

THE GENUS *INDIGOFERA* (FABACEAE) IN ALABAMA

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ABSTRACT

The goals of this project were to determine which taxa of *Indigofera* occur in Alabama and to report the distribution of each. *Indigofera* (Fabaceae), commonly known as indigo, consists of four species in Alabama. The most common species is *I. caroliniana* Miller. The less common species are *I. hirsuta* Linnaeus, *I. tinctoria* Linnaeus and *I. miniata* Ortega var. *leptosepala* (Nuttall ex Torrey & A. Gray) B. L. Turner. The dichotomous key and descriptions were generated based on morphological features of vegetative and reproductive structures reported in the literature and of more than 200 specimens studied. County-level distribution maps were compiled entirely from herbaria vouchers.

INTRODUCTION

Indigofera, commonly known as indigo, is a member of the legume family Fabaceae (Leguminosae), subfamily Papilionoideae, tribe Indigoferinae (Schrire, 1995). The Indigoferinae, primarily a tribe of the Old World tropics, is recognized as being derived from a woody Tephrosieae (=Millettieae) (Pohill, 1981). Findings by Doyle *et al.* (1997), using *rbcL* sequence data, support this classification.

Indigofera consists of approximately 700 species worldwide and occurs on all major land masses, but is most abundant in Africa and Asia (Isely, 1990). In the United States, *Indigofera* consists of both native and introduced taxa (Isely, 1990). Fifteen species and four infraspecific taxa of have been reported from the United States. Of these, 12 species have been reported from the southeastern United States (USDA, NRCS, 2010).

Indigofera tinctoria Linnaeus was introduced into the United States in the seventeenth century and cultivated as a source of indigo dye, which was an important commodity of commerce until it was replaced by synthetic dyes in the late nineteenth century (Isely, 1990).

MATERIALS AND METHODS

Distribution maps are based on more than 200 plant specimens deposited in the herbaria of Troy University (TROY), J. D. Freeman (AUA), The University of Alabama

(UNA), The University of South Alabama (USAM), Jacksonville State University (JSU), University of North Alabama (UNAF), and Vanderbilt University (VDB), which is housed at the Botanical Research Institute of Texas (BRIT) in Fort Worth.

Herbarium specimens were initially divided into groups based on overall morphological similarity and the species concept established by Isely (1990). The dichotomous key is a modification of Isely (1990) and Weakley (2007). Descriptions for each taxon are based on Isely (1990). For *Indigofera caroliniana* Miller and *I. hirsuta* Linnaeus, morphological measurements were taken from selected specimens from throughout the geographical range in Alabama and incorporated into the descriptions if they differed from Isely (1990). Since both *I. tinctoria* Linnaeus and *I. miniata* Ortega var. *leptosepala* (Nuttall ex Torrey & A. Gray) B. L. Turner are known from single collections in the state, morphological measurements are entirely from Isely (1990), which allows for the range of variation throughout the southeastern United States. Illustrations are by the first author. The lists of specimens examined are limited to one record from each county.

RESULTS

Four species of *Indigofera* occur in Alabama. The most common species is *I. caroliniana* Miller (14 counties). The less common species are *I. hirsuta* Linnaeus (three counties), *I. tinctoria* Linnaeus (one county) and *I. miniata* Ortega var. *leptosepala* (Nuttall ex Torrey & A. Gray) B. L. Turner (one county).

TAXONOMIC TREATMENT OF *INDIGOFERA*

Indigofera Linnaeus, Sp. Pl. 751. 1753.

Anil (Ludwig) Miller, Gard. Dict. abr. ed. 4. 1754.

Bremontiera de Candolle, Mem. Legum. part 5. Paris. 249-312. 1825.

Hemispodon Endlicher, Flora. 15: 385. 1832.

Eilemanthus Hochstetter, Flora. 29: 593. 1846.

Amecarpus Benthams, Lindl. Veg. Kingd. 554. 1847.

Indigastrum Jaubert & Spach, Illust. Pl. Orient. pl. 492. 1857.

Anila Kuntze, Rev. Gen. 160. 1891.

Vaughania S. Moore, J. Bot. 58: 188. 1920.

