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Cowthorpe Oak

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spots are got, and there is a beautiful demonstration in miniature of the misty vapour making its escape.

(4) The Phycophæin retreats like a cloud before the heat (this is observable in the first experiment).

When a metal mould of an Ivy leaf is heated and pressed on the frond, one gets an impression of the same size as the mould well defined in green, and three minutes after removing metal, an outline beyond the contour line in pale green, which latter is surrounded by another outline in pale brown impinging on the natural brown.

(5) If a heated double split ring be applied on frond, the ring forms a light green circle, bordered on either side by a broad green band. Towards the periphery in three minutes the condition as in Ivy leaf is seen, a light green succeeded by a light brown ring appearing.

From the central brown area, corresponding with the hollow of the ring, similar phenomena occur in three minutes—a light brown ring next the brown (natural), and a light green ring beyond.

After an exposure to air of a few hours, and an afternoon and night wrapped up in paper, and thus excluded from atmospheric agency, the central brown (natural) area of the manipulated frond is surrounded by a green ring, and a brown occupies the place of the previous green ring.

Towards the periphery of the figure, one finds a green ring touching the natural brown of the frond, and within the green ring a circle of brown.

COWTHORPE OAK. By JOHN CLAYTON. Communicated by
Dr. DAVID CHRISTISON. (With Photo. Illustrations.)

(Read 12th March 1903.)

The oak tree at Cowthorpe, near Wetherby, is acknowledged to be the largest in diameter of all oaks that are known. It therefore commands an attention that is specially its own—as a king among men—and it is doubtful whether any other living tree has had as much written about it as it has, for wherever books on forestry in the English language are printed and read, so far has spread the fame of the Cowthorpe Oak.

Famous English trees and the records we have respecting them have furnished data to the scientific men of all countries; no other country being possessed of the double blessing of wonderful trees and reliable recorders. The recorders deserving to be remembered in connection with our subject are John Evelyn, Robert Marsham, H. Rooke, Dr. Hunter, J. G. Strutt, Loudon, and Empson. The records consist of a statement such as—that in a certain locality, on the date of writing, there was a tree of such a species, which girthed so many feet and inches at, say, 5 ft. from the ground; that the spread of the head was so many feet; the height so many feet; that the trunk was sound or not, as the case might be; and any other peculiarity. Statements like these would seem valueless to most people, and not worth recording, but being facts, scientific men can with them in after times prove or disprove theories of great interest and importance. One particular theory being De Candolle's, which claims for trees the possibility of an immortal life. Besides, the statements afford means of comparison, and without them it would not be known that some of the dimensions of the oak at Cowthorpe are larger than those of any other oak that is known.

John Evelyn was the first to make a number of records, and his "*Sylva*; or, Discourse of Forest Trees," published in 1664, was so popular that afterwards he was known as *Sylva Evelyn*. At present "*Evelyn's Diary*" is a more popular work; to his credit it may also be remembered that he was one of the founders of the Royal Society. It is only a little more than two hundred years since Evelyn wrote the "*Sylva*," and of the noteworthy trees which he mentioned there are only three living at the present time—the Yew at Crowhurst, the Great Chestnut at Tortworth, and the Greendale Oak in Welbeck Park, near Worksop.

The yew tree at Crowhurst, in Surrey, stands to the east of the ancient church of that place—in the graveyard. In records of Edward I.'s time the church is mentioned. Within the building there are monuments with a date as early as 1450, and several others without a date which must be earlier still, as they are of Saxon and Norman workmanship. Our oldest trees are generally near some church, and it seems as if the sacredness of the edifice helps to shelter

and preserve them. This yew is one of about half a dozen which very closely compete for the distinction of being the largest in Britain (Photo. No. 1). It girths 34 ft. 4 in. on the ground; at 3 ft. above the ground, 32½ ft.; and at 5 ft. above, 30 ft. The pieces of paper pinned to the trunk indicate the girthing places—3 ft. and 5 ft. above the ground. The foliage and twig growth of the tree are very healthy and vigorous, but the trunk is hollow, and is a mere shell. There is a door which admits to the cavity, which is seated all round, being quite large enough to hold a number of people, for it measures in diameter 8 ft. one way and 9 ft. 3 in. another. Since Evelyn's time, it would seem this tree has not increased in girth, for he then speaks of it as being about ten yards in compass. The Great Chestnut at Tortworth, in Gloucestershire, is a tree about which there has been much discussion. In summertime its head appears a dense mass of healthy foliage (Photo. No. 2). The trunk girths 49 ft. 2 in. at 4 ft. from the ground—the place indicated by the paper pinned to the tree. This tree is on the Earl of Ducie's estate, and is about a hundred yards away from another very old and beautiful church. In 1646, when John Evelyn recorded the measurements of the Greendale Oak, it was evidently in a flourishing condition. It was 88 ft. high, "the diameter of the head was 81 ft. from bough end to bough end," and was very fresh and sound. The Greendale Oak is in Welbeck Park, and belongs to the Duke of Portland. Visitors at the Dukeries will not see this tree unless they inquire for it specially, as it stands a little away from the ordinary drive, in an open glade (Photo. No. 3). A roadway was cut through the trunk in 1724, as a consequence, it is said, of an after-dinner bet of Henry, the first Duke of Portland. Since then it has been the custom of the successive dukes to pass through the roadway with their brides shortly after marriage. The height of the archway when newly made is given as 10 ft. 2 in. Now at the highest point it is only 9 ft. 3 in., and at the lowest it is only 8½ ft., thus it is evident that the trunk has shrunk considerably, and does not stand as high out of the ground as it did formerly. At present the trunk girths 30 ft. 1 in. at 4½ ft. from the ground, or at the place indicated by the paper which appears

