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Additions to the Flora of Singapore: New and overlooked records of casual and naturalised plant species (5)

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Abstract. Four non-native plant species, *Coccoloba uvifera* L., *Echinodorus grandiflorus* (Cham. & Schltdl.) Micheli, *Euphorbia opthlamica* Pers. and *Richardia scabra* L., from the families Polygonaceae, Alismataceae, Euphorbiaceae and Rubiaceae, respectively, are new records for the spontaneous flora of Singapore. *Coccoloba*, *Echinodorus* and *Richardia* are new generic records.

Key words. aquarium plants, aquatic plants, casual, escape from cultivation

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INTRODUCTION

This paper belongs to a series dealing with the naturalised flora of Singapore to better document its diversity with proper specimen records. So far, 24 species have been added to the non-indigenous species of Singapore in the first four parts of this series (Chen et al., 2018a; Chen et al., 2018b, Chen et al., 2020, Choo et al., 2020). In this fifth part, four more species—of which three are new generic records—are reported here for Singapore as part of this ongoing project. A brief description is provided for each new record based on the respective specimens studied (cited in the text). Specimens are deposited in the herbarium of the Singapore Botanic Gardens (SING).

NEW RECORDS OF NATURALISED PLANTS IN SINGAPORE

1. *Coccoloba uvifera* (L.) L., Syst. Nat. ed. 10. 2: 1007 (1759) (Polygonaceae)

(Fig. 1)

Description. Juvenile tree: Stems yellowish-brown to brown, lenticellate; ocrea cylindrical, c. 4–5 mm in length. Leaves leathery, lamina transversely elliptic, 17.5–19 × 19.5–23.5 cm, bright orange-red when young, turning bluish-green to green on adaxial surface and dull light green on abaxial surface with age, veins orange-red, base ± cordate, apex rounded, margin entire to revolute; petioles c. 1.5 cm long.

Taxonomic notes. The above description was made from saplings within the vicinity of the parental populations, which were in fruit at the time of collection, at Kallang Riverside Park and St. John's Island. The leaves and the ochrea match the description given by Freeman (2005). For a full description of adult trees, see Freeman (2005).

Distribution. *Coccoloba uvifera* is native to Mexico, Central and South America and the West Indies (Freeman, 2005). This small tree species is cultivated in Thailand and Vietnam (Ho, 1999; Kantachot et al., 2018), as well as in the Philippines, where it is grown for its edible fruit (Jansen et al., 1991).

Occurrence in Singapore. This species is cultivated (Chong et al., 2009) as an ornamental and is grown mainly in parks near the coast or areas with sandy soil.

