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Further Studies of the Germination and Juvenile Forms of Some Trees and Woody Shrubs, 1927

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FURTHER STUDIES¹ OF THE GERMINATION AND
JUVENILE FORMS OF SOME TREES AND
WOODY SHRUBS, 1927

L. H. PAMMEL AND C. M. KING

A number of papers upon the germination² of trees and shrubs have recently appeared, of which a few may be herein noted. P. W. Zimmerman³ of Boyce-Thompson Institute, in discussing influences affecting germination, calls attention to the early development of the embryo of the soft maple, while in the ginkgo the seed falls before the fertilization of the ovule has occurred. Notes upon the influence of drying and extreme temperatures upon many seeds are also recorded. Delayed germination in cases of rose, apple, hawthorn, cotoneaster, basswood and some junipers is attributed by him to immature embryos and hard seed coats.

The seeds of *Berberis Thunbergii* were studied in a paper by Toshitaro Morinaga.⁴

The germination of seeds under water was studied by Toshitaro Morinaga.⁵ Kinzel⁶ obtained good germination in seeds kept under water in case of Rhododendron, Azalea, Hypericum and other genera. Freeman Weiss⁷ made a study of germination of *Betula populifolia*. He finds that the seeds of this birch are still immature in September; and even at maturity, after wintering, the percentage of germination is still low.

We have observed that while the birches of the campus at Iowa State College seed very freely, seedlings are rarely found. In case of hard maple, soft maple and the ash seedlings are extremely numerous.

Results of studies in germination of seeds of flowering dogwood, Japanese barberry, elderberry and highbush cranberry are recorded

¹ The present contribution is the tenth of a series which has appeared in the *Proceedings of Iowa Academy of Science*.

² Seeds and Seed Germination. The Florists' Exchange and Horticultural Trade World. Aug. 7, 1926.

³ Precocious germination has been observed by the senior author in the garden pea, lima beans, timothy, and in some hybrid cucurbits. Beans germinating in the pod in wet weather also have been observed by R. I. Cratty.

⁴ Effect of Alternating Temperatures upon the Germination of Seeds. *Am. Journ. of Bot.* 13: 141-158.

⁵ Germination of Seeds Under Water, *Am. Journ. of Bot.* 13: 126-140.

⁶ Kinzel W. Lichtkeimung (Erläuterungen und Ergänzungen). *Ber. Deutsch. Bot. Ges.* 27: 536-545. 1909.

⁷ Seed Germination in the Gray Birch, *Betula populifolia*. *Am. Journ. of Botany* 13: 737-742.

by Dr. Opal Hart Davis.⁸ He finds that in the *Cornus florida* poor germination results from empty seeds from isolated trees, and from molding of seeds during storage. The *Berberis Thunbergii* seeds prefer alternating temperatures. In case of *Sambucus canadensis* some seeds have dormant embryos and in some the embryos are not dormant. The *Viburnum Opulus* seeds require two years for germination. He finds that lower temperatures favor the development of the radicle and root system, the seed leaves remaining later in the seed and utilizing all the abundant food material.

Seeds of the trees and shrubs considered in this paper were collected during the fall and winter of 1926-1927. Earlier descriptions of a few of the species appear in previous papers of the series. The following kinds of seeds were planted in the greenhouse at Iowa State College, shortly after their collection:

- Zamia integrifolia* Willd. (Florida, Jan. 30, 1927, L. H. P.).
Pinus canariensis (C. Smith, Forestry Service, U. S. Dept. of Agr., Feb. 28, 1927).
Smilax pseudo-china L. (Florida, Mar. 17, 1927, L. H. P.).
Smilax laurifolia L. (Florida, Mar. 17, 1927, L. H. P.).
Ostrya virginiana (Mill.) K. Koch (Ledges, Oct. 16, 1926, L. H. P.).
Carpinus carolinianus Walt. (Ledges, Oct. 16, 1926, L. H. P.).
Castanea pumila (L.). Mill. (Farmington, Iowa, Oct. 16, 1926, L. H. P.).
Calycanthus fertilis Walt. (Washington, D.C., Jan. 31, 1927, L. H. P.).
Cinnamomum Camphora L. (Gainesville, Fla., Jan. 27, 1927, L. H. P.).
 Germinated freely Feb. 20 to Mar. 25, 1927.
Liquidambar styraciflua L. (College Park, Md., Mar. 10, 1927, F. Trenck).
Physocarpus opulifolius var. *intermedius* (Rydb.) Robinson. (Campus, I.S.C., Oct. 20, 1926, L. H. P.).
Cotoneaster acutifolia Turcz. (Grinnell, Iowa, Jan. 25, 1927).
Prunus serotina Ehrh. (Late fruits, Campus, I.S.C., Oct. 20, 1926, L. H. P.).
Schrankia uncinata Willd. (Rockwell City, Apl. 5, 1927).
Sophora japonica L. (Washington, D.C., Jan. 10, 1927, L. H. P.). Germinated Feb. 28, 1927.
Amorpha fruticosa L. (Ames, Iowa, Feb. 16, 1927, C. M. K.).
Ptelea trifoliata L. (Gainesville, Florida, Jan. 10, 1927, L. H. P.).
Rhus copallina L. (Florida, Jan. 23, 1927, L. H. P.). Germinated Feb. 22 to Mar. 1, 1927.
Schinus terebinthifolia Raddi. (Florida, Jan. 24, 1927, L. H. P. and J. L. Seal). Germinated Mar. 15, 1927.
Ilex verticillata (L.) Gray (Bay City, Mich., Dec. 1, 1926, J. B. Pollock).
Ilex myrtifolia Lam. (Florida, Mar. 17, 1927, L. H. P.).
Ilex opaca Art. (Florida, Jan. 30, 1927, L. H. P.).
Fraxinus pennsylvanica var. *lanceolata* (Boerk) Sarg. (Tabor, Iowa, Dec. 2, 1926, U. Gore).
Nerium Oleander L. (Gainesville, Fla., Jan. 30, 1927, L. H. P.). Germinated freely Feb. 14, 1927.
Tecoma radicans L. Juss (Pittsburg, Iowa, Dec. 2, 1926, L. H. P.). Germinated freely Jan. 14, 1927.

