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Further Studies of the Germination of Woody Plants

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FURTHER STUDIES OF THE GERMINATION OF WOODY PLANTS [1]

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Twenty-nine species of seeds were tried out; of these the following germinated: *Betula alba* var *papyrifera,* (Marsh) Spach, *Betula fontinalis* Sarg., *Quercus nigra* L., *Cinnamomum camphora* L., *Platanus occidentalis* L., *Physocarpus opulifolius* var *intermedius* (Rydb.) Robinson *Pyrus ioensis* L., *Cercis canadensis* L., *Amorpha canescens* Pursh., *Melia Azedarach* L., *Cissus ampelopsis* Pers., *Callicarpa americana* L., *Prunus Cerasus* was collected germinating beneath the trees in April.

Seeds of all northern species were wintered out-of-doors, lightly covered on the ground, and transferred to greenhouse about March 3.

Descriptions of the seedlings were made, accompanied by drawings.

For our study of seedlings during the year 1923-1924 there were planted seeds from the following species:

1. *Smilax herbacea* L. Carrion-flower. Wintered out of doors, no germination.

2. *Carya illinoensis* (Wang) K. Koch, Pecan. Planted direct in greenhouse, no germination.

3. *Betula fontinalis* Sarg. Birch. Wintered out of doors, free germination.

4. *Betula papyrifera* Marsh, Paper birch. Wintered out of doors, free germination.

5. *Quercus nigra* L. Water oak. Free germination.

6. *Liriodendron Tulipifera* L. Tulip tree. Wintered out of doors, no germination.

7. *Cinnamomum camphora* L. Camphor tree. Planted direct in greenhouse, several seeds germinated.

8. *Liquidambar Styraciflua* (No. 1) L. Sweet Gum. Wintered out of doors, no germination.

9. *Liquidambar Styraciflua* (No. 2) L. Sweet Gum. Planted direct in greenhouse, no germination.

10. *Platanus occidentalis* L. Sycamore. Wintered out of doors, free germination.

11. *Physocarpus opulifolius* var *intermedius* (Rydb.) Robinson. Wintered out of doors, 100 percent germination.

12. *Pyrus ioensis* (Wood) Bailey. Wild crab, Campus. Win-

[1] Contribution No. 7 on the germination of woody plants.

tered out of doors, germination of 1 seed. (Interfered with by mice).

13. *Pyrus ioensis* (Wood) Bailey, Wild crab, Olson's. Wintered out of doors, no germination.

14. *Crataegus punctata* Jacq. Yellow-fruited Haw. Wintered out of doors, no germination.

15. *Rosa setigera* Michx. Climbing rose. Wintered out of doors, no germination.

16. *Rosa blanda* Ait. Wild rose. Wintered out of doors, no germination.

17. *Rosa rugosa,* Thunb. Japanese rose. Wintered out of doors, no germination.

18. *Cercis canandensis* L. Red-bud. Wintered out of doors, free germination.

19. *Cladrastis lutea* (Michx. f.) Koch. Yellow-wood. Planted direct in greenhouse, no germination.

20. *Amorpha canescens* Pursh, Lead Plant. Wintered out of doors, free germination.

21. *Amorpha fruticosa* L. False Indigo. Wintered out of doors, no germination.

22. *Melia Azedarach* L. China-berry. Wintered out of doors, germinated very freely.

23. *Cissus Ampelopsis* Pers. Ampelopsis. Planted direct in greenhouse, free germination.

24. *Nyssa* sp. Planted direct in greenhouse, 1 seed germinated.

25. *Vaccinium arboreum* Marsh. Farkleberry. Wintered out of doors, no germination.

26. *Chionanthus virginica* L. Old Man's Beard. Wintered out of doors, no germination.

27. *Callicarpa americana* L. French mulberry. Planted direct in greenhouse, numerous seeds germinated.

28. *Cephalanthus occidentalis* L. Buttonbush. Planted direct in greenhouse, no germination.

29. *Symphoricarpos orbiculatus* Moench. Indian Currant. Wintered out of doors, no germination.

30. Seedlings of *Prunus Cerasus* L. were collected under trees in April.

31. *Symphoricarpos racemosus* var *laevigatus* (Fernald). No germination.

32. *Viburnum Lantana* L. Wayfaring Tree. Wintered out of doors, no germination.

33. *Viburnum Opulus* L. Highbush Cranberry. Wintered out of doors, no germination.

Descriptions follow, of seedlings of those species which germinated.

FAGALES

Fagaceae

Betula fontinalis Sarg. Birch.

