



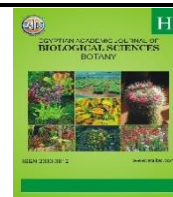
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Macromorphological Revision of *Indigofera* L. (Faboideae, Fabaceae) in Egypt

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ABSTRACT

This study presents a taxonomic revision of the genus *Indigofera* L. (tribe *Indigofereae*, subfamily Faboideae, Fabaceae) in Egypt. The revision is based on 58 specimens representing 13 taxa of *Indigofera* collected from different locations and habitats. The morphological characteristics of the vegetative and reproductive parts, such as indumentum; leaf shape, and size; stipule shape and length; calyx shape and length; corolla color, shape, and size; pod and seeds (color, shape, and size) were proved to have high taxonomic significance in distinguishing the species belonging to the genus *Indigofera*. Generally, all parts of the plant are covered with dense white two-armed hairs, which give the plant a silvery appearance. In *Indigofera cordifolia* B. Heyne ex Roth, the leaves are unifoliolate, but they are compound among the other investigated species. An artificial key to the studied taxa, full species description and illustrations, local and global distribution, habitat, and conservation status are provided to facilitate the identification and recognition of these species.

INTRODUCTION

The genus *Indigofera* L. (tribe *Indigofereae*, subfamily Faboideae), is the third largest genus in Fabaceae after *Astragalus* L. and *Acacia* Mill (s. l.), comprising about 713 accepted species distributed throughout the pantropics (POWO, 2023). *Indigofera* species have a significant economic importance. The plant's stem and foliage are used to make blue indigo dye, some species are utilized as medicine, fodder, cover crops, green manure, human food, erosion management, and ornamentals (Siva, 2007; Chauhan *et al.*, 2015). The genus was the subject of taxonomical studies; in 1753, Linnaeus described the genus based on the three species of *Indigofera tinctoria* L., *I. hirsuta* L., and *I. glabra* L. The infrageneric classification of *Indigofera* has been based on habit, indumentum, glands, leaf, inflorescence, calyx, corolla, stamen morphology, and pod morphology (Chauhan & Pandey, 2015; De Candolle, 1825; Meyer, 1836; Robert & Arnott, George, 1834; Schrire, 1995).

Indigofera was represented by nine species in the Flora of Egypt (Täckholm *et al.*, 1956). Later, the number of species increased to 14 (Täckholm, 1974; El Hadidi *et al.*, 1995; Boulos, 2009; El Hadidi *et al.*, 1995). However, recently, only 13 species of *Indigofera* were listed in the country's flora after removing *Indigofera tritoides* Baker from Täckholm's list (Boulos, 1999, 2009; Hosni, 2000). Hosni (2000) examined the macro and micromorphological traits of 13 taxa of *Indigofera*. The results revealed that the size and shape of pods, seeds, the number of leaflets, and the pubescence of the plant, along with the

micromorphological traits like seed coat sculpture and the characteristics of the leaf epidermal cells, have the most significant systematic value. However, her study did not update the morphological descriptions of the genus *Indigofera* in Egypt. Thus, the current study aims to employ the macro and micromorphological characteristics in updating the descriptions of the Egyptian *Indigofera* and update their identification key as well.

MATERIALS AND METHODS

Plant Materials:

Plant materials (mature leaves and stems) were taken from previously collected herbarium specimens in the herbaria of Aswan University (ASW), South Valley University, Assiut University (ASTU), and Cairo University (CAI) in Egypt (herbarium acronyms follow (Thiers, 2023). Plant taxa were reviewed according to the available literature (Boulos, 1999, 2000, 2002, 2005; Täckholm, 1974). The taxonomic names were updated according to Plants of the World Online (POWO, 2023) provided by the Royal Botanic Gardens, Kew.

Methods For Morphological Studies:

Macro-Morphological Characters:

The macro-morphological characteristics of the species under study, including their leaves, stems, inflorescences, floral components, and fruits were examined using a Ray Wild stereomicroscope. The dried plant material was either examined immediately or placed in heated lactic acid for 1–2 minutes before examination. Dimensions of the leaves, petioles, and stipules were measured by using a ruler. In contrast, the floral components (epicalyx, calyx lobes, corolla, staminal tube, stamens, and styles) and the fruits were measured using ImageJ v1.45 (Schneider *et al.*, 2012). A total of 58 plant samples from 13 taxa of *Indigofera* were described. The conservation status of the studied taxa in Egypt was assessed according to the International Union for Conservation (IUCN, 2022). Macrophotography was performed with a Nikon D600 digital camera (Nikon Inc., Japan).

RESULTS AND DISCUSSION

Indigofera L., Sp. Pl. 2: 751 (1753).

Annual or perennial; herb to shrub, generally with canescent appressed, two-armed hairs; Stem ascending, prostrate to erect; Leaves compound and rarely simple; Stipules filiform to subulate; Leaflets opposite or alternate, obovate; Inflorescence axillary raceme or clusters; Calyx lobes or teeth narrowly subulate to triangular; Corolla usually bright red to red; standard broadly ovate to orbicular; Wing glabrous, spatulate to oblong; Stamens 9+1, diadelphous; Pod straight to curved cylindrical, torulose, 1-12-seeded per pod. Seeds olive to dark brown, ± spherical, oblong to rectangular.

Artificial Key to the Egyptian species of *Indigofera* L.

- | | |
|---|--|
| 1a. Leaves simple (unifoliolate), stipules setaceous, leaf base cordate | 6. <i>I. cordifolia</i> |
| 1b. Leaves compound, stipules not setaceous, leaf base acute | 2 |
| 2a. Leaflets alternate | 3 |
| 2b. Leaflets opposite | 4 |
| 3a. Shrubs; flowers and pods in small axillary clusters, sessile | 9. <i>I. sessiliflora</i> |
| 3b. Annual herbs; flowers and pods raceme, pedunculate | 8. <i>I. oblongifolia</i> |
| 4a. Armed shrubs, inflorescence spinescent | 11. <i>I. spinosa</i> |
| 4b. Unarmed shrubs or herbs; inflorescence not spinescent..... | 5 |
| 5a. Leaves exstipulate | 4. <i>I. coerulea</i> var. <i>coerulea</i> |
| 5b. Leaves stipulate | 6 |
| 6a. Pods straight cylindrical | 7 |
| 6b. Pods curved cylindrical | 8 |

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- 7a. Stem prostrate; stipules filiform; Seed Rectangular, brown with black spots7. *I. hochstetteri*
 7b. Stem erect; stipules subulate; Seed ± spherical, dark brown 1. *I. arabica*.
 8a. Glandular hairs present on the vegetative organs 9
 8b. Glandular hairs absent on the vegetative organs 10
 9a. Herb, stem erect; wings spathulate; staminal tube 2 mm; pod 3–5 seeded 2. *I. argentea*
 9b. Under shrub, stem ascending, leaves elliptic or obovate, wings oblong; staminal tube 3 mm; pod 8–12 seeded 5. *I. colutea*
 10a. Leaves 3–5(–7) foliolate; pod 1–3 seeded; seeds spherical, 2.09 mm length 3. *I. articulata*
 10b. All leaves 3-foliolate; pod > 3 seeded; seeds bone-shaped, rectangular, or oblong, < 1.2 mm length 11
 11a. Leaf rachis 9–12 mm; seeds oblong, < 1mm length 12. *I. subulata* var. *subulata*
 11b. Leaf rachis very short, ca. 1 mm; seeds bone-shaped or rectangular, > 1mm length 12
 12a. Stem erect, leaflets obcordate or broadly ovate; pod to 30.34 mm length; seeds rectangular 13. *I. trita*
 12b. Stem ascending to sprawling, leaflets obovate-cuneate; pod to 8.46 mm length; seeds bone-shaped 10. *I. spiniflora*

1. *Indigofera arabica* Jaub. & Spach., Ill. Pl. Orient. 5: 89 (1856):

Homotypic Synonyms:

***Anil arabica* (Jaub. & Spach) Kuntze in Revis. Gen. Pl. 2: 938 (1891):**

Perennial herb, 15–30 cm in length, densely canescent. Stems erect, branched, and woody, especially at the base, with non-glandular (two-armed) trichomes covering the above-ground parts. Leaves imparipinnate, opposite, 3–5-foliolate; stipulate; stipules 2–3 mm long, subulate; Petiole 4–5 mm long; leaf rachis 7–10 mm long; leaflets 5–16 × 2–5 mm, obovate to oblanceolate, base acute to ± oblique; apex mucronate, margin entire; covered with densely non-glandular (two-armed) trichomes on both surfaces, three-armed trichomes characterize the abaxial surface. Inflorescences axillary; racemes pedunculate, peduncle 13–20 mm long, longer than the subtending leaves, 5–12-flowered. Flowers pedicelled; calyx labiate, ca. 3 mm long toothed with subulate teeth, apex acute, covered with densely non-glandular (two armed trichomes) and glandular (filiform-clavate) trichomes; Corolla red, papilionaceous; standard 3 × 2 mm, orbicular, base rounded, apex rounded, with two-armed trichomes all over the surface except margin and base; keel 3 × 2 mm with two-armed trichomes confined to the distal half of its midrib zone; wings 2.5 × 1 mm, spathulate, base truncate, apex slightly retuse; glabrous; androecium 10-stamens, diadelphous, stamen tube 2.5 mm long; gynoecium monocarpellate, unilocular, glabrous. Fruit leguminate, pods 6.30–8.69 × 1.23–2.21 mm, light brown, slightly straight cylindrical, torulose, 2–5 seeds per pod, covered with densely two-armed trichomes. Seeds 0.73–1.40 × 0.81–1.65 mm, dark brown, ± spherical; hilum 0.18–0.22 × 0.06–0.07mm, ovate, takes a central position.

