

## The Diameter-Increment of Trees.<sup>1</sup>

BY

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There are two methods, apart from the use of callipers, by which the diameter-increment or rate of growth in thickness of trees can be ascertained. One of these—the tape-method—has already been described by Dr. Christison; the other is by use of a very simple instrument invented by Pressler, and known as Pressler's increment-borer. By means of this instrument cylinders of wood about a quarter-inch in diameter and from two to six inches long—according to species—can be extracted, and upon these the breadth of the year-rings may be measured. In order to allow for any eccentricity or irregularity of growth it is safer to take the mean of four cylinders, one from each end of two diameters at right angles.

The great difference between these two methods is that the tape-method requires a very considerable period of time in order to get reliable results, as we cannot draw an average from one or two season's growths. In very few cases have careful measurements extending over a long period of time been carried out, but in the whole history of British arboriculture there is no place where more extensive and careful girth-measurements have been made than in the Royal Botanic Garden, Edinburgh.<sup>1</sup>

By the kind permission of the Regius Keeper I have had the rare opportunity of testing whether the increment-borer would yield the same, or approximately the same, results as were obtained by Dr. Christison by means of the tape. The trees I examined were those measured by Dr. Christison, and the

<sup>1</sup> See Notes from the Royal Botanic Garden, Edinburgh, Number III. (1900), p. 41.

numbers attached to the trees are those of his lists. In many cases I was able to extract cylinders fully five inches long, and in no case less than two inches. The length of the cylinder is, however, not necessarily an indication of the number of year-rings in it. A cylinder five inches long from a broad-ringed or fast-growing tree may contain no more or even fewer year-rings than a cylinder four inches long from a narrow-ringed or slow-growing tree. The greatest number of year-rings extracted was forty from a horse-chestnut, while fifteen to twenty-five was an easily obtained number from other species. (See Table 1.)

The breadth of the year-rings sometimes varies greatly on different sides of the same tree, especially in isolated trees which have not been grown in the company of others. This was well shown on many of the cylinders, so that cylinders of the same length from different sides of the tree do not necessarily have the same number of year-rings, and conversely cylinders with the same number of year-rings are not necessarily of equal lengths. This can be seen from the accompanying Table 111.

Having got the four borings I counted off the number of year-rings in each. It was generally found that one of the cylinders showed a smaller number than any of the others. I therefore marked off this number (say  $n$ ) on each of the other cylinders, disregarding any that were left over, as they did not come into consideration in making out an average. Having done this, I next found the aggregate length of the cylinders for this number of year-rings, and by dividing this by two and subtracting the result from the present diameter (bark included) I obtained the diameter which the tree had as many years ago as there were marked off rings in the cylinders. I next subtracted in succession twice the mean breadth of each annual ring from the diameter of the corresponding year, which gave the diameter of the preceding year. This operation gave the intermediate diameters and again the diameter  $n$  years ago. The first operation was an excellent means of checking the second.

It was then an easy matter to get the circumference for each year from the diameters. By subtracting the circumference for a certain year from that of the year following I got the circumference increment.

On comparing the results obtained by both methods—tape and

borer—it is extremely interesting to find how closely they coincide. The actual figures are not the same, because the borings were not taken at the same level as the tape-measurements. I purposely took them slightly higher or lower as seemed expedient in order not to interfere with the marked circumference measured by Dr. Christison.

Although the actual figures for each separate year do not exactly coincide, still the mean or average increment for a period of five or ten years does correspond very closely. In order to show the parallelism between both methods I have arranged the final results in adjacent columns in the appended Table 11.

It has been suggested that the increment-borer might damage the trees, but if care is taken to properly fill up the holes no danger can possibly exist. I may also point out that a very short time is required for the tree to naturally occlude such a trifling wound as the instrument makes. In almost every case the trees which I bored in the spring of last year were occluded by the autumn of this year and scarcely any trace of a scar remains.

The increment-borer can also be used in pathological work. For example, in making artificial infections, in order to study the course of development and effect on the tree of any wood-destroying fungus, there is no better method than to introduce a cylinder bored from a diseased tree into a healthy one. It is then an easy matter to extract cylinders from such an artificially infected tree at different times and from different parts, and thus get exact information regarding the rate at which the disease spreads and the various pathological appearances presented by the wood as the disease runs its course.