Seeds of this birch were collected at Manitou, Colorado, by L. H. Pammel in August, 1923. They were wintered out of doors at surface of the soil and planted in the green house March 3, 1924. Cotyledons pushed up March 16. The plant was tiny, and growth slow. By April 1, the first leaf was well formed. There was a very high percentage of germination.

The three-leaved seedling about 11 mm in height, slightly smaller than seedling of paper birch. Germination epigaeous. Hypocotyl pale, stem distinctly reddish, very slightly pubescent, Cotyledons about 2 mm by 4 mm. in size, elliptical, obtuse. Leaves simple, alternate. First leaf ovate-cordate, deeply 3-notched. Second leaf oval with several deep serrations. Leaves much smoother than in seedling of paper birch.

Betula papyrifera Marsh.

Seeds collected on campus of Iowa State College, October 25, 1923. They were kept on the ground, lightly covered, during the winter, and planted in the greenhouse March 3, 1924. Date of first germination March 16. The development of this and the preceding species alike, as to date. First true leaf unfolding March 20. A high percentage of seeds germinated.

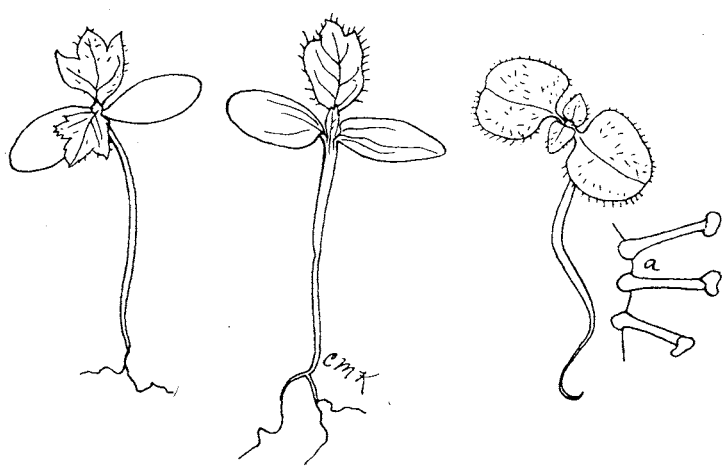

Fig. 1. Seedlings. a. *Betula fontinalis* Sarg. b. *Betula papyrifera* Marsh. c. *Callicarpa americana* L. a margin of leaf showing stipitate glands, enlarged.

Three-leaved seedling, 12 mm in height. Germination epigaeous. Hypocotyl pale green, upper portion reddish, about 8 mm above the soil, finely pubescent, straight tap root. Cotyledons about 2 mm by 1 mm in size, broad elliptical obtuse, petiolate, paler on underside, petiole grooved above. Stem

becoming woody, pubescent. Leaves simple, alternate. 1st leaf ovate, cordate, a few deep serrations, obscurely 5-nerved, glandular and hairy on both surfaces. Stipules small, caducous.

Quercus nigra L. Water Oak.

Jan. 15, 1924. Acorns from this oak, collected by L. H. Pammel at Gulfport, Mississippi, were planted in the greenhouse January 27. On March 25, the seedling had made a growth of 25 mm, bearing 3 scale-like leaves. On April 1st, the seedling bore four lanceolate leaves, about 10 mm to 25 mm in length. All the acorns grew, germinating at the following times: March 1, one; April 1, two; May 1, two. In one case the acorn sent out double shoots.

Quercus nigra L. Water Oak.

Nut or acorn globose, 8 to 10 mm long, cup saucer-shaped.

Germination hypogaeous, cotyledons subterranean. Stem reddish, numerous scattered hairs, increasing in numbers towards the top of the stem.

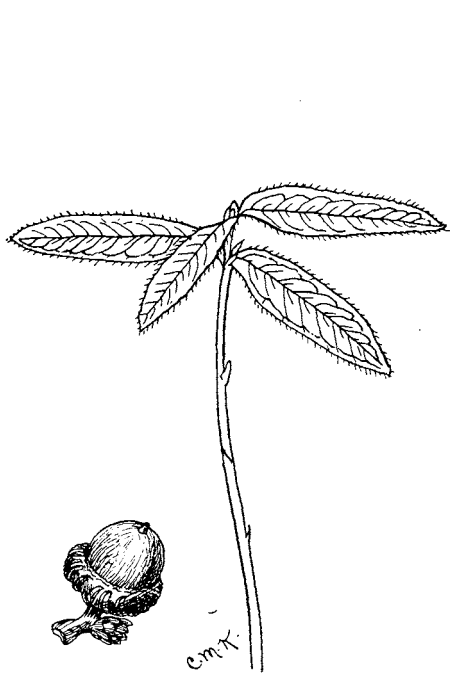

Fig. 2

Fig. 3

Fig. 2. *Quercus nigra* L. acorn and seedling.