in the photograph. The highest twig reaches an altitude of about 54 ft.

The observations of Robert Marsham were communicated to the Royal Society by Dr. Hales in the middle of the eighteenth century. He in various ways contributed to our knowledge of forest trees. His measurements of the Cowthorpe Oak were the earliest which were properly verified by bearing the date of the measurements, and the name of the measurer. Marsham was a Norfolk gentleman who travelled extensively in England at a time when travelling was not so easy, for besides visiting Cowthorpe and other places, his records respecting the Tortworth Chestnut show that he had wandered as far as Gloucestershire.

Dr. Alexander Hunter, of York, published an edition of Evelyn's "*Sylva*" in 1776, with copious notes, which form a very valuable addition. Dr. Hunter corresponded with Marsham and many prominent scientific men. In this way he collected his published information respecting large and noted trees. The yew trees near Fountains Abbey he may have measured, but the dimensions he gives of the Cowthorpe Oak must be of a date long before his time, for they do not agree either with the measurements of his contemporaries, or the proportions shown by his excellent print of the celebrated tree. Dr. Hunter's work has in all probability spread the fame of the Cowthorpe Oak more than that of others. His dimensions of the tree are always given in popular descriptions—perhaps because they are the largest,—but though it is likely they once were correct, they are so no longer, and in quoting them some explanation ought to be given, or certainly a very exaggerated idea will be formed of what the old tree is at present.

Major Rooke in 1790 published descriptions and sketches of Remarkable Oaks at Welbeck and in Sherwood Forest. The Greendale Oak and others are carefully drawn and described, but the tree which bears his name, and is called the "Major Oak," is not mentioned by him. He had heard of the Cowthorpe Oak through Mr. Marsham, but was ignorant of Dr. Hunter's work, though it had been published thirteen years before. This fact seems to show a slow circulation of books in those days.

Jacob George Strutt, who was a landscape painter, travelled throughout England and Scotland during 1822 and several years following, sketching and painting forest trees distinguished for their size and antiquity. He left us fifty beautiful and faithful pictures, as memorials of grand trees scattered all over our island.

J. C. Loudon published the "*Arboretum Britannicum*" in 1838. It is a work of eight volumes, consisting of prints and letter-press, illustrative of all the information which he could gather about trees. Ten thousand pounds sterling was the cost of the production, and the sale was so slow that all Loudon was worth had to be pledged to the publishers for payment. It is said, the work and anxiety connected with it shortened the life of the author. How very often is scientific enterprise, not only unremunerative, but attended with disastrous loss.

Charles Empson published a pamphlet on the Cowthorpe Oak in 1842. He, in conjunction with four others, visited the tree, and took minute particulars and measurements in January of the same year. These measurements, which seem to have been taken with extreme care, along with a truthful print (which accompanies his pamphlet), form an important link in the history of the oak from the time of Dr. Hunter to the present. Who Empson was it is impossible to tell now, or anything more about him than that his name will always be remembered in any really worthy account of the venerable tree.

In 1893, or fifty-one years after Empson, the investigations, measurements, photographs, etc., were made, which are the subject matter of this paper. Four times during that year the Cowthorpe Oak was visited—in January, April, June, and October—with a view of seeing the tree under the aspects of the various seasons, and collecting at each time as much local information as possible. Besides, pilgrimages have been made to the tree once or twice in each year since.

