

MORPHOLOGY AND IDENTIFICATION OF THE SEEDLINGS
OF SELECTED WOODY/SEMI-WOODY SPECIES OF DICOTYLEDONS
SENSU LATO GROWING WILD IN SOUTH FLORIDA (U.S.A.).

PART I. SPECIES WITH EPIGEAL GERMINATION

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ABSTRACT

We describe and compare the seedlings of 70 species of trees, shrubs, and woody/semi-woody vines of dicotyledons sensu lato which have epigeal germination and which grow wild in south Florida. For each species we characterize the macroscopical features of the hypocotyl, cotyledons, supra-cotyledonary internodes, and supra-cotyledonary leaves as well as the presence vs. absence of, the kinds of, and the distribution of trichomes. We conclude with a taxonomic key for identifying the seedlings of all considered species. Fifty-nine and 11 of the investigated species are native to, and exotic within Florida, respectively.

RESUMEN

Describimos y comparamos las plántulas de 70 especies de árboles, arbustos y enredaderas leñosas/semi-leñosas de dicotiledóneas sensu lato que tienen germinación epigea y que crecen silvestres en el sur de Florida. Para cada especie, caracterizamos los rasgos macroscópicos del hipocótilo, los cotiledones, los entrenudos supracotiledóneos y las hojas supracotiledóneas, así como la presencia o ausencia de los tipos y distribución de los tricomas. Concluimos con una clave taxonómica para identificar las plántulas de todas las especies consideradas. De las especies investigadas cincuenta y nueve y 11 respectivamente son nativas y exóticas en Florida.

INTRODUCTION

Herein, we consider the morphology and identification of the seedlings of 70 species of trees, shrubs, and woody/semi-woody vines of dicotyledons sensu lato which have epigeal germination and which grow wild in south Florida. During epigeal germination the hypocotyl of a seedling elongates, carrying the cotyledons above ground. Too, the cotyledons lose their surrounding seed coat and fruit wall, becoming exposed to light. By contrast, during hypogeal germination the hypocotyl does not elongate. The cotyledon(s) remain(s) at or below ground level and to the inside of the seed coat and/or fruit wall.

The 70 presently considered species represent 39 families of dicotyledons sensu lato. Fifty-nine and 11 of the species are native to, and exotic within Florida, respectively. South Florida as defined here and by Gann et al. (2002) includes ten counties: Broward, Charlotte, Collier, Glades, Hendry, Lee, Martin, Miami-Dade, Monroe, and Palm Beach counties.

Previous workers have published numerous descriptions of seedlings (see the extensive bibliographies in Lubbock [1892], De Vogel [1980], and Garwood [2009]). Lubbock (1892) authored a classic two-volume treatise entitled “A contribution to our knowledge of seedlings,” wherein he described the morphology and development of the seedlings of numerous species and families worldwide. Included, were gymnosperms, dicotyledons sensu lato, and monocotyledons. Subsequent workers contributed additional works pertaining to more circumscribed areas and/or taxa (e.g., Kummer 1951; Franklin 1961; Chancellor 1966; Haring 1968; de Vogel 1980; Stucky 1981; Garwood 2009; Williams 2010); however, no prior account focused on the seedlings of south Florida. This work addresses that gap. A companion paper in preparation focuses on the seedlings of selected species of dicotyledonous woody plants from south Florida which manifest hypogeal germination.

The Results section of this paper includes individual descriptions of the seedlings of the presently considered species. The Summary and Discussion section presents, in part, comparisons between the seedlings. An ensuing section provides a taxonomic key to the species, based on their seedlings.

Differing definitions of cotyledons

Two main definitions exist. **Classical definition.**—The basal-most leaf, leaf pair, or leaf whorl of the embryo and seedling is/are the cotyledon(s) (Gray 1879; Lubbock 1892; Jackson 1928; Eames 1961; Esau 1977; Garwood 2009). **De Vogel's (1980) definition.**—De Vogel (1980) asserted: **a.** that classically defined cotyledons, collectively, include two kinds of entities, viz., “true cotyledons” and “paracotyledons,” **b.** that solely true cotyledons are the actual cotyledons, and **c.** that individual taxa generally produce either true cotyledons or paracotyledons, but not both. De Vogel (1980) defined paracotyledons as cotyledon-like leaves which “... through abortion of the true cotyledons ...” have become the basal-most leaves on the seedling stem. He envisioned abortion in a broad sense, indicating that at least sometimes the true cotyledons are not even initiated. De Vogel (1980) attributed paracotyledons to “... the large majority ...” of dicotyledons, particularly to species having epigeal germination.

Herein, we follow the classical definition, neither supporting nor contesting de Vogel's (1980) interpretation.

METHODS AND TERMINOLOGY

We examined primarily seedlings during the present study; however, young saplings were investigated in addition to seedlings when they retained features, thereof (e.g., the cotyledons and/or the first-formed supra-cotyledonary leaves/leaf scars). Herein, we refer to as **specimens** all presently studied seedlings/saplings.

We collected specimens growing wild either on natural land or, less often, in disturbed areas, from 29 Feb 2004 to 4 Jan 2021. Mostly, we obtained the specimens in south Florida, i.e., in Collier, Hendry, Lee, and Monroe Counties; however, we acquired some/all specimens of five species in northern Florida (*Triadica sebifera* [Suwanee Co.] and *Viburnum obovatum* [Columbia Co.]), in central Florida (*Ulmus americana* [Highlands Co.] and *Zanthoxylum fagara* [DeSoto Co.]), and in the Florida Panhandle (*Nyssa biflora* [Liberty Co.]). We undertook collecting largely during fieldwork focused on other investigations (Wilder 2020; Wilder & McCombs 2006; Wilder & Roche 2009; Wilder & Barry 2012; Wilder et al. 2014, 2019, 2021; Wilder & Thomas 2016; Wilder & McCollom 2018). We cite collection numbers and collection dates separately for each species, in the Results section of this paper.

In the wild the specimens grew separately or, more often, they composed monospecific groups of varying sizes. Whenever possible we collected many specimens of a species, but for certain species we could only acquire few specimens. Herein, we describe the seedlings of the poorly represented, as well as of the amply represented species. We do so, because the limited data from the poorly represented species permit their identification and enhance our general understanding of seedlings.

We identified seedlings to species in two ways. **a.** We compared their form and surficial characteristics to those of known saplings with transitional morphology and known adult plants likely to be conspecific with them. **b.** We considered their proximity in situ to (and thus their possible taxonomic equivalence with) adult plants of species growing nearby. Certainly, method **b**, while helpful, was not alone definitive in making an identification.

It was vital to not confuse seedlings/saplings with root sprouts (i.e., shoots initiated endogenously within the roots of other plants). The primary root of a seedling is characteristically narrowed and terminates distally, and unlike root sprouts the seedling does not join the root of another plant. Also, because root sprouts connect to their parent roots, one generally requires greater force to extricate them from the substrate than one requires for seedlings.

We pressed and dried all specimens. Because living specimens were generally unwieldy, to maximize control while pressing we pressed them singly or in small groups, utilizing multiple layers within the press. We later affixed the specimens to a smaller number of herbarium sheet(s) (Fig. 71). The living seedlings of

Ipomoea pes-caprae were unusually brittle, being difficult to transport during fieldwork and to press without breakage. By freezing and then thawing those seedlings we rendered them less brittle. After freezing/thawing, we pressed and dried them. We deposited all specimens at SWF.

The utility and limitations of herbarium specimens

Our specimens were advantageous because of their permanence, relative ease of preparation, and because they facilitated the measurement of plant parts; however, they were disadvantageous because one surface of each specimen was affixed permanently to its herbarium sheet. That circumstance sometimes made it difficult to characterize phyllotaxy. Also, while pressing seedlings we often had to twist their internodes to properly position their laminae. For specimens with opposite phyllotaxy in a broad sense, twisting made it unclear whether the specific kind of phyllotaxy was decussate, bijugate, or otherwise. Thus, for specimens with opposite phyllotaxy in a broad sense, we simply characterize their phyllotaxy as opposite.

Measurements

For each species, whenever possible we made 10 to 12 measurements for each parameter considered (e.g., cotyledon length). Also, with two exceptions we selected for measurement examples of each kind of structure (e.g., cotyledons) to best indicate the lower and upper limits of size, rather than at random. That approach mostly precluded us from doing statistical tests. The two exceptions were measurements that we made of the laminae of the dimorphic cotyledons of *Guapira discolor* and *Pisonia aculeata*. In those cases, we randomly chose specimens for measurement, thus allowing for statistical analyses.

Structurally, stems and roots differ from each other primarily according to differences in their internal anatomy (e.g., positional differences involving the primary xylem and primary phloem) and they are not always distinguishable in surface view. Accordingly, with our present non-anatomical methods it was sometimes difficult or impossible to locate the boundary between the hypocotyl (a kind of stem) and the primary root. In such cases we could not measure the lengths of some or all hypocotyls available. The problem was compounded because **a.** many hypocotyls were naturally curved or bent, diminishing the accuracy of measurements, and **b.** in older specimens the outermost tissues of the hypocotyl and primary root were degraded or sloughed away, eliminating any external marker(s) between those structures. Thus, some of our measurements of hypocotyls (but not of other structures) are approximate. Garwood (2009) reported similar difficulties in determining hypocotyl lengths, stating that “more typically ... the length of the hypocotyl must be estimated.”

Also, we initially attempted to characterize the venation of cotyledons, but in our dried specimens the cotyledonary major veins varied from being clearly visible (e.g., *Coccoloba diversifolia*, *Coccoloba uvifera*, *Drypetes diversifolia*, *Drypetes lateriflora*, *Gymnanthes lucida*, and *Ipomoea alba*) to undetectable or essentially so (e.g., *Abrus precatorius*, *Avicennia germinans*, *Chrysophyllum oliviforme*, *Cynophalla flexuosa*, *Krugiodendron ferreum*, and *Morella cerifera*). Because of that inconsistency, we do not consider cotyledonary venation herein. Specimens cleared with solvents and stored in liquid would better facilitate that work (Wilder 1981).

Terminology

Herein, the term “**supra-cotyledonary**” refers to portions of the seedling situated distal to the cotyledons, including the **supra-cotyledonary nodes**, **supra-cotyledonary internodes**, and **supra-cotyledonary leaves**. On the main stem of the seedling, beginning immediately distal to the cotyledonary node(s) the first three supra-cotyledonary nodes are numbered in acropetal order from 1 to 3, as are the first three supra-cotyledonary internodes.

Seedlings and saplings comprise a developmental continuum. For descriptive purposes we distinguish between them arbitrarily, as follows. On the main stem of a seedling, no more than the first three supra-cotyledonary nodes manifest expanded supra-cotyledonary leaf(s) and/or the leaf scar(s) thereof. By contrast, on the main stem of a sapling such leaf(ves) and/or leaf scar(s) accompany the first four or more supra-cotyledonary nodes. The supra-cotyledonary part of the seedling, as defined here, either conforms or does not conform to given one(s) of the varied definitions of epicotyl and plumule of previous workers (Gray 1879;

Jackson 1928; Swartz 1971; Esau 1977; Garwood 2009). Also, herein, we utilize the quantitatively based terminology of Radford et al. (1974) for characterizing the shapes, margins, apices, and bases of the laminae of the foliage leaves and cotyledons.

Drawings

We represent the seedling of each species with drawing(s) of one or more representative herbarium specimens. Because our specimens were flattened during pressing, our drawings are mainly silhouettes rather than more lifelike renderings; however, some line drawings are also provided.

RESULTS

We consider the described species individually, in alphabetical order of the names of the families they represent. For each family we consider the species in alphabetical order of their scientific names. Each species description includes eight or nine sections. **Section 1** presents the currently accepted scientific name (sometimes together with a synonym or misapplied name [Wunderlin et al. 2021]), family name (sometimes together with a widely accepted, alternative family name), common name(s), a statement of whether the species is native or exotic, and the number of specimens studied. **Section 2** provides information about adult plants, i.e., their growth habit and the phyllotaxy of and the kind of foliage leaves. Information is mainly from personal observations, but also from the descriptions of Barrett (1956), Nelson (1994, 1996) and Tomlinson (2001). **Section 3** provides the range of measurements (if any) of hypocotyl lengths and sometimes additional information about the hypocotyl. **Section 4** describes the cotyledons (exclusive of trichomes). **Section 5** describes phyllotaxy, i.e., the number of leaves present at each of supra-cotyledonary node nos. 1, 2, and/or to 3. **Section 6** characterizes other aspects of the supra-cotyledonary leaves (exclusive of trichomes). **Section 7** describes the trichomes present, if any. **Section 8** provides the collection numbers and collection dates of the studied specimens. **Section 9**, where present, offers additional information.

Avicennia germinans (L.) L.; **Acanthaceae**

Black Mangrove. Native

No. specimens studied: 34

Adult morphology

Tree or shrub with opposite, simple foliage leaves.

Seedling morphology (Fig. 1).

Hypocotyl. Length: 25.5–66.5 mm ($n = 11$).

Cotyledons. The cotyledons remain folded at maturity and exhibit a **cotyledon dimorphism**, as follows. Each seedling has an outer cotyledon (the larger of the two cotyledons) and an inner cotyledon. Each cotyledon is folded lengthwise along its midrib. The **outer cotyledon** is folded such that the two halves of its adaxial surface face one another and thereby enclose, collectively, both the seedling stem and the inner cotyledon; the **inner cotyledon** is folded such that the two halves of its abaxial surface face one another. Number of cotyledons: 2, opposite and unequal.

Lamina: **Shape (for both types of cotyledons, collectively):** simple; often widely reniform, but sometimes having the two sides of the lamina directed downward at a considerable angle. **Ranges of lengths and widths:** Lamina of outer cotyledon: 17–21 mm $\times$ 42.5–44.5 mm ($n = 2$ [each parameter]); lamina of inner cotyledon: 8–15 mm $\times$ 23–36 mm ($n = 4$ [each parameter]). **Range of length-to-width ratios:** Lamina of outer cotyledon: 0.40–0.47 ($n = 2$); lamina of inner cotyledon: 0.35–0.42 ($n = 4$). **Lamina margins (for both types of cotyledons, collectively):** essentially entire. **Lamina apex (for both types of cotyledons, collectively):** determined with the lamina spread out as being approximately truncate or with slight, various curvatures. **Lamina base (for both types of cotyledons, collectively):** more-or-less reniform. **Lamina thickness:** flat, thin.

Petiole: Present. **Range of lengths.** Few petioles were measurable because of folding of the cotyledons. Petiole of the outer cotyledon: 1.5 mm ($n = 1$). Petiole of the inner cotyledon: 1.5–2 mm ($n = 4$).

Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node nos. 1, 2: two leaves per node ($n = 100\%$ of 40 and 22 cases of these nodes, respectively).

Leaves of the first three supra-cotyledonary nodes (except where indicated otherwise).

Lamina: **Shape**: simple; unlobed; the leaves at node nos. 1 and 2 are frequently narrowly elliptic to elliptic, but also sometimes widely elliptic, lanceolate, lanceolate-ovate, or narrowly oblong. **Lamina margins**: entire and sometimes revolute. **Lamina apex**: mostly rounded; sometimes broadly acute.

Lamina base: mostly cuneate; sometimes narrowly cuneate, rarely rounded.

Petiole: Present and often poorly differentiated from the lamina (the leaf then being sessile) or absent.

Stipules: Absent

Trichomes.

Hypocotyl: sericeous when young (i.e., with long, silky, white hairs, generally appressed). **Cotyledons**. Lamina: normally glabrous; non-ciliate. Petiole: the margins with short, white, densely arranged hairs.

First two supra-cotyledonary internodes: glabrous. **Leaves of the first three supra-cotyledonary nodes**: Lamina (adaxial surface): glabrous or with loosely distributed, minute, white hairs. Lamina (abaxial surface): obscured/partly obscured by a dense, compact mat of minute hairs (except for supra-cotyledonary leaf no. 1, which sometimes lacks such a mat). Petiole: with densely arranged, short, whitish or brown marginal hairs.

Dates of collection and collection numbers of examined specimens.

22750, Mar 2005; 24204, 8 Nov 2005; 26780, 26781, 15 Apr 2007; 28032, 28033, 9 Mar 2008; 33176, 30 Jan 2010.

Viburnum obovatum Walter; **Adoxaceae**

Walter's Viburnum. Native

No. specimens studied: 9

Adult morphology

Tree or shrub with opposite, simple foliage leaves

Seedling morphology (Fig. 2).

Hypocotyl. Length: 38–73.5 mm (n = 5).

Cotyledons.

Number of cotyledons: 2, opposite; essentially equal.

Lamina: **Shape**: simple; unlobed; lanceolate or lanceolate-narrowly oblong. **Ranges of lengths and widths**: 13–16 mm × 3.2–5 mm (n = 4 [each parameter]). **Range of length-to-width ratios**: 3.2–4.3 (n = 4). **Lamina margins**: entire. **Lamina apex**: subacute to narrowly rounded. **Lamina base**: cuneate.

Lamina thickness: flat, thin.

Petiole: Present. **Range of lengths**: 1.5 (n = 3).

Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node nos. 1–3: two leaves per node (n = 100% of 8, 7, and 5 cases of these nodes, respectively).

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape**: simple; unlobed; generally lanceolate-ovate to ovate. **Lamina margins**: coarsely to finely serrate. **Lamina apex**: generally acute; sometimes subacute. **Lamina base**: cuneate or more-or-less abruptly narrowly cuneate.

Petiole: Present.

Stipules: Absent.

Trichomes.

Hypocotyl: glabrous. **Cotyledons**. Lamina: glabrous/essentially glabrous; non-ciliate. Petiole: glabrous or with scattered brown scales. **First three supra-cotyledonary internodes**: varying from glabrous (glabrescent?) to having moderately distributed brown (often dark brown) or black scales. In top view the scales generally appear more-or-less isodiametric (often circular), ca. 0.05 to 0.15 mm in diameter, and they frequently appear tightly appressed to the stem surface. They either exhibit or lack marginal, stub-like rays. **Leaves of the first three supra-cotyledonary nodes**: with scales like those described above. Lamina: glabrous (glabrescent?) or sparsely pubescent. Petiole: sparsely pubescent.

Dates of collection and collection numbers of examined specimens.

26488, 22 Mar 2007; 32062, 26 Feb 2011.

Metopium toxiferum (L.) Krug & Urb.; **Anacardiaceae**

Poisonwood. Native.

No. specimens studied: 28.

Adult morphology

Tree with alternate, once-pinnately compound foliage leaves.

Seedling morphology (Fig. 3).**Hypocotyl.** Length: 24.5–56 mm (n = 10).**Cotyledons.**Number of cotyledons: 2, opposite; essentially equal.Lamina: **Shape:** simple; mostly unlobed but sometimes with a few terminal lobes; variously shaped, often asymmetrical but sometimes oblong. **Ranges of lengths and widths:** 6.5–10 mm × 3–4.5 mm (n = 10 [each parameter]). **Range of length-to-width ratios:** 1.8–3.0 (n = 10). **Lamina margins:** entire to undulate. **Lamina apex:** abruptly acuminate to caudate or cirrhose. **Lamina base:** often oblique; sometimes broadly cuneate to rounded. **Lamina thickness:** flat, thickened.Petiole: present. **Range of lengths:** 1.5–4 mm (n = 10).Stipules: Absent.**Number of leaves per supra-cotyledonary node.****Node no. 1:** two leaves per node (n = 100% of 20 cases). **Node nos. 2, 3:** one leaf per node (n = 100% of 5 and 5 cases, respectively).**Leaves of the first three supra-cotyledonary nodes.**Lamina: **Shape:** simple; unlobed; lanceolate to ovate. **Lamina margins:** entire. **Lamina apex:** generally acuminate; sometimes rounded. **Lamina base:** rounded to subcordate.Petiole: Present.Stipules: Absent.**Trichomes.****Hypocotyl:** glabrous. **Cotyledons:** glabrous; non-ciliate. **First three supra-cotyledonary internodes:** glabrous/essentially glabrous. **Leaves of the first three supra-cotyledonary nodes:** Lamina: glabrous or with very sparse, stiff, appressed or spreading, transparent hairs 0.1 to 0.2 mm long; sometimes the hairs are mostly on the midrib. **Petiole:** glabrous or with sparse hairs like those described above.**Additional information**

When observed with the light microscope, the seedlings normally manifest localized blackened areas (including black tar-like deposits) on the primary root, hypocotyl, cotyledons, supra-cotyledonary stem, and supra-cotyledonary leaves.

Dates of collection and collection numbers of examined specimens.

34414, 12 Dec 2012; 34466, 27 Dec 2012; 35092, 35094, 20 Aug 2013; 35093, 20 Sep 2013; 35189, 10 Oct 2013.

Schinus terebinthifolia Raddi.; **Anacardiaceae**

Brazilian Pepper. Exotic.

No. specimens studied: 38.

Adult morphology

Tree or shrub with alternate, once-pinnately compound foliage leaves.

Seedling morphology (Fig. 4).**Hypocotyl.** Length: 12–50.5 mm (n = 10).**Cotyledons.**Number of cotyledons: 2, opposite; essentially equal.Lamina: **Shape:** simple; unlobed; the lamina is generally asymmetrical, with its two margins being convex and either straight or concave, respectively. **Ranges of lengths and widths:** 8.5–14.5 mm × 4–6 mm (n = 10 [each parameter]). **Range of length-to-width ratios:** 1.6–2.6 (n = 10). **Lamina margins:** entire. **Lamina apex:** rounded. **Lamina base:** cuneate to rounded; commonly oblique. **Lamina thickness:** flat, thin.Petiole: Present. **Range of lengths:** 1–3 mm (n = 10).Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node no. 1: one or two leaves per node ($n = 37.5\%$ and 62.5% of 16 cases, respectively).

Node nos. 2, 3: one leaf per node ($n = 100\%$ of 14 and 8 cases, respectively).

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape:** At node no. 1: simple and undivided, simple and divided, or once-compound with two leaflets ($n = 94\%$, 4% , and 2% of 47 leaves, respectively). At node no. 2: simple and undivided, simple and divided, or once-compound with two or three leaflets ($n = 17\%$, 6% , and 78% of 18 leaves, respectively). At node no. 3: simple and undivided or once-compound with three leaflets ($n = 8\%$ and 92% of 13 leaves, respectively). **Lamina margins:** coarsely/sharply serrate. **Lamina apex of undivided laminae and of the pinnae of compound leaves:** generally, cuneate to narrowly cuneate; sometimes rounded. **Lamina base of undivided laminae and of the leaflets of compound leaves:** generally, cuneate to broadly acute; sometimes rounded.

Petiole: Present.

Stipules: Absent.

Trichomes.

Hypocotyl: distally, with densely concentrated, transparent papillae, papilla-like hairs, and trichomes intermediate between them; the hairs spreading, straight or somewhat curved, and up to 0.05 mm long.

Cotyledons. Lamina: glabrous/essentially glabrous, except basally where hairs sometimes occur which resemble those described above; non-ciliate. Petiole: with densely concentrated hairs like those described above or with additional similar but longer hairs; occasional minute purplish hairs may also occur. **First three supra-cotyledonary internodes:** with dense pubescence like that of the cotyledonary petioles. **Leaves of the first three supra-cotyledonary nodes:** with the kinds of hairs, aforementioned. Lamina: essentially glabrous or with sparse pubescence mainly over the vein(s). Petiole: sparsely to moderately pubescent.

Dates of collection and collection numbers of examined specimens.

24805, 7 Mar 2006; 24806, 14 Mar 2006; 29413, 4 Feb 2009; 29444, 31 Jan 2009.

***Annona glabra* L.; Annonaceae**

Pond-Apple. Native.

No. specimens studied: 18.

Adult morphology

Tree or shrub with alternate, simple foliage leaves.

Seedling morphology (Fig. 5).

Hypocotyl. Length: 84 – 182 mm ($n = 11$).

Cotyledons.

Number of cotyledons: 2, opposite; more-or-less equal.

Lamina: **Shape:** simple; unlobed; lanceolate to narrowly elliptic. **Ranges of lengths and widths:** 28.5 – 40 mm $\times$ 7.5 – 13 mm ($n = 10$ [each parameter]). **Range of length-to-width ratios:** 2.5 – 4.4 ($n = 10$). **Lamina margins:** entire. **Lamina apex:** narrowly rounded. **Lamina base:** cuneate, narrowly cuneate, sometimes also oblique. **Lamina thickness:** flat, thin.

Petiole: Present. **Range of lengths:** 2.5 – 8 mm ($n = 10$).

Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node nos. 1–3: one leaf per node ($n = 100\%$ of 8, 7, and 7 cases of these nodes, respectively).

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape:** simple; unlobed; lance-ovate, ovate, or elliptic. **Lamina margins:** entire and commonly revolute. **Lamina apex:** acuminate or acute. **Lamina base:** mostly cuneate; sometimes rounded.

Petiole: Present.

Stipules: Absent

Internodes: the first several internodes are readily discernable; they are more-or-less long, beginning with the first internode distal to the cotyledons

Trichomes.

Hypocotyl: glabrous. **Cotyledons:** glabrous; non-ciliate. **First three supra-cotyledonary internodes:** glabrous or the first or second internode with sparse brown hairs. **Leaves of the first three supra-cotyledonary nodes:** glabrous.

Additional information.

The abaxial, but not adaxial, surfaces of the cotyledons and of the laminae of the supra-cotyledonary leaves are glaucous.

Dates of collection and collection numbers of examined specimens.

26482, 22 Mar 2007; 26519, 26520, 26521, 23 Mar 2007; 29739, Apr 2009.

***Ilex cassine* L. var. *cassine*; Aquifoliaceae**

Dahoon. Native.

No. specimens studied: 55.

Adult morphology

Tree with alternate, simple foliage leaves.

Seedling morphology (Figs. 6, 6A).

Hypocotyl. Length: 15.5–32.5 mm (n = 10).

Cotyledons.

Number of cotyledons: 2, opposite; essentially equal to subequal.

Lamina: **Shape:** simple; unlobed; normally ovate; sometimes lance-ovate. **Ranges of lengths and widths:** 7–10 mm × 4–6 mm (n = 10 [each parameter]). **Range of length-to-width ratios:** 1.4–2.3 (n = 10).

Lamina margins: entire. **Lamina apex:** simultaneously rounded and either retuse or emarginate. **Lamina base:** abruptly narrowly cuneate. **Lamina thickness:** flat, thin.

Petiole: Present. **Range of lengths:** 0.5–3 mm (n = 9).

Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node nos. 1–3: one per node (n = 100% of 15, 14, and 7 cases of these nodes, respectively).

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape:** simple; unlobed; generally obovate to widely obovate or elliptic to widely elliptic.

Lamina margins: serrate from the leaf apex to a point ca. ½ to ¾ of the distance down the lamina; entire beyond that point. **Lamina apex:** mostly broadly acute to rounded and simultaneously mucronulate (sometimes barely so); sometimes truncate. **Lamina base:** short-narrowly cuneate to caudate.

Petiole: Present.

Stipules: A pair of stem-borne stipules normally borders the base of each petiole.

Trichomes.

Hypocotyl: glabrous. **Cotyledons:** glabrous; non-ciliate. **First three supra-cotyledonary internodes:** with variously abundant, uncinatate or straight, white or transparent, often predominantly antrorse hairs which generally range from less than 0.05 mm to 0.15 mm long. **Leaves of the first three supra-cotyledonary nodes:** with hairs like those described above. **Lamina:** glabrous/essentially glabrous or with scattered hairs situated mainly on the midrib. **Petiole:** glabrous or with variously abundant hairs.

Dates of collection and collection numbers of examined specimens.

28153, 12 Apr 2008; 28435, 31 Jan 2009; 29404, 3 Feb 2009; 29407, 27 Jan 2009; 29436, 8 Feb 2009; 29437, 9 Feb 2009; 29599, 29 Mar 2009.

***Cynophalla flexuosa* (L.) J. Presl (*Capparis flexuosa* (L.) L.); Brassicaceae (Capparaceae)**

Bayleaf Capertree. Native.

No. specimens studied: 28.

Adult morphology

Tree or shrub with alternate, simple foliage leaves.

Seedling morphology (Fig. 7).

Hypocotyl. Length: 6–28.5 mm (n = 10).

Cotyledons.

Number of cotyledons: 2, opposite to slightly subopposite; equal.

Lamina: **Shape:** simple; unlobed; widely elliptic, very widely ovate, widely depressed ovate, or orbicular. **Ranges of lengths and widths:** 7–10 mm × 7–11 mm (n = 5 [each parameter]). **Range of length-to-width**

Figures 1–70 are drawings of pressed and dried seedlings, a sapling (*Casuarina equisetifolia*), and portions of seedlings of the species considered herein. The drawings are silhouettes except when indicated otherwise.

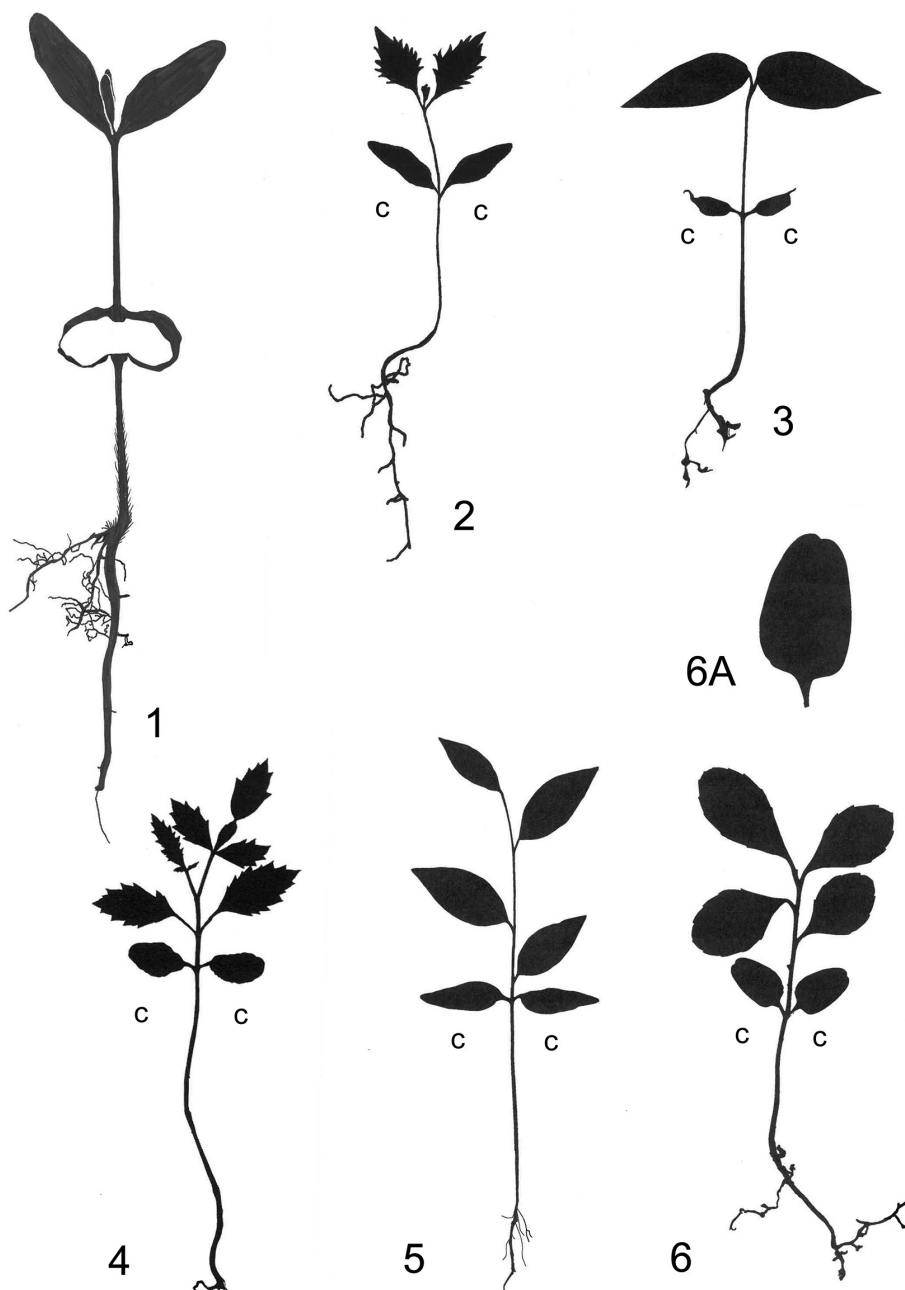


FIG. 1. *Avicennia germinans*. Seedling. The cotyledons were unfolded artificially. As depicted here, the inner cotyledon covers the outer cotyledon and the two cotyledons appear white and black, respectively. $\times 0.50$; K.R. FIG. 2. *Viburnum obovatum*. Seedling. $\times 0.77$; K.R. FIG. 3. *Metopium toxiferum*. Seedling. $\times 0.72$; M.P. FIG. 4. *Schinus terebinthifolia*. Seedling. $\times 1.2$; J.B. FIG. 5. *Annona glabra*. Seedling. $\times 0.69$; M.P. FIGS. 6, 6A. *Ilex cassine* var. *cassine*. Seedling and a separate cotyledon, respectively. $\times 1.1$, $\times 2.7$. Indicated sequentially, after each figure description or group of descriptions are the magnification(s) of, and the initials of the artist who prepared, the drawing(s) (J.B. = Julio Gonzalez Batista; M.P. = Marcella Pulgarin; K.R. = Katja Redes). C. Cotyledon.

ratios: 0.8–1.1 (n = 5). **Lamina margins:** undulate. **Lamina apex:** broadly rounded. **Lamina base:** mostly reniform; sometimes broadly cuneate. **Lamina thickness:** flat, a little thickened.

Petiole: Present. **Range of lengths:** 1–2 mm (n = 10).

Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node no. 1: one or two leaves per node (n = 96% and 4% of 23 cases, respectively). **Node nos. 2, 3:** one leaf per node (n = 100% of 22 cases of each node).

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape:** simple; unlobed; commonly oblanceolate to obovate; sometimes narrowly elliptic to elliptic. **Lamina margins:** entire. **Lamina apex:** mostly abruptly acuminate; sometimes acute or rounded. **Lamina base:** mostly cuneate; sometimes nearly rounded.

Petiole: Present.

Stipules: A pair of very short (ca. 0.5 to 1 mm long) stem-borne stipules borders the base of each petiole.

Trichomes.

Hypocotyl: generally, minute-papillate, especially toward/at its distal end. **Cotyledons:**

Lamina: glabrous, non-ciliate. Petiole: sometimes minute-papillate. **First three supra-cotyledonary internodes:** densely minute-papillate. **Leaves of the first three supra-cotyledonary nodes:** often minute-papillate.

Dates of collection and collection numbers of examined specimens.

28034, 28035, 28036, 9 Mar 2008; 30999, 15 May 2010.

Quadrella jamaicensis (Jacq.) J. Presl (*Capparis jamaicensis* Jacq.,
Capparis cynophallophora L., misapplied); **Brassicaceae (Capparaceae)**

Jamaican Capertree. Native.

No. specimens studied: 40.

Adult morphology

Tree or shrub with alternate, simple foliage leaves.

Seedling morphology (Fig. 8).

Hypocotyl. Length: 24–47 mm (n = 10).

Cotyledons.

Number of cotyledons: 2, opposite; essentially equal to subequal.

Lamina: **Shape:** simple; unlobed; mostly ovate; sometimes widely oblong or elliptic. **Ranges of lengths and widths:** 11.5–18 mm × 8.5–12 mm (n = 10 [each parameter]). **Range of length-to-width ratios:** 1.2–1.6 (n = 10). **Lamina margins:** entire. **Lamina apex:** narrowly to broadly rounded. **Lamina base:** cordate and simultaneously either symmetric or oblique. **Lamina thickness:** flat, thin.

Petiole: Present. **Range of lengths:** 1.5–2.5 mm (n = 10).

Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node nos. 1–3: one leaf per node (n = 100% of 14, 12, and 7 cases of these nodes, respectively).

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape:** simple; unlobed; often narrowly elliptic, but sometimes narrowly oblong, lanceolate, or oblanceolate. **Lamina margins:** entire. **Lamina apex:** mostly rounded to acute; sometimes retuse. **Lamina base:** mostly cuneate to rounded; sometimes narrowly cuneate.

Petiole: Present.

Stipules: Absent.

Trichomes.

Hypocotyl: typically exhibiting minute papillae toward/at its distal end. **Cotyledons:** Lamina: glabrous; non-ciliate. Petiole: minute-papillate. **First three supra-cotyledonary internodes.** Extending distally from, and sharply delimited from the base of, the first internode is a dense, compact, unbroken mat of white and brown peltate scales. **Leaves of the first three supra-cotyledonary nodes:** Lamina (adaxial surface): glabrous. Lamina (abaxial surface): covered with numerous peltate scales. Petiole: with a dense, compact, unbroken mat of white and brown peltate scales.

Dates of collection and collection numbers of examined specimens.

30837, 24 Apr 2010; 31324, 19 Jun 2010; 31793, 23 Oct 2010; 43206, 18 Jun 2020.

***Bursera simaruba* (L.) Sarg.; Burseraceae**

Gumbo Limbo. Native.

No. specimens studied: 35.

Adult morphology

Tree with alternate, once-pinnately compound foliage leaves.

Seedling morphology (Fig. 9).

Hypocotyl. Length: 46–138.5 mm (n = 10).

Cotyledons.

Number of cotyledons: 2, opposite and equal.

Lamina: **Shape:** simple and deeply divided into three more-or-less equal segments; the segments vary from narrowly elliptic to narrowly lanceolate. **Ranges of lengths and widths:** 22.5–38 mm × 26–51 mm (n = 10 [each parameter]). **Range of length-to-width ratios:** 0.67–1.1 (n = 10). **Lamina margins:** entire. **Lamina apex:** the apices of the lobes vary from acute to narrowly rounded. **Lamina base:** more-or-less rounded to nearly truncate. **Lamina thickness:** flat, thin.

Petiole: Present. **Range of lengths:** 1–6.5 mm (n = 10).

Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node no. 1: two leaves per node (n = 100% of 19 cases). **Node no. 2:** one leaf per node (n = 100% of 15 cases). **Node no. 3:** one leaf per node (n = 100% of 8 cases).

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape:** simple; unlobed; narrowly lanceolate to ovate. **Lamina margins:** entire. **Lamina apex:** mostly acuminate (and then with a pointed or narrowly rounded tip); sometimes rounded or emarginate. **Lamina base:** mostly rounded to cordate; sometimes truncate.

Petiole: Present.

Stipules: Absent

Trichomes.

Hypocotyl: glabrous. **Cotyledons:** glabrous, except for a few small, marginal hairs which sometimes occur basally within the sinuses between the lamina segments. **First three supra-cotyledonary internodes:** glabrous/essentially glabrous. **Leaves of the first three supra-cotyledonary nodes:** the mature leaves are glabrous/essentially glabrous.

Dates of collection and collection numbers of examined specimens.

28690, Jul 2008; 28747, 7 Jul 2008; 28748, 28749, 15 Jul 2008; 28849, 22 Aug 2008; 28883, 1 Aug 2008; 29301, 20 Dec 2008.

***Canella winterana* (L.) Gaertn.; Canellaceae**

Pepper Cinnamon, Cinnamon Bark. Native.

No. specimens studied: 39.

Adult morphology

Tree or shrub with alternate, simple foliage leaves.

Seedling morphology (Fig. 10).

Hypocotyl. Length: 40.5–61 mm (n = 9).

Cotyledons.

Number of cotyledons: 2, opposite; essentially equal.

Lamina: **Shape:** simple; unlobed; generally, narrowly elliptic; sometimes narrowly oblong or lanceolate. **Ranges of lengths and widths:** 16.5–28 mm × 3.5–6 mm (n = 11 [each parameter]). **Range of length-to-width ratios:** 4.1–6.4 (n = 11). **Lamina margins:** entire. **Lamina apex:** mostly rounded and narrow; sometimes subacute. **Lamina base:** narrowly cuneate. **Lamina thickness:** flat, thin.

Petiole: Absent. The cotyledons are sessile.

Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node nos. 1–3: one leaf per node ($n = 100\%$ of 9 cases of each of the three nodes).

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape:** simple; unlobed; elliptic, lanceolate, oblanceolate, or obovate. **Lamina margins:** entire. **Lamina apex:** mostly rounded (and then sometimes with a tiny mucro), but sometimes acute or subacute. **Lamina base:** more-or-less narrowly cuneate.

Petiole: Present.

