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STUDIES IN THE FLORA OF ARABIA: XXX. A SYNOPSIS OF THE NATIVE AND NATURALISED SPECIES OF *SENNA* (LEGUMINOSAE: CAESALPINIOIDEAE) IN THE ARABIAN PENINSULA

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A synopsis of the native and naturalised species of *Senna* (Leguminosae: Caesalpinioideae) in the Arabian Peninsula is provided. Nine species are recognised. A key to the species is presented. For each species the accepted name with selected synonymy is given, followed by a diagnostic morphological description, the geographical distribution, details of habitat preference, and citation of specimens studied. Preliminary regional conservation assessments are given for all species.

Keywords. Angiosperms, Arabia, *Cassia*, conservation, Fabaceae, taxonomic study.

Introduction

The genus *Senna* Mill. (Leguminosae: Caesalpinioideae) was reinstated at generic rank and separated from *Cassia* L. and *Chamaecrista* Moench by Irwin & Barneby (1982), thus recognising at generic rank distinctions previously treated at subgeneric rank by Bentham (1871). Irwin & Barneby (1982) revised and classified the species of all three genera in the Americas. Their findings have been widely adopted (Lock, 1988; Randell & Barlow, 1988; Li *et al.*, 2010). Phylogenetic studies uphold the monophyly of *Senna* (Marazzi *et al.*, 2006) and place the genus *Cassia* as sister (Bruneau *et al.*, 2008). However, of the six generic sections recognised by Irwin & Barneby (1982), only *Senna* sect. *Psilorhegma* was supported as monophyletic (Marazzi *et al.*, 2006).

Senna comprises c.350 species (Marazzi *et al.*, 2006) and is most diverse in tropical America, with secondary centres of diversity in tropical Africa, Madagascar and Australia. Only a few species are found in southeastern Asia and in the Pacific Islands. A number of species are also found in subtropical regions of which nine are native or naturalised in the Arabian Peninsula.

This synopsis forms part of a wider study of the systematics, phylogenetics and biogeography of *Senna* in the Arabian Peninsula. The work presented here is based

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principally on herbarium holdings of Arabian *Senna* from the Royal Botanic Garden Edinburgh, the Royal Botanic Gardens, Kew and the Natural History Museum (London), supplemented with field observations made in the Kingdom of Saudi Arabia, the Sultanate of Oman and the Republic of Yemen (Miller and Banfield, pers. comm.). Following the selection criteria of Lock & Simpson (1991), a non-exhaustive synonymy is included which accounts for (i) names that have been used in standard regional works and (ii) names that appear as annotations on the herbarium vouchers on which this synopsis is based. The original place of publication is cited for all names. During the preparation of this paper, we have identified six names that require typification (*Cassia didymobotrya* Fresen., *Cassia holosericea* Fresen., *Cassia obtusata* Hayne, *Senna hookeriana* Batka, *Senna italica* Mill. and *Senna ovalifolia* Batka). The typification of those names will be the subject of a later nomenclatural paper. Specimens examined and cited in the text are listed by country, in order of decreasing size, hence Saudi Arabia, Yemen, Oman, Qatar and Bahrain. Specimens from Socotra are listed after Yemen. We do not report phenology data because, as is widely recognised, seasonality does not follow a regular pattern in hyper-arid zones. Typically, flowering and fruiting are stimulated in response to erratic weather events such as intermittent rains or flash flooding.

In-house software, developed at the Royal Botanic Garden Edinburgh, has been used to store the data. All herbarium specimens cited have been seen by the authors unless otherwise indicated. The plant descriptions given in this paper are based on dried herbarium material and the terms used follow those described by Beentje (2010).

Nine species are recognised here as native or naturalised in the Arabian Peninsula. In addition, four species are recorded as cultivated in the region (Wood, 1997). These include the frequently planted Latin American ornamental street tree, *Senna alata* (L.) Roxb.; the Indian shrub or small tree with conspicuous stipules, *S. auriculata* Roxb.; the linear-leaved Australian shrub, *S. artemisioides* subsp. *artemisioides* (DC.) Randell, and *S. multiglandulosa* (Jacq.) H.S.Irwin & Barneby, a shrub or small tree from Central and South America.

Systematic Treatment

Senna Mill., Gard. Dict., ed. 8, *Senna* no. 1 (1768). – *Cassia* sect. *Senna* (Mill.) DC. ex Collad., Hist. Nat. Méd. Casses 94 (1816). – *Cassia* subgen. *Senna* (Mill.) Benth. in Martius, Fl. Bras. 15(2): 96 (1870), and in Trans. Linn. Soc. London 27(4): 513 (1871). – Type species: *Senna alexandrina* Mill.

Cassia auct. non L.: J.R.I.Wood, Handb. Yemen Fl. 163 (1997), p.p.

Erect herbs, shrubs or small trees, unarmed. *Stipules* persistent or caducous. *Leaves* paripinnate. *Extrafloral nectaries* present. *Inflorescence* an erect axillary or terminal raceme. *Bracts* persistent or caducous. *Bracteoles* absent. *Sepals* 5, subequal or graduated. *Petals* 5, subequal, yellow, orange or occasionally pinkish. *Stamens* 8−10, heteromorphic,

in three or four ranks, dehiscing through apical pores or slits, fertile or staminodal. *Ovary* glabrous to hairy; *style* linear, incurved. *Pod* variable, dehiscent (not in the Arabian Peninsula) or indehiscent; seeds up to 80, usually compressed.

Distribution within the Arabian Peninsula. *Senna* occurs throughout the Arabian Peninsula in Bahrain, Kuwait, Oman, Saudi Arabia, Qatar, the United Arab Emirates and Yemen, including the Socotran Archipelago.