Figures: 1.1, 2.1.

Distribution:

Local: Very rare, Sinai in Egypt

Global:

Native: Djibouti, Eritrea, Ethiopia, Gulf States, Oman, Pakistan, Saudi Arabia, Egypt, Somalia, Yemen

Habitat: In Egypt, *Indigofera arabica* is found in stony wadis.

Conservation Status: *Indigofera arabica* has not been assessed for The IUCN Red List of Threatened Species. However, the species has been reported as very rare in Egypt.

Specimens Examined: EGYPT. Sinai, 2006, *A.k. Osman s.n.* (South Valley University Herbarium).

2. *Indigofera argentea* Burm.f., Fl. Indica: 171 (1768):

Heterotypic Synonyms:

Anil argentea Kuntze in Revis. Gen. Pl. 2: 938 (1891)

Indigofera arenaria var. *strigosa* A.Terracc. in Annuario Reale Ist. Bot. Roma 5: 109 (1894)

Indigofera argentea L. in Mant. Pl. 2: 273 (1771), nom. illeg.

Indigofera brachycarpa Graham in N.Wallich, Numer. List: n.° 5470 (1831), not validly publ.

Indigofera burmanni Boiss. in Fl. Orient. 2: 187 (1872)

Indigofera retusa Graham in N.Wallich, Numer. List: n.° 5476 (1831), not validly publ.

Indigofera semitrijuga var. *tetrasperma* DC. in Prodr. 2: 230 (1825)

Indigofera simplicifolia Dennst. in Schlüssel Hortus Malab.: 34 (1818), nom. illeg.

Perennial undershrub, 20–50 cm length, densely canescent. Stem ascending, with non-glandular (two-armed) trichomes and sparsely glandular (clavate) trichomes. Leaves imparipinnate, opposite, 5–7(–9)-foliolate; stipulate; Stipules 1–2 mm long, subulate; leaflets 3–6 × 2–3 mm, opposite, obovate, base acute, apex slightly retuse or obtuse, margins entire; Leaf rachis 10–19 mm long; Petiole 2–7 mm long, covered with densely non-glandular (two-armed) and glandular (clavate) trichomes on both surfaces, the adaxial surface is characterized by sparsely simple trichome. Inflorescences axillary, racemes, pedunculate; Peduncle 15–27 mm, much longer than the subtending leaves 4–10 flowered. Flowers pedicelled; calyx ca. 2 mm long toothed with narrowly triangular teeth, acute apex, covered with densely non-glandular (two-armed) and glandular (clavate) trichomes; Corolla bright-red; standard 3 × 2 mm, broadly obovate, base truncate, apex rounded with sparsely two-armed, simple and clavate trichomes confined to the distal half of its midrib zone; Keel 3 × 2 mm with sparsely two-armed and simple trichomes limited to the distal half of its midrib zone; wings 3 × 1 mm glabrous, spatulate, base truncate, apex obtuse, glabrous, Androecium 10 stamens, Diadelphous, stamen tube ca. 2 mm long; Gynoecium monocarpellate, unilocular, with non-glandular trichomes. Fruit leguminate, pods 7.14–10.58 × 1.64–2.18 mm, light brown, straight cylindrical, torulose, 3–5 seeded, covered with densely non-glandular (two-armed and three-armed) and glandular (clavate and peltate) trichomes. Seeds 0.71–1.60 × 1.10–1.44 mm, dark brown, rectangular; hilum 0.29–0.32 × 0.06–0.09 mm, ovate, takes a subcentral position.

Figures: 1.2, 2.2.

Distribution:

Local: Rare, The Nile Valley, from Cairo to Wadi Halfa., The part of the Arabian desert from Qena-Qosseir Road southwards to the Sudan boundary. (mer. stands for meridional, South), The Red Sea coastal region.

Global:

Native: Algeria, Chad, Egypt, Eritrea, Gulf States, India, Iran, Lebanon-Syria, Mali, Mauritania, Niger, Oman, Pakistan, Saudi Arabia, Socotra, Somalia, Sudan, Yemen

Introduced: Haiti

Habitat: In Egypt, *Indigofera argentea* is found in sandy plains and stony wadis.

Conservation Status: *Indigofera argentea* has not been assessed for The IUCN Red List of Threatened Species. However, the species has been reported as rare in Egypt.

Specimens Examined: Egypt. Nubia, Aniba, 28 Jan. 1964, *L. Boulos s.n.* (CAI).

3. *Indigofera articulata* Gouan, In Ill. Observ. Bot.: 49 (1773).

Homotypic Synonyms:

Anil articulata (Gouan) Kuntze in Revis. Gen. Pl. 2: 938 (1891).

Heterotypic Synonyms:

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Indigofera articulata var. *brachycarpa* Vatke in Oesterr. Bot. Z. 28: 213 (1878).

Indigofera glauca Lam. in Encycl. 3: 246 (1789).

Indigofera tinctoria Forssk. in Fl. Aegypt. Arab.: 138 (1775), sensu auct.

Perennial shrub 5–1.5 m in length, densely canescent. Stems erect, branched with non-glandular trichomes (two-armed and three-armed) covering the above-ground parts. Leaves imparipinnate, opposite, 3–5(–7) foliolate, stipulate; stipules ca.1 mm long, triangular; petiole 5–16 mm long; leaf rachis 10–45 mm long; leaflets 13–31 × 16–20 mm, obovate to broadly obovate, base acute, apex obtuse, ± retuse, margin entire, covered with densely non-glandular (two-armed and sparsely simple) trichomes on both surfaces, the abaxial surface is characterized by sparsely three-armed trichomes. Inflorescences axillary, racemes pedunculate; peduncle 15–27 mm long, shorter than the subtending leaves, 10–20 flowered. Flowers pedicelled; Calyx labiate, ca. 2 mm long, toothed with triangular teeth, apex acute, covered with densely non-glandular (two-armed) and glandular (clavate and filiform) trichomes; Corolla red, papilionaceous; Standard 3.5 × 2.5 mm, orbicular, truncate base, rounded apex, with two-armed trichomes all over the surface except base and margin; keel 4 × 3 mm with two-armed trichomes confined to the distal half of its midrib zone; wings 3 × 1 mm, spatulate, base truncate, apex ± acute, glabrous; Androecium 10 stamens, diadelphous, stamen tube 2 × 1 mm; Gynoecium monocarpellate, unilocular, glabrous. Fruit leguminate, pod 4.19–8.25 × 3.06–4.37 mm, brown, ± straight cylindrical, conspicuously torulose with globular segments, 1–3 seeds per pod, densely covered with two-armed trichomes. Seeds 1.56–2.49 × 1.23–2.57 mm, light olive to brown, spherical; hilum 0.13–0.23 × 0.54–0.76 mm, ovate, takes a central position.

Figures: 1.3, 2.3.

Distribution:

Local: Rare, The Nile Delta, including Cairo but not further south, The Nile Valley, from Cairo to Wadi Halfa, The Oases of the Libyan desert, The part of the Arabian desert from Qena-Qosseir Road south-wards to the Sudan boundary. (mer. stands for meridional, South), The Red Sea coastal region, Gebel Elba, and surrounding mountains are situated in the southeast corner of Egypt at the Sudan frontier.

Global:

Native: Algeria, Djibouti, Egypt, Eritrea, Ethiopia, Gulf States, Iran, Oman, Pakistan, Saudi Arabia, Socotra, Somalia, Sudan, Yemen

Introduced: Dominican Republic

Habitat: In Egypt, *Indigofera articulata* is found on the edges of cultivation and sandy plains.

Conservation Status: *Indigofera articulata* has not been assessed for The IUCN Red List of Threatened Species. Therefore, the conservation status in Egypt is not currently known. However, the species has been reported as rare in Egypt.

Specimens Examined: EGYPT. Gebel Elba, Wadi Diib, E. of Hamata Dom, 2 March 1967, Osborn & Helmy s.n. (CAI). Saudi Arabia. Alaya–Baha Road, 25 Km from Alaya, 28 Feb. 1992, M. Zareh s.n. (ASTU).