Herbs or shrubs. Stems prostrate, sprawling, ascending or erect, strigose, pilose or hirsute. Leaves odd pinnate (-trifoliolate), petioled; leaflets paired, alternate, or irregularly arranged, entire; stipules free, persistent or caducous. Inflorescences axillary; bracts caducous. Calyx broad, bowl-shaped, lobes subequal or unequal, shorter or longer than tube; corolla early deciduous, reddish-orange, tinted with pink or salmon; stamens 10, diadelphous (9 + 1); styles glabrous. Fruits deflexed (-ascending or divergent), dehiscent (-indehiscent), oblong, subterete or tetragonal (-laterally compressed) in cross section, ovoid in one species, coriaceous. Seeds few to numerous.

KEY TO THE ALABAMA SPECIES OF *INDIGOFERA*

- 1. Stems hirsute or pilose; legumes hispid..... 1. *I. hirsuta*
- 1. Stems glabrous or appressed strigose; legumes glabrous to strigose2
 - 2. Leaflets, at least some, alternate or irregularly arranged on leafstalk; stipules 2-6 mm long; calyx 3-6 mm long 2. *I. miniata*
 - 2. Leaflets opposite on leafstalk; stipules obsoluescent to 2 mm long; calyx 1-2 mm long 3
- 3. Legumes 5-10 mm long, ovoid, straight, indehiscent; seeds 2-3; stipules 3. *I. caroliniana*
- 3. Legumes 25-35 mm long, slightly falcate, dehiscent; seeds 3-10 or more; stipules 1-2 mm long; corolla 5-6 mm long 4. *I. tinctoria*

- 1. *Indigofera hirsuta* Linnaeus, Sp. Pl. 751. 1753. [Figure 1a]
 - Indigofera ferruginea* Schumach & Thonner, Guin. Pl. 370. 1827.
 - Indigofera fusca* G. Don, Gen. Hist. 2: 211. 1832.
 - Anila hirsuta* (Linnaeus) Kuntze, Revis. Gen. Pl. 2: 939. 1891.

Herbs. Stems sprawling or erect, brownish hirsute or pilose. Leaves odd pinnate, petioles 3-8 cm long; leaflets 5-9 paired, elliptic to obovate, 2-4 cm long, pubescent both surfaces with subappressed hairs; stipules setaceous, to 1 cm long, persistent. Racemes 6-20 cm long, flowers crowded, pedunculate; pedicels 1 mm long. Calyx 3.5-5 mm long, lobes setaceous, longer than tube, bristly-plumose; corolla salmon to maroon, 6-7 mm long. Fruits 1.5-2.0 cm long, hispid, imbricate, deflexed, dehiscent, oblong, straight, turgid. Seeds numerous.

Native of Old World tropics, now pantropical, cultivated and established; introduced in southern United States.

Habitat and distribution in Alabama: roadsides, old fields, disturbed woodlands, waste areas; widely scattered in the southern one-fourth of the state (Fig. 1b).

Specimens examined. Henry County: *Lindsay Leverett* 7, 2 October 2008 (TROY), Mobile County: *Michel G. Lelong* 9572, 6 October 1976 (BRIT), Pike County: *Michael Woods* 10210, 22 November 2004 (TROY).

- 2. *Indigofera miniata* Ortega var. *leptosepala* (Nuttall ex Torrey & A. Gray) B. L. Turner, Field & Lab. 24: 104. 1956. [Figure 1c]

- Indigofera ornithopodioides* Schlechtendal & Chamisso, Linnaea 5: 577. 1830.
- Indigofera leptosepala* Nuttall ex Torrey & A. Gray, Fl. N. Amer. 1: 198. 1838.
- Indigofera cinerea* Buckland, Proc. Acad. Phila. 1861: 451. 1861.
- Indigofera texana* Buckland, Proc. Acad. Phila. 1861. 451. 1861.
- Anila leptosepala* (Nuttall ex Torrey & A. Gray) Kuntze, Revis. Gen. Pl. 2: 939. 1891.

Herbs. Stems prostrate or ascending, greenish or cinereous, strigulose. Leaves odd pinnate, petioles 0.6-3 cm long; leaflets 5-9 opposite or irregularly arranged, cuneate-obovate to narrowly oblanceolate, 0.5-2.5 cm long; stipules subulate, 2-6 mm long, semipersistent. Flowers 3-numerous initially crowded, then loosening, shortly or well pedunculate; pedicels 1 mm long. Calyx 3-6 mm long, lobes longer than tube, subulate; corolla salmon-red (-pink, -orange), 8-12 mm long. Fruits 1.5-2.5 cm long, coriaceous, irregularly spreading or deflexed, dehiscent, oblong, straight, subterete. Seeds few to several.

