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SHORT COMMUNICATION

First record of baobab (*Adansonia digitata* L.) in Uganda

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Abstract The baobab (*Adansonia digitata* L.) is a remarkable key tree species with different uses in many African countries. International interest in the species has intensified in recent years. Despite the wide distribution of the baobab in many African regions, the tree has been reported to be absent in Uganda. In 2015 and 2016, research trips in the Central, Western, Eastern and Northern Regions of Uganda were conducted to screen the cultivated and natural flora for baobabs. As a result, four vigorous baobab trees aged 9 and 22 years were identified in two gardens in the Iganga and Soroti Districts in the Eastern Region of Uganda. The origins of the planting materials were Nyala in Sudan and Mombasa in Kenya. To our knowledge, these are the first scientific records of baobab in Uganda and some research questions and key propositions are formulated based on this discovery.

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Introduction

The baobab (*Adansonia digitata* L., Malvaceae, subfamily Bombacoideae, Baum et al. 2004) also known as Africa's wooden elephant (Gebauer et al. 2016) is a remarkable key tree species in many African countries (e.g. Jama et al. 2008; Buchmann et al. 2010, Venter and Witkowski 2013). This impressive tree (for botanical description see Gebauer et al. 2002) is of economic and cultural importance. It is used for human food, water storage, fodder and medicine among many other purposes (Wickens and Lowe 2008 and references therein). In West Africa, both baobab fruits and leaves contribute to human diets in a major way, while in East and Southern Africa the fruits are the most important plant part used (NRC 2006). In recent years, international interest in the species has intensified following the acceptance of baobab fruit pulp as a food ingredient by the European Union (EC 2008) and the US Food and Drug Administration (FDA 2009). A recent study by Gebauer et al. (2014) revealed that more than 300 baobab products or products with baobab as an ingredient are available in Europe.

In Africa, products of the multipurpose tree are mainly collected from the wild and we know of no commercial baobab plantations. Due to the high local,

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national and international demand of baobab products, trees are intensively harvested, which often leads to overexploitation of the natural stands (Dhillion and Gustad 2004). This situation calls for the development and implementation of sustainable utilization methods and the cultivation of baobabs within and outside of its natural range. In some East and West African countries such as Niger and Sudan, the baobab can be found in urban and rural gardens (Bernholt et al. 2009; Gebauer 2005; Goenster et al. 2011; Wiehle et al. 2014). In Kenya and Tanzania baobab trees are often left standing and are protected on farms (Beentje 1989, 1994; Ruffo et al. 2002).

Despite the wide distribution and importance of the baobab in many African regions, the tree is widely known to be absent in Uganda (e.g. Katende et al. 1995; Bosch et al. 2004; Wickens and Lowe 2008; Orwa et al. 2009; Nussinovitch 2010; Dharani 2011; Kalema and Beentje 2012; Lim 2012). Ecological niche modelling results of Cuní Sanchez et al. (2010) indicated that the presence of baobab trees is mainly related to annual precipitation and temperature seasonality. Jensen et al. (2011) stated that the ability of the species to compete with other plants is relatively weak in the humid sites. In Uganda the baobab is not only regarded as absent in natural habitats, it is also not known to be cultivated on farm-land (Eilu et al. 2003, 2007; Agea et al. 2007; Okullo and Waithum 2007; Tabuti et al. 2010; Tabuti 2012; Nyamukuru et al. 2015) or in private/homegardens (Oduol and Aluma 1990; Okullo et al. 2003; Whitney and Gebauer 2014).

Materials and methods

In July and August of 2015 and January of 2016, research trips to the Central, Western, Eastern and Northern Regions of Uganda were conducted within the collaborative research project "Reduction of Post-Harvest Losses and Value Addition in East African