4. *Indigofera coerulea* Roxb, Fl. Ind., ed. 1832. 3: 377, 864 (1832), orth. var. *coerulea*
Heterotypic Synonyms:

Indigofera caerulea Roxb. in Fl. Ind., ed. 1832. 3: 377, 864 (1832), orth. var.

Perennial shrub, up to 1 m in length, densely canescent. Stems erect, branched with non-glandular trichomes (two and three-armed trichomes) covering the above-ground parts. Leaves imparipinnate, opposite, 5–7 (–9) foliolate, exstipulate; petioles 5–12 mm long; leaf rachis 11–40 mm long; leaflets 8–20 × 4–12 mm, oblong or obovate, base acute, apex acute or obtuse, margin entire, densely covered with non-glandular (two armed and sparsely of simple) trichomes on both surfaces, sparsely three-armed trichomes characterize the abaxial surface. Inflorescences are axillary, racemes, pedunculate; peduncles 11–20, equaling or

longer than the subtending leaves, many-flowered. Flowers pedicelled; calyx labiate ca. 1.5 mm long, toothed with triangular teeth, acute apex, covered with non-glandular (two-armed) and glandular (clavate and filiform-clavate) trichomes; Corolla red, papilionaceous; standard 3×2 mm long, orbicular, base rounded, apex rounded with two-armed and simple trichomes all over the surface including margin except base; keel 4×3 mm, with two-armed and simple trichomes confined to the distal half of its midrib zone including margin; wings 3×1 mm, oblong, base truncate, apex obtuse, glabrous; androecium 10-stamens, diadelphous, stamen tube 3 mm long; gynoecium monocarpellate, unilocular, with sparsely two-armed and simple trichomes. Fruit leguminate, pods $6.86\text{--}10.4 \times 2.17\text{--}4.42$ mm, brown, curved cylindrical, less torulose, 2–3- seeds per pod covered with densely two-armed trichomes. Seeds $2.05\text{--}3.03 \times 1.88\text{--}3.20$ mm, olive to brown olive, wide oblong to rectangular; hilum $0.22\text{--}0.27 \times 0.18\text{--}0.24$ mm, ovate, takes a subcentral position.

Figures: 1.4, 2.4.

Distribution:

Local: Very rare, the part of the Arabian Desert from Qena-Qosseir Road south-wards to the Sudan boundary. (Mer. stands for meridional, South), Gebel Elba and surrounding mountains are situated in the southeast corner of Egypt at the Sudan frontier.

Global:

Native: Andaman Is., Chad, Djibouti, Egypt, Eritrea, Gulf States, India, Kenya, Nicobar Is., Oman, Pakistan, Palestine, Saudi Arabia, Socotra, Somalia, Sri Lanka, Sudan, Uganda, Yemen

Introduced: East Himalaya

Habitat: In Egypt, *Indigofera coerulea* var. *coerulea* is found in stony wadis.

Conservation status: *Indigofera coerulea* var. *coerulea* has not been assessed for The IUCN Red List of Threatened Species. However, the species has been reported as very rare in Egypt.

Specimens Examined: EGYPT. Gebel Elba, Wadi Diib, 3 January 1979, *Boulos s.n.* (CAI). Saudi Arabia, Umm Al-Sabaya Island: 50 Km S.W. of Al Qunfida town, about 13 Km from the seashore, 14 February 2001, *A. Fayed s.n.* (ASTU).

5. *Indigofera colutea* (Burm.f.) Merr., Philipp. J. Sci. 19: 355 (1921)

Homotypic Synonyms:

Galega colutea Burm.f. In Fl. Indica: 172 (1768)

Annual or short-lived perennial herb, 20-40 (–60) cm length, densely canescent. Stems erect or spreading branched with non-glandular (two-armed) and glandular (clavate) trichomes covering the above-ground parts. Leaves imparipinnate, opposite, 7–11-foliolate, stipulate; stipules 2–3 mm long, subulate; Petiole 6–7 mm long; leaf rachis 7–8 mm long; leaflets $3\text{--}4 \times 1\text{--}2$ mm, elliptic or obovate, base acute, apex obtuse, margins entire, densely covered with non-glandular (two-armed) and glandular (clavate) trichomes on both surfaces. Inflorescences axillary, racemes pedunculate; peduncle 11–12 mm long, longer than the subtending leaves, 8–18- flowered. Flowers pedicelled; calyx labiate ca. 3 mm long, toothed with subulate teeth, apex acute, covered with densely non-glandular (two-armed) and glandular (clavate) trichomes; corolla dull purple, Papilionaceous; standard 2×2 mm long, orbicular, base rounded, apex rounded, glabrous; keel 3×2 with two-armed and simple trichomes; wings 2×1 mm oblong, base truncate, apex obtuse, glabrous; androecium 10 stamens, diadelphous, stamen tube 3 mm long; gynoecium monocarpellate, unilocular, glabrescent. Fruit leguminate, pods $5.38\text{--}7.13 \times 1.07\text{--}1.46$ mm, brown, straight cylindrical, torulose, 8–12 seeds per pod, covered with densely two-armed and clavate trichomes. Seeds $0.58\text{--}0.83 \times 0.59\text{--}0.76$ mm light brown, rectangular, hilum $0.07\text{--}0.08 \times 0.08\text{--}0.09$ mm, ovate, takes a subcentral position.

Figures: 1.5

Distribution:

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Local: Very rare, The Red Sea coastal region.

Global:

Native: Afghanistan, Angola, Assam, Bangladesh, Botswana, Burkina, Burundi, Cameroon, Cape Verde, Central African Repu, Chad, China Southeast, Djibouti, East Himalaya, Egypt, Eritrea, Ethiopia, Gambia, Gulf of Guinea Is., Gulf States, Hainan, India, Ivory Coast, Jawa, Kenya, Lesser Sunda Is., Malawi, Mali, Mauritania, Mozambique, Myanmar, Namibia, New Guinea, New South Wales, Niger, Nigeria, Northern Provinces, Northern Territory, Oman, Pakistan, Queensland, Rwanda, Saudi Arabia, Senegal, Socotra, Somalia, South Australia, South China Sea, Sri Lanka, Sudan, Sulawesi, Tanzania, Thailand, Togo, Uganda, Vietnam, West Himalaya, Western Australia, Yemen, Zambia, Zaire, Zimbabwe

Introduced: Dominican Republic, Haiti, Jamaica

Habitat: In Egypt, *Indigofera colutea* is found in stony plains.

Conservation Status: *Indigofera colutea* has not been assessed for The IUCN Red List of Threatened Species. However, the species has been reported as very rare in Egypt.

Specimens Examined: EGYPT. Gebel Elba, Gebel Hamra Dom, 2019, *T. Ramadan*, *A. Faried*, *A. Amro* & *M. Aboulela s.n.* (ASTU).

6. *Indigofera cordifolia* B. Heyne ex Roth, Nov. Pl. Sp.: 357 (1821)

Homotypic Synonyms:

Anil cordifolia (B.Heyne ex Roth) Kuntze in Revis. Gen. Pl. 2: 939 (1891)

Heylandia cordifolia (B.Heyne ex Roth) Graham in N.Wallich, Numer. List: n.° 5343 (1831)

Annual herb, 10–20 cm in length, densely canescent. Stems prostrate, branched with non-glandular trichomes (two-arms, three-armed and simple) trichomes covering the above-ground parts. Leaves simple, alternate, stipulate; stipules ca. 2 mm long setaceous; petioles ca. 5 mm long, subulate; leaflets 4–9 × 2–5 mm, broadly ovate or cordate; base cordate, apex mucronate or acute, margin entire; covered with densely non-glandular trichomes (two-armed) on both surfaces, the adaxial surface is characterized by simple trichomes. Inflorescences sessile axillary clusters, shorter than the subtending leaves, 3–7-flowered. Flowers pedicelled. Calyx labiate 4 mm long, toothed with narrowly subulate teeth, apex acute, covered with densely non-glandular (two-armed and simple) trichomes; Corolla bright red; standard 3.5 × 1 mm long, Spathulate, base truncate, apex rounded with two-armed trichomes confined to the distal half of its midrib zone near to the margin; keel 3 × 2 mm, glabrous, wings 3 × 0.5 mm long, Linear, base truncate, apex obtuse; androecium 10 stamens, diadelphous, stamen tube ca. 2.5 mm long; gynoecium monocarpellate, unilocular, with non-glandular (two-armed and simple) trichomes. Fruit leguminous, pods 3.61–5.78 × 1.12–1.99 mm, light brown, straight cylindrical, torulose, 1–2 seeds per pod, covered with densely two-armed trichomes. Seeds 0.83–1.48 × 1.03–1.83 mm, light brown with grooves and black spots, rectangular to oblong, hilum 0.06–0.12 × 0.05–0.10 mm, ovate, takes a central position.

Figures: 1.6, 2.8.