Fig. 3. *Cinnamomum Camphora* L. Camphor tree, seedling, 6 weeks growth, showing cotyledons.

The three alternate primary leaves reduced to scales. When the stem is about 75 mm in height, the first leaf appears; it is lanceolate, pinnati-veined, acuminate, entire; the petiole is very short; stipules hairy, about 2 mm in length, deciduous. Leaf smooth above and below, except that the midrib,

on both sides of the leaf bears numerous hairs, and the margin is fringed with prominent hairs.

Second, third, and fourth leaves alternate, similar to the first in form and appearance. All these leaves reddish when young, greener and slightly coriaceous in aspect as they mature. Older leaves wholly smooth.

RANUNCULALES

Lauraceae

Cinnamomum Camphora L. Camphor tree.

Seeds of this species were collected by L. H. Pammel in Gulfport, Mississippi, and planted in the greenhouse, January 17, 1924. Two seedlings appeared about April 25; by June 1 they had reached the height of 65 mm.

Germination hypogaeous. Seedling smooth, sturdy. Hypocotyl green, 13 mm long, stem purplish-green, bearing alternate leafy scales. First and second scales, 3 mm long, sharp-tipped; third to fifth scales, 6 mm long, entire, sharp-tipped; sixth bract leafy, lanceolate, acuminate, about 8 mm long. Leaves alternate. First leaf 25 mm long, lanceolate, mucronate, entire, light green on both sides, veining reticulate, margin and veins translucent. Petiole flat, short, with bud at base; second leaf 32 mm long, similar to first; succeeding leaves similar to first and second. The leaves when crushed give off a camphor odor.

ROSALES

Platanaceae

Platanus occidentalis L. Sycamore.

Seeds of this species were collected bp L. H. Pammel in Ohio, December 30, 1923. They remained on the surface of the ground, lightly covered, until March 3, 1924, when they were planted in the greenhouse. On April 1st the seedlings were about 75 mm in height with 3 to 4 leaves. High percentage of germination.

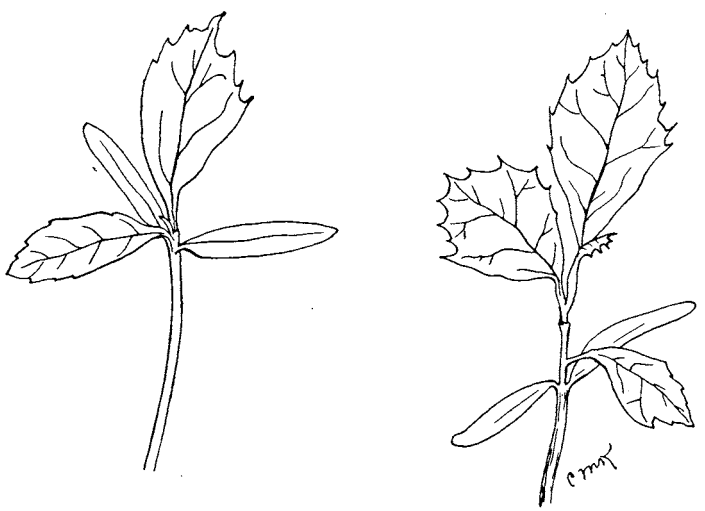

Fig. 4. Seedling of *Platanus occidentalis* L.

Germination epigaeous. Hypocotyl reddish. The cotyledons linear, fleshy about 14 mm. in length, 4 mm. in width, with short petiole, pointed at tip. Dentations of margin scattered with sharp tips, sinuate, more numerous toward the tip; conspicuously reticulately-veined, stipule prominent. Stipule broad at base, somewhat pointed. Second leaf similar to the first, larger. Stipule larger than of 1st leaf, dentate. Third leaf similar to second, broader in proportion. Fourth leaf, increasing in breadth, and in number of sinuate dentations around the outer half of the leaf, assuming distinctly the characteristic aspect of the full-sized sycamore leaf.

Rosaceae

Physocarpus opulifolius var *intermedius*. (Rydb) Robinson.

Seeds of this shrub were collected on the Iowa State College Campus by C. M. King, October 25, 1923. They were left out of doors, lightly covered, on the ground during the winter. On March 3, 1894 they were planted in the greenhouse; the first germination showed March 16; on April 1st the seedlings were about 13 mm in height, with one or two leaves. Very free germination.

