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Changes in conservation statuses of two presumed extinct plant species in Singapore: *Abutilon indicum* (L.) Sweet (Malvaceae) and *Cyperus dubius* Rottb. (Cyperaceae)

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Abstract. Two native plant species, *Abutilon indicum* (L.) Sweet (Malvaceae) and *Cyperus dubius* Rottb. (Cyperaceae), were presumed to be Nationally Extinct (NEx) according to the latest plant checklist of Singapore published in 2022. Both species have, however, been collected since the publication of that checklist, and an update to their national conservation statuses is thus necessary. We report the changes in statuses, provide brief descriptions, and discuss proposed conservation measures for both species in this account.

Key words. conservation status, flora of Singapore, native plants, Red Data Book

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INTRODUCTION

During a series of ongoing surveys targeted at non-native species growing in open areas and scrubland, the authors chanced upon and collected two native plant species, *Abutilon indicum* (L.) Sweet (Malvaceae) and *Cyperus dubius* Rottb. (Cyperaceae), both of which have been listed as Nationally Extinct in the Flora of Singapore checklist (Lindsay et al., 2022). In view of these recent collections, the conservation statuses for both species are reviewed in this paper. This report also forms the basis upon which the upcoming third edition of the Singapore Red Data Book (see pre-published online version; National Parks Board, 2023) derived the national conservation statuses for these two species. The provisional IUCN conservation assessments for these species in Singapore are based on the criteria set out in Davison (2008). Voucher specimens are deposited in the herbarium of the Singapore Botanic Gardens (SING).

BRIEF DESCRIPTIONS & DISCUSSION

1. *Abutilon indicum* (L.) Sweet subsp. *indicum* (Malvaceae) (Fig. 1)

Shrub to 2 m tall. All parts velutinous with minute densely-appressed stellate hairs. **Leaves** simple, spirally-arranged, lamina 1.5–7 cm by 1–9 cm, ovate or orbicular, apex acute to attenuate, sometimes acuminate, base cordate, margins crenate to dentate or undulate, venation palmate, 7–9 main secondary veins; petioles 1–8.5 cm, often with scattered, spreading simple hairs c. 0.5 mm long (also sometimes found on the stems). **Stipules** linear, up to 5 mm long. **Flowers** axillary, solitary; pedicels

geniculate, 4–5.5 cm on flowers, up to 7 cm on fruits; calyx campanulate, sepals free, 5, broadly ovate to triangular, each 3–6 mm by 3–4 mm; corolla yellow or orange, up to 3 cm across, petals free, 5, broadly obovate. **Fruit** a schizocarp, globular, 1.5–2 cm across, apex flat or slightly indented, mericarps up to 22, much longer than the calyx, each 13–20 mm by 8–15 mm, flattened-reniform, laterally glabrous, dorsally sparsely covered with stellate hairs. **Seeds** 2 or 3 per mericarp, reniform, glabrous or sparsely stellate-hairy.

Distribution. Widely distributed in the tropics and subtropics, including throughout Malesia.

Notes. *Abutilon indicum* shows considerable morphological variation. Several subspecies and varieties have been distinguished by various authors (see Fryxell, 2002). According to the treatment of this genus in Malesia by van Borssum Waalkes (1966), the plants in Singapore belong to subspecies *indicum*. This can be mainly distinguished from the other two subspecies by the calyx being much shorter than the fruit.

Ecology. Recorded from various locations in Singapore, typically in coastal areas, open areas, secondary vegetation, or along the wayside. The recently discovered individuals were found growing next to a dirt path on Coney Island.

Specimens examined. Singapore: Pulau Ubin, 1890, H.N. Ridley s.n. (SING [SING0013418]); Alexandra Road, 1893, H.N. Ridley s.n. (SING [SING0013417]); without locality (From 'Chinese drug seller'), 04 April 1924, C.X. Furtado s.n. (SING [SING0013420]); Geylang, 10 July 1930, Z. Teruya 1280 (2 sheets, SING [SING0013419, SING0394450]; without locality, 26 May 1958, Abu Kassim 1422 (SING [SING0365011]); Dairy Farm, Bukit Timah Road, 21 October 1969, Jumali Herb. 4077 (SING [SING0365010]); Sungei Buloh Bird Sanctuary, 22 May 1991, P.T. Chew et al., SB 1024 (2 sheets, SING [SING0365013, SING0365014]); Coney Island, 06 March 2019, L.M.J. Chen et al. LCMJ 2019-170 (2 sheets, SING [SING0395000]).