Distribution:

Local: Very rare, The Libyan desert, west of the Nile. (Giza Pyramids)

Global

Native: Afghanistan, Assam, Cape Verde, Chad, China Southeast, Egypt, Eritrea, Ethiopia, Gulf States, India, Jawa, Laccadive Is., Lesser Sunda Is., Mali, Mauritania, Myanmar, Niger, Oman, Pakistan, Socotra, Sudan, West Himalaya

Introduced: Northern Territory

Habitat: In Egypt, *Indigofera cordifolia* is found in sandy plains.

Conservation Status: *Indigofera cordifolia* has not been assessed for The IUCN Red List of Threatened Species. However, the species has been reported as very rare in Egypt.

Specimens Examined: EGYPT. Giza, 5 Nov.1926, *G. Täckholm s.n.* (CAI)

7. *Indigofera hochstetteri* Baker., D. Oliver & auct. suc. (eds.), Fl. Trop. Afr. 2: 101 (1871)

Homotypic Synonyms:

Anil hochstetteri (Baker) Kuntze in Revis. Gen. Pl. 2: 939 (1891)

Indigofera ornithopodioides Hochst. & Steud. ex Jaub. & Spach in Ill. Pl. Orient. 5: t. 480 (1856), nom. illeg.

Heterotypic Synonyms:

Anil anabaptista (Steud. ex-Baker) Kuntze in Revis. Gen. Pl. 2: 938 (1891)

Elasmocarpus ornithopodioides Hochst. in Annuario Reale Ist. Bot. Roma 8: 87 (1903 publ. 1902)

Indigofera anabaptista Steud. ex-Baker in J.D.Hooker, Fl. Brit. India 2: 102 (1876)

Indigofera arenaria A. Rich. in Tent. Fl. Abyss. 1: 183 (1848), nom. illeg.

Indigofera jaubertiana Schweinf. in Bull. Herb. Boissier 4(App. 2): 245 (1896)

Indigofera semhaensis Vierh. in Denkschr. Kaiserl. Akad. Wiss., Wien. Math. Naturwiss. Kl. 71: 362 (1907)

Annual herb, up to 50 cm in length, densely canescent. Stems prostrate, branched with non-glandular trichomes (two-armed) covering the above-ground parts. Leaves imparipinnate, opposite 3–5-foliolate; stipulate; stipules 2 mm long, filiform; petioles 3–6 mm long; leaf rachis 5–15 mm long; leaflets 7–13 × 2–4 mm, oblanceolate, base acute, apex retuse-mucronate, margins entire; covered with densely non-glandular trichomes (two-armed) on both surfaces. Inflorescences axillary, racemes, pedunculate; peduncles 6–13 mm long, shorter than or equaling the subtending leaves, many-flowered. Flowers pedicelled (sessile); calyx labiate 3 mm long, toothed with narrowly subulate-filiform teeth, acute apex, covered with densely non-glandular (two-armed) and glandular (clavate and filiform-clavate) trichomes; Corolla bright red; standard 3 × 2 mm, orbicular, base rounded, apex rounded, with two-armed trichomes confined to the distal half of its midrib zone. Keel 3 × 1.5 mm, glabrous; wings 3 × 1 mm, spatulate, base truncate, apex acute; androecium diadelphous stamen tube 2 mm long; gynoecium monocarpellate, unilocular, with two-armed trichomes. Fruit leguminous, pods 7.58–9.69 × 1.12–2.00 mm, light brown, curved cylindrical, flattened, 5–9 seeds per pod covered with densely two-armed trichomes. Seeds 0.67–1.1 × 1.17–1.68 mm, brown with black spots, rectangular; hilum 0.08–0.1 × 0.05–0.07 mm, circular, takes a Subcentral position.

Figures: 1.7, 2.7

Distribution:

Local: Rare, The Nile Valley, from Cairo to Wadi Halfa, The Oases of the Libyan Desert, Gebel Elba, and surrounding mountains, situated in the southeast corner of Egypt at the Sudan frontier.

Global:

Native: Algeria, Angola, Benin, Burkina, Cameroon, Chad, Djibouti, Egypt, Eritrea, Ethiopia, India, Kenya, Mali, Mauritania, Niger, Oman, Pakistan, Saudi Arabia, Senegal, Socotra, Somalia, Sudan, Tanzania, Uganda, Yemen, Zambia, Zaïre

Introduced: Western Australia.

Habitat: In Egypt, *Indigofera hochstetteri* is found on the edges of cultivation and sandy soils.

Conservation Status: *Indigofera hochstetteri* was assessed most recently for The IUCN Red List of Threatened Species 2010. *Indigofera hochstetteri* is listed as Least Concern; therefore, the conservation status in Egypt is not currently known. However, the species has been reported as rare in Egypt.

Specimens Examined: EGYPT. Gebel Elba, Wadi Yahmeeb, 2019, *T. Ramadan, A. Faried, A. Amro & M. Aboulela s.n.* (ASTU).

8. *Indigofera oblongifolia* Forssk., Fl. Aegypt. -Arab.: 137 (1775)**Heterotypic Synonyms:**

Anil lotoides (Lam.) Kuntze in Revis. Gen. Pl. 2: 938 (1891)

Anil paucifolia (Delile) Kuntze in Revis. Gen. Pl. 2: 939 (1891)

Indigofera argentea Buch.-Ham. ex Roxb. in Fl. Ind., ed. 1832. 3: 374 (1832), nom. illeg.

Indigofera colorata Roxb. ex-Wight & Arn. in Prodr. Fl. Ind. Orient. 1: 202 (1834)

Indigofera desmodioides Baker in Bull. Misc. Inform. Kew 1894: 331 (1894), nom. illeg.

Indigofera erythrantha Hochst. ex-Baker in D.Oliver & auct. suc. (eds.), Fl. Trop. Afr. 2: 88 (1871)

Indigofera heterophylla Roxb. ex-Wight & Arn. in Prodr. Fl. Ind. Orient. 1: 200 (1834), not validly publ.

Indigofera lotoides Lam. in Encycl. 3: 247 (1789)

Indigofera paucifolia Delile in Descr. Egypt, Hist. Nat. 2(Mém.): 251 (1813)

Indigofera rarifolia Steud. in Nomencl. Bot., ed. 2, 1: 808 (1840), not validly publ.

Perennial shrub 1–1.5 m in length, densely canescent. Stems erect, Spreadingly branched with non-glandular trichomes (two armed) covering the above-ground parts. Leaves imparipinnate, bifoliolate; alternate, stipulate; Stipules 2–3 mm long, triangular; Petioles 3–6 mm long; leaf rachis 6–11 mm long; leaflets 10–26 × 3–8 mm, oblanceolate or elliptic-oblong, base acute, apex obtuse or retuse, margin entire, covered with densely non-glandular trichomes (two armed) on both surfaces. Flowers axillary racemes; pedunculate; peduncles 8–11 mm long, shorter than the subtending leaves, many-flowered; calyx labiate 1.5 mm long, toothed with triangular teeth, acute apex, covered with densely non-glandular (two-armed) and glandular (clavate and filiform-clavate) trichomes; corolla Purple, Papilionaceous; standard 2×2 mm, Orbicular, base truncate, apex rounded with two-armed trichomes all over the surface except base and margin; keel 2×1.5 mm long, glabrous; wings 2×1 mm, spatulate, base truncate, apex obtuse, glabrous; androecium 10 stamens, Diadelphous. Stamen tube 4 mm long; gynoecium monocarpellate, unilocular, with sparsely two-armed and simple trichomes. Fruit leguminous, pods 6.25–22.5 × 1.17–2.20 mm, brown, straight cylindrical, torulose, 5–8-seeded per pod, covered with densely two-armed trichomes. Seeds 1.04–1.50 × 1.40–2.40 mm, olive to brown, oblong to rectangular; hilum 0.13–0.22 × 0.10–0.16 mm, ovate, takes a subcentral position.

Figures: 1.8, 2.6.

Distribution:

Local: Rare, The Nile Valley, from Cairo to Wadi Halfa, The Oases of the Libyan desert. The part of the Arabian desert from Wadi Tumilat to Qena-Qosseir Road. (Sept. stands for septentrionale (north).), Gebel Elba and surrounding mountains are situated in the southeast corner of Egypt at the Sudan frontier.

Global:

Native: Angola, Bangladesh, Burkina, Cameroon, Chad, Congo, Djibouti, Egypt, Eritrea, Ethiopia, Gulf States, India, Iran, Madagascar, Mali, Mauritania, Niger, Nigeria, Oman, Pakistan, Palestine, Saudi Arabia, Senegal, Socotra, Somalia, Sri Lanka, Sudan, Yemen

Introduced: Jawa, Western Australia

Habitat: In Egypt, *Indigofera oblongifolia* is found in sandy plains and rocky wadis.

Conservation status: *Indigofera oblongifolia* was most recently assessed for The IUCN Red List of Threatened Species 2010. *Indigofera oblongifolia* is listed as Least Concern. However, the species has been reported as rare in Egypt.

Specimens Examined: EGYPT. Aswan Governorate, Abu-Subeira, 1 November 1984, *A. Shaheen s.n.* (ASW).