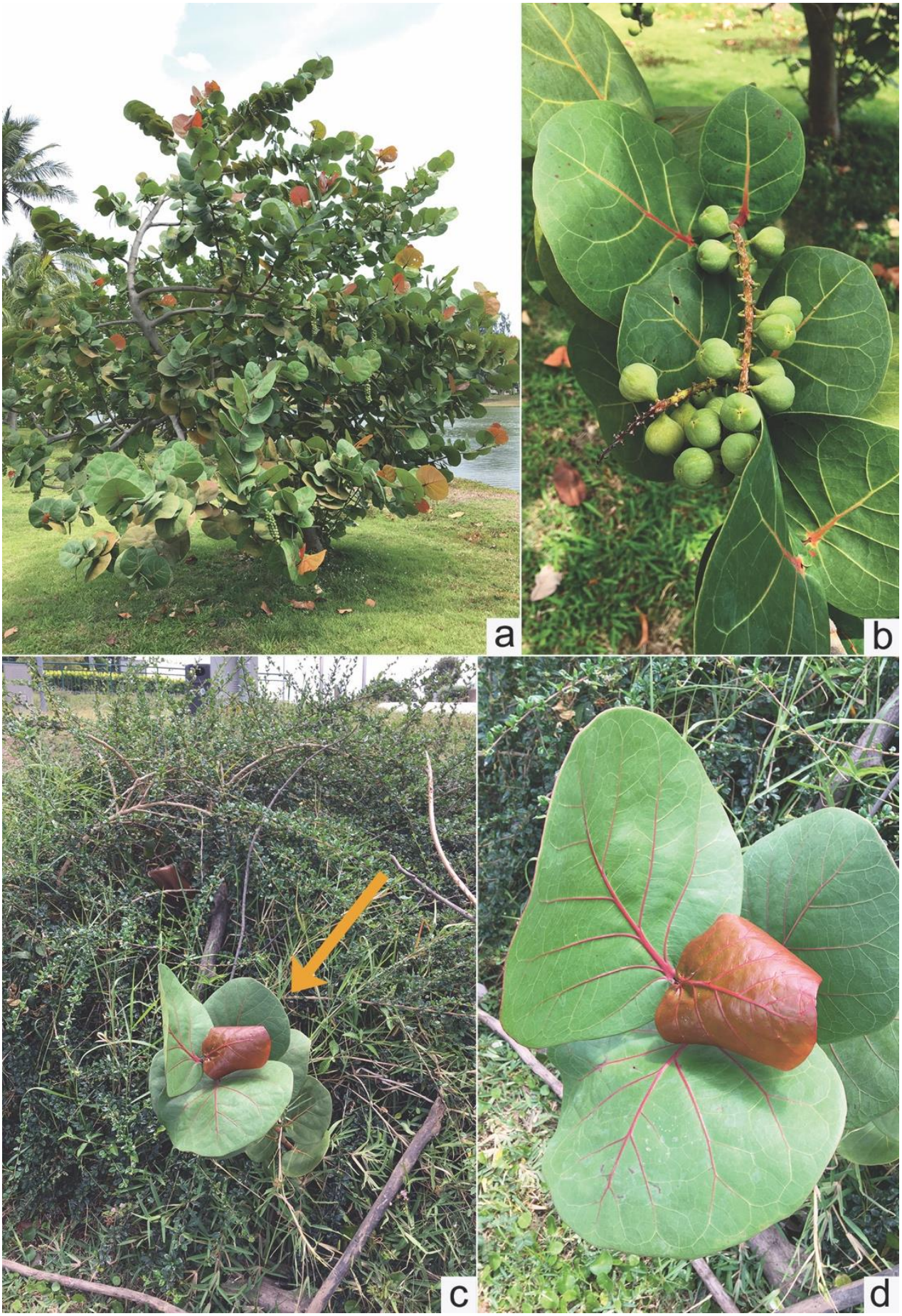

Fig. 1. *Coccoloba uvifera* L. in Kallang Riverside Park. a, one of several cultivated specimens present along the banks of the Kallang River; b, fruiting branch of cultivated specimen; c, sapling growing alongside a self-sown specimen of *Ehertia microphylla* Lam.; d, close-up of sapling. c, d from Chen LCMJ2020-051 (SING). (Photographs by: L. M. J. Chen).

Local status. Casual—seedlings and large saplings (to c. 1.2 m tall) of this species have been observed on St John's Island, where they grow relatively unmolested near the beaches and rock embankments. It is likely that, with time, this species will also become established on this offshore island, alongside other exotic species such as *Chrysobalanus icaco* L. (Chrysobalanaceae).

Specimens examined. SINGAPORE: St. John's Island, 6 August 2019, Chen, L.M.J. et al. LCMJ2019-038 (SING, 2 sheets); Kallang Riverside Park, 7 February 2020, Chen, L.M.J. LCMJ2020-051 (SING, sapling); Kallang Riverside Park, 7 February 2020, Chen, L.M.J. LCMJ2020-052 (SING, fruiting, cultivated specimen).

2. *Echinodorus grandiflorus* (Cham. & Schltdl.) Micheli in A.DC. & C.DC., Monogr. Phan. 3: 57 (1881) (Alismataceae)
(Fig. 2)

Description. Large aquatic herb to 60 cm tall. Leaves emersed, lamina ovate to broadly ovate, 15–18 × 9.8–12.7 cm, apex acute, base subcordate, veins 7–10, sparse stellate hairs present on mid rib and veins, more prominently so on the abaxial surface, pellucid markings on leaf blade present as dots and lines; petioles 80–90 cm long, sparsely stellate hairy, winged at base. Inflorescence emerging well above the leaves, paniculate, c. 30–50 × 15 cm, with 7–8 whorls of flowers, each whorl 5–11 flowered, peduncles c. 60 cm long, rachis stellate pubescent. Flowers white, c. 3 cm across when fully opened; pedicel c. 3 cm long, sparsely stellate hairy; sepals ovate, c. 7 × 5 mm, with raised veins, sparsely hairy on the outer surface, margins ± hyaline; stamens 16–25, anthers yellow, oblong, c. 2 mm long; carpels numerous (> 100), yellow, c. 1 mm long. Fruit oblanceoloid, ribbed, tapering to a beak, c. 4 × 1 mm, with 2–3 glands scattered between the ribs.