As indicated, nine of the above named species had germinated by April 15, 1927; *Zamia* seeds, on examination, were found to have swollen and sent out the radicle.

⁸ Germination of Seeds of Certain Horticultural Plants. The Florists' Exchange and Horticultural Trade World. Nov. 13, 1926.

Additional young plants, or seedlings, collected by the senior author in Florida are as follows:

- Pinus Taeda* L. Seedling (Florida, Mar. 27, L. H. P.).
Pinus palustris Mill. Seedling (Florida, Mar., 1927, L. H. P.).
Juniperus barbadensis Sarg. Seedling (Gainesville, Fla., Feb. 20, 1927, L. H. P.).
Sabal Palmetto R. and S. Seedling (Florida, Mar., 1927, L. H. P.).
Quercus nigra L. Seedling (Gainesville, Fla., Feb. 20, 1927, L. H. P.).
Planera aquatica Gmel. Juvenile form (Gainesville, Fla., Mar. 11, 1927, L. H. P.).
Celtis mississippiensis Bosc. Seedling and juvenile form (Gainesville, Fla., March 11, 1927, L. H. P.).
Persca Borbonia (L.) Spring. Juvenile form (Gainesville, Fla., Jan., 1927, L. H. P.).
Cinnamomum Camphora L. Seedlings and juvenile form (Gainesville, Fla., Jan. 25, 1927, L. H. P.).
Prunus caroliniana Art. Seedling and juvenile form (Gainesville, Fla., Jan. 25, 1927, L. H. P.).
Melia Azederach L. Seedling (Gainesville, Fla., Mar. 7, 1927, L. H. P.).
Rhus Toxicodendron L. Juvenile form (Florida, Jan. 27, 1927, L. H. P.).
Cissus incisa (Nutt.) Des Moulins. Seedling (Florida, Jan., 1927, L. H. P.).
Dipterocarpus turbinatus Gaertn. Seedling (Gainesville, Fla., Mar. 10, 1927, L. H. P.).
Rhododendron maximum L. Seedling (Knoxville, Tenn., Mar. 19, 1927, L. H. P.).
Ardisia crenulata Vent. Seedlings (Gainesville, Fla., Jan., 1927, L. H. P.).
Lantana Camara L. Seedling (Ocala, Fla., Feb., 1927, L. H. P.).

Descriptions with figures⁹ follow, of the seedlings and juvenile forms studied. We are indebted to Prof. Larsen for some germinating material and to the U. S. Forest Service.

Cycadales

Cycadaceae. *Cycas* Family

Zamia integrifolia Willd., Coontie.

Seeds of this species were collected in Florida by L. H. Pammel, January 27, 1927. They were placed in the I. S. C. greenhouse February 1. On examination April 1 all the seeds were found to show signs of germination, which proceeded very slowly. On June 1 they had sent out a thick radicle about one inch in length. Germination proceeded no further.

Coniferales

Pinaceae

Pinus Taeda L., Loblolly or Old Field Pine.

Seedlings of this pine were collected from beneath parent trees at Gainesville, Fla., Mar. 4, 1927, by L. H. Pammel.

Hypocotyl at first reddish, becoming green. Cotyledons usually six in number. Leaves slender, distinctly minutely serrate; leaves of first and second years' growth scattered along the stem, not arranged in bundle. Needles shorter than in *Pinus palustris*.

