

AGE OF SCALE BARK FORMATION IN CARYA OVATA.

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The writer has observed a number of vigorous specimens of *Caryta ovata* over a period of 18 years in order to ascertain among other facts especially the age at which the bark will be rifted and the "scale bark" formed. It has been possible to observe five specimens which have been under controlled conditions and which constitute an average of many trees as to growth and scale bark formation. These trees range in age from five to twenty-nine years. The trees which are five years old have retained their bark in a smooth condition throughout and the lenticels which are very numerous and well defined have retained their distinctness from the base to the top. The bark in the five-year-old trees, and even at times in younger ones, has begun at the base to show an interrupted system of light colored lines which extend, on the average, one meter from the ground up the stem. These mark the location of the scale bark which is produced on the older trees of this species. This tree was two meters high and one cm. in diameter at the ground.

In the trees of *C. ovata* which were six years old, on the average, the longitudinal lines above referred to, have become more distinct and the light color at the base of these lines has become more intensified. The second noticeable change is that the lenticels, have disappeared beginning at the base of the stem and have reappeared 71 cm. from the ground where the tree is two cm. in diameter. This specimen of *C. ovata* is three meters high and 2.5 cm. in diameter at the ground. The longitudinal lines above mentioned are much broader in some specimens than in others but at this stage average only 0.5 mm. or less in depth. They are frequently criss-crossed by lines of the natural color and surface elevation. This is due to the increase in diameter of the stem which pulls the closely situated lines apart in many instances. In other cases it is due to the splitting of layers of bark of the natural elevation left between two lines. In some specimens of *C. ovata* these shallow criss-crossed lines often attain a diameter of 8 mm. in one year. This amount of expansion of the original white lines was equivalent to 1.8 mm. per month for one observed growing period of five months. In most of the trees the longitudinal lines did not widen in the manner just mentioned but remained light lines as at first mentioned.

The observed specimens of *C. ovata* which were eight years old averaged four meters in height and 8 cm. in diameter at the ground. In the specimen taken as an average example, the bark remained firm and smooth except for the numerous fine, rather short, more or less wavy light lines parallel with the trunk. The lines in the bark of the five-year-old tree were nearly straight, but the waviness shown in the eight-year specimen, as well as older ones, indicated the unequal peripheral

growth to which the bark at this age could not accommodate itself. These wavy lines deviated from two to four mm. in some places in a straight line two cm. long. This was shown by penciled lines parallel with the lines in the bark. Lines made with ink, even the best quality of Chinese ink, are not durable or satisfactory since under the conditions encountered here they are more or less quickly effaced. This is not the case with suitable dark pencil lines. In the eight-year-old specimen of *C. ovata* the lenticels, as would be expected, had entirely disappeared from the trunk. They were only to be seen on the small branches, where the diameter was about one cm. or less.

The 11-year-old specimen of *C. ovata* is six meters high and 12 cm. in diameter at the base. It is an average specimen and its bark is conspicuously furrowed by the light lines referred to in the other trees. These furrows are, however, more plainly marked by their length, breadth and color than in the younger specimens. The waviness is also more pronounced for in a length of two cm. they were kinked in places as much as seven mm. from a straight line. At times they almost assumed a zig-zag course in a length of a few cm. All the lines, as in the younger trees here discussed, assumed a general parallel course with the stem. No breaks in the light lines in a transverse direction were present after they were formed. The lenticels as before were present on the younger parts of the small branches. All of the trees were vigorous and wounds caused by the cutting off of branches were quickly healed and grown over. In a few years some scars thus made were entirely covered and scarcely any external mark was left to indicate where the branch had been removed. The rate of growth was rapid for this species and showed a healthy condition.