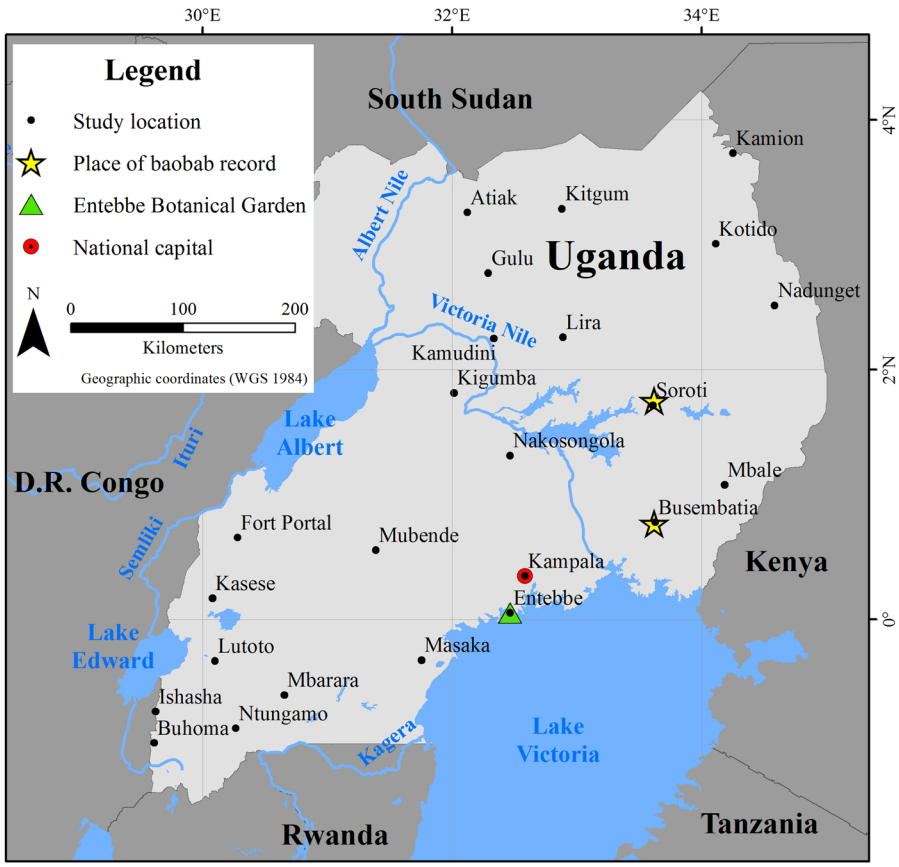

Fig. 1 Map of Uganda indicating the study locations and the places of the baobab records

Food Value Chains" (RELOAD). Cultivated and natural flora was screened and local people interviewed about the occurrence of baobabs. The expeditions comprised the following main study locations: Atiak, Buhoma, Busembatia, Entebbe, Fort Portal, Gulu, Ishasha, Kamion, Kampala, Kamudini, Kasese, Kigumba, Kitgum, Kotido, Lira, Lutoto, Masaka, Mbale, Mbarara, Mubende, Nadunget, Nakosongola, Ntungamo and Soroti (Fig. 1). In total the trips covered a distance of 4975 km with a range in elevation between 809 m a.s.l. and 1680 m a.s.l. To access cultivated plant species, homegardens and fields were visited and farmers interviewed. In the surroundings of the locations and along roads, natural vegetation was screened in detail on the spot or from outcrops using Swarovski CL 8 × 30 and Leica Ultravid 10 × 25 BR binoculars. Baobab tree height and stem circumference at 130 cm was measured using a 30 m hand-operated tape. For better comparison with other studies, stem diameter at breast height (DBH) was determined arithmetically, assuming a circular stem shape. The location of each tree was recorded using a Global Positioning System (GPS) receiver (Garmin eTrex 30).

Results and discussion

As a result of our expeditions, four vigorous baobab trees were identified in the Eastern Region of Uganda.

Two baobab trees (Fig. 2) were located to the north-east of Soroti town (Fig. 1) in the Soroti District in 2015. The trees (locations: 01°45.048′N, 33°37.010′E, 01°45.055′N, 33°37.015′E, 1070 m a.s.l.) with heights of 4.36 and 4.79 m and DBHs of 52 and 40 cm were both found at the roadside edge of a unfenced grass courtyard along Moroto Road. The garden owner told us that he obtained two seedlings from a tree nursery in Nyala in South Darfur, Sudan and planted them as ornamentals in 2007. The plants developed well,