Key to Senna *species native or naturalised in the Arabian Peninsula*

1a. Leaflets in 3 pairs _____ 2
1b. Leaflets in 4 or more pairs _____ 3

2a. Extrafloral nectaries present at point of insertion between lowest leaflet pair only _____ **6. S. obtusifolia**
2b. Extrafloral nectaries present at point of insertion between lower and median leaflet pairs _____ **9. S. tora**

3a. Pods narrow, at least 12 times longer than wide; leaflets lanceolate, at least some greater than 10 mm wide _____ 4
3b. Pods broad, less than 7 times longer than wide; leaflets obovate, oblong-elliptic or, if lanceolate, then all or most leaflets less than 8 mm wide _____ 5

4a. Leaflets acuminate; extrafloral nectaries globose _____ **7. S. occidentalis**
4b. Leaflets acute; extrafloral nectaries ovoid _____ **8. S. sophera**

5a. Pods crested along centre of both valves _____ **5. S. italica**
5b. Pods without a crest _____ 6

6a. Leaflets in 6–14 pairs; pods 7.5–13 cm long with a short apical beak _____ **2. S. didymobotrya**
6b. Leaflets in 4–8 pairs; pods 2–6 cm long with a clearly lateral or subapical beak _____ 7

7a. Leaves moderately to densely spreading whitish pubescent; petals 5.5–7.5 cm long _____ **3. S. holosericea**
7b. Leaves sparsely to moderately appressed hairy; petals 8–14 cm long _____ 8

8a. Pods glabrous or with a few scattered hairs, 1.3–1.9 cm wide; leaflets less than three times as long as wide _____ **4. S. hookeriana**
8b. Pods sparsely to densely appressed hairy, 1.5–2.5 cm wide; leaflets at least four times longer than wide _____ **1. S. alexandrina**

1. Senna alexandrina Mill., Gard. Dict., ed. 8, *Senna* no. 1: 1069 (1768). – *Cassia senna* L., Sp. Pl. 377 (1753). – *Cassia alexandrina* (Mill.) Spreng., Bot. Gart. Halle 21 (1800). – *Cassia acutifolia* Delile, Fl. d'Egypte 75 (1813), *nom. superfl.* – *Senna acutifolia* (Delile) Batka, Bot. Zeit. 7: 193, t. 2, fig. 2 (1849), *nom. superfl.* – Type:

Morison, Pl. Hist. Univ., 2: 201, s. 2, t. 24, f. 1 (1680), lectotype designated by Valenti (1971: 62).

Cassia angustifolia Vahl, Symb. Bot. 1: 29 (1790). – *Senna angustifolia* (Vahl) Batka, Bot. Zeit. 7: 193, t. 2 (1849). – Type: Yemen, *Forsskål* s.n. (holo C; iso BM).

Senna alexandrina Garsault, Fig. Pl. Méd. 1: Pl. t. 42, fig. B. and Expl. Pl. 33 (1765), *opera utique oppressa.* – *Cassia alexandrina* Thell., Bull. Herb. Boiss. ser. 2, 8: 783 (1908), *nom. illeg.*

Senna alexandrina var. **alexandrina**

Erect, perennial herb to 1.5 m high. *Stipules* usually persistent, narrowly lanceolate to triangular with a wide base, 1.5–4 × 0.5–1 mm. *Leaflets* in 4–8 pairs, lanceolate to widely lanceolate, 1.5–4 × 0.2–1 cm, appressed hairy on both surfaces, more densely so abaxially, apex acute or subacute. *Extrafloral nectaries* usually present between the upper leaflet pair, in a cluster on the interpetiolar ridge between leaflet pairs, on the distal part of the petiolules, or at the base of the adaxial surface of the stipules. *Inflorescence* an erect axillary raceme, axis 6–24 cm long; sparsely to moderately off-white puberulous. *Sepals* 5, pale yellow, obovate, 7–14 × 3.5–7 mm. *Petals* 5, yellowish, dark brown-veined, obovate, 8–12 × 1.5–8.5 mm. *Stamens* 9 or 10, in three ranks; anthers dehiscing through apical pores or slits. *Ovary* moderately to densely sericeous. *Pod* elliptic, broadly-elliptic to oblong, compressed, not crested, 3–6 × 1.5–2.5 cm, sparsely to densely appressed pubescent, beak lateral; seeds 1–9, whitish, 6–7 × 3.5–4 × 0.5–1.5 mm, smooth to bullate or reticulate.

Habitat and ecology. In wadi beds, on dry plains and in grassland, or on rocky or sandy soils, at 15–1280 m altitude.

Distribution. Saudi Arabia, Yemen, Socotra and Oman. Also widespread in northern and eastern dryland Africa, extending eastward to the Indian subcontinent.

Proposed regional IUCN conservation status. Senna alexandrina var. *alexandrina* is assessed here as Least Concern (LC) in the Arabian Peninsula where it has a widespread distribution.

Specimens examined. **Saudi Arabia**. Makkah, 10 iv 1986, *Fayed, A.A.* 1232 (E); Makkah to Taif, 21 xi 1981, *El-Sheikh, A.M., Frey, W., Konig, P., Kurschner, H., Mahmoud, A. & Migahid, A.M.* 81346a (E); Wadi Khulais, 3 xii 1954, *Schwan, H.E.* 53 (K); Wadi Khulays, iii 1977, *Balston, M.E.* 8 (K). **Yemen**. 1 x 1978, *Miller, A.G.* 295 (E); El Barh, 23 x 1983, *Gordon, K.J.* 398 (E); Huraidha, 16 ii 1938, *Wakefield Expedition* 41 (K); Ogly, 11 iii 1952, *Popov, G.B. et al.* 4263 (K); Tehama, 21 xi 1982, *King, R.A.* 236 (E); ibid., 12 iii 1984, *Miller, A.G. & King, R.A.* 5114 (E); Wadi Ain, 11 vi 1955, *Hemming, C.F.* 539 (K); Wadi Ar Rub, 10 viii 1983, *Gordon, K.J.* 195 (E); Wadi Beihan, 13 iv 1953, *Grierson, A.* 236 (E); Wadi Dhabab, 4 i 1890, *Deflers, M.* 229 (K); Wadi Moor, 12 iii 1973, *Wood, J.R.I.* 73/85 (BM); Wadi Ser, 23 viii 1949, *Guichard, K.M.* KG/HAD/79 (BM). **Socotra**. Wadi Schi'gn, 1881, *Schweinfurth, G.A.* 151 (K). **Oman**. Ras al Hadd to Bilad Bani bu Ali, 7 ix 1978, *Whitcombe, R.* 357 (E).