⁹ Drawings by C. M. King.



Fig. 1. Seedlings of Conifers, a, b, *Pinus canariensis*; c, *Pinus palustris*; d, *Pinus Taeda*; e., *Juniperus Barbadensis*.

Pinus Canariensis C. Smith, Canary Island Pine.

Nuts of this species, contributed by Forestry Service, U. S. Dept. of Agriculture, were planted in the greenhouse Jan. 25, 1927. One hundred of these germinated Mar. 20 and 21. Germination epigeaeous. The cotyledons gradually push out of the seed coat, at the same time lifting it above the ground, still enclosing their tips, and gradually taking an erect position. When the endosperm has been completely absorbed by the cotyledons the seed coat slips off, and the cotyledons straighten out. Cotyledons usually nine in number, two inches in length. Hypocotyl greenish white. Plant robust.

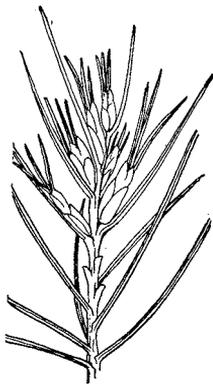


Fig. 2. Seedling of *Pinus palustris* Mill., Long-leaved Pine.

Pinus palustris Mill. Long-leaved Pine.

Seedlings collected under parent tree, Gainesville, Fla., Mar. 4, 1927, by L. H. Pammel.

Hypocotyl brownish to reddish, soon becoming green. Cotyledons five to seven, slender, attenuate, smooth.

Succeeding leaves slightly roughtened with lucid secretions. Leaves fine, erect, dense.

Juniperus Barbadosensis L., Bermuda Cedar.

Year old plants were collected at Magnesia Springs, near Gainesville, Fla., Mar. 11, 1927, by L. H. Pammel.

The species is common in deep forest with *Carpinus*, *Planera*, *Magnolia foetida*, and *Azalea*. The year old plants from four to six inches in height; foliage soft and fine. The young leaves, one-third inch long, are pointed but less spiny than the leaves of older plants. Leaves bright green, placed singly at each joint. Young stem below, brown. Bark on young branches shreddy.

Principes

Palmaceae

Sabal Palmetto R. and S., Cabbage Palmetto.

Seedlings were observed germinating freely under palm-trees and water oak trees at Cedar Keys, Florida, Mar. 6, 1927, by L. H. Pammel.

Germination hypogaeous. Radicle descends into the earth. The end of the cotyledon remains in the seed, where it absorbs the endosperm. Hypocotyl short. First and second leaves erect, slender, blade-like, dark green, parallel-veined from four to seven inches in length. The first blade is the plumule leaf. In respect to the germination of the *Palmaceae*, Sir John Lubbock makes the following statement:¹

“Germination takes place according to a very prevalent monocotyledonous type. The radicle, pushing aside the operculum in the testa, emerges first, and penetrates the soil, usually to a considerable depth, becoming both long and strong. The very short hypocotyl is thus drawn out of the seed, bearing the rapidly elongating sheath of the cotyledon which encloses the plumule. The other end of the cotyledon remains in the seed, forming a sucker to absorb the endosperm; a narrow neck connects it with the sheath portion from which the first green leaf soon protrudes.”

Temperature conditions in growth of the date palm are discussed by S. C. Mason.²

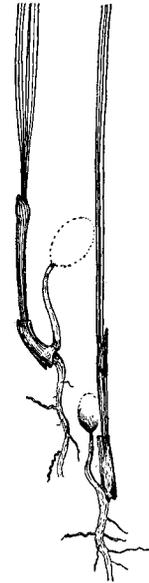


Fig. 3. Germination of *Sabal Palmetto* R. & S., Cabbage Palmetto, showing part of cotyledon still attached to seed; the descending radicle and the ascending plumule with enclosing sheath at the base.

¹ A Contribution to Our Knowledge of Seedlings, 2: 580-581.

² The Minimum Temperature for Growth of the Date Palm and the Absence of a Resting Period. Journ. of Agr. Res. 31: 401-414.

Fagales

Fagaceae

Quercus nigra L., Water oak.

Acorns were observed by L. H. Pammel at Gainesville, Fla., Feb. 20, 1927. Germinating very freely in sandy soil under the parent oak trees.

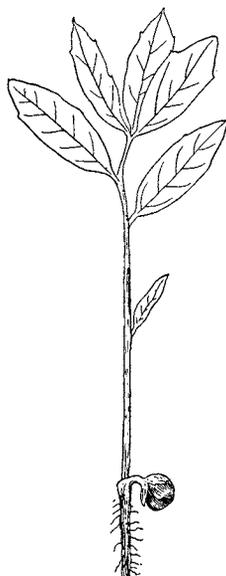


Fig. 4. *Quercus nigra* L. Water Oak. Seedling, showing series of early leaves of young plant, and the germinating acorn.