Taxonomic notes. The genus *Echinodorus* is one of the most economically important groups of plants in the aquarium plant trade (Lehtonen & Falck, 2011). The large numbers of hybrids and cultivars introduced to the trade can make it a challenge to name plants in cultivation (Lehtonen & Falck, 2011), and will likely pose difficulties for the identification of plants that have escaped cultivation. For our current paper, we have identified the escaped plants at Kallang Riverside Park as *Echinodorus grandiflorus* based on the following characters: i) a relatively large leaf blade of more than 15 cm in length; ii) the presence of pellucid markings that are present as "dots and dashes" on the leaf blade; and iii) the large, erect paniculate inflorescence that is about 1 m tall.

A new combination for the species, *Aquarius grandiflorus* (Cham. & Schltdl.) Christenh. & Byng, has recently been proposed (Christenhusz et al., 2018) based on the interpretation that the type species, *Echinodorus berteroi* (Spreng.) Fassett, "is often found separated from the remainder of *Echinodorus*", primarily in reference to Lehtonen & Myllys (2008). Although the nuclear DNA-based analysis in Lehtonen & Myllys (2008) showed that *Echinodorus* is paraphyletic, they and subsequent papers (Lehtonen, 2009a; Lehtonen & Falck, 2011) consider the monophyly of *Echinodorus* from total-evidence analysis—combining data from nuclear and plastid DNA as well as morphology—to be the most reliable hypothesis of the phylogenetic relationships of *Echinodorus*, where *E. berteroi* is sister to the remaining species of the genus. Thus, we retain the use of the name *Echinodorous grandiflorus* (Cham. & Schltdl.) Micheli in A.DC. & C.DC.

Distribution. This species is native to the South American Atlantic Coast (Lehtonen, 2009a). It has also naturalised in Florida, where the population is believed to have been either a result of an "accidental" escape from cultivation, or deliberately introduced by aquatic farms seeking to "farm" such plants for a guaranteed supply and to lower production costs (Lehtonen, 2009b).

Occurrence in Singapore. Members of the genus *Echinodorus* are sold in many local aquariums and nurseries as ornamentals for aquascaping and in water features (L. M. J. Chen, pers. obs.). Despite their popularity in the horticultural and aquarium trade, only *Echinodorus palaefolius* (Nees & Mart.) J.F.Macbr. is listed in an earlier checklist (Chong et al., 2009), and only as an exotic in cultivation.

Local status. Casual—the species is currently known from a single population of about 15 adult plants on a muddy riverbank alongside apparently self-sown *Ipomoea aquatica* Forssk. (Convolvulaceae) and *Colocasia esculenta* (L.) Schott (Araceae).

The current population has been observed to reproduce vegetatively, via plantlets produced on the rachis of older inflorescences that root as soon as the rachis bends downwards and touches suitable substrate. While plants in the existing population are also producing fruits, we have not observed any other plants along the riverbanks in the park thus far. This could be due to "physical barriers", as most of the riverbanks in the park have either been reinforced with riprap, or have steep, vertical inclines, or are made up of pure, coarse sand, all of which could hamper seedling establishment. We thus consider the species to be 'Casual' in occurrence until there is further evidence to support its spread and naturalisation.

Specimens examined. SINGAPORE: Kallang Riverside Park: opposite Old Terminal Lane (road), 31 May 2018, Chen, L.M.J. LCMJ2018-001 (SING, 3 sheets).

