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Short communication

From fragments to figures: Estimating the number of Encephalartos stems in a muthi market

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ABSTRACT

There is an active trade in South African *Encephalartos* species in traditional medicine (*muthi*) outlets throughout the country. No attempt has been made to date to estimate the number of individual stems damaged by harvesters supplying stem fragments (including bark strips) to the markets. To progress from stem fragments to stem figures, a plausible technique of enumerating the number of stems from which the fragments were derived is proposed. The method considered the physical condition, post-harvest age and stem diameter of fragments identified to species level. From the samples of 133 cycad fragments purchased in the Johannesburg and Durban *muthi* markets in 2009, it was estimated that they originated from 81 different damaged stems (66% of which were likely to have been from *Encephalartos natalensis*). This estimate is a significant advance in quantifying this hitherto unknown aspect of the cycad trade.

1. Introduction

Two-thirds of South African cycad species are reported to be used for traditional medicine (*muthi*) and/or ritual purposes, primarily in the form of stem material (Cousins et al., 2012), and collection for the trade has contributed to the declining cycad populations and increased threats to the species concerned (Donaldson and Bösenberg, 1999). In previous publications we explored the trade in *Encephalartos* species in local *muthi* markets by conceiving quantification and species identification methodologies appropriate for the genus (Cousins et al., 2011, 2012), including the development of a photographic key to assist fieldworkers and law enforcement officers with the recognition of taxa from observed or confiscated cycad stem fragments (Cousins et al., 2013) (Fig. 1). This exploratory research is unique for southern Africa and contributes significantly to our capacity to monitor the cycad trade for *muthi* and horticultural purposes and thereby effect conservation measures for this highly threatened genus. As a consequence of the publications of Cousins et al. a colleague queried whether, by reassembling the cycad fragments into complete stems, one could determine how many stems of each size-class were represented in the *muthi* markets. Such a determination would provide a helpful estimate of the number and size of *Encephalartos* plants impacted by harvesting in the wild. An attempt to address this question led to this investigation.

Our previous papers included a focus on determining the species from which the fragments had been harvested and the stem diameter size classes thereof (Cousins et al., 2011, 2012). With this information, we could attempt an analysis that estimated the number of stems that the fragments originally came from. Hence, the aim of this paper is to progress from stem fragments to stem figures and to provide guidelines for data collection in markets that answer key conservation questions.

2. Methods

Two factors need to be considered when estimating the potential number of cycad stems from which the fragments were originally derived. Firstly, all the fragments sold represent part of one or more individual plants and not necessarily the whole stem. Gatherers frequently remove only a portion of the plant material from individual *Encephalartos* stems from a population (e.g. Fig. 2), and then several traders in a market would purchase a proportion of this material from a gatherer. By the time a resource inventory is conducted during a market survey, an unknown proportion of that original quantity would have been sold to consumers—thus leaving behind an unknown fraction of the original material by which to estimate the potential number of stems. It was from this remaining material that samples were purchased for this investigation.

Secondly, since it is unlikely that whole stems can be reassembled from the fragments at the stalls in the markets, it is the condition of the fragments (e.g. degree of desiccation and darkening of leaf bases),

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Fig. 1. *Encephalartos* sp. stem fragments in the Faraday *muthi* market. (Photo: V.L. Williams).

and not necessarily the quantity *per se*, that is important for determining whether the fragments came from unique stems or not. In other words, a single fragment with characters unlike any other sold alongside it indicates that the material originated from a separate stem. Thus, it was the condition of the fragments in the markets that was carefully scrutinised during this investigation.

With these factors in mind, figures for stem numbers were enumerated from stem fragments as follows:

1. Samples of *Encephalartos* stem fragments were purchased from traders in the *muthi* markets of Faraday (Johannesburg, Gauteng) ($n = 33$ samples; total 104 stem pieces) and Warwick (Durban, KwaZulu-Natal) ($n = 23$ samples; 29 stem pieces) in 2009 (Table 1). Information on post-harvest age (i.e. approximate age of the fragments indicated by the time since harvesting) and harvesting locality, if known, were noted.
2. Fragments were given a unique code and close-up, high-resolution photographs were taken of each.
3. Where possible, the fragments were identified to species and the diameters of the stems from which the fragments were originally harvested were estimated as per the methods described in Cousins et al. (2011, 2012, 2013). Based on the estimated stem diameters, the fragments were allocated to one of six stem diameter size-classes (Figs. 3 & 4).
4. Once information on every fragment was collated, the data (including photographs) were carefully scrutinised to evaluate whether the different fragments sold by a trader were likely to have originally come from the same or different stems and, thus, how many stems in total the sample fragments came from. Importantly, the total stem numbers represent what was in the markets at the time of the surveys and not the numbers taken to the markets annually.
5. Several assumptions were made in order to estimate the number of stems:
   a. If all the fragments in a sample were harvested from the same locality, were of the same post-harvest age, were the same species, and were estimated to have come from a stem of the same size, then the fragments in the sample were derived from the same stem.
   b. Other stems of the same diameter in an *Encephalartos* sp. population could have been targeted by a harvester. To assess this, the colour, the condition and extent of deterioration of the fragments in a sample were visually compared for differences that indicated that more than one stem of the same size was harvested.
   c. If all the fragments from one trader were from the same species, but were from stems of different sizes and/or post-harvest ages and/or different localities, then the fragments were harvested from different stems.

Fig. 2. An *Encephalartos natalensis* stem damaged by harvesters. (Photo: J.S. Donaldson).

3. Results and discussion

3.1. Number of species sold per trader

Bark and stem fragments from the 56 samples purchased from traders in the *muthi* markets were identified to probable species, where possible, by using stem and leaf base morphological characters in tandem with harvesting locality records (Cousins et al., 2012). Three to four *Encephalartos* species each were positively identified in the Faraday and Warwick markets (a total of five species between the markets), but it is likely that more species were sold than could be identified (Tables 1 & 2; Figs. 3 & 4). On a subsequent visit to Faraday, for example, two fragments from the same stem were identified as being from *Encephalartos ngoyanus*, a species not recorded in the initial Faraday and Warwick survey (Cousins et al., 2012). On average, each trader had fragments from only one species represented in the material displayed to customers.

3.2. Condition of the fragments

The post-harvest age of the samples ranged from one week to three months, although material in Warwick tended to be fresher and had usually been harvested two to four weeks before the resource survey was conducted (Table 1). The post-harvest time and the extent of fragment deterioration probably played a role in the difficulty with identifying a larger proportion of the samples from Faraday compared to Warwick (since Faraday is further away from cycad harvesting localities in KwaZulu-Natal it takes longer for harvested material to reach Johannesburg than Durban). (In addition to the post-harvest age of the *Encephalartos* material on display at the stalls of Faraday vendors being older, the quantity on display was 4.3 times greater at Faraday than at Warwick (Cousins et al., 2011). One inference that can be made from this observation is that because the traditional harvesting areas for *Encephalartos* material in KwaZulu-Natal (KZN) are further