thulamela Local Municipality. A survey was conducted to quantify the threats to the population. Forty-seven percent of the plants had been damaged by bark harvesting for traditional medicine, and the population showed a mortality rate of 9%. We recommend further studies across a range of *E.transvenosus* populations to provide a broader understanding of impacts of harvesting and population trends. We also recommend community-based initiatives to enhance the protection of this species in the communities in which they are found.

Keywords: Bark, class distribution, conservation, cycad, population decline, threat

INTRODUCTION

The use of plant materials for traditional medicine is an ancient practice that has gained prominence in recent times (Fabricant and Farnsworth 2001; World Health Organization 2008, 2013, 2015). This has promoted much reliance on plant utilization with local trades of plant parts becoming a very lucrative business worldwide (Crouch and Smith 2011; Barata et al. 2016). This practice promotes indiscriminate harvest of several plant species resulting in an extinction crisis of certain plant taxa (Williams et al. 2013; Traffic International 2018). This makes continuous assessment of biological resources listed for medicinal purposes extremely important, especially taxa that are threatened. In South Africa, it is estimated that 60% of the total populace consult traditional healers and majority of these traditional healers use plant materials as medicine to cure various diseases in their clients (van Wyk et al. 2009). The trade of medicinal plants (*muthi*) in South Africa's markets, *muthi* shops and street vendors have enjoyed exponential growth due to high level of patronage (Botha et al. 2001; Dold and Cocks 2002; Mander 1997; Mander 1998; Williams 2003, 2007; Moeng 2010; Williams et al. 2013; Bamigboye et al. 2018).

Cycads are one of the most threatened groups of organisms globally (Hoffmann et al. 2010). Threats to cycads include illegal harvesting for horticultural purpose, harvesting for medicinal purpose, presence of invasive alien species, reproduction failure and climate change (Donaldson 2003; Mankga and Yessoufou 2017). The extinction risk of African cycads has increased over recent decades (Bamigboye et al. 2016). South Africa which harbors 70% of the continent's cycad species is also not immune to these threats (Golding and Hurter 2003), since there is currently a major cycad extinction crisis (Cousins and Witkowski 2017). Of the 38 cycad taxa indigenous to South Africa, 3 are classified as Extinct in the wild (Ex), 12 are Critically Endangered (CR), 4 are Endangered (EN), 9 are Vulnerable (VU), while 7 are Near Threatened (NT) and 3 are Least Concern (LC) (International Union of Conservation of Nature 2017).

Using repeated photographs to document changes in South African cycad populations, Okubamichael et al. (2016) discovered that cycads were declining more in Limpopo Province than in any other province in South Africa. This trend indicates that without any serious conservation interventions, the cycad species in Limpopo Province may experience ongoing population declines, with resultant local population extirpations and elevated extinction risk.

Unlike in other parts of the world where habitat destruction is a major threat to cycads, one of the main threats to South African cycads is harvest for traditional medicine (Donaldson 2006; 2010). Although South African cycads are protected (National Environmental Management Biodiversity Act (NE: MBA) 2004), the harvest of these taxa for medicinal purposes have been a continuous practice in South Africa (Donaldson 2003, 2006; Cousin et al. 2011, 2012, 2013; Williams et al. 2013, 2014; Williamson et al. 2016). Sixty-eight percent of South African cycads have been cited in literature as harvested for medicinal purposes and one species of cycad (*Encephalartos woodii*) is reportedly extinct due to harvest for traditional medicine (Donaldson 2009; Bamigboye et al.

2018). The medicinal uses of cycads include treating stomach aches, stroke, heart attack (Ravele and Makhado 2009), high blood pressure (Ndawonde et al. 2007) and breast cancer (Bamigboye et al. 2017). The parts used for medicinal purposes are mainly roots, leaves, and bark (Ndawonde et al. 2007; Ravele and Makhado 2009; Bamigboye et al. 2017).

Encephalartos transvenosus Stapf & Burtt Davy is a cycad species endemic to Limpopo Province (Goode 2001). It is protected under provincial and national legislation in South Africa (Limpopo Environmental Management Act (LEMA) 2004; National Environmental Management Biodiversity Act (NE: MBA) Act 10 of 2004). Hilton-Taylor (1996) listed this species as rare although it is currently abundant in some places such as Modjadji Nature Reserve. With a total population of approximately 15,000 individuals, it is currently listed as a species of Least Concern (Donaldson 2009). Although this species is not classified as threatened, it is experiencing population declines due to habitat destruction and illegal collection (Donaldson 2009). *Encephalartos transvenosus* bark has been reported to be traded at *muthi* (traditional medicine) shops and street vendors in different districts of Limpopo Province (Moeng 2010; Tshisikhawe 2002; 2012). Other studies have also shown that the bark, leaves, and roots of *E. transvenosus* are currently being harvested for traditional medicine, hard drugs, and roofing material (Bamigboye et al. 2017).

