

Flora of Singapore precursors, 31: The genus *Boerhavia* (Nyctaginaceae) in Singapore and clarification of *Boerhavia diffusa* in Singapore and Peninsular Malaysia

L.M. Choo¹, L.M.J. Chen¹ & I.M. Turner^{1,2}

¹Singapore Botanic Gardens, National Parks Board,
1 Cluny Road, Singapore 259569, Singapore
choo_le_min@nparks.gov.sg

²Singapore Botanical Liaison Officer,
Royal Botanic Gardens, Kew, Richmond,
Surrey, TW9 3AE, UK

ABSTRACT. Past studies of the genus *Boerhavia* in Singapore have listed *Boerhavia diffusa* L. as the only *Boerhavia* species with glandular anthocarps in Singapore. However, recent field collections and a study of herbarium specimens have uncovered the presence of two taxa hitherto included under the name '*Boerhavia diffusa*' in Singapore. All material previously identified as *Boerhavia diffusa* in Singapore is *Boerhavia repens* L. More recently collected material, however, is the first actual material of *Boerhavia diffusa* for Singapore and is consequently a new record. A similar misapplication of the name *Boerhavia diffusa* also applies in Peninsular Malaysia. In light of this nomenclatural confusion pertaining to specimens in Singapore and Peninsular Malaysia, we clarify the use of the name *Boerhavia diffusa* L., resurrect the use of the name *Boerhavia repens* L., and provide a taxonomic revision and identification key for *Boerhavia* in Singapore.

Keywords. *Boerhavia repens*, cryptogenic, misapplied name, naturalised, new record

Introduction

Boerhavia L. is a genus of unarmed herbs from the family Nyctaginaceae found across tropical and subtropical regions across the world, commonly as weeds. The genus is characterised mainly by its anthocarps, which are fruits formed from the lower part of the perianth, with the upper petaloid part of the perianth shrivelling after anthesis and falling off as the fruit develops. These anthocarps are the dispersal units of the plant, are 5-ribbed and often viscid with stalked or sessile glands, or straight glandular hairs. There are currently 61 accepted species in this genus (POWO, 2021) but a recent monograph to more accurately assess the species across the genus is lacking.

In Singapore, two species of *Boerhavia* have historically been recorded, namely *Boerhavia diffusa* L. and *Boerhavia erecta* L. *Boerhavia erecta* can be recognised by its glabrous anthocarps. It was known from a very restricted distribution along railway lines in Telok Ayer and the current Keppel area from 1941 to 1965 but has not been collected or seen since then and is regarded as historically casual (Lindsay et al., 2022). The second species of *Boerhavia*, with glandular anthocarps, has been referred

to as *Boerhavia diffusa* (Ridley, 1924; Stemmerik, 1964). It is known from a more extensive local distribution and from herbarium collections over a longer period, as recorded in literature such as Ridley (1924), Keng (1990), Turner et al. (1990), Turner (1993), Turner & Tan (1994), and Chong et al. (2009). However, recent opportunistic collections of spontaneously occurring wildflowers in Singapore has uncovered another species of *Boerhavia* with glandular anthocarps that otherwise do not match the morphology of the plant hitherto known as '*Boerhavia diffusa*' in Singapore. A study of specimens from Peninsular Malaysia has similarly uncovered the presence of two taxa under the name '*Boerhavia diffusa*'. In light of this taxonomic confusion pertaining to specimens in Singapore and Peninsular Malaysia, we clarify the use of the name *Boerhavia diffusa* L., resurrect the use of the name *Boerhavia repens* L., formerly included in synonymy of *Boerhavia diffusa*, and provide a taxonomic revision and identification key for *Boerhavia* species in Singapore.

History and usage of the names *Boerhavia diffusa* L. and *Boerhavia repens* L.

The names *Boerhavia diffusa* and *Boerhavia repens* were first validated by Linnaeus (1753), but with very sparse descriptions of 'caule diffuso [diffuse stems]' and 'caule repente [creeping stems]' respectively. Lamarck (1791) appears to have been the first to combine the two species, making *Boerhavia repens* a synonym of *B. diffusa*. Subsequently, authors have varied in whether they recognised one or two species. In local treatments, a broad view of *Boerhavia diffusa* has prevailed. Gamble (1912) in his treatment in the *Materials for a Flora of the Malay Peninsula* synonymised the name *Boerhavia repens* under *Boerhavia diffusa*, while recognising *Boerhavia diffusa* as the only species present in the Malay Peninsula at that time. Ridley (1924) similarly retained *Boerhavia repens* under *B. diffusa*. This was likewise followed by Stemmerik (1964) in his *Flora Malesiana* treatment. Stemmerik used a very broad species concept, considering *Boerhavia* to consist of only three species in Malesia. He included *Boerhavia acutifolia* (Choisy) J.W.Moore, *B. diandra* L., *B. glabrata* Blume, *B. mutabilis* R.Br., *B. procumbens* Roxb. ex R.Br. and *B. tetrandra* G.Forst. as synonyms of *B. diffusa*, all of which are now often considered as distinct species in modern accounts.

However, Stemmerik's (1964) view was not shared by other authors working on the genus outside of Asia. Meikle (1954), Codd (1966) and Whitehouse (1996), in their respective treatments of the genus for various parts of Africa, kept *Boerhavia repens* and *B. diffusa* as separate, with *B. diffusa* being the taxon with flowers in lax, much-branched cymes resembling terminal panicles, and *B. repens* being the taxon with axillary clusters or short cymes. This was echoed by Fosberg (1978), who found *Boerhavia diffusa* and *B. repens* to be separate taxa which can be divided based on the 'strictly terminal paniculate inflorescences' for the former and 'axillary pendunculate cymes or umbels' for the latter. However, he noted that the two species could be confused with each other 'in populations of *B. repens* where repeated branching takes place distally, giving a paniculate appearance', but that 'the presence of axillary peduncles

with umbellate or glomerulate inflorescences on the median parts of the plant' is a key distinguishing feature for *B. repens*. A conserved type specimen designated by Whitehouse (1998) further fixed the application of the name *Boerhavia diffusa* to the taxon with a 'terminal paniculate inflorescence'.

Later accounts by other workers have also accepted *Boerhavia diffusa* and *B. repens* to be separate, such as Lu & Gilbert (2003) for China, Chen & Wu (2007) for Taiwan, and Struwig & Siebert (2013) for Southern Africa. However, Larsen (1991) for Thailand and Rafidah (2017) for Peninsular Malaysia used the broader concept of *Boerhavia diffusa* to include *B. repens*.

A key difficulty with working on this genus is that the anthocarps, along with the glands on them, and the glands and hairs on other parts of the plants, are very small and can be challenging to discern on old or digitised herbarium specimens. As descriptions of the plants in the protologues were sometimes quite vague or subjective, type specimens are all the more important to determine the correct application of a name. Also, as many *Boerhavia* species are pantropical weeds, a certain level of variation within a species is to be expected. With recent collections and colour photographs, along with the conserved type in Whitehouse (1998) fixing the application of *Boerhavia diffusa*, it has been ascertained that what was formerly known as *B. diffusa* in Singapore is in fact *B. repens*. However, although it may appear rather counterintuitive due to confusion over the name, recent collections of plants that really are *Boerhavia diffusa* mean that this species is newly recorded for Singapore.