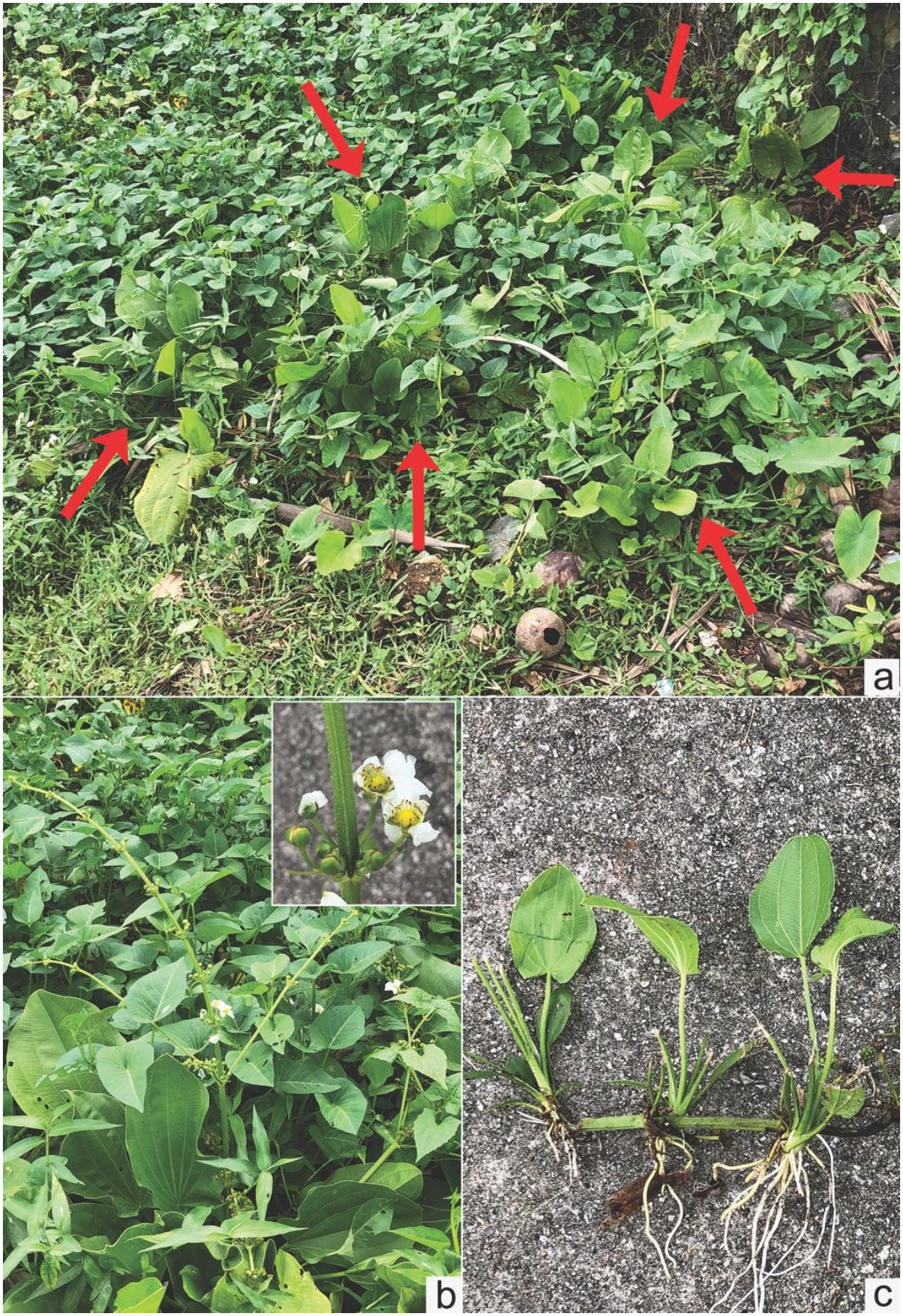

Fig. 2. *Echinodorus grandiflorus* (Cham. & Schltdl.) Micheli. a, escaped individuals growing with other weedy species along a riverbank in Kallang Riverside Park—red arrows indicate some of the adult plants present; b, plant with inflorescence with inset showing close-up of flowers; c, plantlets produced on rachis of old inflorescences aid in vegetative reproduction of the species. a–c from Chen LCMJ2018-001 (SING). (Photographs by: L. M. J. Chen).

Fig. 3. *Euphorbia ophthalmica* Pers. a, plants (indicated by red arrows) growing as a lawn weed in the Singapore Botanic Gardens. b–d from Woodlands Town Park East; b, branch with terminal inflorescence; c, d, close-up of inflorescence. (Photographs by: L. M. J. Chen [a]; K. H. Ong [b–d]).