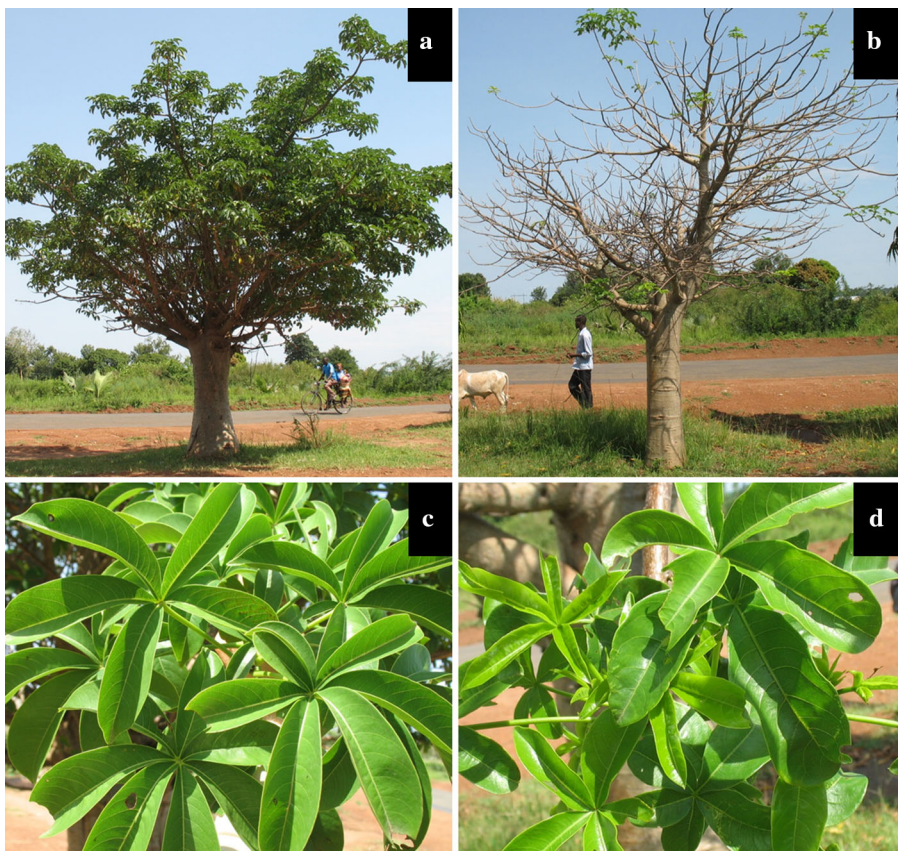

Fig. 2 Baobab trees (**a**, **b**) and leaves (**c**, **d**) in a private garden north-east of Soroti town in the Soroti District, Eastern Region of Uganda

showing high vitality and fast growth. The garden owner had worked from 2005 to 2008 in development projects in Darfur and was impressed by the beauty of baobabs in this region. He was curious to explore the development and performance of the baobabs in Soroti's environmental conditions, with annual rainfall of between 1100 and 1200 mm. However, the trees had to be trimmed some years ago to allow construction of power lines close to the baobabs. In general, the peculiar tree shape has attracted many people's attention and is the main reason why African baobabs are planted as ornamentals throughout the tropics and subtropics (Sidibé and Williams 2002). Due to its unique eye-catching profile it is also cultivated as a bonsai in many countries (Gebauer et al. 2014).

Two more baobab trees standing side by side (Fig. 3) were recorded south-west of Busembatia town (Fig. 1) in the Iganga District in 2016. The trees (location: 00°46.148′N, 33°37.159′E, 1089 m a.s.l.) with heights of 9.90 and 9.55 m and DBHs of 79 and 85 cm were found in a fenced homegarden along Tirinyi Road. The garden owner told us that he extracted the seeds from baobab fruits which were sent by his sister from Mombasa, Kenya and planted them in 1994. Two seeds germinated and the seedlings developed well, showing high vitality and fast growth. According to the owner, the main reason for raising the baobabs in his garden was to harvest fruits. He was impressed by the delicious taste of the baobab fruits and was hopeful that those he planted would bear fruits. However, so far the 22 year old baobabs have not borne any fruits. There is little information available on the age at which baobabs first flower. Wickens (1982) and Assogbadjo and Loo (2011) noted that this can take up to 23 years. According to Watson (2007) it can take 30 years for a baobab to produce the first flowers. Therefore, efforts are made to accelerate fruit precocity through horticultural techniques such