In determining the age of trees, if the diameter is not more than one foot the number of year-rings on an extracted cylinder will give this at once. If it is not possible to bore right into the centre we can still obtain the number of year rings on a certain length of the radius and from this compute the probable amount on the whole, always taking care to allow for the greater year-ring breadth near the centre of the stem. In many cases the pith is eccentric; if, therefore, we bore four cylinders in the radial direction one of them is generally found to reach the pith even though the diameter of the stem be more than one foot.

The relation between the wood-mass of a tree and the time taken to produce it is a subject of considerable scientific and practical importance. No matter whether the trees are grown for ornamental or economic purposes, a knowledge of the relation between time-increment and volume-increment cannot fail to be of great service. The proprietor of parks and ornamental policy-grounds is always interested to know how his trees are doing, whether they are still increasing by growth or are already mature. On the other hand in economic forestry it is essential to know the amount of timber which is or can be produced in a given time under certain climatic conditions and silvicultural treatment, otherwise financial calculations cannot be made with anything like the degree of accuracy which the case demands. The manifold external conditions influencing the growth of trees and plants in general make it well-nigh impossible to lay down any definite rules which are generally applicable for all species. A tree which is a fast grower in one locality may behave very differently in another, hence it is necessary for accurate results to collect statistics for each locality.

At present the German yield-tables are used in this country, and for general purposes are found to be approximately accurate, but the mere fact that in Germany local yield-tables are found to be necessary shows that the general yield-tables are not indiscriminately applicable. Our climate being an insular one, milder and moister, is bound to have a different effect on tree-growth from the continental climate of Europe.

If statistics were collected, especially for the Highlands, to which the German yield-tables are probably least applicable, they would be of great service to the forester, especially in making out working plans to guide the future management of the forests.

[TABLE.

## I.

DIAMETER-INCREMENT AND NUMBER OF YEAR-RINGS  
BORED.

	Increment in Inches.	No. of Rings.
<i>Æsculus</i> - - - -	9'44	40
<i>Carpinus Betulus</i> - - - -	2'01	20
<i>Castanea vesca</i> - - - -	7'58	28
<i>Cedrus</i> - - - -	8'82	23
<i>Fagus sylvatica</i> - - - -	3'91	14
" " - - - -	3'71	14
<i>Fraxinus excelsior</i> - - - -	3'39	12
<i>Liriodendron</i> - - - -	3'17	21
<i>Quercus Cerris</i> - - - -	2'05	12
" " - - - -	4'54	12
<i>Taxus</i> - - - -	3'62	28
<i>Tilia</i> - - - -	1'74	20
<i>Ulmus</i> - - - -	7'06	15

## II.

COMPARISON OF DR. CHRISTISON'S RESULTS OBTAINED BY  
MEANS OF TAPE WITH THOSE OBTAINED BY MEANS OF  
PRESSLER'S BORER.<sup>1</sup>

<i>ÆSCULUS.</i>				<i>CARPINUS.</i>			
Tape.		Borer.		Tape.		Borer.	
'35	- - -	'37		'25	- - -	'31	
'5	- - -	'38		'40	- - -	'31	
'10	- - -	'21		'45	- - -	'37	
'00	- - -	'12		'30	- - -	'28	
'25	- - -	'09		'45	- - -	'31	
'10	- - -	'18		'55	- - -	'37	
'25	- - -	'09		'35	- - -	'40	
'25	- - -	'18		'30	- - -	'21	
'30	- - -	'16		'50	- - -	'31	
'00	- - -	'12		'25	- - -	'31	
<hr/>				<hr/>			
1'65		1'90		3'80		3'18	
		1'90				3'80	
		1'65				3'18	
<hr/>				<hr/>			
Circum. Diff. =	-	'25		Circum. Diff. =	-	'62	
Diam. Diff. <sup>2</sup> =	-	'08		Diam. Diff. =	-	'20	
Mean Annual Diff. =		'008		Mean Annual Diff. =		'02	

<sup>1</sup> Measurements in both cases are in inches.<sup>2</sup> The Circumference-Difference has been divided in each case by 3. This gives the Diameter-Difference roughly, but near enough for the present purpose.