Methods

Field collections of *Boerhavia* specimens were made around Singapore. All measurements were taken from freshly collected specimens with the exception of *Boerhavia erecta* which is no longer extant in Singapore. Morphological comparisons between *Boerhavia diffusa* and *Boerhavia repens* are detailed in Table 1. As noted in Spellenberg (2000), flowers of *Boerhavia* are fully open in the morning, but as the day progresses the flower parts become compacted and shrink as the flower closes by the late afternoon. Therefore, collections and observations were made in the earlier part of the day whenever possible.

All specimens of *Boerhavia* from Singapore and Peninsular Malaysia in the BM, K and SING herbaria were also studied. It was found that *Boerhavia diffusa* had only been collected in Singapore from 2020, while in Peninsular Malaysia the species had been recorded once in 1935, again in 1980, and all other collections were recent, between 2006 and 2015. The determinations of the Peninsular Malaysian specimens are also noted along with the specimens from Singapore in the taxonomic treatment below. This suggests that *Boerhavia diffusa* may be an increasingly common weed in both Singapore and Peninsular Malaysia. We have refrained from updating the treatment of the genus for Peninsular Malaysia as this would require studies of more herbarium specimens, notably from KEP, and field surveys to establish the distribution and abundance of *Boerhavia diffusa* compared to the previously recorded species *B. repens*.

Table 1. Comparison of *Boerhavia diffusa* L. with *Boerhavia repens* L.

Character	<i>Boerhavia diffusa</i>	<i>Boerhavia repens</i>
Habit	Decumbent herb with robust, erect inflorescences to 50 cm	Generally prostrate herb with inflorescences held on short stalks not far from the ground, ends of the stems somewhat decumbent, rarely seen with erect inflorescences to 30 cm when mature and growing in undisturbed places
Stems	Hairy with small erect glandular hairs	Pubescent to puberulous all over with short, simple adpressed hairs or strigose hairs, and longer incurved multicellular hairs which form a small tight curve when dry
Leaf margin	Pubescent with multicellular glandular hairs 0.3–0.5 mm long	Finely serrulate with purplish tips ending in a short, tightly incurved hair, sometimes sparsely interspersed with 0.1–0.2 mm long, slightly strigose hairs
Inflorescences	Terminal compound cymes, rarely axillary in immature plants, branching and developing new compound cymes from the axils of existing inflorescence branches, causing it to sometimes resemble a panicle in form, to 50 cm long	Mostly axillary simple or compound cymes, rarely terminal towards the distal ends of the stem
Upper petaloid portion of perianth	Crimson to magenta	Pink to pale purple
Filaments	Crimson to magenta throughout, 1.2–1.3 mm long	Magenta, fading pale purple to white at both ends, 1.3–2 mm long
Anthers	Crimson to magenta	Yellow
Style	Crimson as in filaments but fading to white at the base, 1.4–1.6 mm long	Pale purple and fading to white at the base as in the filaments, 1.6–2.2 mm long
Stigma	Crimson to magenta	Pale purple
Anthocarp shape	Obovoid, apex rounded when fresh but shortly umbonate when dry	Ellipsoid, apex rounded to acute
Anthocarp size	Mature size c. 4 × 1.5–1.6 mm	Mature size 2.9–3.5 × 1–1.3 mm
Anthocarp hairs	Ribs prominently and densely dotted with stalked glandular hairs, furrows very sparsely dotted with shortly stalked glandular hairs and covered with very small narrowly conical papillae	Both ribs and furrows densely dotted with stalked glandular hairs and ribs also interspersed with straight multicellular hairs

Taxonomic treatment

Boerhavia L., Sp. Pl. 1: 3 (1753); Choisy, Prodr. 13(2): 449 (1849); Boissier, Fl. Orient. 4: 1044 (1879), p.p.; Hooker, Fl. Brit. India 4: 708 (1885), p.p.; Ridley, Fl. Malay Penins. 3: 1 (1924), p.p.; Gamble, J. Asiat. Soc. Bengal 75(1): 2 (1936); Stemmerik in Van Steenis (ed.), Fl. Males., ser. 1, 6: 452 (1964), p.p.; Fosberg, Smithsonian Contr. Bot. 39: 2 (1978), p.p. – TYPE: *Boerhavia diffusa* L. (lectotype designated by Hitchcock in Hitchcock & Green, Prop. Brit. Bot. 115 (1929)).

Perennial herb with a large, thickened and woody root. *Stems* purplish to purplish red. *Leaves* opposite, paired leaves unequal in size; petioles pubescent; lamina ovate to elliptic to rounded, margins wavy; upper surface dark to mid-green, lower surface glaucous or silvery; midrib and secondary veins flat or sunken on the upper surface and slightly raised on the lower surface. *Inflorescences* terminal or axillary compound or solitary cymes; inflorescence stems green flushed reddish or purplish at the lower parts; cymes subtended by bracts, bract margins pubescent or puberulous; cymes with 3–7 flowers, each subtended by 2–3 bracteoles; bracteoles minute, pale green to pale brown, margins pubescent with long multicellular hairs; pedicels short, subsessile to 2 mm long. *Perianth* constricted at the middle; upper petaloid part purple to mauve, tubular and campanulate, shallowly 5-lobed, emarginate; lower part 5-ribbed, green, obovoid, clavate or obconical, surface glandular or eglandular (*B. erecta*). *Stamens* 2–3; filaments glabrous; anthers with two thecae, bilobed when dehiscent, pollen grains round and numerous. *Pistil* 1, style exerted at anthesis; stigma capitate. *Anthocarps* obovoid to ellipsoid to obconical, apex rounded or shortly peaked, 5-ribbed, ribs 0.2–0.3 mm wide, glandular or eglandular (*B. erecta*).

Distribution. About 60 weedy species of the tropics and subtropics, widely distributed across many countries, likely introduced in some cases, obscuring natural distributions.

Key to the genus *Boerhavia* in Singapore

- 1a. Anthocarps obconical with a truncate apex, ribs flared towards apex, surface glabrous and eglandular 2. *B. erecta*
- 1b. Anthocarps clavate (club-shaped), obovoid or ellipsoid, ribs not flared, surface with stalked, sessile glands or straight unstalked hairs 2
- 2a. Leaf margins entire and pubescent with multicellular glandular hairs 0.3–0.5 mm long; inflorescences mainly terminal panicles, very rarely axillary in immature plants with only 1 or 2 anthocarps; upper part of perianth crimson to magenta; anthers and stigma crimson to magenta; anthocarps c. 4 × 1.5–1.6 mm when mature, with glands mostly on the ridges, furrows sparsely glandular and dotted with small narrowly conical papillae 1. *B. diffusa*

- 2b. Leaf margins finely serrulate with purplish tips ending in a short, tightly incurved hair, sometimes sparsely interspersed with 0.1–0.2 mm long, slightly strigose hairs; inflorescences generally axillary but can also be terminal towards the distal ends of the stem; upper part of perianth pink to pale purple; anthers yellow, stigma pale purple; anthocarps 2.9–3.5 × 1–1.3 mm when mature, with glands on both the ridges and furrows 3. *B. repens*