Stipules: Absent.

Trichomes.

Hypocotyl: glabrous. **Cotyledons:** glabrous. **First two supra-cotyledonary internodes:** glabrous.

Leaves of the first three supra-cotyledonary nodes: glabrous.

Additional information.

On old seedlings the base of the first supra-cotyledonary internode is often conspicuously swollen.

Dates of collection and collection numbers of examined specimens.

35185, 14 Oct 2013; 35308, 23 Oct 2013; 35354, 20 Sep 2013; 35482, 12 Dec 2013; 42893, 8 Jan 2020.

***Celtis laevigata* Willd.; Cannabaceae**

Hackberry. Native.

No. specimens studied: 20.

Adult morphology

Tree with alternate, simple foliage leaves.

Seedling morphology (Fig. 11).

Hypocotyl. Length: 38.5–78.5 mm ($n = 5$).

Cotyledons.

Number of cotyledons: 2, opposite or, more often, slightly to distinctly subopposite; essentially equal.

Lamina: **Shape:** simple; lobed; obovate, obovate-oblong, narrowly oblong, or oblong. **Ranges of lengths and widths:** 10–15 mm $\times$ 4.5–7.5 mm ($n = 10$ [each parameter]). **Range of length-to-width ratios:** 1.7–2.5 ($n = 10$). **Lamina margins:** entire. **Lamina apex:** cleft with a conspicuous V-shaped notch.

Lamina base: cuneate to rounded. **Lamina thickness:** flat, thin.

Petiole: present. **Range of lengths:** 0.5–2 mm ($n = 10$).

Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node no. 1: one or two leaves per node ($n = 53\%$ and 47% of 15 cases, respectively). **Node nos. 2, 3:** one leaf per node ($n = 100\%$ of 11 and 5 cases, respectively). Reminiscent of the cotyledons of this species, the first two supra-cotyledonary leaves were often closely subopposite (and were then counted as one per node).

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape:** simple; unlobed; ovate. **Lamina margins:** serrate/coarsely serrate. **Lamina apex:** mostly acute, but sometimes narrowly rounded and simultaneously mucronulate. **Lamina base:** cuneate to rounded.

Petiole: Present.

Stipules: A pair of stem-borne, pale, minute stipules (0.5 to 1.0 mm long [$n = 10$]) borders the base of the petiole of a young supra-cotyledonary leaf.

Trichomes.

Hypocotyl: either glabrous or with numerous, minute, colorless/white, frequently uncinat hairs (those generally being most concentrated on the distal half of the hypocotyl).

Cotyledons: **Lamina:** glabrous or with densely arranged hairs like those described above. **Supra-cotyledonary internode nos. 1–3:** with densely arranged hairs like those described above. **Leaves of the first three supra-cotyledonary nodes:** **Lamina:** with more loosely arranged, larger, white/colorless, uncinat, strigose hairs.

Dates of collection and collection numbers of examined specimens.

38216, 19 Dec 2015; 38260, 12 Dec 2015.

Casuarina equisetifolia L.; Casuarinaceae

Australian Pine. Exotic.

No. specimens studied: 11.

Adult morphology

Tree with whorled, simple foliage leaves.

Seedling morphology (Figs. 12, 12A).

Hypocotyl. Length was not determined because of difficulty in identifying the hypocotyl-primary root boundary.

Cotyledons.

Number of cotyledons: 2, opposite; more-or-less equal.

Lamina: **Shape:** simple; unlobed; obovate. **Ranges of lengths and widths:** 2.3–2.4 mm × 1 mm (n = 4 and 1, respectively). **Range of length-to-width ratios:** not determinable. **Lamina margins:** entire.

Lamina apex: rounded. **Lamina base:** the margins of the cotyledons are connate basally, composing a short, persistent tube. **Lamina thickness:** flat, thin.

Petiole: absent. The cotyledons are sessile.

Stipules: Absent.

Number of leaves per supra-cotyledonary node.

This could not be assessed in pressed material; however, for *Allocasuarina torulosa* (“*Casuarina torulosa*”), Goebel (1900, 1905), citing previous literature, attributed two, two, and four leaves to supra-cotyledonary node nos. 1–3, respectively.

Leaves of the first supra-cotyledonary nodes.

Immediately distal to the cotyledons, there occurs a stem sector ca. 0.5 mm long which bears up to at least five, minute juvenile leaves that vary from distinct to basally connate-decurrent for up to half of their lengths. The leaves are separated from the cotyledons and from one another by no, or by hardly discernable, internodes. They measure 0.4 to 1.2 mm long (n = 10). Distal to them the stem bears whorls of longer, darker-colored leaves, those of each whorl being decurrent basally for a higher proportion of their lengths.

The distinct juvenile leaves are not segmented into lamina, petiole, and leaf base. They are simple and unlobed (as are the laminae of subsequently formed leaves) and are lanceolate, ovate, or obovate. Their margins are entire and their apices are acuminate or caudate. As indicated, the juvenile leaves are sessile.

Trichomes.

The seedling is sometimes completely glabrous, albeit the hypocotyl of one specimen was minutely papillate.

Dates of collection and collection numbers of examined specimens.

20266, 29 Feb 2004.

Tricerna phyllanthoides (Benth.) Lundell (*Maytenus phyllanthoides* Benth.); Celastraceae

Florida Mayten. Native.

No. specimens studied: 23.

Adult morphology

Tree or shrub with alternate, simple foliage leaves

Seedling morphology (Fig. 13).

Hypocotyl. Length: 10.5–16.5 mm (n = 9).

Cotyledons.

Number of cotyledons: 2, opposite; essentially equal.

Lamina: **Shape:** simple; unlobed; mostly ca. narrowly elliptic-elliptic to elliptic; sometimes oblanceolate-obovate. **Ranges of lengths and widths:** 15–17 mm × 7–9 mm (n = 10 [each parameter]). **Range of length-to-width ratios:** 1.8–2.4 (n = 10). **Lamina margins:** entire. **Lamina apex:** rounded. **Lamina base:** abruptly narrowly cuneate. **Lamina thickness:** flat, thin to thick.

Petiole: Present. **Range of lengths:** 0.5–3.5 mm (n = 11).

Stipules: Absent.

Number of leaves per supra-cotyledonary node

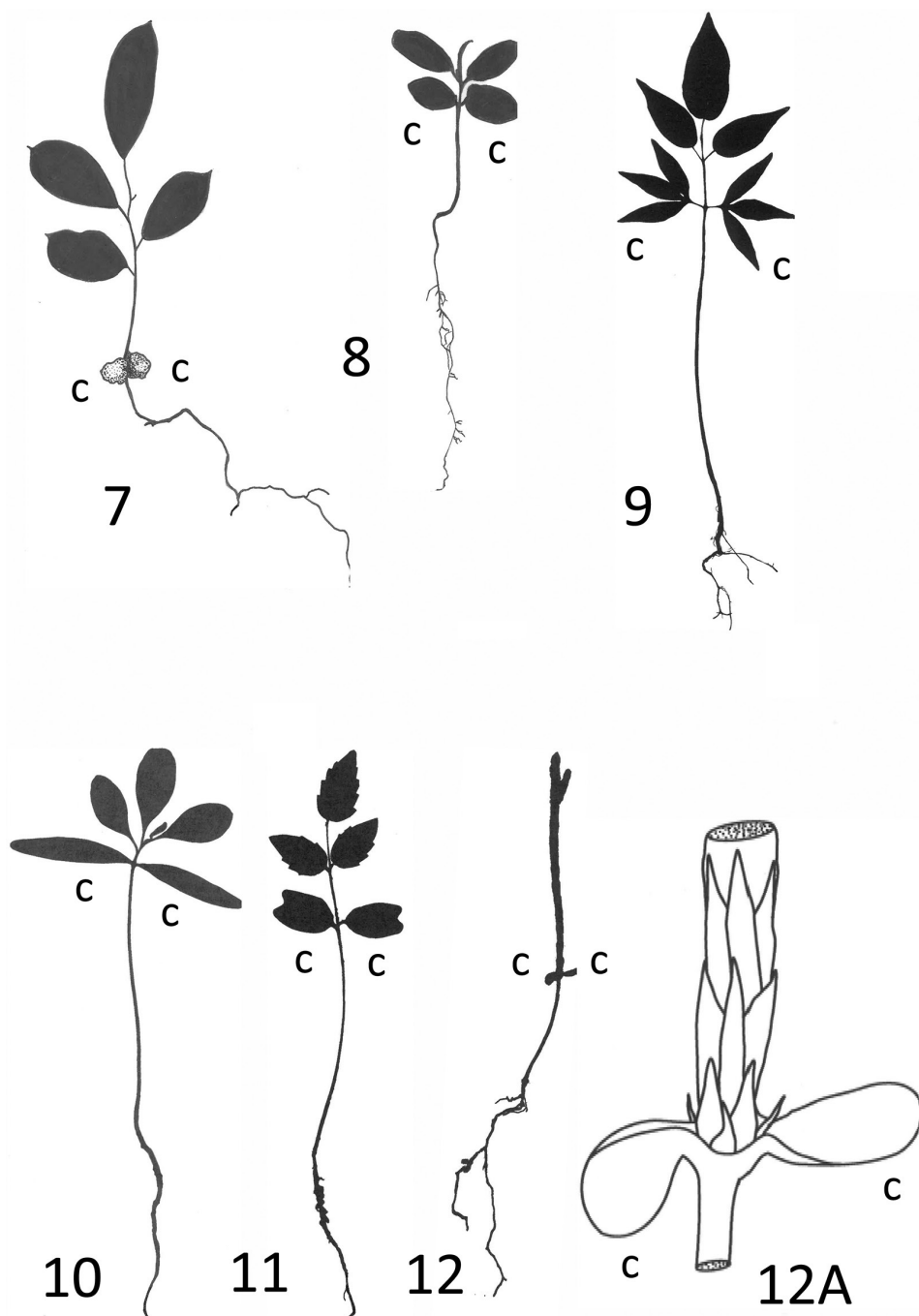


FIG. 7. *Cyanophalla flexuosa*. Seedling. $\times 0.49$; K.R. FIG. 8. *Quadrella jamaicensis*. Seedling. $\times 0.50$; K.R. FIG. 9. *Bursera simaruba*. Seedling. $\times 0.33$; J.B. FIG. 10. *Canella winterana*. Seedling. $\times 0.68$; M.P. FIG. 11. *Celtis laevigata*. Seedling. $\times 0.67$; M.P. FIGS. 12, 12A. *Casuarina equisetifolia*. Sapling and a portion, thereof, respectively. The line drawing in FIG. 12A depicts, in acropetal order, the terminal portion of the hypocotyl, the cotyledons, the supra-cotyledonary leaves, and part of the supra-cotyledonary portion of the stem. $\times 1.2$, $\times 11$; M.P. Indicated sequentially, after each figure description or group of descriptions are the magnification(s) of, and the initials of the artist who prepared, the drawing(s) (J.B. = Julio Gonzalez Batista; M.P. = Marcella Pulgarin; K.R. = Katja Redes). C. Cotyledon.

Node nos. 1–3: one leaf per node ($n = 100\%$ of 15, 6, and 1 case(s) of these nodes, respectively).

Leaves of the first three supra-cotyledonary nodes.

At each of supra-cotyledonary node nos. 1 and 2, *T. phyllanthoides* produces a leaf of one of two discretely different types: **depauperate leaves** and **normally expanded leaves**. At supra-cotyledonary node no. 3 there develops a normally expanded leaf. The depauperate leaves measure 0.7 to 1.5 mm long ($n = 3$), unlike the much larger normally expanded leaves. Too, they are purple, in contrast to the green normally expanded leaves. Aside from *Abrus precatorius*, *T. phyllanthoides* is the only presently studied species with depauperate supra-cotyledonary leaves. The descriptions of lamina, petiole, and stipules, below, are of the normally expanded leaves.

Lamina: **Shape:** simple; unlobed; commonly oblanceolate-obovate; sometimes elliptic or lanceolate-ovate. **Lamina margins:** entire/essentially entire to serrate; the teeth are at least sometimes mucronate or apiculate. **Lamina apex:** mostly acute to rounded and sometimes simultaneously mucronate; sometimes retuse. **Lamina base:** cuneate or abruptly narrowly cuneate.

Petiole: Present (very short) or absent.

Stipules: Present. The stipules - 2 per leaf - are stem-borne. They are purplish and manifest short to long marginal projections which are either non-glandular or partly or entirely glandular.

Trichomes.

Hypocotyl. A non-basal portion, thereof, bears more-or-less concentrated papillae.

Cotyledons: glabrous; non-ciliate. **First three supra-cotyledonary internodes:** sometimes papillate.

Leaves of the first three supra-cotyledonary nodes: glabrous.

Dates of collection and collection numbers of examined specimens.

43129, 1 Sep 2020; 43150, 30 May 2020; 43244, 13 May 2020.

Conocarpus erectus L.; Combretaceae

Buttonwood. Native.

No. specimens studied: 59.

Adult morphology

Tree or shrub with opposite, simple foliage leaves.

Seedling morphology (Fig. 14).

Hypocotyl. Length: 12–45 mm ($n = 10$).

Cotyledons.

Number of cotyledons: 2, opposite; essentially equal.

Lamina: **Shape:** simple; unlobed; mostly very widely obovate to widely depressed obovate. **Ranges of lengths and widths:** 3–7 mm $\times$ 4.5–8 mm ($n = 10$ [each parameter]). **Range of length-to-width ratios:** 0.67–1.0 ($n = 10$). **Lamina margins:** entire but commonly appearing minutely roughened. **Lamina apex:** broadly rounded to truncate. **Lamina base:** attenuate. **Lamina thickness:** flat, somewhat thickened.

Petiole: present. **Range of lengths:** 2.4–4.5 mm ($n = 10$).

Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node no. 1: one or two leaves per node ($n = 95\%$ and 5% of 19 cases, respectively). **Node no. 2:** one leaf per node ($n = 100\%$ of 18 cases). **Node no. 3:** one leaf per node ($n = 100\%$ of 18 cases).

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape:** simple; unlobed; narrowly elliptic to elliptic or oblanceolate to obovate. **Lamina margins:** entire. **Lamina apex:** acute to rounded. **Lamina base:** attenuate.

Petiole: Minute or absent.

Stipules: Absent.

Trichomes.

Hypocotyl: glabrous. **Cotyledons:** glabrous; non-ciliate. **First three supra-cotyledonary internodes:** glabrous. **Leaves of the first three supra-cotyledonary nodes:** generally, glabrous but sometimes having very sparse, appressed, long, whitish hairs.

Dates of collection and collection numbers of examined specimens.

28564, 16 Jun 2008; 29956, 14 Jul 2009; 43242, 13 May 2020.

Laguncularia racemosa (L.) C.F. Gaertn.; **Combretaceae**

White Mangrove. Native.

No. specimens studied: 58.

Adult morphology

Tree or shrub with opposite, simple foliage leaves.

Seedling morphology (Fig. 15).**Hypocotyl.** Length: 49–111.5 mm (n = 10).**Cotyledons.**Number of cotyledons: 2, opposite, mostly essentially equal; sometimes unequal.Lamina: **Shape:** simple; unlobed; oblanceolate-obovate to obovate; often asymmetrical (sometimes markedly so). **Ranges of lengths and widths:** 18–34.5 mm × 7.5–19.5 mm (n = 10 [each parameter]).**Range of length-to-width ratios:** 1.6–2.7 (n = 10). **Lamina margins:** entire and/or undulate. **Lamina apex:** mostly broadly rounded; sometimes truncate. **Lamina base:** cuneate to narrowly cuneate.**Lamina thickness:** flat, thin.Petiole: Present. **Range of lengths:** 2.5–6.5 mm (n = 10).Stipules: Absent.**Number of leaves per supra-cotyledonary node.****Node nos. 1, 2:** two leaves per node (n = 100% of 10 and 1 case(s) of these nodes, respectively).**Leaves of the first two supra-cotyledonary nodes.**Lamina: **Shape:** simple; unlobed; oblanceolate-obovate to obovate. **Lamina margins:** entire. **Lamina apex:** rounded to retuse. **Lamina base:** cuneate to narrowly cuneate or sessile.Petiole: Present or absent.Stipules: Absent.**Trichomes.****Hypocotyl:** glabrous. **Cotyledons:** glabrous/essentially glabrous; non-ciliate. **First two supra-cotyledonary internodes:** glabrous or having sparse, white hairs ca. 0.1 to 0.2 mm long. **Leaves of the first two supra-cotyledonary nodes:** Lamina/petiole: glabrous or with sparse hairs like those described above.**Dates of collection and collection numbers of examined specimens.**

24621, 18 Jan 2006; 24622, 16 Jan 2006; 25704, 11 Oct 2006; 28047, 9 Mar 2008; 29345, 22 Nov 2008; 43309, 1 Oct 2020.

Ipomoea alba L.; **Convolvulaceae**

Moonflowers. Native.

No. specimens studied: 6.

Adult morphology

Climbing vine with alternate, simple foliage leaves.

Seedling morphology (Fig. 16).**Hypocotyl.** Length: 50.5–128 mm (n = 3).**Cotyledons.**Number of cotyledons: 2, opposite; essentially equal.Lamina: **Shape:** simple. The cotyledons manifest a very wide medial sinus which demarcates two broad lateral lobes. The lobes vary from acute to rounded. The leaf apex (located at the basal edge of the sinus) varies from angular to gently concave. Not considering the sinus, the lamina varies from widely depressed obovate to depressed obovate. **Ranges of lengths and widths:** 45–63.5 mm × 60.5–100 mm (n = 10 [each parameter]). **Range of length-to-width ratios:** 0.64–0.84 (n = 10). **Lamina margins:** entire. **Lamina apex:** see above. **Lamina base:** reniform. **Lamina thickness:** flat, thin.Petiole: Present. **Range of lengths:** 18.5–70 mm (n = 10).Stipules: Absent.**Number of leaves per supra-cotyledonary node.****Node nos. 1–3:** one leaf per node (n = 100% of 5, 5, and 5 cases of these nodes, respectively).

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape:** simple; unlobed or with 3, 4, or 5 lateral lobes which vary from small and tooth-like to prominent; ovate to very widely ovate. **Lamina margins:** entire. **Lamina apex:** acuminate-caudate to caudate. **Lamina base:** reniform or approximately so.

Petiole: Present.

Stipules: Absent.

Trichomes.

Hypocotyl: essentially glabrous or bearing very sparse, minute, white papillae and hairs. **Cotyledons:** Lamina: glabrous/essentially glabrous and non-ciliate, or exhibiting, abaxially, varying concentrations of white papillae over the main longitudinal veins. Petiole: glabrous/essentially glabrous. **First three supra-cotyledonary internodes:** with variously concentrated hairs and papillae like those described above. **Leaves of the first three supra-cotyledonary nodes:** Lamina: essentially glabrous on leaves at node nos. 1, 2; however, on the leaf at node no. 3, adaxially, the lamina may exhibit numerous, more robust, stiff, white hairs, 1 to 4.5 mm long. The hairs situated over the veins are antrorse, whereas those inserted between the veins are mainly pointed toward the nearest margin of the lamina.

Petiole: with papillae and hairs like those of the hypocotyl.

Additional information. Numerous pellucid, microscopic, mounds pervade the cotyledonary lamina.

Dates of collection and collection numbers of examined specimens.

29196, 23 Aug 2008.

Ipomoea pes-caprae* (L.) R. Br. subsp. *brasiliensis* (L.) Ooststr.; *Convolvulaceae

Railroad Vine. Native.

No. specimens studied: 13.

Adult morphology

Prostrate vine with alternate, simple foliage leaves.

Seedling morphology (Fig. 17).

Hypocotyl. Length: 50–88.5 mm (n = 7).

Cotyledons.

Number of cotyledons: 2, opposite; essentially equal to unequal.

Lamina: **Shape:** simple. The cotyledons manifest a very wide medial sinus which demarcates two lateral lobes. Among different cotyledons the lobes may vary considerably in width. The tips of the lobes are generally rounded. The leaf apex (located at the basal edge of the sinus) varies from angular to gently concave. Not considering the sinus, the lamina varies from very widely obovate to depressed obovate. **Ranges of lengths and widths:** 19.5–25.5 mm × 24.5–35.5 mm (n = 10 [each parameter]).

Range of length-to-width ratios: 0.58–0.98 (n = 10). **Lamina margins:** entire. **Lamina apex:** see above. **Lamina base:** reniform, more-or-less truncate, or abruptly narrowly cuneate. **Lamina thickness:** flat, thin.

Petiole: Present. **Range of lengths:** 3.5–19 mm (n = 10).

Stipules: Absent.

Number of leaves per supra-cotyledonary node.

The three first-formed supra-cotyledonary leaves may alternate with one another or be crowded together in various ways. For example, they may compose a pseudo-whorl or, possibly, a whorl.

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape:** simple; unlobed or with lobes barely developed; elliptic, widely elliptic, ovate, obovate, or oblong. **Lamina margins:** entire. **Lamina apex:** rounded to retuse. **Lamina base:** ca. rounded, reniform, or truncate.

Petiole: Present.

Stipules: Absent.

Trichomes.

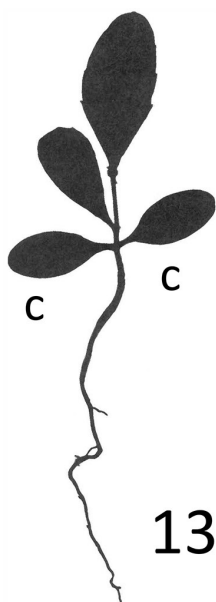
Hypocotyl: glabrous. **Cotyledons:** glabrous. **First three supra-cotyledonary internodes:** glabrous.

Leaves of the first three supra-cotyledonary nodes: glabrous/essentially glabrous.

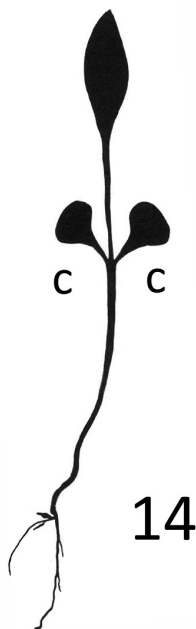
Additional information. Numerous pellucid microscopic mounds pervade the cotyledons.

Dates of collection and collection numbers of examined specimens.

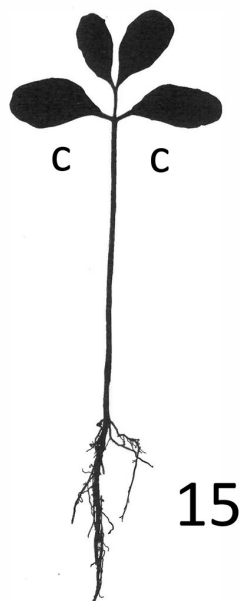
28483, 21 Jun 2008; 43006, 15 Jul 2020; 43026, 25 Jun 2020; 43027, 16 May 2020.



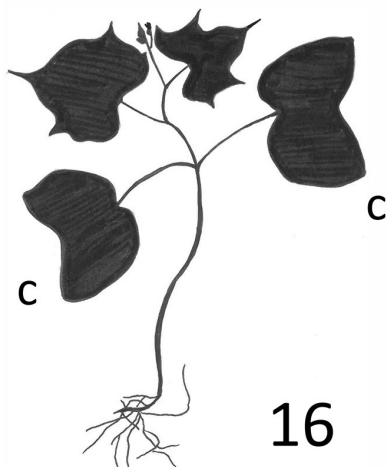
13



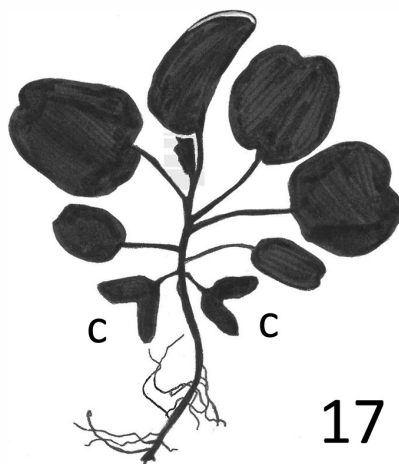
14



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16



17

FIG. 13. *Tricerna phyllanthoides*. Seedling. $\times 0.78$; M.P. FIG. 14. *Conocarpus erectus*. Seedling. $\times 1.1$; J.B. FIG. 15. *Laguncularia racemosa*. Seedling. $\times 0.39$; J.B. FIG. 16. *Ipomoea alba*. Seedling. $\times 0.26$; K.R. FIG. 17. *Ipomoea pes-caprae*. Seedling. $\times 0.27$; K.R. Indicated sequentially, after each figure description are the magnification of, and the initials of the artist who prepared, the drawing (J.B. = Julio Gonzalez Batista; M.P. = Marcella Pulgarin; K.R. = Katja Redes). C. Cotyledon.

***Ipomoea quamoclit* L.; Convolvulaceae**

Cypressvine. Exotic.

No. specimens studied: 20.

Adult morphology

Climbing vine with alternate, simple foliage leaves.

Seedling morphology (Fig. 18).**Hypocotyl.** Length: 32.5–72 mm (n = 10).**Cotyledons.**Number of cotyledons: 2, opposite; essentially equal or subequal.Lamina: **Shape:** simple. The cotyledons are forked into two long, narrow (sometimes nearly linear) lobes that diverge from one another at a wide angle. Because of their lengths and wide divergence angle, the lobes are each substantially longer than is the lamina itself (lamina length being measured along the lamina long axis). The leaf apex (located at the basal edge of the sinus between the lobes) is concave.**Ranges of lengths and widths:** 9.5–17.5 mm × 35–58 mm (n = 10 [each parameter]). **Range of length-to-width ratios:** 0.19–0.41 (n = 10). **Lamina margins:** entire. **Lamina apex:** see above. **Lamina base:** often reniform; sometimes rounded or abruptly narrowly cuneate. **Lamina thickness:** flat, thin.Petiole: Present. **Range of lengths:** 8–18 mm (n = 10).Stipules: Absent.**Number of leaves per supra-cotyledonary node.****Node nos. 1–3:** one leaf per node (n = 100% of 11, 11, and 10 cases of these nodes, respectively).**Leaves of the first three supra-cotyledonary nodes.**Lamina: **Shape:** The lamina is pinnately compound, having an alate rachis which is little wider than the subjacent petiole. The rachis bears narrow, linear pinnae which are mostly unbranched; however, frequently the basal-most pinnae are forked at/near their basal ends. **Pinna margins:** entire. **Pinna apex:** acute to narrowly rounded. **Pinna base:** sessile.Petiole: Present.Stipules: Absent; however, the (solitary) buds subtended by the supra-cotyledonary leaves (and by the cotyledons) may each produce a pair of prophylls (first-formed leaves) which expand early, are compound, and may be mistaken for stipules.**Trichomes.****Hypocotyl:** glabrous. **Cotyledons:** glabrous or bearing very sparse, minute, white hairs. **First three supra-cotyledonary internodes:** glabrous/essentially glabrous. **Leaves of the first three supra-cotyledonary nodes:** Lamina and petiole: glabrous or with very scarce, minute, white hairs.**Dates of collection and collection numbers of examined specimens.**

32479, 15 Jun 2011.

***Ipomoea triloba* L.; Convolvulaceae**

Littlebell. Exotic.

No. specimens studied: 4.

Adult morphology

Climbing vine with alternate, simple foliage leaves.

Seedling morphology (Fig. 19).**Hypocotyl.** Length: 38–43 mm (n = 2).**Cotyledons.**Number of cotyledons: 2, opposite; essentially equal to unequal.Lamina: **Shape:** simple. The cotyledons manifest a wide medial sinus which demarcates two broad lateral lobes. The lobes vary from acute to rounded. The leaf apex (located at the basal edge of the sinus) varies from angular to narrowly concave. Not considering the sinus, the lamina is obovate to depressed obovate or oblong-obovate. **Ranges of lengths and widths:** 13.5–19 mm × 12.5–21.5 mm (n = 6 [each parameter]). **Range of length-to-width ratios:** 0.65–1.5 (n = 6). **Lamina margins:** entire. **Lamina apex:** see above. **Lamina base:** reniform to truncate. **Lamina thickness:** flat, thin.Petiole: Present. **Range of lengths:** 9–15 mm (n = 8).Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node nos. 1–2: one leaf per node ($n = 100\%$ of 3 and 3 cases of these nodes, respectively).

Leaves of the first three supra-cotyledonary nodes (except where indicated).

Lamina (at supra-cotyledonary node nos. 1, 2): **Shape:** simple; unlobed; ovate to very widely ovate or widely ovate-deltate. **Lamina margins:** entire. **Lamina apex:** acute to narrowly rounded or abruptly acuminate. **Lamina base:** reniform to nearly truncate.

Petiole: Present.

Stipules: Absent.

Trichomes.

Hypocotyl: essentially glabrous (i.e., with very sparse, white or transparent hairs of varying lengths).

Cotyledons: glabrous; non-ciliate. **First three supra-cotyledonary internodes:** glabrous/essentially glabrous. **Leaves of the first three supra-cotyledonary nodes:** glabrous/essentially glabrous.

Additional information. Numerous pellucid microscopic mounds pervade the cotyledonary lamina

Dates of collection and collection numbers of examined specimens.

39302, 13 Sep 2016.

***Ipomoea violacea* L.; Convolvulaceae**

Beach Moonflower. Native.

No. specimens studied: 14.

Adult morphology

Climbing vine with alternate, simple foliaceous leaves.

Seedling morphology (Figs. 20, 20A).

Hypocotyl. Length was not determined because of difficulty in identifying the hypocotyl-primary root boundary.

Cotyledons.

Number of cotyledons: 2, opposite; essentially equal to unequal.

Lamina: **Shape:** simple. The cotyledons manifest a very wide medial sinus which demarcates two broad lateral lobes; the lobes vary from acute to rounded. The leaf apex (located at the basal edge of the sinus) varies from angular to concave or nearly truncate. Not considering the sinus, the lamina varies from very widely obovate to depressed obovate. Individual cotyledons vary from essentially symmetrical (Fig. 20) to conspicuously asymmetrical (Fig. 20A). Asymmetry may be manifested **a.**, **b.** in uneven lengths and/or widths of the two cotyledonary lobes, and **c.** in an oblique lamina base (i.e., a reniform base in which the two basal lamina-extensions protrude basally to different extents). **Ranges of lengths and widths:** 27–51 mm $\times$ 28–70 mm ($n = 12$ [each parameter]). **Range of length-to-width ratios:** 0.60–0.99 ($n = 12$). **Lamina margins:** entire. **Lamina apex:** see above. **Lamina base:** reniform.

Lamina thickness: flat, thin.

Petiole: Present. **Range of lengths:** 11–30 mm ($n = 11$).

Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node nos. 1–3: one leaf per node ($n = 100\%$ of 3, 3, and 2 cases of these nodes, respectively).

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape:** simple; unlobed; lanceolate-ovate to widely ovate; **Lamina margins:** entire or undulate. **Lamina apex:** acute, subacute, acuminate, or caudate. **Lamina base:** approximately reniform, rounded, or cordate.

Petiole: Present.

Stipules: Absent.

Trichomes.

Hypocotyl: glabrous or essentially glabrous (i.e., with very sparse, white hairs of varying lengths).

Cotyledons: glabrous/essentially glabrous; non-ciliate. **First three supra-cotyledonary internodes:** essentially glabrous. **Leaves of the first two supra-cotyledonary nodes:** Lamina: essentially glabrous or white-papillate. Petiole: essentially glabrous.

Dates of collection and collection numbers of examined specimens.

34962, 11 Jul 2013; 43007, 8 Jul 2020; 43207, 9 Jun 2020.

***Cornus foemina* Mill.; Cornaceae**

Swamp Dogwood. Native.

No. specimens studied: 63.

Adult morphology

Tree or shrub with opposite, simple foliage leaves.

Seedling morphology (Fig. 21).**Hypocotyl.** Length: 29.5–63.5 mm (n = 10).**Cotyledons.**Number of cotyledons: 2, opposite; essentially equal.Lamina: **Shape:** simple; unlobed; commonly narrowly elliptic to elliptic; less often ovate, narrowly oblong, or oblong. **Ranges of lengths and widths:** 12.5–16.5 mm × 5.5–10.5 mm (n = 12 [each parameter]). **Range of length-to-width ratios:** 1.6–2.7 (n = 12). **Lamina margins:** entire. **Lamina apex:** rounded. **Lamina base:** cuneate to rounded, short narrowly cuneate. **Lamina thickness:** flat, thin.Petiole: Present. **Range of lengths:** 1–2 mm (n = 10).Stipules: Absent.**Number of leaves per supra-cotyledonary node.****Node nos. 1–3:** two leaves per node (n = 100% of 48, 27, and 6 cases of these nodes, respectively).**Leaves of the first three supra-cotyledonary nodes.**Lamina: **Shape:** simple; unlobed; generally, lanceolate-ovate to ovate; sometimes ca. narrowly elliptic or rhombic. **Lamina margins:** entire. **Lamina apex:** subacute, narrowly rounded, or acuminate.**Lamina base:** cuneate to rounded.Petiole: Present.Stipules: Absent.**Trichomes.****Hypocotyl:** glabrous. **Cotyledons:** glabrous; non-ciliate. **First three supra-cotyledonary internodes:** with variously concentrated T-shaped hairs which individually are white and/or brown. For each hair, the central axis of the “T” is erect, extremely short, and not readily perceived in top view; the two branches of the “T” are much longer, are appressed to the stem, and extend acropetally and basipetally, respectively. **Leaves of the first three supra-cotyledonary nodes:** Lamina. White/mostly white T-shaped hairs are abundant on each lamina-surface. Generally, on each surface the two branches of a hair are antrorse and retrorse, respectively. Petiole. White and/or brown T-shaped hairs are abundant. Generally, the two branches of a hair extend basally and distally, respectively on the petiole.**Dates of collection and collection numbers of examined specimens.**

28038, 23 Mar 2008; 29390, 20 Jan 2009; 29629, 11 Mar 2009; 29688, 7 Feb 2009.

***Lyonia fruticosa* (Michx.) G.S. Torr.; Ericaceae**

Coastalplain Staggerbush. Native.

No. specimens studied: 10.

Adult morphology

Shrub with alternate, simple foliage leaves.

Seedling morphology (Fig. 22).**Hypocotyl.** Length: 5–6.5 mm (n = 3).**Cotyledons:**Number of cotyledons: 2, opposite; essentially equal to subequal.Lamina: **Shape:** simple; unlobed; lance-ovate or ovate. **Ranges of lengths and widths:** 1.3–2.3 mm × 0.7–1.2 mm (n = 6 and 7, respectively). **Range of length-to-width ratios:** 1.6–2.4 (n = 6). **Lamina margins:** entire. **Lamina apex:** acute, subacute, rounded. **Lamina base:** cuneate, narrowly cuneate. **Lamina thickness:** flat, thin.Petiole: Present. **Range of lengths:** 0.2–0.7 mm (n = 7).Stipules: Absent.**Number of leaves per supra-cotyledonary node.****Node nos. 1–3:** one leaf per node (n = 100% of 10 cases of each of these nodes, respectively). Commonly,

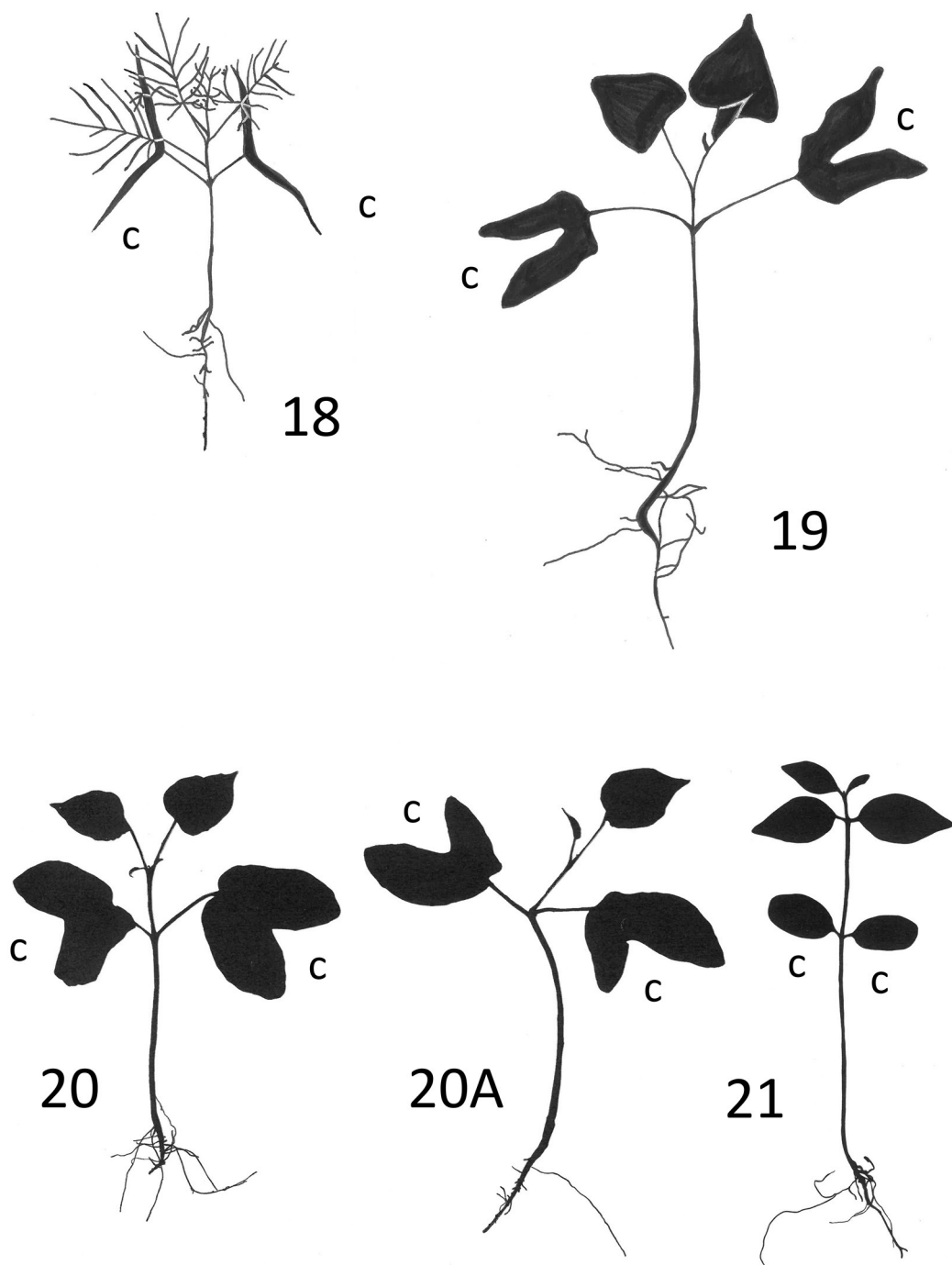


FIG. 18. *Ipomoea quamoclit*. Seedling. $\times 0.50$; K.R. FIG. 19. *Ipomoea triloba*. Seedling. $\times 1.0$; K.R. FIGS. 20, 20A. *Ipomoea violacea*. Two seedlings which exhibit relatively symmetrical cotyledons and asymmetrical cotyledons, respectively. $\times 0.35$, $\times 0.48$; J.B. FIG. 21. *Cornus foemina*. Seedling. $\times 0.71$; J.B. Indicated sequentially, after each figure description or group of descriptions are the magnification(s) of, and the initials of the artist who prepared, the drawing(s) (J.B. = Julio Gonzalez Batista; K.R. = Katja Redes). C. Cotyledon.

on a seedling some supra-cotyledonary internode(s) were very short, if existent, making it difficult to determine the number of leaves per node.

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape:** simple; unlobed; obovate to widely depressed obovate or widely elliptic-circular.

Lamina margins: mostly entire; sometimes undulate. **Lamina apex:** mostly rounded; sometimes sub-acute. **Lamina base:** cuneate, narrowly cuneate, or reniform.

Petiole: Present.

Stipules: Absent.

Trichomes.

Hypocotyl: glabrous or sometimes papillate from its distal end partway to the base.

Cotyledons: glabrous; non-ciliate. **First three supra-cotyledonary internodes.** There are **a.** sparse gray-to-brown scales, and **b.** moderately concentrated, minute (up to 0.5 mm long), spreading, straight to little-curved, transparent hairs. **Leaves of the first three supra-cotyledonary nodes.** The lamina and petiole bear loosely distributed (lamina) or sparse (petiole) brown, peltate scales (but they lack the white trichomes, aforementioned).

