Will *Mauritia flexuosa* (Arecaceae) in the Erin Savanna, Trinidad Become Locally Extinct?

Moriche Palm *Mauritia flexuosa* (Arecaceae-Calamoideae) is an arborescent palm species found throughout much of South America. However, it is only found on one Caribbean island, Trinidad, which represents the species' northern geographical extent (EMA 2007). Over the millennia, *M. flexuosa* has survived in both wet and dry conditions (Rodríguez-Zorro *et al.* 2017). In Trinidad, it is found predominantly in the Aripo Savannas [Strict Nature Reserve] Environmentally Sensitive Area (ASESA) on ecotones between savannas and swamp forest (Arneaud *et al.* 2017). Other locations where *M. flexuosa* exist are associated with open areas that are permanently or temporarily inundated during the wet season, such as boundaries of the herbaceous swamps in the Nariva and Los Blanquizales wetlands (Arneaud and Duncan 2019, Comeau *et al.* 2003).

The Erin Savanna (ES) is an assemblage of small areas of grassland situated within the Erin Forest Reserve; directly east of Buenos Ayres village and north of the Erin-Cap de Ville road (Beard 1953). These open areas are hilly, approximately 75m above sea-level (asl) and experience an annual rainfall of less than 165cm (Beard 1953). This is considerably dryer than the ASESA (Comeau 1990) which is flat (≈ 45m asl) with 250cm annual rainfall (T.T.M.S 2016). Most of the open area within the Erin Forest Reserve (in particular the western savannas) were planted with Caribbean Pine *Pinus caribaea* during the 1990s by the Forestry Division of Trinidad and Tobago. Today, many of these pine stands have extended to other open areas and are associated with the palm *Acrocomia aculeata* due to the palm's ability to withstand high-intensity fires.

There are no records of *M. flexuosa* in the Erin Forest Reserve prior to 1990. Beard (1953) did not record any *M. flexuosa* in the ES during his extensive survey of the savanna vegetation of Northern Tropical America. Comeau (1990) reported one sighting of the palm during his studies on the savannas of Trinidad, and Sewlal (2004) reported sighting a patch of *M. flexuosa* during a botanical walk. As a result of this, some ecologists believe that the single stand of *M. flexuosa* in the ES derived from a human origin (Michael Oatham 2020, personal communication).

Observations on *M. flexuosa* stands were made during field visits to the Erin Forest Reserve (Fig. 1) in mid-September 2016 (for forest stands) and early January 2020 (for savanna stands). Upon finding a *M. flexuosa* palm, a circular quadrat of 50m radius centred on the initial palm was searched for additional individuals; this was done until no additional palms could be found. In an attempt to detect any *M. flexuosa* stands not observed during field visits, digital searches were made of high-resolution (approximately 4cm/pixel) aerial photography of the Erin Forest Reserve taken in 2014 (Trinidad and Tobago. M.A.L.F 2014). Aerial photography was interpreted using the QGIS Desktop 3.10.2 version Software (QGIS Development Team 2020). *M. flexuosa* crowns were identified following palm tree identification and classification guidelines from Tagle Casapia *et al.* (2020). Carat palms *Sabal mauritiiformis* are the only other palm species with a similar crown appearance in the Erin Forest Reserve and were differentiated from *M. flexuosa* palm crowns as having fronds with drooping leaflets that do not spread in different planes; the tips of *M. flexuosa* leaflets do not droop and tend to spread in different planes (Comeau *et al.* 2003, Tagle Casapia *et al.* 2020). Environmental observations (canopy coverage, number of stands, habitat, proximity to the nearest housing settlement, and type of human exploitation) were part of a more comprehensive study based on the geographical distribution and threats of *M. flexuosa* populations in Trinidad (Arneaud 2020).

Only four *M. flexuosa* palms were identified in savanna habitat, all in the 'Middle Savanna' of the Erin Forest Reserve (which is in pristine condition) and all of which were adults (Fig. 2). Palms within forest habitat (approximately 2km from the savanna palms mentioned above) accounted for between 100–200 individuals (Fig. 1). The average canopy coverage percent was higher in forested areas. Both *M. flexuosa* stands were associated with a running watercourse (i.e. a stream, river or both). Savanna *M. flexuosa* palms were located approximately 1km from the nearest housing development and 0.5km from the Seegobin Quarry.