3. *Euphorbia ophthalmica* Pers., Syn. Pl. 2: 13 (1806) (Euphorbiaceae)
(Fig. 3)

Description. Terrestrial herb 5–17 cm tall; flowering and fruiting from c. 3 cm tall. Stems prostrate to ascending, branching dichotomously along the middle and upper nodes, red, green, or green tinged with red, sparsely to densely villous; stipules interpetiolar, subulate, bifid to bipartite, hirsute, c. 0.7–1 mm long. Leaves: lamina 5–23 × 4–9 mm, ± elliptical to rhombic, adaxial surface mid-green or dull reddish-brown, sparsely hirsute or ± glabrous, abaxial surface sparsely to densely hirsute, margins tinged with red, ± serrate, apex acute or obtuse, base oblique; petioles 0.8–2 mm. Inflorescence in dense, terminal heads on peduncles to 8 mm long. Involucre obconical, c. 0.8 × 0.7 mm; 5-lobed, lobes subulate; glands 4, pinkish-orange to dark red, shallowly cupuliform. Staminate flowers: 4–5 per cyathia, pedicels 0.4–0.5 mm. Pistillate flowers: Pedicels 0.4–0.5 mm long; ovary strigillose; styles 0.2–0.5 mm long, bifid ½ way to about ¾ of its length, tips clavate, red to dark red. Capsules ovoid, strigillose, c. 1–1.2 × 1–1.3 mm. Seeds orange-brown, 0.7–1 mm long.

Taxonomic notes. This species can be distinguished from the similar but more common and widespread *Euphorbia hirta* L. by the branching pattern and position of the inflorescences. *Euphorbia ophthalmica* exhibits dichotomous branching from the middle and upper nodes of the stem, and the capitate cyathia are terminal, whereas *Euphorbia hirta* branches only at the lower nodes near the base of the stems, and the inflorescences are axillary.

Distribution. Native and widespread in the Neotropics, where it can be found in southeastern United States, southern Mexico to Ecuador (Steinmann et al., 2016) and Argentina (Halford & Harris, 2012), although there is some uncertainty as to whether the species is native to the United States (Steinmann et al., 2016). Outside of its native range, it has been recorded as having naturalised in New South Wales in Australia (Hosking et al., 2001; Halford & Harris, 2012; PlantNET, 2021) and Italy (Mugnai et al., 2021).

Occurrence in Singapore. The second author first documented the species via his website ('The Plant Observatory') from several populations that were growing in Woodlands Town Park East in 2017, but he did not collect any voucher specimens. Voucher specimens of the species were subsequently acquired recently from various places (see cited specimens), confirming its presence and spread in Singapore. We have subsequently located this species in the Khatib area, Choa Chu Kang Park, Cluny Road, Pasir Panjang and in the Singapore Botanic Gardens.

Local status. Naturalised—this species can often be found growing alongside *Euphorbia hirta*, which it resembles (see 'Taxonomic notes').

Specimens examined. SINGAPORE: Bah Soon Pah Road (Khatib), 9 December 2020, Chen, L.M.J. LCMJ2020-091 (SING); Choa Chu Kang Park, 26 June 2020, Chen, L.M.J. LCMJ2020-076 (SING); Pasir Panjang Nursery, 13 January 2021, Chen, L.M.J. & Ho, B.C. LCMJ2021-001 (SING); NUS Bukit Timah Campus, 5 July 2020, Chen, L.M.J. LCMJ2020-086 (SING); Cluny Road, 10 July 2020, Chen, L.M.J. LCMJ2020-087 (SING); Singapore Botanic Gardens, 18 April 2020, Chen, L.M.J. LCMJ2020-065 (SING); ibid., 18 July 2020, Chen, L.M.J. LCMJ2020-088 (SING).