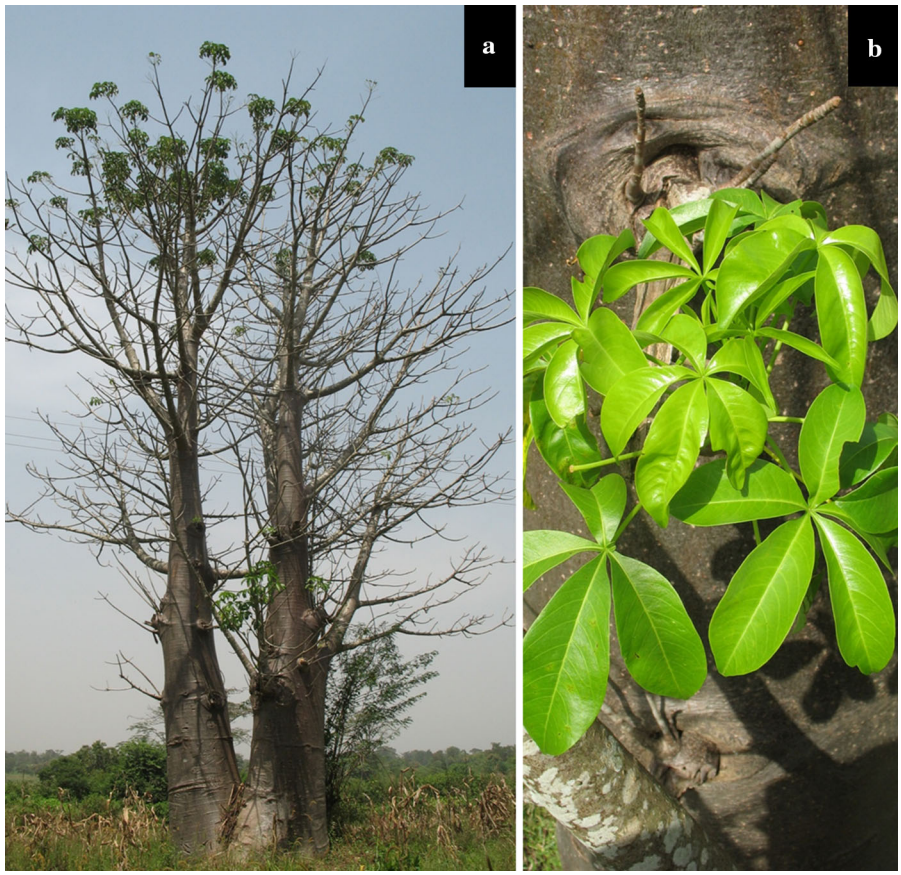

Fig. 3 Baobab trees (**a**) and leaves (**b**) in a homegarden south-west of Busembatia town in the Iganga District, Eastern Region of Uganda