Habitat and distribution in Alabama: ballast grounds in southwestern corner of the state (Fig. 1d).

Specimens examined. Mobile County: *Mohr s.n.*, September 1891 (UNA).

3. *Indigofera caroliniana* Miller, Gard. Dict., ed. 8. 1768. [Figure 2a]

Pithecellobium disperma Linnaeus, Syst. Nat., ed. 12. 3: 232. 1768.

Indigofera caroliniana Walter, Fl. Carol. 187. 1788, *non* Miller 1768.

Anila caroliniana Kuntze, Revis. Gen. Pl. 2: 939. 1891.

Herbs. Stems erect or ascending, slightly strigose. Leaves odd pinnate, petioles 2.5-7 cm long; leaflets (7-) 9-13 paired, obovate to oblanceolate, 0.8-2.5 cm long, inevidently strigulose both surfaces, pale below; stipules semipersistent. Racemes slender and lax, flowers numerous, shortly or well pedunculate; pedicels 1-2 mm long, in fruit to 3 mm long. Calyx 1.5-2 mm long, lobes deltate, ca. 0.5 mm long, much shorter than tube; corolla dark flesh-colored to ochroleucous (in fresh condition with rose, tan, and yellow), 6-9 mm long. Fruits 7-9 mm long, declined, persistent, indehiscent, ovoid or shortly oblong, compressed but turgid. Seeds 2-3.

Habitat and distribution in Alabama: pinelands, pine-palmetto, scrub oak communities, sandhills, and roadsides; scattered in the southern one-half of the state, mostly in southeastern corner (Fig. 2b).

Specimens examined. Baldwin County: *R. Kral 32617*, 19 August 1968 (BRIT), Barbour County: *John R. MacDonald 11291*, 27 May 1998 (UNA), Bullock County: *A.R. Diamond 13516*, 8 August 2002 (TROY), Coffee County: *Brian H. Martin 942*, 4 September 2000 (TROY), Crenshaw County: *A.R. Diamond 11379*, 23 August 1998 (AUA), Dale County: *Tiffany Pennington 820*, 27 June 2000 (TROY), Dallas County: *R. Kral 32872*, 22 August 1968 (BRIT), Henry County: *John R. MacDonald 12880*, 26 May 1999 (TROY), Houston County: *John R. MacDonald 19842*, 20 July 1997 (BRIT), Macon County: *D.A. Botts 202*, 2 July 1976 (AUA), Mobile County: *C. Mohr s.n.*, July (UNA), Montgomery County: *A.R. Diamond 12473*, 3 July 2001 (TROY), Pike County: *James A. Hall 56*, 3 July 2000 (TROY), Russell County: *R. Kral 62074*, 19 June 1978 (TROY).

4. *Indigofera tinctoria* Linnaeus, Sp. Pl. 751. 1753. [Figure 2c]

Indigofera anil Linnaeus var. *orthocarpa* de Candolle, Prodr. 2: 225. 1825.

Indigofera indica Lamarck, Encycl. 3: 245. 1789, *nom. illegit. et non* Miller 1768.

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Anila tinctoria (Linnaeus) Kuntze, Revis. Gen. Pl. 1: 160. 1891.

Anila tinctoria (Linnaeus) Kuntze var. *normalis* Kuntze, Revis. Gen. Pl. 1: 160. 1891.

Anila tinctoria (Linnaeus) Kuntze var. *orthocarpa* (de Candolle) Kuntze, Revis. Gen. Pl. 1: 160. 1891.

Herbs. Stems erect or ascending (-sprawling), strigulose. Leaves odd pinnate, petioles 3-9 cm long; leaflets 9-15 paired, obovate or elliptic, 1-2.5 cm long, glabrous above; stipules ca. 2 mm long, caducous. Flowers closely disposed, initially sessile, then pedunculate; pedicels 1-2 mm long. Calyx ca. 1.5 mm long, tube and lobes subequal; corolla reddish-orange, 5-6 mm long. Fruits crowded, 2.8-3.5 cm long, divergent to declined, deciduous, dehiscent, linear and slightly falcate or abruptly upturned at tip, subterete, usually submoniliform, thinly coriaceous, strigose. Seeds several to numerous.