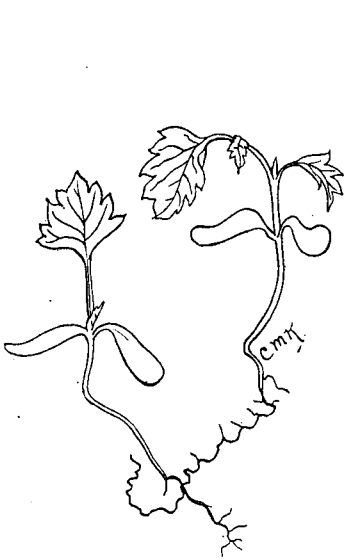

Fig. 5

Fig. 6

Fig. 5. *Physocarpus opulifolius* var *intermedius* (Rydb) Robinson, seedlings.
Fig. 6. *Pyrus ioensis* (Wood) Bailey, seedling.

Germination hypogaeous; hypocotyl erect pale green, or reddish, about 20 mm in length. Cotyledons, oblong-ovate, about 4 mm wide, and 8 mm long, emarginate, plainly nerved. Petiole short, channeled above. Stem erect, slightly winged by the decurrent edges of the petioles, green, becoming brown, and finally woody. First internode 3 mm long. Leaves alternate, simple, petiolate, with rounded, notched stipules. Leaves bright green above, paler beneath, penni-nerved. Petioles slightly winged on edges. First leaf broadly ovate, obtuse, palmately 3-nerved, dentate, with gland-

tipped teeth. Second leaf, slightly 3-lobed, dentate-serrate with obtuse, gland-tipped teeth, palmately 3-nerved.

Pyrus ioensis (wood) Bailey. Wild crab-apple.

Seeds collected on the campus, Iowa State College, October 1, 1923; kept at surface of the ground out of doors all winter. Planted in the greenhouse March 3, 1924. Germinated April 20. Germination epigaeous. Cotyledons about 4 mm long and 3 mm wide, truncate, oval, fleshy, dark green. Surface granular. First and second leaves alternate, ovate, with a few coarse serrations; distinctly veined, green, lighter on under side, slightly hairy. Petiole short, grooved. Third leaf similar. Stipules large, entire, lanceolate, rounded at the top, slightly hairy. The three-leaved seedling about 19 mm in height.

Prunus Cerasus L. Cultivated Cherry.

Seeds beneath the tree, at the surface of the ground, germinating freely April 20, 1924. Germination epigaeous. Hypocotyl smooth, fleshy, pale. Cotyledons oval, light green, fleshy, upper surface granular, about 10 mm long and 8 mm wide, hollowed longitudinally on under side. The cotyledons have stipulate glandular bodies at the base, two on each side. First and second leaves at first folded, the two halves against each other, alternate. The first two leaves are almost opposite. Leaves bright shining green, ovate lanceolate, sharply double-serrate, about 25 mm in length, with glandular stipules.

Fig. 7. *Prunus Cerasus* L. Seedling showing cotyledons.

Leguminosae

Cercis canadensis L. Redbud.

Seeds of the redbud were collected upon the campus of Iowa State College, by C. M. King, October 1, 1923. They were kept over the winter months, upon the ground out-of-doors, lightly covered; on March 3, 1924, they were transferred to soil of the greenhouse bench. First germination showed March 16; on April 1 the seedlings had attained a height of about

10 cm, with 2 or 3 leaves beyond the large leafy cotyledons. Seeds germinated freely.

Germination epigaeous. Hypocotyl of 3 leaved seedling 50 mm. long; pale green, slightly reddish above surface. Cotyledons broadly elliptical, obtuse toward end, bright green above, paler beneath, entire, smooth, pinnati-nerved with numerous veinlets. Stem slender, erect, herbaceous, at length woody. First internode 18mm long. First and second leaves simple, entire, heart-shaped, long-petioled, the leaves at right angles to the petioles. Leaves smooth, slightly leathery in aspect, lighter green on under side, strongly pinni-veined, and closely net-veined, veining conspicuous on under side of leaf.

Fig. 8. Seedlings; a. *Amorpha canescens* Pursh., b. *Cercis canadensis* L.

Amorpha canescens Pursh. Lead Plant.

Seeds of this shrubby plant were collected at Ames by L. H. Pammel, October 20, 1923. They were wintered out of doors, and planted in the greenhouse March 3, 1924. First germination showed March 16. By April 1 seedlings were about 25 mm in height and bore 3 to 4 leaves. Free germination of seeds.