Germination hypogaeous, radicle long, slender, brownish, coming from a hollowed out micropyle at the apical part of the acorn. Lower part of the stem brownish; scales small, scattered, alternate; internodes variable, usually lengthened. First leaf small, elliptical, reticulate, paler below than above. Internodes reddish. Petioles short. Second leaf elliptical, larger than the first; margin undulate, bearing a few bristles. Fourth leaf undulate margined, somewhat dentate, bristle-tipped. The fifth leaf oblanceolate, undulate margined, bristle-tipped; in one specimen, terminal lobe pointed, with dentations below the tip. The two-year-old plant, with leaves undulate to dentate margined, bristle-tipped; petioles short. Buds in axils of the leaves. The two year plants bear shoots with conspicuous lobes; leaves reticulate veined, coriaceous in texture.

Urticales

Urticaceae

Planera aquatica Gmel., Planer Tree or Water Elm.

Seedlings gathered at Magnesia Springs near Gainesville, Fla., Mar. 11, 1927, by L. H. Pammel.

Location, deep forest, with *Carpinus*. Germination free. (Probably) epigaeous. Year old seedling. Young leaves, ovate lanceolate, of elmlike aspect; coarsely toothed with smaller teeth between the large teeth. Upper surface roughened, with minute hairs, dark green; lower surface paler in color, smooth. Lateral veins straight. Stipules brownish, soon falling. Young branches zigzag, pubescent.

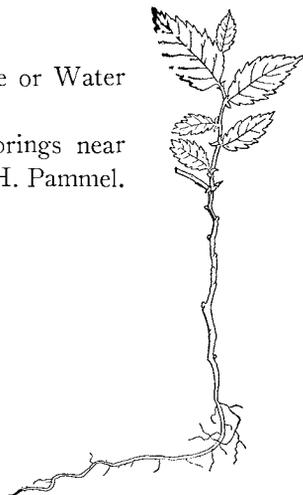


Fig. 5. Year old plant of *Planera aquatica* Gmel. Planer Tree or Water Elm

Celtis Mississipiensis Bosc., Southern Hackberry

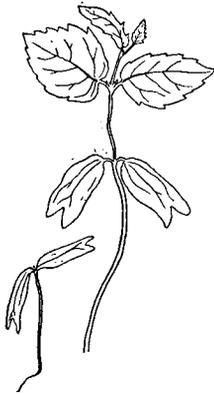


Fig. 6. Seedling of *Celtis mississippiensis* Bosc. Southern Hackberry. Showing cotyledons and early leaves.

Seedling collected at Gainesville, Fla., Feb. 23, 1927, by L. H. Pammel, where they were coming up freely after heavy rain of a week previous.

Germination epigeaeous. Cotyledons with straight sides, elliptical, deeply incised at the end, prominently veined above and below, margins entire. Hypocotyl whitish below, green as it approaches the cotyledons.

First pair of leaves opposite, ovate, dentate, smooth above, hairs on midrib. Third and fourth leaves nearly opposite. Stipules slender, scarious, soon folding. The unfolding young leaves pubescent. Internodes hairy. The stem soon becomes woody. Roots brownish.

Ranunculales

Lauraceae

Persea Borbonia (L.) Spring. Sweet Bay.

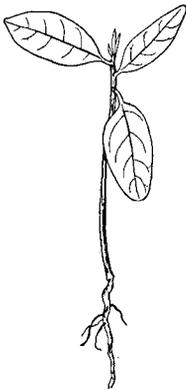


Fig. 7. Young plant of *Persea Borbonia* (L.) Spring. Sweet Bay.

Young plants of this species were collected under the trees at Gainesville, Fla., March 7, 1927.

Second year plants with alternate leaves; stem, yellowish green. First leaf lanceolate, or oblanceolate, second similar. Smooth above and below; prominently reticulately veined. Margin entire. No stipules. Leaves evergreen. Plant with odor of sassafras.

Cinnamomum Camphora L., Camphor Tree.

(Second study. For first study see Proc. Iowa Acad. Sci. 31.)

Seeds of this species were collected in Florida by L. H. Pammel in January, 1927. They were planted in the greenhouse on January 23. Seedlings appeared from February 25 to March 25.

Germination hypogaeous. Seedling three and one-half inches in height, smooth. Hy-

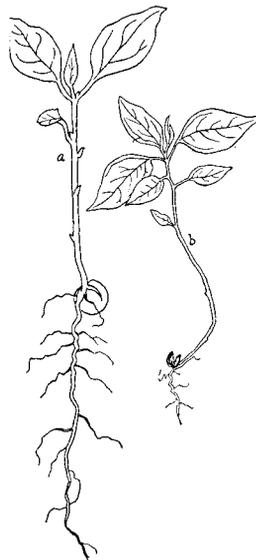


Fig. 8. *Cinnamomum Camphora* L., Camphor Tree. (a) Seedling grown in greenhouse. (b) Young plant collected under parent tree.

pocotyl green, 18mm. long, stem purplish green, bearing alternate leafy scales each with a bud at base. First and second scales 3mm. long, green, oval sharp-pointed. Third scale 4mm. long, entire, sharp-pointed.