9. *Indigofera sessiliflora* DC., Prodr. 2: 228 (1825)**Homotypic Synonyms**

Anil sessiliflora (D.C.) Kuntze in Revis. Gen. Pl. 2: 940 (1891)

Heterotypic Synonyms:

Anil tribuloides (Boiss.) Kuntze in Revis. Gen. Pl. 2: 940 (1891)

Indigofera tribuloides Boiss. in Fl. Orient. 2: 189 (1872)

Perennial herb 15–30 cm in length, densely canescent. Stems ascending, branched with non-glandular (two-armed) trichomes covering the above-ground parts. Leaves imparipinnate, alternate, 5-foliolate, stipulate; stipules 2–3 mm long, subulate; petioles 3–5 mm long; leaf rachis 6–15 mm long; leaflets 4–15 × 2–3 mm, elliptic or oblanceolate, base acute, apex mucronate or acute, margin entire, covered with densely non-glandular trichomes (two-armed) on both surfaces. Inflorescence dense axillary sessile clusters, shorter than the subtending leaves, many-flowered. Flowers sessile; calyx labiate ca. 3 mm long, toothed with setaceous teeth, acute apex, covered with non-glandular (two-armed) and glandular (clavate) trichomes; Corolla red; standard 2 × 2 mm, broadly ovate, base truncate, apex acute with two-armed and simple trichomes confined to the distal half of its midrib zone; keel 2 × 2 mm, glabrous; wings 2 × 1 mm, oblong, base truncate, apex obtuse; androecium 10 stamens, diadelphous, stamen tube 2 mm long; gynoecium monocarpellate, unilocular, with sparsely two-armed and simple trichomes. Fruit leguminate, pods 6.28–10.86 × 1.00–2.01 mm, brown, straight cylindrical, torulose, 3–6 seeds per pod, covered with densely two-armed trichomes. Seeds 0.77–1.32 × 0.80–1.41 mm olive to light brown, spherical, hilum 0.07–0.14 × 0.06–0.15 mm, ovate, takes a central position.

Figures: 1.9, 2.9.

Distribution:

Local: Very rare, The Oases of the Libyan desert (Uweinat), Gebel Elba, and surrounding mountains are situated in the southeast corner of Egypt at the Sudan frontier.

Global:

Native: Algeria, Burkina, Chad, Egypt, Eritrea, India, Ivory Coast, Libya, Mali, Mauritania, Niger, Pakistan, Saudi Arabia, Senegal, Sudan, Yemen

Introduced: Western Australia

Habitat: In Egypt, *Indigofera sessiliflora* is found in sandy plains.

Conservation status: *Indigofera sessiliflora* has most recently been assessed for The IUCN Red List of Threatened Species in 2010. *Indigofera sessiliflora* is listed as Least Concern. However, the species has been reported as very rare in Egypt.

Specimens Examined: EGYPT. Gebel Elba, Wadi Yahmeeb, 2006, *A. K. Osman s.n.* (South Valley University Herbarium).

10. *Indigofera spiniflora* Hochst. ex Boiss., Fl. Orient. 2: 190 (1872):**Homotypic Synonyms:**

Indigofera spinosa var. *spiniflora* (Hochst. ex Boiss.) Schweinf. in Bull. Herb. Boissier 4(App. 2): 237 (1896)

Heterotypic Synonyms:

Indigofera spinosa f. *densissima* Chiov. in Annuario Reale Ist. Bot. Roma 8: 91 (1903 publ. 1902)

Perennial small shrub 20–50 cm in length, densely canescent. Stems ascending to sprawling, branched with non-glandular (two-armed) trichomes covering the above-ground parts. Leaves imparipinnate, opposite, 3–5-foliolate, stipulate, Stipules ca. 1 mm long subulate; Petioles ca. 2 long; leaf rachis ca. 1 mm long; leaflets 5–8 × 3–4 mm, obovate-cuneate, base acute, apex retuse, margin entire, covered with densely (two-armed) non-glandular trichomes on both surfaces, the adaxial surface is characterized by sparsely three-armed trichomes; Inflorescences axillary; racemes pedunculate; peduncle 13–20 mm, longer than the subtending leaf, 5–12-flowered. Flowers pedicelled. Calyx labiates 3 mm, toothed

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with subulate teeth, acute apex covered with non-glandular (two-armed) and glandular (clavate and filiform-clavate) trichomes. Corolla orange-red, Papilionaceous; Standard disc-shaped, with a claw on top, bristles covering the back, inconspicuously veined; Keel has a rounded front and a flat dorsal edge covered with dense bristles arranged on both edges; wings scoop-like; Androecium 10 stamens, Diadelphous. Gynoecium is monocarpellate, unilocular.

Fruit leguminate, pods $7.55\text{--}9.29 \times 1.35\text{--}1.73\text{mm}$, brown, straight cylindrical, torulose, 4–6 seeds per pod, covered with densely two-armed trichomes. Seeds $0.89\text{--}1.16 \times 1.36\text{--}1.66\text{ mm}$, brown, rectangular; hilum $0.10\text{--}0.11 \times 0.06\text{--}0.07\text{ mm}$, ovate, takes a subcentral position.

Figures: 1.10, 2.5.

Distribution:

Local: Very rare. The Red Sea coastal region, Gebel Elba, and surrounding mountains are situated in the southeast corner of Egypt at the Sudan frontier.

Global:

Native: Djibouti, Egypt, Eritrea, Kenya, Oman, Saudi Arabia, Socotra, Somalia, Sudan, Tanzania, Yemen

Habitat: In Egypt, *Indigofera spiniflora* is found in sandy plains.

Conservation status: *Indigofera spiniflora* has not been assessed for The IUCN Red List of Threatened Species. However, the species has been reported as very rare in Egypt.

Specimens Examined: EGYPT. Gebel Elba, Wadi Laseitit, 2006, *A. K. Osman s.n.* (South Valley University Herbarium).

11. *Indigofera spinosa* Forssk., Fl. Aegypt. -Arab.: 137 (1775):

Homotypic Synonyms

Anil spinosa (Forssk.) Kuntze in Revis. Gen. Pl. 2: 940 (1891)

Heterotypic Synonyms:

Indigofera spinosa var. *grandifolia* Schweinf. in Bull. Herb. Boissier 2: 237 (1896)

Indigofera spinosa var. *microphylla* A.Rich. in Tent. Fl. Abyss. 1: 185 (1848)

Perennial small spiny shrub, 30–60 cm in length, densely canescent. Stems erect, much branched with non-glandular (two-armed) trichomes covering the above-ground parts. Leaves imparipinnate, opposite, 3-foliolate, stipulate; stipules 1.5–2 mm long, subulate; petioles ca. 3 mm long; leaf rachis ca. 1mm long; leaflets $3\text{--}6 \times 1\text{--}3\text{ mm}$, elliptic or obovate-cuneate, base acute, apex mucronate or retuse, margins entire, densely covered with non-glandular (two armed and sparsely of simple trichomes) trichomes on both surfaces. Inflorescences axillary, racemes, spiny and glabrescent, pedunculate; peduncles 6–21 mm long, longer than the subtending leaves, many-flowered. Flowers pedicelled; calyx labiates, ca. 2 mm long toothed with subulate teeth, acute apex, covered with densely non-glandular (two-armed) and glandular (filiform, filiform-clavate and clavate) trichomes; Corolla, pink to purple, Papilionaceous; standard $4 \times 2\text{ mm}$, wide oblong, base rounded, apex acute; with two-armed and simple trichomes confined to the distal half of its midrib zone; keel $3 \times 1.5\text{ mm}$ with sparsely simple trichomes on the margin; wings $3 \times 1\text{ mm}$, spatulate, base truncate, apex obtuse, glabrous; androecium 10 stamens Diadelphous; stamen tube 2.5 mm long; gynoecium monocarpellate, unilocular, glabrous. Fruits leguminate, pods $10.23\text{--}14.34 \times 1.10\text{--}2.04\text{ mm}$; brown, straight cylindrical, flattened, 6–9 seeds per pod, densely covered with two-armed trichomes. Seeds $1.18\text{--}2.11 \times 1.40\text{--}2.04\text{ mm}$, light brown with black spots, rectangular, hilum $0.0.14\text{--}0.15 \times 0.11\text{--}0.13\text{mm}$, ovate, takes a subcentral-to-subcentral position.

Figures: 1.11., 2.12.

Distribution:

Local: Rare, the Arabian desert East of the Nile, The Red Sea coastal region, Gebel Elba, and surrounding mountains, situated in the southeast corner of Egypt at the Sudan frontier.

Global:

Native: Djibouti, Egypt, Eritrea, Ethiopia, Gulf States, Saudi Arabia, Somalia, Sudan, Tanzania, Yemen

Habitat: In Egypt, *Indigofera spinosa* is found on hillsides and rocky ground.

Conservation Status: *Indigofera spinosa* has not been assessed for The IUCN Red List of Threatened Species. However, the species has been reported as rare in Egypt.