In this study, we conducted a field survey to quantify the impact of bark harvest to a population of *E. transvenosus* and to also suggest conservation plan that can minimize illegal harvest of these species.

MATERIALS AND METHODS

Study site

The population surveyed was found at the entrance of the Mahunguwi village at the East facing slope within the Soutpansberg Mountain range in the Thulamela Municipality, Vhembe District, Limpopo Province, South Africa. The vegetation type of this area is Bushveld of savanna biome (Acocks 1998). The average rainfall of this area is 698mm per annum (Samsam Weather Climate Tool 2016). The altitude of this mountain is from 25 m above sea level up to 1748m of its highest western peak (Mostert et al. 2008).

Study species

Encephalartos transvenosus is a tall tree that can grow over 6m in height (Goode 1989). It is regarded as one of the tallest and one of the fastest-growing cycads in South Africa (Ravele and Makhado 2009). It has broad leaves with network of veins (Jones 1993). The leaves are glossy and dark green in color (Giddy 1984). The leaflets of this plant are attached to the stalk (Dyer 1971). It grows on the mountains in Limpopo Province in South Africa (Ravele and Makhado 2009).

Field survey

An entire *E. transvenosus* population (n=34 individuals) located on this Mahunguwi village mountain was surveyed for this study. For each individual in this population, stem height, basal stem diameter, and crown damage were recorded. The number of dead and live individuals were also recorded. Out of the 34 individuals surveyed, 31 were alive and 3 were dead. Size-class distribution curve based on stem diameter was constructed for this population to assess its overall health, and to detect any possible impacts of harvesting. Stem height versus number of individuals curve was also constructed and compared with a similar curve that was plotted for *E. transvenosus* in Modjaji Nature Reserve as reported in Konings (2016).

Percentage of individuals that had suffered bark damage was determined and also quantified the extent of the damage by categorizing stems based on the percentage of their outer surface that had been damaged. Individuals with 5-30% damage, were categorized as mildly damaged, while individuals with 30-50% were considered "moderately damaged", and those with >50% of the bark removed from their stems were classified as "severely damaged". Crown damage was also noted if individuals were affected by this.

RESULTS AND DISCUSSION

The size-class distribution based on basal stem diameter is bell-shaped curve. The result of basal stem size-class distribution showed lack of juveniles and young individuals (Figure 1), which is an indication of a population facing extinction risk (Ravele and Makhado 2009). Results on stem length versus number of stems (Figure 2) showed that there are fewer young individuals in the population sampled compared to the Modjaji population curve found in Konings (2016). Nine percent mortality (three dead individuals) was recorded (Figures 4-5) and 47% of the population suffered some degree of bark damage with 8.8% showing mild bark damage, 11.8% moderate damage and 26.5% severe damage (Table 1). Four individuals (11.7%) suffered complete crown damage (Table 1; Figure 3). Eighty-seven percent of the total number of individuals that have suffered bark damage is between basal stem diameter size-class of 35 cm to 50 cm (Table 1). Majority of the highly and moderately damaged individuals (75%) also fell into the size class of 40cm to 45cm basal stem diameter. These showed that majority of individuals that have suffered severe damage are within the middle class of this population.

Okubamicheal et al. (2016) on their estimation of cycads loss in South Africa discovered that the second-largest factor responsible for cycads loss, based on repeated photograph study of South African cycads population, is harvest for traditional medicine. This showed that harvest of South African cycads for traditional medicine is a threat that is trending among South African cycads, in particular at Mphaphuli Nature Reserve in Limpopo Province, South Africa, where the majority of people indicated that the cycads were harvested mainly for medicinal purposes

(Ravele and Makhado 2009). Bark harvest was the main threat found in the cycad population in this study, and this practice of bark harvest of cycads in South Africa have been reported in a number of previous studies (Donaldson 2006; Cousins et al. 2011, 2012, 2013; Williams et al. 2013, 2014; Bamigboye et al. 2017; Cousins and Witkowski 2017). From our observations, the dead individuals recorded in the population are attributed to bark harvesting as it exposes the plants to fungal infections (Figure 3). Size-class distribution of a population shows the reproductive capacity, recruitment, the probability of individuals in one class surviving to the next, and the ability of the population to survive ecological disturbances (Shaukat et al. 2012; Tshisikhawe 2012; Tshisikhawe and van Rooyen 2012). Lack of juveniles in this population might be due to ecological disturbance brought about by bark harvesting.