Provisional conservation assessment. Globally not assessed. Critically Endangered (CR/D) in Singapore (National Parks Board, 2023). It has been listed as a weed of uncertain origin (Chong et al., 2009) but was recognised as native in the Flora of Singapore checklist (Lindsay et al., 2022) on account of its widespread distribution throughout Malesia in a variety of open habitats such as "waste places, along road-sides, on dikes between fish-ponds near the sea, along the beach, in coconut plantations, as a weed in native gardens, in teak- and monsoon-forest, and in secondary growths, always as low altitude, usually near the sea" (van Borssum Waalkes, 1966). Some of such habitats, in particular, beach and secondary growth, were conceivably part of the original vegetation of Singapore. *Abutilon indicum* was listed as Nationally Extinct in Lindsay et al. (2022) as, at the time, there were no local collections known for more than 30 years since it was last reported from the Sungei Buloh Wetland Reserve (SBWR, previously known as the Sungei Buloh Bird Sanctuary) in 1991. Although there have been several past collections from Singapore, the specimens were all gathered 11–30 years apart from the preceding sample. It is likely that *Abutilon indicum* subsp. *indicum* is uncommon and sporadic in its occurrence, as it can hardly be missed by local collectors since it is a rather robust shrub with brightly coloured flowers. It is uncertain if it still survives in the vicinity of SBWR, as there have been no sightings or reports of its occurrence since 1991. Currently, it is only known from a single population from Coney Island. More intensive surveys will have to be conducted in areas surrounding SBWR and Coney Island to determine if there are other populations in the vicinity.

Proposed conservation measures. The sole known population of *Abutilon indicum* subsp. *indicum* currently sits on an area of Coney Island which is largely dominated by *Casuarina equisetifolia* L. This tree species, which is rather common along sandy coastal areas in Singapore, is known to inhibit seed germination as well as the growth of other plants in surrounding areas (Batish et al., 2001; Ahmed et al., 2019). The competitive advantage of *Casuarina equisetifolia* can be largely attributed to allelopathy (Batish et al., 2001) from compounds such as 2,4-DTBP (2,4-di-tert-butylphenol) and its