Additional information. The first two supra-cotyledonary internodes may be very condensed. (In at least six of 10 seedlings examined the first internode was essentially nonexistent). Supra-cotyledonary internode no. 3 is often longer than the first two internodes.

Dates of collection and collection numbers of examined specimens.

32581, 5 Jul 2011.

Gymnanthes lucida Sw.; **Euphorbiaceae**

Crabwood. Native

No. specimens studied: 52.

Adult morphology

Tree or shrub with alternate, simple foliage leaves.

Seedling morphology (Fig. 23).

Hypocotyl. Length: 38–63.5 mm (n = 10).

Cotyledons.

Number of cotyledons: 2, opposite; essentially equal.

Lamina: **Shape:** simple; unlobed; generally obovate to almost very widely obovate; sometimes widely ovate or widely elliptic. **Ranges of lengths and widths:** 13–22 mm × 9.5–16.5 mm (n = 10 [each parameter]). **Range of length-to-width ratios:** 1.1–1.5 (n = 10). **Lamina margins:** normally entire; rarely with very low, rounded teeth. **Lamina apex:** generally, broadly rounded to truncate; sometimes retuse. **Lamina base:** rounded to broadly cuneate. **Lamina thickness:** flat, thin.

Petiole: Present. **Range of lengths:** 1–2.5 mm (n = 10).

Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node nos. 1–3: one leaf per node (n = 100% of 14, 8, and 3 cases of these nodes, respectively).

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape:** simple; unlobed; generally oblanceolate-obovate to obovate; sometimes elliptic-rhombic. **Lamina margins:** serrate. **Lamina apex:** generally acute to acuminate; sometimes narrowly rounded or retuse. **Lamina base:** cuneate to narrowly rounded.

Petiole: Present.

Stipules: A pair of stem-borne stipules borders the base of each petiole.

Trichomes.

Hypocotyl: glabrous. **Cotyledons:** glabrous; non-ciliate. **First three supra-cotyledonary internodes:** with numerous minute, white (sometimes white-to-yellowish) hairs which generally project more-or-less perpendicular to the stem axis. **Leaves of the first three supra-cotyledonary nodes:** with hairs which resemble those of the hypocotyl. **Lamina:** both lamina surfaces are glabrous or essentially so. **Petiole:** glabrous or with sparsely distributed hairs.

Dates of collection and collection numbers of examined specimens.

35061, 14 Aug 2013; 35227, 20 Aug 2013; 43060, 10 Aug 2020; 43128, 1 Oct 2020.

Triadica sebifera (L.) Small [*Sapium sebiferum* (L.) DumCours.]; **Euphorbiaceae**

Popcorn tree. Exotic.

No. specimens studied: 7.

Adult morphology

Tree with alternate, simple foliage leaves.

Seedling morphology (Fig. 24).

Hypocotyl. Length: 39–78 mm (n = 4).

Cotyledons.

Number of cotyledons: 2, opposite; mostly essentially equal; sometimes unequal.

Lamina: **Shape:** simple and unlobed; obovate. **Ranges of lengths and widths:** 15.9–24 mm × 9–14.5 mm (n = 10 [each parameter]). **Range of length-to-width ratios:** 1.5–2.2 (n = 10). **Lamina margins:** entire. **Lamina apex:** truncate or rounded. **Lamina base:** cuneate. **Lamina thickness:** flat, thin.

Petiole: Present. **Range of lengths:** 2.5–5 mm (n = 10).

Stipules: Absent.

Number of leaves per supra-cotyledonary node

Node no. 1: one or two leaves per node (n = 14% and 86% of 7 cases, respectively). **Node nos. 2 and 3:** one leaf per node (n = 100% of 6 and 5 cases, respectively).

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape:** simple; unlobed; mostly ovate to very widely ovate (in those cases sometimes approaching triangular); typically obovate. **Lamina margins:** entire. **Lamina apex:** mostly acute; sometimes subacute, abruptly acuminate, or rounded. **Lamina base:** rounded to truncate; cuneate.

Petiole: Present.

Stipules: Present. The stipules, at least sometimes two per leaf, are stem-borne and border the base of the petiole.

Trichomes.

Hypocotyl: essentially glabrous. **Cotyledons:** glabrous; non-ciliate. **First three supra-cotyledonary internodes:** essentially glabrous or with sparsely distributed, minute, sessile/subsessile white hairs.

Leaves of the first three supra-cotyledonary nodes: glabrous/essentially glabrous.

Dates of collection and collection numbers of examined specimens.

30374, 2 Jun 2009.

Abrus precatorius L.; **Fabaceae**

Rosary Pea. Exotic.

No. specimens studied: 14.

Adult morphology

Climbing vine with alternate, once-pinnately compound foliage leaves.

Seedling morphology (Fig. 25).

Hypocotyl. Length: 57–109 mm (n = 8).

Cotyledons. The cotyledons remain folded (at least often conduplicately folded) at maturity. They were measured/otherwise described in that condition.

Number of cotyledons: 2, opposite, essentially equal.

Lamina: **Shape:** simple; unlobed; oblanceolate to obovate. **Ranges of lengths and widths:** 9–11 mm × 3–4.7 mm (n = 11 [each parameter]). **Range of length-to-width ratios:** 2.1–3.7 (n = 11). **Lamina margins:** entire. **Lamina apex:** subacute to rounded. **Lamina base:** sessile. **Lamina thickness:** flat, thin.

Petiole: Absent. The cotyledons are sessile.

Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node no. 1: two leaves per node (n = 100% of 5 cases). **Node no. 2:** one or two leaves per node (n = 8% and 92% of 13 cases, respectively). **Node no. 3:** one leaf per node (n = 100% of 13 cases).

Leaves of the first three supra-cotyledonary nodes.

Abrus precatorius is unique among the presently studied species because the leaves of supra-cotyledonary node no. 1 are always depauperate. They range from 0.6 to 1.3 mm long (n = 10), lack petioles, and vary from being esipulate to having two well defined stipules.

Lamina: Shape: At node no. 1: simple and depauperate (see above). At node nos. 2, 3: once-pinnately compound ($n = 100\%$ of 14 and 12 cases, respectively). **Pinna margins:** entire. **Pinna apex:** truncate to retuse, and simultaneously minutely mucronulate. **Pinna base:** cuneate to rounded.

Petiole: Absent at supra-cotyledonary node no. 1; present at supra-cotyledonary node nos. 2, 3.

Stipules: Sometimes present at supra-cotyledonary node no. 1; always present at supra-cotyledonary node nos. 2 and 3. Consider three seedlings in which supra-cotyledonary node no. 2 manifested opposite leaves. Seedling no. 1: node no. 2 exhibited two distinct stipules per interpetiolar region (i.e., four stipules altogether). Seedling nos. 2, 3: node no. 2 exhibited one bifid interpetiolar stipule per interpetiolar region (interpretable as two marginally connate stipules).

Trichomes.

Hypocotyl: glabrous. **Cotyledons:** glabrous; non-ciliate. **First three supra-cotyledonary internodes:** with moderately concentrated, thick, sharp-tipped, straight, prominently white, antrorse hairs commonly 0.3 but up to 0.45 mm long. **Leaves of the first three supra-cotyledonary nodes:** hairs, where present, like those described above. Lamina (adaxial surfaces of pinnae): glabrous. Lamina (abaxial surfaces of pinnae): sparsely to moderately pubescent; hairs antrorse. Rachis: sparsely to moderately pubescent; hairs antrorse. Petiole: sparsely to moderately pubescent; hairs antrorse.

Additional information. Supra-cotyledonary internode no. 1 is little elongated, varying from 0.3 to 0.7 mm long ($n = 10$). Supra-cotyledonary internode nos. 2 and 3 are always much longer ($n = 10$ cases for each of node nos. 2 and 3).

Dates of collection and collection numbers of examined specimens.

23558, 20 Jul 2005; 23559, 20 Jul 2005; 23590, 22 Jul 2005.

Acacia auriculiformis A. Cunn. ex Benth.; **Fabaceae**

Earleaf Acacia. Exotic.

No. specimens studied: 19.

Adult morphology

Tree with simple, ensiform foliage leaves ("phyllodes").

Seedling morphology (Fig. 26).

Hypocotyl. Length: 24–72 mm ($n = 10$).

Early in seedling development the hypocotyl-primary root junction becomes swollen and a short, hollow cylinder of outer tissue splits away from the base of the hypocotyl. The cylinder is persistent, remaining attached to the hypocotyl at its distal end

Cotyledons.

Number of cotyledons: 2, opposite, essentially equal.

Lamina: Shape: simple; unlobed above the base; elliptic-obovate, elliptic. **Ranges of lengths and widths:** 5.5–7 mm $\times$ 3–5 mm ($n = 10$ and 11, respectively). **Range of length-to-width ratios:** 1.3–2.3 ($n = 10$).

Lamina margins: entire. **Lamina apex:** rounded. **Lamina base:** sagittate or auriculate. **Lamina thickness:** flat, thin.

Petiole: Present (minute). **Range of lengths:** 0.15–0.5 mm ($n = 8$).

Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node nos. 1–3: one leaf per node ($n = 100\%$ of 12, 12, and 12 cases of these nodes, respectively).

Leaves of the first three supra-cotyledonary nodes.

Lamina: Shape: At node no. 1: once-pinnately compound ($n = 100\%$ of 12 leaves). At node no. 2: twice-pinnately compound with two opposite pinnae ($n = 100\%$ of 9 leaves). At node no. 3: twice pinnately compound with two opposite pinnae ($n = 100\%$ of 9 leaves). **Pinna/pinnule margins:** entire. **Pinna/pinnule apex:** mucronulate (the mucro terminating the rounded subterminal portion of the lamina). **Pinna/pinnule base:** generally oblique, sometimes rounded.

Petiole: Present. It is ca. terete on leaves at node nos. 1 and 2 ($n = 100\%$ of 12 and 9 leaves of those two nodes, respectively) and moderately ensiform on leaves at node no. 3 ($n = 100\%$ of 9 leaves).

Stipules: Stem-borne stipules normally develop at the petiole bases.

Trichomes.

Hypocotyl: glabrous. **Cotyledons.** Lamina: glabrous or essentially so; non-ciliate. Petiole: glabrous. **First three supra-cotyledonary internodes:** glabrous (sometimes on the first internode) to mostly

moderately pubescent with appressed to spreading, curved, unicellular, white hairs varying up to 0.4 mm long. **Leaves of the first three supra-cotyledonary nodes:** hairs, where present, are like those described above. Lamina: laminar portions glabrous or essentially so. First-order and second-order rachises: sparsely to densely pubescent. Petiole: sparsely to densely pubescent

Additional information. Supra-cotyledonary internode no. 1 varies from non-existent to expanded, albeit, generally less expanded than are supra-cotyledonary internode nos. 2 and 3.

Dates of collection and collection numbers of examined specimens.

43597, 4 Oct 2005.

***Canavalia rosea* (Sw.) DC.; Fabaceae**

Baybean, Seaside Jackbean. Native.

No. specimens studied: 16.

Adult morphology

Prostrate or low-climbing vine with alternate, trifoliolate foliage leaves.

Seedling morphology (Fig. 27).

Hypocotyl. Length: 38–162 mm (n = 10).

Cotyledons.

Number of cotyledons: 2, opposite or slightly subopposite, equal to commonly unequal (in both size and shape).

Lamina: **Shape:** simple; unlobed above the base; narrowly oblong, oblong, oblanceolate, or obovate.

Ranges of lengths and widths: 14.5–24.5 mm × 6.5–11 mm (n = 10 [each parameter]). **Range of length-to-width ratios:** 1.7–3.6 (n = 10). **Lamina margins:** entire. **Lamina apex:** rounded, truncate, or retuse.

Lamina base: commonly oblique, one half of the base having a small basal lobe, the other half being tapered. **Lamina thickness:** flat, somewhat thickened.

Petiole: Absent or, perhaps sometimes present and minute.

Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node no. 1: two leaves per node (n = 100% of 13 cases). **Node no. 2:** one leaf per node (n = 100% of 3 cases). **Node no. 3:** one leaf per node (n = 1 case).

Leaves of the first two supra-cotyledonary nodes.

Lamina of the first supra-cotyledonary node: **Shape:** simple; unlobed; very widely ovate to widely depressed ovate. **Lamina margins:** entire. **Lamina apex:** mucronulate and simultaneously gently rounded, truncate, or retuse. **Lamina base:** cordate. Lamina of the second supra-cotyledonary node: **Shape:** compound (trifoliolate with a terminal, stalked pinna); the pinnae being unlobed. **Pinna margins:** entire. **Pinna apex:** mucronulate and simultaneously retuse or broadly acute to rounded. **Pinna base:** rounded.

Petiole: Present.

Stipules: The two opposite leaves at the first supra-cotyledonary node exhibit, collectively, two interpetiolar stipules (as opposed to the four stipules that one might expect). The single leaf at the second supra-cotyledonary node manifests two stem-borne stipules.

Trichomes.

Hypocotyl: glabrous or with more-or-less sparse, minute, appressed or spreading hairs. **Cotyledons:** glabrous or essentially so; non-ciliate. **First supra-cotyledonary internode:** with sparse to common hairs like those described above. **Leaves of the first three supra-cotyledonary nodes:** Lamina: with mainly sparse hairs like those described above.

Dates of collection and collection numbers of examined specimens.

26661, 30 Apr 2007; 29030, 29031, 22 Oct 2008; 30637, 30638, 26 Aug 2009; 43023, 16 May 2020.

***Leucaena leucocephala* (Lam.) de Wit.; Fabaceae**

White Leadtree. Exotic.

No. specimens studied: 26.

Adult morphology

Tree or shrub with alternate, twice-pinnately compound foliage leaves.

Seedling morphology (Fig. 28).

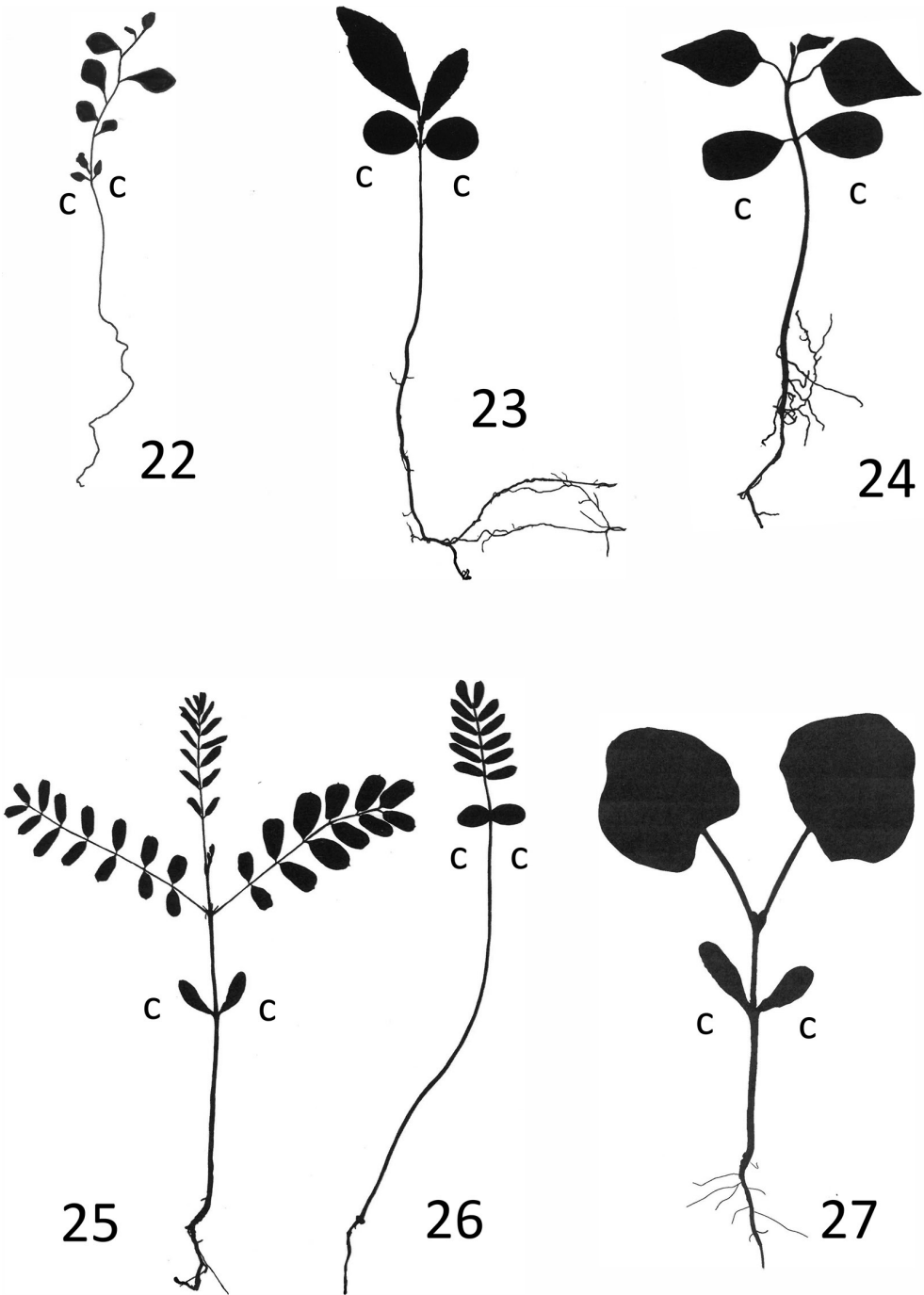


FIG. 22. *Lyonia fruticosa*. Seedling. $\times 1.5$; K.R. FIG. 23. *Gymnanthes lucida*. Seedling. $\times 0.54$; J.B. FIG. 24. *Sapium sebiferum*. Seedling. $\times 0.50$; J.B. FIG. 25. *Abrus precatorius*. Seedling. $\times 0.73$; J.B. FIG. 26. *Acacia auriculiformis*. Seedling. $\times 0.88$; J.B. FIG. 27. *Canavalia rosea*. Seedling. $\times 0.53$; M.P. Indicated sequentially, after each figure description are the magnification of, and the initials of the artist who prepared, the drawing (J.B. = Julio Gonzalez Batista; M.P. = Marcella Pulgarin; K.R. = Katja Redes). C. Cotyledon.

Hypocotyl. Length: 53.5–80.5 mm (n = 10).

Early in seedling development, frequently—but not always—the hypocotyl-primary root junction becomes swollen and a short region of its outer tissue splits away from the underlying tissues. The region of outer tissue is persistent, its distal end remaining attached to the hypocotyl. Splitting resembles, but is less pronounced than, its counterparts in *Simarouba glauca* and *Acacia auriculiformis* (see pp. 103, 137 of this paper).

Cotyledons.

Number of cotyledons: 2, opposite, essentially equal to unequal.

Lamina: **Shape:** simple; unlobed above the base; elliptic-obovate to widely elliptic-obovate; sometimes oblanceolate or widely obovate. **Ranges of lengths and widths:** 12–17 mm × 4.7–12 mm (n = 10 [each parameter]). **Range of length-to-width ratios:** 1.2–2.8 (n = 10). **Lamina margins:** entire. **Lamina apex:** generally rounded to truncate; sometimes retuse. **Lamina base:** generally, sagittate to hastate or auriculate; sometimes rounded. **Lamina thickness:** flat, thin.

Petiole: Present. **Range of lengths:** 1.5–2 mm (n = 10).

Stipules: Typical stipules are absent; however, many narrow, semi-persistent scales are inserted at/by the cotyledonary node which are, collectively, interpretable as stipules and which vary from apparently distinct to basally connate. The scales arise from the stem, along a circular, transverse line extending immediately distal to each cotyledonary petiole and between the cotyledonary petioles. Where the interpetiolar scales are connate basally, the connate portion may be adnate to the margin of one of the cotyledonary petioles. Based on their positions, the scales, collectively, resemble the common ochrea of *Coccoloba* species (see pp. 121, 122 herein).

Number of leaves per supra-cotyledonary node.

Node nos. 1–3: one leaf per node (n = 100% of 21, 21, and 17 cases of these nodes, respectively).

Leaves of the first three supra-cotyledonary nodes.

Lamina: At node no. 1: once-pinnately compound (n = 100% of 19 leaves). At node no. 2: twice-pinnately compound with two opposite pinnae (n = 100% of 17 leaves). At node no. 3: twice pinnately compound with two opposite pinnae (n = 100% of 16 leaves). **Pinna/pinnule margins:** entire. **Pinna/pinnule apex:** acute to rounded; sometimes also mucronulate. **Pinna/pinnule base:** oblique.

Petiole: Present.

Stipules: A pair of stem-borne stipules borders the base of each petiole.

Trichomes.

Hypocotyl: glabrous basally; the distal part with a spectrum of trichomes varying from papillae to short hairs generally up to 0.1 mm long; the hairs spreading; straight or minimally curved; either transparent, white, or brownish; and ranging up to moderately concentrated. **Cotyledons:** Lamina: glabrous; non-ciliate. Petiole: essentially glabrous or with moderately concentrated trichomes like those described above. **First three supra-cotyledonary internodes:** glabrous/essentially glabrous. **Leaves of the first three supra-cotyledonary nodes.** Hairs are like those described above. The laminar portions of the pinnae and pinnules are glabrous. The remaining portions of the lamina vary from glabrous to sparsely pubescent (with hairs on the bipinnate leaves being most plentiful on the petiolules, rachises, and at the bases of the pinnules). Petiole: glabrous to moderately pubescent.

Dates of collection and collection numbers of examined specimens.

29957, 14 Jul 2009; 30420, 24 Aug 2009.

Lysiloma latisiliquum (L.) Benth.; **Fabaceae**

False Tamarind. Native.

No. specimens studied: 17.

Adult morphology

Tree with alternate, twice-pinnately compound foliage leaves.

Seedling morphology (Fig. 29).

Hypocotyl. Length: 24.5–38 mm (n = 10).

Generally, early in seedling development swelling sometimes accompanied by minimal peeling of outer tissues occurs at the hypocotyl-primary root junction. These phenomena resemble, but are less pronounced than, their counterparts in *Simarouba glauca* and *Acacia auriculiformis* (see pp. 103, 137 of this paper).

Cotyledons.

Number of cotyledons: 2, opposite; essentially equal to unequal.

Lamina: **Shape:** simple; unlobed above the base; narrowly oblong, oblong-obovate, or oblanceolate-obovate. **Ranges of lengths and widths:** 6.5–9 mm × 2.5–3.5 mm (n = 10 [each parameter]). **Range of length-to-width ratios:** 2.1–3.2 (n = 10). **Lamina margins:** entire. **Lamina apex:** rounded to truncate; sometimes acute or retuse. **Lamina base:** sagittate or auriculate. **Lamina thickness:** flat, thin.

Petiole: Present. **Range of lengths:** 0.5–1.5 mm (n = 7).

Stipules: The cotyledonary nodes of two specimens each manifested at least one laminar, stem-borne stipule similar to those of the supra-cotyledonary leaves. The cotyledonary nodes of other seedlings exhibited a ring of minute hairs/scales(?) some of which were connate basally.

Number of leaves per supra-cotyledonary node.

Node no. 1: two leaves per node (n = 100% of 9 cases). **Node nos. 2, 3:** one leaf per node (n = 100% of 8 and 9 cases, respectively).

Leaves of the first three supra-cotyledonary nodes.

Lamina: At node no. 1: once-pinnately compound (n = 100% of 10 leaves). At node no. 2: twice-pinnately compound with two opposite pinnae (n = 100% of 8 leaves). At node no. 3: twice pinnately compound with two opposite pinnae (n = 100% of 6 leaves). **Pinna/pinnule margins:** entire. **Pinna/pinnule apex:** acute to rounded; sometimes also mucronulate. **Pinna/pinnule base:** generally oblique; sometimes cuneate to rounded.

Petiole: Present.

Stipules: Stem-borne stipule(s) border the base of each petiole. At least sometimes at node no. 1 two stipules of the two opposite leaves are connate, composing one interpetiolar stipule.

Trichomes.

Hypocotyl: glabrous. **Cotyledons:** glabrous; non-ciliate. **First three supra-cotyledonary internodes:** glabrous. **Leaves of the first three supra-cotyledonary nodes:** Lamina: glabrous or essentially so. **Petiole:** glabrous.

Additional information. Supra-cotyledonary internode no. 1 generally varies from barely—if at all—elongated to little-elongated (n = 90% of 10 cases); supra-cotyledonary internode nos. 2 and 3 are always considerably elongated (n = 100% of 10 cases for each of node nos. 2 and 3).

Dates of collection and collection numbers of examined specimens.

33644, 30 May 2012; 34963, 20 Jul 2013.

***Piscidia piscipula* (L.) Sarg.; Fabaceae**

Jamaican Dogwood. Native.

No. specimens studied: 27.

Adult morphology

Tree with alternate, once-pinnately compound foliage leaves.

Seedling morphology (Fig. 30).

Hypocotyl. Length: 39–68.5 mm (n = 3).

Cotyledons.

Number of cotyledons: 2, opposite; mostly essentially equal; sometimes unequal.

Lamina: **Shape:** simple; unlobed; generally asymmetrical with the two margins being to different extents concave and convex, respectively. **Ranges of lengths and widths:** 10–16.5 mm × 4.5–9.5 mm (n = 11 [each parameter]). **Range of length-to-width ratios:** 1.6–2.2 (n = 11). **Lamina margins:** entire. **Lamina apex:** rounded (mostly broadly rounded). **Lamina base:** generally cuneate to rounded; sometimes reniform. **Lamina thickness:** flat, thin.

Petiole: Present. **Range of lengths:** 0.5–2.5 mm (n = 10).

Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node no. 1: one or two leaves per node (n = 11% and 89% of 18 cases, respectively). **Node nos. 2 and 3:** one leaf per node (n = 100% of 13 and 6 cases, respectively).

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape:** simple; unlobed; generally ovate-widely ovate to very widely ovate-widely depressed

ovate; sometimes oblate. **Lamina margins:** entire. **Lamina apex:** generally acute to rounded; sometimes truncate, emarginate, or retuse. **Lamina base:** subcordate to truncate.

Petiole: Present.

Stipules: A pair of stem-borne stipules normally borders the base of each petiole; however, at supra-cotyledonary node no. 1, where the leaves are opposite there may be four distinct stipules or stipules that are connate to different extents. Two adjacent stipules (each being from a separate one of the opposite leaves) may **a.** be connate basally by their margins for half of their length, or **b.** be connate in entirety, thus appearing unequivocally as one interpetiolar stipule.

Trichomes.

Hypocotyl. A distal portion of the hypocotyl manifests densely arranged (and sometimes tangled), spreading, mostly curved, transparent hairs which generally measure to 0.4 mm long. **Cotyledons.** Lamina. Both lamina surfaces are glabrous except at the very base; the margins are ciliate (sometimes abundantly so). Petiole: moderately to densely pubescent with hairs like those described above. **First three supra-cotyledonary internodes:** densely covered with hairs like those described above. **Leaves of the first three supra-cotyledonary nodes.** The hairs are like those described above, albeit, sometimes brownish. Either the abaxial surface or both surfaces of the lamina are moderately to densely pubescent. The lamina margins are moderately to densely ciliate. The petiole is moderately to densely pubescent; the pulvinus at its distal end is especially pubescent.

Dates of collection and collection numbers of examined specimens.

28485, 18 Jun 2008; 29025, 22 Oct 2008; 29028, 21 Oct 2008; 29311, 20 Dec 2008.

***Itea virginica* L.; Iteaceae**

Virginia Willow. Native.

No. specimens studied: 25.

Adult morphology

Shrub with alternate, simple foliage leaves.

Seedling morphology (Fig. 31).

Hypocotyl. Length: 16.5–33.5 mm (n = 10).

Cotyledons.

Number of cotyledons: 2, opposite; essentially equal to subequal.

Lamina: Shape: simple; unlobed; often more-or-less elliptic to widely elliptic; sometimes elliptic-oblong. **Ranges of lengths and widths:** 6–11.5 mm × 3–8 mm (n = 11 [each parameter]). **Range of length-to-width ratios:** 1.3–2.0 (n = 11). **Lamina margins:** entire. **Lamina apex:** rounded. **Lamina base:** cuneate, abruptly narrowly cuneate, rounded. **Lamina thickness:** flat, thin.

Petiole: Present. **Range of lengths:** 2.5–8.5 mm (n = 10).

Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node nos. 1, 2: two leaves per node (n = 100% of 16 and 1 case(s) of these nodes, respectively).

Leaves of the first two supra-cotyledonary nodes.

Lamina: Shape: simple; unlobed; generally lanceolate to lanceolate-ovate; sometimes elliptic. **Lamina margins:** entire. **Lamina apex:** acute to narrowly rounded; sometimes mucronulate. **Lamina base:** cuneate to rounded.

Petiole: Present.

Stipules: A pair of stem-borne stipules borders the base of each petiole. The mature stipules are minute (0.1 to 0.2 mm long) and consist largely or entirely of thickened, white tissue.

Trichomes.

Hypocotyl: glabrous/essentially glabrous. **Cotyledons:** glabrous/essentially glabrous; non-ciliate. **First two supra-cotyledonary internodes:** varying from essentially glabrous to having moderately concentrated, minute hairs (mostly up to 0.1 mm long) which range from transparent to white. **Leaves of the first three supra-cotyledonary nodes:** Lamina: glabrous/essentially glabrous or with hairs more densely concentrated abaxially on the midrib; the hairs being like those described above. Petiole: essentially glabrous or with more concentrated hairs like those described above.

Dates of collection and collection numbers of examined specimens.

29625, 18 Apr 2009; 30582, 6 Apr 2009.

***Magnolia virginiana* L.; Magnoliaceae**

Sweetbay. Native.

No. specimens studied: 33.

Adult morphology

Tree with alternate, simple foliage leaves.

Seedling morphology (Fig. 32).**Hypocotyl.** Length: 41–100 mm (n = 10).**Cotyledons.**Number of cotyledons: 2, opposite; generally essentially equal, sometimes subequal.Lamina: **Shape:** simple; unlobed; the shape is particularly variable, i.e., narrowly elliptic, elliptic, narrowly elliptic-lanceolate, or lanceolate to ovate. **Ranges of lengths and widths:** 22.5–35 mm × 5–15 mm (n = 10 [each parameter]). **Range of length-to-width ratios:** 2.1–4.5 (n = 10). **Lamina margins:** entire. **Lamina apex:** mostly narrowly rounded to rounded; sometimes subacute. **Lamina base:** sessile, cuneate, or narrowly cuneate. **Lamina thickness:** flat, thin.Petiole: Present or absent. **Range of lengths:** 0–3 mm (n = 10).Stipules: On some seedlings, in at least one of the two interpetiolar regions between the cotyledons there was a short (0.2–0.3 mm long), membranous structure connecting the submarginal portions of the two adjacent cotyledonary petioles. That structure, which could be interpreted as stipular, is reminiscent of the interpetiolar stipules of the rubiaceous species considered herein.**Number of leaves per supra-cotyledonary node.****Node nos. 1–3:** one leaf per node (n = 100% of 12, 12, and 12 cases of these nodes, respectively).**Leaves of the first three supra-cotyledonary nodes.**Lamina: **Shape:** simple; unlobed; often narrowly elliptic to elliptic; sometimes lanceolate-ovate, ovate, or oblanceolate. **Lamina margins:** entire. **Lamina apex:** mostly narrowly rounded to rounded; sometimes subacute. **Lamina base:** cuneate to nearly rounded.Petiole: Present.Stipules: Present. Each stipule is partly stem-borne and partly epi-petiolar.**Trichomes.****Hypocotyl:** glabrous. **Cotyledons:** glabrous; non-ciliate. **First three supra-cotyledonary internodes:** varying from glabrous (particularly the first supra-cotyledonary internode) to moderately pubescent; the hairs appearing long (up to at least 1.3 mm long), narrow, straight or variously curved, transparent or white, and often appressed. **Leaves of the first three supra-cotyledonary nodes:** with hairs like those described above. **Lamina/petiole:** varying from glabrous to moderately pubescent.**Dates of collection and collection numbers of examined specimens.**

28048, 28049, 28050, 30 Mar 2008; 29406, 3 Feb 2009; 29740, 19 Apr 2009.

***Gossypium hirsutum* L.; Malvaceae**

Upland Cotton, Wild Cotton. Native.

No. specimens studied: 25.

Adult morphology

Tree or shrub with alternate, simple foliage leaves.

Seedling morphology (Fig. 33).**Hypocotyl.** Length: 39–60.6 mm (n = 10).**Cotyledons.**Number of cotyledons: 2, normally opposite, sometimes slightly subopposite; essentially equal to unequal.Lamina: **Shape:** simple; unlobed; depressed obovate to transversely elliptic. **Ranges of lengths and widths:** 11.5–15 mm × 19.5–30 mm (n = 11 [each parameter]). **Range of length-to-width ratios:** 0.48–0.72 (n = 11). **Lamina margins:** entire. **Lamina apex:** truncate/approximately truncate or very broadly rounded. **Lamina base:** commonly truncate/approximately truncate; sometimes cuneate. **Lamina thickness:** flat, thin.Petiole: Present. **Range of lengths:** 6–10.5 mm (n = 10).Stipules: Absent.

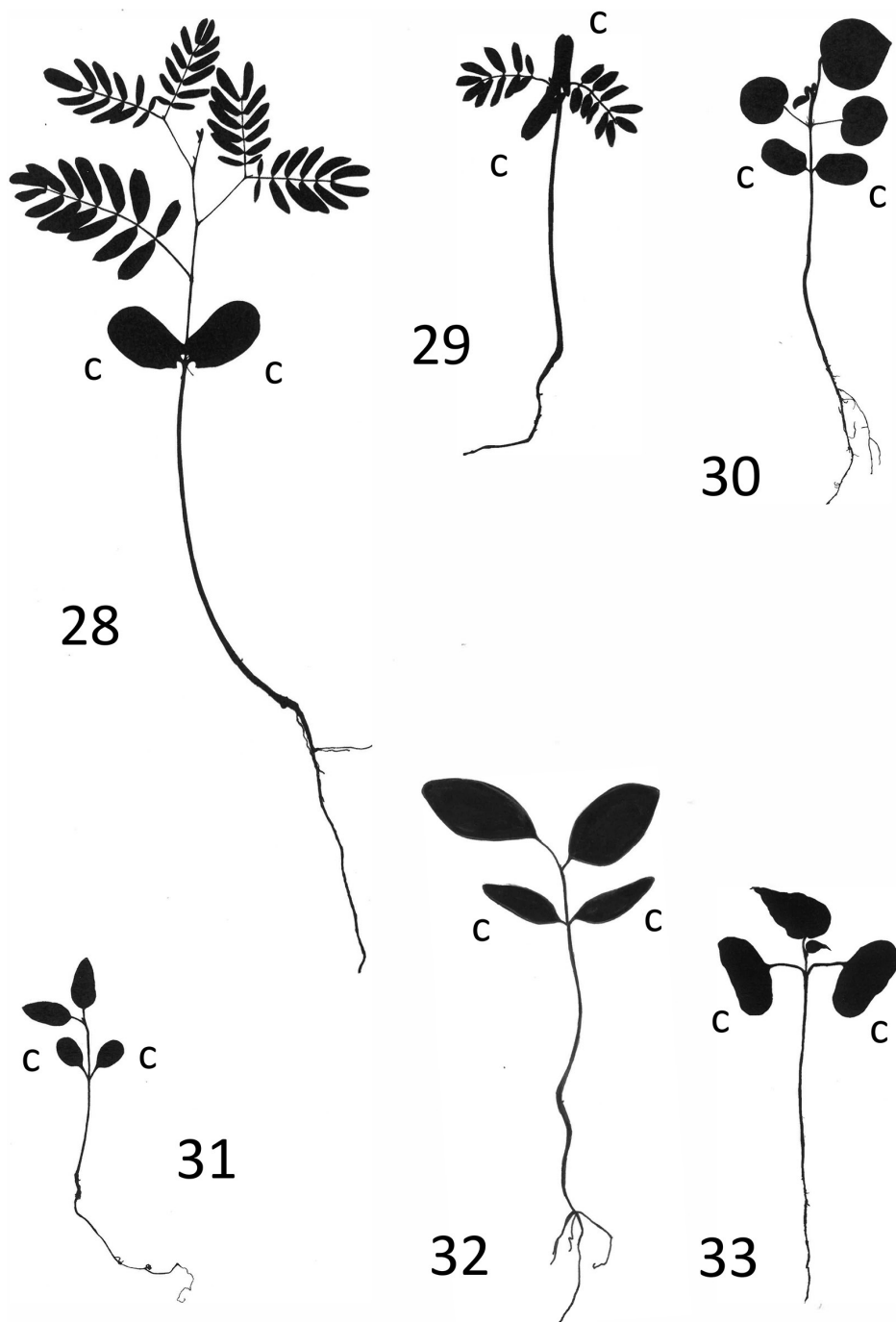


FIG. 28. *Leucaena leucocephala*. Seedling. $\times 0.72$; J.B. FIG. 29. *Lysiloma latisiliquum*. Seedling. $\times 1.0$; J.B. FIG. 30. *Piscidia piscipula*. Seedling. $\times 0.51$; J.B. FIG. 31. *Itea virginica*. Seedling. $\times 0.56$; J.B. FIG. 32. *Magnolia virginiana*. Seedling. $\times 0.50$; K.R. FIG. 33. *Gossypium hirsutum*. Seedling. $\times 0.49$; J.B. Indicated sequentially, after each figure description are the magnification of, and the initials of the artist who prepared, the drawing (J.B. = Julio Gonzalez Batista; K.R. = Katja Redes). C. Cotyledon.

Number of leaves per supra-cotyledonary node.

Node nos. 1–3: one leaf per node ($n = 100\%$ of 9, 6, and 5 cases of these nodes, respectively).

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape:** simple; unlobed; ovate to very widely ovate. **Lamina margins:** entire (on most laminae) but sometimes partly entire and partly crenate with very low teeth. **Lamina apex:** acuminate. **Lamina base:** retuse to truncate.

Petiole: Present.

Stipules: A pair of stem-borne stipules borders the base of each petiole.

Trichomes.

Hypocotyl: glabrous or with more-or-less sparse, short, thin, more-or-less uncinat, transparent, spreading hairs which occur mainly on the distal half of the hypocotyl. **Cotyledons:** Lamina: glabrous; non-ciliate. Petiole: glabrous or with hairs like those described above. **First three supra-cotyledonary internodes:** glabrous. **Leaves of the first three supra-cotyledonary nodes.** Hairs are like those described above. Lamina (adaxial surface): essentially glabrous or sparsely hairy on the main longitudinal veins. Lamina (abaxial surface): essentially glabrous. Lamina (margins): glabrous or sparsely to densely ciliate. Petiole: essentially glabrous to pubescent.

Additional information. Numerous black pustules cover the hypocotyl, cotyledons, supra-cotyledonary internodes, and supra-cotyledonary leaves. On an axial structure (hypocotyl, supra-cotyledonary internode, or petiole of a cotyledon or supra-cotyledonary leaf) the pustules are generally elliptical in top view and manifest long axes parallel to the long axis of the structure. On the laminae of cotyledons and supra-cotyledonary leaves the pustules are mostly circular in top view.

Dates of collection and collection numbers of examined specimens.

33026, 3 Sep 2011; 33172, 24 Sep 2011; 42753, 17 Dec 2019.

Hibiscus acetosella Welw. ex Hiern.; **Malvaceae**

African Rosemallow. Exotic.

No. specimens studied: 15.

Adult morphology

Shrub with alternate, simple foliage leaves.

Seedling morphology (Fig. 34).

Hypocotyl. Length: 41–57 mm ($n = 3$).

Cotyledons.

Number of cotyledons: 2; opposite or subopposite; essentially equal.

Lamina: **Shape:** simple; unlobed; widely depressed ovate, circular, or oblate. **Ranges of lengths and widths:** 8.5–13 mm $\times$ 9–15 mm ($n = 9$ [each parameter]). **Range of length-to-width ratios:** 0.79–1.0 ($n = 9$). **Lamina margins:** entire; sometimes undulate. **Lamina apex:** truncate to retuse. **Lamina base:** rounded, truncate, reniform, or short-narrowly cuneate. **Lamina thickness:** flat, thin.

Petiole: Present. **Range of lengths:** 5–7 mm ($n = 9$).

Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node no. 1: one or two leaves per node ($n = 92\%$ and 8% of 12 cases, respectively). **Node no. 2:** one or two leaves per node ($n = 90\%$ and 10% of 10 cases, respectively). **Node no. 3:** one, two, or more than two leaves per node ($n = 78\%$, 11% , and 11% of 9 cases, respectively).