Table 1. Some of the parameters recorded on *Encephalartos transvenosus* individuals sampled in the study

Individuals number	Stem height (cm)	Basal stem diameter (m)	Stem damage category	Crown damage (yes or no)
1	200	41	A	No
2	270	45	D	No
3	100	41	D	No
4	350	54	A	No
5	30	22	A	No
6	550	57	B	No
7*	Dead individual	No record	No record	No
8	470	41	C	No
9	200	38	D	No
10	190	41	C	No
11*	Dead individual	No record	No record	No
12	420	45	B	No
13	250	34	D	No
14	190	35	B	No
15*	Dead individual	No records	No records	No
16	360	45	D	No
17	230	29	D	Yes
18	430	45	D	Yes
19	350	38	D	Yes
20	430	45	D	No
21	520	45	C	Yes
22	470	41	C	No
23	500	51	A	Yes
24	250	38	A	No
25	350	32	A	No
26	250	29	A	No
27	480	35	A	No
28	130	38	A	No
29	280	48	A	No
30	200	41	A	No
31	250	48	A	No
32	500	51	A	No
33	200	38	A	No
34	600	70	A	No

Note: *Dead individual. A. 0% of stem area affected by bark damage B. mild damage (5-30%), C. moderate damage (30-50%) and D. severe damage (>50%)

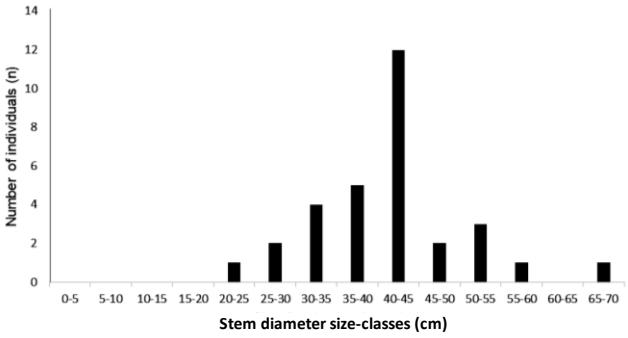

Figure 1. Stem diameter size-class distribution of a population of *Encephalartos transvenosus* in Mutale Municipality in Limpopo Province, South Africa

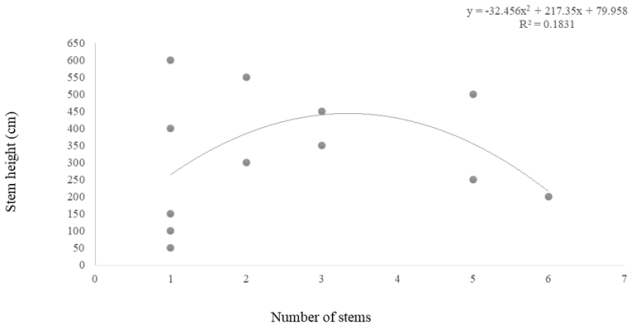

Figure 2. Correlation between stem height and number of stems for the population of *Encephalartos transvenosus* sampled in this study

