

STUDIES ON *BERBERIS VULGARIS* AND RELATED SPECIES: I. ON SEED GERMINATION AND THE SURVIVAL OF SEEDLINGS OF *BERBERIS VULGARIS* IN MONROE COUNTY, INDIANA

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In September, 1929, a series of studies on the common barberry, *Berberis vulgaris* L. was begun with the hope of their continuance through a number of years. The studies as planned include the germination of seeds in the greenhouse and in the open, the survival of seedlings in the open together with morphological and cytological investigations. It is intended to extend the morphological and cytological studies also to *B. Thunbergii* and perhaps to other species. Other features of interest may be included.

The results thus far obtained on the seed germination and on the survival of seedlings of *Berberis vulgaris* L. are given in the following paragraphs.

Germination of Seeds. The seeds used in the studies were supplied by the U. S. Department of Agriculture through the office of Mr. Wayne E. Leer, State Leader in barberry eradication in Indiana.

Germination experiments were made in the greenhouse and in the open. In the open, plantings were made in full sunshine in both poor and well fertilized soil, in an open thicket, and in a virgin beech-maple forest.

In the greenhouse the seeds were sown in flats. The conditions in the greenhouse were such as are usually maintained in a hot house used for general purposes in connection with a department of botany.

The results secured from the seed pans may be shown from the data as given in the following:

Flat No. 25. In this flat 750 seeds, removed from the fruits, were sown in rich woods earth on September 20, 1929.

Oct.	29, 1929—	31 seedlings appeared above ground
Nov.	8, 1929—	12 additional seedlings were up
Nov.	19, 1929—	3 additional seedlings were up
Dec.	20, 1929—	17 additional seedlings were up
Jan.	29, 1930—	4 additional seedlings were up
Feb.	28, 1930—	4 additional seedlings were up
Mar.	28, 1930—	5 additional seedlings were up
May	15, 1930—	14 additional seedlings were up
May	30, 1930—	1 additional seedling was up
After May 30 no seedlings appeared.		

From the 750 seeds in this flat a total of 91 seedlings appeared above the surface of the soil, or a viability of 1.2 per cent. The germination extended over a period of 8 months and ten days.

Flat No. 23. 500 seeds were sown in this flat Oct. 4, 1929.

Nov. 8, 1929— 6 seedlings were above ground
Nov. 21, 1929— 1 additional seedling appeared
Dec. 20, 1929— 8 additional seedlings appeared
Jan. 29, 1930—11 additional seedlings appeared
Feb. 28, 1930— 3 additional seedlings appeared
Mar. 28, 1930— 4 additional seedlings appeared
May 15, 1930—12 additional seedlings appeared
May 30, 1930— 1 additional seedling appeared

After May 30 no additional seedlings appeared. Of the 500 seeds in this flat 46 germinated or .92 per cent. An examination of the soil in both flats after another month revealed only the remains of decayed seeds.

From the foregoing it will be seen that germination was poor and it extended over a period 7 months and 26 days.

In order to determine whether a small opening made in the seed coat by means of a file, would have any effect upon germination, 500 seeds, each with a small slit-like opening thus made in the seed coat, were sown in a flat on October 2, 1929, and kept under green house conditions. Of these not a single seed germinated; all decayed.

Survival of Seedlings in the Open. In order to determine the survival of seedlings in the open, sowings were made in beds exposed to different conditions of soil, illumination, and shade.

Two beds were shown side by side in the open under full sunlight in a clay-loam soil, one being well fertilized with barnyard manure and the other unfertilized. The fertilizer was well rotted and thoroughly worked into the soil before the seeds were planted. In the fertilized bed 500 seeds were planted about one-half inch deep on July 20, 1929. On October 29, 1930, there was not a single survivor in this bed. Of these seeds only a few germinated.

In the same bed 100 fruits were planted at about the same depth. On October 29, 1930, there was but one surviving seedling. As the fruits average about two seeds each, there was under the conditions mentioned, one survivor from the 200 seeds.

In the unfertilized bed 500 seeds were also sown on July 20, 1929. From these seeds there were two survivors on October 29, 1930.

In this bed 100 fruits were also planted on October 5, 1929. On October 29, 1930, there were three survivors.

The two beds just mentioned were kept weeded, but the soil was not cultivated. On October 1, 1931, there were but two survivors in the unfertilized bed, the larger being ten inches high, and one survivor in the fertilized bed.

In the two beds above mentioned second sowings of 500 seeds were made in each on October 29, 1930. On October 1, 1931, there were 8 survivors in the fertilized bed and 10 in the unfertilized bed. From the thousand seeds, 18 survivors resulted. All of the plants are small, measuring two to three inches in height.

From the 2,400 seeds planted in the two beds a total of 18 seedlings were present in October, 1931.

Beds in the Thicket. The soil is a clay-loam and poor. The beds in the thicket sloped somewhat towards the north and the shading was much less than that under a full canopy of foliage, such as occurs in a beech-maple forest. From 1,000 seeds sown on October 14, 1929, there was a survival of 20 seedlings on October 29, 1930. On October 1, 1931, 18 plants were present, a little better showing than in full exposure to the sun. They are small and apparently stunted, the largest being four inches tall and unbranched.