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape:** simple; mostly unlobed, but sometimes manifesting one or two very short lateral lobe(s); ovate to almost very widely ovate. **Lamina apex:** acute to rounded. **Lamina margins:** crenate, crenate-serrate, or serrate. **Lamina apex:** acute to rounded. **Lamina base:** cuneate, rounded, truncate, or cordate.

Petiole: Present.

Stipules: At each of supra-cotyledonary node nos. 1 and 2 a pair of stem-borne stipules sometimes borders the base of the petiole; however, sometimes only one, rather than a pair, of stipules is present. At node no. 3 we noted at least one stipule per leaf.

Trichomes.

Hypocotyl: with numerous long hairs along its entire length, which are simple and stellate, spreading

or appressed, curved to various degrees, and transparent. **Cotyledons:** Lamina (abaxial surface only): essentially glabrous; non-ciliate. Petiole: with densely concentrated hairs like those described above. **First three supra-cotyledonary internodes:** more-or-less densely pubescent with hairs like those described above. **Leaves of the first three supra-cotyledonary nodes:** with hairs like those described above. Lamina: sparsely hairy on both lamina surfaces. Lamina margins: abundantly ciliate. Petiole: densely pubescent.

Dates of collection and collection numbers of examined specimens.

27203, 20 Aug 2007.

***Thespesia populnea* (L.) Sol. ex Corrêa; Malvaceae**

Portia Tree. Exotic.

No. specimens studied: 31.

Adult morphology

Tree or shrub with alternate, simple foliage leaves.

Seedling morphology (Fig. 35).

Hypocotyl. Length: 49–122.5 mm (n = 9).

Cotyledons:

Number of cotyledons: 2, generally opposite (sometimes subopposite in older seedlings); essentially equal to unequal.

Lamina: **Shape:** simple; unlobed; widely depressed obovate to depressed obovate. **Ranges of lengths and widths:** 16.5–31 mm × 26–43.5 mm (n = 10 [each parameter]). **Range of length-to-width ratios:** 0.55–0.79 (n = 10). **Lamina margins:** entire or partly entire-partly sinuate. **Lamina apex:** commonly more-or-less truncate; sometimes truncate-rounded or shallowly concave. **Lamina base:** cuneate, abruptly narrowly cuneate, or rounded. **Lamina thickness:** flat, thin.

Petiole: present. **Range of lengths:** 2–10.5 mm (n = 10).

Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node nos. 1–3: one leaf per node (n = 100% of 13, 13, and 2 cases of these nodes, respectively).

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape:** simple; unlobed; generally lanceolate-ovate to ovate; sometimes very widely ovate. **Lamina margins:** entire. **Lamina apex:** acute to narrowly rounded. **Lamina base:** cuneate, rounded, subcordate, or truncate.

Petiole: Present.

Stipules: At supra-cotyledonary node no. 1: absent (n = 100% of 9 cases). At supra-cotyledonary node no. 2: present or absent (n = 50% of 6 cases). At supra-cotyledonary node no. 3: present at the one node examined. More robust stipules occur on the later-formed leaves of saplings. The stipules—2 per leaf—are stem-borne.

Trichomes.

Hypocotyl: glabrous or having a small number of peltate scales near its distal end. **Cotyledons.** Lamina: glabrous/essentially glabrous (the lamina base sometimes having minute, clear or yellowish trichomes). Petiole: essentially glabrous or with sparse peltate scales or sparse minute yellowish trichomes. **First three supra-cotyledonary internodes:** with peltate scales like those indicated above, each scale consisting of a short stalk and a cap. The cap exhibits **a.** a central portion variously suffused with brown, and **b.** marginal hairlike rays which vary considerably in length from one scale to another. The central portion and rays normally parallel the stem surface. **Leaves of the first three supra-cotyledonary nodes:** with scales like those described above. On a scale the central portion and rays parallel the leaf surface. The lamina surfaces vary from being essentially glabrous to having moderately concentrated scales. The petiole exhibits sparse to densely concentrated scales.

Additional information. The cotyledonary laminae exhibit **numerous black pustules** which are circular in top view and conspicuous at 10X magnification. Pustules also cover the hypocotyl, cotyledonary petioles, supra-cotyledonary internodes, and the laminae and petioles of the supra-cotyledonary leaves, but those pustules are sometimes less conspicuous and may appear brown, purple, or black. On the laminae of the supra-cotyledonary leaves the pustules are predominantly circular in top view, but on axial structures (the hypocotyl, supra-cotyledonary internodes, and the petioles of the cotyledons and

supra-cotyledonary leaves) they vary from circular to elliptical. On those structures the long axis of an elliptical pustule, generally, parallels the long axis of the structure.

Dates of collection and collection numbers of examined specimens.

28746, 5 Jul 2008; 43151, 3 Jun 2020; 43262, 12 Sep 2020.

Morella cerifera (L.) Small (*Myrica cerifera* L.); **Myricaceae**

Wax Myrtle. Native.

No. specimens studied: 12.

Adult morphology

Tree or shrub with alternate, simple foliage leaves.

Seedling morphology (Fig. 36).

Hypocotyl. Length: 13.5–34.5 mm (n = 8).

Cotyledons.

Number of cotyledons: 2, opposite; essentially equal.

Lamina: **Shape:** simple; unlobed; obovate to widely obovate. **Ranges of lengths and widths:** 4.3–6.2 mm × 3–5 mm (n = 12 [each parameter]). **Range of length-to-width ratios:** 1.2–1.6 (n = 12). **Lamina margins:** entire to crenulate. **Lamina apex:** emarginate, retuse, or truncate. **Lamina base:** sessile.

Lamina thickness: flat, somewhat thickened.

Petiole: Absent. The cotyledons are sessile.

Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node no. 1: one or two leaves per node (n = 37.5% and 62.5% of 8 cases, respectively).

Node nos. 2, 3: one leaf per node (n = 100% of 6 and 7 cases, respectively).

Leaves of the first three supra-cotyledonary nodes.

Lamina: The laminae are simple and manifest two or three terminal lobes; however, in *M. cerifera* lobes and teeth intergrade with one another. **Shape:** oblanceolate-obovate or obovate. **Lamina margins:** entire or serrate with up to four teeth. **Lamina apex:** generally acute to rounded and simultaneously mucronulate to mucronate; sometimes emarginate. **Lamina base:** cuneate, narrowly cuneate, or sessile.

Petiole: Present (and short) or absent.

Stipules: Absent.

Trichomes.

Hypocotyl: glabrous/essentially glabrous. **Cotyledons.** Numerous minute, discrete, yellow, sessile trichomes, which appear ca. circular in top view and measure a little less than 0.1 mm across, compose a well-defined submarginal ring on the adaxial surface. Aside from bearing those trichomes the cotyledons are glabrous and non-ciliate. **First three supra-cotyledonary internodes.** They exhibit **a.** scattered to more abundant, yellow trichomes like those described above and, **b.** moderately concentrated uncinuate to otherwise curved, mostly appressed, mostly antrorse, transparent hairs generally up to 0.35 mm long. **Leaves of the first three supra-cotyledonary nodes:** Lamina: having sparse to moderately concentrated yellow trichomes like those described above, which are well distributed over both lamina surfaces, rather than composing, solely, a submarginal ring. Present, also, are very sparse transparent hairs like those described above. Petiole: with very sparse trichomes of one or both types, aforementioned.

Dates of collection and collection numbers of examined specimens.

26485, 22 Mar 2007; 28120, 10 Apr 2008; 28158, 12 Apr 2008; 28159, 13 Apr 2008.

Ardisia escallonioides Schlttdl. & Cham.; **Myrsinaceae (Primulaceae)**

Marlberry. Native.

No. specimens studied: 10.

Adult morphology

Shrub with alternate, simple foliage leaves.

Seedling morphology (Fig. 37).

Hypocotyl. Length: 24.5–70 mm (n = 7).

Cotyledons.

Number of cotyledons: 2, opposite; equal to subequal.

Lamina: **Shape:** simple; unlobed; widely ovate, widely elliptic, or less often widely obovate. **Ranges of lengths and widths:** 7.5–13.5 mm × 6–10.5 mm (n = 10 [each parameter]). **Range of length-to-width ratios:** 1.3–1.6 (n = 10). **Lamina margins:** crenulate to minutely crenulate (except by the base of the lamina) or less often essentially entire. **Lamina apex:** acute, rounded, retuse, or mucronate. **Lamina base:** rounded or less often cuneate. **Lamina thickness:** flat, thin.

Petiole: Present. **Range of lengths:** 1–3 mm (n = 9).

Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node nos. 1–3: one leaf per node (n = 100% of 6, 4, and 3 cases of these nodes, respectively).

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape:** simple; unlobed; oblanceolate, obovate, elliptic, or narrowly elliptic. **Lamina margins:** essentially entire to more-or-less crenulate distal to the base of the lamina. **Lamina apex:** acute or rounded. **Lamina base:** cuneate or narrowly cuneate.

Petiole: Present.

Stipules: Absent

Trichomes.

Hypocotyl: the hypocotyl or its distal portion with numerous spreading/ascending, or in places primarily antrorse, hairs up to 0.1 mm long, which manifest purplish, sometimes swollen tips. Intermingled, are minute white hairs. Hairs are shed after a short time. **Cotyledons:** Lamina: glabrous; non-ciliate. Petiole: with numerous hairs like those aforementioned. **First three supra-cotyledonary internodes:** with numerous hairs like those aforementioned. **Leaves of the first three supra-cotyledonary nodes:** Lamina: more-or-less glabrous. Petiole: with variously concentrated hairs like the aforementioned.

Additional information. With a 10X hand lens (and with the stereoscopic microscope) one readily observes—in surface view of the individual cotyledons and supra-cotyledonary leaves—numerous protruding orange or purple punctae of one general type, which appear more-or-less circular or short-elliptic.

Dates of collection and collection numbers of examined specimens.

26536, 26 Mar 2007; 29502, 29503, 10 Feb 2009; 29540, 17 Mar 2009.

Myrsine cubana A. DC. (*Rapanea punctata* (Lam.) Lundell); **Myrsinaceae (Primulaceae)**

Myrsine. Native.

No. specimens studied: 68.

Adult morphology

Tree or shrub with alternate, simple foliaceous leaves

Seedling morphology (Fig. 38).

Hypocotyl. Length: 27–55 mm (n = 10).

Cotyledons.

Number of cotyledons: 2, opposite; essentially equal.

Lamina: **Shape:** simple; normally unlobed (but one 3-lobed cotyledon was observed); mostly lanceolate-ovate to widely depressed ovate; sometimes obovate-widely obovate, narrowly elliptic, or elliptic. **Ranges of lengths and widths:** 9–14 mm × 5–12 mm (n = 10 [each parameter]). **Range of length-to-width ratios:** 0.90–1.8 (n = 10). **Lamina margins:** vary from essentially entire or undulate to having few to many teeth; the toothed margins are generally serrate, but sometimes crenate. **Lamina apex:** mainly acute to rounded; sometimes retuse or emarginate. **Lamina base:** cuneate to rounded; sometimes reniform. **Lamina thickness:** flat, thin.

Petiole: Present. **Range of lengths:** 1–2 mm (n = 10).

Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node nos. 1–3: one leaf per node (n = 100% of 10, 10, and 5 cases of these nodes, respectively).

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape:** simple and mostly unlobed (one three-lobed lamina was observed on a leaf of supra-cotyledonary node no. 2); oblanceolate to obovate; ovate. **Lamina margins:** either entire/essentially

entire, undulate and sometimes also toothed, or serrate with one to ca. ten teeth. **Lamina apex:** generally acute to rounded; sometimes truncate. **Lamina base:** cuneate or narrowly cuneate (sometimes abruptly so).

Petiole: Present.

Stipules: Absent.

Trichomes.

Hypocotyl: with numerous spreading/ascending hairs mostly up to 0.1 mm long, which are commonly stalked and manifest purplish, often swollen tips. **Cotyledons:** Hairs are like those described above (and some sessile hairs occur on the petiole). Lamina: glabrous/essentially glabrous or sparsely pubescent at the base; sparsely ciliate distally. **Petiole:** sparsely to moderately pubescent. **First three supra-cotyledonary internodes:** moderately to densely pubescent with hairs like those described above, plus sessile hairs. **Leaves of the first three supra-cotyledonary nodes:** hairs are like those described above, and there also occur some sessile hairs. Lamina: glabrous/essentially glabrous or sparsely pubescent at the base or on more of the lamina. **Petiole:** sparsely to moderately pubescent.

Additional information. Visible, in surface view of the cotyledons and supra-cotyledonary leaves are numerous protruding punctae which are green, brown, purple, or black. The punctae appear either more-or-less circular or linear. Within individual cotyledons and supra-cotyledonary leaves, the punctae of these two shapes frequently occur together, but some cotyledons manifest solely the more-or-less circular punctae.

Dates of collection and collection numbers of examined specimens.

26537, 25 Mar 2007; 26672, 17 Apr 2007; 29412, 4 Feb 2009; 29441, 8 Feb 2009; 29442, 9 Feb 2009; 29837, 22 May 2009; 31856, 5 Dec 2010; 43081, 29 Feb 2020.

Guapira discolor (Spreng.) Little; Nyctaginaceae

Blolly. Native.

No. specimens studied: 25.

Adult morphology

Tree or shrub with alternate, subopposite, or opposite, simple foliage leaves.

Seedling morphology (Fig. 39).

Hypocotyl. Length: 12–35.5 mm ($n = 10$).

Cotyledons. There is a **cotyledon dimorphism**, i.e., the cotyledons of a seedling are consistently unequal in lamina area. Thus, each seedling manifests a **larger cotyledon** and a **smaller cotyledon**.

Number of cotyledons: 2, mostly opposite, sometimes slightly subopposite.

Lamina: **Shape:** simple; unlobed. The larger cotyledon of a pair being depressed ovate. The smaller cotyledon of a pair generally being widely depressed ovate to depressed ovate; sometimes being depressed obovate. **Ranges of lengths and widths:** Lamina of the larger cotyledon of a pair: 7–11 mm × 10.5–17.5 mm ($n = 10$ [each parameter]); lamina of the smaller cotyledon of a pair: 4.5–9 mm × 6.5–10 mm ($n = 10$ [each parameter]). Also, see table of additional data, below. **Range of length-to-width ratios:** Lamina of the larger cotyledon of a pair: 0.53–0.76 ($n = 10$); lamina of the smaller cotyledon of a pair: 0.67–0.95 ($n = 10$).

Lamina margins: either entire or partly entire and partly crenate. **Lamina apex:** commonly truncate, sometimes retuse or broadly rounded. **Lamina base:** generally truncate or reniform, sometimes cuneate-narrowly cuneate. **Lamina thickness:** flat, thin.

Petiole: Present. Range of lengths: 1.5–5 mm ($n = 10$).

Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node no. 1: one or two leaves per node ($n = 90\%$ and 10% of 20 cases, respectively). **Node no. 2:** one or two leaves per node ($n = 94\%$ and 6% of 16 cases, respectively). **Node no. 3:** one leaf per node ($n = 100\%$ of 8 cases, respectively).

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape:** simple; unlobed; oblanceolate to obovate, narrowly elliptic or elliptic. **Lamina margins:** entire. **Lamina apex:** generally rounded; sometimes subacute. **Lamina base:** sessile to cuneate.

Petiole: Absent to present.

Stipules: Absent.

Trichomes.

Hypocotyl: with up to many short, dark-brown, spreading, or appressed hairs which predominate distally on, and are absent from the basal portion, thereof. **Cotyledons:** Lamina: glabrous, except for its basal-most portion which varies from essentially glabrous to sparsely pubescent with hairs like those described above; non-ciliate. Petiole: with hairs like those described above. **First three supra-cotyledonary internodes:** with hairs like those described above, which are more-or-less densely concentrated and largely appressed. **Leaves of the first three supra-cotyledonary nodes:** with hairs like those described above. Lamina: Both lamina surfaces are glabrous/essentially glabrous or manifest sparse hairs basally and/or along the midrib. Petiole: with concentrated hairs.

Additional information. Numerous microscopical streaks/ellipses/solid circles are often evident in surface view of the hypocotyl, supra-cotyledonary internodes, and the laminae and petioles of the cotyledons and supra-cotyledonary leaves; they appear white against a darker background. On an axial structure (hypocotyl, supra-cotyledonary internode, petiole of a cotyledon or supra-cotyledonary leaf) the long axes of the streaks/ellipses parallel the long axis of the structure.

Data for the laminae of ten cotyledon pairs

	The larger cotyledon of each pair			The smaller cotyledon of each pair		
	Length (mm)	width (mm)	length/ width ratio	length (mm)	width (mm)	length/ width ratio
pair no. 1	8.0	14.5	0.55	6.5	9.0	0.72
pair no. 2	9.0	15.5	0.58	7.0	8.5	0.82
pair no. 3	11.0	17.5	0.63	6.0	9.0	0.67
pair no. 4	11.0	17.0	0.65	9.0	9.5	0.95
pair no. 5	10.0	15.5	0.65	7.5	10.0	0.75
pair no. 6	9.0	13.5	0.67	7.0	10.0	0.70
pair no. 7	8.0	15.0	0.53	6.5	7.5	0.87
pair no. 8	7.0	10.5	0.67	4.5	6.5	0.69
pair no. 9	9.5	12.5	0.76	7.0	9.5	0.74
pair no.10	8.0	14.0	0.57	6.5	9.0	0.72
	mean length	mean width	mean ratio	mean length	mean width	mean ratio
	9.1 mm	14.6 mm	0.63	6.8 mm	8.9 mm	0.76

For data in the table above, a matched-pairs t-test was conducted on the lamina lengths, widths, and length/width ratios, using JMP® Version 16 (SAS Institute Inc., Cary, NC, 1989–2021). The results indicated that in seedlings of *G. discolor* the laminae of the two types of cotyledons differ significantly from one another with respect to their lengths, widths, and length/width ratios.

Matched pairs t-test analysis:
length: p<0.0001
width: p<0.0001
length/width ratio: p=0.007

Dates of collection and collection numbers of examined specimens.

35156, 20 Aug 2013; 35157, 15 Sep 2013; 35483, 12 Dec 2013.

***Pisonia aculeata* L.; Nyctaginaceae**

Devil's Claws. Native

No. specimens studied: 71.

Adult morphology

Vine with opposite or subopposite, simple foliage leaves.

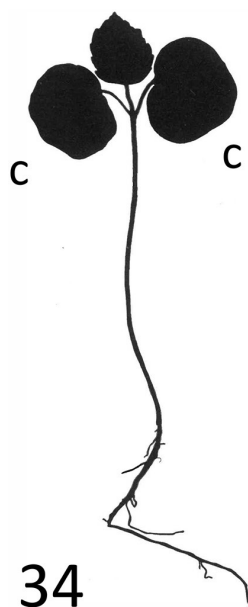
Seedling morphology (Figs. 40, 71).

Hypocotyl. Length: 30–64 mm (n = 10).

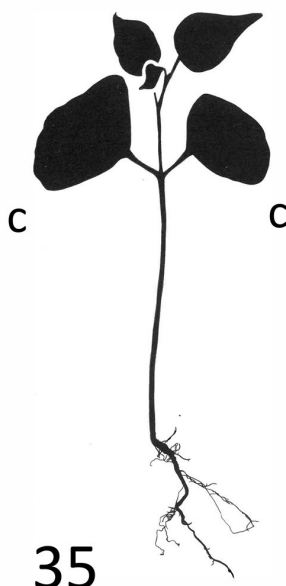
Cotyledons. There is a **cotyledon dimorphism**, i.e., the cotyledons of a seedling are consistently unequal in lamina area. Thus, each seedling manifests a **larger cotyledon** and a **smaller cotyledon**.

Number of cotyledons: 2, mostly opposite, sometimes slightly subopposite.

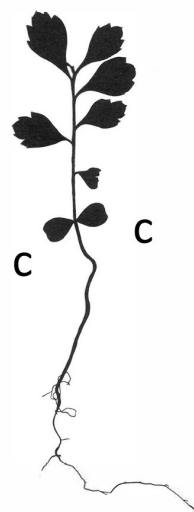
Lamina: Shape: simple; unlobed or with two basal lobes (see below). The larger cotyledon of a pair being ovate-widely ovate to very widely ovate; also obovate to widely obovate. The smaller cotyledon of



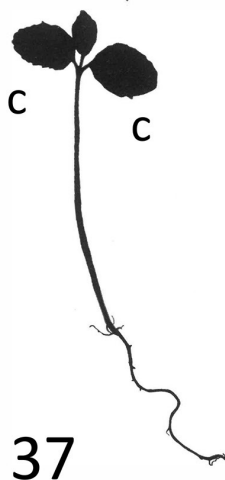
34



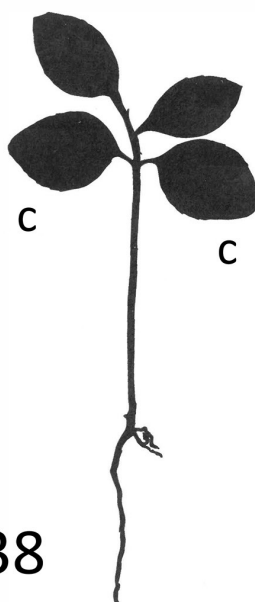
35



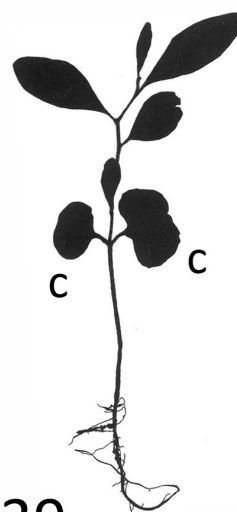
36



37



38



39

FIG. 34. *Hibiscus acetosella*. Seedling. $\times 0.90$; J.B. FIG. 35. *Thespesia populnea*. Seedling. $\times 0.40$; J.B. FIG. 36. *Morella cerifera*. Seedling. $\times 0.75$; J.B. FIG. 37. *Ardisia escallonioides*. Seedling. $\times 0.74$; J.B. FIG. 38. *Myrsine cubana*. Seedling. $\times 0.89$; M.P. FIG. 39. *Guapira discolor*. Seedling. $\times 0.81$; J.B. Indicated sequentially, after each figure description are the magnification of, and the initials of the artist who prepared, the drawing (J.B. = Julio Gonzalez Batista; M.P. = Marcella Pulgarin; C. Cotyledon).

a pair being elliptic, oblong, ovate-oblong, or ovate to very widely ovate. **Ranges of lengths and widths:** Lamina of the larger cotyledon of a pair: 13–18 mm × 10–14.5 mm (n = 10 [each parameter]); lamina of the smaller cotyledon of a pair: 10.5–13.5 mm × 6.5–8.5 mm (n = 10 [each parameter]). Also, see table of additional data below. **Range of length-to-width ratios:** Lamina of the larger cotyledon of a pair: 1.0–1.5 (n = 10); lamina of the smaller cotyledon of a pair: 1.3–1.7 (n = 10). **Lamina margins:** generally entire, sometimes undulate. **Lamina apex:** mostly narrowly to broadly rounded; sometimes truncate. **Lamina base:** reniform, auriculate, abruptly narrowly acuminate, abruptly narrowly acuminate-truncate, or rounded. **Lamina thickness:** flat, thin.

Lamina base: additional comments. Within individual cotyledon pairs the base of the larger cotyledon is more often reniform or auriculate than is that of the smaller cotyledon. If the base is reniform or auriculate in both cotyledons, then it is more pronouncedly so in the larger cotyledon. Also, in this species reniform and auriculate leaf bases intergrade, based on lengths of the basal lobes of the lamina. If two long basal lobes occur the lamina base is auriculate; if the lobes are short, it is reniform.

Petiole: Present. Range of lengths: 1.5–6.5 mm (n = 10).

Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node nos. 1–3: one leaf per node (n = 100% of 18, 17, and 17 cases of these nodes, respectively).

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape:** simple; unlobed; narrowly elliptic-elliptic to elliptic, narrowly rhombic, or obovate.

Lamina margins: entire. **Lamina apex:** generally acute or subacute; sometimes emarginate. **Lamina base:** cuneate to narrowly cuneate.

Petiole: Present.

Stipules: Absent.

Trichomes.

Hypocotyl. A distal sector, thereof, exhibits spreading, often much-curved (sometimes recurved), transparent or white, generally up to 0.4 mm long and relatively broad hairs that are uniseriate and manifest conspicuous dark cross walls. **Cotyledons:** with hairs like those described above. Lamina: glabrous, except for its pubescent basal-most portion; non-ciliate. Petiole: sparsely to densely pubescent. **First three supra-cotyledonary internodes:** moderately to densely pubescent with hairs like those described above. **Leaves of the first three supra-cotyledonary nodes:** with hairs like those

	The larger cotyledon of each pair			The smaller cotyledon of each pair		
	Length (mm)	width (mm)	length/ width ratio	length (mm)	width (mm)	length/ width ratio
pair no. 1	14.5	10.0	1.5	10.5	7.5	1.4
pair no. 2	15.5	12.5	1.2	13.5	8.0	1.7
pair no. 3	15.5	12.0	1.3	13.0	8.5	1.5
pair no. 4	13.0	11.0	1.2	11.0	7.0	1.6
pair no. 5	16.0	10.5	1.5	11.0	7.5	1.5
pair no. 6	17.0	14.0	1.2	12.0	8.2	1.5
pair no. 7	16.1	11.5	1.4	11.0	6.5	1.7
pair no. 8	16.5	14.0	1.2	11.0	8.5	1.3
pair no. 9	14.5	14.0	1.0	11.0	8.0	1.4
pair no.10	18.0	14.5	1.2	12.0	7.5	1.6
	mean length 15.7 mm	mean width 12.4 mm	mean ratio 1.27	mean length 11.6 mm	mean width 7.7 mm	mean ratio 1.52

For data in the table above, a matched-pairs t-test was conducted on the lamina lengths, widths, and length/width ratios, using JMP® Version 16 (SAS Institute Inc., Cary, NC, 1989–2021). The results indicated that in seedlings of *P. aculeata* the laminae of the two types of cotyledons differ significantly from one another with respect to their lengths, widths, and length/width ratios.

Matched pairs t-test analysis:
length: p<0.0001
width: p<0.0001
length/width ratio: p=0.003

described above. The lamina surfaces are glabrous or essentially so, or manifest sparsely distributed hairs basally. The petiole manifests scarce to moderately concentrated pubescence.

Additional information. Microscopical streaks/ellipses/solid circles are sometimes evident in surface view of the hypocotyl, supra-cotyledonary internodes, and the laminae and petioles of the cotyledons and supra-cotyledonary leaves. They appear white against a darker background. On an axial structure (hypocotyl, supra-cotyledonary internode, or petiole of a cotyledon or supra-cotyledonary leaf) the long axes of the streaks/ellipses parallel the long axis of the structure.

Dates of collection and collection numbers of examined specimens.

29303, 29304, 20 Dec 2008; 35187, 14 Oct 2013; 35292, 23 Oct 2013; 35296, 23 Oct 2013; 37713, 28 Jul 2015.

Nyssa biflora Walter (*Nyssa sylvatica* Marshall var. *biflora* (Walter) Sargent); **Nyssaceae**
Swamp Tupelo. Native.
No. specimens studied: 10.

Adult morphology

Tree with alternate, simple foliage leaves.

Seedling morphology (Fig. 41).

Hypocotyl. Length: 37–63.5 mm (n = 9).

Cotyledons.

Number of cotyledons: 2, opposite; essentially equal.

Lamina: **Shape:** simple; unlobed; often lanceolate-ovate; sometimes narrowly elliptic-elliptic or narrowly oblong-oblong. **Ranges of lengths and widths:** 25.5–33.5 mm × 9–13.5 mm (n = 10 [each parameter]). **Range of length-to-width ratios:** 2.1–3.1 (n = 10). **Lamina margins:** entire. **Lamina apex:** rounded to subacute. **Lamina base:** cuneate to rounded; sessile. **Lamina thickness:** flat, thin.

Petiole: Present or absent. **Range of lengths:** 0–2 mm (n = 10).

Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node nos. 1, 2: one leaf per node (n = 100% of 3 cases of each node).

Leaves of the first two supra-cotyledonary nodes (except where indicated).

Lamina: **Shape:** simple; unlobed, or manifesting one lateral lobe; lanceolate, narrowly oblong, or oblanceolate-obovate. **Lamina margins:** entire or undulate. **Lamina apex:** acute to acuminate.

Lamina base: cuneate.

Petiole (at supra-cotyledonary node no. 1): Present.

Stipules: Absent.

Trichomes.

Hypocotyl: glabrous. **Cotyledons:** glabrous; non-ciliate. **First two supra-cotyledonary internodes:** with moderately concentrated, stiff, straight to little-curved, appressed, antrorse, transparent hairs which mostly measure 1 to 4 mm long. **Leaves of the first two supra-cotyledonary nodes:** with hairs like those described above. Lamina: the hairs are moderately concentrated on the midrib and lamina margins but are sparse elsewhere. Petiole: densely pubescent.

Additional information. Along the mature first supra-cotyledonary internode there is a single series of many regularly spaced swollen areas. Perhaps, those areas are an artifact of drying, resulting from the presence of a septate pith.

Dates of collection and collection numbers of examined specimens.

36093, 15 Jun 2014.

Forestiera segregata (Jacq.) Krug & Urb.; **Oleaceae**
Florida Swampprivet. Native.
No. specimens studied: 29.

Adult morphology

Tree or shrub with opposite, simple foliage leaves.

Seedling morphology (Fig. 42).

Hypocotyl. Length: 11–29.5 mm (n = 10).

Cotyledons.

Number of cotyledons: 2, opposite; essentially equal.

Lamina: **Shape:** simple; unlobed; narrowly elliptic to elliptic; elliptic-ovate to ovate. **Ranges of lengths and widths:** 9.5–15 mm × 5–7 mm (n = 10 [each parameter]). **Range of length-to-width ratios:** 1.9–2.9 (n = 10). **Lamina margins:** entire. **Lamina apex:** rounded. **Lamina base:** cuneate to rounded. **Lamina thickness:** flat, thin.

Petiole: Present. **Range of lengths:** 1–2 mm (n = 10).

Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node no. 1: one or two leaves per node (n = 6% and 94% of 18 cases, respectively). **Node no. 2:** one or two leaves per node (n = 22% and 78% of 9 cases, respectively). **Node no. 3:** one or two leaves per node (n = 20% and 80% of 5 cases, respectively). These data reflect the occasional occurrence of subopposite phyllotaxy of single leaves between/including node nos. 1–3.

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape:** simple; unlobed; lanceolate to ovate, elliptic, or oblanceolate-obovate. **Lamina margins:** entire. **Lamina apex:** acute to rounded. **Lamina base:** cuneate or narrowly cuneate.

Petiole: Present; sometimes very short.

Stipules: Absent.

Trichomes.

Hypocotyl: with minute, short, thick, sharp-tipped, transparent, spreading, and mainly antrorse papillae; the papillae arising along most of the hypocotyl and becoming increasingly concentrated progressing distally, thereon. **Cotyledons:** Lamina: glabrous or essentially so. Petiole: essentially glabrous to papillate. **First three supra-cotyledonary internodes:** with densely concentrated papillae like those described above. Progressing distally along the three internodes, collectively, the papillae commonly appear longer and intergrade with hairs of similar structure. The papillae/hairs tend to be antrorse. **Leaves of the first three supra-cotyledonary nodes:** Lamina: glabrous or essentially so on both lamina surfaces. Petiole: glabrous to papillate.

Dates of collection and collection numbers of examined specimens.

43028, 22 Jul 2020; 43030, 25 Jul 2020.

Fraxinus caroliniana Mill.; **Oleaceae**

Pop Ash. Native.

No. specimens studied: 26.

Adult morphology

Tree with opposite, once-pinnately compound foliage leaves.

Seedling morphology (Fig. 43).

Hypocotyl. Length: 24–56 mm (n = 10).

Cotyledons.

Number of cotyledons: 2, opposite; essentially equal.

Lamina: **Shape:** simple; unlobed; oblong to narrowly oblong or narrowly lanceolate-oblong. **Ranges of lengths and widths:** 28.5–50.5 mm × 4–9 mm (n = 10 [each parameter]). **Range of length-to-width ratios:** 4.4–7.2 (n = 10). **Lamina margins:** entire. **Lamina apex:** mostly rounded; sometimes subacute-rounded. **Lamina base:** sessile. **Lamina thickness:** flat, thin.

Petiole: Absent. The cotyledons are sessile.

Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node no. 1: one or two leaves per node (n = 12.5% and 87.5% of 16 cases, respectively). **Node no. 2:** one or two leaves per node (n = 40% and 60% of 5 cases, respectively). **Node no. 3:** two leaves per node (n = 100% of 2 cases). These data reflect the occasional occurrence of subopposite phyllotaxy of single leaves at node nos. 1 and 2.

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape:** simple; unlobed; mostly lanceolate-ovate to ovate; sometimes elliptic. **Lamina margins:** serrate from the leaf apex to a point ca. half-way or farther down the lamina; entire beyond that point. **Lamina apex:** acute to subacute. **Lamina base:** mostly cuneate or narrowly cuneate.

Petiole: Present.

Stipules: Absent.

Trichomes.

Hypocotyl: glabrous. **Cotyledons**: glabrous. **First three supra-cotyledonary internodes**: glabrous or with brown peltate scales which tend to become more abundant progressing acropetally along the three internodes, collectively. **Leaves of the first three supra-cotyledonary nodes**: Lamina (adaxial surface): glabrous. Lamina (abaxial surface [only observed on supra-cotyledonary leaf no. 1]): glabrous. Petiole: glabrous or with sparse, brown peltate scales.

Dates of collection and collection numbers of examined specimens.

26483, 26484, 22 Mar 2007; 26542, 23 Mar 2007; 29393, 18 Jan 2009.

***Coccoloba diversifolia* Jacq.; Polygonaceae**

Pigeon Plum. Native.

No. specimens studied: 71.

Adult morphology

Tree with alternate, simple foliage leaves.

Seedling morphology (Fig. 44).

Hypocotyl. Length: 38–43 mm ($n = 2$).

Cotyledons.

Number of cotyledons: 2, opposite; essentially equal to subequal.

Lamina: **Shape**: simple; unlobed; widely elliptic, orbicular, oblate, or obovate to widely depressed obovate. **Ranges of lengths and widths**: 10.5–15.5 mm $\times$ 7.5–15 mm ($n = 12$ [each parameter]). **Range of length-to-width ratios**: 0.86–1.5 ($n = 12$). **Lamina margins**: entire or having sparse, low, rounded teeth. **Lamina apex**: commonly retuse to cleft; also rounded to truncate. **Lamina base**: often cuneate; also rounded to truncate. **Lamina thickness**: flat, thin.

Petiole: Present. **Range of lengths**: 0.5–4 mm ($n = 10$).

Stipules: A **common ocrea** (interpretable as two fused ocreas) is present. It is a continuous, short, thin tube anchored to the stem along a circular, transverse line extending immediately distal to each cotyledonary petiole and between the cotyledonary petioles. We call it a common ocrea because it belongs to two leaves (cotyledons), whereas an ocrea belongs solely to one leaf (see below). At a stage of its development the common ocrea is the peripheral-most portion of the terminal bud of the parent stem (as is also true of the ocrea of an unpaired supra-cotyledonary leaf). The form of the common ocrea is best observed on older cotyledons.

Number of leaves per supra-cotyledonary node.

Node nos. 1–3: one leaf per node ($n = 100\%$ of 16, 9, and 4 cases of those nodes, respectively). An additional example of node no. 1 possibly bore two leaves.

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape**: simple; unlobed; generally obovate-oblongate to obovate; sometimes narrowly elliptic or rhombic. **Lamina margins**: entire. **Lamina apex**: rounded to truncate. **Lamina base**: cuneate or narrowly cuneate.

Petiole: Present.

Stipules: An **ocrea** is present. It resembles the common ocrea of the cotyledonary node, except that it belongs to solely one leaf (as opposed to two cotyledons). It is a continuous, thin tube anchored along a line that encircles the stem at a level immediately distal to the rest of the supra-cotyledonary leaf.

Trichomes.

Hypocotyl: with short, brown, uniseriate, hairs which are spreading (especially transverse to the long axis of the hypocotyl) and concentrated on the distal portion of the hypocotyl. **Cotyledons**: Lamina: glabrous, non-ciliate. Petiole: with hairs like those described above. **First three supra-cotyledonary internodes**: with hairs like those described above, except that they are either predominantly spreading or predominantly retrorse (at each of node nos. 1, 2) or predominantly retrorse (at node no. 3). **Leaves of the first three supra-cotyledonary nodes**: Lamina: glabrous. Petiole: sparsely pubescent with hairs like those, aforementioned, but predominantly spreading.

Dates of collection and collection numbers of examined specimens.

29305, 29306, 29307, 29308, 20 Dec 2008; 29431, 10 Feb 2009; 34724, 17 Apr 2013.

Coccoloba uvifera; Polygonaceae

Seagrape. Native.

No. specimens studied: 26.

Adult morphology

Tree with alternate, simple foliage leaves.

Seedling morphology (Fig. 45).**Hypocotyl.** Length: 28.5–89.5 mm (n = 10).**Cotyledons.**Number of cotyledons: 2, opposite; essentially equal to subequal.Lamina: **Shape:** simple; unlobed; very widely obovate to depressed obovate. **Ranges of lengths and widths:** 13–21 mm × 17.5–25.5 mm (n = 11 [each parameter]). **Range of length-to-width ratios:** 0.67–0.93 (n = 11). **Lamina margins:** entire. **Lamina apex:** typically, emarginate to obcordate or nearly truncate. **Lamina base:** cuneate, rounded, or truncate. **Lamina thickness:** flat, thin.Petiole: Present or absent. **Range of lengths:** 0–3 mm (n = 10).Stipules—A **common ocrea** (interpretable as two fused ocreas [stipules]) like that of *Coccoloba diversifolia* is present (see p. 121 of this paper).**Number of leaves per supra-cotyledonary node.**Quantitative data were difficult to acquire from pressed specimens. At least sometimes each of node nos. 1 to 3 bears one leaf; however, one example of node no. 1 bore opposite/nearly opposite leaves.**Leaves of the first three supra-cotyledonary nodes.**Lamina: **Shape:** simple; unlobed; obovate or elliptic to orbicular. **Lamina margins:** entire. **Lamina apex:** rounded to truncate or emarginate to cleft. **Lamina base:** retuse.Petiole: present or absent.Stipules: An **ocrea** like that of *Coccoloba diversifolia* is present (see p. 121 of this paper).**Trichomes.****Hypocotyl.** The distal portion, thereof, manifests minute, intergrading papillae and uniseriate hairs. They project outward and are either translucent or white; the hairs are uniseriate and sometimes uncinuate. **Cotyledons:** Lamina: glabrous; non-ciliate. Petiole: glabrous to sparsely covered with papillae/hairs like those described above. **First two supra-cotyledonary internodes:** glabrous or with sparse papillae like those described above. **Leaves of the first three supra-cotyledonary nodes:** Lamina: glabrous or essentially so. Petiole: glabrous or with minute papillae like those described above.**Dates of collection and collection numbers of examined specimens.**

26543, 25 Mar 2007; 27951, 14 Jan 2008; 28848, 22 Aug 2008.

Drypetes diversifolia Krug & Urb.; **Putranjivaceae**

Milkbark. Native.

No. specimens studied: 38.

Adult morphology

Tree or shrub with alternate, simple foliage leaves.

Seedling morphology (Fig. 46).**Hypocotyl.** Length: 44.5–65 mm (n = 10).**Cotyledons.**Number of cotyledons: 2, opposite; essentially equal.Lamina: **Shape:** simple; unlobed; generally ovate, sometimes elliptic. **Ranges of lengths and widths:** 2–30 mm × 9–16 mm (n = 11 [each parameter]). **Range of length-to-width ratios:** 1.3–2.0 (n = 11). **Lamina margins:** entire. **Lamina apex:** acute to rounded. **Lamina base:** generally rounded or retuse. **Lamina thickness:** flat, thin.Petiole: Present or absent. **Range of lengths:** 0–1.5 mm (n = 10).Stipules: Absent.**Number of leaves per supra-cotyledonary node.****Node no. 1:** one or two leaves per node (n = 86% and 14% of 14 cases, respectively). **Node nos. 2, 3:** one leaf per node (n = 100% of 13 cases of each node, respectively).