Cowthorpe is a small village about four miles north-east of Wetherby. It is within a bend of the river Nidd. The church there was built in 1458, and is regarded with much interest. The old oak is near the church, and again the proximity of the two suggests it as probable that the tree

may have received some protecting influence from the sacredness of the church. In a photograph of the tree from the north the church appears, and in that from the south the old manor house is seen. When the tree was seen for the first time it was in January, but the earlier photographs were taken in April (Photo. No. 4). From the photographs it will be readily understood that the first sight of the celebrated Cowthorpe Oak was a disappointment. It seemed merely a heap of decaying stumps and props. However, after having made a circuit of the trunk outside the palings, which are about 5 ft. high, the sense of disappointment about the old monarch gradually gave place to a feeling of respect. The diagram shows the dimensions of the tree in various ways. The measurements were taken very carefully on 16th June 1893, and when tabulated as they are on the subjoined table, they can be easily compared with the measurements of others. The comparison shows the dimensions of the tree have diminished since Dr. Hunter's measurements were taken. That the old tree as it decays should shrink and settle somewhat into the ground is natural, and the difference between the earlier and later measurements is due to this circumstance mainly.

TABLE OF MEASUREMENTS of the COWTHORPE OAK from the time when first recorded to 1893.

Measurements in Dr. HUNTER's edition of Evelyn's "*Sylva*," which must have been taken about 1700—

Girth on ground	78 ft.
Length of branch	48 ft.
Height of tree	80 ft.

1768. ROBERT MARSHAM's measurements—

Girth 4 ft. above ground	46½ ft.
„ 5 ft. „	36½ ft.
„ 6 ft. „	32 ft. 1 in.

No hollow or cavity mentioned.

1774. Aug. THOMAS MAUDE's measure. Had heard it to be 81 ft. 6 in. in girth, but his measure a few inches above ground was 54 ft. No cavity is mentioned. Wind storm in 1703 damaged the tree, but the leading branch was torn away in 1718.

1776. The date of Dr. HUNTER's portrait of the tree. In the portrait no cavity appears, and none is mentioned in his letter-press description.

In 1829 Dr. JESSOP measured the tree, and the measurements are given by J. G. Strutt—

Girth on ground	60 ft.
„ 3 ft. above ground	45 ft.
Length of branch	50 ft.
Circumference of branch	8 ft.
Height of tree	45 ft.

Cavity big enough to hold 40 men, and hollow throughout to the top. Leaves are sessile, and acorns are on stalks.

1829. Oct. A cor. of J. C. LOUDON measures—

Length of largest living branch, about	48 ft.
Girth of branch 3 ft. from bole	8½ ft.
Branch supported by 3 props which rested on stone pedestals.	
Height of tree, including dead branch	56 ft.
Diameter of cavity on ground	9 ft. 10 in.
Branch torn away by storm in 1722.	

1834. LAUDER says the main branch was rent away by a storm in 1718.**1842.** CHARLES EMPSON'S measurements—

Girth on ground	60 ft.
„ 1 ft. above ground	56 ft.
„ 3 ft. „	45 ft.
„ 4 ft. „	38 ft. 6 in.
„ 5 ft. „	36 ft. 3 in.
„ 8½ ft. „ and close under the great branch	34 ft. 6 in.
Length of main branch	50½ ft.
Girth of „ close to trunk	10 ft.
„ „ 3 ft. from trunk	8 ft. 4 in.
„ „ 9 ft. „	6 ft. 9 in.
„ „ 17 ft. „	5 ft. 3 in.
Height of tree, including dead wood	43 ft.
„ „ without „	33 ft.
Length of second principal branch	30 ft.
Girth „ „ 8 ft. from trunk	5 ft.
Diameter of cavity on ground	11 ft.
Average diameter 8 ft. above ground	7 ft. 8 in.
„ „ 12 ft. „	7 ft.
Soil—deep rich loam on fine clay.	
Prof. Burnett's estimate of age, 1600 years.	

1853. GRIGOR, in his “Arboriculture,” says: “Cattle enter the cavity for shade and shelter;” hence it appears there were no palings round the tree then.

1879. Rev. THOMAS WHITE, Rector of Cowthorpe for thirty-five years, says: “I think the venerable tree has shrunk very much in my time.”

1883. A cor. of “Notes and Queries” says: “The tree bears acorns.”

Girth on ground	53 ft.
„ 3 ft. above ground	44½ ft.

1888. H. CROSSLEY, of Wetherby, says: “The consequence is that the tree has shrunk somewhat during recent years.”

1893. JOHN CLAYTON'S measurements—

Girth on ground	51 ft. 3 in.
„ 3 ft. above ground	44 ft.
„ 5½ ft. „	36 ft. 10½ in.
Length of main branch	33½ ft.
Girth of branch 2 ft. from bole	9 ft. 9 in.
„ „ 5 ft. „	8 ft. 9 in.
Distance of underside of branch from the ground near the bole	7 ft. 3 in.
Ditto 6 ft. away from the bole	7 ft. 8 in.
Diameter of cavity on ground	13 ft. × 9 ft.
„ „ 2 ft. above ground	11 ft. 1 in. × 8 ft. 7 in.
„ „ 5 ft. „	10½ ft. × 7½ ft.
Opening into cavity, west side on ground	6 ft. wide.
Ditto 4 ft. above ground	3½ ft. wide.
Ditto 6 ft. „	3 ft. wide.
Opening into cavity, south side, circular in shape, and 4 ft. diameter.	
Height of tree, including dead wood	37 ft.