Leaves alternate. First leaf 12mm. long, petiole 4mm. long, purplish at base; oval, leathery or firm in texture, entire, reticulate veined, sharp-pointed. Second leaf 24mm. in length, petiole, length 6mm., reddish at base. Leaf rich bright green, ovate-elliptical, obtuse at second leaf. Fourth leaf, young, 12mm. in length. Root vigorous, length three and one-half inches, as long as seedling. Plant more slender than specimen described from Gulfport, Miss., in earlier paper. Year old plants of the camphor tree, also, were collected at Gainesville, Fla., in March, by Pammel.

In plants of second season's growth, leaves alternate, first leaf ovate, second leaf ovate-lanceolate, third leaf slender toward the tip, pointed. Leaves pale beneath, smooth, prominently reticulately veined. Upper surface light green, mid-rib yellowish. Third leaf same as second, margin undulate, buds in axils of leaves. Stipules absent.

Rosales

Hamamelidaceae

Liquidambar styraciflua L., Sweet Gum.

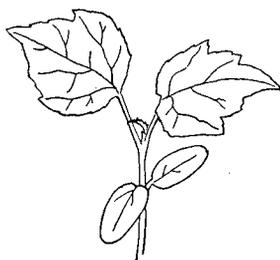


Fig. 9. Seedling of *Liquidambar styraciflua* L., Sweet Gum, showing cotyledons and early leaves.

Seeds received Mar. 10; sent from College Park, Maryland, by F. Trenck. These seeds were planted, when received, in the college greenhouse. Free germination from April 14 to May 1.

Germination epigeaeous. Hypocotyl red, one inch in length. Cotyledons dark green, broad elliptical, length one-half inch, width one-fourth inch, thick, indistinctly veined, petioled. Hypocotyl, stem and petioles pubescent. First leaf roundish triangular, one and one-half inches long, one inch wide, palmately veined, margin sparsely dentate, each dentation armed with a small glandular trichome. Leaf pale beneath. Petiole one-half inch long. Second leaf roundish triangular, cordate at the base, pointed toward the tip, distinctly five-lobed.

Leaves shining, glossy. Stipules glandular, deciduous.

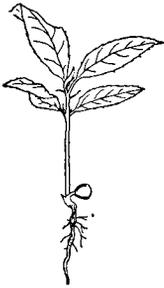
Prunus serotina Ehrh., Wild Cherry

Fig. 10. Seedling of *Prunus serotina* Ehrh., Wild Cherry (Florida form), showing first leaves and shell of seed.

(Second study. For first study see Proc. Iowa Acad. Sci. 25.)

Florida form with larger branches, grayish in color.

Juvenile forms and seedling collected under trees at Gainesville, Fla., Feb. 21, 1927, by L. H. Pammel. This form of *Prunus serotina* appears quite different than the Iowa type. Germination hypogaeous. Shell containing the radicle descending. Hypocotyl pale. Stem pale in color, soon becomes woody brownish to greenish. Radicle descending. Leaves somewhat irregularly placed.

First leaves nearly opposite, nodes swollen. Leaves lanceolate to ovate-lanceolate, petioled, prominently serrate, paler beneath. Young leaves reddish.

Second internode reddish green. Third and fourth leaves alternate. Stipules reddish above, pale green below, glandular serrate. Third group of two leaves nearly opposite followed by a group of two alternate to each other.

Prunus caroliniana Ait., Mock Orange

(Second study. For first study see Proc. Iowa Acad. Sci. 29).

Seedling collected under parent tree at Gainesville, Fla., Feb. 28, 1927, by L. H. Pammel.

Germination hypogaeous. Seedlings two to four inches in height. Leaves alternate. First leaf ovate, one-half inch in length, glossy, dark green above, paler beneath, prominently reticulately veined, finely glandular serrate. Stipules of first and succeeding leaves slender, reddish, soon falling. Second leaf similar to first. Third leaf narrow to broad lanceolate. Fourth leaf larger, serrations more prominent. Hypocotyl whitish to brownish. Cotyledons remain within the shell, easily separable from it, fleshy, roundish, stalked. Stem just above the cotyledons reddish, smooth.