The 29-year-old specimen of *C. ovata* is 10 meters high and 18 cm. in diameter at the ground. For a distance of eight cm. above the ground the light lines above referred to are very conspicuous. These are discontinued then until a height of 130 cm. is reached where the diameter is 11.5 cm. when they begin again and follow the trunk to a height of 6.5 m. These light lines began in this tree at the age of four years, which is somewhat earlier than was the case with the first specimen noted in this paper. The age at which scale bark formation began in this tree was during the eighteenth year and this is also the average age for its appearance in *Carya ovata* as was shown by comparative observations on other trees. The longitudinal cracks appeared three inches above the ground and ended at a height of 130 cm. where the light lines above noted began. When the longitudinal cracks began they widened rapidly as the circumference of the trunk increased so that at the twenty-ninth year the strips of bark so formed were separated from one to four cm. from one another in places. This separation was most conspicuous on the south side of the tree, which grows in a semi-open situation. The cross cracks which separate the above mentioned strips begin 25 cm. from the ground on the north side and end 50 cm. above this point. On the south side of the tree the cross cracks begin 12.5 cm. above the ground and are evident for a distance of 118 cm. above this point. The strips of scale bark turn back much

more on the south side and show much more development than on the north side due to differences of temperature, and growth conditions. The longitudinal lines have remained light brown in color at the base throughout the 29 years but in much older specimens of *C. ovata* this color has changed to almost black. This change of color is gradually effected by exposure especially to light and is usually completed in the rifts of bark on trees of this species at about 40 years of age. The young rifts in the bark of trees even of 40 years of age are still light brown at the bottom of the depression which they form but this gradually changes to a dark color in the older cracks toward the base of the tree.

A very old specimen of *C. ovata* which stands near the tree in question and which is at least 300 years old¹ has rifts both cross and longitudinal that are very wide and which are very dark throughout the length of the trunk. The scale bark produced in this 300-year-old specimen varies in width from 3 to 20 cm. and is loose from the trunk for a distance of one to four meters and is widely turned out at the cross divisions, a condition which gives the entire trunk a very shaggy appearance. The rate of callus formation, while slower than in some trees, shows nevertheless a fair rate of growth in the young trees. Limb scars having a diameter of one inch were completely healed over in six years in the 29-year-old specimen and left only a slight disfiguration on the surface. The specimens varying in age from 5 to 29 years, first discussed in this paper, grew from nuts formed on this 300-year-old specimen.

As the bark becomes older it finally hangs in loose strips and eventually falls off so that it never accumulates to any considerable thickness. It may even adhere at times, as in the very old specimen mentioned, in a more or less shingle-like fashion so that the beginnings or complete formation of several alternating strips may be seen. Due to the slow growth of the phellogen, the formation of these long strips in an old tree and their subsequent separation often requires years to accomplish even though the layers are comparatively thin. This rate of growth in *C. ovata* is quite different from that shown in *Quercus suber* with respect to the outer layers and especially as regards the thickness of the "female cork" which may have a thickness of 17 cm.² *C. ovata* continues to form the scale bark as long as it lives. Many young specimens, even at 75 years of age, show the same characteristic shaggy appearance but to a somewhat less degree. In *Q. suber* the cork may be removed from the tree and reforms until the tree is about 150 years old³. As de Bary⁴ states only a few accurate statements exist concerning the age of bark formation and desquamation. It is known to begin in the following named trees and at the ages mentioned: *Robinia pseudo-acacia* at the age of one year; *Ulmus effusa* at three to

¹ Andrews, F. M. Proc. Ind. Acad. Sci., 1918, p. 263.

² De Bary, A. Vergleichende Anatomie der Vegetativen Organe der Phanerogamen und Farne, 1877, p. 573.

³ De Bary, A. l. c., p. 573.

⁴ De Bary, A. l. c., p. 574.

four; *Betula alba* five or six; *Pinus sylvestris* eight to ten⁵; *Salix Amygdalina* eight to ten; *Alders* 15 to 20; *Quercus* 25 to 35 years; *Abies pectinata* and *Carpinus* at the 50th year⁶. The specimens of *C. ovata* here referred to began to form their scale bark during the eighteenth year. The color of the bark ranged from light or gray color to dark when the scale bark in the old trees was formed. This is due to changes in the cell walls and to the formation of certain phlobaphenes in the cells at certain stages of bark production.

⁵ Mohl, von Bot. Zeit., 1859, p. 338.

⁶ Haberlandt, G. Physiologische Pflanzenanatomie, 1909, Vierte Auflage, p. 131.