1. *Boerhavia diffusa* L., Sp. Pl. 1: 3 (1753); Choisy, Prodr. 13(2): 452 (1849); Backer & Backhuizen van den Brink, Fl. Java (Spermatoph.) 1: 271 (1963); Stemmerik in Van Steenis (ed.), Fl. Males., ser. 1, 6: 454 (1964), p.p.; Fosberg, Smithsonian Contr. Bot. 39: 5 (1978); Turner, Gard. Bull. Singapore 47: 390 (1997 ['1995']), p.p.; Rafidah, Fl. Penins. Malaysia, ser. 2, 6: 37 (2017), p.p. – *Boerhavia repens* L. f. *diffusa* (L.) Boiss., Fl. Orient. 4: 1045 (1879). – *Boerhavia repens* L. var. *diffusa* (L.) Hook.f., Fl. Brit. India 4: 709 (1885). – TYPE: Virgin Islands, St. Croix, Teague Bay, West Indies Laboratory, 30 May 1977, Fosberg 56776 (conserved type BM [BM000593477], designated by Whitehouse, Taxon 47: 873 (1998); isotypes B [B100346000], US [US00956230]). (Fig. 1–3)

Decumbent herb with robust, erect inflorescences to 50 cm. **Stems** hairy with small erect glandular hairs sparsely interspersed with longer glandular hairs to up to 1 mm long, becoming lenticellate and green to light brown with age, nodes often corky in older stems. **Leaves:** petioles reddish, densely dotted with small club-shaped glandular hairs interspersed with long multicellular glandular hairs, furrowed across entire length, 0.5–2.7 cm; lamina ovate to rounded, 0.8–5.1 × 0.5–3.5 cm, apex obtuse, rarely acute, base rounded to subcordate or obtuse; both upper and lower surfaces puberulous to sparsely puberulous with small glandular hairs which are more conspicuous on the midrib and secondary veins; margins entire and pubescent with multicellular glandular hairs 0.3–0.5 mm long; reticulations minute, more clearly visible on upper surface of dried leaves. **Inflorescences** terminal compound cymes, rarely axillary in immature plants with only 1 or 2 anthocarps, branching and developing new compound cymes from the axils of existing inflorescence branches, causing it to sometimes resemble a panicle in form, to 50 cm long; peduncle at base of compound inflorescence 1.6–7(–9.5) cm long; peduncle green, flushed reddish at the base, glabrous to sparsely pubescent with short incurved hairs; each cyme branching out from the inflorescence subtended by a bract; bracts caducous, linear to narrowly lanceolate, 1–2.5 mm long, surface puberulous and margins pubescent; cymes with 3–5 flowers; bracteoles ovate to narrowly lanceolate, 0.6–0.7 × 0.15–0.3 mm; pedicels very short, 0.5 mm or less. **Perianth:** upper petaloid part crimson to magenta, c. 1.1 mm long, c. 3.6 mm across when open, lobes c. 0.6 mm across, inner surface glabrous, outer surface with a brownish green triangle at the middle of each lobe, pubescent with multicellular hairs along the edge of the triangle; lower part obovoid to clavate, surface densely crowded



Fig. 1. *Boerhavia diffusa* L. **A.** Habit. **B.** Close-up of terminal inflorescences with hairs on the leaf margin visible. A from Choo LCMJ 2021-032; B from Choo LCMJ 2021-027. (Photos: L.M. Choo)

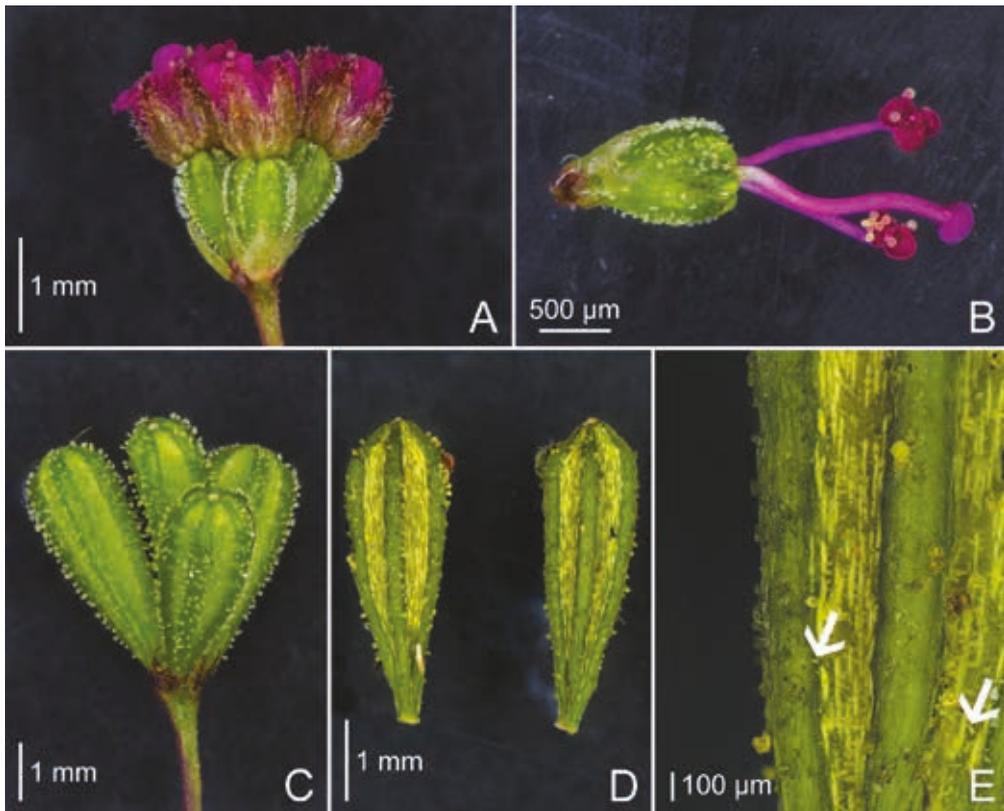


Fig. 2. *Boerhavia diffusa* L. **A.** Flowers. **B.** Flower with the upper petaloid part of the perianth removed, showing the stamens, pistil and pollen grains. **C.** Anthocarps from a fresh specimen, with glands mostly on the ridges. **D.** Dried anthocarps. **E.** Close-up of a dried anthocarp, with white arrows pointing out the position of the small conical papillae on the furrow surface between the ridges. A–C from Choo LCMJ 2020-119; D, E from Choo LCMJ 2021-027. (Photos: L.M. Choo)

with stalked glandular hairs along the ridges. **Stamens:** filaments crimson to magenta throughout, 1.2–1.3 mm long; anthers dark crimson to magenta, c. 0.4 mm across; pollen grains yellow. **Pistil:** style 1.4–1.6 mm long, crimson as in filaments but fading to white at the base; stigma dark crimson to magenta as in anthers, 0.3–0.4 mm diam. **Anthocarps** obovoid, when mature c. 4×1.5 –1.6 mm, apex rounded when fresh but umbonate when dry, ribs prominently and densely dotted with stalked glandular hairs, furrows very sparsely dotted with shortly stalked glandular hairs and also covered with very small narrowly conical papillae.

Distribution. A pantropical weedy species, found across many areas and probably native in much of the Americas, Africa and Asia, including Peninsular Malaysia, and more recently introduced and naturalised in Singapore.