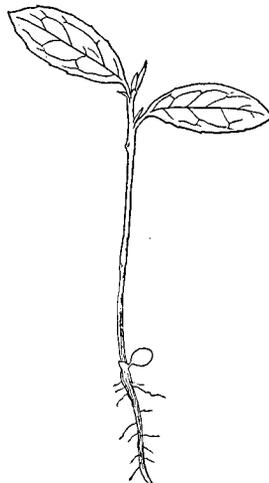


Fig. 11. Seedling of *Prunus caroliniana* Ait., Mock Orange.

Sophora japonica L., Chinese Pagoda Tree

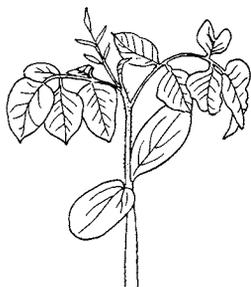


Fig. 12. Seedling of *Sophora japonica* L., showing cotyledons and first leaves.

Seeds collected at Washington, D.C., Jan. 10, 1927, by L. H. Pammel and planted in the greenhouse at Iowa State College Jan. 24, 1927. Cotyledons appeared Feb. 28 to Mar. 10.

Cotyledons two-thirds of an inch in length, one-third inch broad, elliptical, obscurely veined, fleshy. Hypocotyl pale green, first node one inch long with soft hairs.

First leaf compound with fine pinnate leaflets. Leaflets oval with acute tip, entire; terminal leaflet largest. Scattered hairs above and below on the leaves. Under side slightly paler than upper side. Short petioled, a pair of stiff bristles at the base. The compound leaves alternate. The second and the third like the first.

Amorpha fruticosa L., False Indigo

Seeds of this species collected from the shrub were planted in the greenhouse Feb. 26, 1927. Cotyledons appeared April 10, the growth being rather slow. Germination 90 per cent. Germination epigeaeous. Cotyledons, at full size, two-fifths inch long, elliptical, about one-fourth inch wide, green, short-petioled. Hypocotyl one and one-half inches long, slender, with rootlets clustered about the base; radicle strong.

First internode one-third inch long, second and third internodes very short. First leaf roundish, about one-fourth inch across, net-veined, petioled, with stipules at base of petiole. Second, third and fourth leaves similar to first. The fifth leaf compound, with three orbicular leaflets, pinnately arranged, somewhat smaller than the earlier leaves. Each leaflet with short petioles and stipules. The stem throughout with minute striations of red.

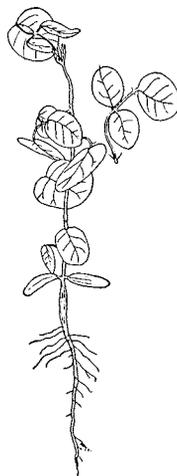


Fig. 13. Seedling of *Amorpha fruticosa* L., False Indigo, showing cotyledons, early simple leaves and later compound leaves.

Geraniales

Meliaceae

Melia Azedarach L., Pride of India, China-berry

(Second study. For first study see Proc. Iowa Acad. of Sci. **37**: 165.)

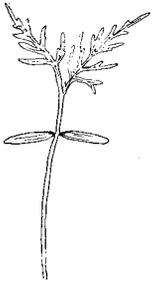


Fig. 14. Seedling of *Melia Azedarach* L., Pride of India, showing cotyledons and first leaves.

Seedlings of china-berry were collected at Gainesville, Fla., March 7, 1927, by L. H. Pammel. These seedlings were from one to three inches in height.

Germination epigeaeous. Cotyledons fleshy, short stalked, narrowly elliptical, soon falling. Hypocotyl at first pale in color, becoming green. First leaf compound, bipinnate or ternate. Leaf smooth, slightly paler beneath, smooth, prominently ribbed. Second leaf almost opposite the first.

Sapindales

Anacardiaceae

Rhus Toxicodendron L., Poison Ivy.

Seedlings growing about the mature plants were collected at Gainesville, Fla., Feb. 20, 1927, by L. H. Pammel.

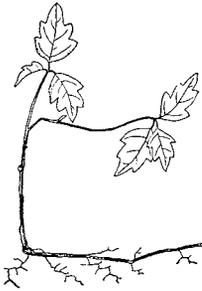


Fig. 15. Young shoot of *Rhus Toxicodendron* L., showing scales of last year's leaves along the stem.

First leaf with three leaflets, coarsely dentate, the middle leaflet being slightly larger than the others. Leaflets often one-sided, pale beneath, darker green above, reticulately veined.

Rhus copallina L., Dwarf Sumach

Seeds of this species were received from Florida, Jan. 23, 1927. They germinated, in sand, March 1 to 15. Growth vigorous.

Germination epigeaeous. Cotyledons elliptical, green above, reddish beneath. Hypocotyl reddish.