The main secondary dispersal agents of *M. flexuosa* are mammals; in particular, those greater than 13kg (Bodmer 1991, Endress *et al.* 2013). Elsewhere in the Neotropics, these include Golden-backed Uakari *Cacajao melanocephalus melanocephalus* (Bodmer 1991), Tapir *Tapirus terrestris* (Gilmore *et al.* 2013), White-lipped Peccary *Tayassu pecari* and the Collared Peccary *Tayassu tajacu* (Bodmer 1991). Of these only the Collared Peccary is found in Trinidad (Boos 1986) but has seldom been seen within Erin Reserve in the past (Wing 1962).

Galetti *et al. (*2010) and Johansson (2009) consider medium-sized mammals to be too small to disperse the large fruit of *M. flexuosa* (51g to 74g according to Arneaud *et al.* 2017). This may not be entirely true for short distance dispersal (as far as 10m), as researchers have occasionally

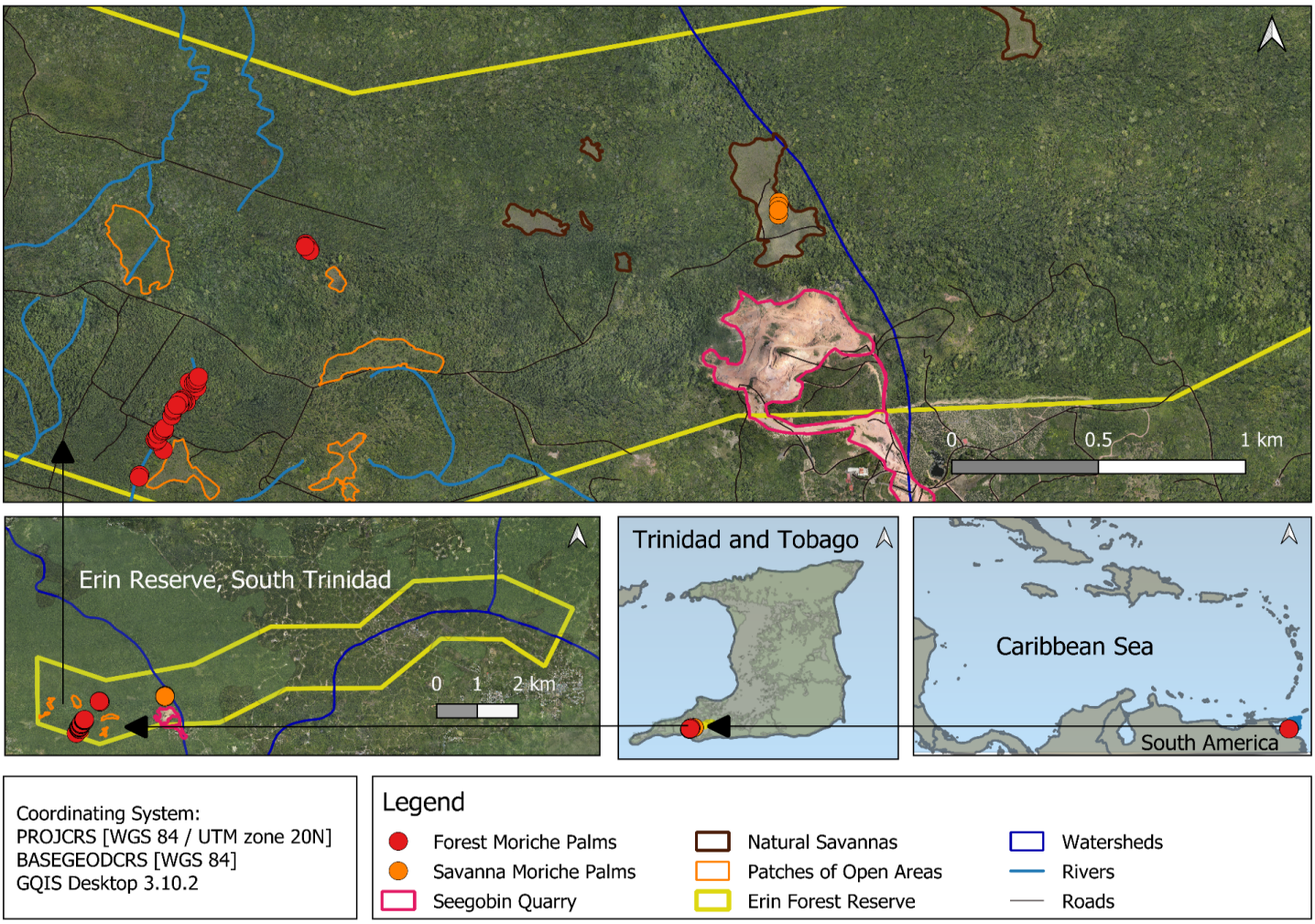

Fig. 1. Location of Moriche Palms *Mauritia flexuosa* population in the Erin Forest Reserve, south Trinidad. Aerial photographs provided by the Trinidad and Tobago Ministry of Agriculture, Land and Fisheries (2014).