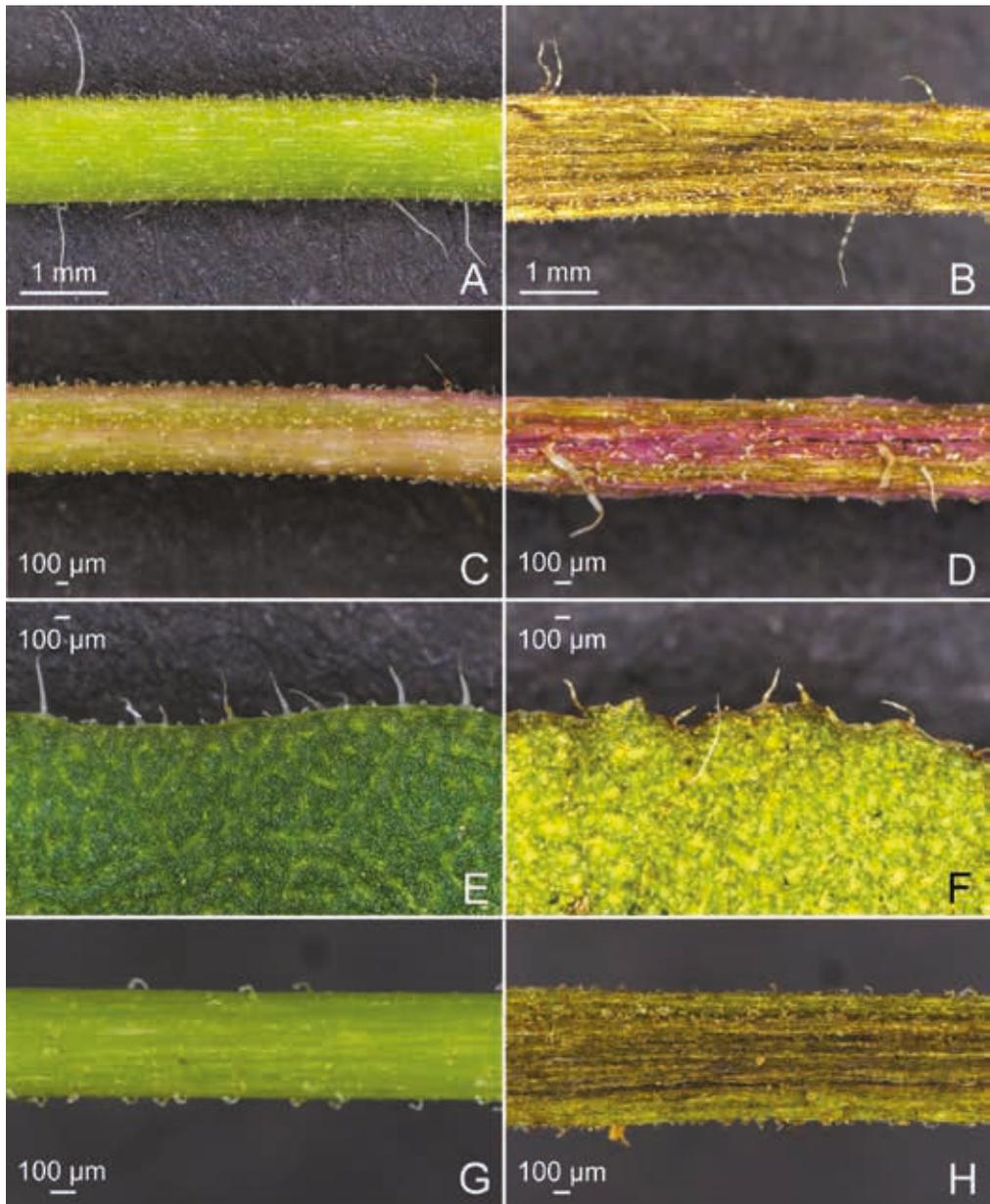


Fig. 3. Hair types on *Boerhavia diffusa* L. **A.** Fresh stem, with a mix of small erect glandular hairs and long multicellular glandular hairs. **B.** Dried stem. **C.** Fresh petiole, with small club-shaped glandular hairs interspersed with long multicellular glandular hairs. **D.** Dried petiole. **E.** Fresh leaf margin, with multicellular glandular hairs. **F.** Dried leaf margin. **G.** Fresh peduncle, sparsely pubescent with short incurved hairs. **H.** Dried peduncle. A, C, E, G from *Choo LCMJ 2020-119*; B, D, F, H from *Choo LCMJ 2021-032*. (Photos: L.M. Choo)

Ecology. *Boerhavia diffusa* is found in sunny, dry open areas, such as disturbed waste places, in sand near the seashore, and grass patches in urban areas.

Specimens examined. SINGAPORE: **Changi:** Changi Beach Park, 22 Nov 2020, *Choo LCMJ 2020-118* (SING [SING0291137]); ibidem, 6 Dec 2020, *Choo LCMJ 2020-119* (SING [SING0291144]); outside SAF Ferry Terminal, 21 Mar 2021, *Choo LCMJ 2021-019* (SING [SING0291138, SING0291139]); Changi Beach Park, 21 Mar 2021, *Choo LCMJ 2021-021* (SING [SING0291141, SING0291142, SING0291143]). **East Coast:** East Coast Park Carpark B1, 24 Sep 2021, *Choo LCMJ 2021-029* (SING [SING0291132]); East Coast Park Carpark B1, 24 Sep 2021, *Choo LCMJ 2021-030* (SING [SING0291131]); East Coast Park Area B, on the breakwater, 24 Sep 2021, *Choo LCMJ 2021-031* (SING [SING0291130]). **Eunos:** in field below Eunos MRT Station, 2 Oct 2021, *Choo LCMJ 2021-032* (SING [SING0291129]). **Pasir Ris:** outside Block 425, Pasir Ris Drive 1, 3 Apr 2021, *Choo LCMJ 2021-023* (SING [SING0291135]). **Tanah Merah:** Tanah Merah Reclaimed Land, 23 Apr 2021, *Lua LCMJ 2021-025* (SING [SING0267398]); 45 Limau Gardens, 25 Jun 2021, *Choo LCMJ 2021-027* (SING [SING0291124]).

PENINSULAR MALAYSIA: **Perlis:** Titi Tinggi, Kaki Bukit, 8 May 2008, *Siti Munirah FRI 55496* (K); Chuping, Bt Keteri, 28 Nov 2013, *Rafidah FRI 75881* (K). **Penang:** Penang Hill, main road to funicular station, 25 Mar 2009, *Yao FRI 65415* (SING [SING0148087]). **Perak:** Lumut, near seaside, 12 Jun 1980, *Teo & Pachiappan 655*, also as *KL 3255* (K, SING [SING0361513]). **Terengganu:** Kuala Terengganu Jetty, 26 Sep 2006, *Kiew FRI 53115* (SING [SING0123887]). **Pahang:** Pulau Tioman, 16 Aug 1935, *Corner 29785* (K, SING [SING0361512]); Pulau Tioman, Kampung Mukut, 3 May 2012, *Siti Munirah FRI 76672* (SING [SING0241387]). **Selangor:** Kuala Selangor Nature Park, 4 Dec 2014, *Rafidah FRI 75988* (SING [SING0219357]); Kuala Selangor, Pantai Remis, 24 Mar 2015, *Syahida Emiza FRI 66907* (SING [SING0231089]).

Notes. As all previous records of this species for Singapore are misapplied, it is actually a new record for Singapore, the first specimen having been collected only in 2020. Most specimens in Peninsular Malaysia are also recent, with the first record in 1935 and another from 1980.