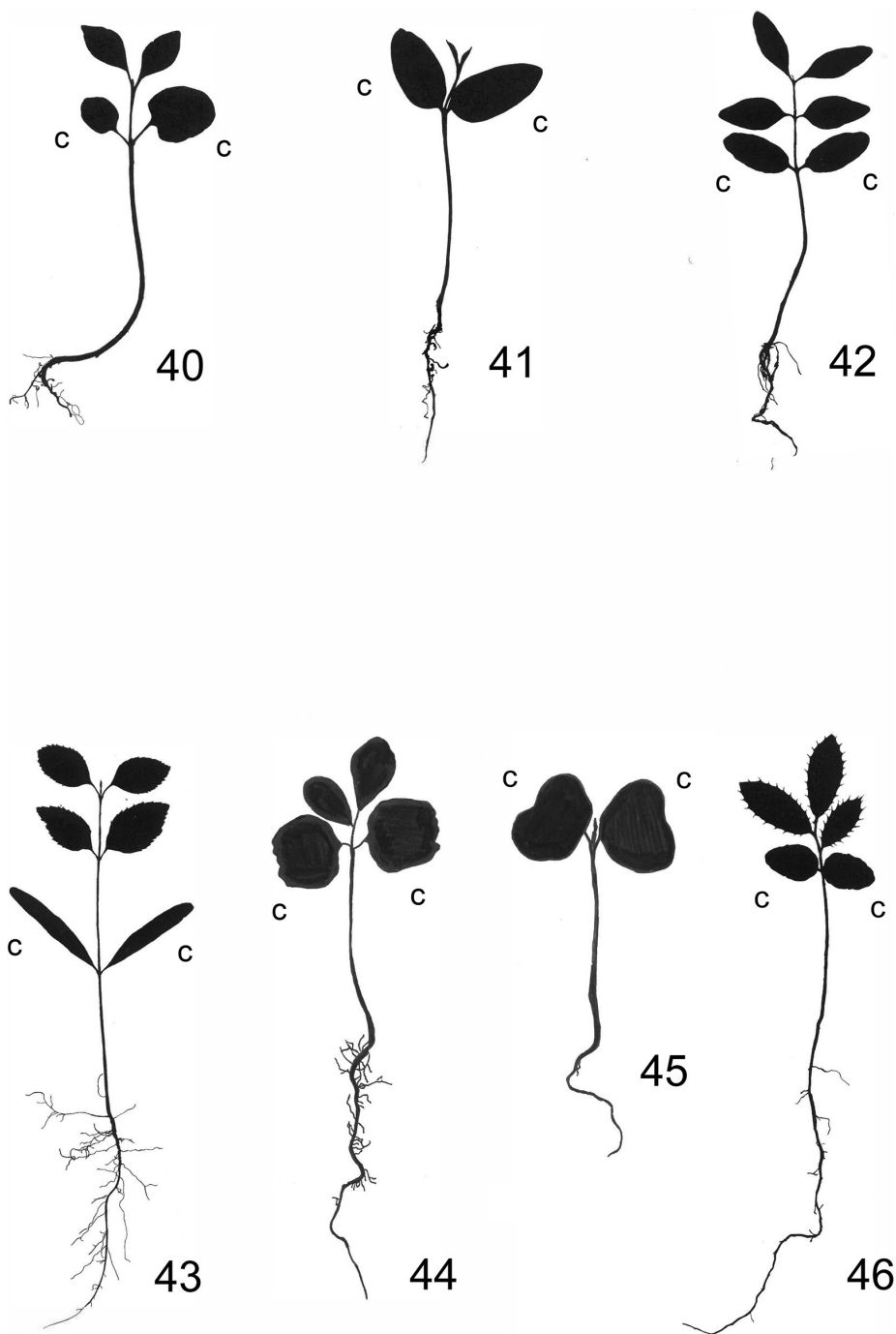


FIG. 40. *Pisonia aculeata*. Seedling. $\times 0.56$; J.B. FIG. 41. *Nyssa biflora*. Seedling. $\times 0.49$; J.B. FIG. 42. *Forestiera segregata*. Seedling. $\times 0.71$; J.B. FIG. 43. *Fraxinus caroliniana*. Seedling. $\times 0.34$; J.B. FIG. 44. *Coccoloba diversifolia*. Seedling. $\times 0.51$; K.R. FIG. 45. *Coccoloba uvifera*. Seedling. $\times 0.49$; K.R. FIG. 46. *Drypetes diversifolia*. $\times 0.38$; J.B. Indicated sequentially, after each figure description are the magnification of, and the initials of the artist who prepared, the drawing (J.B. = Julio Gonzalez Batista; K.R. = Katja Redes). C. Cotyledon.

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape**: simple; unlobed; generally elliptic and lance-elliptic; sometimes lanceolate or oblanceolate-elliptic. **Lamina margins**: spinulose-dentate (unlike the entire margins of the adult leaves of this species). Most marginal teeth exhibit a basal laminar portion and a terminal spine, but some teeth consist totally of spine. **Lamina apex**: acute to acuminate, often culminating in a small spine. **Lamina base**: cuneate to rounded.

Petiole: Present.

Stipules: A pair of stem-borne stipules borders the base of each petiole.

Trichomes.

Hypocotyl: distally, and for most of its length, having numerous long, appressed, mostly moderately uncinuate (but sometimes essentially straight), white to tawny, predominantly antrorse hairs. **Cotyledons**: Lamina: predominantly glabrous, except for having hairs at/near its basal end; non-ciliate. Petiole: with hairs like those described above. **First three supra-cotyledonary internodes**: with numerous hairs like those described above. **Leaves of the first three supra-cotyledonary nodes**: with hairs essentially like those described above. Lamina (adaxial surface): glabrous or essentially so. Lamina (abaxial surface): very weakly pubescent on the midrib; glabrous/essentially glabrous elsewhere. Petiole: glabrous to pubescent.

Dates of collection and collection numbers of examined specimens.

34215, 17 Nov 2012; 34534, 9 Feb 2013; 34553, 16 Feb 2013; 35186, 10 Oct 2013.

Drypetes lateriflora (Sw.) Krug & Urb.; **Putranjivaceae**

Guiana Plum. Native.

No. specimens studied: 21.

Adult morphology

Tree or shrub with alternate, simple foliage leaves.

Seedling morphology (Figs. 47, 47A).

Hypocotyl. Length: 35–52 mm (n = 5).

Cotyledons.

Number of cotyledons: 2, opposite; essentially equal.

Lamina: **Shape**: simple; unlobed; very widely ovate. **Ranges of lengths and widths**: 15.5–21 mm × 16–22 mm (n = 10 [each parameter]). **Range of length-to-width ratios**: 0.95–1.1 (n = 10). **Lamina margins**: entire. **Lamina apex**: subacute to rounded. **Lamina base**: reniform. **Lamina thickness**: flat, thin.

Petiole: Present. **Range of lengths**: 2–2.5 mm (n = 10).

Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node no. 1: one or two leaves per node (n = 83% and 17% of 6 cases, respectively). **Node nos. 2, 3**: one leaf per node (n = 100% of 6 cases of each node, respectively).

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape**: simple; unlobed; lanceolate, lanceolate-ovate, oblanceolate, or elliptic. **Lamina margins**: entire. **Lamina apex**: acuminate or rounded. **Lamina base**: cuneate.

Petiole: Present; very short.

Stipules: A pair of stem-borne stipules borders the base of each petiole.

Trichomes.

Hypocotyl: distally, and for most of its length, having long, appressed to spreading, mostly moderately uncinuate (but sometimes essentially straight), white to tawny hairs. **Cotyledons**: Lamina: glabrous or sparsely pubescent on its basal-most portion or over the basal parts of its main longitudinal veins; non-ciliate. Petiole: pubescent. The cotyledonary hairs are like those described above and are often antrorse on the petiole. **First three supra-cotyledonary internodes**: with hairs like those described above, that are sometimes numerous, often appressed, and predominantly antrorse. **Leaves of the first three supra-cotyledonary nodes**: Hairs are essentially like those described above. Lamina (adaxial surface): glabrous or essentially so. Lamina (abaxial surface): glabrous or sometimes very weakly pubescent on the midrib. Petiole: nearly glabrous to pubescent with predominantly antrorse hairs.

Dates of collection and collection numbers of examined specimens.

34694, 6 Apr 2013; 34722, 17 Apr 2013.

***Colubrina asiatica* (L.) Brongn.; Rhamnaceae**

Latherleaf. Exotic.

No. specimens studied: 17.

Adult morphology

Tree or shrub with alternate, simple foliage leaves.

Seedling morphology (Fig. 48).

Hypocotyl. Length: 24–49.5 mm (n = 10).

Cotyledons.

Number of cotyledons: 2, opposite; essentially equal.

Lamina: **Shape:** simple; unlobed; widely elliptic, obovate to nearly very widely obovate. **Ranges of lengths and widths:** 8.5–12 mm × 5.5–9 mm (n = 11 [each parameter]). **Range of length-to-width ratios:** 1.2–1.6 (n = 11). **Lamina margins:** mostly entire or having a few localized, rounded teeth.

Lamina apex: mostly broadly rounded to truncate; sometimes cleft. **Lamina base:** cuneate, abruptly narrowly cuneate, or rounded. **Lamina thickness:** flat, thin.

Petiole: Present. **Range of lengths:** 1.5–3.5 mm (n = 10).

Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node no. 1: one or two leaves per node (n = 75% and 25% of 12 cases, respectively). **Node no. 2:** one leaf per node (n = 100% of 11 cases). **Node no. 3:** one or two leaves per node (n = 70% and 30% of 10 cases, respectively).

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape:** simple; unlobed; generally ovate; sometimes elliptic or obovate. **Lamina margins:** very weakly to coarsely serrate with few to many teeth per margin. **Lamina apex:** mostly subacute to narrowly rounded, but sometimes cleft. **Lamina base:** cuneate to broadly rounded.

Petiole: Present.

Stipules: Stem-borne stipule(s) border the base of each petiole (at least sometimes two per leaf).

Trichomes.

Hypocotyl: with minute, uncinata, projecting hairs that are either brown or colorless. They are most concentrated on the distal portion of the hypocotyl and absent near its basal end. **Cotyledons:** Lamina: glabrous and non-ciliate. Petiole: generally, with sparse to densely arranged hairs like those described above; however, sometimes the petiole is essentially glabrous. **First three supra-cotyledonary internodes:** generally, with densely concentrated hairs (but sometimes having sparsely concentrated hairs) like those described above. **Leaves of the first three supra-cotyledonary nodes:** Lamina (adaxial surface): glabrous. Lamina (abaxial surface): glabrous or very sparsely pubescent with hairs like those described above.

Dates of collection and collection numbers of examined specimens.

28482, 12 Jun 2008.

***Krugiodendron ferreum* (Vahl) Urb.; Rhamnaceae**

Black Ironwood. Native.

No. specimens studied: 31.

Adult morphology

Tree or shrub with alternate, subopposite, or opposite, simple foliage leaves.

Seedling morphology (Fig. 49).

Hypocotyl. Length: 12–25 mm (n = 11).

Cotyledons.

Number of cotyledons: 2, opposite to conspicuously subopposite; essentially equal to unequal.

Lamina: **Shape:** simple; unlobed above the base; very widely obovate to widely depressed obovate.

Ranges of lengths and widths: 3.9–5 mm × 4.3–5.7 mm (n = 10 [each parameter]). **Range of length-to-width ratios:** 0.85–0.98 (n = 10). **Lamina margins:** entire to irregularly crenate with few teeth.

Lamina apex: very broadly rounded or retuse. **Lamina base:** sagittate with rounded to sharply pointed basal lobes which vary from a little shorter than to a little longer than the associated petiole.

Lamina thickness: flat, thickened.

Petiole: Present. **Range of lengths:** 1–1.6 mm (n = 7).

Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node no. 1: two leaves per node (n = 100% of 31 cases). **Node nos. 2, 3:** one leaf per node (n = 100% of 2 and 2 cases, respectively).

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape:** simple; unlobed; ovate to very widely ovate. **Lamina margins:** entire. **Lamina apex:** generally, minutely apiculate and simultaneously narrowly rounded or, less often, retuse. **Lamina base:** rounded, subcordate, or cordate.

Petiole: Present.

Stipules: A pair of stem-borne stipules borders the base of each petiole. Thus, where leaves are opposite each node bears four stipules.

Trichomes.

Hypocotyl: more-or-less densely pubescent either along its entire length or on all but its basal-most sector; the hairs being minute (mostly 0.5–1 mm long), spreading, straight or moderately curved, and transparent or brownish. **Cotyledons:** **Lamina:** glabrous/essentially glabrous; non-ciliate. **Petiole:** more-or-less densely pubescent with hairs like those described above. **First three supra-cotyledonary internodes:** more-or-less densely pubescent with hairs like those described above. **Leaves of the first three supra-cotyledonary nodes:** **Lamina:** essentially glabrous or with hairs more-or-less concentrated over the midvein or distal to the basal portion, thereof. **Petiole:** densely pubescent with hairs like those described above.

Dates of collection and collection numbers of examined specimens.

35188, 10 Oct 2013; 35291, 23 Oct 2013.

Casasia clusiifolia (Jacq.) Urb. (*Genipa clusiifolia* (Jacq.) Griseb.); **Rubiaceae**

Sevenyear Apple, Common Buttonbush. Native.

No. specimens studied: 3.

Adult morphology

Tree or shrub with opposite, simple foliage leaves.

Seedling morphology (Fig. 50).

Hypocotyl. Length: 28.5–30.5 mm (n = 2).

Cotyledons.

Number of cotyledons: 2, opposite.

Lamina: **Shape:** simple; unlobed; obovate. **Ranges of lengths and widths:** 14 mm × 6 mm (n = 2 and 1, respectively). **Range of length-to-width ratios:** 2.3 (n = 1). **Lamina margins:** entire. **Lamina apex:** rounded. **Lamina base:** narrowly cuneate. **Lamina thickness:** flat, thin.

Petiole: Present. **Range of lengths:** 2–3 mm (n = 2).

Stipules: Two interpetiolar stipules occur, one within each of the interpetiolar regions between the cotyledons. The stipules are deltoid, each manifesting a caudate tip.

Number of leaves per supra-cotyledonary node.

Node nos. 1–3: two leaves per node (n = one case of each of the three nodes, respectively).

Leaves of the first three supra-cotyledonary nodes (except where indicated).

Lamina: **Shape:** simple; unlobed; linear or linear-oblancoolate. **Lamina margins:** entire. **Lamina apex:** acute to short acuminate **Lamina base:** narrowly cuneate.

Petiole (at supra-cotyledonary node nos. 1, 2): Present, albeit short and the leaves subsessile.

Stipules (at supra-cotyledonary node nos. 1, 2): A separate interpetiolar stipule occurs within each of the two interpetiolar regions associated with a leaf pair. The interpetiolar stipule has a thickened midrib and membranous lateral portions. It is often deltoid, culminating in a caudate apex. The stipule margins are not adnate with the petiole margins, but arise from stem tissue situated along the adaxial side of each petiole

Trichomes.

Hypocotyl. Minute, transparent papillae with rounded tips are concentrated at the distal end of the hypocotyl. **Cotyledons:** Lamina: glabrous; non-ciliate. Petiole: glabrous or with papillae like those of the hypocotyl. **First supra-cotyledonary internode:** with papillae like those of the hypocotyl and/or with short, sharp-tipped, transparent, uncinata, predominantly antrorse hairs. **Leaves of the first three supra-cotyledonary nodes:** Lamina (on the adaxial surface at node nos. 1, 2): glabrous. Lamina (on the abaxial surface at node nos. 1–3): glabrous or the midvein bearing sparse to numerous stiff, uncinata to straight, predominantly antrorse hairs. Lamina (margins at node nos. 1–3): conspicuously ciliate with hairs like those, aforementioned.

Additional information. Supra-cotyledonary internode no. 1 is long (11 mm on each of two seedlings, respectively). By contrast, supra-cotyledonary internode nos. 2 and 3 are barely, if at all, if developed.

Dates of collection and collection numbers of examined specimens.

43031, 16 May 2020.

***Cephalanthus occidentalis* L.; Rubiaceae**

Common Buttonbush. Native.

No. seedlings studied: 29.

Adult morphology

Tree or shrub with opposite and whorled, simple foliage leaves.

Seedling morphology (Fig. 51).

Hypocotyl. Length: 9–21 mm (n = 5).

Cotyledons.

Number of cotyledons: 2, always opposite; equal or a little unequal.

Lamina: **Shape:** simple; unlobed; lanceolate to ovate; elliptic. **Ranges of lengths and widths:** 7–11 mm × 3–5.5 mm (n = 9 [each parameter]). **Range of length-to-width ratios:** 1.8–2.8 (n = 9). **Lamina margins:** entire. **Lamina apex:** narrowly rounded to acute. **Lamina base:** mostly cuneate; sometimes narrowly cuneate. **Lamina thickness:** flat, thin.

Petiole: Present. **Range of lengths:** 0.5–3 mm (n = 10).

Stipules: Present. The two cotyledonary petioles alternate with, and are adnate marginally with, two interpetiolar stipules. The four structures thereby compose a short tube that sometimes persists after death of the cotyledons. Each interpetiolar stipule is membranous and generally manifests a transverse distal margin; however, the margin sometimes projects distally for a short distance.

Number of leaves per supra-cotyledonary node.

Node nos. 1–3: two leaves per node (n = 100% of 15, 15, and 9 cases of these nodes, respectively).

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape:** simple; unlobed; usually lance-ovate, ovate, or elliptic; sometimes rhombic. **Lamina margins:** entire. **Lamina apex:** acute to narrowly rounded. **Lamina base:** cuneate, narrowly cuneate, or caudate.

Petiole: Present.

Stipules: Interpetiolar stipules occur that are, structurally, fundamentally like those of the cotyledons; however, distally each interpetiolar stipule exhibits a distinct, broadly triangular extension. Also, marginally the interpetiolar stipules usually manifest a small number of purplish, glandular projections which are most apparent on older seedlings.

Trichomes.

Hypocotyl: glabrous or minutely papillate near its distal end. **Cotyledons:** glabrous; non-ciliate. **First three supra-cotyledonary internodes:** essentially glabrous or with a combination of minute papillae and minute, transparent or white, often uncinata papilla-like hairs. **Leaves of the first three supra-cotyledonary nodes.** The lamina surfaces are glabrous, albeit the lamina margins may be ciliate, sometimes densely so.

Dates of collection and collection numbers of examined specimens.

26673, 8 May 2007; 29545, 29546, 17 Mar 2009; 29548, 24 Mar 2009.

Chiococca alba (L.) Hitchc. sensu lato; **Rubiaceae**

Snowberry. Native.

No. specimens studied: 5.

Adult morphology

Climbing vine with opposite, simple foliage leaves

Seedling morphology (Fig. 52).**Hypocotyl.** Length: 23–29.5 mm (n = 4).**Cotyledons.**Number of cotyledons: 2, opposite; essentially equal.Lamina: **Shape:** simple; unlobed; ovate. **Ranges of lengths and widths:** 5.5–7 mm × 4–5 mm (n = 5 and 4, respectively). **Range of length-to-width ratios:** 1.4–1.6 (n = 4). **Lamina margins:** entire. **Lamina apex:** rounded. **Lamina base:** short-narrowly acuminate. **Lamina thickness:** flat, thin.Petiole: Present. **Range of lengths:** 1–1.5 mm (n = 4).Stipules: Present. The two cotyledonary petioles alternate with, and are adnate marginally with, two interpetiolar stipules. The four structures thereby compose a short tube. Each interpetiolar stipule is membranous and its distal portion projects distally as a short triangle.**Number of leaves per supra-cotyledonary node.****Node nos. 1–3:** two leaves per node (n = 100% of 3, 4, and 2 cases of these nodes, respectively).**Leaves of the first three supra-cotyledonary nodes.**Lamina: **Shape:** simple; unlobed; ovate or oblanceolate-obovate. **Lamina margins:** entire. **Lamina apex:** acute to rounded. **Lamina base:** cuneate, short narrowly cuneate.Petiole: Present but very short; ca. purplish.Stipules: At each node the two petioles alternate with two interpetiolar stipules, and each stipule is at least sometimes free from the two adjacent petioles. It is a triangular, membranous or somewhat thickened, commonly ca. purplish structure which sometimes manifests a small number of terminal brown, glandular projections.**Trichomes.****Hypocotyl:** glabrous. **Cotyledons:** glabrous; non-ciliate. **First three supra-cotyledonary internodes:** varying from glabrous (or, perhaps, glabrescent) to having densely distributed, minute, narrow, pointed papillae often oriented perpendicular to the internode long axes. **Leaves of the first three supra-cotyledonary nodes:** glabrous.**Dates of collection and collection numbers of examined specimens.**

26664, 12 Apr 2007.

Psychotria nervosa Sw.; **Rubiaceae**

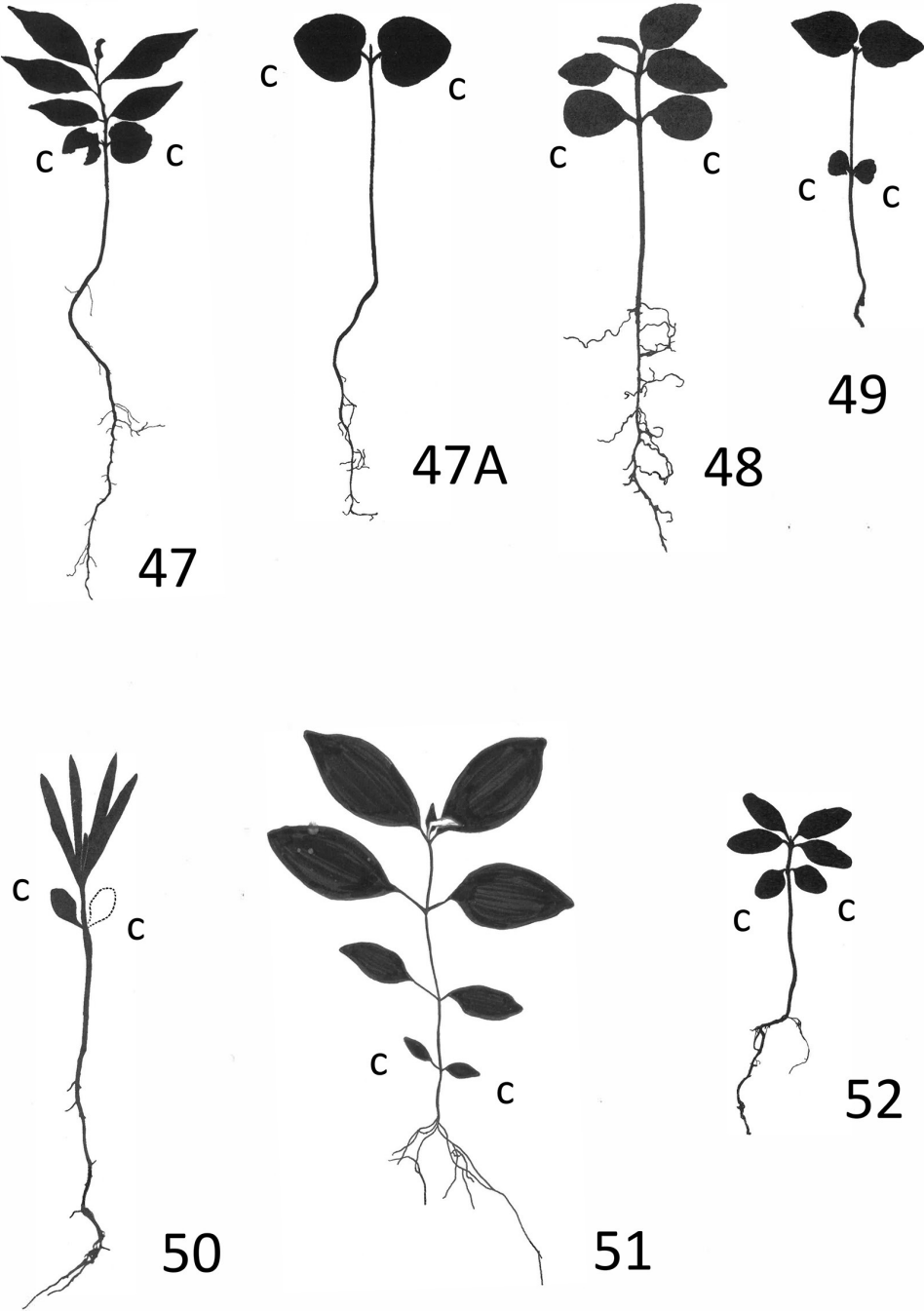
Wild Coffee. Native.

No. specimens studied: 22.

Adult morphology

Shrub with opposite, simple foliage leaves.

Seedling morphology (Fig. 53).**Hypocotyl.** Length: 23.5–45 mm (n = 9).**Cotyledons.**Number of cotyledons: 2, opposite, essentially equal.Lamina: **Shape:** simple; unlobed; ovate to very widely ovate. **Ranges of lengths and widths:** 9.5–13 mm × 6.5–10.2 mm (n = 10 [each parameter]). **Range of length-to-width ratios:** 1.1–1.7 (n = 10). **Lamina margins:** entire. **Lamina apex:** generally acute or subacute; sometimes rounded. **Lamina base:** reniform, truncate, or rounded. **Lamina thickness:** flat, thin.Petiole: present. **Range of lengths:** 1.5–4 mm (n = 10).Stipules: Two interpetiolar stipules occur, each being centered within a separate interpetiolar region between the cotyledons. Each interpetiolar stipule appears free from the two petioles. It is membranous and lacks a midrib. Its right portion (as seen in external view of the seedling) arises from stem tissue situated, partly, along the adaxial side of the cotyledon at right; its left portion arises from stem tissue situated, partly, along the adaxial side of the cotyledon at left. The two interpetiolar stipules are at least



FIGS. 47, 47A. *Drypetes lateriflora*. An old seedling (with cotyledons and supra-cotyledonary leaves) and a young seedling (with cotyledons but without supra-cotyledonary leaves). On the older seedling the cotyledon at left is damaged. $\times 0.32$, $\times 0.56$; J.B. FIG. 48. *Colubrina asiatica*. Seedling. $\times 0.76$; M.P.; FIG. 49. *Krugiodendron ferreum*. Seedling. $\times 0.72$; J.B. FIG. 50. *Casasia clusiifolia*. Seedling. It lacked the cotyledon at right, which is reconstructed here with a dashed line. $\times 0.57$; M.P. FIG. 51. *Cephalanthus occidentalis*. Seedling. $\times 0.52$; K.R. FIG. 52. *Chiococca alba* sensu lato. Seedling. $\times 0.98$; J.B. Indicated sequentially, after each figure description or group of descriptions are the magnification(s) of, and the initials of the artist who prepared, the drawing(s) (J.B. = Julio Gonzalez Batista; M.P. = Marcella Pulgarin; K.R. = Katja Redes). C. Cotyledon.

sometimes connate marginally. Distally, an interpetiolar stipule may appear gently rounded or be tapered to a point.

Number of leaves per supra-cotyledonary node.

Node nos. 1–3: two leaves per node ($n = 100\%$ of 15, 15, and 3 cases of these nodes, respectively).

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape:** simple; unlobed; lanceolate to ovate. **Lamina margins:** entire. **Lamina apex:** acute to acuminate. **Lamina base:** cuneate.

Petiole: Present.

Stipules: Two interpetiolar stipules develop which resemble those of the cotyledons (see description above).

Trichomes.

Hypocotyl: glabrous. **Cotyledons:** Lamina: glabrous; non-ciliate. Petiole: glabrous/essentially glabrous. **First three supra-cotyledonary internodes:** glabrous to having moderately concentrated, uniseriate hairs that vary from spreading to appressed and are generally curved, white to brown, and up to 0.5 mm long. **Leaves of the first three supra-cotyledonary nodes:** with hairs like those of the hypocotyl. Lamina: glabrous to sparsely pubescent with hairs situated mainly over the midvein. Petiole: glabrous to sparsely pubescent.

Dates of collection and collection numbers of examined specimens.

23911, 4 Sep 2005; 26346, 4 Feb 2007; 28168, 5 Apr 2008.

***Psychotria tenuifolia* Sw. (*Psychotria sulzneri* Small); Rubiaceae**

Shortleaf Wild Coffee. Native.

No. specimens studied: 41.

Adult morphology

Shrub with opposite, simple foliage leaves.

Seedling morphology (Fig. 54).

Hypocotyl. Length: 22.5–40.5 mm ($n = 7$).

Cotyledons.

Number of cotyledons: 2, opposite, essentially equal.

Lamina: **Shape:** simple; unlobed; generally, widely ovate to very widely ovate; sometimes elliptic.

Ranges of lengths and widths: 7–11.5 mm $\times$ 6.1–11.5 mm ($n = 10$ [each parameter]). **Range of length-to-width ratios:** 1.0–1.4 ($n = 10$). **Lamina margins:** entire. **Lamina apex:** rounded (often broadly rounded). **Lamina base:** reniform, truncate, or cuneate. **Lamina thickness:** flat, thin.

Petiole: present. **Range of lengths:** 1–2.5 mm ($n = 10$).

Stipules: Two interpetiolar stipules develop, each being centered within a separate interpetiolar region between the cotyledons. Each interpetiolar stipule appears free from the two adjacent petioles. It is more-or-less membranous and lacks a midrib. Its right portion (as seen in external view of the seedling) arises from stem tissue situated, partly, along the adaxial side of the cotyledon at right; its left portion arises from stem tissue situated, partly, along the adaxial side of the cotyledon at left. Distally, an interpetiolar stipule may manifest an extended (sometimes caudate) apex.

Number of leaves per supra-cotyledonary node.

Node no. 1: two or apparently three leaves per node ($n = 93\%$ and 7% of 15 cases, respectively). **Node**

nos. 2 and 3: two leaves per node ($n = 100\%$ of 14 and 7 cases, respectively).

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape:** simple; unlobed; lanceolate to ovate. **Lamina margins:** entire. **Lamina apex:** acute to subacute. **Lamina base:** generally cuneate; sometimes rounded.

Petiole: Present.

Stipules: Two interpetiolar stipules develop which closely resemble those of the cotyledons (see description above). At least sometimes both interpetiolar stipules at a node are connate, marginally. Distally, an interpetiolar stipule may vary from being caudate to being tapered gradually to a point.

Trichomes.

Hypocotyl: glabrous. **Cotyledons:** Lamina: glabrous; essentially non-ciliate. Petiole: glabrous. **First three supra-cotyledonary internodes:** moderately to densely pubescent with minute, commonly

spreading, sharp-tipped, transparent or white trichomes ca. 0.01 to 0.05 mm long, which appear intermediate between hairs and papillae. **Leaves of the first three supra-cotyledonary nodes.** Almost all trichomes are like those described above. Lamina: varying from glabrous to having trichomes concentrated at the base of the lamina; the lamina margins ciliate (sometimes abundantly so). Petiole: varying from glabrous to having densely concentrated trichomes.

Dates of collection and collection numbers of examined specimens.

28307, 27 May 2008; 29410, 27 Jan 2009.

***Randia aculeata* L.; Rubiaceae**

White Indigoberry. Native.

No. specimens studied: 43.

Adult morphology

Tree or shrub with opposite, simple foliage leaves.

Seedling morphology (Fig. 55).

Hypocotyl. Length: 10.5–25 mm (n = 9).

Cotyledons.

Number of cotyledons: 2, opposite; equal or essentially so

Lamina: **Shape:** simple; unlobed; obovate, widely elliptic, or orbicular. **Ranges of lengths and widths:** 6.5–12.5 mm × 5.5–8.5 mm (n = 11 [each parameter]). **Range of length-to-width ratios:** 0.93–1.6 (n = 11). **Lamina margins:** entire. **Lamina apex:** mostly broadly rounded; rarely truncate. **Lamina base:** cuneate, abruptly narrowly cuneate, or rounded. **Lamina thickness:** flat, thin.

Petiole: present to absent. **Range of lengths:** 0–1.5 mm (n = 10).

Stipules: Two interpetiolar stipules develop, each being centered within a separate interpetiolar region between the cotyledons. Each interpetiolar stipule appears free from the two adjacent petioles. It exhibits a thick midrib along its median long axis and appears membranous to either side of the midrib. The membranous portion to the right of the midrib (as seen in external view of the seedling) arises from stem tissue situated, partly, along the adaxial side of the cotyledon at right; The membranous portion situated to the left of the midrib arises from stem tissue situated, partly, along the adaxial side of the cotyledon at left.

Number of leaves per supra-cotyledonary node.

Node nos. 1–3: two leaves per node (n = 100% of 16, 12, and 5 cases of these nodes, respectively).

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape:** simple; unlobed; narrowly elliptic or oblanceolate to obovate. **Lamina margins:** entire. **Lamina apex:** acute to rounded. **Lamina base:** sessile or essentially so.

Petiole: Present (then minute) or absent.

Stipules: Two **interfoliar stipules** develop which resemble the interpetiolar stipules of the cotyledons (see description above). We call them interfoliar, rather than interpetiolar, stipules because leaves of the first three supra-cotyledonary nodes are often sessile.

Trichomes.

Hypocotyl: glabrous or bearing numerous minute papillae distally. **Cotyledons:** glabrous; non-ciliate.

First three supra-cotyledonary internodes: glabrous, minutely papillate, or with minute, white, and generally appressed and antrorse hairs. **Leaves of the first three supra-cotyledonary nodes:** glabrous.

Dates of collection and collection numbers of examined specimens.

23856, 12 Sep 2005; 26789, 15 Apr 2007; 28052, 23 Mar 2008.

***Zanthoxylum fagara* (L.) Sarg.; Rutaceae**

Wild Lime. Native

No. specimens studied: 16.

Morphology of adult plant

Tree or shrub with alternate, once-pinnately compound foliage leaves.

Seedling morphology (Fig. 56).

Hypocotyl. Length: 19–35 mm (n = 10).

Cotyledons.

Number of cotyledons: 2, mostly opposite (sometimes subopposite); essentially equal.

Lamina: **Shape:** simple; unlobed; obovate to widely obovate. **Ranges of lengths and widths:** 6–8 mm × 4.5–6.5 mm (n = 10 [each parameter]). **Range of length-to-width ratios:** 1.2–1.7 (n = 10). **Lamina margins:** crenulate. **Lamina apex:** rounded to truncate; retuse. **Lamina base:** cuneate to rounded.

Lamina thickness: flat, thin.

Petiole: Present. **Range of lengths:** 1–1.5 mm (n = 10).

Stipules: Absent.

Number of leaves per supra-cotyledonary node

Node nos. 1–3: one leaf per node (n = 100% of 10, 10, and 9 cases of these nodes, respectively).

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape:** Once-pinnately compound. The number of pinnae per leaf is as follows. At supra-cotyledonary node no. 1: 2 or 3 pinnae (n = 12 leaves). At supra-cotyledonary node no. 2: 3 pinnae (n = 10 leaves). At supra-cotyledonary node no. 3: 3, 4, or 5 pinnae (n = 10 leaves). **Pinna margins:** generally, serrulate or crenulate-serrulate; sometimes undulate. **Pinna apex:** generally, retuse or rounded; sometimes acute. **Pinna base:** narrowly cuneate.

Petiole: Present.

Stipules: Absent; however, minute dark-brown excrescences (ca. 0.1 mm long) border the stem-petiole junctions of some leaves (thereby occupying the positions of typical stem-borne stipules). We do not consider them stipules because they develop sparsely elsewhere on the seedling (e.g., on the hypocotyl and on the rachis of the lamina).

Trichomes.

Hypocotyl: glabrous or with a few excrescences (apparently, either trichomes or emergences).

Cotyledons: glabrous; non-ciliate. **First three supra-cotyledonary internodes:** glabrous or with a few excrescences. **Leaves of first three supra-cotyledonary nodes:** Lamina: glabrous aside from relatively few excrescences. Petiole: glabrous.

Additional information. Resin glands are abundant within the hypocotyl, supra-cotyledonary internodes, cotyledons, and the petioles and laminae of the first three supra-cotyledonary leaves. In top view they appear colorless or green, they vary from circular to short-elliptical, and they generally measure ca. 0.1 to 0.15 mm in diameter.

Dates of collection and collection numbers of examined specimens.

29549, 17 Mar 2009; 29636, 15 Mar 2009; 43362, 4 Jan 2021.

***Salix caroliniana* Michx.; Salicaceae**

Carolina Willow, Coastalplain Willow. Native

No. specimens studied: 32.

Adult morphology

Tree with alternate, simple foliage leaves

Seedling morphology (Fig. 57).

Hypocotyl. Length: 3.5–12 mm (n = 10).

Cotyledons.

Number of cotyledons: 2, opposite; essentially equal.

Lamina: **Shape:** simple; unlobed; lance-ovate to ovate, narrowly oblong-oblong, narrowly elliptic to elliptic, or obovate. **Ranges of lengths and widths:** 4.1–6.2 mm × 2.1–3.3 mm (n = 10 [each parameter]). **Range of length-to-width ratios:** 1.5–2.5 (n = 10). **Lamina margins:** entire. **Lamina apex:** mostly rounded; sometimes subacute or mucronate. **Lamina base:** cuneate to narrowly cuneate.

Lamina thickness: flat, thin.

Petiole: Present. **Range of lengths:** 2–4.5 mm (n = 10).

Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node nos. 1–3: one leaf per node (n = 100% of 13, 15, and 13 cases of these nodes, respectively).

Leaves of the first three supra-cotyledonary nodes.

Lamina: simple; unlobed; mostly ovate to widely ovate; sometimes obovate. **Lamina apex:** acute to rounded and, commonly, simultaneously mucronate. **Lamina margins:** entire/essentially entire or

manifesting one or two sharp teeth. **Lamina apex:** acute to rounded and, commonly, simultaneously mucronate. **Lamina base:** cuneate, narrowly cuneate, rounded, or reniform.

Petiole: Present.

Stipules: They are mostly absent, although on one of 11 leaves from supra-cotyledonary node no. 3 at least one side of the petiole base was sufficiently enlarged to qualify as a depauperate stipule. Better-defined stipules develop on the later-formed leaves of saplings. They represent extensions of the basal part of the winged (sheath-like) petiole.

Trichomes.

Hypocotyl: glabrous/essentially glabrous. **Cotyledons.** Lamina: glabrous/essentially glabrous; non-ciliate. Petiole: glabrous. **First three supra-cotyledonary internodes:** mostly glabrous/essentially glabrous but sometimes with sparse, white, uniseriate hairs up to 0.4 mm long. **Leaves of the first three supra-cotyledonary nodes:** with hairs comparable to, albeit sometimes longer than, those described above. Both lamina surfaces: glabrous to sparsely pubescent. Lamina margins: sparsely to densely ciliate. Petiole: sparsely pubescent.

Additional information. Compared to more distally situated internodes of the seedling, supra-cotyledonary internode no. 1 is short/very short ($n = 62\%$ of 13 cases) or it is non-existent ($n = 38\%$ of 13 cases).

Dates of collection and collection numbers of examined specimens.

26606, 8 Apr 2007; 29601, 23 Mar 2009.

Acer rubrum L.; **Sapindaceae**

Red Maple. Native.

No. specimens studied: 61.

Adult morphology

Tree with opposite, simple foliage leaves.

Seedling morphology (Fig. 58).

Hypocotyl. Length: 44–74 mm ($n = 10$).

Cotyledons.

Number of cotyledons: 2, opposite; equal or essentially so.

Lamina: **Shape:** simple; unlobed; narrowly oblong, narrowly elliptic, or narrowly lanceolate-elliptic.

Ranges of lengths and widths: 15–22 mm $\times$ 4–7.5 mm ($n = 11$ [each parameter]). **Range of length-to-width ratios:** 2.7–5.1 ($n = 11$). **Lamina margins:** entire. **Lamina apex:** narrowly to broadly rounded; rarely retuse. **Lamina base:** mostly narrowly cuneate. **Lamina thickness:** flat, thin.

Petiole: Present. **Range of lengths:** 0.5–3.5 mm ($n = 10$).

Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node nos. 1–3: two leaves per node ($n = 100\%$ of 51, 20, and 7 cases of these nodes, respectively).

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape:** Simple. At each node the lamina varies from unlobed to weakly 3-lobed. **Lamina margins.** At node nos. 1, 2: coarsely crenate to coarsely serrate. At node no. 3: coarsely serrate. **Lamina apex:** subacute to acuminate. **Lamina base:** subcordate to cordate, truncate, or rounded.