The pods of *Senna alexandrina* var. *alexandrina* resemble those of *S. holosericea*, but differ in having a sparse indumentum (moderately dense in *S. holosericea*) and in being generally narrower, at least two times longer than wide (whereas the pods of *S. holosericea* are at most one and a half times longer than wide). In addition, the pods of *Senna alexandrina* var. *alexandrina*, at 3–6 cm long, are often longer than those of *S. holosericea*, at 2–4 cm long.

Three collections studied, two from Yemen (*Miller* 295; *Gordon* 398) and one from Oman (*Whitcombe* 357) compare well with *Senna alexandrina* var. *alexandrina* in most respects but differ in seed characters. Seeds of these collections are obovate (not obcordate to narrowly obcordate), smaller, 4–5 × 2–3 × 0.4–0.5 mm (not 6–7 × 3.5–4 × 0.5–1.5 mm) and are grey in the centre (not whitish). The areole shape also differs, being oblong not oblanceolate. These collections may represent an undescribed variant, but more material is needed before any formal recognition can be made.

A single unlocalised and undated collection from Saudi Arabia (*Kotschy* s.n. (E)) may represent the otherwise exclusively African taxon *Senna alexandrina* var. *obtusata* (Brenan) Lock. The gathering is not of sufficient quality to confirm the verification below species level. Further collections are needed to confirm the presence of this taxon in the Arabian Peninsula.

2. Senna didymobotrya (Fresen.) H.S.Irwin & Barneby, Mem. New York Bot. Gard. 35(2): 467 (1982). – *Cassia didymobotrya* Fresen., Flora 22(1): 53 (1839). – Type: Ethiopia, *Rüppell* s.n. (holo FR†). – Type: to be neotypified.

Shrub 1.5–2 m high. *Stipules* persistent, obovate to cordate, 15 × 5–8 mm. *Leaflets* in 6–14 pairs, elliptic to oblong, 2–4.5 × 0.5–1.5 cm; adaxial surface sparsely sericeous, abaxial surface more densely hairy, apex rounded to obtuse. *Extrafloral nectaries* usually present between upper leaflet pair. *Inflorescence* an erect axillary raceme, axis 16.5–39 cm long, moderately white pubescent. *Sepals* 5, ovate to obovate, 10–25 × 5–10 mm. *Petals* 5, yellowish, dark brown-veined, obovate, 15–30 × 10–26 mm. *Stamens* 8 or 9, in three ranks; anthers dehiscing through lateral slits. *Ovary* dense, brownish yellow appressed hairy. *Pod* oblong, compressed, depressed between seeds, not crested, 7.5–13 × 1.5–2 cm; moderately appressed hairy, more densely so on the sutures, beak apical; seeds 9–16, 6–8 × 2–4 × 0.8–2 mm, creamy brown or dark brownish yellow, smooth.

Habitat and ecology. On roadside banks, at 1400–2300 m altitude.

Distribution. Yemen, native (and planted) in tropical Africa and naturalised in India and Sri Lanka. A single collection seen from Saudi Arabia (*Naylor* 349) is planted in the lawn of a house in Dhahran.

Proposed regional IUCN conservation status. Senna didymobotrya is assessed here as Data Deficient (DD). Whilst the species is globally widespread and not threatened by genetic erosion (Schmelzer & Gurub-Fakim, 2008), only three specimens have been seen from the Arabian Peninsula. This may be a true reflection of its limited

distribution in the region and thus indicate that a regional assessment of Near Threatened may be appropriate. Alternatively, the species may have been overlooked and under-collected. As there is still some uncertainty we have designated this species as DD.

Specimens examined. **Yemen**. DAFRD, 7 ix 1987, *Cope, T.A. & Murtland, R.* 293 (K); Taiz, 7 ix 1976, *Wood, J.R.I.* 1176 (BM, K).

Senna didymobotrya is unique within the region in having oblong-elongate leaflets with caudate apices. Although three other species (*Senna alexandrina*, *S. holosericea* and *S. italica*) also have compressed pods, they rarely exceed 6 cm long whereas those of *S. didymobotrya* are 7.5–13 cm and relatively narrower, four to five times longer than wide rather than two (*S. alexandrina* and *S. holosericea*) to three (*S. italica*) times as long as wide.

3. Senna holosericea (Fresen.) Greuter, Willdenowia 15(2): 429 (1986). – *Cassia holosericea* Fresen., Flora 22(1): 54 (1839). – Type: Ethiopia, *Rüppel* s.n. (FR†). – Type: to be neotypified. **Fig. 1A.**

Fig. 1. A, *Senna holosericea* flower showing dimorphic porose anthers and ovary with dense indumentum. B, *Senna italica* var. *italica* showing compressed and crested pods. C, *Senna sophera* showing terete pod. D, *Senna sophera* showing shrubby habit and arid, rocky habitat. Photographer: A. G. Miller (RBGE).

Senna ovalifolia Batka, Monogr. Cassiengruppe *Senna* 35, 50 t. 4 (1866). – Type: to be lectotypified.

Cassia oocarpa Baker, Bull. Misc. Inform. Kew 1895: 181 (1895). – Type: Oman, Dhofar, Merbat, 1895, *Bent, J.T.* 69 (holo K).