CASTANEA VESCA.				CEDRUS ATLANTICA.			
Tape.	-	-	Borer.	Tape.	-	-	Borer.
'60	-	-	'78	1'30	-	-	1'09
'75	-	-	'81	1'20	-	-	1'16
1'00	-	-	'65	1'30	-	-	1'13
'60	-	-	'78	1'20	-	-	1'03
'90	-	-	'81	1'20	-	-	1'19
'90	-	-	'59	1'50	-	-	1'53
'40	-	-	'65	1'25	-	-	1'44
'80	-	-	'53	1'10	-	-	1'13
'45	-	-	'50	'50	-	-	'34
'55	-	-	'69	'50	-	-	'53
<hr/>				<hr/>			
6'95			6'79	11'05			10'57
			6'95				11'05
			6'79				10'57
<hr/>				<hr/>			
Circum. Diff. =	-		'17	Circum. Diff. =	-		'48
Diam. Diff. =	-		'06	Diam. Diff. =	-		'16
Mean Annual Diff.=			'006	Mean Annual Diff.=			'016

FAGUS SYLVATICA.				FAGUS SYLVATICA.			
Tape.	-	-	Borer.	Tape.	-	-	Borer.
'75	-	-	'87	'80	-	-	'97
'80	-	-	'75	'95	-	-	'97
'95	-	-	'94	'95	-	-	'97
'90	-	-	'91	'90	-	-	'87
1'20	-	-	'87	'90	-	-	'94
1'10	-	-	'87	'90	-	-	'87
'85	-	-	'87	'90	-	-	'72
'60	-	-	'69	'90	-	-	'72
'90	-	-	'81	1'10	-	-	'94
'80	-	-	'78	'90	-	-	'65
<hr/>				<hr/>			
8'85			8'36	9'20			8'62
			8'85				9'20
			8'36				8'62
<hr/>				<hr/>			
Circum. Diff. =	-		'49	Circum. Diff. =	-		'58
Diam. Diff. =	-		'16	Diam. Diff. =	-		'19
Annual Mean Diff.=			'016	Annual Mean Diff.=			'019

FRAXINUS EXCELSIOR.				LIRIODENDRON.			
Tape.	-	-	Borer.	Tape.	-	-	Borer.
...	-	-	...	'35	-	-	'40
...	-	-	...	'40	-	-	'31
...	-	-	...	'80	-	-	'59
...	-	-	...	'50	-	-	'53
1'30	-	-	1'09	'65	-	-	'33
1'10	-	-	1'13	'40	-	-	'50
1'20	-	-	1'25	'75	-	-	'43
1'25	-	-	1'19	'35	-	-	'43
...	-	-	...	'40	-	-	'37
...	-	-	...	'25	-	-	'21
<hr/>				<hr/>			
4'85			4'66	4'85			4'10
			4'85				4'85
			4'66				4'10
<hr/>				<hr/>			
Circum. Diff. =	-		'19	Circum. Diff. =	-		'75
Diam. Diff. =	-		'06	Diam. Diff. =	-		'25
Mean Annual Diff. =			'006	Mean Annual Diff. =			'025

QUERCUS CERRIS.				QUERCUS CONFERTA.			
Tape.	-	-	Borer.	Tape.	-	-	Borer.
'70	-	-	'47	1'30	-	-	1'35
'45	-	-	'37	1'75	-	-	1'25
'65	-	-	'56	2'05	-	-	1'94
'50	-	-	'47	1'50	-	-	1'57
'70	-	-	'47	1'75	-	-	1'66
'85	-	-	'62	2'30	-	-	1'79
'70	-	-	'62	...	-	-	...
'55	-	-	'47	...	-	-	...
'80	-	-	'65	...	-	-	...
'60	-	-	'65	...	-	-	...
<hr/>				<hr/>			
6'50			5'35	10'65			9'56
			6'50				10'65
			5'35				9'56
<hr/>				<hr/>			
Circum. Diff. =	-		1'15	Circum. Diff. =	-		1'09
Diam. Diff. =	-		'35	Diam. Diff. =	-		'36
Mean Annual Diff. =			'035	Mean Annual Diff. =			'036