2. *Boerhavia erecta* L., Sp. Pl. 1: 3 (1753); Choisy, Prodr. 13(2): 450 (1849); Backer & Backhuizen van den Brink, Fl. Java (Spermatoph.) 1: 271 (1963); Stemmerik in Van Steenis (ed.), Fl. Males., ser. 1, 6: 454 (1964); Turner, Gard. Bull. Singapore 47: 390 (1997 [‘1995’]); Lu & Gilbert, Fl. China 5: 434 (2003); Rafidah, Fl. Penins. Malaysia, ser. 2, 6: 38 (2017). – TYPE: Vera Cruz, *Herb. Linn. No. 19.1* (neotype LINN [LINN-HL19-1], designated by Fawcett & Rendle, Fl. Jamaica 3: 148 (1914)). (Fig. 4)

Semi-erect herb to 30 cm. **Stems** mostly glabrous and finely striate, in young stems densely puberulous with small tightly incurved hairs, becoming finely lenticellate with age but not becoming corky. **Leaves** often with axillary growth; petioles densely pubescent with short tightly incurved hairs interspersed with longer multicellular hairs, furrowed above and with multiple ridges, 0.5–2.3 cm long; lamina ovate to elliptic, 0.8–3.5 × 0.5–2.0 cm, apex acute to very narrowly acute, base acute to obtuse;

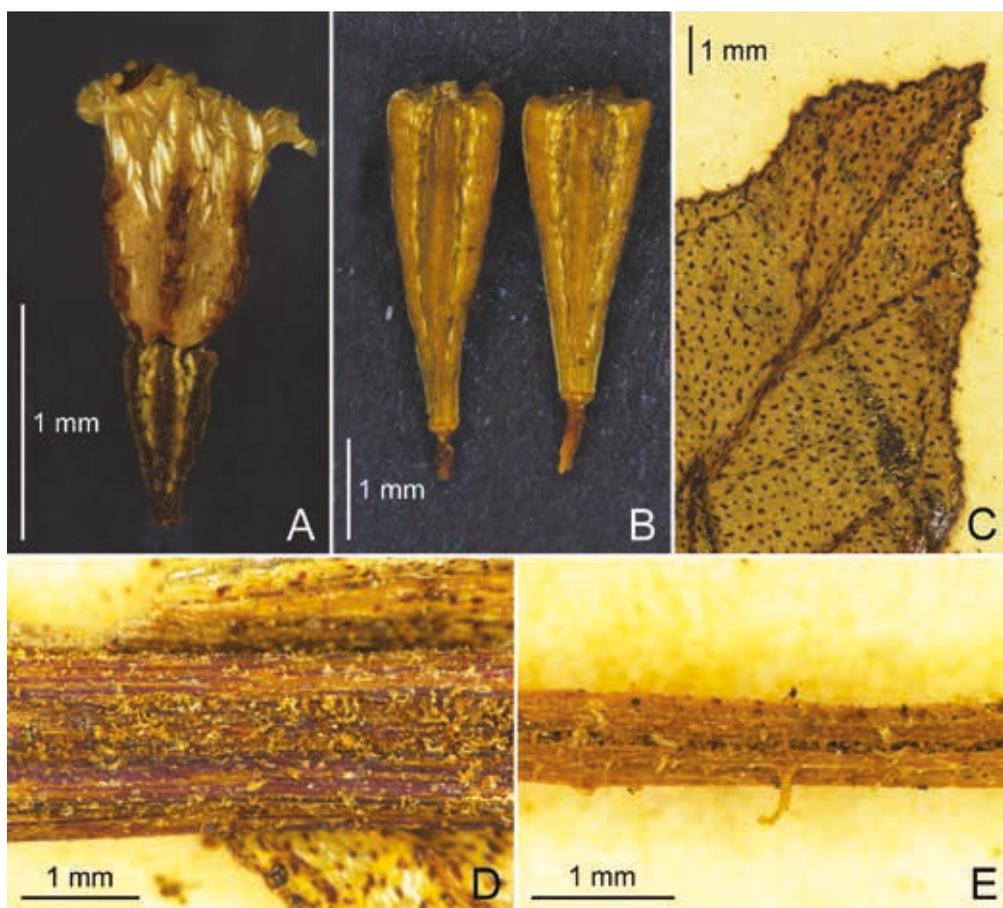


Fig. 4. *Boerhavia erecta* L. **A.** Flower. **B.** Anthocarps with eglandular surfaces. **C.** Underside of a leaf, showing the reddish-brown scurfy dots while the calcium oxalate deposits are too small to be seen here, and leaf margins with short hairs. **D.** Stem puberulous with small, tightly incurved hairs. **E.** Petiole pubescent with short tightly incurved hairs interspersed with longer multicellular hairs. A, B from *Burkill HMB 1876*; C, D & E from *Sinclair 10783*. (Photos: L.M. Choo)

upper and lower surfaces with reddish brown scurfy dots and calcium oxalate deposits clearly visible, glabrous except for the veins and midrib on the lower surface which are sparsely pubescent with the same hair type as the petiole; margins finely serrulate and apex of each tooth with a hair c. 0.1 mm long; reticulations inconspicuous on both surfaces. **Inflorescences** consisting of both terminal and axillary compound cymes, 13–31 cm long; peduncle 4–6.3 cm long, generally glabrous; consisting of compound cymes subtended by bracts, bracts caducous, lanceolate, 1–2 × 0.3–0.4 mm, surfaces glabrous but margins pubescent; cymes with 3–5 flowers, bracteoles narrowly lanceolate, 0.6–0.7 × c. 0.1 mm; pedicels 1.5–2 mm long. **Perianth:** upper petaloid part mauve, c. 1.2 mm long, lobes c. 0.6 mm across, both inner and outer surface glabrous and lined with clearly visible spindle-shaped calcium oxalate crystals when

dry; lower part obconical, surface strongly ridged and glabrous. **Stamens:** filaments 1.1–1.3 mm long; anthers 0.3–0.35 mm across. **Pistil:** style 1.2–1.3 mm long; stigma 0.15–0.2 mm diam. **Anthocarps** obconical, when mature 3–3.5 × 1–1.3 mm, apex truncate but shortly umbonate when dry, ribs flared towards the apex and completely glabrous and eglandular.

Distribution. Pantropical weed originating from tropical America. In Asia recorded from India, Sri Lanka, Thailand, Laos, Vietnam, Taiwan and throughout Malesia. In Peninsular Malaysia recorded only in Kelantan (Rafidah, 2017). In Singapore it is considered historic casual (Lindsay et al., 2022); it was recorded three times, but not since 1965.

Ecology. In dry, open, sandy or waste spaces. The species is associated with railway tracks in Singapore and Peninsular Malaysia.

Specimens examined. SINGAPORE: **Tanjong Pagar:** Nelson Road, Malayan Railway Goods Yard, 1 Jul 1959, *Burkill HMB 1876* (K, SING [SING0014445]); Nelson Road, 8 May 1965, *Sinclair 10783* (BM, K, SING [SING0042611]). **Telok Ayer:** on railway track on sea front, 23 Feb 1941, *Holtum s.n.* (SING [SING0042610]).

PENINSULAR MALAYSIA: **Kelantan:** Gua Musang Railway Station, 28 Sep 2006, *Yao FRI 53190* (K, SING [SING0253996]).