Erect, perennial herb 5–50 cm high. *Stipules* persistent, commonly narrowly triangular and sometimes hastate, 2.5–7 × 0.5–1.5 mm. *Leaflets* in 4–7(–8) pairs, elliptic to narrowly elliptic, 1–3.5 × 0.5–1.5 cm; moderately to densely spreading whitish pubescent on both surfaces, apex obtuse or retuse. *Extrafloral nectaries* usually present between upper leaflet pair, occasionally also between other leaflet pairs, at the base of the petiolule or at the base of the stipule. *Inflorescence* an erect axillary raceme, axis 5–20 cm long, indumentum dense, white, appressed pubescent. *Sepals* 5, pale yellow with dark orange veins, obovate, 5–10 × 3.5–5.5 mm. *Petals* 5, yellowish, obovate, 5.5–7.5 × 3–5 mm. *Stamens* 8, in three ranks dehiscing through pores. *Ovary* densely whitish to brownish appressed hairy. *Pod* broadly elliptic, reniform, at least when immature, compressed, 2–4 × 1.5–2.5 cm; moderately white appressed pubescent, more densely so on the sutures, beak lateral; seeds 6–8, obcordate, 4–5.5 × 2–3 × 0.6–1 mm, pale creamy brown.

Habitat and ecology. On beaches, sandy or rocky slopes, in dry wadis and in coastal scrub at 0–800 m altitude.

Distribution. Western Saudi Arabia, Yemen, Socotra, Oman. Also in NE Africa and Mali extending eastwards to the Indian subcontinent.

Proposed regional IUCN conservation status. Senna holosericea is assessed here as Least Concern (LC), being widely distributed in the Arabian Peninsula, Africa and the Indian subcontinent.

Specimens examined. **Saudi Arabia**. Burayman, 19 i 1947, *Vesey-Fitzgerald* Y/16720/29 (BM); Jeddah, 1820–1826, *Ehrenberg, C.G.* s.n. (K); ibid., 23 xii 1935, *Fischer, S.* 70 (K); ibid., 14 x 1875, *Marchesetti, C. de* s.n. (K); ibid., 12 xi 1926, *Philby, H.S.J.B.* 2 (BM); ibid., 25 xii 1855, *Schimper, A.F.W.* 780 (K); ibid., *Schimper, W.* s.n. (E); ibid., 23 xii 1855, *Schimper, W.* 780 (K); Qaryat al Fau, 21 ii 1965, *Dickson, V.P.* 1000 (K); Rub-al-Khali, 13 xi 1945, *Thesiger, W.P.* s.n. (BM); Thamad, 13 ii 1946, *Thesiger, W.P.* s.n. (BM); Wadi Al Remmah, 3 iv 1947, *Thesiger, W.P.* s.n. (BM); Zamekh, 1 vi 1955, *Hemming, C.F.* 534 (K). **Yemen**. Aden, 12 vii 1947, *Popov, G.B.* GP/49/300 (BM); ibid., 11 iv 1861, *Thompson, A.T.* s.n. (K); Aden, Abiyan, 12 vi 1987, *Boulos L. et al.* 16842 (E); At Tur, 31 x 1982, *Müller-Hohenstein, K. & Deil, U.* 1134 (E); Az Zuhrah, 24 x 1982, *Müller-Hohenstein, K. & Deil, U.* 981 (E); Dar al Qudaymi, 18 iii 1952, *Popov, G.B. et al.* 4303 (BM); Maduda, 11 xii 1947, *Thesiger, W.P.* s.n. (BM); Raiyan, 15 i 1953, *Grierson, A.* 57 (E); Say'un, 17 i 1985, *Sanadiki, N.* 00169 (E); Wadi Bin Ali, viii 1949, *Guichard, K.M.* KGIHAD/146 (BM); Wadi Shibun, 11 ii 1947, *Thesiger, W.P.* s.n. (BM); Yakhtul, 12 iii 1984, *Miller, A.G. & King, R.A.* 5109 (E). **Socotra**. 6 iii 2003, *Kilian, N. et al.* YP3692 (E). **Oman**. Dhofar, Ain Razat, 16 vi 1988, *McLeish, I.* 822 (E); Dhofar, Merbat, 1895, *Bent, J.T.* 69 (K[3]); Dhofar, Mudhai, 10 i 1985, *McLeish, I.* 470 (E); Dhofar, Mughsayl, 17 ii 1989, *McLeish, I.* 1014 (E); Dhofar, Salalah, 26 x 1981, *Maconochie, J.R.* 2888 (K); ibid., 24 ix 1979, *Miller, A.G.* 2194 (E); ibid., 5 x 1977, *Radcliffe-Smith, A.* 5361 (K); Dhofar, Taqah, 2 x 1979, *Miller, A.G.* 2447 (E); Dhofar, Wadi Uyun, 21 xii 1988, *Whithead, J.* 838 (K); Northern Oman, Bimmah, 13 v 1993, *McLeish, I.* 1930 (E); Ras al Junayz, *Gallagher, M.D.* 80212 (E); Salnahawt,

9 v 1978, *Berkeley, A.* 27 (E); Wadi Jarsis, 25 xi 1981, *Maconochie, J.R.* 2982 (E); Wadi Sabkhar, 22 x 1977, *Radcliffe-Smith, A.* 5544 (K); Wadi Shawram, 27 ii 1985, *Clarke, J.E.* 0005 (E).

Senna holosericea can be distinguished by its rather dense, spreading, soft whitish indumentum.

4. Senna hookeriana Batka, Bot. Zeit. (Leipzig) 21: 264 (1863). – *Cassia adenensis* Benth., Trans. Linn. Soc. London 27: 553 (1871). – Type: to be lectotypified.

Erect perennial herb or shrub to 2 m high. *Stipules* persistent, subulate, 2.5–6 × 0.5–1.5 mm. *Leaflets* in 4–7 pairs, elliptic to broadly elliptic, 1–3 × 0.5–2 cm, sparsely appressed puberulous on both surfaces, apex acute to rounded. *Extrafloral nectaries* usually present between upper leaflet pair, narrow, up to 3 mm long. *Inflorescence* an erect axillary or terminal raceme, axis 9–29 cm long, sparsely puberulous. *Sepals* 5, obovate, 5–15 × 5–9 mm. *Petals* 5, bright yellow, conspicuously veined, obovate, 9–14 × 9–13 mm. *Stamens* 10, in four ranks; anthers dehiscing through apical pores. *Ovary* glabrous. *Pod* oblong-elliptic, compressed, falcate, not crested, 2.6–3.8 × 1.3–1.9 cm, glabrous or with sparse appressed hairs, beak when present small, lateral; seeds 4–5, blue-grey, 6.5–7.5 × 3–4.5 × 0.5–0.8 mm, reticulate.