The tree is supported by 25 props, disposed mostly on the south and east sides. There is a paling round the tree about 5 ft. high. It seems as if it had been put up from twenty to forty years ago.

A Cowthorpe man, named OATES, said: "The tree has shrunk very much in my time, and, in shrinking, the tree has twisted—the eastern branches towards the south."

There is to be seen a circle all round the tree 14 ft. away from the bole, showing that the soil was once thrown up about the bottom of the tree.

Age of the tree estimated to be about 500 years.

From an acorn borne by the celebrated old tree in 1893, a young plant has been reared and planted near its parent as a memorial.

In forest trees the work of death and decay is first seen at the extremities of the highest branches. These branches in a dying tree lose their leaves and twigs, and the tree becomes what is called stag-headed. This fact suggests that death in the roots commences in the extremities also, supposing the suggestion to be true, it is easy to understand why old trees shrink and settle into the ground (Photo. No. 5). The diagram is drawn on this supposition, and will illustrate what we mean.

Allow the figure under the year 1700 to represent the roots of the Cowthorpe Oak at that time, and assuming that the roots perish by decay at their extremities (as we know the branches do), then by 1842 their decay will have shortened them, probably to the dotted line anent that year, and will thus have made room for a general sinking or subsidence of the tree, the sinking of course being caused by the weight of the tree. The subsidence will also be gradual, according exactly with the progress of decay in the roots; and by 1893 their further decay will have shortened them again, say, to the second dotted line, and thus made room for a further subsidence.

It is impossible to prove a subsidence of trees in general as they grow old and decayed, because records are not made respecting their elevations. But the subsidence of the Greendale Oak, which has already been referred to, is beyond a doubt. The picture is a copy of a print of the Greendale Oak published in 1727, or three years after the roadway was cut through the tree. Along with the print is a statement that the archway was 10 ft. 2 in. high. In 1775 the height of the arch was measured again, and the former measurement was confirmed (Photo. No. 7),—this is given in Dr. Hunter's "Evelyn's Sylva" (Photo. No. 3). In 1894 the highest point in the arch was 9 ft. 3 in. from the ground. Thus this evidence shows a subsidence in the Greendale Oak

of 11 in., a fact which is important, for although there is ample independent evidence that the Cowthorpe Oak has sunk somewhat into the ground, yet it is more assuring to find that other trees do the same under similar conditions.

In 1879, the Rev. Thomas White, who had been Rector of Cowthorpe for thirty-five years, writes, "I think the venerable tree has shrunk very much in my time." In 1888, H. Crossley of Wetherby says, "The tree has shrunk somewhat during recent years." In 1893, a Cowthorpe man named Oates (sixty-seven years old) said, "The tree has shrunk very much in my time" (Photo. No. 5). In 1842, Empson gives a girth close under the great branch, which he stated was $8\frac{1}{2}$ ft. from the ground, but this branch in 1893 was only 7 ft. 3 in. from the ground. These two measurements in fifty-one years show a subsidence of the tree during the time of 15 in. There is collateral evidence of the subsidence, furnished by the slanting position at the present time of the three props, which already supported the main branch in October 1829, for then they would be upright, and the difference between the upright position and the present slanting one shows a decrease in the elevation of the branch of 2 ft. There is another circumstance in connection with the Cowthorpe Oak which should be considered when comparing the earlier measurements with those of a later date. Sometime before Empson wrote (viz. 1842), the soil was dug up all round the tree at a distance of 13 or 14 ft. from the bole, and was thrown up about the bottom of the tree. By this operation the circumference of the tree where it meets the soil would be reduced, but certainly not so much as some writers would lead us to believe, for the trenching round the tree is evident to-day, and it was so little that one may see it could not affect the tree's dimensions as seriously as it has been asserted.

The explanations and proofs of the subsidence of the Cowthorpe Oak may be tedious, but they are important, as the phenomenon established thereby is common to forest trees. And without the explanations it would be impossible to reconcile the various measurements from the earliest time until now.

(Photo. No. 5.) The diagram shows the shape of the trunk of the tree, the diameter of which is greatest on the

ground and gradually gets less above. To be consistent with this shape, if we were to dig below the level of the ground the diameter would become greater still; but, instead of digging, suppose the tree were raised 15 in., or to the elevation it had in Empson's time, 1842—and Empson's measurement of the girth on the ground, 60 ft., appears quite credible and accurate, although it is certain the girth in 1893 was only 54 ft. 3 in.,—and suppose the tree were raised still further to make up for the subsidence between the dates of Dr. Hunter's measurements and Empson's, then Dr. Hunter's girth, 78 ft., would also appear credible. Thus the apparent discrepancies in the measurements of the girth of the tree on the ground are fully and reasonably explained. Other discrepancies in the measurements will be seen in the table, but none are serious, and most of them can be accounted for by the same reasons that have been employed in reconciling the measurements of the girth on the ground-level.