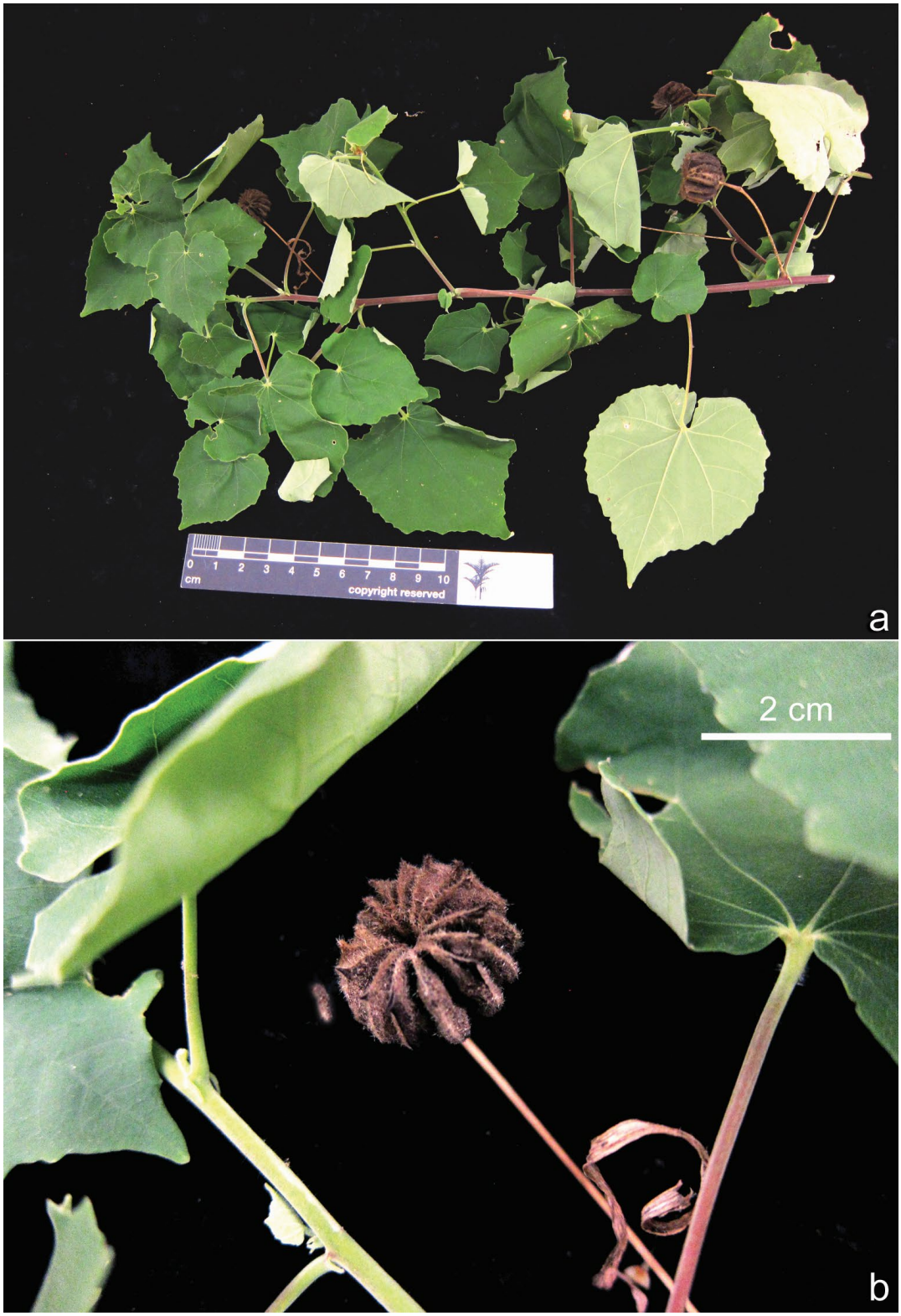

Fig. 1. *Abutilon indicum* subsp. *indicum.* a, Fruiting branch with several ripe capsules; b, Close-up of ripe capsule. All from Chen et al. LCMJ 2019-170 (SING). (Photographs by: WH Lim).

analogues, resulting from the decomposition of leaf litter by various fungal species (Xu et al., 2022). As the presence of *Casuarina equisetifolia* could potentially adversely affect the long-term survival and regeneration of the *Abutilon indicum* subsp. *indicum*, we recommend monitoring of the population on Coney Island, from which materials for propagation could be obtained. Selective removal of the *Casuarina* trees and replanting the area with other native species that are not known to be allelopathic could also be considered to aid conservation measures.

2. *Cyperus dubius* Rottb. (Cyperaceae) (Fig. 2)

As *Cyperus dubius* has already been treated in detail in the Cyperaceae accounts for both the Flora of China (Dai et al., 2010) and the Flora of Singapore (Simpson, 2019), only a brief description of the species is provided here. For a complete description and diagnostic characters of *Cyperus dubius*, see Dai et al. (2010) and Simpson (2019).

Rhizomatous herb. **Culms** to c. 50 cm tall, base bulbous. **Leaves** linear, 4.5–37.5 cm × 1.8–2 mm. **Inflorescence** capitate or ± globose-ovoid, 0.5–1.5 × 0.5–0.9 cm. **Glumes** greenish-white, broadly ovate to elliptic-lanceolate, c. 3 mm × 2 mm.

Distribution. Widely distributed species, occurring in tropical and South Africa across to tropical Asia, and native to Singapore (Simpson, 2019). The species has also been reported from southwest Asia (Yemen) and the Pacific Islands, and has naturalised in southeast Australia (Dai et al., 2010).

Ecology. Throughout its range, the species occurs on sandy areas near the seashore, although it can also be found further inland growing on rocky substrate or in crevices (Dai et al., 2010; Simpson, 2019). In Singapore, plants of *Cyperus dubius* were observed growing sporadically on the rock bunds at East Coast Park, while those at Changi Beach Park and Tanah Merah Coast Road were growing in sandy substrate.