First pair of leaves nearly opposite, no stipules. First leaf, with three leaflets, green above, slightly reddish beneath, petioles; the two lateral leaflets lanceolate, terminal one broader at the base. Leaflets sessile. Second leaf compound,



Fig. 16. *Rhus copallina* L., Dwarf Sumach. (a) Seedling, showing cotyledons and first leaves; (b) Third leaf; (c) Fourth leaf.

similar to first, slightly larger. Third leaf, the two lateral leaflets and terminal leaflets deeply dentate, rachis margined. The fourth and fifth leaves with five sessile leaflets each; rachis winged; the lateral leaflets dentate toward top. Terminal leaflet larger, two deep indentations on each side, near the top. Sixth, like two preceding, but with fewer dentations, lateral leaflets nearly entire. Seventh leaf with seven leaflets. Stem and petioles pubescent. Young leaves all reddish on under side.

Schinus Terebinthifolia Raddi., Christmas Berry

(Introduced from Brazil)

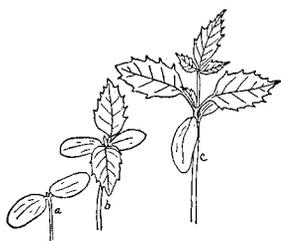


Fig. 17. Seedling of *Schinus terebinthifolia* Raddi., Christmas Berry. (a) 7 days, (b) 14 days, (c) 21 days.

Seeds of this species collected at Gainesville, Fla., Jan. 24, 1927, by L. H. Pammel and J. L. Seal, were planted in the greenhouse Jan. 28, and germinated freely Mar. 15, 1927. Germination epigeaeous. Hypocotyl rapidly elongating. Epicotyl reddish, smooth. Cotyledons oval, one-half inch in length, somewhat coriaceous, smooth, indistinctly net-veined. Cotyledons pe-

tioloed, petioles grooved.

First and second leaves opposite, simple, lanceolate; margins coarsely serrate, serrations sharp pointed. Upper and lower surfaces alike, bright green in color.

Rhamnales

Vitaceae

Cissus incisa (Nutt.) Des Moulins.

Seedling collected in Florida, Jan., 1927, by L. H. Pammel.

Germination epigeaeous. Hypocotyl long. Cotyledons oval, pointed at apex, about three-fourth inch broad, reddish.

First leaf trifoliolate; Internode about an inch long. Petiole of this compound leaf about one and a half inches long. Leaflets of nearly equal size, three-fourths inch long; margins incised with two deep, sharp-tipped serrations. Margins of leaflets and corresponding leaf stems with a row of minute spiny trichomes.

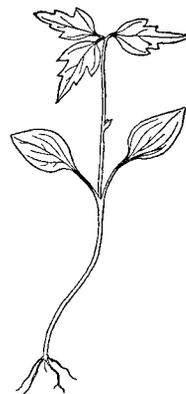


Fig. 18. *Cissus incisa* (Nutt.) Des Moulins, seedling showing seed-leaves and first trifoliolate leaf.

Violales

Dipterocarpus turbinatus Gaertn.,
Tung-oil plant.

Seedlings observed growing freely under parent trees at Gainesville, Fla., March 10, 1927, by L. H. Pammel.

Stem of year old plant tough, root system copious, densely clustered at the end of the hypocotyl. Lower part of the stem pale, becoming purplish.

Leaves opposite. Distinct scars left on stem, where last year's leaves dropped off. First leaf of second year seedling cordate, prominently ribbed, wavy margined. Second leaf with marginal teeth, some of which are spinulose. Leaf inclined to be three-lobed. Leaves thin, light green above, paler underneath, smooth. Petioles half the length of the leaf, reddish.

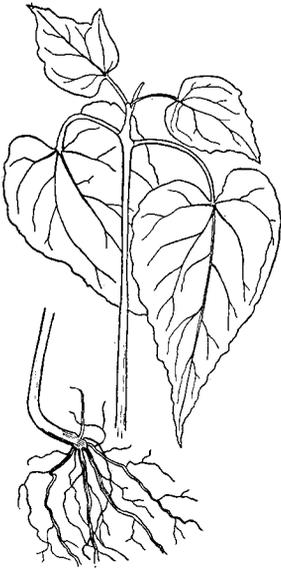


Fig. 19. Young plant of *Dipterocarpus turbinatus* Gaertn., Tung-oil plant.

Ericales

Ericaceae. Heath Family

Rhododendron maximum L., Great Laurel

Seeds of this species were observed by L. H. Pammel germinating freely on a fallen hemlock log at Knoxville (Smoky Mountains), Tennessee, March 19, 1927.

Germination epigeaeous, Cotyledons roundish, petioled, reddish below. Hypocotyl and plumule of reddish color; radicle brownish. Year old evergreen plants; first leaf small, ovate-orbiculate, entire, firm in texture. Upper surface dark green, smooth; lower surface reddish.

Second and third leaves ovate, green above, reddish beneath. Some hairs on the margins of the leaves. Petioles reddish.