We are therefore prepared to receive Dr. Hunter's measurements as the dimensions of the tree before its decline, and if we can realise them properly we shall have a better idea of the former magnificence of the Cowthorpe Oak, and why it became so famous. Many people have seen the Major Oak at the Dukeries, near Edwinstowe. It is a wonderful tree, and is generally regarded as a sight worth seeing. But the Cowthorpe Oak was a much grander sight, as may be readily conceived by comparing a diagram of the two trees drawn to one scale. The Major Oak is 53 ft. high; the Cowthorpe Oak was 80 ft. high. From bough end to bough end of the Major Oak, it measures 94 ft. In this respect the Cowthorpe Oak measured about 120 ft. The Major Oak at 5 ft. from the ground girths $29\frac{1}{2}$ ft.; at the same level the Cowthorpe Oak girths 36 ft. 10 in.

It is difficult to imagine a more suitable place for the largest development of a growing tree than the situation of the Cowthorpe Oak. The conformation of the locality, and its natural and artificial surroundings, would at all times make it a warm and sheltered spot. The tree is about the middle of a field which slopes gently towards the river—the river being near enough to afford a constant supply of moisture. At present there are other trees near it, but when it was young and in its prime, it

evidently stood somewhat alone—a condition favourable for the full attainment of its utmost magnitude. The soil where the oak stands is alluvial, and is both rich and deep.

If tradition may be trusted, it is nearly two hundred years since the first token of decline appeared in the Cowthorpe Oak. In November 1703, a terrible wind-storm swept over western Europe. In its violence it damaged the tree to a large extent; but it was another November storm, in 1718, that wrought the most injury, for by it the leading and central branch was torn away. It is also said that in 1722 the tree suffered much damage from another storm. After these disasters, the work of decay would doubtless proceed more rapidly, and now the work is so nearly accomplished that it seems impossible for the tree to survive much longer. However, what remains puts forth new shoots and leaves every season, though imperceptibly dwindling each year. In 1893 it bore a good crop of acorns, considering its ruined state. The acorns were not sessile, but were on long stalks. From some of them young plants have been reared, and, by permission of the late Mr. Montagu, of Ingmanthorpe, one has been planted, in the hope that it will perpetuate the memory of the doomed giant. The young oak is planted near its illustrious parent, and is securely fenced in. The Rector of Cowthorpe, the Rev. Mr. Clarke, has kindly undertaken to be the guardian of its youth.

Interesting as the Cowthorpe Oak is on account of its size, it is no less so when considered in relation to its age. Therefore we claim to be allowed to extract to the full the lesson which it teaches in this respect.

In the beginning of this century, the elder De Candolle promulgated the theory that trees never die of old age, and, barring the accidents of injury and disease, they would live for ever. Of course a doctrine so novel was not accepted at once, but before the century was half gone we find that it had taken strong hold in the scientific world, and among its adherents were Dr. Lindley and Dr. Asa Gray, both very eminent and learned botanists. The discovery of the Big-trees of California, and the indisputable testimony of their antiquity furnished by the annual

rings, seems to have completed the argument in favour of the theory. For since then the controversy has ceased. But the theory is so contrary to what is known of life that gradually it is beginning to be doubted, and now distinguished professors of forestry hesitate to commit themselves either for or against it.

We will quote Dr. Asa Gray's explanation of the theory:¹ "For the tree (unlike the animal) is gradually developed by the successive addition of new parts. It annually renews not only its buds and leaves, but its wood and its roots, everything, indeed, that is concerned in its life and growth. Thus, like the fabled *Æson*, being restored from the decrepitude of age to the bloom of youth, the most recent branchlets being placed by means of the latest layer of wood in favourable communication with the newly formed roots, and these extending at a corresponding rate into fresh soil, why has not the tree all the conditions of existence in the thousandth that it possessed in the hundredth or the tenth year of its age?

"The old and central part of the trunk may, indeed, decay, but this is of little moment so long as new layers are regularly formed at the circumference. The tree survives, and it is difficult to show that it is liable to death from old age, in any proper sense of the term."