Survival in Virgin Forest. On November 27, 1929, 1,000 seeds were sown in a bed in a beech-maple forest. In preparing the bed the dead leaves were raked off and the 1,000 seeds sown in rows and covered one-half inch deep with the rich leaf mould, after which a light covering of half-decayed leaves was spread over the bed. The bed was in the shade of a full canopy of the beech-maple forest.

Germination was poor. On November 1, 1930, seventy-five seedlings survived. A few of these had been lifted almost out of the ground as a result of freezing. Of these seventy-five survivors thirty only were present in the bed October 1, 1931. They had made a slow growth, the most vigorous having attained a height of about six inches.

On April 8, 1931, in a similar bed near the locality of the former, 3,000 seeds were sown, and on October 1, 1931, there were but seven survivors. They are all small, weak plants.

From the 7,400 seeds sown in the open under the conditions mentioned in the experiments a total of 73 plants resulted as survivors.

The shaded condition of thicket and forest seemed to be more favorable for the survival of *Berberis vulgaris* than open ground.

It will be recalled that the drought and heat of the growing season of 1930 were unusually severe, and only the most thrifty seedlings located in the most favorable natural environment could survive.

Pot Cultures of Seedlings in Greenhouse. From seeds sown Sept. 20, 1929, resulting seedlings were transplanted to six-inch pots November 20, 1929. On March 28, 1930, the first axillary dwarf branch developed from the axil of the 19th leaf. This leaf was reduced in size and had long spines typical of the species. The 20th leaf was almost reduced to spines, while the 21st leaf was completely changed to spines.

On June 15, 1930, two long branches had developed from older nodes of the primary stem just above the surface of the ground. On October 15, 1930, the primary shoot had attained a height of about four feet. The two long branches present on June 15 were almost three feet tall. During the summer three new long branches developed, two from the primary axis below the insertion of those appearing on June 15, and the third was a branch from one of the secondary long shoots. The foregoing record pertains to the most thrifty of pot grown plants. During the winter months of 1930 the potted plants were placed in the cold room of the greenhouse. In the spring of 1931 they were transplanted to the open in the garden. During the summer they grew into bushy specimens, the largest having 15 long branches. The branching took place near the ground. A number of the branches arose from the primary axis, while others sprang from the branches of the second order.

The order of development of the plants grown from seed sown in the open was the same as in the pot grown specimens.

Tischler¹ in his rather complete account of the development of *Berberis vulgaris* from the seed states that, during the first year short shoots only developed, the long branches appearing first in the second year. The rapidity and extent of growth attained the first year or season will depend upon the conditions facilitating growth. Even in the pot grown plants a considerable difference in the rapidity of growth was observed, and in the open the wide variation in the growth made by different plants is very apparent.

Development of Adventitious Shoots from the Roots. In addition to the well formed root system of the three-year old barberry bush, subterranean shoots develop, according to Citerne as reported by Tischler, which bear cataphylls and send up above the ground leafy shoots. "Ausser den Wurzeln giebt Citerne noch an 'rameaux souterrains enracinés, couverts de bractées, qui se redressent et s'épanouissent en rameaux feuilles après un trajet plus ou moins long dans de sol.'" In order to determine whether these subterranean branches arise from the stem or from roots, Tischler made an experiment as follows:

"Von einem dreijährigen Stämmchen schnitt ich Mitte Januar 1902 die ganzen oberirdischen Teile und selbst die von Nebenwurzeln freie obere Partie der Wurzel ab. Schon in den ersten Tagen des März war (bei Warmhausculturen) an der oberen Wundfläche eine grosse Laubknospe angelegt, die bereits anfang, ihre Blätter auszutreiben, und ausserdem noch eine weitere unentwickelte Knospe. Als ich die Wurzel aus der Erde herausnahm, entdeckte ich an vier Stellen an den Wurzeln ansitzende Laubknospen, zum Teil in ziemlicher Tiefe im Boden. Die oberste lag $5\frac{1}{2}$ cm., die anderen 6, 8 und 10 cm. von der Erdoberfläche entfernt, während die Wurzeln selbst bis zu einer Tiefe von 16 cm. reichten. An drei von diesen vier Orten waren mehr als eine Knospe, gerade wie an der oberen Wundfläche ausgebildet, zum Teil auch schon ein wenig ausgewachsen. Diese Adventivbildungen kommen aus der Cambialregion der Wurzel heraus, wie dies ganz normal ist." The internodes of subterranean branches ("rameaux souterrains") of Citerne, varied in length, the longest not exceeding 10 mm., and possessed small, spirally arranged cataphylls.

Tischler's experiment demonstrated the development of adventitious buds from the roots of a three-year old plant when all the parts above the soil, including that portion of the tap root which was free from lateral roots were cut away.

It is to be noted that the subterranean buds which appeared in Tischler's experiment developed from roots in which secondary thickening had begun and upon a root system of a plant from which the stem or stems had been cut away. Whether *Berberis vulgaris* will develop adventitious shoots from the roots under normal conditions is unknown at present to the writer.

¹ Tischler, George. Die Berberidaceen und Podophyllaceen. Versuch einer morphologisch-biologischen Monographie, Bot, Jahrb. Eng. 31:596-727. 1902.