observed Red-rumped Agouti *Dasyprocta leporina* (a medium-sized mammal) feeding on *M. flexuosa* fruit in the ASESA (Johnson 2002) and in the southeast region of Guárico State, Venezuela (Calderon 2002), additionally, Arneaud (2020) has recorded *D. leporina* effectively dispersing *M. flexuosa* fruit/seeds over several metres in the ASESA. Long-distance dispersal of *M. flexuosa* over the scale of kilometres has never been observed by medium-sized mammals, but studies on mammaliochory of seeds of other species of trees with similar-sized seeds to *M. flexuosa* such as *Carapa guianensis* have shown that repeated pilfering of caches established by caviomorph rodents such as *D. leporina* can disperse individual seeds over long distances (Wang *et al.* 2014).

Bird species have also been recorded as dispersers of *M. flexuosa* palms by some authors (Bonadie and Bacon 2000, Hosein *et al.* 2017). However, these authors did not document the distance over which fruit were dispersed, but it is likely to have been over relatively short distances (probably less than 2m) (Villalobos and Bagno 2013), and not the 2km between forest and savanna stands (Fig. 1).

Mauritia flexuosa palms in the Middle Savanna are thought to be of human origin, from seeds collected from the adjacent forest (Michael Oatham 2020, personal communication). Amerindians were present within the Erin Bay and environs (Fewkes 1914, Boomert 2009, Lans 2018), they were the last people to use and value the palm (Gilmore *et al.* 2013). This hypothesis is consistent with that of Granville (1992) who proposed that anthropogenic transportation was responsible for the distribution of *M. flexuosa* outside of the Amazon basin, and Rull and Montoya (2014) who suggested that postglacial neotropical expansion of *M. flexuosa* in the Gran Sabana of Southern Venezuela occurred 2,000 years ago as the result of human management of fires.

Savanna palms in the Erin Forest Reserve may go locally extinct because there are only male individuals present. Even though the floral morphology of *M. flexuosa* is intricate, indicating that the species may have hermaphroditic origins (i.e. having both male and female sex organs), this was not observed. There are over 1,000,000 flowers in a single staminate inflorescence and up to 6,000 flowers

Fig. 2. Only one Moriche Palm *Mauritia flexuosa* stand can be found on the margins of the Erin Savanna, south Trinidad. The stand is made up of four male trees (evidence of male inflorescences provided in the inset photos).

in a single pistillate inflorescence. Additionally, insect pollination is considered the original pollination mode in palms (Silberbauer-Gottsberger 1990), and the sweet floral fragrance of *M. flexuosa* nectaries together with the presence of staminodes (an abortive stamen in a pistillate flower) and pistillodes (a sterile under-developed pistil in a staminate flower) suggests that *M. flexuosa* ancestors were once hermaphroditic (Rosa and Koptur 2013). The possibility that palms in the ES practised hermaphroditism is low, as no evidence of seedlings/young juveniles was observed under/near parent palms.

Unfortunately, there is little to no information on the average life expectancy of *M. flexuosa* palms (Melo *et al.* 2018). Dransfield *et al.* (2008) reported that the typical life span for palms is 50–70 years. In the 'Place des Palmistes', Cayenne, French Guiana, there is a population of Royal palms *Roystonea oleracea* (Jacq.) O.F.Cook containing individuals that are over 200 years old (Tomlinson and Huggett 2012). *Mauritia flexuosa*, being a wild arborescent palm, similar to *R. oleracea* is expected to have a comparable life span.

With no female *M. flexuosa* palms in the Middle Savanna or ES, individual palms cannot reproduce. Savanna palms are therefore not expected to survive beyond the next century; providing all environmental conditions remain the same. Furthermore, ecological managers should pay close attention to these palms against encroaching anthropogenic impacts and plant *M. flexuosa* seedlings in streams along the savanna edges.

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