4. *Richardia scabra* L., Sp. Pl. 1: 330 (1753) (Rubiaceae)
(Figs. 4, 5)

Description. Terrestrial herb. Stems prostrate or decumbent, c. 15–30 cm long, 4-angled, green with purple on the ridges, or completely reddish-purple, densely hirsute with long hairs to c. 2 mm long; stipules fused to form a stipular sheath, sheath 3–4 mm wide, usually with five 2–5 mm long setae. Leaves: lamina ovate to elliptic-lanceolate, 1.6–5.7 × 0.6–2.2 cm, sparsely to densely scabrous on both surfaces, more so on the veins, apex acute to obtuse, base attenuate; petioles 2–5 mm long or long attenuate. Inflorescence a many-flowered capitula with two pairs of decussate, ovate to broadly ovate bracts, the inner pair smaller than the outer. Flowers white, usually 20 or more in each capitula; calyx lobes 5–7, green, 2–3 × 0.8–1 mm, margins often tinged dark red, ciliate; corolla white, ± funnelform, tube 4–5 mm long, lobes 6, 1.2–2 × 0.8–1 mm, ± glabrous or with conspicuous tufts of hairs near the tips. Mericarps 3, 2–2.5 mm × 0.8–1.3 mm, oblong to ± obovate, abaxial surface densely papillose and with ± ovoid excrescences, adaxial surface less so, closed to a narrow groove.

Taxonomic notes. *Richardia scabra* can be easily separated from *Richardia brasiliensis* Gomes—a similar looking species that has widely naturalised in the tropics (Lewis & Oliver, 1974) but is not yet seen in Singapore—by the mericarps; in *Richardia scabra*, the adaxial face of the mericarp is closed to a narrow median groove (Fig. 5b; see also Lewis & Oliver, 1974: fig. 8), whereas in *Richardia brasiliensis*, the adaxial face is broad and with a median keel (Lewis & Oliver, 1974: fig. 9). In Singapore, some species in the genus *Spermacoce* L. may be somewhat similar to *Richardia scabra*, but they can be easily distinguished from each other. In *Richardia scabra*, the inflorescences are placed in terminal capitula, the number of corolla lobes vary from 5 to 8, but are predominantly 6-lobed, and the fruits dehisce into 3–6 mericarps (Lewis & Oliver, 1974). The species of *Spermacoce* recorded from Singapore thus far (see Wong et al., 2019, for the complete list of *Spermacoce* species) have both axillary and terminal inflorescences on the same stem, corollas are 4-lobed, and the fruits are 2-valved capsules dehiscing septicidally (Wong et al., 2019).