3. *Boerhavia repens* L., Sp. Pl. 1: 3 (1753); Choisy, Prodr. 13(2): 453 (1849) 453; Boissier, Fl. Orient. 4: 1045 (1879), p.p.; Hooker, Fl. Brit. India 4: 709 (1885), p.p.; Ridley, J. Straits Branch Roy. Asiat. Soc. 33: 125 (1900), as '*Boerhaavia*'; Backer & Backhuizen van den Brink, Fl. Java (Spermatoph.) 1: 271 (1963); Fosberg, Smithsonian Contr. Bot. 39: 8 (1978). – TYPE: Egypt, *Herb. Linn. No. 9.8* (lectotype LINN [LINN-HL9-8], designated by Codd, Bothalia 9: 121 (1966)). (Fig. 5–7)

Boerhavia diffusa auct. non L.: Gamble, J. Asiat. Soc. Bengal 75(1): 3 (1912), as '*Boerhaavia*'; Ridley, Fl. Malay Penins. 3: 1 (1924), as '*Boerhaavia*'; Henderson, Malay. Wild Fls., Dicot. 406 (1959), as '*Boerhaavia*'; Stemmerik in Van Steenis (ed.), Fl. Males., ser. 1, 6: 454 (1964), p.p.; Keng, Concise Fl. Singapore, vol. 1, Gymn. Dicot. 59 (1990); Turner et al., J. Singapore Natl. Acad. Sci. 18 & 19: 76 (1990); Turner, Gard. Bull. Singapore 45: 157 (1993); Turner & Tan in Wee & Ng (ed.), First Look Biodivers. Singapore 121 (1994); Ng & Wee (ed.), Singapore Red Data Book 298 (1994); Turner, Gard. Bull. Singapore 47: 390 (1997 ['1995']), p.p.; Chong et al., Checkl. Vasc. Pl. Fl. Singapore 19, 157, 269 (2009); Rafidah, Fl. Penins. Malaysia, ser. 2, 6: 37 (2017), p.p.

Boerhavia coccinea auct. non Mill.: Kaw & Neo, Wayside Fl. Singapore 44 (2018).



Fig. 5. *Boerhavia repens* L. **A.** Habit. **B.** Close-up of axillary inflorescences. All from Choo LCMJ 2021-022. (Photos: L.M. Choo)

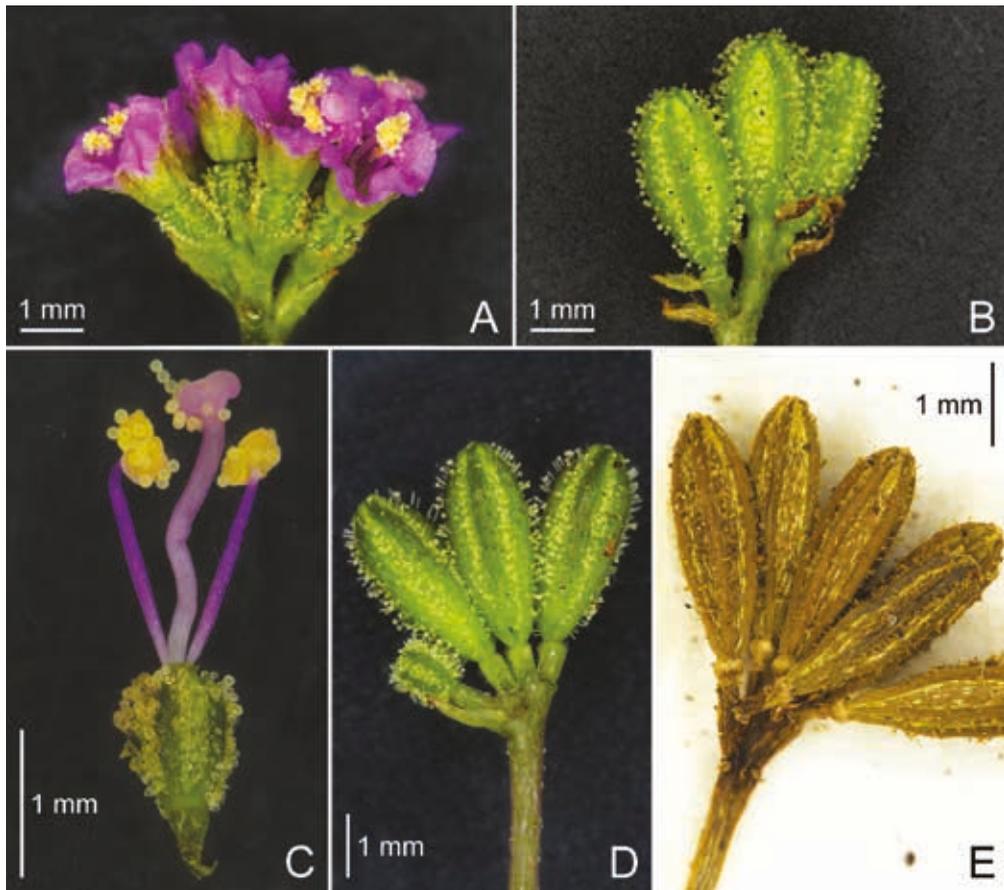


Fig. 6. *Boerhavia repens* L. **A.** Flowers. **B.** Anthocarps from a fresh specimen, with glands on both the ridges and the furrows. **C.** Flower with the upper petaloid part of the perianth removed, showing the stamens, pistil and pollen grains. **D.** Fresh anthocarps of a variant with straight glandular hairs on the anthocarp in addition to stalked and sessile glands. **E.** Close-up of a dried anthocarp of a variant with straight glandular hairs on the anthocarp in addition to stalked and sessile glands. A, C from Choo LCMJ 2021-024; B from Choo LCMJ 2021-022; D from Niissalo SING2021-789; E from Lee s.n. (SING [SING0014443]). (Photos: L.M. Choo)

A generally prostrate herb with inflorescences held on short stalks not far from the ground, ends of the stems somewhat decumbent, rarely seen with erect inflorescences to 30 cm when mature and growing in undisturbed places. **Stems** pubescent to puberulous all over with short adpressed hairs or strigose hairs, and longer incurved multicellular hairs which form a small tight curve when dry, becoming lenticellate and green to light brown with age, nodes often corky in older stems. **Leaves** often with axillary growth; petioles dark maroon to green, densely pubescent with multicellular hairs, furrowed along its entire length, 0.5–3.6 cm long; lamina ovate to rounded,