TAXUS.				TILIA.			
Tape.			Borer.	Tape.			Borer.
'40	-	-	'37	'00	-	-	'18
'60	-	-	'50	'50	-	-	'09
'55	-	-	'47	'40	-	-	'21
'55	-	-	'40	'25	-	-	'28
'45	-	-	'31	'20	-	-	'31
'45	-	-	'40	'40	-	-	'28
'45	-	-	'40	'35	-	-	'34
'40	-	-	'31	'00	-	-	'25
'55	-	-	'37	'30	-	-	'28
'20	-	-	'34	'35	-	-	'31
<hr/>				<hr/>			
4'55			3'87	2'75			2'53
			4'55				2'75
			3'87				2'53
<hr/>				<hr/>			
Circum. Diff. =	-		'68	Circum. Diff. =	-		'22
Diam. Diff. =	-		'22	Diam. Diff. =	-		'07
Mean Annual Diff. =			'022	Mean Annual Diff. =			'007

## ULMUS.

Tape.						Borer.
1'75	-	-	-	-	-	1'66
1'80	-	-	-	-	-	2'16
1'75	-	-	-	-	-	1'72
1'50	-	-	-	-	-	1'82
1'30	-	-	-	-	-	1'34
1'70	-	-	-	-	-	1'57
1'60	-	-	-	-	-	1'19
2'05	-	-	-	-	-	0'94
1'75	-	-	-	-	-	1'57
1'35	-	-	-	-	-	1'44
<hr/>						
16'55						15'41
						16'55
						15'41
<hr/>						
Circum. Diff. =	-	-	-	-		1'14
Diam. Diff. =	-	-	-	-		'38
Mean Annual Diff. =	-	-	-	-		'038



## III.

DETAILED RESULTS OBTAINED BY MEANS OF PRESSLER'S BORER.

## ÆSCULUS HIPPOCASTANUM.

Diam. Inct. for 40 years=9.44.

Diam. in 1899=17.16.

Diam. in 1859=7.72.

Year.	N.	S.	E.	W.	Sum.	Average.		Diameter.	Circumference.	Circumference Increment.
						Vulg.	Decimal.			
1860	11	11	11	11	11	11	.33	8.05	25.289880	1.036728
1861	11	11	11	11	11	11	.36	8.41	26.420656	1.130976
1862	11	11	11	11	11	11	.39	8.80	27.646080	1.225224
1863	11	11	11	11	11	11	.37	9.17	28.808472	1.162392
1864	11	11	11	11	11	11	.32	9.49	29.813784	1.005312
1865	11	11	11	11	11	11	.42	9.91	31.133256	1.319472
1866	11	11	11	11	11	11	.37	10.28	32.295648	1.162392
1867	11	11	11	11	11	11	.37	10.65	33.458040	1.162392
1868	11	11	11	11	11	11	.38	11.03	34.661848	1.193808
1869	11	11	11	11	11	11	.32	11.35	35.657160	1.005312
1870	11	11	11	11	11	11	.33	11.68	36.693888	1.036728
1871	11	11	11	11	11	11	.39	12.07	37.919112	1.225224
1872	11	11	11	11	11	11	.35	12.42	39.018672	1.099560
1873	11	11	11	11	11	11	.37	12.79	40.181064	1.162392
1874	11	11	11	11	11	11	.36	13.15	41.312040	1.130976
1875	11	11	11	11	11	11	.33	13.48	42.348768	1.036728
1876	11	11	11	11	11	11	.34	13.82	43.416912	1.068144
1877	11	11	11	11	11	11	.33	14.15	44.453640	1.036728
1878	11	11	11	11	11	11	.34	14.49	45.521784	1.068144
1879	11	11	11	11	11	11	.34	14.83	46.589928	1.068144
1880	11	11	11	11	11	11	.28	15.11	47.469576	.879468
1881	11	11	11	11	11	11	.24	15.35	48.223560	.753984
1882	11	11	11	11	11	11	.28	15.63	49.103208	.879648
1883	11	11	11	11	11	11	.25	15.88	49.888608	.785400
1884	11	11	11	11	11	11	.20	16.08	50.516928	.628320
1885	11	11	11	11	11	11	.21	16.29	51.176664	.659736
1886	11	11	11	11	11	11	.11	16.40	51.522240	.345576
1887	11	11	11	11	11	11	.11	16.51	51.867816	.345576
1888	11	11	11	11	11	11	.12	16.63	52.244808	.376992
1889	11	11	11	11	11	11	.09	16.72	52.527552	.382744
1890	11	11	11	11	11	11	.07	16.79	52.747464	.219912
..	..	..	..	..	..	..	9.44	..	..	..