Petiole: Present.

Stipules: Absent.

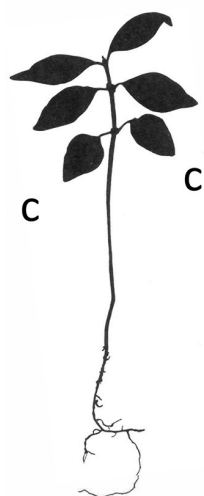
Trichomes.

Hypocotyl: glabrous. **Cotyledons:** glabrous; non-ciliate. **First three supra-cotyledonary internodes:** glabrous. **Leaves of the first three supra-cotyledonary nodes:** glabrous.

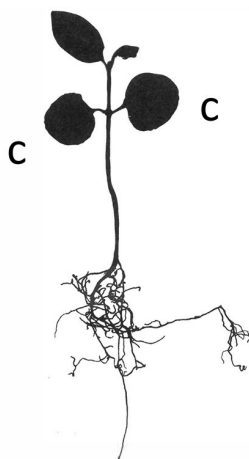
Additional information: Abaxially, the laminae of the first four pairs of supra-cotyledonary leaves are glaucous.

Dates of collection and collection numbers of examined specimens.

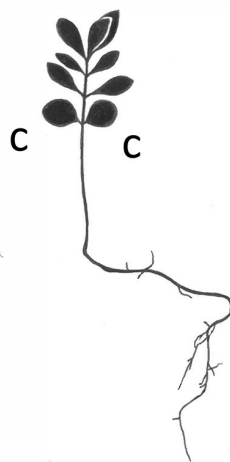
26481, 22 Mar 2007; 28031, 23 Mar 2008; 29387, 29388, 18 Jan 2009; 29389, 20 Jan 2009; 29402, 4 Feb 2009; 29428, 29429, 31 Jan 2009.



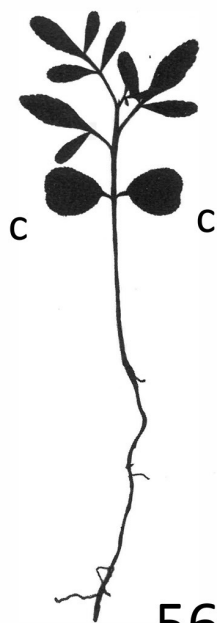
53



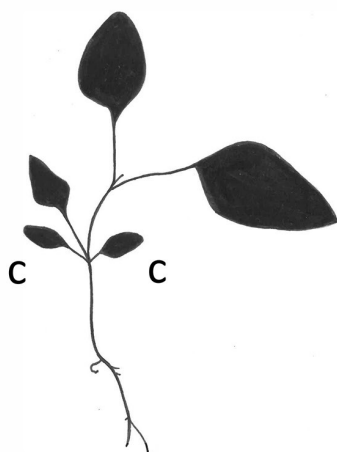
54



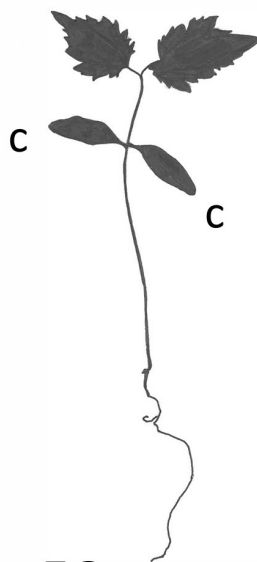
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56



57



58

FIG. 53. *Psychotria nervosa*. Seedling. $\times 0.72$; J.B. FIG. 54. *Psychotria tenuifolia*. Seedling. $\times 0.68$; J.B. FIG. 55. *Randia aculeata*. Seedling. $\times 0.49$; K.R. FIG. 56. *Zanthoxylum fagara*. Seedling. $\times 0.99$; J.B. FIG. 57. *Salix caroliniana*. Seedling. $\times 1.5$; K.R. FIG. 58. *Acer rubrum*. $\times 0.50$; K.R. Indicated sequentially, after each figure description are the magnification of, and the initials of the artist who prepared, the drawing (J.B. = Julio Gonzalez Batista; K.R. = Katja Redes). C. Cotyledon.

Hypelate trifoliata Sw.; **Sapindaceae**

White Ironwood. Native.

No. specimens studied: 44.

Adult morphology

Tree or shrub with alternate, trifoliolate foliage leaves.

Seedling morphology (Figs. 59, 59A).**Hypocotyl.** Length: 25–49 mm (n = 10).**Cotyledons.**Number of cotyledons: 2; opposite; rarely subopposite; essentially equal.Lamina: **Shape:** simple; unlobed; narrowly elliptic, narrowly oblong, oblong-elliptic, oblong-oblancoate, oblanceolate, or lanceolate. **Ranges of lengths and widths:** 8–14.5 mm × 1.5–4 mm (n = 12 [each parameter]). **Range of length-to-width ratios:** 3.0–7.0 (n = 12). **Lamina margins:** entire to sinuate.**Lamina apex:** generally rounded; sometimes subacute. **Lamina base:** more-or-less sessile. **Lamina thickness:** flat, thickened.Petiole: Generally absent. Sometimes, however, the basal portion of the cotyledon is narrowed sufficiently to be interpretable as a minute petiole.Stipules: Absent.**Number of leaves per supra-cotyledonary node.**

The first three to five (generally four) supra-cotyledonary leaves compose a whorl or, less often, a pseudo-whorl. The two nodes situated distal to the whorl/pseudo-whorl normally manifest one leaf apiece.

Leaves of the first three to four supra-cotyledonary nodes.Lamina: **Shape:** This is variable within the whorl/pseudo-whorl and among leaves of the next two supra-cotyledonary nodes. Examples of shapes are listed: **a.** the lamina simple, either unlobed or lobed; **b.** the lamina pinnatifid, having a terminal lobe and one, two, or three lateral lobes; **c.** the lamina compound with one terminal, and one or two lateral pinnae (all pinnae are sessile). The unlobed laminae and pinnae are often oblanceolate but sometimes oblong-oblancoate or elliptic. **Lamina margins:** entire. **Lamina apex:** generally rounded (sometimes with an apiculus) or acute; sometimes truncate. **Lamina base:** sessile or narrowly cuneate.Petiole: Present or absent (mostly absent in the pseudo-whorl).Stipules: Absent; however, sometimes unidentified minute outgrowths develop at the bases of the leaves.**Trichomes.****Hypocotyl:** glabrous. **Cotyledons:** glabrous; non-ciliate. **First three supra-cotyledonary internodes:** glabrous. **Leaves of the first three supra-cotyledonary nodes:** glabrous.**Dates of collection and collection numbers of examined specimens.**

34615, 11 Mar 2013; 34616, 5 Mar 2013; 34633, 16 Feb 2013; 35228, 17 Oct 2013.

Chrysophyllum oliviforme L.; **Sapotaceae**

Satinleaf. Native.

No. specimens studied: 3.

Adult morphology

Tree or shrub with alternate, simple foliage leaves.

Seedling morphology (Fig. 60).**Hypocotyl.** Length: 54.5–69.5 mm (n = 3). At least sometimes the base of the first supra-cotyledonary internode is conspicuously swollen.**Cotyledons.**Number of cotyledons: 2, always opposite; essentially equal.Lamina: **Shape:** simple; unlobed; narrowly elliptic or lanceolate. **Ranges of lengths and widths:** 17–19 mm × 5.5–6 mm (n = 6 [each parameter]). **Range of length-to-width ratios:** 2.9–3.2 (n = 6). **Lamina margins:** entire. **Lamina apex:** narrowly rounded. **Lamina base:** sessile. **Lamina thickness:** flat, thin.Petiole: Absent. The cotyledons are sessile.Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node no. 1: two leaves per node ($n = 100\%$ of 3 cases).

Leaf of the first supra-cotyledonary node.

Lamina: **Shape:** simple; unlobed; elliptic to widely elliptic. **Lamina margins:** entire. **Lamina apex:** acute or rounded and simultaneously apiculate. **Lamina base:** cuneate or narrowly cuneate.

Petiole: Present.

Stipules: Absent.

Trichomes.

Hypocotyl: glabrous. **Cotyledons:** glabrous; non-ciliate. **First supra-cotyledonary internode:** with moderately to densely concentrated, long, brownish, appressed, antrorse hairs. **Leaves of the first supra-cotyledonary node:** Lamina (adaxial surface): glabrous. Lamina (abaxial surface): with sparsely arranged, long, brownish, appressed hairs; the hairs are most abundant on the midvein or on the lamina margins. Petiole: with moderately concentrated antrorse hairs like those, aforementioned.

Dates of collection and collection numbers of examined specimens.

29237, 20 Nov 2008; 31716, 24 Sep 2010.

Sideroxylon salicifolium (L.) Lam. (*Bumelia salicifolia* (L.) Swartz); **Sapotaceae**

Willow Busic. Native.

No. specimens studied: 62.

Adult morphology

Tree or shrub with alternate, simple foliage leaves.

Seedling morphology (Figs. 61, 61A, 61B).

Hypocotyl. Length: 35.5–63 mm ($n = 10$).

Cotyledons.

The cotyledons are unusual among those of presently studied species, because: **a.** they are off-white rather than green (therefore, apparently lacking photosynthesis), and **b.** they are abscinded early (i.e., soon after being carried upward by hypocotylar elongation and after expansion of the first pair of supra-cotyledonary leaves).

Number of cotyledons: 2, opposite; essentially equal.

Lamina: **Shape:** simple; unlobed; approximately narrowly oblong or narrowly elliptic to narrowly lanceolate. **Ranges of lengths and widths:** 4.3–6.3 mm $\times$ 1.0–1.5 mm ($n = 10$ [each parameter]). **Range of length-to-width ratios:** 3.6–5.7 ($n = 10$). **Lamina margins:** entire. **Lamina apex:** rounded and sometimes also slightly cuculate; sometimes truncate. **Lamina base:** sessile. **Lamina thickness:** flat, thin.

Petiole: Absent. The cotyledons are sessile.

Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node no. 1: one or two leaves per node ($n = 7\%$ and 93% of 27 cases, respectively). **Node nos. 2 and 3:** 1 leaf per node ($n = 100\%$ of 12 and 13 cases, respectively).

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape:** simple; unlobed; ovate to ovate-widely ovate, narrowly elliptic-elliptic to elliptic, or obovate. **Lamina margins:** entire. **Lamina apex:** acute to rounded. **Lamina base:** cuneate to rounded.

Petiole: Present but sometimes very short.

Stipules: Absent.

Trichomes.

Hypocotyl: glabrous. **Cotyledons:** glabrous; non-ciliate. **First three supra-cotyledonary internodes:** densely covered with short-stalked, I-shaped, dark brown hairs. The two branches of a hair are narrow and much longer than the stalk (ranging up to at least 1.2 mm long, collectively). The branches vary from appressed to ascending, are aligned parallel to the stem long axis, and each culminates in a sharp tip. **Leaves of the first three supra-cotyledonary nodes:** with hairs like those described above. Lamina (adaxial surface): glabrous/essentially glabrous. Lamina (abaxial surface): pubescent, the hairs tending to be most concentrated over the midvein. Petiole: with densely arranged hairs aligned parallel to the petiole long axis.

Dates of collection and collection numbers of examined specimens.

29512, 10 Feb 2009; 30636, 17 Jan 2010; 34535, 2 Feb 2013; 35063, 27 Jul 2013.

Schoepfia schreberi J.F. Gmel. [*Schoepfia chrysophylloides* (A. Rich.) Planch.]; **Schoepfiaceae**
Graytwig. Native.

No. specimens studied: 21.

Adult morphology

Tree or shrub with alternate, simple foliaceous leaves.

Seedling morphology (Figs. 62, 62A, 62B).

Hypocotyl. Length: 51–75.5 mm (n = 11).

Cotyledons.

Number of cotyledons: 2 or 3 (n = 15 and 3 of 18 seedlings, respectively).

Lamina: **Shape:** simple; unlobed; lanceolate to ovate. The lamina is sometimes more-or-less curved to one side. **Ranges of lengths and widths:** 17.5–28 mm × 7–13 mm (n = 11 [each parameter]). **Range of length-to-width ratios:** 1.8–2.9 (n = 11). **Lamina margins:** entire. **Lamina apex:** acute or acuminate.

Lamina base: cuneate to rounded. **Lamina thickness:** flat, thin.

Petiole: Present or absent. **Range of lengths:** 0–2.5 mm (n = 10).

Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node nos. 1–3: one leaf per node (n = 100% of 3, 3 and 2 cases of these nodes, respectively).

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape:** simple, unlobed, lanceolate to lanceolate-ovate. **Lamina margins:** entire. **Lamina apex:** acute to acuminate. **Lamina base:** cuneate to narrowly cuneate.

Petiole: Present.

Stipules: Absent.

Trichomes.

Hypocotyl: glabrous. **Cotyledons:** glabrous; non-ciliate. **First three supra-cotyledonary internodes:** glabrous. **Leaves of the first three supra-cotyledonary nodes:** glabrous.

Dates of collection and collection numbers of examined specimens.

29234, 3 Dec 2008; 29312, 10 Dec 2008; 29313, 30 Dec 2008.

Simarouba glauca DC.; **Simaroubaceae**

Paradisetre. Native.

No. specimens studied: 43.

Adult morphology

Tree with alternate, once-pinnately compound foliaceous leaves.

Seedling morphology (Fig. 63).

Hypocotyl. Length: 43.5–115 mm (n = 11).

Early in seedling development the hypocotyl-primary root junction becomes swollen and a short, hollow cylinder of outer tissue splits away from the base of the hypocotyl. The cylinder is persistent, remaining attached to the hypocotyl at its distal end.

Cotyledons.

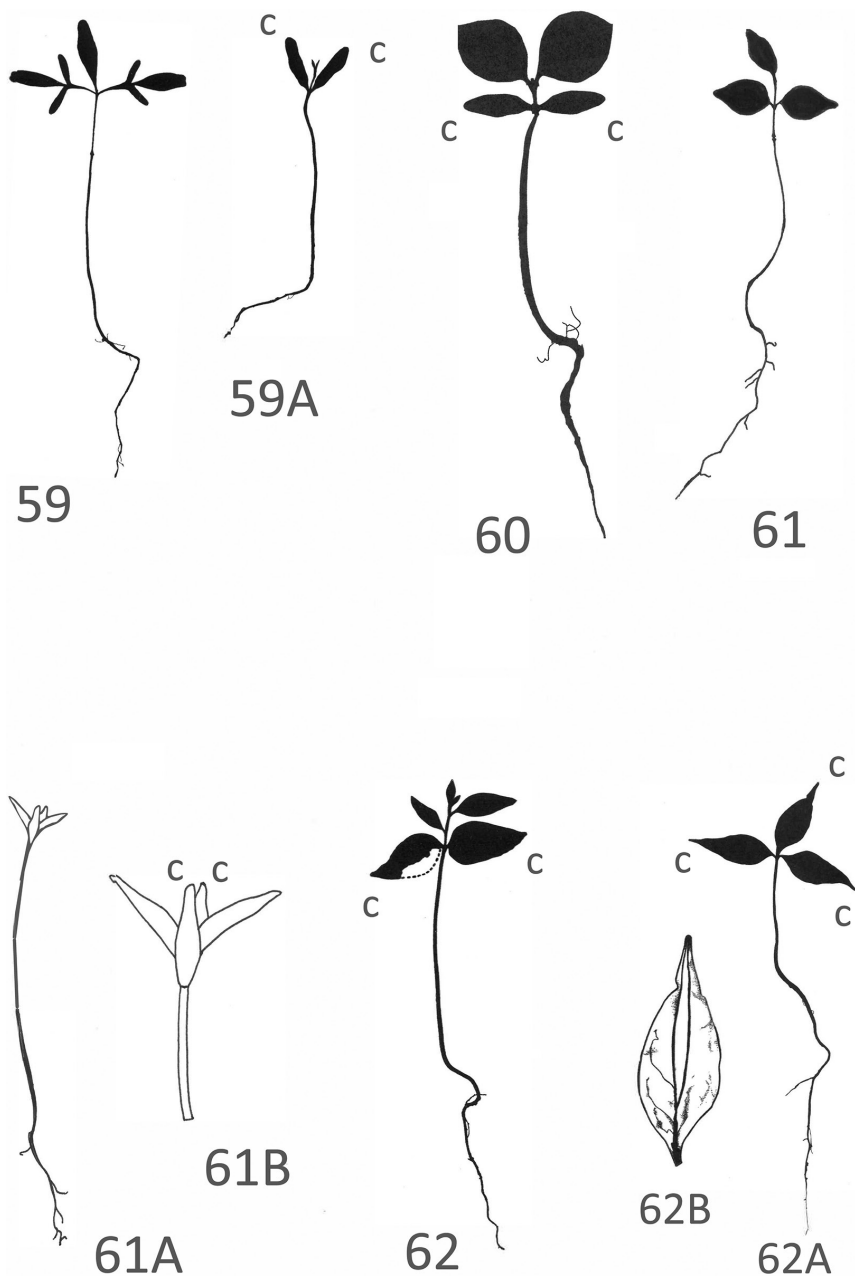
Number of cotyledons: 2, opposite, sometimes subopposite; essentially equal.

Lamina: **Shape:** simple; unlobed above the base; oblanceolate to oblanceolate-obovate. The cotyledon long axis is commonly curved to one side. **Ranges of lengths and widths:** 10–15 mm × 3.8–6.5 mm (n = 10 [each parameter]). **Range of length-to-width ratios:** 2.3–3.1 (n = 10). **Lamina margins:** entire.

Lamina apex: rounded. **Lamina base:** commonly consisting of two short extensions which are involute, revolute, or flat and which, collectively, often make the lamina base appear sagittate, hastate, or auriculate. **Lamina thickness:** flat, thickened.

Petiole: Present. **Range of lengths:** 1–3 mm (n = 11).

Stipules: Absent.



FIGS. 59, 59A. *Hypelate trifoliata*. An older seedling and a younger seedling, respectively. The older seedling has abscinded its cotyledons but manifests a whorl of three mature supra-cotyledonary leaves. The younger seedling exhibits two mature cotyledons, but its supra-cotyledonary leaves have just begun to expand. $\times 0.59$, $\times 0.69$; J.B. FIG. 60. *Chrysophyllum oliviforme*. Seedling. $\times 0.53$. M.P. FIGS. 61, 61A, 61B. *Sideroxylon salicifolium*. An older seedling, a young seedling, and the distal portion of the young seedling, respectively. The older seedling has abscinded its cotyledons, whereas the cotyledons remain on the young seedling. $\times 0.50$, $\times 1.0$, $\times 2.8$; K.R.). FIGS. 62, 62A, 62B. *Schoepfia schreberi*. Two seedlings and a separate cotyledon, respectively. One seedling (Fig. 62) manifests two cotyledons plus supra-cotyledonary leaves. The cotyledon at left was damaged and is reconstructed here with a dashed line. The other seedling (Fig. 62A) exhibits a whorl of three cotyledons. $\times 0.50$, $\times 0.45$, $\times 1.1$; J.B. Indicated sequentially, after each figure description or group of descriptions are the magnification(s) of, and the initials of the artist who prepared, the drawing(s) (J.B. = Julio Gonzalez Batista; M.P. = Marcella Pulgarin; K.R. = Katja Redes). C. Cotyledon.

Number of leaves per supra-cotyledonary node.

Node no. 1: two leaves per node ($n = 100\%$ of 19 cases). **Node nos. 2 and 3:** 1 leaf per node ($n = 100\%$ of 15 and 5 cases, respectively).

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape:** once-pinnately compound. **Pinna margins:** entire. **Pinna apex:** subacute to rounded; acuminate. **Pinna base:** generally cuneate to rounded; sometimes narrowly cuneate.

Petiole: Present.

Stipules: Absent.

Trichomes.

Hypocotyl: glabrous. **Cotyledons:** glabrous; non-ciliate. **First three supra-cotyledonary internodes:** glabrous. **Leaves of the first three supra-cotyledonary nodes:** glabrous.

Dates of collection and collection numbers of examined specimens.

30422, 30423, 17 Aug 2009; 30424, 30425, 30426, 21 Aug 2009; 35072, 20 Aug 2013.

***Suriana maritima* L.; Surianaceae**

Bay Cedar. Native.

No. specimens studied: 30.

Adult morphology

Shrub with alternate, simple foliage leaves.

Seedling morphology (Fig. 64).

Hypocotyl. Length: 13.5–21.5 ($n = 7$).

Cotyledons.

Number of cotyledons: 2, opposite; essentially equal.

Lamina: **Shape:** simple; unlobed; oblanceolate or narrowly oblong. **Ranges of lengths and widths:** 6.0–8.8 mm $\times$ 1.3–2.1 mm ($n = 10$ [each parameter]). **Range of length-to-width ratios:** 2.9–4.7 ($n = 10$). **Lamina margins:** entire. **Lamina apex:** mostly rounded; sometimes truncate. **Lamina base:** sessile. **Lamina thickness:** flat, thin.

Petiole: Absent. The cotyledons are sessile.

Stipules: Absent.

Number of leaves per supra-cotyledonary node

This was difficult to assess because the internodes are condensed. Data are solely for node no. 1, where there were one or two leaves per node ($n = 67\%$ and 33% of 9 cases, respectively).

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape:** simple; unlobed; generally oblanceolate; sometimes linear. **Lamina margins:** entire. **Lamina apex:** generally acute; sometimes narrowly rounded. **Lamina base:** sessile or narrowly cuneate.

Petiole: Present (minute) or sessile.

Stipules: Absent.

Trichomes.

Hypocotyl: glabrous. **Cotyledons:** glabrous; non-ciliate. **First three supra-cotyledonary internodes:** sparsely to densely covered with hairs of two types: **a.** sharp-tipped hairs lacking pigment throughout, and **b.** hairs manifesting blunt yellow or pink tips. The hairs, collectively, vary from spreading to appressed and from straight to considerably curved; they are transparent or white (aside from their tips, if pigmented), narrow, and up to 0.9 mm long. **Leaves of the first three supra-cotyledonary nodes:** with sparse hairs of both types, aforementioned, often largely on the margins.

Dates of collection and collection numbers of examined specimens.

28974, 2 Oct 2008.

Jacquinia keyensis Mez; **Theophrastaceae**

Joewood. Native.

No. specimens studied: 28.

Adult morphology

Tree or shrub with alternate, opposite, or whorled, simple foliage leaves.

Seedling morphology (Fig. 65).**Hypocotyl.** Length: 18–29 mm (n = 10).**Cotyledons.**Number of cotyledons: 2, opposite; equal or essentially so.Lamina: **Shape:** simple; unlobed; narrowly elliptic to elliptic, narrowly elliptic-lanceolate, narrowly elliptic-ob lanceolate, or lanceolate. **Ranges of lengths and widths:** 4–9.5 mm × 2.5–3.1 mm (n = 10 [each parameter]). **Range of length-to-width ratios:** 1.4–3.3 (n = 10). **Lamina margins:** entire; sometimes thickened; revolute and off-white. **Lamina apex:** mostly rounded, sometimes subacute or retuse.**Lamina base:** rounded, cuneate, short narrowly cuneate. **Lamina thickness:** flat, thin.Petiole: Present. **Range of lengths:** 0.5–1 mm (n = 10).Stipules: Absent.**Number of leaves per supra-cotyledonary node**

This was not assessed because the internodes were too condensed; however, the first two supra-cotyledonary leaves expand at different times, suggesting that they are from different nodes.

Leaves of the first three supra-cotyledonary nodes.Lamina: **Shape:** simple; unlobed; oblanceolate to obovate. **Lamina margins:** entire, thickened, revolute, and off-white. **Lamina apex:** cuspidate. **Lamina base:** narrowly cuneate or sessile.Petiole: Present (very short) or absent.Stipules: Absent. The prophylls (first two leaves) of an axillary bud are stipule-like, may expand early and might be confused with stipules.**Trichomes.****Hypocotyl:** densely pubescent with long, narrow, straight or moderately curved hairs generally 0.1 to 0.3 mm long, which are either of one type (entirely transparent hairs) or of two types (entirely transparent hairs and largely transparent hairs with purplish tips). The hairs are either mainly perpendicular to the hypocotyl or—on two different sectors of the hypocotyl—they may be predominantly perpendicular to the hypocotyl and predominantly antrorse, respectively. **Cotyledons:** Lamina: glabrous/essentially glabrous (i.e., sometimes sparsely pubescent basally on the abaxial surface); non-ciliate or sparsely ciliate. Petiole: more-or-less densely pubescent with hairs like those described above. **First two supra-cotyledonary internodes:** with variously concentrated hairs. **Leaves of the first three supra-cotyledonary nodes:** with hairs like those described above. Lamina: glabrous or pubescent basally to various extents; Lamina margins: non-ciliate to sparsely ciliate. Petiole: pubescent.**Additional information.** The supra-cotyledonary internodes are highly condensed if they exist at all.**Dates of collection and collection numbers of examined specimens.**

43009, 2 May 2020; 43261, 9 Sep 2020.

Ulmus americana L.; **Ulmaceae**

American Elm. Native.

No. specimens studied: 32.

Adult morphology

Tree with alternate, simple foliage leaves.

Seedling morphology (Figs. 66, 66A).**Hypocotyl.** Length: 26–45 mm (n = 10).**Cotyledons.**Number of cotyledons: 2, opposite; generally, essentially equal, sometimes unequal.Lamina: **Shape:** simple; unlobed above the base; obovate to widely obovate. **Ranges of lengths and widths:** 5.5–7 mm × 4.3–6.5 mm (n = 12 [each parameter]). **Range of length-to-width ratios:** 1.1–1.5 (n = 12). **Lamina margins:** entire or partly entire-partly sinuate. **Lamina apex:** generally rounded to

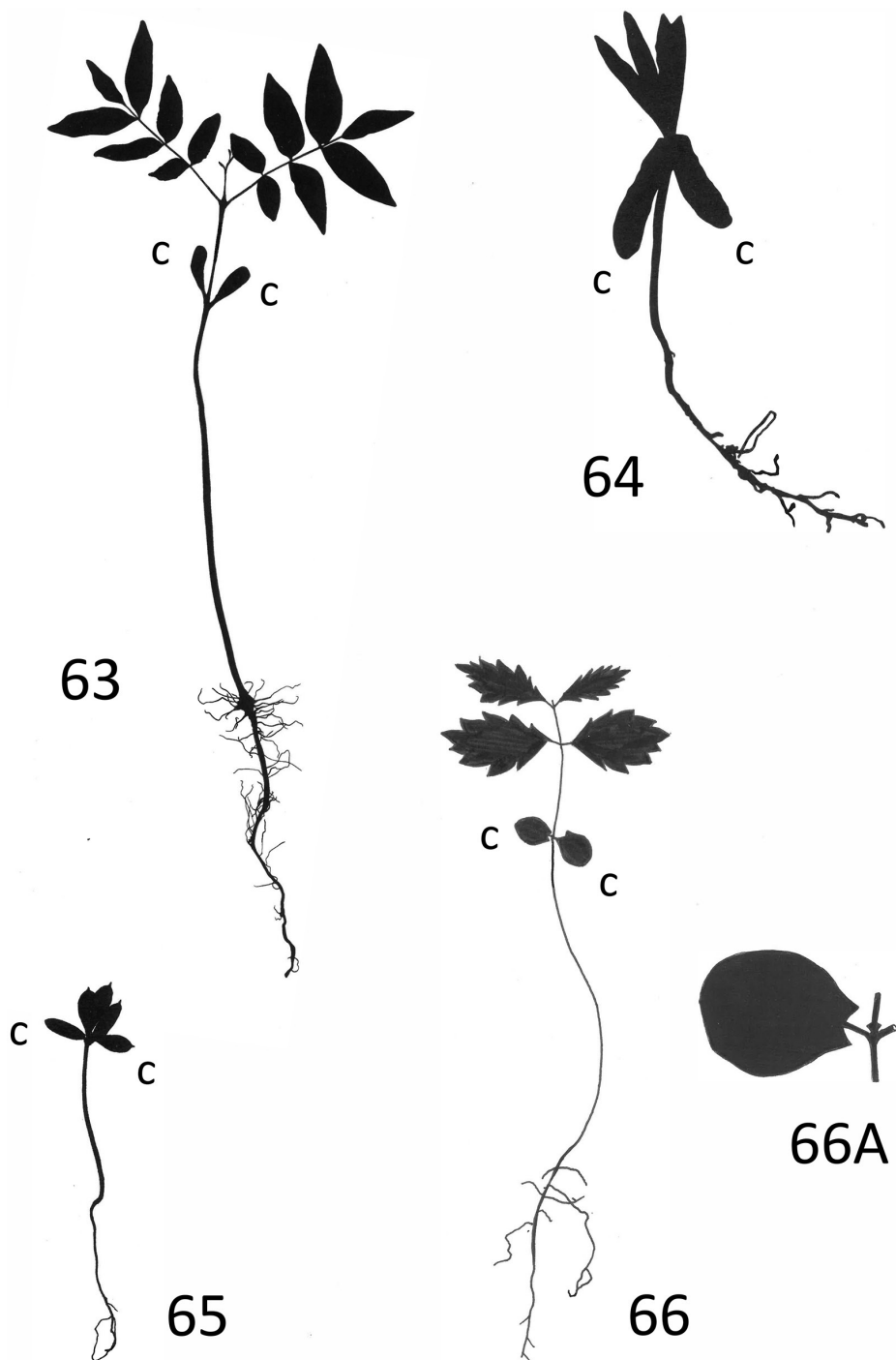


FIG. 63. *Simarouba glauca*. Seedling. $\times 0.46$; J.B. FIG. 64. *Suriana maritima*. Seedling. $\times 2.2$; J.B. FIG. 65. *Jacquinia keyensis*. Seedling. $\times 0.65$; J.B. FIGS. 66, 66A. *Ulmus americana*. A seedling and a separate cotyledon, respectively. $\times 1.0$; $\times 3.3$; K.R. Indicated sequentially, after each figure description or group of descriptions are the magnification(s) of, and the initials of the artist who prepared, the drawing(s) (J.B. = Julio Gonzalez Batista; K.R. = Katja Redes). C. Cotyledon.

truncate; sometimes shallowly concave. **Lamina base:** sagittate to nearly hastate. **Lamina thickness:** flat, thin.

Petiole: present. **Range of lengths:** 0.5–0.9 mm (n = 10).

Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node no. 1: one or two leaves per node (n = 14% and 86% of 29 cases, respectively). **Node no. 2:** one or two leaves per node (n = 20% and 80% of 30 cases, respectively). **Node no. 3:** one or two leaves per node (n = 30% and 70% of 20 cases, respectively).

Leaves of the first three supra-cotyledonary nodes.

Lamina: **Shape:** simple; unlobed; lanceolate-ovate, ovate, narrowly elliptic-elliptic, elliptic, oblanceolate-obovate, or obovate. **Lamina margins:** mostly coarsely serrate; sometimes crenate. **Lamina apex:** mostly acute, sometimes rounded. **Lamina base:** mostly cuneate, sometimes rounded.

Petiole: Present.

Stipules: Present.

Trichomes.

Hypocotyl: glabrous/essentially glabrous, basally. Distally, with up to densely concentrated, non-septate, sharp-tipped, curved, light brown or white hairs up to 0.1 mm long. On some seedlings the hairs are predominantly retrorse. Additional, comparably long, uniseriate hairs may occur. **Cotyledons:** with hairs like those described above. Lamina surfaces: glabrous/essentially glabrous or sometimes moderately pubescent and sparsely pubescent submarginally and medially, respectively. Lamina margins: moderately to densely ciliate with inconspicuous hairs. Petiole: essentially glabrous or sparsely pubescent. **First three supra-cotyledonary internodes:** moderately pubescent with hairs like those described above, but sometimes longer (up to 0.25 mm). The hairs may be predominantly retrorse, predominantly antrorse, predominantly spreading (and then less curved), and sometimes transparent. **Leaves of the first three supra-cotyledonary nodes:** Lamina surfaces: with sparse, stiff, sharp-tipped, appressed, transparent hairs up to 0.3 mm long. The hairs are, generally, either antrorse or directed toward the nearest lamina margin. Lamina margins: ciliate with comparable hairs. Petiole: moderately to densely pubescent with hairs like those described above.

Dates of collection and collection numbers of examined specimens.

26487, 22 Mar 2007; 29548, 17 Mar 2009; 29602, 23 Mar 2009; 29635, 15 Mar 2009.

Cissus verticillata (L.) Nicolson & C.E. Jarvis; **Vitaceae**

Possum Grape. Native.

No. specimens studied: 33.

Adult morphology

Tendrill-climbing vine with alternate, simple foliage leaves.

Seedling morphology (Fig. 67).

Hypocotyl. Length: 23–71.5 mm (n = 10).

Cotyledons.

Number of cotyledons: 2, opposite; ca. equal or subequal.

Lamina: **Shape:** simple. The lamina manifests terminal extensions (most commonly 4 or 5, but sometimes 3 or 8 which vary from being lobes to rounded teeth. The lamina is more-or-less shallowly obtriangular. **Ranges of lengths and widths:** 10–15 mm × 18–25.5 mm (n = 10 [each parameter]). **Range of length-to-width ratios:** 0.48–0.72 (n = 10). **Lamina margins:** entire (excluding the terminal rounded teeth or rounded teeth plus lobes). **Lamina apex:** ill-defined. **Lamina base:** short-narrowly cuneate, truncate. **Lamina thickness:** flat, thin.

Petiole: Present. **Range of lengths:** 2–6 mm (n = 10).

Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node no. 1: one leaf per node (n = 1).

Leaf of the first supra-cotyledonary node.

Lamina: **Shape:** simple; unlobed; ovate. **Lamina margins:** serrate. **Lamina apex:** acute. **Lamina base:** ca. truncate.

Petiole: Present.

Stipules: A pair of stem-borne stipules borders the base of the petiole.

Trichomes.

Hypocotyl: glabrous. **Cotyledons**: glabrous; non-ciliate. **First supra-cotyledonary internode**: glabrous. **Leaves of the first supra-cotyledonary node**: Lamina (adaxial surface): glabrous except for short, spreading, colorless hairs inserted at the boundary between the lamina and petiole (n = one seedling).

Dates of collection and collection numbers of examined specimens.

37130, 18 Apr 2015; 37283, 11 Apr 2015.

Nekemias arborea (L.) J. Wen & Boggan (*Ampelopsis arborea* (L.) Koehne); **Vitaceae**

Peppervine. Native

No. specimens examined: 37.

Adult morphology

Tendrill-climbing vine with alternate, twice-pinnately compound foliage leaves.

Seedling morphology (Fig. 68).

Hypocotyl. Length: 27–74.5 mm (n = 10).

Cotyledons.

Number of cotyledons: 2, opposite; essentially equal.

Lamina: **Shape**: simple; unlobed; ovate to widely ovate. **Ranges of lengths and widths**: 15–25 mm × 8.5–17 mm (n = 11 [each parameter]). **Range of length-to-width ratios**: 1.2–2.2 (n = 11). **Lamina margins**: entire. **Lamina apex**: acute to acuminate. **Lamina base**: truncate, rounded, or obtuse. **Lamina thickness**: flat, thin.

Petiole: Present. **Range of lengths**: 3–5 mm (n = 10).

Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node no. 1: one or two leaves per node (n = 95% and 5% of 19 cases, respectively). **Node nos. 2, 3**: one leaf per node (n = 100% of 11 and 3 cases of these nodes respectively).

Leaves of the first three supra-cotyledonary nodes.

Lamina: At node no. 1: either simple and 3-lobed or once-pinnately compound with 3 pinnae (n = 5% and 95% of 19 leaves, respectively). At node no. 2: either once or twice-pinnately compound (n = 91% and 9% of 11 leaves, respectively), with 3 to 5 pinnae. At node no. 3: either once- or twice-pinnately compound (n = 75% and 25% of 4 leaves, respectively), with 3 or 5 pinnae. **Pinna/pinnule margins**: very coarsely serrate; occasionally crenate; the teeth being mucronulate to apiculate. **Pinna/pinnule apex**: acute or acuminate; the apex being simultaneously mucronulate to apiculate. **Pinna/pinnule base, collectively**: cuneate, narrowly cuneate, rounded, or sometimes truncate.

Petiole: Present.

Stipules: A pair of stem-borne stipules borders the base of each petiole.

Trichomes.

Hypocotyl: glabrous or minute-papillate, distally. **Cotyledons**: Lamina: glabrous or minute-papillate over the main veins. Petiole: glabrous or minute-papillate, basally. **First three supra-cotyledonary internodes**: glabrous or bearing up to moderately concentrated hairs of two generally distinguishable types: **a.** short, stiff, sharp-tipped, uncinat, primarily white (sometimes light-brown) hairs and/or **b.** soft, narrow, uniseriate, conspicuously septate hairs. **Leaves of the first three supra-cotyledonary nodes**. Lamina. Both lamina surfaces and the lamina margins manifest, predominantly, the short, stiff white hairs. Abaxially, they are concentrated over the main veins and on the basal-most portion of the lamina. The marginal hairs vary from moderately to densely concentrated. Petiole: with sparse to moderately concentrated hairs of both types described above.

Dates of collection and collection numbers of examined specimens.

28045, 28046, 23 Mar 2008; 28062, 16 Mar 2008.

Parthenocissus quinquefolia (L.) Planch.; **Vitaceae**

Virginia Creeper. Native.

No. specimens studied: 42.

Adult morphology

Tendrill-climbing vine with alternate, once-palmately compound foliage leaves.

Seedling morphology (Fig. 69).**Hypocotyl.** Length: 20–65 mm (n = 10).**Cotyledons.**Number of cotyledons: 2, opposite; most often equal.Lamina: **Shape:** simple; unlobed; widely ovate, sometimes with a basal, short, medial, cuneate extension merging with the petiole. **Ranges of lengths and widths:** 20–27 mm × 14–23.5 mm (n = 11 [each parameter]). **Range of length-to-width ratios:** 1.1–1.7 (n = 11). **Lamina margins:** entire or slightly crenate or slightly undulate. **Lamina apex:** generally acute to narrowly rounded; sometimes acuminate. **Lamina base:** truncate, rounded, or reniform. **Lamina thickness:** flat, thin.Petiole: Present. **Range of lengths:** 6–28 mm (n = 10).Stipules: Absent.**Number of leaves per supra-cotyledonary node.****Node nos. 1–3:** one leaf per node (n = 100% of 20, 20, and 9 cases of these nodes, respectively).**Leaves of the first three supra-cotyledonary nodes.**Lamina: **Shape:** once-palmately compound. At supra-cotyledonary node no. 1: 3, 4, or 5 pinnae per leaf (n = 40%, 23%, and 37% of 35 leaves, respectively). At supra-cotyledonary node no. 2: 3, 4, or 5 pinnae per leaf (n = 6%, 33%, and 61% of 18 leaves, respectively). At supra-cotyledonary node no. 3: 5 pinnae per leaf (n = 100% of 7 leaves). **Pinna margins:** coarsely serrate, crenate, or crenate/dentate (i.e., having both rounded and pointed teeth); the teeth being mucronulate to apiculate. **Pinna apex:** mostly acute to acuminate; sometimes rounded; the apex simultaneously being mucronulate or mucronate. **Pinna base:** cuneate to narrowly cuneate; sometimes oblique.Petiole: Present.Stipules: A pair of stem-borne stipules borders the base of the petiole.**Trichomes.****Hypocotyl:** in most cases, barely to densely minute-papillate, distally. **Cotyledons:** sometimes minute-papillate on parts of the petiole and of the main longitudinal veins of the lamina; non-ciliate. **First three supra-cotyledonary internodes:** often glabrous but sometimes with sparse/very sparse papillae or uniseriate hairs. **Leaves of the first three supra-cotyledonary nodes.** The lamina margins and, to varying degrees both lamina surfaces, manifest stiff, appressed, sharp-tipped hairs which are colorless and frequently uniseriate. The non-marginal hairs are most concentrated along the main veins, where they are more-or-less antrorse. Away from the veins they point either toward the lamina apex or to the nearest leaf margin. The marginal hairs are generally shorter than the non-marginal ones. The petiole is glabrous to sparsely pubescent with hairs like those described above**Dates of collection and collection numbers of examined specimens.**

23081, 13 May 2005; 28041, 28042, 28043, 30 Mar 2008; 28044, 23 Mar 2008; 29438, 6 Feb 2009; 29631, 15 Mar 2009; 29632, 11 Mar 2009; 29690 7 Feb 2009; 39633, 8 Feb 2017.