It is clear De Candolle sincerely believed in his theory, for he worked continuously a number of years gathering evidence in its favour. The literature dealing with notable trees was at his command. This, along with his own observations, led him to believe that the oaks were among the veterans of Europe, but that of all species the yews attained the greatest age (of course it will be remembered he arrived at this judgment before the Sequoias or the Big-trees of California were discovered). From a number of sections of trees of various species, he assumed that he could determine an average growth by measuring the annual increment of each species. Thus he made the increase of the oak and yew on an average to be one-twelfth inch in diameter annually. And with this rate of increase, he computed the ages of three celebrated yews in

¹ Page 80, vol. 2, of "Gray's Essays," published by Macmillan & Co., London, 1889.

England, and one in Scotland. He reckoned the age of one of the yews near Fountains Abbey to be more than twelve centuries, taking a measurement of Pennant's as the basis of his computation. In this instance he confirms his reckoning by affirming that the tree was known in the year 1132—at the time when the foundations of the Abbey were laid. This statement is unreliable, and is due entirely to a passage in Burton's "Yorkshire Monasteries," bearing the comparatively recent date of 1757, where it is said—"We are told by tradition, the monks resided under these yews whilst they built the monastery." The yew at Crowhurst already mentioned, when speaking of John Evelyn, De Candolle estimated to be fourteen centuries old. The age of another yew at Braburn, in Kent, he estimated at three thousand years. And the yew at Fortingall, in Scotland, at twenty-five to twenty-six centuries. The irregularity which is apparent in the computed ages of these four yews is vastly augmented by the ages of yew trees in general, and De Candolle contends that such an irregularity is just what might be expected, and he regards the irregularity as confirmatory of the theory of the indefinite longevity of trees.

About 1830, or at the time when it seems the theory might be most generally accepted, Prof. Burnett assigned sixteen hundred years as the age of the Cowthorpe Oak. That Prof. Burnett made the assertion from a computation made according to De Candolle's theory there is no doubt, and his computation must have been based on some published measurement, for, as far as can be gathered, Prof. Burnett was never at Cowthorpe. Nevertheless Prof. Burnett's estimate of the age of the Cowthorpe Oak is commonly received, but as we believe it to be inaccurate and greatly exaggerated, we imply a want of faith in the basis of his computations; and this is so. We regard De Candolle's theory as altogether untrue, and not sustained by facts. In justification of these remarks, let us consider the photograph.

The picture (Photo. No. 6) represents a portion of the bole of an oak as it was laid in the timber yard of Messrs. Ackroyd, of Birkenshaw, in August 1894. It had been grown at Ravenfield, in an ancient park situated midway between

NO. 1.—TRUNK OF YEW TREE AT CROWHURST.

Girth—34 ft. 4 in., on the ground ; at 3 ft. above, $32\frac{1}{2}$ ft. ; at 5 ft. above, 30 ft.

Photo. taken August 1895.

No. 2.—TRUNK OF GREAT CHESTNUT AT TORTWORTH.

Girth—49 ft. 2 in. at 4 ft. above the ground (*i.e.*, where the paper is fixed).

Photo, taken September 1894.

No. 3.—TRUNK OF GREENDALE OAK.

The roadway was cut through in 1724. Girth—30 ft. 1 in., at 4½ ft. above the ground.

Photo, taken June 1894.

No. 4.—COWTHORPE OAK, SEEN FROM NORTH.

Photo, taken April 1893.

No. 5.

The diagram shows how the ground measurement of the Cowthorpe Oak would get less, as the decay of the roots allowed it to settle farther into the ground.

No. 6.—SECTION OF OAK TREE BOLE.
With a lens the Annual Rings may be seen in the picture.

NO. 7.—GREENDALE OAK IN 1775.

From a print in Dr. Hunter's edition of "Evelyn's Sylva."

Doncaster and Sheffield. The tree was felled in 1885, when it contained altogether 1000 cubic feet of marketable timber. Another portion of the bole (which was 18 ft. long, or the same length as the one represented) had been cut up and sold. Thus the bole originally was one straight piece 36 ft. long without a branch, and had an average diameter of about 5 ft., all sound and clean wood. Certainly it was the finest timber tree we ever saw. A cross section of this tree displayed admirably the annual rings, from the centre to the circumference, and thus afforded a splendid test of De Candolle's theory. From the heart to the circumference it measured $27\frac{3}{4}$ in., and if we compute the age of the tree according to De Candolle by allowing one-twelfth of an inch for each year's increase in diameter, the tree had been growing six hundred and sixty-six years, but really it was only two hundred and twelve years old, according to the testimony of the annual rings. The annual rings were not uncertain or confused, on the contrary they were clear and legible throughout, and furnished such evidence of the tree's age as would have convinced De Candolle himself.