Specimens Examined: EGYPT. Gebel Elba, Wadi Akwa, 30 Jan. 2019, *T. Ramadan, A. Faried, A. Amro & M. Aboulela s.n.* (ASTU); Wadi Aeideib, 2020, *M.O. Badry, & A. K. Osman s.n.* (South Valley University Herbarium).

12. *Indigofera subulata* Vahl ex Poir. var. *subulate*.

Heterotypic Synonyms:

Anil tetragonoloba (E.Mey.) Kuntze in Revis. Gen. Pl. 2: 940 (1891)

Indigofera dimorphophylla Schinz in Verh. Bot. Vereins Prov. Brandenburg 30:164 (1888)

Indigofera subincana N.E.Br. in Bull. Misc. Inform. Kew 1925: 155 (1925)

Indigofera subulata var. *microphylla* Chiov. in Fl. Somalia 1: 138 (1929)

Indigofera subulata var. *nubica* J.B. Gillett in Kew Bull., Addit. Ser. 1: 100 (1958)

Indigofera tephrosiopsis Baill. in Bull. Mens. Soc. Linn. Paris 1: 399 (1883)

Indigofera tetragonoloba E.Mey. in Comm. Pl. Afr. Austr.: 106 (1836)

Indigofera thonningii Schumacher & Thonn. in C.F.Schumacher, Beskr. Guin. Pl.: 366 (1827)

Indigofera trita var. *nubica* (J.B. Gillett) L.Boulos & Schrire in L.Boulos, Fl. Egypt 1: 313 (1999)

Annual woody herb, 30 cm in length, densely canescent; Stem erect or weak, sprawling, branched with non-glandular (two-armed) trichomes covering the above-ground parts. Leaves imparipinnate, opposite 3-foliolate; stipulate, stipules 2–4 mm long, subulate; Petiole 2–3 mm long; leaf rachis 9–12 mm long; leaflets 7–20 × 4–10 mm, elliptic or obovate, base acute, apex obtuse or retuse, margin entire, densely canescent on the lower surface and sparsely canescent on the upper surface with non-glandular (two-armed) trichomes. Inflorescences axillary; racemes pedunculate, peduncle 13–20 mm long, longer than or equal to the subtending leaf, many-flowered. Flowers pedicelled. Calyx labiate, 3 mm long, toothed with subulate teeth, corolla orange-red; standard disc-shaped, with a claw on the top, resting on a stand, covered with bristles outwards, opaquely veined; keel has a tapered nose and uneven dorsal edge, with lateral air pockets oriented parallel to the dorsal edge, covered with dense bristles arranged on both edges; wings scoop-like. Androecium 10 stamens, diadelphous. Gynoecium monocarpellate, unilocular, covered with simple dense bristles. Fruit leguminate, pods 20.21–21.65 × 0.95–1.61 mm, light brown, straight cylindrical, torulose, 8–12 seeds per pod, covered with densely two-armed trichomes. Seeds 0.56–1.23 × 1.42–2.03 mm, dark brown, oblong; hilum 0.13–0.17 × 0.14–0.20 mm, circular, takes a central position.

Figures: 1.13, 2.10.

Distribution:

Local: Rare, Gebel Elba and surrounding mountains, situated in the southeast corner of Egypt at the Sudan frontier.

Global:

Native: Angola, Benin, Botswana, Burkina, Cape Verde, Central African Repu, Eritrea, Ethiopia, Gabon, Ghana, Guinea-Bissau, Gulf of Guinea Is., Ivory Coast, Kenya, KwaZulu-Natal, Liberia, Madagascar, Mozambique, Namibia, Nigeria, Northern Provinces, Rwanda, Senegal, Sierra Leone, Somalia, Sudan, Swaziland, Tanzania, Togo, Uganda, Zambia, Zaire, Zimbabwe

Introduced: Venezuela.

Habitat: In Egypt, *Indigofera subulata* var. *subulata* is found on rocky slopes.

Conservation status: *Indigofera subulata* var. *subulata* has not been assessed for The IUCN Red List of Threatened Species. However, the species has been reported as rare in Egypt.

Specimens Examined: EGYPT. Aswan Governorate, Kom Ombo, 6 February 1975, *El Hadidi s.n.* (CAI).

13. *Indigofera trita* L.f. Suppl. Pl.: 335 (1782).

Homotypic Synonyms:

Anil trita (L.f.) Kuntze in Revis. Gen. Pl. 2: 940 (1891)

Annual undershrub, 60–100 cm in length, densely canescent. Stems erect branched with non-glandular (two and three armed trichomes) trichomes covering the above-ground parts. Leaves imparipinnate, 3-foliolate; stipulate; stipules 1–2 mm long, subulate; Petioles 3–7 mm long; leaf rachis ca. 1; leaflets 4–12 × 3–6 mm, obcordate or broadly obovate; base acute, apex obtuse or retuse; margin entire, covered with densely non-glandular (two armed and sparsely three armed) trichomes on both surfaces. Inflorescences axillary, racemes, pedunculate; peduncles 30–125 mm long, much longer than the subtending leaf, Many-flowered. Flowers pedicelled; calyx labiates ca. 3 mm long, toothed with triangular teeth, acute apex covered with non-glandular (two-armed) trichomes; Corolla red; standard 4 × 4 mm, Orbicular, base truncate, apex rounded, glabrous; keel 2–4 mm, glabrous; wings 4 × 1 mm, spathulate, base truncate, apex obtuse, glabrous; androecium 10 stamens, diadelphous stamen tube 3 mm long; gynoecium monocarpellate, unilocular, with sparsely glandular (clavate) trichomes. Fruit leguminous, pods 24.79–30.34 × 0.85–1.74 mm, olive, straight cylindrical, inconspicuously torulose, 8–12 seeds per pod, covered with densely two-armed trichomes. Seeds 0.85–1.63 × 1.50–2.01 mm, brown to olive, rectangular; hilum 0.07–0.15 × 0.07–0.13 mm, circular, takes a subcentral position.

Figures: 1.12, 2.11.

Distribution:

Global:

Native: Assam, Bangladesh, Botswana, Burundi, Cameroon, Congo, Costa Rica, Djibouti, East Himalaya, Eritrea, Ethiopia, Gabon, Ghana, Gulf of Guinea Is., India, Ivory Coast, Jawa, Kenya, Lesser Sunda Is., Liberia, Madagascar, Malawi, Mozambique, Myanmar, Namibia, Nigeria, Oman, Pakistan, Philippines, Queensland, Rwanda, Saudi Arabia, Senegal, Sierra Leone, Somalia, Sri Lanka, Sudan, Swaziland, Tanzania, Togo, Uganda, West Himalaya, Western Australia, Yemen, Zambia, Zaire, Zimbabwe

Introduced: Colombia

Conservation Status: *Indigofera trita* has most recently been assessed for The IUCN Red List of Threatened Species in 2010. *Indigofera trita* is listed as Least Concern. However, the species has been reported as rare in Egypt.

Specimens Examined: EGYPT. Gebel Elba, Wadi Yahmaib, 25 March. 2006, *A. K. Osman s.n.* (South Valley University Herbarium).



Fig. 1. Herbarium specimens of the studied taxa of *Indigofera* L. in Egypt: (1) *I. arabica*; (2) *I. argentea*; (3) *I. articulata*; (4) *I. coerulea* var. *coerulea*; (5) *I. colutea*; (6) *I. cordifolia*; (7) *I. hochstetteri*; (8) *I. oblongifolia*; (9) *I. sessiliflora*.

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Fig. 1. Continued: (10) *I. spiniflora*; (11) *I. spinosa*; (12) *I. trita*; (13) *I. subulata* var. *subulata*.



Fig. 2. Pod shapes in the studied taxa of *Indigofera* L.: (1) *I. arabica*; (2) *I. argentea*; (3) *I. articulata*; (4) *I. coerulea* var. *coerulea*; (5) *I. spiniflora*; (6) *I. oblongifolia*; (7) *I. hochstetteri*; (8) *I. cordifolia*; (9) *I. sessiliflora*; (10) *I. subulata* var. *subulata*; (11) *I. trita* (12) *I. spinosa*.

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The conventional taxonomic approach in Fabaceae has commended various morphological characters (Habitat, indumentum, glands, leaf, inflorescence, calyx, corolla, and pod morphology) (Chauhan *et al.*, 2015). The current study provides a comprehensive morphological examination of thirteen taxa of the genus *Indigofera* L. The results that appeared in our study agree with previous studies on *Indigofera* (Sanjappa *et al.*, 1995; Hosni, 2000; Wilson *et al.*, 2008; Chauhan *et al.*, 2015; Atta *et al.*, 2022).

All the studied taxa are herb, undershrub, or shrub with annual and perennial duration. However, *I. spinosa* can be delimited from the rest of the species by having a small, spiny shrub. Stems are morphologically crucial in distinguishing between the studied species. The stem is primarily erect but becomes erect with spreading branched in *I. oblongifolia*, ascending in *I. argentea* and *I. sessiliflora*, ascending to sprawling in *I. spiniflora* and prostrate in *I. cordifolia* and *I. hochstetteri*.