Fourth and fifth leaves longer than the earlier leaves, ovate, slightly pointed. Older leaves with revolute margins slightly spinulose. Midrib strong, conspicuous on the under side. Leaves of leathery texture.

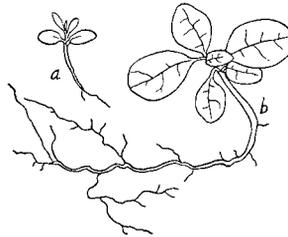


Fig. 20. *Rhododendron maximum* L., Great Laurel, showing cotyledons and early leaves.

Primulales

Myrsinaceae

Ardisia crenulata Vent., Ardisia.

Seedlings were found coming up freely under the shrubs on the grounds of Dr. E. W. Berger, Gainesville, Fla., in January, 1927.

Year old seedling; minute scales at the nodes of the epicotyl. First leaf roundish, one-third inch long, crenate. Second and succeeding leaves alternate, broadly elliptical, length about an inch, paler beneath, crenulate margined; extreme margin rolled under the edge. Leaves glandular along the margin and on the upper surface. Third and fourth leaves nearly opposite, petioled. All of the leaves of leathery texture. Roots many, fibrous.

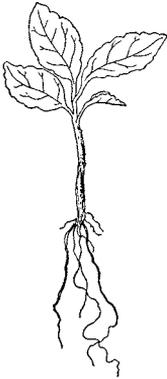


Fig. 21. Young plant of *Ardisia crenulata* Vent.

Gentianales

Apocynaceae.

Nerium Oleander L., Oleander.

Seeds collected at Gainesville, Fla., January 2, 1927, by L. H. Pammel were planted in the Iowa State College greenhouse January 6, 1927.

Germination epigeaeous. Cotyledons about one-half inch long, petiolate, narrowly lanceolate, obtusely pointed at the tip, fleshy, entire. Epicotyl reddish, smooth.

First and second leaves opposite, prominently penni-veined, smooth above and below. Stem swollen at the nodes. Young plant bright green.

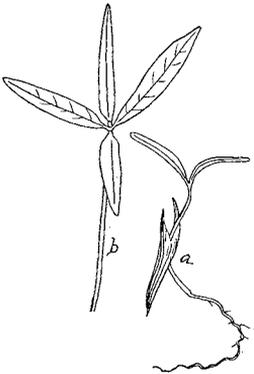


Fig. 22. Germinating seedling of *Nerium Oleander* L., Oleander. (a) Cotyledons emerging from the seed. (b) Later stage of seedling, showing first two leaves.

Polemoniales

Verbenaceae

Lantana Camara L., Lantana.

Seedlings of this species were collected from a lawn in Ocala, Fla., February, 1927, by L. H. Pammel.

Germination epigeaeous. Seedlings from one to two inches in height. Stem soon becoming woody. Leaves opposite. First pair of leaves lanceolate, elliptical; light green above, pale underneath; coarsely dentate. Second and third leaves ovate-lanceolate. Leaves pubescent on the margins. Second year stem pubescent.



Fig. 23. Young plant of *Lantana Camara* L., Lantana, showing early leaves.

Bignoniaceae

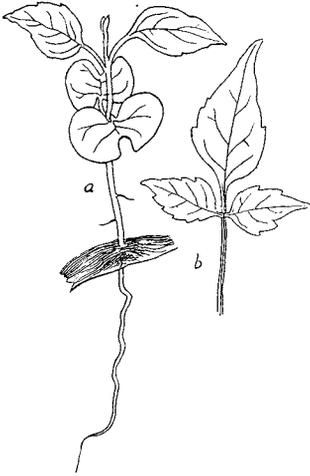
Tecoma radicans (L.) Juss., Trumpet Creeper.

Fig. 24. *Tecoma radicans* (L.) Juss., Trumpet Creeper. (a) Seedling showing cotyledons and the first two simple leaves. (b) The fifth leaf, compound.

Pods containing ripened seeds were collected by L. H. Pammel at Pittsburg, Iowa; seeds were planted in the greenhouse Dec. 2, 1926. These seeds germinated at different times of from three to six weeks. The first germination, Dec. 24, 1926, epigaeous. Hypocotyl erect, terete, smooth. Cotyledons about an inch wide, one-half inch long, deeply two-parted, bright green. Midvein and a few lateral veins distinct.

Leaves and petioles minutely papillate along the margins and midribs. Stem erect, green, marked with purplish lines. First internode one-half inch long.

First pair of leaves opposite, simple, exstipulate, petiolate, glabrous, bright green, penni-nerved. Leaves oval, acute, with one or two pronounced serrations on each side. Petiole channeled above. First four leaves simple; the fifth and sixth leaves compound, with three leaflets. Roots of seedling well developed.