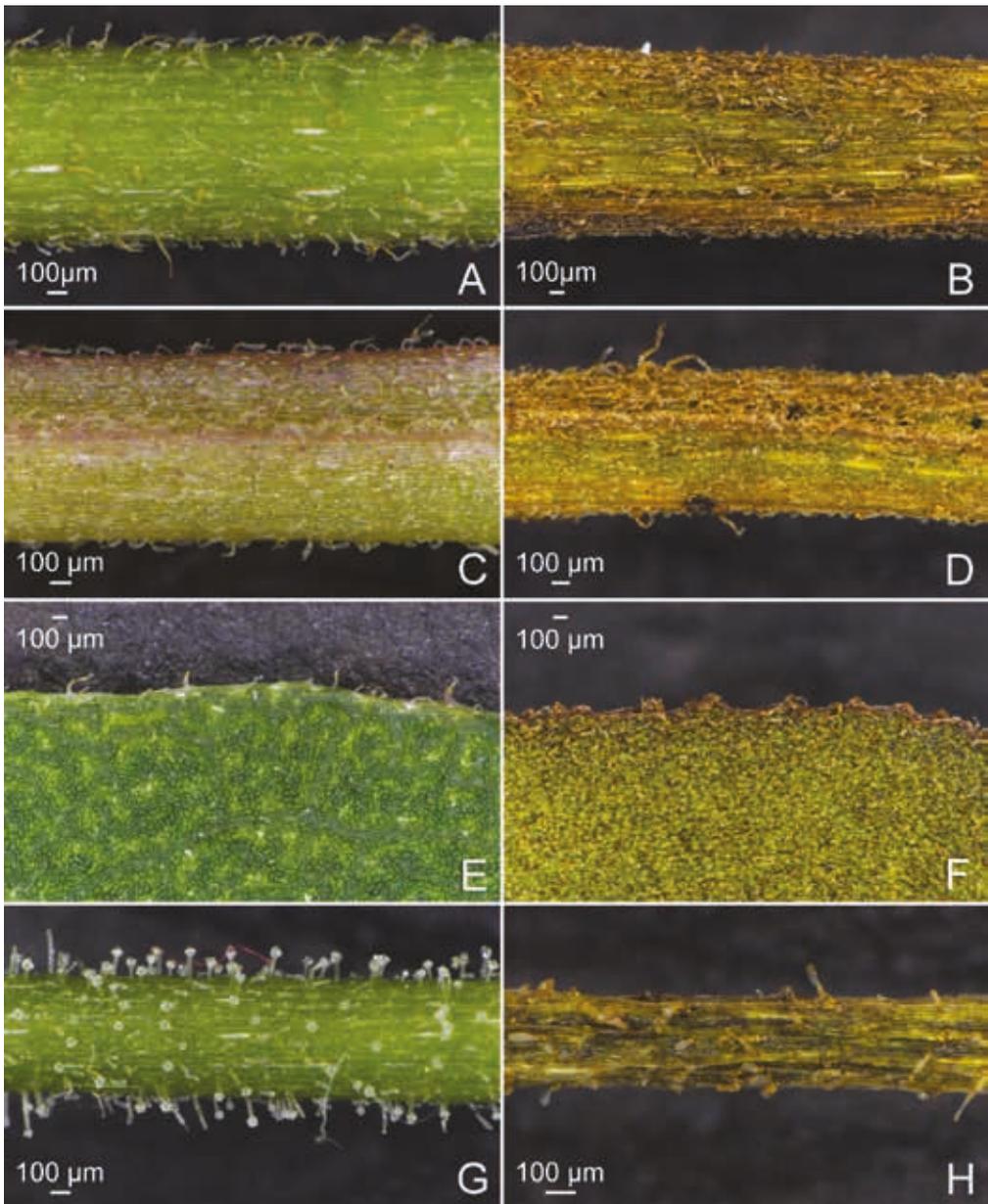


Fig. 7. Hair types on *Boerhavia repens* L. **A.** Fresh stem, pubescent to puberulous with short adpressed or strigose hairs. **B.** Dried stem. **C.** Fresh petiole, densely pubescent with multicellular hairs. **D.** Dried petiole. **E.** Fresh leaf margin, finely serrulate with purplish tips ending in a tightly incurved hair, and also sparsely interspersed with short, 0.1–0.2 mm long, slightly strigose hairs. **F.** Dried leaf margin. **G.** Fresh peduncle, densely glandular pubescent. **H.** Dried peduncle. All from *Niissalo SING2021-789*. (Photos: L.M. Choo)

1–4.7 × 0.7–4.7 cm, upper surfaces entirely puberulous with small incurved to strigose hairs, which are more conspicuous in younger leaves and at the base of the leaf; lower surfaces mostly glabrous, but pubescent at the base of the midrib and along the secondary veins on the lower half of the leaf; reticulations inconspicuous on both surfaces; apex acute to obtuse, rounded or emarginate, often mucronate at the midrib, base rounded to subcordate, margins wavy and finely serrulate with purplish tips ending in a tightly incurved hair, and also sparsely interspersed with short, 0.1–0.2 mm long, slightly strigose hairs. **Inflorescences** mostly axillary simple or compound cymes, rarely terminal towards the distal ends of the stem, 2–4.4 cm long when axillary simple or compound, 20–34 cm long when terminal and compound; peduncle 7–8.5 cm long when terminal and compound, green throughout or tinged with purple at the lower part, sparsely pubescent at the base but becoming densely glandular pubescent towards the tips of the inflorescence; cymes subtended by a bract, bracts caducous, ovate to lanceolate, 1–2.3 mm long, surface and margins puberulous; cymes with 2–7 flowers, bracteoles ovate, 0.7–1.2 × 0.3–1 mm, pedicels very short, 0.5–0.6 mm or less. **Perianth**: upper petaloid part pink to pale purple, 1.3–2 mm long, 2–3 mm across when fully open, lobes 0.7–0.8 mm across, inner surface glabrous, outer surface with a brownish green triangle in between lobes, pubescent with multicellular hairs all over the surface of the triangle; lower part obovoid to clavate to ellipsoid; surface densely dotted with stalked glandular hairs all over and occasionally with straight multicellular hairs. **Stamens**: filaments magenta, pale purple to white at both ends, 1.3–2 mm long; anthers yellow, 0.4–0.5 mm across; pollen grains yellow. **Pistil**: style 1.6–2.2 mm long, pale purple and fading to white at the base as in the filaments; stigma pale purple, 0.4–0.5 mm diam. **Anthocarps** ellipsoid, when mature 2.9–3.5 × 1–1.3 mm, apex rounded to pointed, both ribs and furrows densely dotted with stalked glandular hairs and ribs also interspersed with straight multicellular hairs.

Distribution. A weedy species of Africa, most of tropical and subtropical Asia, and the Pacific Islands including Hawaii. In Asia it is known from China, Taiwan, the Ryukyu Islands, Peninsular Malaysia and Indonesia. In Singapore it is regarded as cryptogenic (Lindsay et al., 2022).

Ecology. *Boerhavia repens* is found in sunny open areas, at seashores growing in sand, and as a common weed of roadsides, grass patches in urban areas and cultivated fields.

Uses. Liquid extracts of the plant are used as a diuretic, while the root is purgative, anthelmintic and also used to treat fevers (Stemmerik, 1964; Rahayu, 2001).

Specimens examined. SINGAPORE: no locality, Jul 1933, *Teruya 2414* (SING [SING0042608, SING0042609]); s.d., *Lobb 309* (BM, K). **Alexandra**: outside 305 Alexandra Road, 10 Nov 2021, *Niissalo SING2021-789* (SING [SING0291125]). **Bras Basah**: Bras Basah Road, 7 Oct 1941, *Furtado SFN 37435* (BM, K, SING [SING0014444]); Seah Street, 28 Mar 2021, *Choo LCMJ 2021-022* (SING [SING0291136]). **East Coast**: East Coast Parkway, 5 Jan 1983, *Lee s.n.* (SING [SING0014443]). **Geylang**: [Gelang], Mar 1898, *Ridley 9131* (BM, K, SING

[SING0014442]). **Mountbatten:** outside Crescent Road Substation, 31 Oct 2021, *Choo LCMJ 2021-037* (SING [SING0291128]); opposite 57B Crescent Road, 31 Oct 2021, *Choo LCMJ 2021-038* (SING [SING0291127]); junction of Arthur Road and Mountbatten Road, 31 Oct 2021, *Choo LCMJ 2021-039* (SING [SING0291126]). **Pasir Ris:** outside Block 105, Pasir Ris Street 12, 3 Apr 2021, *Choo LCMJ 2021-024* (SING [SING0291134]). **Singapore Botanic Gardens:** Potting Yard, 22 Feb 1950, *Henderson s.n.* (SING [SING0000695]). **Tanah Merah:** 46 Jalan Limau Purut, 25 Jun 2021, *Choo LCMJ 2021-026* (SING [SING0267399, SING0291123]); 33 Jalan Haji Salam, 25 Jun 2021, *Choo LCMJ 2021-028* (SING [SING0291133]).