ÆSCULUS HIPPOCASTANUM—*Continued.*

Year.	N.	S.	E.	W.	Sum.	Average.		Diameter	Circumference.	Circumference Increment.
						Vulg.	Decimal.			
1891	♂	♂	♂	♂	♂	♂	·34	16·83	52·873128	·125664
1892	♂	♂	♂	♂	♂	♂	·03	16·86	52·967376	·094248
1893	♂	♂	♂	♂	♂	♂	·06	16·92	53·155872	·188496
1894	♂	♂	♂	♂	♂	♂	·03	16·95	53·250120	·094248
1895	♂	♂	♂	♂	♂	♂	·05	17·01	53·438616	·188496
1896	♂	♂	♂	♂	♂	♂	·05	17·06	53·595696	·167080
1897	♂	♂	♂	♂	♂	♂	·04	17·10	53·721360	·125664
1898	♂	♂	♂	♂	♂	♂	·03	17·13	53·815608	·094248
1899	♂	♂	♂	♂	♂	♂	·03	17·16	54·909856	·094248
..	..	..	..	..	..	..	9·44	..	..	..

## CARPINUS BETULUS, No. 33.

Diam. Inct. for 20 years = 2·61.

Diam. in 1899 = 17.

Diam. in 1879 = 14·99.

Year.	N.	S.	E.	W.	Sum.	Average.		Diameter.	Circumference.	Circumference Increment.
						Vulg.	Decimal.			
1880	♂	♂	♂	♂	♂	♂	·09	15·08	47·375328	·282744
1881	♂	♂	♂	♂	♂	♂	·09	15·17	47·658072	·282744
1882	♂	♂	♂	♂	♂	♂	·11	15·28	48·003648	
1883	♂	♂	♂	♂	♂	♂	·13	15·41	48·412056	·408408
1884	♂	♂	♂	♂	♂	♂	·13	15·54	48·820464	·408408
1885	♂	♂	♂	♂	♂	♂	·12	15·66	49·197456	·376992
1886	♂	♂	♂	♂	♂	♂	·06	15·74	49·448784	·251328
1887	♂	♂	♂	♂	♂	♂	·12	15·86	49·825776	·376992
1888	♂	♂	♂	♂	♂	♂	·10	15·96	50·139936	·314160
1889	♂	♂	♂	♂	♂	♂	·10	16·06	50·454096	·314160
1890	♂	♂	♂	♂	♂	♂	·12	16·18	50·831088	·376992
1891	♂	♂	♂	♂	♂	♂	·09	16·27	51·113832	·282744
1892	♂	♂	♂	♂	♂	♂	·10	16·37	51·427992	·314160
1893	♂	♂	♂	♂	♂	♂	·12	16·49	51·804984	·376992
1894	♂	♂	♂	♂	♂	♂	·13	16·62	52·213392	·408408
1895	♂	♂	♂	♂	♂	♂	·07	16·69	52·433304	·219912
1896	♂	♂	♂	♂	♂	♂	·10	16·79	52·747464	·314160
1897	♂	♂	♂	♂	♂	♂	·10	16·89	53·061624	·314160
1898	♂	♂	♂	♂	♂	♂	·06	16·95	53·250120	·188496
1899	♂	♂	♂	♂	♂	♂	·05	17·	53·407200	·157080
..	..	..	..	..	..	..	2·01	..	..	..

## CEDRUS ATLANTICA, No. 30.

Diam. Inct. for 23 years=8.82.

Diam. in 1839=18.43.

Diam. in 1876=9.61.