Specimens examined. Singapore: Balestier, 1894, H.N. Ridley s.n. (SING [SING0004832]); Changi, November 1890, H.N. Ridley 1746 (SING [SING0004831]); Tanjong Katong, December 1920, H.N. Ridley s.n. (SING [SING0004830]); Geylang, 17 October 1932, Z. Teruya 1967 (SING [SING0057618]); East Coast Park, 25 October 2022, Y.W. Jong & O.X.J. Ong, SING 2022-993 (SING [SING0395003]); Tanah Merah Coast Road, 14 November 2022, Y.W. Jong LCMJ 2022-117 (SING [SING0395001]); Changi Beach Park, 24 February 2023, C.M. Boo LCMJ 2023-013 (SING [SING 0395005]); along Berlayer Creek, near former Keppel Club at Bukit Chermin Road, February 2023, Y.W. Jong SING 2022-1063 (SING [SING0395004]).

Provisional conservation assessment. Globally Least Concern (LC). In Singapore, it was last collected more than 90 years ago and presumed to be Nationally Extinct (Simpson, 2019; Lindsay et al., 2022), but the second author (Jong Ying Wei) and botanist Boo Chih Min recently collected this species from four locations situated near the coast: Changi Beach Park (CBP), Tanah Merah Coast Road (TMCR), East Coast Park (ECP) and Berlayer Creek (BC) near the former Keppel Club.

Based on preliminary observations, only the population that sits on an area designated by the staff of CBP for ‘re-wilding’ purposes (Siti Syakirah Muhammad, pers. comm.) could be viable in the long term, as it has the largest number of individuals (estimated to be about 200+ plants) and is free from intensive horticultural management practices such as grass cutting. However, most of the plants in CBP are growing under the shade of *Casuarina equisetifolia* trees. Although this appears to help *Cyperus dubius* escape competition from fast growing and more aggressive grass species such as *Ischaemum muticum* L., its survival and regeneration may be hampered in the long run as *Casuarina equisetifolia* is known to exhibit allelopathy (Batish et al., 2001, see details in ‘Proposed conservation measures’ under *Abutilon indicum* subsp. *indicum*). Furthermore, as the largest population of *Cyperus*

Fig. 2. *Cyperus dubius*. a, Plant growing on humus collected in rock crevices at East Coast Park (ECP); b, Close-up of inflorescence of an individual at Changi Beach Park (CBP), inset showing the same plant growing on soil. (Photographs by: YW Jong).

dubius in CBP is growing directly underneath the *Casuarina equisetifolia* trees, they can be vulnerable to being wiped out in the event of a tree fall.

As for the other three sites (TMCR, ECP and BC) from which *Cyperus dubius* has been recently recorded, these are likely to be subjected to varying levels of habitat disturbance in the near future. The southeastern shoreline, and particularly the Changi and ECP areas, were previously identified as being vulnerable to sea-level changes, and studies on the possible deployment of coastal or flood protection measures are currently underway (Public Utilities Board, 2021; The Straits Times, 2022; Channel News Asia, 2023), whereas the other site at BC has already been selected for construction of public housing (Channel News Asia, 2022; Urban Redevelopment Authority, 2023). Furthermore, only 5–10 individuals of the species have been recorded at each of these sites and could be easily extirpated even by minor disturbances to these areas. As the existing plants are restricted in their occurrence, and are at high risk of decline due to both natural factors (e.g., 'exterminated' by alleopathic plants, flooding due to climate change) as well as developmental pressures, *Cyperus dubius* is thus assessed here as Critically Endangered (CRB1b(iii, iv)c(iii)) in Singapore.

Proposed conservation measures. Selective maintenance should be carried out at the 're-wilding' zone at CBP periodically to remove some of the more 'aggressive' plant species such as *Ischaemum muticum* that will easily outcompete *Cyperus dubius* and threaten its long-term survival. As the plants growing in the shade of the *Casuarina equisetifolia* trees are not likely to persist in the long run, it is recommended that the individuals be gradually relocated to other areas with suitable growing conditions (e.g., areas near the coast on Pulau Ubin) for the establishment of new populations. Replacing the *Casuarina equisetifolia* trees with other smaller and equally effective sand-binding coastal plant species that will not inhibit the growth of *Cyperus dubius* could be considered as an additional alternative measure. Plants can also be collected for propagation in the Native Plant Centre of the National Parks Board and reintroduced to other suitable habitats thereafter.

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