Vitis rotundifolia Michx.; **Vitaceae**

Muscadine. Native

No. specimens studied: 38.

Morphology of adult plant

Tendrill-climbing vine with alternate, simple foliage leaves.

Seedling morphology (Fig. 70).**Hypocotyl.** Length: 16–52 mm (n = 9).**Cotyledons.**Number of cotyledons: 2, opposite; essentially equal.Lamina: **Shape:** simple; unlobed; ovate to widely ovate. **Ranges of lengths and widths:** 14–21 mm × 11–16.5 mm (n = 11 [each parameter]). **Range of length-to-width ratios:** 1.1–1.5 (n = 11). **Lamina**

margins: entire. **Lamina apex:** mostly subacute to narrowly rounded; sometimes acute. **Lamina base:** cuneate, truncate to rounded, or reniform. **Lamina thickness:** flat, thin.

Petiole: Present. **Range of lengths:** 3–15 mm (n = 10).

Stipules: Absent.

Number of leaves per supra-cotyledonary node.

Node nos. 1–3: one leaf per node (n = 100% of 11, 4, and 2 cases of the these nodes, respectively).

Leaves of the first two supra-cotyledonary nodes.

Lamina: **Shape:** simple; unlobed or weakly 3-lobed. **Lamina margins:** dentate or crenate/dentate (i.e., having both rounded and pointed teeth); the teeth sometimes exhibiting a minute mucronulate or mucronate tip. **Lamina apex:** acute, acuminate, or narrowly rounded; sometimes with a minute mucro. **Lamina base:** cleft with a more-or-less V-shaped sinus which widens progressing basipetally from the distal end of the petiole.

Petiole: Present.

Stipules: A pair of stem-borne stipules borders the base of the petiole.

Trichomes.

Hypocotyl: minute-papillate, distally. **Cotyledons.** Lamina: glabrous; non-ciliate. Petiole: basally, often minute-papillate and sometimes sparsely hairy. **First three supra-cotyledonary internodes:** minute-papillate and with **a.** short, stiff, sharp-pointed, white hairs, and **b.** moderately to densely concentrated, helically much twisted (“cobwebby”), tangled, long hairs which are generally light brown.

Leaves of the first three supra-cotyledonary nodes. Lamina: Hairs of one or both types, aforementioned, occur marginally and on both lamina surfaces. The surficial, short, stiff hairs are situated primarily on the main veins and at the very base of the lamina. Petiole: either solely with the white, stiff hairs or with hairs of both types described above.

Dates of collection and collection numbers of examined specimens.

25440, 28 Apr 2006; 27020, 3 Jul 2007.

SUMMARY AND DISCUSSION

Hypocotyl

It varied from straightforward to impossible to locate the hypocotyl-primary root boundary. The boundary was readily identifiable in *Cornus foemina*, wherein **a.** persistent root hairs or vestiges thereof covered the basal-most portion of the primary root, but not (as expected) the hypocotyl; **b.** the bases of the hypocotyl and primary root were light- and dark colored, respectively; and **c.** sometimes, but not always, the diameter of the hypocotyl-primary root axis decreased, progressing basipetally through the hypocotyl-primary root boundary. Persistent root hairs also served intermittently to identify the hypocotyl-primary root boundary in *Metopium toxiferum*, *Morella cerifera*, *Myrsine cubana*, *Nyssa biflora*, and *Sideroxylon salicifolium*. In *Jacquinia keyensis* we observed an abrupt switch from the robust, somewhat crowded, basally situated trichomes of the hypocotyl to the persistent, visibly different root hairs of the primary root. In *Magnolia virginiana*, a dense cluster of lateral roots (as well as changes in surficial color and texture) normally demarcated the hypocotyl-primary root boundary.

Hypocotyl lengths varied within/between the studied species. Selected species which sometimes produced long hypocotyls (i.e., ones exceeding 100 mm long) include *Annona glabra* (84–182 mm), *Canavalia rosea* (38–162 mm), and *Thespesia populnea* (49–122.5 mm; indicated between parentheses after each species name is the range of hypocotyl lengths, therein). Selected species which sometimes manifested short hypocotyls (i.e., ones less than 15 mm long) are *Conocarpus erectus* (12–45 mm), *Cynophalla flexuosa* (6–28.5 mm), *Forestiera segregata* (11–29.5 mm), *Guapira discolor* (12–35.5 mm), *Krugiodendron ferreum* (12–25 mm), *Lyonia fruticosa* (5–6.5 mm), *Morella cerifera* (13.5–34.5 mm), *Randia aculeata* (10.5–25 mm), and *Salix caroliniana* (3.5–12 mm). Most species manifested intermediate extremes of hypocotyl lengths.

In *Acacia auriculiformis*, *Leucaena leucocephala*, *Lysiloma latisiliquum*, and *Simarouba glauca*, early in seedling development the hypocotyl-primary root junction becomes/sometimes becomes swollen. Concomitantly, either a short hollow cylinder of, or a differently configured mass of outer tissue splits away from the base of the hypocotyl. That tissue may remain attached to the hypocotyl at one end. We don't know

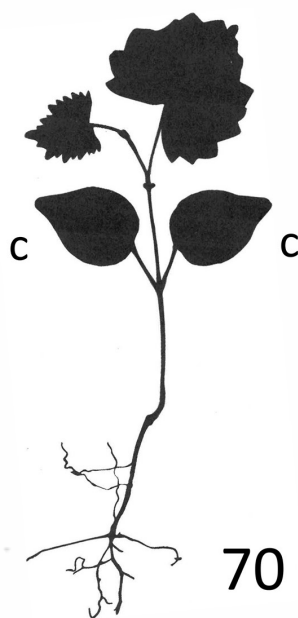
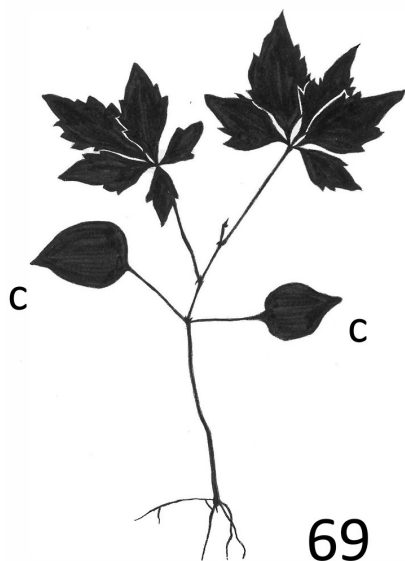
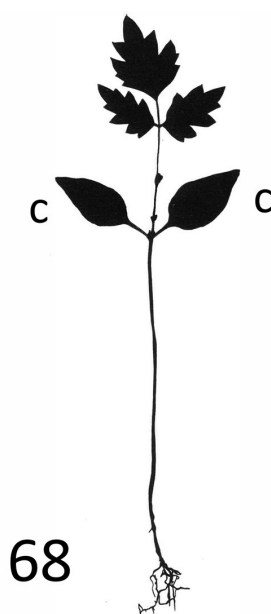
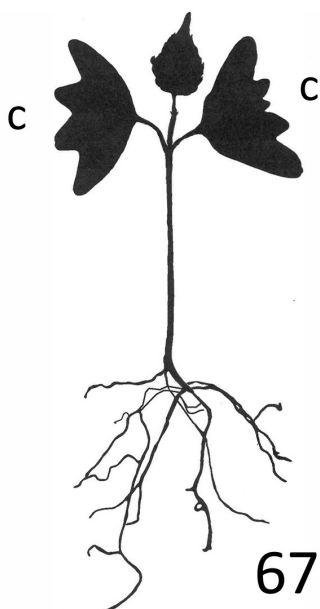


FIG. 67. *Cissus verticillata*. Seedling. $\times 0.87$; M.P. FIG. 68. *Nekemias arborea*. Seedling. $\times 0.62$; J.B. FIG. 69. *Parthenocissus quinquefolia*. Seedling. $\times 0.54$; K.R. FIG. 70. *Vitis rotundifolia*. Seedling. $\times 0.87$; M.P. Indicated sequentially, after each figure description are the magnification of, and the initials of the artist who prepared, the drawing (J.B. = Julio Gonzalez Batista; M.P. = Marcella Pulgarin; K.R. = Katja Redes). C. Cotyledon.

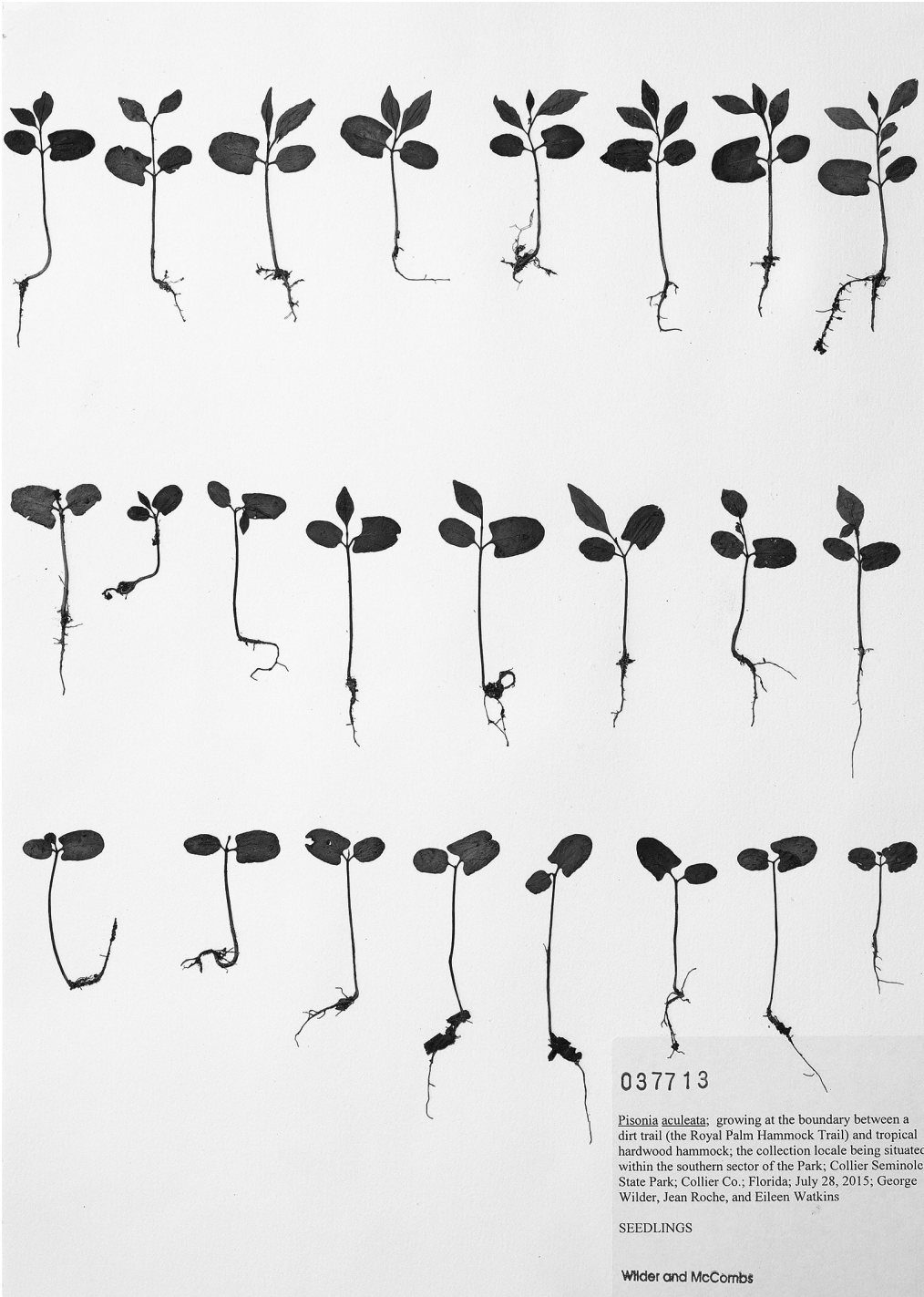


Fig. 71. An herbarium sheet with pressed seedlings of *Pisonia aculeata*. The sheet is representative of the specimens utilized for the present study.

why swelling and splitting occur. Perhaps, they are induced by little-developed, endogenously formed lateral roots which remain enclosed within the hypocotyl-primary root junction. Anatomical study could resolve that issue. It appears significant that the first three species belong to the same family (Fabaceae).

De Fogel (1980), apparently, referred to the kind of swellings, aforementioned. Calling the hypocotyl-primary root junction the "collet," he stated that "it may occur as a swollen portion at the base of the hypocotyl, in the form of a ring, or, as an [sic] unilateral outgrowth." He added that "in temperate epigeal herbaceous seedlings the presence of a thickened collet is rather common."

In *Chrysophyllum oliviforme* the outer cell layer(s) of the hypocotyl is/are commonly shed comparatively early, i.e., before any supra-cotyledonary leaves have expanded. By contrast, in *Cornus foemina* shedding is not evident, even after production of the first two supra-cotyledonary leaf pairs.

PHYLLOTAXY

Cotyledons.—The seedlings of all presently studied species except *Schoepfia schreberi* exhibit solely two cotyledons. In *S. schreberi* 15 (83%) and 3 (17%) of the studied seedlings bore two and three cotyledons, respectively (see below; Figs. 62, 62A).

As a rule, the two cotyledons/cotyledon scars of a seedling are opposite, but occasionally in various species they are sub-opposite (e.g., *Canavalia rosea*, *Celtis laevigata*, *Guapira discolor*, *Krugiodendron ferreum*, *Pisonia aculeata*, *Simarouba glauca*, and *Thespesia populnea*). Moreover, in *Celtis laevigata* the cotyledons are slightly to distinctly subopposite more often than they are opposite. We noted for certain species (e.g., *Krugiodendron ferreum*) that subopposite cotyledons/cotyledon scars were most frequent on older seedlings. Thus, we speculate - in the absence of developmental evidence - that cotyledons which are initially opposite one another may sometimes become separated by asymmetrical elongation within the hypocotyl.

Schoepfia schreberi.—Commentary, aforementioned, elicits the question of how we distinguished cotyledons from supra-cotyledonary leaves in that species. We did so, partly, based on the different number(s) and position(s) of ribs in those two kinds of leaves. Each cotyledon exhibits a midrib that forks into two equal/subequal daughter ribs (Fig. 62B). Forking occurs either by the base of the lamina or at a point situated up to one-third the distance from the base to the leaf apex. Each daughter rib extends distally along a separate side of the lamina, along a curved path culminating just basal to the leaf apex. By contrast, the supra-cotyledonary leaves exhibit solely one, un-forked midrib, which extends from the lamina-base to a point just basal to the leaf apex.

Whether or not a seedling of *S. schreberi* manifests two or three cotyledons, the cotyledons are essentially equal. When the cotyledons are paired, they vary from opposite to slightly subopposite (Fig. 62). Where three cotyledons occur, either **a.** they compose a whorl (Fig. 62A), or **b.** two cotyledons are inserted at a basal-most cotyledonary node and the third cotyledon arises from a cotyledonary node situated slightly distal to the basal-most node. The cotyledons then compose a pseudo-whorl.

Supra-cotyledonary leaves: species in which the adult plants exhibit alternate phyllotaxy.—Those species compose four groups based on the phyllotaxy of their seedlings. **Group 1.** All species consistently exhibit one leaf per supra-cotyledonary node. In those species, collectively, the leaves of the first three supra-cotyledonary nodes may be subopposite and/or alternate. **Group 2.** All species consistently manifest opposite leaves at the first supra-cotyledonary node. **Group 3.** In all species the first supra-cotyledonary node exhibits one leaf or two opposite leaves. **Group 4.** *Hypelate trifoliata* is the sole representative of this group. We elaborate on that species, below.

Clearly, Groups 2 and 3 represent a phyllotactic transition between the generally opposite arrangement of the cotyledons and the alternate phyllotaxy of the adult plants.

Acacia auriculiformis, *Leucaena leucocephala*, *Parthenocissus quinquefolia*, *Pisonia aculeata*, and *Thespesia populnea* exemplify Group 1, by consistently having one leaf at each of the first three supra-cotyledonary nodes. In *L. leucocephala*, the first three supra-cotyledonary nodes are always alternate (as opposed to subopposite; n = 100% of 21, 21, and 17 cases for supra-cotyledonary node nos. 1 through 3, respectively; Fig. 28).

Bursera simarouba (19), *Canavalia rosea* (13), *Krugiodendron ferreum* (31), *Metopium toxiferum* (20), and *Simarouba glauca* (19) represent Group 2, by having solely opposite leaves at the first supra-cotyledonary node (sample sizes are indicated between parentheses after the species names; Figs. 3, 9, 63). By contrast, each of those species produces solely single leaves at supra-cotyledonary node nos. 2 and 3.

Celtis laevigata, *Piscidia piscipula*, *Schinus terebinthifolia*, *Triadica sebifera*, and *Ulmus americana* represent the variable species of Group 3. In *Piscidia piscipula*, 89% of examples of supra-cotyledonary node no. 1 exhibited opposite leaves ($n = 18$; Fig. 30), whereas solely single leaves occurred at supra-cotyledonary node nos. 2 and 3. In *Schinus terebinthifolia*, 63% of examples of supra-cotyledonary node no. 1 exhibited opposite leaves ($n = 16$; Fig. 4), while solely single leaves occurred at supra-cotyledonary node nos. 2 and 3. Seedlings of *Ulmus americana* manifested diverse combinations of opposite and alternate phyllotaxy. We observed seedlings and a sapling of that species in which, collectively, supra-cotyledonary node(s) no. 1, or 1 and 2 (Fig. 66), or 1 through 3, or 1 through 4 exhibited opposite leaves.

Hypelate trifoliata, of Group 4, is unique among the presently studied species, because the first three to five (generally four) supra-cotyledonary leaves compose a whorl or, less often, a pseudo-whorl (Figs. 59 [the cotyledons have been abscinded from this specimen], 59A). By contrast, both nodes situated distal to the whorl/pseudo-whorl normally manifest single leaves.

Supra-cotyledonary leaves: species in which the adult plants exhibit opposite phyllotaxy.—In most such species phyllotaxy is consistently opposite within the first two or three supra-cotyledonary nodes (*Avicennia germinans*, *Casasia clusifolia*, *Chiococca alba* sensu lato, *Cornus foemina*, *Laguncularia racemosa*, *Psychotria nervosa*, *Randia aculeata*, and *Viburnum obovatum*; Figs. 52, 53, 55); however, *Forestiera segregata* and *Fraxinus caroliniana* (the presently studied species of Oleaceae) manifested variable phyllotaxy at those nodes. *Forestiera segregata* exhibited opposite (as opposed to single) leaves at supra-cotyledonary node nos. 1 to 3, in 94%, 78%, and 80% of cases, respectively ($n = 18, 9$, and 5 of those nodes, respectively). *Fraxinus caroliniana* exhibited opposite leaves at the three nodes, in 87.5%, 60%, and 100% of cases, respectively ($n = 16, 5$, and 2 of those nodes, respectively). The data for each species reflect the intermittent occurrence of sub-opposite phyllotaxy among the supra-cotyledonary leaves.

COTYLEDONS

Equal vs. unequal cotyledons.—In most, if not all, presently studied species the cotyledons vary at least minimally in size and shape. Furthermore, the species compose three main groups based on the extent of variation between the cotyledons of individual seedlings. **Group 1.** The cotyledons are equal or essentially so. This group includes most presently studied species (e.g., *Canella winterana*, *Forestiera segregata*, *Fraxinus caroliniana*, *Gymnanthes lucida*, *Metopium toxiferum*, *Myrsine cubana*, and *Sideroxylon salicifolium*; Figs. 10, 38, 43). **Group 2.** Commonly, but not always, individual seedlings produce decidedly unequal cotyledons (*Ipomoea violacea*, *Thespesia populnea*). **Group 3.** The cotyledons are consistently dimorphic (*Avicennia germinans*, *Guapira discolor*, and *Pisonia aculeata*). We focus, below, on those three species.

Avicennia germinans.—This species is unusual because the cotyledons remain folded at maturity. Each seedling manifests an outer cotyledon and an inner cotyledon. Each cotyledon is folded lengthwise along its midrib. The outer cotyledon is folded such that the two halves of its adaxial surface face one another and thereby enclose, collectively, both the seedling stem and the inner cotyledon; the inner cotyledon is folded such that the two halves of its abaxial surface face one another. On a seedling the lamina of the outer cotyledon is both longer and wider than that of the inner cotyledon (Fig. 1; the cotyledons have been pulled apart; the smaller cotyledon [depicted as white] overlies the larger cotyledon [depicted as black]).

Guapira discolor and *Pisonia aculeata* (Figs. 39, 40, 71).—We consider those species jointly, because they belong to the same family (Nyctaginaceae) and because they exhibit similar dimorphisms. In both species the mature cotyledons are expanded, unlike those of *Avicennia germinans*. As in *A. germinans*, however, each seedling manifests a larger cotyledon and a smaller cotyledon. For each of *G. discolor* and *P. aculeata* we randomly selected 10 seedlings and compared the dimensions of the two cotyledonary laminae of each seedling.

For each species, we found that the larger and smaller cotyledons exhibited statistically significant differences in the lengths, widths, and length-to-width ratios of their cotyledonary laminae (see pp. 115–118 of this paper).

Also, within individual cotyledon pairs of *P. aculeata* the base of the larger cotyledonary lamina is more often reniform or auriculate than is that of the smaller cotyledonary lamina. Too, if the lamina base is reniform or auriculate in both cotyledons, then it is more pronouncedly so in the larger cotyledon.

Lubbock (1892) and De Vogel (1980), collectively, indicated diverse species/genera of dicotyledons exhibiting dimorphic cotyledons. We list them, below, in alphabetical order of their family names: Acanthaceae (*Thunbergia reticulata*), Apiaceae (*Carum*), Asteraceae (*Coreopsis atkinsoniana*), Brassicaceae (“cabbage,” “mustard,” and *Raphanus*), Cactaceae (*Cereus*), Euphorbiaceae (*Sauropus*), Moraceae (*Artocarpus* [“some ... species”]; *Streblus*), Nyctaginaceae (*Abronia arenaria*, *Abronia umbellata*, *Mirabilis dichotoma*, *Mirabilis longiflora*, *Mirabilis multiflora*, *Oxybaphus elegans*, *Oxybaphus nyctagineus*, *Oxybaphus ovatus*, *Oxybaphus viscosus*), Petiveriaceae (*Petiveria octandra*), Primulaceae (*Cyclamen*), and Ranunculaceae (*Ranunculus*). Interestingly, despite the length of this list De Vogel (1980) stated that “almost always the cotyledons of a seedling are equal in function, shape, and size.”

Significantly, two of the three presently studied species with dimorphic cotyledons (*Guapira discolor*, *Pisonia aculeata*) belong to the Nyctaginaceae. Lubbock (1892), referring to the nyctaginaceous species that he examined, stated that “the cotyledons are always unequal, but in some cases one is nearly aborted.” Also, Lubbock (1892) attributed the development of cotyledonary dimorphisms in general to positional/structural asymmetries of the seed coat or of the extra-cotyledonary portions of the embryo and to their resulting uneven spatial limitations on cotyledonary growth within the seed.

Early abscission of cotyledons.—In *Sideroxylon salicifolium* the cotyledons are abscinded unusually early, i.e., after expansion of the first pair of supra-cotyledonary leaves (c.f. Figs. 61–61B).

Cotyledonary laminae lobed above the base.—Eight (11.5%) of the 70 presently studied species manifest such laminae. In *Bursera simaruba* the cotyledonary lamina is consistently three-lobed (Fig. 9). In *Cissus verticillata* it manifests terminal extensions (most commonly 4 or 5, but sometimes 3 or 8) which range from being lobes to rounded teeth (Fig. 67). In *Celtis laevigata* the cotyledonary apex is cleft, yielding two lobes which comprise ca. half or less of lamina length (Fig. 11). Similarly, in all five presently studied *Ipomoea* species the cotyledons manifest a very wide medial sinus which demarcates two lobes. Four of the species exhibit broad lobes (*Ipomoea alba*, *Ipomoea pes-caprae*, *Ipomoea triloba*, and *Ipomoea violacea*; Figs 16, 17, 19–20A); however, in *Ipomoea quamoclit* the lobes are long, narrow (sometimes nearly linear), and they diverge from one another at a particularly wide angle and just distal to the lamina base (Fig. 18). Because of their lengths and wide divergence angle, the lobes of *I. quamoclit* are each longer than the lamina itself (lamina length being measured along the median between the two lobes).

Lubbock (1892), Kummer (1951), Haring (1968), Stucky (1981), and Garwood (2009), collectively, reported bilobed cotyledons in ten additional *Ipomoea* species, viz., *I. cairica* (“*Ipomoea palmata*”), *I. coccinea*, *I. dasysperma*, *I. eriocarpa* (“*Ipomoea hispida*”), *I. hederacea*, *I. lacunosa*, *I. leptophylla*, *I. nil*, *I. philomega*, and *I. purpurea*. Thus, bilobed cotyledons might predominate or be omnipresent in that genus. *Ipomoea* (including *Mina* and *Pharbitis*) includes ca. 650 species (Mabberley 1997).

Less incised cotyledonary apices.—*Ilex cassine* var. *cassine* consistently exhibits retuse to emarginate cotyledonary apices (Figs. 6, 6A). Additional species inconsistently manifest retuse apices.

Cotyledonary laminae lobed at the base.—Seven (10%) of the presently studied species (including three of Fabaceae) consistently or inconsistently manifest such laminae: *Acacia auriculiformis*, *Krugiodendron ferreum*, *Leucaena leucocephala*, *Lysiloma latisiliquum*, *Pisonia aculeata*, *Simarouba glauca*, and *Ulmus americana* (Figs. 66, 66A). Depending on the species the lamina base may be sagittate, hastate, auriculate, and/or manifest intermediate conditions.

Thickness of cotyledons.—Most presently studied species exhibit thin cotyledons, but eight species

have cotyledons which are variously thick to the touch: *Canavalia rosea*, *Conocarpus erectus*, *Cynophalla flexuosa*, *Hypelate trifoliata*, *Krugiodendron ferreum*, *Metopium toxiferum*, *Morella cerifera*, and *Simarouba glauca* (Fig. 63). In *Tricerna phyllanthoides* different cotyledons may be thin or thick.

Stipules.—Among the presently studied species the stipules of the cotyledons and supra-cotyledonary leaves (aside from stipules of the supra-cotyledonary leaves of *Magnolia virginiana*) appear stem-borne rather than epi-petiolar. Quantitative data are presented, below.

- 1) Only ten (14%) of the presently studied species exhibited or sometimes exhibited stipulate cotyledons, whereas 35 (50%) of all species exhibited stipulate supra-cotyledonary leaves.
- 2) In 25 (71%) of the species in which the supra-cotyledonary leaves were at least sometimes stipulate, the cotyledons lacked stipules.
- 3) In 100% of the 35 species having estipulate supra-cotyledonary leaves the cotyledons were estipulate, as well.
- 4) In 100% of the 10 species which exhibited or sometimes exhibited stipulate cotyledons, the supra-cotyledonary leaves were stipulate, as well.

Those data (especially, item nos. 1 and 2) suggest that, as a rule, stipules benefit seedlings more (e.g., by protecting the terminal bud) when situated on the supra-cotyledonary leaves than when situated on the cotyledons. The presently studied species which have or sometimes have stipulate cotyledons belong to the Magnoliaceae (*Magnolia virginiana*), Polygonaceae (*Coccoloba diversifolia*, *Coccoloba uvifera*), Rubiaceae (*Casasia clusiifolia*, *Cephalanthus occidentalis*, *Chiococca alba*, *Psychotria nervosa*, *Psychotria tenuifolia*, and *Randia aculeata*), and Fabaceae (*Lysiloma latisiliquum*).

Somewhat contrary to present findings, De Vogel (1980) stated that “stipules at the base of ... cotyledons are very rare ...” Garwood (2009), essentially echoing that conclusion, indicated that stipules “rarely ... grow out from the cotyledonary petioles near the stem.”

Magnolia virginiana.—In this species, in an interpetiolar region between the cotyledons we sometimes observed - and interpreted as stipular - a short (0.2–0.3 mm long), membranous structure connecting the submarginal portions of the two adjacent cotyledonary petioles. The structure barely resembled the stipules of the supra-cotyledonary leaves of this species (see below). It was, however, comparable to an interpetiolar stipule of the rubiaceous species considered, below.

Interpetiolar stipules.—Generally, in dicotyledons alternate stipulate adult leaves each manifest two stipules; however, in certain dicotyledonous species with consistently opposite adult leaves, two interpetiolar stipules develop at each node (yielding an apparent leaf-to-stipule ratio of 1 to 1). Each interpetiolar stipule occupies a separate one of the two associated interpetiolar regions.

In all six presently studied species of Rubiaceae both the cotyledons as well as the adult leaves exhibited opposite phyllotaxy and interpetiolar stipules. At least five of those species were separable into two groups, based on characteristics of the interpetiolar stipules at the cotyledonary node. **Group 1** (*Cephalanthus occidentalis* and *Chiococca alba* *sensu lato*). At the cotyledonary node each margin of each interpetiolar stipule is adnate to a separate one of the two associated cotyledonary petioles. Thereby, the two interpetiolar stipules and the two petioles, collectively, compose a short tube. **Group 2** (*Psychotria nervosa*, *Psychotria tenuifolia*, and *Randia aculeata*). At the cotyledonary node each interpetiolar stipule appears free from the two associated petioles. Rather, its rightmost portion (as seen in external view of the seedling) arises from stem tissue situated along the adaxial side of the cotyledon at right; its leftmost portion arises from stem tissue situated along the adaxial side of the cotyledon at left. At least in *P. nervosa* the two interpetiolar stipules may be connate marginally. (Our pressed specimens precluded us from ascertaining whether this was also true in *P. tenuifolia* and *R. aculeata*).

Polygonaceae.—In many, but not all, polygonaceous species the leaves of the adult plants are alternate and each exhibits an ocrea (sheathing structure) composed of two connate stipules (Cronquist 1981); however, in *Coccoloba diversifolia* and *Coccoloba uvifera* (the two presently studied species of Polygonaceae) the paired cotyledons at the cotyledonary node manifest a common ocrea which we interpret as two fused ocreae. Thus, the common ocrea would consist of four connate stipules.

The common ocrea is a short, thin tube anchored to the stem along a circular, transverse line extending immediately distal to each cotyledonary petiole and between the cotyledonary petioles. We call it a common ocrea because we attribute it to two leaves (cotyledons), whereas an ocrea, as stated, belongs solely to one leaf (see below). Early in its development the common ocrea is the peripheral-most portion of the terminal bud of its parent stem (as is also true of the ocrea of an unpaired supra-cotyledonary leaf). The form of the common ocrea is best observed on older seedlings. Morphologically, it resembles the pair of interpetiolar stipules characteristic of Group 2 of the Rubiaceae, aforementioned.

Leucaena leucocephala (Fabaceae).—The cotyledonary node lacks typical stipules but exhibits many narrow, semi-persistent scales which are, collectively, interpretable as stipules. They arise along a circular, transverse line extending immediately distal to each cotyledonary petiole and between the cotyledonary petioles. They vary from apparently distinct to basally connate. Where they are connate basally, the connate region may be adnate to the margin of one of the cotyledonary petioles. Based on their positions, the scales, collectively, are reminiscent of the interpetiolar stipules of the Rubiaceae and of the common ochrea of *Coccoloba* species.

Petioles.—In fifty-three (76%) of the presently studied species the cotyledons were consistently petiolate, whereas eight (11%) of the species consistently had sessile cotyledons. Nine (13%) of the species each produced both petiolate and sessile cotyledons. The species with consistently sessile cotyledons were *Abrus precatorius*, *Canella winterana*, *Casuarina equisetifolia*, *Chrysophyllum oliviforme*, *Fraxinus caroliniana*, *Morella cerifera*, *Sideroxylon salicifolium*, and *Suriana maritima* (Figs. 10, 12, 12A, 25, 60).

We divide the species with consistently petiolate cotyledons into three main groups, based on the lengths of the cotyledonary petioles. **Group 1.** The species are long-petiolate (i.e., having maximum petiole lengths exceeding 10 mm). There are nine such species: *Gossypium hirsutum*, all studied *Ipomoea* species, *Parthenocissus quinquefolia*, *Thespesia populnea*, and *Vitis rotundifolia* (Figs. 16, 33, 69). *Ipomoea alba* manifests the longest cotyledonary petioles of all presently studied species (18.5 to 70 mm). **Group 2.** The species have petioles that are minute or short (i.e., with maximum lengths of 2 mm or less). Included, are 16 species (e.g., *Acacia auriculiformis*, *Chiococca alba* sensu lato, *Cynophalla flexuosa*, *Forestiera segregata*, *Jacquinia keyensis*, *Krugiodendron ferreum*, *Lyonia fruticosa*, *Myrsine cubana*, and *Ulmus americana*). **Group 3.** The species have maximum petiole lengths that are intermediate (i.e., ranging from over 2 mm to/including 10 mm long). Included, are most (28) of the studied species (e.g., *Conocarpus erectus*, *Itea virginica*, *Laguncularia racemosa*, *Pisonia aculeata*, and *Triadica sebifera*; Figs. 24, 31).

Symmetry of cotyledons.—In most presently studied species the cotyledons are more or less symmetrical, but certain species regularly or sometimes exhibit asymmetrical cotyledons. Generally, in *Piscidia piscipula* the two margins of the cotyledonary lamina are convex and concave, respectively (Fig. 30). Similarly, in *Schinus terebinthifolia* the two lamina margins are generally convex and either straight or concave, respectively. Also, consider *Ipomoea violacea*, which manifests bilobed cotyledons. The individual cotyledons vary from essentially symmetrical (Fig. 20) to conspicuously asymmetrical (Fig. 20A). Asymmetry may be manifested: **a, b.** in uneven lengths and/or widths of the two cotyledonary lobes, and **c.** in an oblique lamina base (i.e., a reniform base in which the two basal lamina-extensions protrude basally to different extents).

Buds axillary to the cotyledons.—In our pressed specimens the bases of the cotyledons often covered and rendered axillary buds indetectable. Never-the-less, we observed buds axillary to some cotyledons, and/or we saw branches axillary to the cotyledon scars, in 44 (63%) of presently studied species (e.g., *Bursera simarouba*, *Fraxinus caroliniana*, *Krugiodendron ferreum*, *Parthenocissus quinquefolia*, *Quadralla jamaicensis*, *Triadica sebifera*, and *Ulmus americana*).

ASPECTS OF THE SUPRA-COTYLEDONARY PORTIONS OF THE SEEDLING

Supra-cotyledonary internodes.—In many presently studied species the early formed supra-cotyledonary internodes are variously expanded and easily recognized (e.g., *Bursera simarouba*, *Krugiodendron ferreum*; Figs. 9, 49); however, in *Casuarina equisetifolia* and *Jacquinia keyensis* those internodes are highly condensed

(Figs. 12, 12A, 65). As well, in *Salix caroliniana* internode no. 1 varies from short to non-existent (Fig. 57), and in *Abrus precatorius* internode no. 1 is little-elongated, varying from 0.3 to 0.7 mm long. By contrast, in *A. precatorius* internode nos. 2 and 3 are always much longer. In *Casasia clusiifolia* the first internode is comparatively long (11 mm in each of two seedlings), whereas the second and third internodes are hardly, if at all, developed (Fig. 50). *Hypelate trifoliata* is unique among the studied species, in producing a long first internode capped by a whorl or pseudo-whorl of crowded leaves (Figs. 59, 59A). Generally, long internodes succeed the whorl/pseudo-whorl.

Transitions from simple to compound leaves.—In diverse species the leaves appear increasingly complex, progressing acropetally from supra-cotyledonary node nos. 1 through 3.

We divide into four groups the species in which the adult plants produce compound leaves. **Group 1.** The seedling produces solely simple supra-cotyledonary leaves. Compound leaves develop later (*Fraxinus caroliniana*, *Metopium toxiferum*, and *Piscidia piscipula*; Figs. 3, 30, 43). **Group 2.** Like the adult leaves, all supra-cotyledonary leaves are once compound (*Parthenocissus quinquefolia* and *Simarouba glauca*; Figs. 63, 69). **Group 3.** Supra-cotyledonary node no. 1 exhibits once-compound leaves, whereas supra-cotyledonary node nos. 2 and 3 manifest twice-compound leaves (*Acacia auriculiformis*, *Leucaena leucocephala* and *Lysiloma latisiliquum*). In each species the twice-compound leaves at node nos. 2 and 3 manifest solely two opposite pinnae, each pinna having many pinnules (Fig. 28). **Group 4.** Supra-cotyledonary node nos. 1 through 3 exhibit a morphological transition from simple to compound leaves (*Abrus precatorius*, *Canavalia rosea*, *Nekemias arborea*, and *Schinus terebinthifolia*; Fig. 4).

Consider *Schinus terebinthifolia*, in which the percentages of different leaf types vary between supra-cotyledonary node nos. 1 to 3. The leaf at node no. 1 is either simple and undivided, simple and divided, or once-compound with two pinnae ($n = 94\%$, 4% , and 2% of 47 leaves, respectively). The leaf at node no. 2 is either simple and undivided, simple and divided, or once-compound with two or three pinnae ($n = 17\%$, 6% , and 78% of 18 leaves, respectively). At node no. 3 the leaves are either simple and undivided or once compound with three pinnae ($n = 8\%$ and 92% of 13 leaves, respectively).

Likewise, *Hypelate trifoliata* may exhibit simple leaves, compound leaves, and leaves intermediate between them within the whorl or pseudo-whorl of leaves situated distal to the cotyledons (Figs. 59).

Depauperate supra-cotyledonary leaves.—In two species some of the supra-cotyledonary leaves of the seedling are depauperate, i.e., discreetly shorter than the other supra-cotyledonary leaves. In *Abrus precatorius* the first supra-cotyledonary node consistently manifests two depauperate leaves. They range from 0.6 to 1.3 mm long, are simple, sessile, and vary from being estipulate to having two well defined stipules. By contrast, supra-cotyledonary node nos. 2 and 3 manifest much longer leaves that are pinnately compound and petiolate. In *Tricerna phyllanthoides* each of the first two supra-cotyledonary nodes manifests either a depauperate leaf or a well-developed leaf. The depauperate leaves are purple and measure 0.7 to 1.5 mm long. The well-developed leaves are green and much longer.

Stipules.—Many presently studied species with stipulate adult leaves consistently produce stipulate supra-cotyledonary leaves (e.g., *Colubrina asiatica*, *Drypetes diversifolia*, *Gossypium hirsutum*, *Leucaena leucocephala*, and *Parthenocissus quinquefolia*), but this is not true of all species. In *Thespesia populnea*, stipules are absent at supra-cotyledonary node no. 1, sometimes present at supra-cotyledonary node no. 2, and at least sometimes present at supra-cotyledonary node no. 3. In *Salix caroliniana* the leaves of adult plants commonly manifest large, persistent, leaf-like stipules (Tomlinson 2001; George Wilder, unpublished observations). Yet, we observed that stipules are normally absent from the leaves at supra-cotyledonary node nos. 1 to 3. We found on only one of 11 leaves from supra-cotyledonary node no. 3 that one side of the petiole base was sufficiently enlarged to rank as a little-developed stipule. Better-defined stipules occurred on the later-formed leaves of saplings. They were clearly extensions of the basal part of the winged (sheath-like) petiole.

In some species the supra-cotyledonary leaves exhibit unusual stipules. In *Itea virginica* those stipules are minute (0.1 to 0.2 mm long) and at maturity consist largely or entirely of thickened, white tissue. In *Tricerna phyllanthoides* the stipules are purplish and manifest short to long marginal projections which are

either non-glandular or partly or entirely glandular. Similarly, the interpetiolar stipules of *Cephalanthus occidentalis* and *Chiococca alba* sensu lato may exhibit small numbers of glandular projections which are purplish and brown in those species, respectively.

In *Jacquinia keyensis* the supra-cotyledonary leaves are estipulate, but the first two leaves (prophylls) of an axillary bud nearby may expand early and may then be mistaken for stipules.