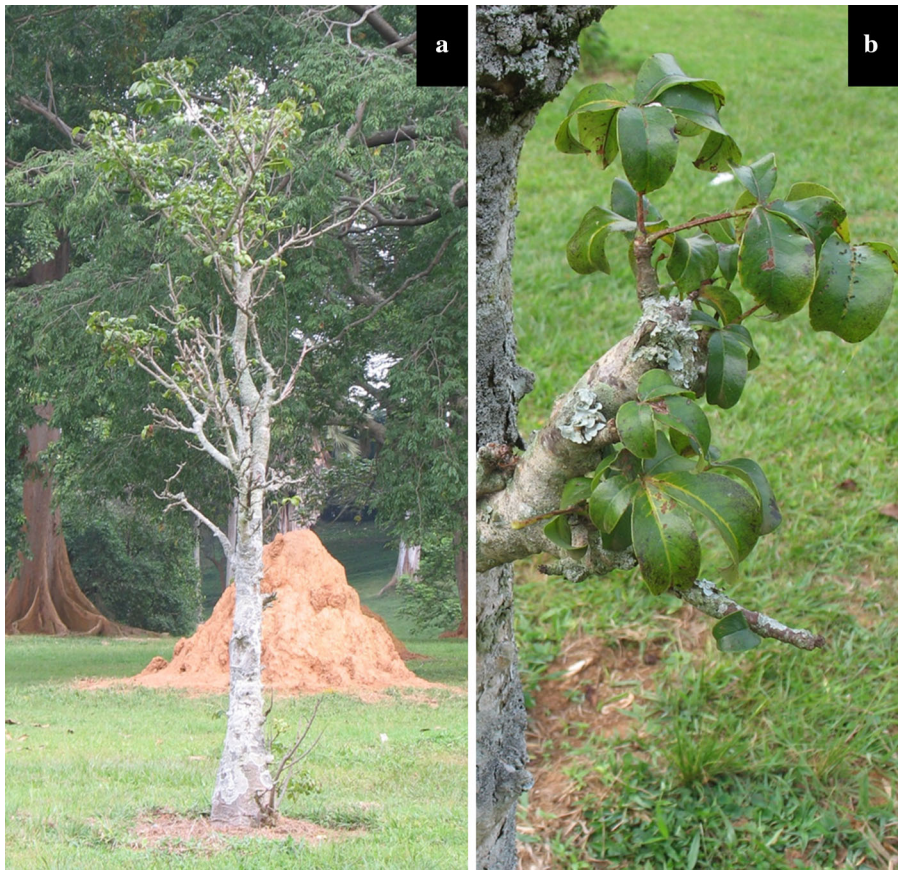

Fig. 4 Baobab tree (**a**) and leaves (**b**) in Entebbe Botanical Garden in the Wakiso District, Central Region of Uganda

as grafting (Kalinganire et al. 2007, Anjarwalla et al. 2015).

To our knowledge these are the first scientific records of baobab in Uganda. An extensive search of literature yielded only one internet source (Geoview.info 2007) displaying a photo of a large mature baobab, claiming that this picture was taken in Entebbe, Central Region of Uganda. We searched the geolocation and the town of Entebbe extensively and did not find any sign of a baobab. People living in the area also stated that this photo was not of a tree they had ever seen.

The extensive collection of Entebbe Botanical Garden in the Central Region of Uganda has one stunted baobab (location: 00°03.785′N, 32°28.643′E, 1158 m a.s.l.). This tree (Fig. 4) is claimed to be more than 100 years old (pers. comm. with Entebbe Botanical Garden guide 2016). Yet it has a height of just 4.20 m and a DBH of only 13 cm. The Botanical Garden has no record of flowering for the tree. Reasons for the weak performance of the tree can be seen in the tropical wet climate with no significant dry or cold season with a year-round rainfall of around 1600 mm. According to von Maydell (1990) the species grows best in regions with an annual rainfall of between 250 and 1000 mm. In contrast to Entebbe, the much dryer climatic conditions in Busembatia and Soroti with prolonged drought followed by heavy rain probably led to the vigorous and fast growth of the recorded baobabs.

Research perspectives

Based on the findings of this preliminary study the following research questions arise:

How will these baobab trees perform in the future?
When will they start to flower and fruit?
What fruit quality can be expected and will local people accept it as food?
Will this tree species become a common plant of homegardens in the Eastern Region of Uganda?

Are there more unknown baobabs in homegardens, on farm-land and/or in the wild of Uganda?

In conclusion it would be important to monitor the performance of the four baobab trees of the two geographical origins in the coming decades and to establish provenance trials including accessions from Western and Southern Africa for evaluation in different regions of Uganda. Such trials can show remarkable differences in survival and performance between provenances (Ræbild et al. 2011; Korbo et al. 2012; Munthali et al. 2012). According to Cuní Sanchez et al. (2010, 2011) it is worthwhile to identify potential cultivation areas outside of the species current distribution range to set up ex situ conservation sites and to support sustainable production of baobab products in Africa. This would be important to satisfy the growing African and international demand for products such as baobab fruit pulp, which is a key raw material for the wide range of baobab products or products that contain baobab as an ingredient (Gebauer et al. 2014). The screening of rural and urban markets for baobab products in different regions of Uganda could determine whether baobab products are available e.g. from neighbouring countries, such as South Sudan, Kenya and/or Tanzania, where the species grows naturally and baobab products are common (El Amin 1990; Murray et al. 2001; Ruffo et al. 2002; Robinson 2004; Mwema et al. 2012; McMullin and Kehlenbeck 2015). This would offer insights regarding the cultural acceptance of baobab products for food and nutritional security and other domestic purposes. Furthermore, in-depth botanical studies of wild and cultivated flora with a particular emphasis on baobab identification and evaluation in the dry northern part of the country may produce further evidence of the local presence of the baobab, Africa's wooden elephant in Uganda.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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