If Prof. Burnett had seen the section whilst he was engaged in calculating the age of the Cowthorpe Oak, it is likely he would have taken the ratio of yearly increment from the section, and rejected that of De Candolle's theory. Had he done so, he would have made out the Cowthorpe Oak to be, not sixteen hundred years old, but only five hundred and forty-five years. We suppose his calculation would be something like this—at 5 ft. from the ground the Cowthorpe Oak girths about 36 ft. Divide this dimension by three, and roughly the diameter is found to be 12 ft. Half this is 6 ft., or 72 in., which would represent the radius. The radius of the section is about 28 in., in which are 212 annual rings. How many annual rings ought there to be in 72 in.—the radius of the Cowthorpe Oak? Answer 545.

But we cannot accept the age of the old tree from any calculation based on ratios, whether they be those of the section or of De Candolle, or of any other tree. For no two trees grow alike, and no one tree increases in the same ratio one year after another. And if a small section were

taken from the circumference of the Cowthorpe Oak itself, and the rings measured with a view of arriving at the annual increment of the tree throughout its life, this method would be quite as fallacious, for trees when they are young grow much faster than when they are old.

Whilst considering the photograph (No. 6) of the section, let us see whether it supports or opposes De Candolle's theory of indefinite longevity of trees. From the centre to No. 1 there are 100 annual rings of growth. From No. 1 to No. 2 there are 50 rings. From No. 2 to No. 3 there are 20 rings, and from No. 3 to the circumference there are 42 rings. That is, for one hundred and fifty years, or to No. 2, the tree had increased upon the whole in a uniform degree, but during the next twenty years the growth slowed down to less than half as much, and the last forty-two years of its existence it had slowed down still more, so that there was hardly any growth at all. This decadence in growth during the latter years is said to be only apparent, and not real. For, during the latter years, the tree is said to be so much bigger than what it was formerly, that though the annual layer of growth which covers the whole tree is thinner, the extended area of the surface of the enlarged tree is so much more as to account for the difference in the thickness of the annual growth. This explanation might be convincing in the absence of the photograph, but with the photograph before us it is not, for that plainly indicates that the thickness of the annual growth was nearly uniform to the time when the tree would be one hundred and fifty years old, notwithstanding that during all those years the surface of the tree would be annually enlarging. Therefore the lessening of the thickness of the annual growth in the latter years is distinctly different to what had happened during the one hundred and fifty years before, and it is a natural decadence which had come with years, that pointed as certainly to death from old age, as it flatly contradicted the theory of indefinite longevity of trees.

If we could have watched this tree during all the two hundred and twelve years of its life, we should have seen it grow in height and spread of branches till perhaps it was seventy to one hundred years of age. Then for fifty

years its appearance in these respects would not alter. The amount of foliage it would put forth each year would increase, for the twigs would have ceased as a whole from extending, and as they became effete towards their extremities, younger and more numerous twigs would push out somewhat lower down, and all would bear leaves. Thus we see the constant increase in the amount of foliage would be quite adequate to support an annual increment such as the section displays for one hundred and fifty years of its life. Then younger twigs would not so readily push forth, consequently the leaves would become fewer, and the annual increment, as shown by the section, would become less; and had not the tree been cut down this process would have gone on—increasingly so—till the top had become stag-headed and the bole of the tree hollow. Asa Gray, in his statement of De Candolle's theory, says: "The old and central part of the trunk of the tree may, indeed, decay, but this is of little moment, so long as new layers are regularly formed at the circumference. The tree survives, and it is difficult to show that it is liable to death from old age in any proper sense of the term." But to a tree, the becoming hollow is of great moment. The trunk is the only channel for the sap to pass from the roots to the head, and if the channel be narrowed by decay, less sap will pass, and there will be fewer leaves as a consequence, and the new layers formed at the circumference will become thinner. This process only needs to go on a while and the tree will no longer survive, and old age and its attendants will as surely bring about the death of the tree as they do that of other living organisms.

Having refuted De Candolle's theory, and shown how unreasonable Prof. Burnett's calculation is respecting the age of the Cowthorpe Oak, we now take upon ourselves the task of stating, not definitely, the age of the tree, but particulars of its history, during the hundred years that it has been known and recorded, with the hope that these particulars may help us to form an estimate of the age—within rather extended limits it is true, but probably as near as it is possible.

We have seen that in the life of a tree there is a period when it grows in all directions, and another period when

its general appearance—such as height and spread of limbs and foliage—remains almost unaltered, and a third period which is one of decay. The third period in the life of the Cowthorpe Oak we know almost perfectly, and the problem is, What was the duration of the other two periods? From evidence afforded by other trees, we think the time would not be much more than double the duration of the third period.

In Sherwood Forest and the neighbourhood there are some remarkable trees. At Studley the trees are finer still. But it is at Castle Howard that arboreous vegetation reaches nearest to perfection. There the natural conditions seem to be exceedingly suitable to the well-being of trees, and it is evident that the conditions have been aided for nearly two hundred years with all the ability at the command of man.