PENINSULAR MALAYSIA: **Kedah:** Langkawi, Kuah [Coah], Mar 1891, *Derry s.n.* (SING [SING0361517]); Langkawi, Kuah [Kwah], Mar 1910, *Ridley 14932* (K, SING [SING0361520]). **Penang:** Batu Feringgi, s.d., *Fox s.n.* (SING [SING0361522]); Jul 1886, *Curtis 902* (SING [SING0361515]); Tanjong, Oct 1889, *Curtis s.n.* (SING [SING0361521]); Province Wellesley, Telok Ayer Tawar, Dec 1895, *Ridley 6983* (K, SING [SING0361514]); Old Fort, 22 Apr 1918, *Mhd Nur 3419* (K, SING [SING0361518]). **Perak:** Slim River, 25 Jan 1941, *Reed 2* (SING [SING0361524]); Bidor Estate, 18 Feb 1941, *Reed 7* (SING [SING0361523]). **Pahang:** Pulau Tioman, Juara Bay [Jaora Bay], Jun 1915, *Burkill s.n.* (SING [SING0361516]); Pulau Tioman, Telok Paya, 19 May 1927, *Henderson 18436* (SING [SING0361519]). **Selangor:** Quay at Port Swettenham, 1 Aug 1917, *Burkill 1272* (SING [SING0361525]).

Notes. There is considerable variation in the hair type of the anthocarps among *Boerhavia repens* specimens in Singapore. Although most of the specimens have anthocarp glands that are stalked or sessile, there are two collections in which there are also straight multicellular hairs on the anthocarp surface. These are *Lee s.n.* (SING [SING0014443]), 5 Jan 1983 from East Coast and *Niissalo SING2021-789* (SING [SING0291125]), 10 Nov 2021 from Alexandra Road. The proportion of straight multicellular hairs to stalked and sessile glands on the anthocarp differs even within the same plant, where some anthocarps have mostly the usual stalked and sessile glands, while others are mostly covered with straight multicellular hairs. The flower characteristics of these two individuals also match the other *Boerhavia repens* specimens, suggesting this is just a variation, which can be expected of a widespread weed species. As such, we have retained these specimens in *Boerhavia repens*.

References

- Chen, S.-H. & Wu, M.-J. (2007). A taxonomical study of the genus *Boerhavia* (Nyctaginaceae) in Taiwan. *Taiwania* 52(4): 332–342.
- Chong, K. Y., Tan, H. T. W. & Corlett, R. T. (2009). *A Checklist of the Total Vascular Plant Flora of Singapore: Native, Naturalised and Cultivated Species*. Singapore: Raffles Museum of Biodiversity Research, National University of Singapore.
- Codd, L. E. W. (1966). Notes on *Boerhavia* in Southern Africa. *Bothalia* 9(1): 113–121.
- Fosberg, F. R. (1978). Studies in the genus *Boerhavia* L. (Nyctaginaceae). *Smithsonian Contr. Bot.* 39: 1–5.
- Gamble, J. S. (1912). Nyctaginaceae. Materials for a flora of the Malayan Peninsula, no. 22. *J. Asiat. Soc. Bengal* 75(1): 2–3.

- Keng, H. (1990). *The Concise Flora of Singapore: Gymnosperms and Dicotyledons*. Singapore: Singapore University Press.
- Lamarck, J.B.-P. (1791). *Tableau Encyclopédique et Méthodique des trois règnes de la nature, Botanique*, vol. 1. Paris: Panckoucke.
- Larsen, K. (1991). Nyctaginaceae. In: Niyomdham, C., Chayamarit, K., Sirirugsa, P, Forman, L.L. & Larsen, K. (ed.) *Flora of Thailand*, vol. 5(3), pp. 366–374. Bangkok: Forest Herbarium, Royal Forest Department.
- Lindsay, S., Middleton, D.J. Ho, B.C., Chong, K.Y, Turner, I.M., Ali Ibrahim, Alonso-García, M., Ang, W.F., Ashton, P.S., Athen, P. et al. (2022). Flora of Singapore: Checklist and bibliography. *Gard. Bull. Singapore* 74(Suppl. 1): 3–860.
- Linnaeus, C. (1753). *Species Plantarum*, vol. 1. Holmiae [Stockholm]: Impensis Laurentii Salvii.
- Lu, D. & Gilbert, M.G. (2003). Nyctaginaceae. In: Wu, Z.Y., Raven, P.H. & Hong, D.Y. (ed.) *Flora of China*, vol 5, pp. 430–434. Beijing: Science Press; St. Louis: Missouri Botanical Garden Press.
- Meikle, R.D. (1954). Nyctaginaceae. In: Hutchinson, J. & Dalziel, J.M. (ed.) *Flora of West Tropical Africa*, vol 1(1), pp. 176–178. London: Crown Agents for Oversea Governments and Administrations.
- POWO (2021). Plants of the World Online. Facilitated by the Royal Botanic Gardens, Kew. <https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:326857-2>. Accessed 29 Dec. 2021.
- Rafidah, A.R. (2017). Nyctaginaceae. In: Kiew, R., Chung, R.C.K., Saw, L.G. & Soepadmo, E. (ed.) *Flora of Peninsular Malaysia*, ser. II, Seed Plants, vol 6, pp. 36–39. Kepong, Kuala Lumpur: Forest Research Institute Malaysia.
- Rahayu, S.S.B. (2001). *Boerhavia diffusa* L. In: Van Valkenburg, J.L.C.H. & Bunyaphrathasara, N. (ed.) *Plant Resources of South-East Asia*, vol 12(2): Medicinal and Poisonous Plants 2. Bogor: PROSEA Foundation.
- Ridley, H.N. (1924). Apetalae. *The Flora of the Malay Peninsula*, vol. 3. London: L. Reeve & Co.
- Spellenberg, R. (2000). Blooming “behaviour” in five species of *Boerhavia* (Nyctaginaceae). *Sida* 19(2): 311–323.
- Stemmerik, J.F. (1964). Nyctaginaceae. *Fl. Males.*, Ser. I, 6(3): 450–468.
- Struwig, M. & Siebert, S.J. (2013). A taxonomic revision of *Boerhavia* (Nyctaginaceae) in southern Africa. *S. African J. Bot.* 86: 116–134.
- Turner, I.M. (1993). The names used for Singapore plants since 1900. *Gard. Bull. Singapore* 45: 1–287.
- Turner, I.M. & Tan, H.T.W. (1994). List of plants and animals found in Singapore: Plantae. In: Wee, Y.C & Ng, P.K.L. (ed.) *A First Look at Biodiversity in Singapore*, pp. 110–127. Singapore: National Council on the Environment.
- Turner, I.M., Chua, K.S. & Tan, H.T.W. (1990). A checklist of the native and naturalised vascular plants of the Republic of Singapore. *J. Singapore Natl. Acad. Sci.* 18–19: 58–88.
- Whitehouse, C. (1996). Nyctaginaceae. In: Polhill, R.M. (ed.) *Flora of Tropical East Africa*, pp. 2–8. Richmond: Royal Botanic Gardens, Kew.
- Whitehouse, C. (1998). (1375) Proposal to conserve the name *Boerhavia diffusa* (Nyctaginaceae) with a conserved type. *Taxon* 47(4): 873–874.