Germination epigaeous. 3-leaved seedling, 25mm in height. Hypocotyl pale green; cotyledons 4x6 mm in size, green, paler beneath, roundly oval, very short-petioled, somewhat fleshy. First leaf simple, pointed, entire, tiny, lanceolate, about 1 mm long. First internode 4mm long, stem reddish. Second internode 6 mm long, stem reddish, 2nd leaf simple, oval heart-shaped at base, emarginate, smooth, entire, about 4 mm across, petiole slender, leaf set nearly right angles to stem. Pinnately netted-veined, keeled

along midrib, the 2 halves lying in approaching planes, third leaf like second.

GERANIALES

Meliaceae

Melia Azedarach L. Pride of India, China-berry

Fruits of the china-berry tree were collected by L. H. Pammel, at Hansboro, Mississippi, January 25, 1924. They were planted January 29 in the greenhouse. The first germination appeared March 16. The seedlings made vigorous growth; by April 1 they were about 75 mm or 90 mm in height, bearing two leaves above the cotyledons. A large percentage of the seeds germinated.

Fig. 9. *Melia Azedarach* L., germinating seeds and young seedlings.

Fruit, a globose, yellowish, berry-like drupe. Germination hypogaeous, the cotyledons bringing the seed coat above the surface, with them. Hypocotyl erect, pale green, pubescent; cotyledons almost opposite, about 13 mm long, linear-oblong, obtuse, glabrous; petiole short. Stem erect, light green, with short hairs.

First and second leaves very nearly opposite, similar, compound, without stipules, finely pubescent above, pale green on under side; petioles about 13 mm in length. First and second leaves three-divided; the separate segments are oblong-lanceolate, deeply toothed or lobed.

RHAMNALES

Vitaceae

Cissus Ampelopsis Pers. Ampelopsis.

Seeds of this species were collected from vines upon the Iowa State

Campus October 20, 1923, by C. M. King. They were kept on the ground out of doors lightly covered, during the winter and planted March 3, 1924, in the greenhouse. The first germination was observed on March 18. On April 1, the seedlings were about 75 mm in height, and bore 2 or 3 notched leaves above the larger leafy seed-leaves.

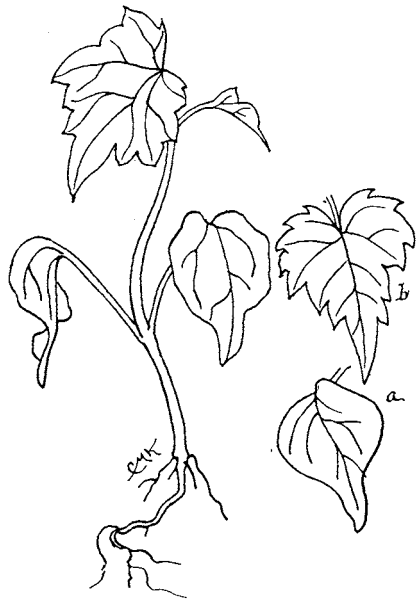

Fig. 10. *Cissus Ampelopsis* Pers. Seedling; a. *Cotyledon,* b. first leaf.

Germination epigaeous, hypocotyl reddish. Cotyledon cordate, acuminate, about 25 mm in length, 13 mm in width. Blade droops at an angle from the petiole. Petiole grooved, first leaf folded at first, cordate, acuminate, thin, reticulately veined, dentate with large serrations, a few hairs on the margin, deciduous stipules, hairy margined. Second leaf like the first. A large percentage of the seeds germinated.

POLEMONIALES

Verbenaceae

Callicarpa americana L. French Mulberry.

Germination epigaeous. Hypocotyl erect, finely pubescent, light green. Cotyledons round ovate, about 4 mm across, slightly emarginate, petiolate, indistinctly tri-nerved, covered with numerous stipitate glands, or gland-tipped hairs on upper side; smooth on under side. First leaves simple, opposite, exstipulate. Petiole short. Leaves elliptical, coarsely serrate, pubescent, pinnati-nerved. Leaf arrangement decussate.

RUBIALES

Caprifoliaceae

Viburnum Lantana L. Wayfaring Tree.

Seeds of this plant were collected in October, 1923; they were kept

under natural conditions at the surface of the ground out of doors throughout the winter. Upon March 3, 1924, the seeds were planted in the greenhouse, and one seed germinated May 25. Seedling described June 5. Height of seedling 50 mm.

Fig. 11. *Viburnum Lantana* L. Seedling two views.

Germination epigaeous. Root straight, hypocotyl reddish. Cotyledons, cordate, light green paler underneath, distinctly veined, size 13 mm by 17 mm, smooth. First pair of leaves opposite, bright green, ovate, a few large dentations beyond the middle of the leaf-edge. Both sides of leaves and petiole, freely pubescent. No stipules evident.