Native of tropical Africa, now widely distributed in warm regions and tropics; introduced in southern United States.

Habitat and distribution in Alabama: ballast grounds in southwestern corner of the state (Fig. 2d).

Specimens examined. Mobile County: *Mohr s.n.*, October 1869 (UNA).

DISCUSSION

In Alabama, *Indigofera* is a conspicuous taxon of pinelands, scrub oak communities, sandhills, roadsides, old fields, disturbed woodlands and urban waste areas.

The four taxa of *Indigofera* in this treatment are a combination of native and introduced species. *Indigofera caroliniana* Miller is based on a collection from "Carolina" and is the first North American species of the genus described (Miller, 1768). This taxon is endemic to the Southeastern United States and is known from all coastal states from North Carolina southwest to Louisiana (USDA, NRCS, 2010). Linnaeus (1753) described *I. hirsuta* based on a specimen collected from India. Presently, it has escaped cultivation in the United States and has been reported from Alabama, Florida, Georgia and South Carolina (USDA, NRCS, 2010). Although known from only three populations in Alabama, this taxon appears to be becoming more common in the southern section of the state, where two of the three known populations have been discovered in the past five years. Ortega (1798) described *I. miniata* based on a specimen collected from Cuba. This taxon is considered native to the United States and has been reported from Alabama, Arkansas, Georgia, Kansas, Louisiana, Oklahoma and Texas (USDA, NRCS, 2010). The Alabama collection is represented by *I. miniata* Ortega var. *leptosepala* (Nuttall ex Torrey & A. Gray) B. L. Turner. It is known from a single historical collection, September 1891, from ballast grounds in Mobile County. Although this taxon has not been reported from the state in 119 years, Alabama is in its natural range (Florida to Texas) and it possibly still occurs in the state. *Indigofera tinctoria* is the type of the genus and was described by

Linnaeus (1753) based on a specimen collected from India. In the United States, this taxon has escaped cultivation and has been collected in Alabama, Florida, North Carolina, South Carolina and Tennessee (USDA, NRCS, 2010). In Alabama, it is known from a single historical collection, October 1869, from ballast grounds in Mobile County. Since these ballast grounds have been developed, it is likely that this taxon is extirpated from the state.