Within the studied taxa of *Indigofera*, the plants' vegetative and reproductive parts are covered with different types of trichomes, forming an indumentum of variable density and texture. This present study revealed two morphotypes of non-glandular trichomes: unbranched (simple trichomes with four subtypes) and branched (uniseriate macroform two-armed with six subtypes and three-armed trichomes). Of all non-glandular trichomes observed, the most prevalent type was uniseriate macroform two-armed trichomes, which appeared in all the studied taxa. Some authors have already pointed out this (Prabhakar *et al.*, 1985; Lievens, 1992; Quesada, 1997; Sengsai *et al.*, 2014; Osman, 2012; Badry, 2015; Shokirovna, 2023). Four types of glandular trichomes appear (filiform with three subtypes, filiform-clavate with three subtypes, clavate with seven subtypes, and peltate trichomes). Of all glandular trichomes observed, the most familiar type is clavate glandular trichomes. It was the only glandular type that appeared in the vegetative and reproductive parts, whereas the rest appeared only in the reproductive parts. This type of glandular trichomes was also reported in *Indigofera* by (Schrire, 1995; Quesada, 1997; Wilson *et al.*, 2008).

In the current study, the leaf characters proved helpful in the distinction among specific taxa. There are two types of leaves: simple leaves, which distinguish only *I. cordifolia*, and pinnately compound leaves, which characterize the rest of the studied taxa. One morphological feature differentiating *I. coerulea* var. *coerulea* from the other taxa is the absence of stipules. The familiar shape of stipules is subulate, but *I. hochstetteri* has a filiform shape, and *I. cordifolia* has a setaceous shape. *I. subulata* var. *subulata* has the longest stipules (2–4) mm, while *I. articulata* and *I. spiniflora* have the shortest stipules ca. 1 mm.

Petiole length is beneficial in distinguishing *I. articulata*, which has the longest petiole (5–16) mm, and *I. cordifolia*, which has the shortest petiole, ca. 5 mm. Within the studied taxa, leaf rachis ranges from very short ca. 1mm in *I. spiniflora*, *I. spinosa*, and *I. trita* to very long (10–45) mm in *I. articulata*. The most popular shape of the blade is obovate with an acute leaf base, but within a species, the variation is always between narrower limits. *I. cordifolia* can be separated from the other taxa by having a cordate leaf base. Leaf apex varies from acute, obtuse, retuse, or mucronate among the studied taxa. The margin is always entire. The lateral leaflets are primarily opposite and alternate in only *I. oblongifolia* and *I. sessiliflora* (Table. 1).

Most of the studied taxa flowers are born in axillary pedunculate racemes, while *I. cordifolia* and *I. sessiliflora* can be delimited from the other taxa by flowers in axillary clusters. This result is consistent with (Chauhan *et al.*, 2015). *I. trita* is distinguished by the longest peduncle (30–125) mm, while *I. hochstetteri* has the shortest peduncle (6 -13) mm.

The calyx is campanulate with five teeth. The studied characters of the calyx teeth (shape, size, and indumentum) have significant taxonomic importance. The shape of calyx teeth among the studied taxa exhibits substantial differences. The teeth are narrowly subulate

in *I. cordifolia*, narrowly subulate-filiform in *I. hochstetteri*, subulate in *I. arabica*, *I. colutea* and *I. spinosa*, narrowly triangular in *I. argentea*, triangular in *I. articulata* *I. coerulea* var. *coerulea* and *I. trita*, finally setaceous in *I. sessiliflora*. The calyx length ranges from 1 mm in *I. argentea* to 4 mm in *I. cordifolia*.

Corolla is papilionaceous and usually bright red to red. Within *Indigofera*, the shape and size of (standard, wings, and keel) show significant variation among the species. The shape of the standard is orbicular with a truncated base and rounded apex in most of the studied taxa. However, *I. cordifolia* is marked by a spatulate shape, While *I. argentea* and *I. sessiliflora* are distinguished by broadly ovate shape. The size of the standard ranges from 2×2 mm in *I. sessiliflora* to 4×4 mm in *I. trita*. The most popular shape of wings is spatulate with a truncate base and acute to obtuse apex. However, *I. cordifolia* can be separated from the other taxa by linear shape; *I. coerulea* var. *coerulea*, *I. colutea*, and *I. sessiliflora* are distinguished by oblong shape. The size of the standard ranges from 2×1 mm in *I. coerulea* var. *coerulea*, *I. colutea*, *I. oblongifolia*, and *I. sessiliflora* to (4×1) mm in *I. trita*. Keel size can be used as a supportive taxonomic where it ranges from (2×2) mm in *I. oblongifolia* to (4×4) mm in *I. trita*.

Stamens are diadelphous (9 + 1), in which the vexillary filament is free, and the other 9 filaments are connate. The length of the staminal tube also can be used to delimit between the studied species. *I. argentea*, *I. hochstetteri* and *I. sessiliflora* have the shortest staminal tube (2 mm) While *I. oblongifolia* has the highest staminal tube (4 mm) (Table 2).

In the current study, the variability in fruit characters (shape, length, width, and color) has proved to be helpful in recognizing specific taxa of the Egyptian *Indigofera*. Within the studied species, the color of the pod varies from olive to brown. The typical shape of a pod is straight cylindrical but can be curved cylindrical in *I. coerulea* and *I. hochstetteri*. The longest observed pod is 30.34 mm in *I. trita*, while the shortest is 4.59 mm in *I. cordifolia*, the broadest is 3.88 mm in *I. articulata* and the narrowest is 1.29 mm in *I. colutea*. The number of seeds per pod is usually 2–12, but it can be as low as 1–2 seeded in *I. cordifolia* and 1–3 seeded in *I. articulata*.

Seeds of flowering plants exhibit significant variation in their features. In the present study, the color of the seed varies from olive to dark brown, but *I. colutea*, *I. cordifolia*, *I. hochstetteri*, and *I. spinosa* can be separated from the other taxa by having black spots. The shape of seeds showed a considerable variation among the investigated taxa. Most seeds have a rectangular shape, but an oblong shape corresponds to *I. subulata* var. *subulata*. The spherical shape corresponds to *I. colutea*, *I. arabica*, *I. articulata*, *I. sessiliflora*, and *I. spinosa*. Seed size varies significantly among the examined taxa; the giant seeds in *I. coerulea* have a diameter of 2.37×2.38 mm, and the smallest seeds measure 0.75×0.68 mm in *I. colutea*. These findings agree with (Hosni, 2000; Al-Ghamdi, 2011; Elkordy et al., 2022) (Table 3).

Macromorphological Revision of *Indigofera* L. (Faboideae, Fabaceae) in Egypt

Table 1: Macro-morphological characters of stipules, petioles and leaves in the studied taxa; measurements (Minimum–Maximum).

Taxa	Stipule		Petiole (mm)	Leaf						
	Shape	length (mm)		No. of foliolate	leaf-rachis (mm)	Blade shape	L×W (mm)	Base	Margin	Apex
<i>Indigofera arabica</i>	Subulate	2–3	4–5	3–5	7–10	Obovate to oblanceolate	5–16 × 2–5	Acute to ± oblique	Entire	Mucronate
<i>Indigofera argentea</i>	Subulate	1–2	2–7	5–7 (9)	10–19	Obovate	3–6 × 2–3	Acute	Entire	Slightly retuse or obtuse
<i>Indigofera articulata</i>	Subulate	1	5–16	3–5 (7)	10–45	Obovate to broadly obovate	5–16 × 2–5	Acute	Entire	Obtuse, ± retuse
<i>Indigofera coerulesa</i> var. <i>coerulesa</i>	Exstipulate	-	5–12	5–7	11–40	Oblong or obovate	8–20 × 4–12	Acute	Entire	Acute or obtuse
<i>Indigofera colutea</i>	Subulate	2–3	6–7	7–11	7–8	Elliptic or obovate	3–4 × 1–2	Acute	Entire	Obtuse
<i>Indigofera cordifolia</i>	Setaceous	2	0.5	1	-	Broadly ovate or cordate	4–9 × 2–5	Cordate	Entire	Mucronate or acute
<i>Indigofera hochstetteri</i>	Filiform	2	3–6	3–5	5–15	Oblanceolate	7–13 × 2–4	Acute	Entire	Obtuse, retuse or Mucronate
<i>Indigofera oblongifolia</i>	Subulate	2–3	3–6	2	6–11	Oblanceolate or elliptic-oblong	10–26 × 3–8	Acute	Entire	Obtuse or retuse
<i>Indigofera sessiliflora</i>	Subulate	2–3	3–5	5	6–15	Elliptic or oblanceolate	4–15 × 2–3	Acute	Entire	Mucronate or acute
<i>Indigofera spiniflora</i>	Subulate	1	ca. 2	3	ca. 1	Obovate-cuneate	5–8 × 3–4	Acute	Entire	Retuse
<i>Indigofera spinosa</i>	Subulate	1.5–2	3	3	ca. 1	Elliptic or obovate- cuneate	3–6 × 1–3	Acute	Entire	Mucronate or retuse
<i>Indigofera subulata</i> Vahl ex Poir. var. <i>subulata</i>	Subulate	2–4	2–3	3	9–12	Elliptic or obovate	7–20 × 4–10	Acute	Entire	Obtuse or retuse
<i>Indigofera tria</i>	Subulate	1–2	3–7	3	ca. 1	Obcordate or broadly obovate	4–12 × 3–6	Acute	Entire	Obtuse or retuse

Table 2. Macromorphological characters of Peduncles, Calyx and Corolla measurements (Min.–Max.).