Habitat and ecology. In semi-desert or open bushland, in wadi bottoms, also on rocky slopes and volcanic rubble, at 0–520 m altitude.

Distribution. Saudi Arabia, Yemen, Socotra and Somalia.

Proposed regional IUCN conservation status. Senna hookeriana is assessed here as Least Concern (LC) under IUCN (2001) guidelines. It has a wide distribution in the Yemen and has been collected once in Saudi Arabia.

Taxonomic notes. Senna hookeriana Batka is not to be confused with *Cassia hookeriana* Gillies ex Hook. which is the basionym of the unrelated *Senna birostris* (Vogel) var. *hookeriana* (Gillies ex Hook.) H.S.Irwin & Barneby from Bolivia and Argentina.

Specimens examined. **Saudi Arabia**. *Carter, R.M.* 57 (E). **Yemen**. Aden, iii 1892, *Hay, G.W.R.* s.n. (E); ibid., xii 1927, *Moreau, R.E.* 5601 (K); Gold Mohur Bay, 29 iii 1953, *Grierson, A.* 115 (E); Hadramaut, 15 ix 1949, *Guichard, K.M.* KG/HAD/146A (BM); ibid., 1893–1894, *Lunt, W.* 61 (BM); Jebel Shamsan, 5 x 1889, *Deflers, M.A.* 31 (K); Mukalla, iv 1974, *Risopoulos, S.A.* 68 (BM); Sif, 21 iii 1964, *Rauh, W. & Lavranos, J.J.* 13343 (K); Wadi Dheiqa, 12 vi 1987, *Boulos, L. et al.* 16878 (E, K); Wadi Washa, 9 iv 1947, *Thesiger, W.P.* s.n. (BM).

Pods of *Senna hookeriana* are similar to those of *S. alexandrina* but are generally smaller (2.6–3.8 × 1.3–1.9 cm vs. 3–6 × 1.5–2.5 cm). In addition, the pods of *Senna hookeriana* are shiny and often glabrous whereas those of *S. alexandrina* var. *alexandrina* are dull with a sparse to dense indumentum.

5. Senna italica Mill., Gard. Dict., ed. 8, *Senna* no. 2 (1768). – *Cassia italica* (Mill.) Lam. ex F.W.Andr., Fl. Pl. Anglo-Egypt. Sudan 2: 117 (1952). – Type: to be lectotypified. **Fig. 1B.**

Cassia aschrek Forssk., Fl. Aegypt.-Arab. 86 (1775). – Type: Yemen, Wadi Mawr, *Forsskål* 1052 (holo C).

Cassia obovata Collad., Hist. Nat. Méd. Casses 92, t. 15A (1816), *nom. illeg*. – Type: to be lectotypified.

Erect or spreading, perennial herb or prostrate subshrub, 20–60 cm high. *Stipules* persistent, triangular to narrowly triangular, 2–7.5 × 0.5–2 mm. *Leaflets* in 4–7 pairs, obovate to elliptic, 1–3 × 0.5–2 cm, both surfaces appressed puberulous, apex obtuse to rounded, occasionally retuse. *Extrafloral nectaries* usually present between the upper leaflet pair, also present between each leaflet. *Inflorescence* an erect, axillary raceme, axis 7.5–30 cm long, appressed puberulous. *Sepals* 5, dark orange in centre and pale yellow on the margins, veins pale orange, ovate, elliptic to occasionally oblanceolate, 6.5–10 × 2.5–6.5 mm. *Petals* 5, yellowish, occasionally with a pale orange centre, brown-veined, obovate, 8.5–14 × 3–6.5 mm. *Stamens* 10, in four ranks; anthers dehiscing through lateral slits. *Ovary* densely appressed pubescent. *Pod* reniform, compressed, crested along the centre of each valve, 3–6 × 1–2 cm, appressed white puberulous, beak subapical to lateral; seeds 6–10, grey, mottled brown, 4–6 × 3–3.5 × 1.5–2 mm, rugulose.

Senna italica is unique among the Arabian species in having a crest along the centre of each valve.

1a. Raceme 7.5–30 cm long, commonly longer than the leaves _____ **5a. S. italica** subsp. **italica**

1b. Raceme 4.5–12 cm long, shorter than the leaves _____ **5b. S. italica** subsp. **micrantha**

5a. Senna italica subsp. **italica**

The typical subspecies has longer racemes, longer petals and shorter leaves than *Senna italica* subsp. *micrantha.*

Habitat and ecology. In shallow wadis, on lower plains of jabals, and in sandy silt at sea level, to 950 m altitude.

Distribution. Saudi Arabia, Yemen and Oman. Also in Jordan and Palestine, extending east to Iran and the Indian subcontinent; widespread throughout dryland Africa.

Proposed regional IUCN conservation status. Senna italica subsp. *italica* is assessed here as Least Concern (LC), being widely distributed in the Arabian Peninsula, Africa and the Indian subcontinent.

Specimens examined. **Saudi Arabia**. Al Hasa, *Mandaville, J.P.J.* 1049 (Dhahran n.v.); Khawat, 31 i 1946, *Thesiger, W.P.* s.n. (BM); South Coastal Lowlands, *Mandaville, J.P.J.* 2947 (BM); Zubaida, 21 i 1971, *Hugh, W. & Leach, R.* 71/51 (BM). **Yemen**. Bir Ahmed, 17 x 1987, *Boulos L. et al.* 16597 (BM); Dhala, 12 ix 1937 – 14 ix 1937, *Scott, H. & Britton, E.B.* 23 (BM); Harad, *Mandaville, J.P.J.* 2101 (Dhahran n.v.); ibid., *Mandaville, J.P.J.* 1029 (Dhahran n.v.); Taiz,

3 ix 2010, *Miller, A.G.* 46146 (E). **Oman**. Musandam, Al-Maksar Isthmus to Khalidiyah, 18 ii 1979 – 6 iii 1979, *Mandaville, J.P.J.* 7297 (BM); Musandam, Bukha, 21 iii 1985, *Ash, R.E.* 288 (E).