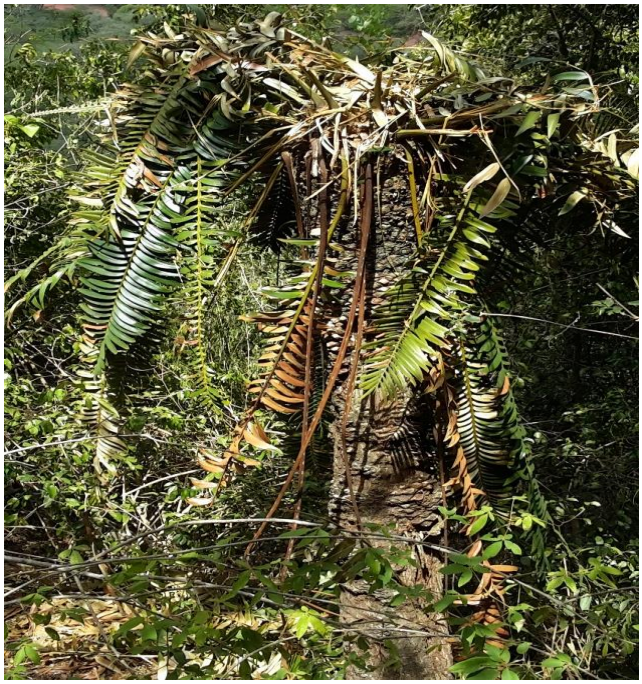

Figure 3. Crown damage on individual of *Encephalartos transvenosus*

Figure 4. Bark damage to various *Encephalartos transvenosus*

Figure 5. Dead *Encephalartos transvenosus* plants which suffered bark damage

Cycads have slow growth rate and exhibit poor recovery after a disturbance making these taxa vulnerable to extinction when they are collected for medicinal purposes (Donaldson 2003; Cousin et al. 2011: Cousin 2012). A size-class of 60.1 - 65cm stem diameter, which should have some of the oldest individuals in this population, is totally missing (n=0) (Figure 1). Absence of individuals in this size-class showed that there might be difficulties in these individuals persisting into the next class due to bark harvest which results in death of individuals. Harvest of middle-sized stems leads to absence of adult individuals in larger stem diameter classes hence leading to poor seed and poor regeneration that causes population decline (Luoga et al. 2004; McLaren et al. 2005; Makana and Thomas 2006; Bakali et al. 2017).

Since the Modjaji Nature Reserve has relatively younger individuals than the population we sampled in respect to stem height (Konings 2016), it can be concluded that harvesting of this unprotected population might have resulted in poor recruitment of young individuals in this population. In their study, Okubamicheal et al. (2016) showed that majority of cycad loss due to traditional medicine in South Africa occurred on communal lands. This revealed that less of this practice can be found in the Nature Reserves. Their study also supports that the practice of bark harvest of *E. transvenosus* found on the communal land sampled in this study might have affected this population negatively, resulting in poor recruitment of young individuals as compared to the ones in Modjaji Nature Reserve.

Observations from this study revealed that the majority of individuals that have not yet been affected by bark harvesting in the population studied are located on the upper part of the mountain which is difficult to access. The relative inaccessibility of these individuals to harvesters likely prevented them from being exploited.

The possible causes of crown damage noticed in this study could not be ascertained, however, Ravele and Makhado (2009) noted that monkeys and baboons eat the cones and leaves of *E. transvenosus*. Destructive feeding by these animals may account for the crown damage noticed on some individuals in this population, as baboons were present on the mountain during the field survey, and individuals with crown damage have their leaves and cones completely destroyed (Figure 4). Crown damage may also be due to harvesting of leaves for roofing huts and decorations (Ravele and Makjado 2009; Bamigboye et al. 2017). Evidence of bark harvest was also observed on individuals that have suffered crown damage (Table 1). The combination of crown damage with bark harvesting will accelerate decline of this population. If these individuals cannot recover by producing suckers, the destruction of their crowns may lead to their eventual death.

In conclusion, the bell-shaped curve size-class distribution, as well as lack of juveniles and young individuals, exposed the cycad population in the study as vulnerable to extinction. In addition, continued bark harvesting and crown damage to *E. transvenosus* individuals could result in ongoing population decline and increased extinction risk. Therefore conservation efforts will need to be intensified in the areas where *E. transvenosus* occurs in order to prevent further population decline due to unsustainable harvesting. It is recommended that surveys of other *E. transvenosus* populations be conducted in order to determine the extent to which they are being impacted by harvesting for traditional medicine.

It is also recommended that plant taxa that are not threatened, have a better regeneration potential and have same medicinal value with cycads, be introduced to communities and *muthi* markets and shops in South Africa to be used in place of cycads. This approach might be needful as totally discouraging people from using these cycad taxa without providing alternative might not produce results due to the economic value that comes with trade of traditional medicine in recent times (Crouch and Smith 2011; Barata et al. 2016). This approach might also work effectively with consultations and in involvement of traditional healers in South Africa. These kinds of approaches uniquely applied might decrease wild harvest of South African cycads for medicinal purposes hence reducing the risk of extinction. It can, therefore, be concluded that community involvement conservation planning is non-negotiable planning that must be put in place and well implemented in curtailing illegal harvest of cycads for traditional medicine.

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