Year.	N.	S.	E.	W.	Sum.	Average.		Diameter.	Circumference.	Circumference Increment.
						Vulg.	Decimal.			
1877	11	11	11	11	11	11	.42	10.03	31.510248	1.319472
1878	11	11	11	11	11	11	.55	10.58	33.238128	1.727980
1879	11	11	11	11	11	11	.46	11.04	34.683264	1.445136
1880	11	11	11	11	11	11	.50	11.54	36.254064	1.570800
1881	11	11	11	11	11	11	.46	12.00	37.699200	1.445136
1882	11	11	11	11	11	11	.49	12.49	39.238584	1.539384
1883	11	11	11	11	11	11	.40	12.89	40.495224	1.256740
1884	11	11	11	11	11	11	.48	13.37	42.003192	1.507968
1885	11	11	11	11	11	11	.42	13.79	43.322664	1.319472
1886	11	11	11	11	11	11	.42	14.21	44.642136	1.319472
1887	11	11	11	11	11	11	.42	14.63	45.961608	1.319472
1888	11	11	11	11	11	11	.35	14.98	47.061168	1.099560
1889	11	11	11	11	11	11	.37	15.35	48.223560	1.162392
1890	11	11	11	11	11	11	.36	15.71	49.354536	1.130976
1891	11	11	11	11	11	11	.33	16.04	50.391264	1.036728
1892	11	11	11	11	11	11	.38	16.42	51.585072	1.193808
1893	11	11	11	11	11	11	.49	16.91	53.124456	1.539384
1894	11	11	11	11	11	11	.46	17.37	54.569592	1.445136
1895	11	11	11	11	11	11	.36	17.73	55.700568	1.130976
1896	11	11	11	11	11	11	.11	17.84	56.046144	.345576
1897	11	11	11	11	11	11	.17	18.01	56.580216	.534072
1898	11	11	11	11	11	11	.21	18.22	57.239952	.669736
1899	11	11	11	11	11	11	.21	18.43	57.899688	.669736
..	..	..	..	..	..	..	8.82	..	..	..

## CASTANEA, NO. 4.

Diam. Inct. for 28 years = 7.58.

Diam. in 1899 = 28.5.

Diam. in 1871 = 20.92.

Year.	N.	S.	E.	W.	Sum.	Average.		Diameter.	Circumference.	Circumference Increment.
						Vulg.	Decimal.			
1872	11	11	11	11	11	11	.41	21.33	67.010328	1.288056
1873	11	11	11	11	11	11	.36	21.69	68.141304	1.130976
1874	11	11	11	11	11	11	.21	21.90	68.801040	.659736
1875	11	11	11	11	11	11	.39	22.29	70.026264	1.225224
1876	11	11	11	11	11	11	.35	22.64	71.125824	1.099560
1877	11	11	11	11	11	11	.35	22.99	72.225384	1.099560
1878	11	11	11	11	11	11	.35	23.34	73.324944	1.099560
1879	11	11	11	11	11	11	.33	23.67	74.361672	1.036728
1880	11	11	11	11	11	11	.33	24.00	75.398400	1.036728
1881	11	11	11	11	11	11	.32	24.32	76.403712	1.005312
1882	11	11	11	11	11	11	.28	24.60	77.283360	.879648
1883	11	11	11	11	11	11	.31	24.91	78.257256	.973896
1884	11	11	11	11	11	11	.27	25.18	79.105488	.848232
1885	11	11	11	11	11	11	.29	25.47	80.016552	.911064
1886	11	11	11	11	11	11	.26	25.73	80.833368	.816816
1887	11	11	11	11	11	11	.23	25.96	81.555936	.722568
1888	11	11	11	11	11	11	.25	26.21	82.341336	.781400
1889	11	11	11	11	11	11	.26	26.47	83.158152	.816816
1890	11	11	11	11	11	11	.21	26.68	83.817888	.659736
1891	11	11	11	11	11	11	.25	26.93	84.603288	.785400
1892	11	11	11	11	11	11	.26	27.19	85.420104	.816816
1893	11	11	11	11	11	11	.19	27.38	86.017008	.596904
1894	11	11	11	11	11	11	.21	27.59	86.676744	.659736
1895	11	11	11	11	11	11	.17	27.76	87.210816	.534072
1896	11	11	11	11	11	11	.16	27.92	87.713472	.502656
1897	11	11	11	11	11	11	.22	28.14	88.404624	.691152
1898	11	11	11	11	11	11	.17	28.31	88.938696	.534072
1899	11	11	11	11	11	11	.19	28.5	89.535600	.596904
..	..	..	..	..	..	..	7.58	..	..	..