5b. Senna italica Mill. subsp. **micrantha** (Brenan) Lock, Kew Bull. 43(2): 339 (1988). – *Cassia italica* (Mill.) F.W.Andr. subsp. *micrantha* Brenan, Kew Bull. 13: 241 (1958). – Type: Kenya, Turkana Province, *Padwa* 144 (holo K).

Habitat and ecology. In sandy or gravelly wadis or on open stony ground near running water, at 20–1500 m altitude.

Distribution. Saudi Arabia, Oman, Qatar and Bahrain. Also widespread in tropical dryland Africa and extending eastward to Pakistan and India.

Proposed IUCN conservation status. Senna italica subsp. *micrantha* is assessed here as Least Concern (LC), being widely distributed in the Arabian Peninsula, Africa and the Indian subcontinent.

Specimens examined. **Saudi Arabia**. Al 'Alah, 15 i 1982, *Dean, G.* E92 (E); Jeddah, 17 vi 1976, *Batanouny, K.H.* 16 (BM); ibid., 17 vi 1976, *Batanouny, K.H.* 13 (BM); Kalaat Zamrud, 8 i 1947, *Vesey-Fitzgerald, D.* 16688/28 (BM); Wadi Ghurra, 23 vi 1835, *Schimper, W.* 303 (BM). **Oman**. Breik Qotait, 30 i 1980, *Whitcombe, R.* 817 (E); Dhofar, Salalah, 29 iv 1993, *McLeish, I.* 1845 (E); Dhofar, Wadi Shihan, 15 v 1982, *Gallagher, M.D.* 646444 (E); Jabal al Akhdar, 3 iv 1975, *Mandaville, J.P.J.* 6144 (BM); Misfah to Hamra, 6 iii 1978, *Whitcombe, R.* 122 (E). **Qatar**. Al Jumayliyah, 29 xii 1970, *Willcox, C.* 42 (K). **Bahrain**. Riffa, 13 iii 1950, *Good, R.D.* 121 (BM).

6. Senna obtusifolia (L.) H.S.Irwin & Barneby, Mem. New York Bot. Gard. 35(1): 252 (1982). – *Cassia obtusifolia* L., Sp. Pl. 1: 377 (1753). – Type: A specimen grown from seed collected in Cuba near Havana in Dillenius, Hort. Eltham. 71, t. 62 (1732) (lecto OXF, n.v., designated by Brenan (1958: 251)).

Erect, robust, annual herb to 0.5−2 m high. *Stipules* persistent, subulate, 6.5–11 × 0.3–0.4 mm. *Leaflets* usually in three pairs, obovate (or the lower leaflet pair occasionally elliptic), 1.5–6 × 1–3.5 cm, both surfaces appressed hairy, more densely so on abaxial surface, apex rounded or retuse. *Extrafloral nectaries* usually present between the lower leaflet pair only, erect, stalked, linear, 0.5–2 mm long. *Inflorescence* an erect, axillary few-flowered raceme, axis 1.5–7 cm long, appressed to spreading, off-white, villous. *Sepals* 5, greenish, light olive to pale yellow in centre and off-white on margins, elliptic to obovate, veins greenish to brownish, 4.5–7 × 3–6 mm. *Petals* 5, pale pink to pinkish orange, white blotch in centre near the base, occasionally light brownish yellow with off-white margins, veins light to dark brown, obovate, occasionally elliptic, 7.5–14.5 × 4–7 mm. *Stamens* 9, in four ranks, anthers dehiscing through apical pores or lateral slits. *Ovary* appressed pubescent. *Pod* linear, angular, not crested, 10.5–20 × 0.3–0.5 cm, sparsely appressed pubescent, more densely so towards the base, beak apical; seeds 12–30, dark brown to dark greyish brown, 5–7 × 2.5–3.5 × 1–2.2 mm, foveolate.

Habitat and ecology. In wadis, woodlands and shrublands, up to 850 m altitude.

Distribution. Saudi Arabia, Yemen and Socotra. Native distribution uncertain but occurring widely throughout the tropics.

Proposed regional IUCN conservation status. Senna obtusifolia is assessed here as Least Concern (LC), being widely distributed in the Arabian Peninsula and elsewhere.

Specimens examined. **Saudi Arabia**. Al Aridah, 12 xi 1986, *Collenette, I.S.* 5925 (E); Rijal Alma', 25 x 1984, *Nasher, A.K.* 17884 (E); Wadi Al Uss, 17 x 1981, *Collenette*, *I.S.* 2972 (E). **Yemen**. Aden, 3 ix 2010, *Miller, A.G.* 46061 (E); Taiz, 24 x 1974, *Wood, J.R.I.* Y/74/128 (BM). **Socotra**. Hadiboh Plain, *Popov, G.B.* 4 (BM). **Oman**. Ayn Razat, 4 x 1984, *Ash, R.E.* 132 (E); Dhofar, Sarfayt, 10 x 1979, *Miller, A.G.* 2671 (E); Dhofar, Wadi Aynaynah, 25 viii 1988, *Lawton, R.M.* 2385 (BM); Jebel Qamar, 10 ix 1989, *Miller, A.G. & Nyberg, J.A.* M9262 (E); Khadrafi, *Mandaville, J.P.J.* 6940 (BM); Kharfawt, 25 ix 1977, *Radcliffe-Smith, A.* 5235 (K).

Senna obtusifolia can be distinguished from all other native Arabian *Senna* species by the combination of three pairs of leaflets, linear pods and the presence of extrafloral nectaries only between the lower leaflet pair. *Senna obtusifolia* shares the characters of number of leaflet pairs and pod shape with the closely related *S. tora*. However, in *Senna obtusifolia* extrafloral nectaries occur only between the lower leaflet pair, whereas in *S. tora* extrafloral nectaries can be seen between the lower and median pairs and sometimes also between the upper pair of leaflets.