The work in connection with building of Castle Howard—the laying out of the grounds and the planting of trees—was commenced in 1702, and was finished in 1731. Thus the magnificent avenues there must be composed of trees about one hundred and eighty to two hundred years of age. The species which most abound are limes, beeches, and oaks. Their condition is that of a vigorous old age; they look well, but are certainly all on the decline. Here and there one has fallen as the consequence of premature decay and storms. In approaching the mansion, there is a number of large old oaks to be seen, 15 and 16 ft. in girth, all hollow and stag-headed. This circumstance is so peculiarly theirs, that one is bound to believe them to be the remains of a generation which flourished before that of the present plantation, and would be large and fully developed trees at the time Castle Howard was building, and similar in age and vigour to that of the later generation at the present time. Thus their decay has been accomplished in one hundred and fifty to two hundred years. The stage of decay at which these trees have arrived is about the same as that of the Cowthorpe Oak. Suppose, therefore, we take the two generations of oaks at Castle Howard as a criterion to ascertain the age that oaks will live to under favourable conditions, and we shall find the age to be three hundred and fifty to four hundred years.

With the knowledge that trees are not necessarily old if they have a large girth,—for trees with a large girth always grows faster than those with a less girth, and in proportion to the size they ultimately attain. Yet it seems absurd to ascribe four hundred years as the duration of the life of the Cowthorpe Oak, which for seventy years has been regarded nearly as old as the Christian era. However, all trustworthy evidence favours such a term, and if we incline to extend it to five hundred or six hundred years, it is more than the evidence warrants. Two hundred years since, the older generation of oaks at Castle Howard must have been fine trees, otherwise the fastidious founder of that place would have cut them down. Indeed, their condition would be like that of the Cowthorpe Oak, as it is nearly two hundred years since the first great branch was severed from it, and before that date its proportions were exceedingly grand, and no signs of decay had appeared. Since then the decline of the Cowthorpe Oak and the old oaks at Castle Howard has been about equal, and the circumstances of both are so parallel that whatever age is assigned to one must by all that is reasonable be assigned to the other.

The rapid progress of decay in the Cowthorpe Oak is another circumstance that points to a moderate duration of its life. Dr. Hunter's picture represents the tree in 1776. In 1893, scarcely one hundred and twenty years after the photograph, Photo. No. 4 represents the tree. If the tree was hollow in Dr. Hunter's time, it is not apparent in his print, nor does he speak of it in his letter-press description. Thomas Maude saw the tree in 1774, and he made a calculation showing the quantity of timber in it, supposing the trunk to be sound. Robert Marsham measured the tree in 1768, and he does not say anything about the tree being hollow. Hence if the tree was hollow one hundred and twenty years since, it could not be seen from the outside, otherwise one of these observers would certainly have seen it and mentioned it. In 1893 the diameter of the hollow on the ground was 13 ft. one way, and 9 ft. the other, and it had two entrances.

Perhaps there is nothing which shows so forcibly the rapid progress of decay as the contrast between Dr. Hunter's print

and the photographs of the ruined tree in 1893. And in presence of these pictures, which cover only a period of 120 years, the question may be asked, Does the age of the Cowthorpe Oak appear to be 400, 500, or 600 years? If we allow 400 years, then the tree was 280 years old at the time of Dr. Hunter's print, and since then it has been 120 years in coming to the present stage. If we allow 600 years, the tree was 480 years old at the date of Dr. Hunter's print. If 500 years be allowed (and it seems to us the utmost that can reasonably be assigned as the age of the Cowthorpe Oak), this would allow 120 years for the decay, and 380 years for growth and the partial declension which shows itself in Dr. Hunter's print.

Dr. Hunter's print is a faithful portrait of the tree in 1776, as is shown by another print, which depicts the tree about the same time, although it appears in the "Gentleman's Magazine" for 1831. Another picture of the old tree was sent to us by Mr. Carruthers, of the British Museum. It was published in 1806. In all the three engravings (Dr. Hunter's included) there is no sign of a cavity in the trunk; but in 1822, when J. G. Strutt was sketching the tree, the cavity was not only apparent, but could be entered in two places. Loudon, in 1829, says the floor of the cavity measures 9 ft. 10 in. across. Empson's picture, dated 1842, shows the opening to the hollow or cavity, and in his dimensions he states that at the base it measured 11 ft. across. In 1893 our measurement was 13 ft. This dimension and the photograph will show that the trunk was merely a shell.

Notwithstanding the careful and prolonged study of the Cowthorpe Oak, and the many efforts we have made to correct error respecting it, we have little hope that writers for popular papers will be influenced by them. Only six months since, a writer for a leading periodical who had had access to the results of our research, declared the tree to be sixteen hundred years old, and the print (date we believe is 1872) shows what an illustrated paper will do in exaggerating things, when it is compared with an actual photograph.