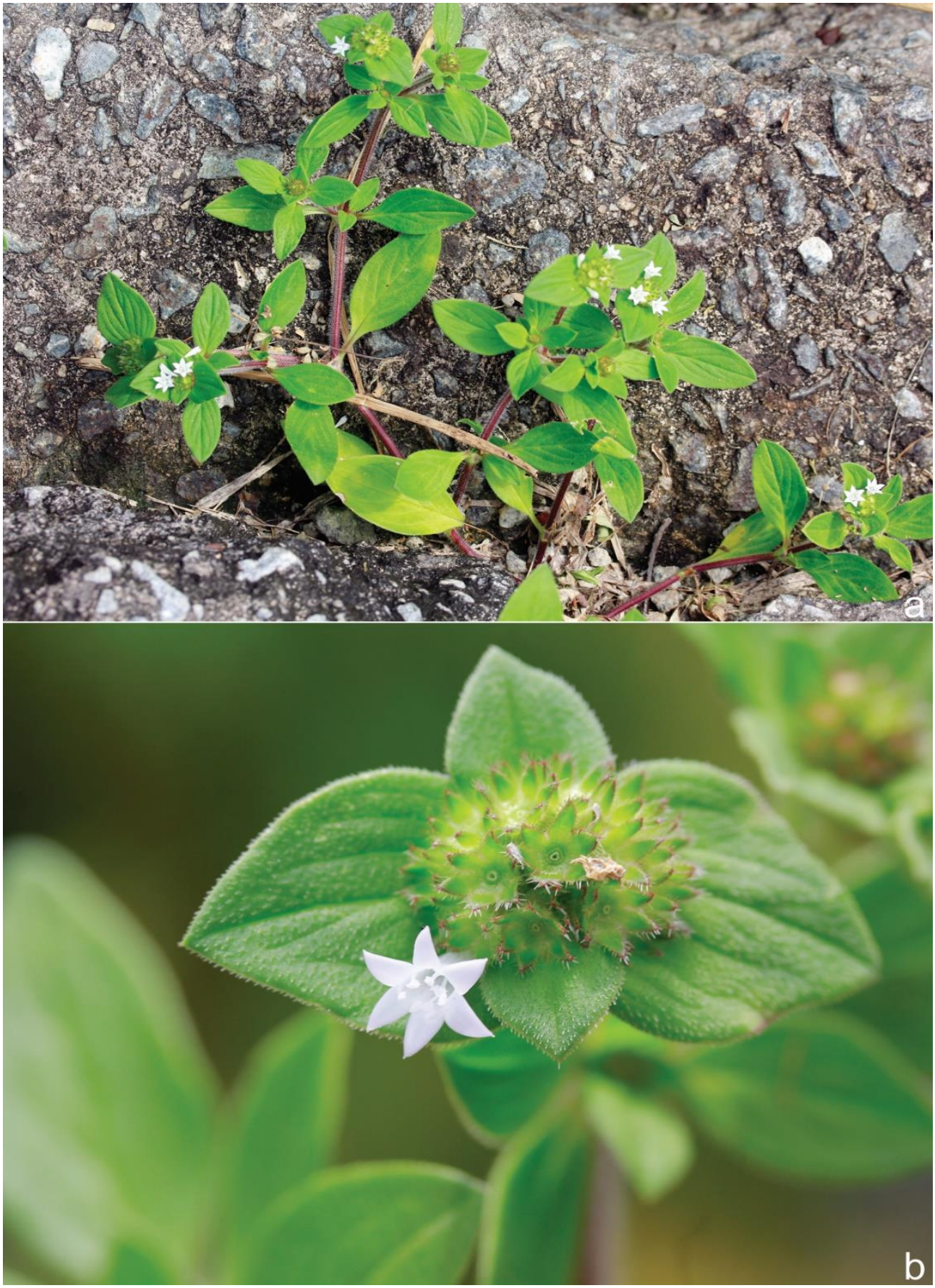

Fig. 4. *Richardia scabra* L. in Bishan-Ang Mo Kio Park. a, plant growing in a crevice on a rock embankment; b, capitula with open flower, subtended by the involucral leaves. (Photographs by: L. M. J. Chen).