7. Senna occidentalis (L.) Link, Handb. 2: 140 (1831). – *Cassia occidentalis* L., Sp. Pl. 1: 377 (1753). – Type: Netherlands, Hartekamp, near Leiden, a cultivated specimen first described in Herb. Cliff. III: 159, Cassia no. 7, numbered 10, *Clifford, G.* s.n. (lecto BM, designated by Reveal (1991: 454)).

A bushy, leafy herb or shrub 0.5−1 m high. *Stipules* persistent, falcate, triangular to narrowly triangular, 0.5–3.5 × 0.5–2 mm. *Leaflets* in (3–)4–5 pairs, broadly lanceolate to ovate, 2–8.5 × 1–3 cm, both surfaces glabrous, the margins sparsely ciliate, apex acuminate. *Extrafloral nectaries* usually present between the upper leaflet pair, falcate, linear; an extrafloral nectary also usually present at the base of the leaf petiole, sessile, globose. *Inflorescence* an erect, axillary raceme, axis 3–19 cm long, sparsely appressed pubescent. *Sepals* 5, centre dark orange, margins pale yellow, veins pale orange, obovate, 6–9 × 4–6 mm. *Petals* 5, pale yellowish, brown-veined, obovate, 9–12.5 × 6–8.5 mm. *Stamens* 9, in three ranks; anthers dehiscing through apical pores. *Ovary* densely sericeous. *Pod* ligulate, compressed, not crested, 9–12 × 0.5–1 cm, centre brown, margins light brown, beak apical; seeds 24–38, brown, 4–4.5 × 3–3.5 × 1.5–2 mm, smooth.

Habitat and ecology. In sandy wadi beds near running water, on rocky hillsides and steep slopes, from sea level to 1800 m altitude.

Distribution. Saudi Arabia and Yemen. Native distribution long obscured but occurring widely throughout the tropics.

Proposed regional IUCN conservation status. Senna occidentalis is assessed here as Least Concern (LC), being widely distributed in the Arabian Peninsula.

Specimens examined. **Saudi Arabia**. Jabal Tharban, 10 viii 1982, *Hassan, H.M., Konig, P. & Kürschner, H.* 822172 (E); Jeddah, 18 v 1981, *Collenette, I.S.* 2728 (E, K); ibid., 1820–1826, *Ehrenberg, C.G.* s.n. (K); Wadi Al Uss, 17 x 1981, *Collenette, I.S.* 2970 (E). **Yemen**. Aden, 3 ix 2010, *Miller, A.G.* 46062 (E); Al Qaidah, 18 vii 1983, *Spellenberg, R.W. & Abushe'ar* 7362 (K); Hajjah, 6 x 1982, *Müller-Hohenstein, K. & Deil, U.* 624 (E); Hodeida, 24 vii 1983, *Spellenberg, R.W.* 7485 (K); Medinat al Abid, Wadi Rima, 17 v 1976, *Henry, P.W.T.* 5676 (K); Sheikh Othman, 26 i 1953, *Grierson, A.* 72 (E); Taiz, 14 viii 1978, *Miller, A.G.* 20 (E); Wadi Ayan, 6 iii 1982, *Müller-Hohenstein, K. & Deil, U.* 126 (E).

Senna occidentalis resembles *S. sophera* and sterile specimens of the two species may be difficult to distinguish. However, generally the leaflets of *Senna occidentalis* are relatively broader (2–3 times longer than wide) than those of *S. sophera* (3–5 times longer than wide). Both species have a globose, sessile extrafloral nectary at the base of each leaf although this is generally larger (1–1.5 mm across) in *Senna occidentalis* than in *S. sophera* (0.5–1 mm). Whilst extrafloral nectaries may be present between the upper leaflet pair of *Senna occidentalis* and *S. sophera*, the presence of extrafloral nectaries between other leaflet pairs or on the internodes of the leaf rachis is characteristic of *S. sophera* but not of *S. occidentalis*. Pods of *Senna occidentalis* are usually compressed whereas those of *S. sophera* are commonly subterete or occasionally terete.

8. Senna sophera (L.) Roxb., Fl. Ind., ed. 2, 2: 347 ('sophora') (1832). – *Cassia sophera* L., Sp. Pl. 1: 379 (1753). – Type: Herb. Hermann 4: 79, No. 150 (lecto BM [BM-000594778], designated by Fawcett & Rendle (1920: 105)). **Fig. 1C, D.**

Cassia socotrana Serrato, Webbia 26(1): 27 (1971), **syn. nov.** – Type: Socotra, *Symony* s.n. (holo W).

Erect or ascending robust perennial herb or shrub 0.5–1 m high. *Stipules* usually caducous, sometimes persistent, narrowly triangular, 1.5–4.5 × 0.1–1 mm. *Leaflets* in 4–9 pairs, lanceolate to broadly lanceolate, 1–5.5 × 0.5–1.5 cm; adaxial surface glabrous, abaxial surface glabrous or sparsely sericeous, more densely so on the midrib and margins, apex acute. *Extrafloral nectaries* variable in position and structure: ovoid, sessile to narrowly or thickly stalked with dark brown heads usually present at the base of each petiole; ensiform or falcate nectaries 0.5–1.2 mm long, present between the upper leaflet pair; minute, filiform nectaries c.0.2 mm long, usually present on the ridge between each leaflet pair; and falcate nectaries 0.2–0.5 mm long, sometimes occurring along the internodes of the leaf rachis. *Inflorescence* a raceme, axis 1.5–3.5 cm long, glabrous or sparsely to moderately sericeous. *Sepals* 5, pale greenish or light yellowish brown, lighter along the margins, occasionally pale pinkish orange and whitish along the margins, veins pale orange or pale brownish yellow, obovate, 5–10 × 3.5–7 mm. *Petals* 5, yellow with a pale yellow blotch towards the apex, or yellowish to saffron coloured, brown-veined, obovate, 7–14 × 4.5–8.5 mm. *Stamens* 9 or 10, in three ranks; anthers dehiscing through apical pores. *Ovary* moderately sericeous. *Pod* linear-oblong, commonly subterete or occasionally terete, not crested, dull brownish yellow on margins, olive and dark brown in centre,

5–11 × 0.5–1 cm, sparsely to moderately sericeous, beak apical; seeds 20–34, pale brownish yellow to dark brown, 2.5–4.5 × 2–4 × 1.5–2.5 mm, smooth.