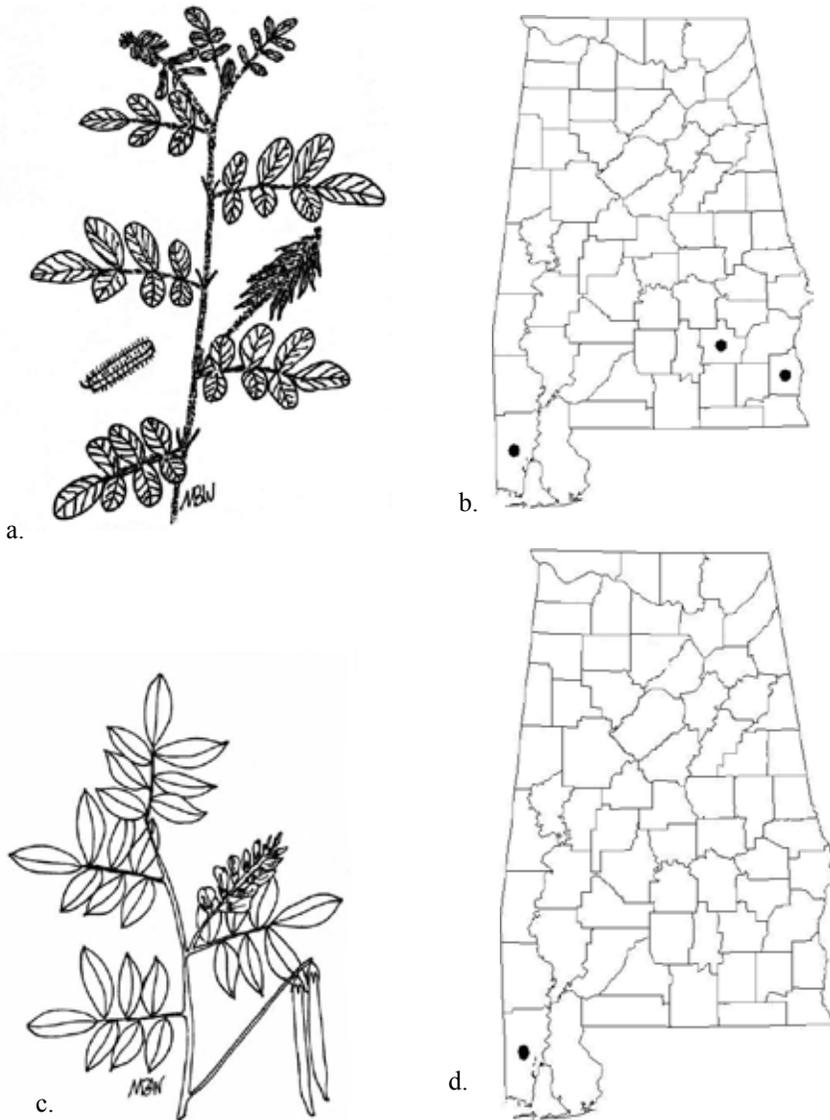


Figure 1. a) illustration of *Indigofera hirsuta*, b) distribution of *I. hirsuta*, c) illustration of *I. miniata*, d) distribution of *I. miniata*.

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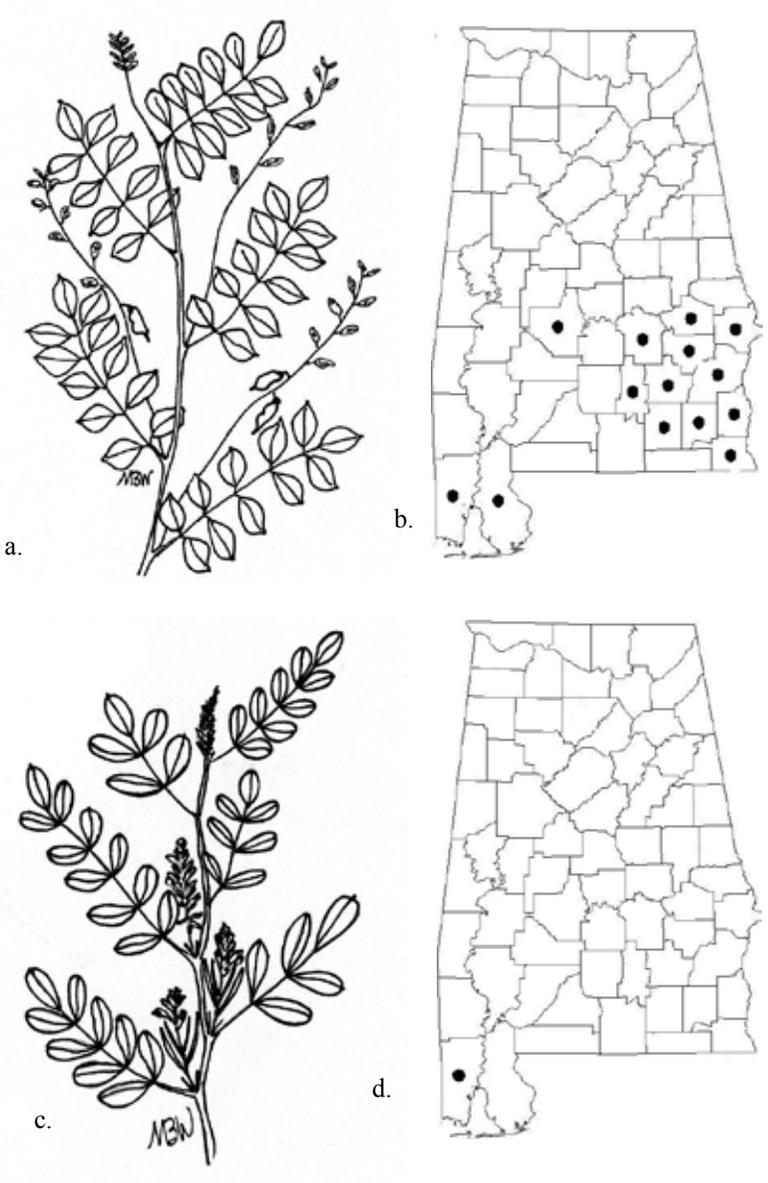


Figure 2. a) illustration of *Indigofera caroliniana*, b) distribution of *I. caroliniana*, c) illustration of *I. tinctoria*, d) distribution of *I. tinctoria*.

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