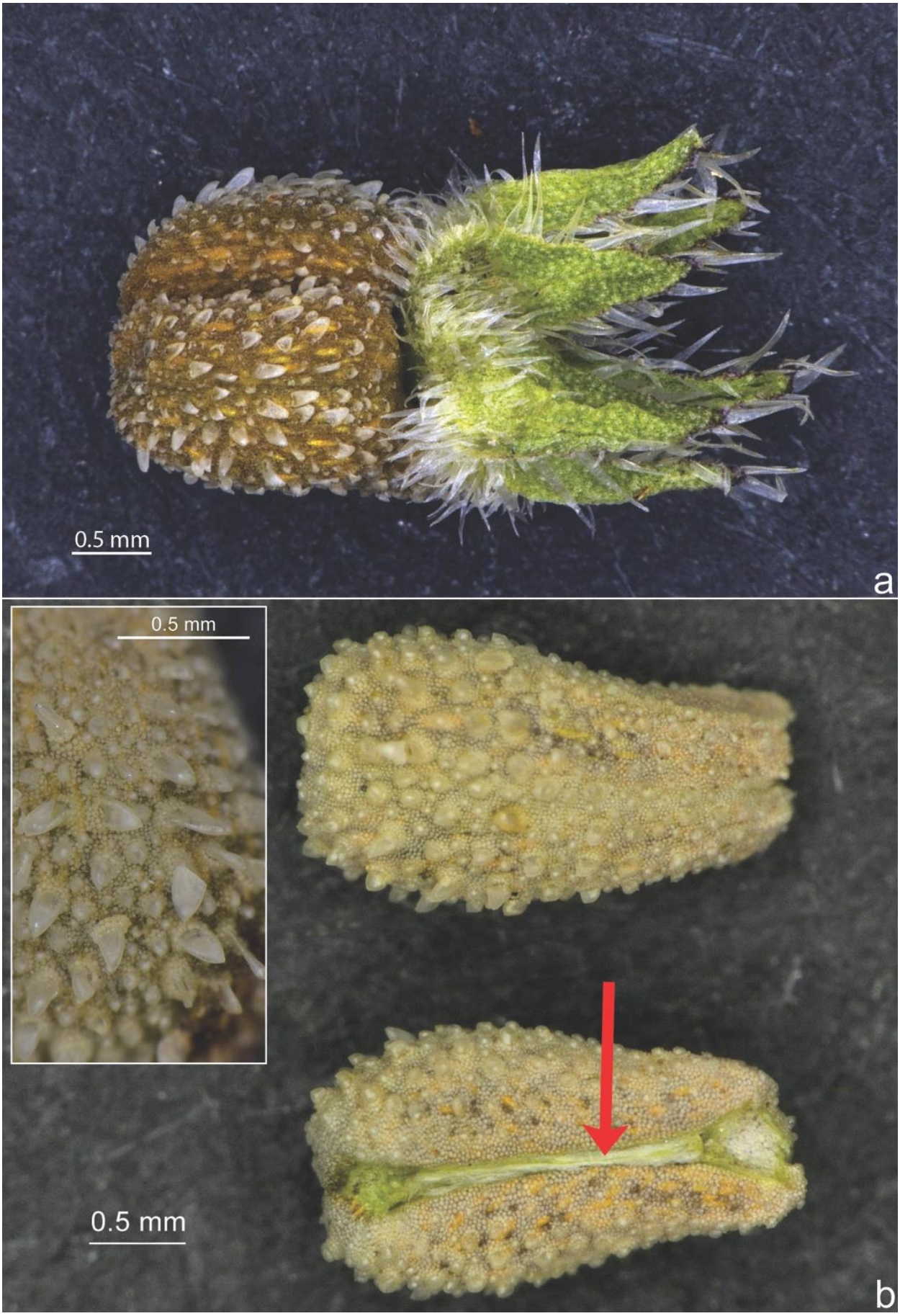

Fig. 5. *Richardia scabra* L. a, fruit with persistent calyx; b, dorsal (top) and ventral (bottom) view of mericarps—red arrow indicates the groove on the adaxial surface that distinguishes this species from *Richardia brasiliensis* Gomes; inset shows a close-up of the excrescences on the dorsal surface of the mericarp. a, b from Lua SING2018-148, inset (b) from Chen SING2017-694. (Photographs by: B. H Tan & S. L. Koh).

Distribution. Native to tropical and warm temperate areas of the Americas (Lewis & Oliver, 1974). It has naturalised in Zimbabwe, Tanzania and Transvaal in southern Africa (Lewis & Oliver, 1974), Hawaii (Imada, 2012), Japan (Mito & Uesugi, 2004) and Taiwan (Wu et al., 2010). It was introduced to southern China in the 1980s and has since naturalised in Guangdong, Hongkong and Hainan (Lo, 1999; Chen & Taylor, 2011).

Occurrence in Singapore. The second author first provided a photographic record of this species in Singapore on his website ('The Plant Observatory') in 2007 from plants observed around the Sembawang area. Voucher specimens of the species were subsequently acquired from 2017 onwards. Rather depauperate specimens of this species have also been collected along the sandy banks of Kallang Riverside Park, where they appear to be much diminished in stature. This is likely due to the impoverished substrate in which they were growing.

Local status. Naturalised—this species appears to be drought-tolerant and is usually found in areas with well-drained substrate or on rock embankments. This species can form large, spreading mats where growing conditions are ideal.

Specimens examined. SINGAPORE: Bishan-Ang Mo Kio Park, 16 November 2017, Chen, L.M.J. SING2017-694 (SING); 26 September 2018, Chen, L.M.J. et al. LCMJ2018-048 (SING); ibid., 29 May 2019, Chen, L.M.J. & Lee, J.J.R. LCMJ2019-109 (SING, 2 sheets); Changi Beach Park, 20 March 2018, Ho B.C. & Yeo R.S.W. LCMJ2018-059 (SING), ibid., 20 March 2018, Ho B.C. & Yeo R.S.W. LCMJ2018-060 (SING); ibid., 17 October 2020, Choo, L.M. LCMJ2020-090 (SING, 2 sheets); Kallang Riverside Park, 7 February 2020, Chen, L.M.J. LCMJ2020-049 (SING); Pulau Seringat, 6 February 2018, Lua, H.K. SING2018-148 (SING, 2 sheets); Lazarus Island, 6 August 2018, Chen, L.M.J. et al. LCMJ2019-142 (SING).

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