Habitat and ecology. In moist sandy soil or in wadi beds, or amongst pebbles in dry river beds, sometimes associated with date palms, and along tracks, at 100–2300 m altitude.

Distribution. Saudi Arabia, Yemen, Socotra and Oman. Also in Bahrain, India, Malaysia and the Philippines.

Proposed regional IUCN conservation status. Senna sophera was assessed as Least Concern (LC) on Socotra by Miller & Morris (2004). We extend that designation to the Arabian Peninsula as a whole, where it is widely distributed.

Specimens examined. **Saudi Arabia**. Wadi Fatimah, 1837, *Fischer, S.* 71 (K); ibid., 1837, *Fisher, S.* 71 (K); ibid., 12 ii 1836, *Schimper, W.* 779 (BM, E). **Yemen**. Ad Dabab, 11 iii 1984, *Miller, A.G. & King, R.A.* 5055 (E); Aden, 3 ix 2010, *Miller, A.G.* 46063 (E); Dabab, 11 vi 1982, *Gordon, K.J.* 21 (E); Taiz, 28 ii 1973, *Wood, J.R.I.* Y/73/11 (BM); ibid., 13 xii 1974, *Wood, J.R.I.* Y/74/344 (BM); Wadi Arafat, 16 iii 1984, *Miller, A.G. & King, R.A.* 5202 (E); Wadi Ribat, 1 ix 1977, *Radcliffe-Smith, A. & Henchie, S.J.* 4892 (K). **Socotra**. Adho di Meleh, 28 ii 2010, *Banfield, L.* LB4976 (E). **Oman**. Al Gayla, 3 iii 1985, *Ash, R.E.* 243 (E); Bahala, 20 iv 1975, *Mandaville, J.P.J.* 6685 (BM); Ibri, 4 iv 1978, *Whitcombe, R.* 168 (E); Ibri to Araq, 13 xi 1978, *Whitcombe, R.* 438 (E); Northern Oman, Tiwi, 29 ix 1989, *Miller, A.G. & Nyberg, J.A.* M9556 (E); Northern Oman, Wadi Sahtan, 4 iv 1975, *Mandaville, J.P.J.* 6202 (BM).

Senna sophera is a variable species and some collections may closely resemble collections of *S. occidentalis*. Characters that may be useful in separating the two species are reported under *S. occidentalis* (above).

9. Senna tora (L.) Roxb., Fl. Ind., ed. 2, 2: 340 (1832). – *Cassia tora* L., Sp. Pl. 1: 376 (1753). – Type: Herb. Hermann 4: 79, No. 152 (lecto BM [BM-000628410], designated by Brenan (1958: 250)).

Annual herb 0.3–2 m high. *Stipules* persistent, subulate, 4–7.5 × 0.2–0.5 mm. *Leaflets* usually in three pairs, obovate, occasionally lowest leaflet pair elliptic, 1–4 × 1–2 cm, adaxial surface sparsely appressed villous, abaxial surface moderately so, apex rounded or retuse. *Extrafloral nectaries* present between the lower and median leaflet pairs, sometimes also present between the upper leaflet pair. *Inflorescence* an erect, axillary few-flowered raceme, axis 2–7 cm long, sparsely to moderately appressed to spreading white villous. *Sepals* 5, light olive, elliptic to obovate, light brown-veined, 4.5–8 × 3.5–5 mm. *Petals* 5, pinkish or pale orange, paler in the middle, brown-veined, obovate, 8.5–14 × 4.5–6 mm. *Stamens* 9 or 10, in three ranks, anthers dehiscing through apical pores. *Ovary* densely appressed white villous. *Pod* linear, angular, not crested, 10.5–16.5 × 0.2–0.5 cm, brown with brownish venation in centre, paler along margins, sparsely to moderately appressed villous, beak attenuate to acuminate, beak apical; seeds 16–25, dark brown, 5.5–6 × 2.5–3 × 0.5–1 mm, foveolate.

Habitat and ecology. Dry and/or gravelly wadis, or in cool cave areas, at 300–1200 m altitude.

Distribution. Introduced and becoming naturalised in Oman, Yemen and Socotra.

Proposed regional IUCN conservation status. The species is assessed here as Least Concern (LC), being widely distributed in the Arabian Peninsula and elsewhere.

Specimens examined. **Yemen**. Wadi Arafat, 16 iii 1984, *Miller, A.G. & King, R.A.* 5199 (E). **Socotra**. Wadi Ayhaft, 31 i 1994 – 1 xi 1994, *Thulin, M. & Gifri, A.N.* 8839 (E). **Oman**. Dhofar, 3 x 1991, *Prendergast, H.D.V.* HDVP469 (K); Dhofar, Ain Garzeez, 14 xi 1984, *McLeish, I.* 344 (E); Dhofar, Shahayt, 24 ix 1993, *McLeish, I.* 2655 (E); ibid., 24 ix 1993, *McLeish, I.* 2676 (E).

Senna tora closely resembles *S. obtusifolia* but even sterile collections can be distinguished due to the differences in the positions of extrafloral nectaries as discussed under *S. obtusifolia* (above).

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The number in brackets corresponds to the number given to the taxon in the species accounts: *Senna alexandrina* var. *alexandrina* (1); *S. didymobotrya* (2); *S. holosericea* (3); *S. hookeriana* (4); *S. italica* (5); *S. italica* subsp. *italica* (5.1); *S. italica* subsp. *micrantha* (5.2); *S. obtusifolia* (6); *S. occidentalis* (7); *S. sophera* (8); *S. tora* (9).

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