Taxa	Peduncle length (mm)	No. of flowers	Calyx				color	Corolla								Staminal tube L (mm)
			Calyx length (mm)	Calyx lobe Shape	Calyx lobe apex	Standard				Wings						
						L×W (mm)		Shape	Base	Apex	L×W (mm)	Shape	Base	Apex	Keel L×W (mm)	
<i>Indigofera arabica</i>	13–20	5–12	3	Subulate	Acute	Red	3 × 2	Orbicular	Rounded	Rounded	2.5 × 1	Spathulate	Truncate	Slightly Retuse	3 × 2	2.5
<i>Indigofera argentea</i>	15–27	4–10	1	Narrowly triangular	Acute	Bright red	3 × 2	Broadly obovate	Truncate	Rounded	3 × 1	Spathulate	Truncate	Obtuse	3 × 2	2
<i>Indigofera articulata</i>	15–46	10–20	2	Triangular	Acute	Red	3.5 × 2.5	Orbicular	Truncate	Rounded	3 × 1	Spathulate	Truncate	±Acute	4 × 3	3
<i>Indigofera coerulesa</i> var. <i>coerulesa</i>	11–20	Many-flowered	1.5	Triangular	Acute	Red	3 × 2	Orbicular	Rounded	Rounded	2 × 1	Oblong	Truncate	Obtuse	4 × 3	3
<i>Indigofera colutea</i>	11–12	Many-flowered	2	Subulate	Acute	Dull purple	2 × 2	Orbicular	Rounded	Rounded	2 × 1	Oblong	Truncate	Obtuse	3 × 2	3
<i>Indigofera cordifolia</i>	-	3–7	4	Narrowly subulate	Acute	Bright red	3.5 × 1	Spathulate	Truncate	Rounded	3 × 5	Linear	Truncate	Obtuse	3 × 2	2.5
<i>Indigofera hochstetteri</i>	6–13	Many-flowered	3	Narrowly subulate-filiform	Acute	Bright red	3 × 2	Orbicular	Rounded	Rounded	3 × 1	Spathulate	Truncate	Acute	3 × 1.5	2
<i>Indigofera oblongifolia</i>	8–11	Many-flowered	1.5	Triangular	Acute	Purple	4 × 1	Orbicular	Truncate	Rounded	2 × 1	Spathulate	Truncate	Obtuse	2 × 1.5	4
<i>Indigofera sessiliflora</i>	-	7–12	3	Setaceous	Acute	Red	2 × 2	Broadly ovate	Truncate	Acute	2 × 1	Oblong	Truncate	Obtuse	2 × 2	2
<i>Indigofera spinosa</i>	6–21	2–4	2	Subulate	Acute	Pink to purple	4 × 2	Orbicular	Rounded	Acute	3 × 1	Spathulate	Truncate	Acute	3 × 1.5	2.5
<i>Indigofera tria</i>	30–125	Many-flowered	3	Triangular	Acute	Red	4 × 4	Orbicular	Truncate	Rounded	4 × 1	Spathulate	Truncate	Obtuse	4 × 4	3

Abbreviations: L= Length, W = Width.

Table 3. Macromorphological characters of pod and seeds measurements (Min.–Max.).

Taxa	Character	Seed				pod				
		Length (mm) Mean (Min–max)	Width (mm) Mean (Min–max)	color	Shape	Length (mm) Mean (Min–max)	Width (mm) Mean (Min–max)	color	Shape	Number of seeds per pod
<i>Indigofera arabica</i>		1.06 (0.73–1.40)	1.19 (0.81–1.65)	Dark Brown	± Spherical	7.93 (6.30–8.69)	1.82 (1.23–2.21)	Light brown	Slightly curved cylindrical	2–5
<i>Indigofera argentea</i>		1.22 (0.71–1.60)	1.29 (1.10–1.44)	Dark brown	Rectangular	9.09 (7.14–10.58)	1.87 (1.64–2.18)	Light brown	Straight cylindrical	3–5
<i>Indigofera articulata</i>		2.09 (1.56–2.49)	2.06 (1.23–2.57)	Light olive to brown	Spherical	6.78 (4.19–8.25)	3.88 (3.06–4.37)	Brown	± Straight cylindrical	1–3
<i>Indigofera coerulesa</i> var. <i>coerulesa</i>		2.37 (2.05–3.03)	2.38 (1.88–3.20)	Olive to brown	Wide oblong to rectangular	9.17 (6.86–10.45)	3.59 (2.17–4.42)	Brown	Curved cylindrical	2–3
<i>Indigofera colutea</i>		0.75 (0.58–0.83)	0.68 (0.59–0.76)	Light brown	Rectangular	6.13 (5.38–7.13)	1.29 (1.07–1.46)	Brown	Straight cylindrical	8–12
<i>Indigofera cordifolia</i>		1.09 (0.83–1.48)	1.42 (1.03–1.83)	Light brown with grooves and black spots	Rectangular to oblong	4.59 (3.61–5.78)	1.65 (1.12–1.99)	Light brown	Straight cylindrical	1–2
<i>Indigofera hochstetteri</i>		0.99 (0.67–1.18)	1.44 (1.17–1.68)	Brown with black spots	Rectangular	8.70 (7.58–9.69)	1.69 (1.12–2.00)	Light brown	Curved cylindrical	5–9
<i>Indigofera oblongifolia</i>		1.29 (1.04–1.50)	1.84 (1.40–2.40)	Olive to Brown	Oblong to rectangular	12.99 (6.25–22.59)	1.59 (1.17–2.20)	Brown	Straight cylindrical	5–8
<i>Indigofera sessiliflora</i>		0.96 (0.77–1.32)	1.05 (0.80–1.41)	Olive to light brown	Spherical	8.22 (6.28–10.86)	1.56 (1.00–2.01)	Brown	Straight cylindrical	3–6
<i>Indigofera spiniflora</i>		1.09 (0.89–1.16)	1.45 (1.36–1.66)	Brown	Rectangular	8.46 (7.55–9.29)	1.66 (1.35–1.73)	Light brown	Straight cylindrical	4–6
<i>Indigofera spinosa</i>		1.70 (1.18–2.11)	1.98 (1.40–2.04)	Light brown with black spots	Rectangular	12.23 (10.23–14.34)	1.60 (1.10–2.04)	Brown	Straight cylindrical	6–9
<i>Indigofera subulata</i> Vahl ex Poir. var. <i>subulata</i>		0.90 (0.56–1.23)	1.69 (1.42–2.03)	Dark brown	Oblong	21.06 (20.21–21.65)	1.31 (0.95–1.61)	light brown	Straight cylindrical	8–12
<i>Indigofera tria</i>		1.16 (0.85–1.63)	1.69 (1.50–2.01)	Brown to Olive	Rectangular	30.34 (24.79–37.00)	1.26 (0.85–1.74)	Olive	Straight cylindrical	-

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ARABIC SUMMARY

مراجعة تصنيفية لجنس النيلة (الانديجوفيرا) في مصر

احمد كمال الدين عثمان، محمد عويس بدري، شرين جعفر
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تقدم هذه الدراسة مراجعة تصنيفية لجنس النيلة *Indigofera* L. في مصر. تعتمد المراجعة على حوالي 58 عينة تم جمعها من مواقع وبيئات مختلفة. الخصائص المورفولوجية للأجزاء الخضرية والتكاثرية، مثل الشعيرات؛ شكل الورقة وحجمها؛ شكل وطول الاذينات؛ شكل وطول الكأس؛ لون وشكل وحجم التويج؛ لون وحجم وشكل كلا من الثمرة والبذور لها أهمية تصنيفية في تمييز الأنواع التي تنتمي إلى جنس *Indigofera*. بشكل عام. جميع أجزاء النبات مغطاة بشعيرات بيضاء كثيفة، مما يعطي للنبات مظهرًا فضيًا. في *Indigofera cordifolia*، تكون الأوراق أحادية الورقة، لكنها مركبة بين الأنواع الأخرى التي تم فحصها. في هذه الدراسة تم عمل مفتاح اصطناعي للأصناف قيد الدراسة، بالإضافة الي وصف كامل للأنواع، والتوزيع المحلي والعالمي، والموائل، وحالة الحفظ لتسهيل تحديد هذه الأنواع والتعرف عليها.