Stipules of *Magnolia virginiana*.—We follow previous workers in recognizing stipules in *Magnolia* species (Lubbock 1899; Trelease 1918; Troll 1937; Muenscher 1950; Bierhorst 1971; Gifford & Foster 1989); however, the stipules of the supra-cotyledonary leaves of *M. virginiana* are unusual, being defined primarily by tearing of tissue rather than, partly, by differential growth. On the supra-cotyledonary leaves of *M. virginiana* the stipules are the two thin, unlobed, lateral portions of a sheath-like petiole. Initially, the petiolar margins are fused together and the base of each lateral portion of the petiole is attached to the associated node, along a line that extends halfway around the node. Late in leaf development the two lateral portions of the petiole become detached from each other and are abscinded from the central axis of the petiole and from the stem. After abscission, on each side of the petiolar central axis a scar extends basipetally from the distal end of that axis to a point situated halfway around the associated node.

On the supra-cotyledonary leaves of *M. virginiana* the intact petiole is interpretable as a closed leaf sheath, because its lateral portions are thin and because its margins are initially fused together. After abscission of the stipules the remaining “petiole” is really the central axis of the petiole. Thus, the intact petiole of *M. virginiana* outwardly resembles the leaf sheaths of various monocotyledonous species (e.g., of certain palms). In them the lateral portions of the leaf sheath die early, but the thickened median part persists long afterward.

Interpetiolar stipules of the Rubiaceae.—In four of the six presently studied rubiaceous species the interpetiolar stipules of the supra-cotyledonary leaves fundamentally resemble those of the cotyledons (*Cephalanthus occidentalis*, *Psychotria nervosa*, *Psychotria tenuifolia*, and *Randia aculeata*; see pp. 127–131 above); however, among the supra-cotyledonary leaves of *Chiococca alba* sensu lato each interpetiolar stipule is at least sometimes free from its associated petioles (contrary to the adnate stipules and petioles among the cotyledons of this species). For *Casasia clusiifolia*, available materials precluded careful comparisons between the interpetiolar stipules of the cotyledons and the supra-cotyledonary leaves.

The dual nature of interpetiolar stipules.—Eames (1961), Gifford and Foster (1989), and others have interpreted interpetiolar stipules as “dual structures” which represent “... the partial or complete union of the adjacent stipules at each side of the node.” Present data from four species of Fabaceae support that interpretation (*Abrus precatorius*, *Canavalia rosea*, *Lysiloma latisiliquum*, and *Piscidia piscipula*). Those species manifest alternate leaves on adult plants but produce opposite leaves at the first supra-cotyledonary node. Consider that node in *P. piscipula*. Four distinct stipules may develop (i.e., two stipules per leaf). Alternatively, one interpetiolar stipule may form in at least one of the two interpetiolar regions, which is either bifid halfway to the base or undivided. We consider the bifid and undivided interpetiolar stipules as two partially connate and two fully connate stipules, respectively. Likewise, we observed individual interpetiolar stipules representing various stages of stipule connation among the supra-cotyledonary leaves of *A. precatorius*, *C. rosea*, and *L. latisiliquum*, collectively.

MACROSCOPICAL DIFFERENCES BETWEEN COTYLEDONS AND SUPRA-COTYLEDONARY LEAVES

In *Cephalanthus occidentalis* the cotyledons more-or-less resemble (but are smaller than) the supra-cotyledonary leaves (Fig. 51); however, in the great majority of species the cotyledons and supra-cotyledonary leaves differ conspicuously from one another. We consider selected differences, below.

Relative sizes.—The cotyledons vary from being obviously shorter and narrower than the supra-cotyledonary leaves (*Krugiodendron ferreum*, *Metopium toxiferum*; Figs. 3, 49) to exceeding them (*Casuarina equisetifolia*; Figs. 12, 12A).

Simple vs. compound leaves.—All presently studied species exhibit simple cotyledons. Yet, as indicated

four species manifest both simple and compound supra-cotyledonary leaves (*Abrus precatorius*, *Canavalia rosea*, *Nekemias arborea*, and *Schinus terebinthifolia*) and six species have solely compound supra-cotyledonary leaves (*Acacia auriculiformis*, *Leucaena leucocephala*, *Lysiloma latisiliquum*, *Parthenocissus quinquefolia*, *Simarouba glauca*, and *Zanthoxylum fagara*; Figs. 26, 28, 29, 56, 69).

Lamina shapes of cotyledons vs. those of simple supra-cotyledonary leaves.—We consider five examples. **1.** *Celtis laevigata*.—The cotyledons are either obovate, obovate-oblong, narrowly oblong, or oblong, whereas, the supra-cotyledonary leaves are ovate (Fig. 11). **2.** *Drypetes lateriflora*.—The cotyledons are very widely ovate, whereas the supra-cotyledonary leaves are lanceolate, lanceolate-ovate, oblanceolate, or elliptic (Figs 47, 47A). **3.** *Fraxinus caroliniana*.—The cotyledons are oblong to narrowly oblong or narrowly lanceolate-oblong. By contrast, the supra-cotyledonary leaves are mostly lanceolate-ovate to ovate. (Fig. 43). **4.** *Ilex cassine* var. *cassine*.—The cotyledons are normally ovate, whereas, the supra-cotyledonary leaves are generally obovate to widely obovate or elliptic to widely elliptic (Figs. 6, 6A). **5.** *Piscidia piscipula*.—The cotyledons are generally asymmetrical (albeit, often approximately oblong), whereas the supra-cotyledonary leaves are generally ovate-widely ovate to very widely ovate-widely depressed ovate (Fig. 30).

Non-basal lobes of the lamina.—We indicated eight species in which the cotyledonary lamina exhibits non-basal lobes. Yet, in six of those species the supra-cotyledonary leaves are either unlobed (*Bursera simarouba*, *Celtis laevigata*, *Cissus verticillata*, *Ipomoea triloba*, *Ipomoea violacea*; Figs. 9, 19, 20, 67) or are unlobed or manifest barely developed lobes (*Ipomoea pes-caprae*; Fig. 17). Of the remaining two species, **a.** *Ipomoea quamoclit* manifests pinnately compound rather than lobed supra-cotyledonary leaves (Fig. 18), and **b.** *Ipomoea alba* exhibits either unlobed or three-to-five lobed supra-cotyledonary leaves (Fig. 16).

Basal lobes of the lamina.—We also indicated seven species in which the lamina base of the cotyledons is consistently or inconsistently lobed (appearing auriculate, hastate, and/or sagittate). Yet, in each such species the laminae of the supra-cotyledonary leaves lack basal lobes. In the two species having simple supra-cotyledonary leaves the lamina bases, thereof, are rounded, subcordate, or cordate (*Krugiodendron ferreum*; Fig. 49) or acute to cuneate (*Pisonia aculeata*; Fig. 40). In *Acacia auriculiformis*, *Leucaena leucocephala*, and *Lysiloma latisiliquum* (species with compound supra-cotyledonary leaves), the pinna/pinnule bases are, collectively, either oblique or generally so. In *Simarouba glauca*, also with compound leaves, the pinna bases are generally acute to rounded, but sometimes acuminate.

Lamina margins.—In certain species the cotyledons have entire margins, yet the margins of the individual supra-cotyledonary leaves are either serrate (e.g., *Gymnanthes lucida*, *Schinus terebinthifolia*, and *Viburnum obovatum*; Figs. 2, 4, 23), partly serrate and partly entire (e.g., *Fraxinus caroliniana*, *Ilex cassine* var. *cassine*; Figs. 6, 6A, 43), spinulose dentate (*Drypetes diversifolia*; Fig. 46), dentate or crenate-dentate (*Vitis rotundifolia*; Fig. 70), or either crenate, crenate-serrate, or serrate (*Hibiscus acetosella*; Fig. 34).

In *Drypetes diversifolia* the leaves of adult plants, unlike the supra-cotyledonary leaves of the seedlings and saplings, have entire rather than toothed lamina margins. Also, the supra-cotyledonary leaves of *Drypetes lateriflora* manifest entire leaf margins, unlike those of *D. diversifolia* (cf. Figs. 46, 47). In *D. diversifolia* most marginal teeth of the supra-cotyledonary leaves consist of a basal laminar portion and a terminal spine, but some teeth consist solely of a spine.

Lamina apex.—We present four examples of differences between cotyledons and supra-cotyledonary leaves. **1.** *Celtis laevigata*.—Whereas the cotyledonary apex is cleft, the supra-cotyledonary leaves manifest mostly acute but sometimes narrowly rounded and simultaneously mucronulate apices (Fig. 11). **2.** *Cissus verticillata*.—The cotyledonary apex is ill-defined, being obscured by terminal lobes and/or teeth; yet, the supra-cotyledonary leaves manifest acute apices (Fig. 67). **3.** *Ilex cassine* var. *cassine*.—The cotyledonary apex is either retuse or emarginate, yet the apices of the supra-cotyledonary leaves are mostly broadly acute to rounded and simultaneously mucronulate (Figs. 6, 6A). **4.** *Triadica sebifera*.—The cotyledonary apex is truncate or rounded, whereas the apex of the supra-cotyledonary leaves, while variable, is mostly acute (Fig. 24).

Lamina thickness.—The eight presently studied species with variously thickened cotyledons produce non-thickened supra-cotyledonary leaves.

TRICHOMES

Trichomes (epidermal appendages) include papillae, hairs, and epidermal scales (Esau 1977). The seedlings of five presently considered species lack trichomes altogether: *Acer rubrum*, *Canella winterana*, *Hypelate trifoliata*, *Schoepfia schreberi*, and *Simarouba glauca*. Those of another species, *Zanthoxylum fagara*, apparently lack trichomes but manifest very sparse, unidentified excrescences (apparently, either trichomes or emergences). Seedlings of the remaining 64 presently considered species exhibit, collectively, all three kinds of trichomes.

Papillae.—These are minute bulges, one per cell, that project outward from the epidermis. They are best seen at high magnification with the stereoscopic microscope, rather than with hand lenses at standard magnifications. In seedlings of four presently studied species papillae were the sole kind of trichomes present (*Chiococca alba* sensu lato, *Cynophalla flexuosa*, *Casuarina equisetifolia* and *Tricerna phyllanthoides*). Other species manifested papillae together with different kinds of trichomes (e.g., *Casasia clusiifolia*, *Quadralla jamaicensis*). Also, the seedlings of various species exhibited papillae with more-or-less rounded tips; however, we noted sharp-tipped papillae in *Chiococca alba* sensu lato, *Forestiera segregata*, and *Krugiodendron ferreum*.

Although papillae and epidermal hairs were generally structurally discrete from one another, the seedlings of certain species produced both types of trichomes plus structures intermediate between them (*Cephalanthus occidentalis*, *Coccoloba uvifera*, *Forestiera segregata*, *Krugiodendron ferreum*, *Leucaena leucocephala*, and *Schinus terebinthifolia*).

In at least some species, e.g., *Forestiera segregata*, papillae appeared less abundant on older hypocotyls, suggesting that papillae are ephemeral. Thus, to properly detect papillae and assess their density, one should examine relatively young seedlings.

Hairs.—Emphasized, below are kinds of, and aspects of, hairs that facilitate the identification of the seedlings of certain species.

Stellate hairs.—*Hibiscus acetosella* is the sole presently studied species with stellate hairs. They are branched basally and co-occur with simple hairs. All main parts of the seedling shoot exhibit the hairs of both types.

T-shaped hairs.—We noted these in *Cornus foemina* and *Sideroxylon salicifolium*, where they occurred on the supra-cotyledonary internodes and supra-cotyledonary leaves. On a T-shaped hair the central axis of the “T” is erect, extremely short, and not readily perceived in top view. In contrast, both arms of the “T” are conspicuous and much longer. In *C. foemina*, on the supra-cotyledonary internodes the two arms of each “T” are appressed to, and extend acropetally and basipetally along, the associated internode, respectively. Also, in *C. foemina*, on each lamina surface of the supra-cotyledonary leaves the two arms of a “T” are antrorse and retrorse, respectively. On the supra-cotyledonary internodes of *S. salicifolium* the arms of each “T” vary from appressed to ascending and each arm culminates in a sharp tip. As in *C. foemina* the arms parallel the internode long axes. In *C. foemina* the hairs are white/mostly white or brown, whereas, in *S. salicifolium* they are lustrous and dark brown (see below).

Helical hairs.—We observed these in *Vitis cinerea*. They are much coiled, sometimes entangled with each other, and generally light brown. On seedlings they develop on the supra-cotyledonary internodes and supra-cotyledonary leaves.

Sessile yellow hairs.—We noted these in *Morella cerifera*, where they occurred on all portions of the seedling shoot except the hypocotyl. The hairs are minute, appearing circular in top view. On individual cotyledons, numerous such hairs compose, and are restricted to, a well-defined submarginal ring situated adaxially on the lamina. On the supra-cotyledonary internodes and supra-cotyledonary leaves the hairs are scattered.

Long, lustrous, dark-brown hairs.—We observed these in both presently studied species of Sapotaceae: *Chrysophyllum oliviforme* and *Sideroxylon salicifolium*. They were simple and T-shaped in the two species,

respectively. In each species they were confined to the supra-cotyledonary internode(s) and supra-cotyledonary leaves.

Epidermal scales.—Five presently studied species manifested scales (*Fraxinus caroliniana*, *Lyonia fruticosa*, *Quadrella jamaicensis*, *Thespesia populnea*, and *Viburnum obovatum*). On the seedlings of *F. caroliniana*, *L. fruticosa*, and *Q. jamaicensis* they occurred on the supra-cotyledonary internodes and supra-cotyledonary leaves, but not on the hypocotyl and cotyledons. In *T. populnea*, they occurred on the hypocotyl, cotyledons, supra-cotyledonary internodes, and supra-cotyledonary leaves. In *V. obovatum* they were on all parts of the seedling shoot except the hypocotyl.

In at least *Fraxinus caroliniana*, *Lyonia fruticosa*, *Quadrella jamaicensis*, and *Thespesia populnea* the scales are peltate, consisting of a stalk and cap. In *T. populnea* the cap exhibits **a.** a central portion variously suffused with brown, and **b.** marginal hairlike rays which vary considerably in length from one scale to another. In *Viburnum obovatum*, in top view the scales generally appear more-or-less isodiametric (often circular) and either exhibit or lack marginal, stub-like rays. In *T. populnea* and *V. obovatum* the cap/scale generally parallels the surface of the associated stem and/or leaf. In all five species with scales, the scales are at least sometimes pigmented (appearing brown, gray, and/or black).

Seedlings having diverse kinds of trichomes.—As indicated, the seedlings of certain species produce two or three kinds of trichomes. Different species manifest papillae and hairs (e.g., *Forestiera segregata*), papillae and scales (e.g., *Quadrella jamaicensis*), or all three kinds of trichomes (*Lyonia fruticosa*). Species of Vitaceae are noteworthy in this regard. Although in three presently studied vitaceous species the hypocotyl is at least sometimes papillate, hairs develop solely on other parts of the seedling shoots (*Nekemias arborea*, *Parthenocissus quinquefolia*, *Vitis rotundifolia*). Whereas all three species exhibit short, stiff, sharp-tipped hairs, **a.** *N. arborea* also produces soft, narrow, and conspicuously septate hairs, while **b.** *V. rotundifolia* manifests the helical hairs, aforementioned.

Seedlings of *Ardisia escallonioides* and *Myrsine cubana* (the two currently studied species of Myrsinaceae) both produce hairs mostly up to 0.1 mm long, which manifest purplish, sometimes swollen tips. Each species also exhibits a second kind of hairs. Similarly, seedlings of *Suriana maritima* manifest two types of hairs distal to the cotyledons: **a.** hairs having blunt pink or yellow tips, and **b.** sharp-tipped hairs completely devoid of pigment. The hairs of both kinds, collectively, are narrow and up to 0.9 mm long.

Preferred locations of trichomes.—The 64 presently studied species having seedlings with trichomes exhibit, collectively, a tendency for the trichomes to be more abundant, progressing acropetally on the seedlings. Evidence is listed.

- 1) In 24 (38%) of the 64 species the hypocotyl consistently lacks trichomes, yet trichomes develop on certain or all of the more distally situated sectors of the seedling (e.g., *Abrus precatorius*, *Chrysophyllum oliviforme*, *Cornus foemina*, *Itea virginica*, *Magnolia virginiana*, *Psychotria nervosa*, and *Suriana maritima*).
- 2) In 18 (28%) of the 64 species, both the hypocotyl and the cotyledons lack trichomes, whereas trichomes occur more distally on the seedling (e.g., *Annona glabra*, *Chiococca alba* sensu lato, *Conocarpus erectus*, *Fraxinus caroliniana*, *Ilex cassine* var. *cassine*, *Lysiloma latisiliquum*, *Nyssa biflora*, and *Sideroxylon salicifolium*). Those 18 species are a subset of the 24 species characterized in item no. 1, above.
- 3) Forty species at least sometimes bear trichomes on the hypocotyl; however, in 26 (65%) of those species the trichomes either develop distal to the basal-most portion of the hypocotyl and/or are most concentrated distally on the hypocotyl (e.g., *Casasia clusiifolia*, *Coccoloba diversifolia*, *Drypetes lateriflora*, *Parthenocissus quinquefolia*, *Piscidia piscipula*, *Pisonia aculeata*, and *Schinus terebinthifolia*).
- 4) In only one of the 64 species (*Casuarina equisetifolia*) may trichomes (papillae) occur basal to, but not on, the supra-cotyledonary portions of the seedling.

For many species the increased abundance of trichomes encountered progressing acropetally on their seedlings suggests that trichomes may be more vital to seedling survival later in seedling development.

In various species the hypocotyl and first supra-cotyledonary internode differ minimally in trichome concentrations. By contrast, in *Chrysophyllum oliviforme* and *Sideroxylon salicifolium* the cotyledonary node sharply demarcates the glabrous hypocotyl from the densely hairy first supra-cotyledonary internode.

Similarly, *Quadrella jamaicensis* manifests a sharp boundary between **a.** the hypocotyl, which is minutely papillate at its distal end, and **b.** the densely scaly first supra-cotyledonary internode.

Certain species have a densely pubescent hypocotyl. In *Avicennia germinans* the young hypocotyl is sericeous, manifesting a mat of long, silky, generally appressed hairs. In *Krugiodendron ferreum* the hypocotyl (and the first supra-cotyledonary node) exhibit numerous minute, projecting, yellow hairs. Also, in *Jacquinia keyensis* the hypocotyl exhibits numerous short hairs. In certain species with petiolate cotyledons the cotyledonary laminae and petioles lack and have trichomes, respectively (*Ardisia escallonioides*, *Avicennia germinans*, *Coccoloba diversifolia*, *Coccoloba uvifera*, *Colubrina asiatica*, and *Quadrella jamaicensis*). In other species the cotyledonary laminae and petioles are/may both be pubescent (e.g., *Drypetes diversifolia* and *Myrsine cubana*). In that connection, De Vogel (1980) stated that "indumentum is almost always absent on the blade of ... cotyledons ..."

On supra-cotyledonary leaves the concentrations of trichomes vary considerably between species. In certain species some/all supra-cotyledonary leaves manifest high concentrations of trichomes. For example, often in *Avicennia germinans* a dense, compact mat of minute hairs obscures/partly obscures the abaxial surface of the lamina; too, the petiole exhibits densely arranged marginal hairs. In *Quadrella jamaicensis* numerous peltate scales cover the abaxial lamina surface. As well, the petiole exhibits a dense, compact, unbroken mat of scales.

HOMOBLASTIC VS. HETEROBLASTIC DEVELOPMENT

Goebel (1900, 1905), speaking of plants in general, called the early-formed part and certain/all later-formed parts of the shoot the "juvenile form" and the "adult form," respectively. Accordingly, seedlings are the juvenile form (or a portion thereof) and their supra-cotyledonary leaves are juvenile leaves. Well-developed foliage leaves, at least those associated with sexual-reproductive structures, are the adult leaves. As well, Goebel (1900, 1905) recognized two kinds of shoot development: homoblastic development and heteroblastic development. In homoblastic development the differences between the juvenile form and the adult form are "very slight," whereas in heteroblastic development the differences are "great." (Goebel 1900, 1905).

Goebel's (1900, 1905) distinction between homoblastic development and heteroblastic development, while instructive, may be difficult to apply. The shoots of certain presently considered species clearly manifest heteroblastic development, particularly those which produce, sequentially, simple supra-cotyledonary leaves, compound supra-cotyledonary leaves, and compound adult leaves (*Abrus precatorius*, *Bursera simarouba*, *Fraxinus americana*, *Metopium toxiferum*). On the other hand, the phrase "very slight," being imprecise, makes it problematical to attribute homoblastic development to certain species. We ascribe homoblastic development, or a close approach thereto, to *Cephalanthus occidentalis* and *Chiococca alba* sensu lato. In both species the supra-cotyledonary leaves and the adult leaves are stipulate, petiolate, simple, unlobed, and manifest entire lamina margins, albeit the supra-cotyledonary leaves are normally smaller than the adult leaves.

Goebel (1900, 1905) cited *Casuarina* as an example of homoblastic development, stating that "... above the cotyledons ..." the "... shoot axes have rudimentary cyclic leaves concrescent in a sheath." Yet, present findings for *Casuarina equisetifolia* indicate more varied morphology (Figs. 12, 12A). In *C. equisetifolia*, immediately distal to the cotyledons there is an inconspicuous stem sector ca. 0.5 mm long which bears up to at least five juvenile leaves that vary from distinct to basally connate and decurrent for up to half of their lengths. Those leaves are separated from the cotyledons and from one another by no, or by hardly discernable, internodes. The distinct juvenile leaves are not segmented into a lamina and a concrescent/decurrent basal portion.

KEY TO THE SEEDLINGS

We provide, below, a taxonomic key to the seedlings of the presently considered species. The key refers largely to macroscopical characteristics of the seedlings; however, various macroscopical characteristics overlap between certain of the species, e.g., the dimensions of the cotyledons, shapes of the laminae, and the types of

lamina apices and bases. Thus, in constructing the key we could not limit ourselves to macroscopical features but had frequently to refer to trichomes as well. Consequently, we recommend using the key together with a stereoscopic microscope.

Two species names, *Magnolia virginiana* and *Salix caroliniana*, appear twice and three times in the key, respectively, because those species inconsistently exhibit certain characteristics utilized for keying them.

The key is primarily artificial, but is also partly natural because some related species key-out together, i.e., certain species of Convolvulaceae (*Ipomoea alba*, *Ipomoea quamoclit*, *Ipomoea pes-caprae*, *Ipomoea triloba*, *Ipomoea violacea*), Fabaceae (*Abrus precatorius*, *Acacia auriculiformis*, *Canavalia rosea*, *Leucaena leucocephala*, *Lysiloma latisiliquum*), Malvaceae (*Gossypium hirsutum*, *Thespesia populnea*), Myrsinaceae (*Ardisia escallonioides*, *Myrsine cubana*), Nyctaginaceae (*Guapira discolor*, *Pisonia aculeata*), Polygonaceae (*Coccoloba diversifolia*, *Coccoloba uvifera*), Rubiaceae (*Casasia clusiifolia*, *Cephalanthus occidentalis*, *Chiococca alba*, *Psychotria nervosa*, *Psychotria tenuifolia*, and *Randia aculeata*), and Vitaceae (*Nekemias arborea*, *Parthenocissus quinquefolia*).

1. The cotyledonary laminae not lobed distal to their bases. _____ 2
2. Cotyledons and supra-cotyledonary leaves estipulate _____ 3
3. Seedlings lacking trichomes or being solely papillate, without epidermal scales or hairs ¹ _____ 4
4. The first 3 to 5 supra-cotyledonary leaves composing a whorl or pseudo-whorl and being subtended by a conspicuous internode _____ **Hypelate trifoliata** (Figs. 59, 59A)
4. The first 3 to 5 supra-cotyledonary leaves arranged otherwise. _____ 5
5. The supra-cotyledonary leaves simple. _____ 6
6. The cotyledons each with a conspicuously two-forked midrib _____ **Schoepfia chrysophylloides** (Figs. 62, 62A, 62B)
6. The cotyledons otherwise _____ 7
7. The laminae of the supra-cotyledonary leaves coarsely serrate or coarsely crenate _____ **Acer rubrum** (Fig. 58)
7. The laminae of the supra-cotyledonary leaves entire. _____ 8
8. The first three supra-cotyledonary internodes hardly discernable _____ **Casuarina equisetifolia** (Figs. 12, 12A)
8. The first three supra-cotyledonary internodes conspicuous _____ **Canella winterana** (Fig. 10)
5. The supra-cotyledonary leaves once compound. _____ 9
9. Resin glands abundant on the hypocotyl, cotyledons, supra-cotyledonary nodes, and supra-cotyledonary leaves _____ **Zanthoxylum fagara** (Fig. 56)
9. Resin glands absent _____ **Simarouba glauca** (Fig. 63)
3. Seedlings exhibiting epidermal scales and/or hairs (sometimes also papillate). _____ 10
10. Epidermal scales (sometimes diffuse and/or combined with hairs) present on the supra-cotyledonary portion of the seedling. _____ 11
11. Epidermal scales composing a dense, compact, unbroken mat on the supra-cotyledonary internodes _____ **Quadrrella jamaicensis** (Fig. 8)
11. Epidermal scales otherwise. _____ 12
12. Margins of the supra-cotyledonary leaves lacking teeth _____ **Lyonia fruticosa** (Fig. 22)
12. Margins of the supra-cotyledonary leaves partly or entirely serrate. _____ 13
13. Cotyledons greater than 25 mm long _____ **Fraxinus caroliniana** (Fig. 43)
13. Cotyledons less than 25 mm long _____ **Viburnum obovatum** (Fig. 2)
10. Epidermal scales absent. _____ 14
14. Cotyledons dimorphic. _____ 15
15. Cotyledons remaining folded at maturity _____ **Avicennia germinans** (Fig. 1)
15. Cotyledons expanded at maturity. _____ 16
16. The hypocotyl and supra-cotyledonary portion of the seedling exhibiting dark brown hairs; the lamina of the larger of the two kinds of cotyledons generally ranging from 7 to 11 mm long. _____ **Guapira discolor** (Fig. 39)
16. The hypocotyl and supra-cotyledonary portion of the seedling exhibiting transparent or white hairs; the lamina of the larger of the two kinds of cotyledons generally ranging from 13 to 18 mm long _____ **Pisonia aculeata** (Fig. 40)
14. Cotyledons equal, subequal, or unequal but not of two discrete types. _____ 17
17. The hypocotyl and/or the supra-cotyledonary portion of the seedling manifesting narrow, protruding hairs with purplish and/or yellow tips; those hairs sometimes accompanied by non-pigmented hairs. _____ 18
18. The hypocotyl glabrous; the supra-cotyledonary internodes highly condensed _____ **Suriana maritima** (Fig. 64)
18. The hypocotyl pubescent; the supra-cotyledonary leaves highly condensed or readily visible. _____ 19
19. The supra-cotyledonary internodes highly condensed _____ **Jacquinia keyensis** ² (Fig. 65)
19. The supra-cotyledonary internodes readily visible _____ 20
20. The green and pigmented punctae of the cotyledons and supra-cotyledonary leaves appearing, collectively, as one general type, i.e., being more-or-less circular or short-elliptic _____ **Ardisia escallonioides** (Fig. 37)

20. The green and pigmented punctae of the cotyledons and supra-cotyledonary leaves, collectively, being of two types, i.e., either more or less circular or linear _____ **Myrsine cubana**³ (Fig. 38)
17. The entire seedling lacking narrow, protruding hairs with purplish or yellow tips. _____ 21
21. The supra-cotyledonary portion of the seedling exhibiting T-shaped hairs. _____ 22
22. The cotyledons less than 10 mm long, off-white, and being abscinded after expansion of the first pair of supra-cotyledonary leaves _____ **Sideroxylon salicifolium** (Figs. 61, 61A, 61B)
22. The cotyledons more than 10 mm long, green, and often more persistent _____ **Cornus foemina** (Fig. 21)
21. The supra-cotyledonary portion of the seedling lacking T-shaped hairs. _____ 23
23. The cotyledons thick to the touch _____ **Metopium toxiferum** (Fig. 3)
23. The cotyledons thin. _____ 24
24. The cotyledonary lamina mostly very widely obovate to widely depressed obovate _____ **Conocarpus erectus** (Fig. 14)
24. The cotyledonary lamina otherwise. _____ 25
25. The cotyledons and supra-cotyledonary portion of the seedling bearing minute, sessile, yellow hairs which appear ca. circular in top view _____ **Morella cerifera** (Fig. 36)
25. Sessile yellow hairs absent. _____ 26
26. The supra-cotyledonary leaves serrate with many marginal teeth and being simple, divided, and/or pinnately compound _____ **Schinus terebinthifolia** (Fig. 4)
26. The supra-cotyledonary leaves either entire or with one or two marginal teeth; leaves all simple. _____ 27
27. The seedling bearing lustrous, brown hairs. _____ 28
28. The hairs short and protruding from the axils of the expanded cotyledons and supra-cotyledonary leaves; hairs being essentially absent elsewhere on the seedling _____ **Annona glabra** (Fig. 5)
28. The hairs long and appressed; present on at least the first supra-cotyledonary internode and abaxially on the supra-cotyledonary leaves _____ **Chrysophyllum oliviforme** (Fig. 60)
27. The seedling lacking such hairs. _____ 29
29. The hypocotyl (especially distally) with short, thick, sharp-tipped, transparent, and mainly antrorse papillae _____ **Forestiera segregata** (Fig. 42)
29. The hypocotyl glabrous/essentially glabrous. _____ 30
30. The cotyledons over 15 mm long. _____ 31
31. Apex of the supra-cotyledonary leaves rounded to retuse _____ **Laguncularia racemosa** (Fig. 15)
31. Apex of the supra-cotyledonary leaves acute to acuminate _____ **Nyssa biflora** (Fig. 41)
30. The cotyledons less than 10 mm long _____ **Salix caroliniana** (Fig. 57)
2. Cotyledons and/or supra-cotyledonary leaves stipulate _____ 32
32. At least some of the supra-cotyledonary leaves of the seedling compound. _____ 33
33. Margins of the supra-cotyledonary leaves coarsely serrate, crenate, or crenate/dentate. _____ 34
34. The supra-cotyledonary leaves all palmately compound; the cotyledonary petioles, generally, 6 to 28 mm long _____ **Parthenocissus quinquefolia** (Fig. 69)
34. The supra-cotyledonary leaves simple, once-compound, or twice compound; the cotyledonary petioles generally 3 to 5 mm long _____ **Nekemias arborea** (Fig. 68)
33. Margins of the supra-cotyledonary leaves entire. _____ 35
35. The supra-cotyledonary leaf/leaves at supra-cotyledonary node no. 1 once compound. _____ 36
36. The cotyledonary lamina generally less than 10 mm long. _____ 37
37. Two (opposite) leaves present at supra-cotyledonary node no. 1; the petiole of the leaf at the third supra-cotyledonary node not ensiform _____ **Lysiloma latisiliquum** (Fig. 29)
37. One leaf present at supra-cotyledonary node no. 1; the petiole of the leaf at the third supra-cotyledonary node moderately ensiform _____ **Acacia auriculiformis** (Fig. 26)
36. The cotyledonary lamina generally more than 10 mm long; one leaf present at supra-cotyledonary node no. 1 _____ **Leucaena leucocephala** (Fig. 28)
35. The two supra-cotyledonary leaves at supra-cotyledonary node no. 1 simple. _____ 38
38. The leaves at supra-cotyledonary node no. 1 depauperate, not exceeding ca. 1.5 mm long _____ **Abrus precatorius** (Fig. 25)
38. The leaves at supra-cotyledonary node no. 1 not depauperate, far exceeding 1.5 mm long _____ **Canavalia rosea** (Fig. 27)
32. All supra-cotyledonary leaves of the seedling simple. _____ 39
39. The cotyledons manifesting interpetiolar stipules or a common ocrea. _____ 40
40. The hypocotyl bearing hairs (at least distally) which may intergrade with papillae. _____ 41
41. Hairs of the hypocotyl brown; the lamina base of the supra-cotyledonary leaves cuneate or narrowly cuneate _____ **Coccoloba diversifolia** (Fig. 44)

41. Hairs of the hypocotyl translucent or white; the lamina base of the supra- cotyledonary leaves retuse _____ **Coccoloba uvifera** (Fig. 45) 42
40. The hypocotyl glabrous or papillate. _____ 42
42. The supra-cotyledonary leaves alternate _____ **Magnolia virginiana** (Fig. 32) 43
42. The supra-cotyledonary leaves opposite _____ 43
43. The interpetiolar stipules of the cotyledons adnate to the margins of the cotyledonary petioles. _____ 44
44. Expanded leaves of the third supra-cotyledonary node ciliate with minute, stubby, transparent, sparsely to densely concentrated hairs _____ **Cephalanthus occidentalis** (Fig. 51) 44
44. Expanded leaves of the third supra-cotyledonary node non-ciliate _____ **Chiococca alba** (Fig. 52) 45
43. The interpetiolar stipules of the cotyledons not adnate to the margins of the cotyledons; rather, extending adaxial to the cotyledons. _____ 45
45. The supra-cotyledonary leaves linear or linear-oblongate _____ **Casasia clusiifolia** (Fig. 50) 46
45. The supra-cotyledonary leaves relatively broad, not linear or linear-oblongate _____ 46
46. The supra-cotyledonary leaves narrowly elliptic or oblongate to obovate _____ **Randia aculeata** (Fig. 55) 47
46. The supra-cotyledonary leaves lanceolate to ovate. _____ 47
47. The first three supra-cotyledonary internodes glabrous to having moderately concentrated, uniseriate hairs that are generally curved, white to brown, and up to 0.5 mm long _____ **Psychotria nervosa** (Fig. 53) 48
47. The first three supra-cotyledonary internodes moderately to densely pubescent with minute, sharp-tipped, transparent or white trichomes ca. to 0.05 mm long, which appear intermediate between hairs and papillae _____ **Psychotria tenuifolia** (Fig. 54) 48
39. The cotyledons lacking interpetiolar stipules or a common ocrea. _____ 48
48. The hypocotyl, cotyledons, and supra-cotyledonary portions of the seedling covered with numerous black, brown, or purple pustules readily visible at 10X. _____ 49
49. The supra-cotyledonary internodes and supra-cotyledonary leaves bearing epidermal scales _____ **Thespesia populnea** (Fig. 35) 49
49. The supra-cotyledonary internodes and supra-cotyledonary leaves without epidermal scales _____ **Gossypium hirsutum** (Fig. 33) 50
48. The hypocotyl, cotyledons, and supra-cotyledonary portions of the seedling lacking such pustules. _____ 50
50. The seedlings lacking hairs, albeit being papillate in places. _____ 51
51. The cotyledonary laminae generally having length-to-width ratios of/between 0.8 to 1.1, appearing widely elliptic, very widely ovate, widely depressed ovate, or orbicular _____ **Cynophalla flexuosa** (Fig. 7) 51
51. The cotyledonary laminae generally having length to width ratios of/between 1.8 to 2.4, appearing mostly ca. narrowly elliptic-elliptic to elliptic; sometimes oblongate-obovate _____ **Tricrma phyllanthoides** (Fig. 13) 52
50. The seedlings pubescent. _____ 52
52. The supra-cotyledonary leaves having toothed margins _____ 53
53. The hypocotyl, cotyledonary petioles, and supra-cotyledonary portion of the seedling bearing both stellate hairs and non-stellate hairs; the cotyledons and supra-cotyledonary leaves purple _____ **Hibiscus acetosella** (Fig. 34) 54
53. The entire seedling lacking stellate hairs; the cotyledons and supra-cotyledonary leaves green. _____ 54
54. The base of the cotyledonary lamina sagittate to nearly hastate _____ **Ulmus americana** (Figs. 66, 66A) 55
54. The base of the cotyledonary lamina unlobed, neither sagittate nor hastate _____ 55
55. The first three supra-cotyledonary internodes bearing helically much-twisted, -tangled, long hairs as well as short, stiff, sharp-pointed hairs _____ **Vitis rotundifolia** (Fig. 70) 56
55. The first three supra-cotyledonary internodes without helically much-twisted, tangled, long hairs. _____ 56
56. The first two supra-cotyledonary leaves estipulate; the third supra-cotyledonary leaf generally estipulate _____ **Salix caroliniana** (Fig. 57) 57
56. All three supra-cotyledonary leaves stipulate. _____ 57
57. The supra-cotyledonary leaves spinulose-dentate _____ **Drypetes diversifolia** (Fig. 46) 58
57. The supra-cotyledonary leaves serrate to various degrees. _____ 58
58. The hypocotyl (especially distally) with minute, uncinat, projecting hairs that are either brown or colorless _____ **Colubrina asiatica** (Fig. 48) 59
58. The hypocotyl glabrous. _____ 59
59. The cotyledonary lamina generally 13–22 mm long and 9.5–16.5 mm wide; the bases of the supra-cotyledonary leaves cuneate to narrowly rounded _____ **Gymnanthes lucida** (Fig. 23) 59
59. The cotyledonary lamina generally 7–10 mm long and 4–6 mm wide; the bases of the supra-cotyledonary leaves short-narrowly cuneate to caudate _____ **Ilex cassine** var. **cassine** (Figs. 6, 6A) 60
52. The supra-cotyledonary leaves with entire margins. _____ 60

60. The supra-cotyledonary leaves bearing epi-petiolar stipules which at maturity abscind from the petioles _____ **Magnolia virginiana** (Fig. 32) 61
60. Stipules, where present are stem-borne. _____ 61
61. On the same seedling, all or most supra-cotyledonary leaves estipulate _____ **Salix caroliniana** (Fig. 57) 62
61. On the same seedling, all supra-cotyledonary leaves stipulate. _____ 62
62. The cotyledons thickened and brown when the the first supra-cotyledonary node bears expanded leaves _____ **Krugiodendron ferreum** (Fig. 49) 63
62. The cotyledons without this combination of characters _____ 63
63. The hypocotyl bearing hairs distally or for most of its length. _____ 64
64. The supra-cotyledonary leaves relatively wide, being either ovate-widely ovate to very widely ovate-widely depressed ovate or oblate _____ **Piscidia piscipula** (Fig. 30) 64
64. The supra-cotyledonary leaves narrower, being either lanceolate, lanceolate-ovate, oblanceolate, or elliptic _____ **Drypetes lateriflora** (Fig. 47) 65
63. The hypocotyl glabrous or essentially glabrous. _____ 65
65. The cotyledonary lamina generally 6–12 mm long and 3–8 mm wide _____ **Itea virginica** (Fig. 31) 65
65. The cotyledonary lamina generally 16–24 mm long and 9–15 mm wide _____ **Triadica sebifera** (Fig. 24) 66
1. The cotyledonary laminae lobed distal to their bases. _____ 66
66. The cotyledons 3-lobed, the lobes arising near the base of the lamina _____ **Bursera simaruba** (Fig. 9) 67
66. The cotyledons otherwise _____ 67
67. The cotyledons with 3 to 8 (most commonly 4 or 5) terminal extensions which vary from being lobes to rounded teeth; the lobes/teeth arising ca. half-way or less from the distal end to the basal end of the lamina _____ **Cissus verticillata** (Fig. 67) 68
67. The cotyledons with two lobes and lacking teeth. _____ 68
68. The cotyledons 4.5 to 7.5 mm wide _____ **Celtis laevigata** (Fig. 11) 69
68. The cotyledons greater than 10 mm wide. _____ 69
69. The lobes narrow (sometimes nearly linear) _____ **Ipomoea quamoclit** (Fig. 18) 70
69. The lobes broader. _____ 70
70. The apices of the supra-cotyledonary leaves broadly rounded to retuse _____ **Ipomoea pes-caprae** (Fig. 17) 71
70. The apices of the supra-cotyledonary leaves narrowly rounded, acute, subacute, acuminate, or caudate. _____ 71
71. The cotyledonary lobes arising near the base of the cotyledonary lamina _____ **Ipomoea triloba** (Fig. 19) 72
71. The cotyledonary lobes arising farther from the base of the cotyledonary lamina _____ 72
72. The cotyledonary lobes arising at/near the middle of the cotyledonary lamina _____ **Ipomoea violacea** (Figs. 20, 20A) 72
72. The cotyledonary lobes arising above the middle of the cotyledonary lamina _____ **Ipomoea alba** (Fig. 16)

¹ Herein, seedlings of *Zanthoxylum fagara* are considered glabrous, although they may exhibit sparse, nondescript, excrescences of unknown nature.

² Not all hypocotyls of *Jacquinia keyensis* exhibit the pink-tipped hairs. One may have to examine more than one seedling to observe them.

³ In individual cotyledons and supra-cotyledonary leaves, the punctae of both shapes frequently occur together, but some cotyledons manifest solely the more-or-less circular punctae.

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