## FAGUS, No. 7.

Diam. Inct. in 14 years = 3.91.

Diam. in 1899 = 30.52.

Diam. in 1885 = 27.01.

Year.	N.	S.	E.	W.	Sum.	Average.		Diameter.	Circumference.	Circumference Increment.
						Vulg.	Decimal.			
1886	♂	♂	♂	♂	♂	♂	.29	27.30	85.765680	.911064
1887	♂	♂	♂	♂	♂	♂	.34	27.64	86.833824	1.068144
1888	♂	♂	♂	♂	♂	♂	.28	27.92	87.713472	.879648
1889	♂	♂	♂	♂	♂	♂	.24	28.16	88.467456	.753984
1890	♂	♂	♂	♂	♂	♂	.30	28.46	89.409936	.942480
1891	♂	♂	♂	♂	♂	♂	.29	28.75	90.321000	.911064
1892	♂	♂	♂	♂	♂	♂	.28	29.03	91.200648	.879648
1893	♂	♂	♂	♂	♂	♂	.28	29.31	92.080296	.879648
1894	♂	♂	♂	♂	♂	♂	.28	29.59	92.959944	.879648
1895	♂	♂	♂	♂	♂	♂	.22	29.81	93.651096	.691152
1896	♂	♂	♂	♂	♂	♂	.26	30.07	94.467912	.816816
1897	♂	♂	♂	♂	♂	♂	.25	30.32	95.253312	.785400
1898	♂	♂	♂	♂	♂	♂	.26	30.58	96.070128	.816816
1899	♂	♂	♂	♂	♂	♂	.34	30.92	97.138272	1.068144
..	..	..	..	..	..	..	3.91	..	..	..

## FAGUS, NO. 8.

Diam. Inct. for 14 years=3.71.

Diam. in 1899=26.4.

Diam. in 1885=22.69.

Year.	N.	S.	E.	W.	Sum.	Average.		Diameter.	Circumference.	Circumference Increment.
						Vulg.	Decimal.			
1886	6	6	11	11	34	4	.25	22.94	72.068304	.78 400
1887	6	6	11	6	29	11	.23	23.17	72.790872	.722568
1888	6	6	11	11	34	6	.31	23.48	73.764768	.973896
1889	6	6	11	11	34	6	.31	23.79	74.738664	.973896
1890	6	6	11	11	34	6	.31	24.10	75.712560	.973896
1891	6	6	11	6	29	6	.28	24.38	76.592208	.879648
1892	6	6	11	6	29	11	.30	24.68	77.531688	.942480
1893	6	6	11	6	29	11	.28	24.96	78.414336	.87 648
1894	6	6	11	6	29	11	.23	25.19	79.176901	.722568
1895	6	6	11	6	29	11	.23	25.42	79.659472	.722568
1893	6	6	11	11	34	11	.30	25.72	80.501952	.942480
1897	6	6	6	6	24	11	.21	25.93	81.461688	.659736
1898	6	6	6	6	24	11	.21	26.14	82.121424	.659736
1899	11	11	6	6	34	11	.26	26.4	82.938240	.8.6816
..	..	..	..	..	..	..	3.71	..	..	..

## FRAXINUS EXCELSIOR, NO. 2.

Diam. Inct. for 12 years=3.39.

Diam. in 1900=6.8.

Diam. in 1888=3.41.

Year.	N.	S.	E.	W.	Sum.	Average.		Diameter.	Circumference.	Circumference Increment.
						Vulg.	Decimal.			
1889	6	11	11	6	34	11	.32	3.73	11.718168	1.105312
1890	6	11	11	6	34	11	.32	4.06	12.723480	1.005.12
1891	6	11	11	11	34	11	.35	4.40	13.823040	1.099560
1892	6	11	11	11	34	11	.35	4.75	14.922600	1.099560
1893	11	11	11	11	44	11	.36	5.11	16.053576	1.130976
1894	11	11	11	11	44	11	.40	5.57	17.310216	1.256640
1895	6	11	11	11	34	11	.35	5.86	18.409776	1.199.60
1896	6	6	6	6	24	11	.21	6.07	19.069512	.559736
1897	6	6	6	6	24	11	.17	6.24	19.603584	.534072
1898	6	6	6	6	24	11	.12	6.36	19.980576	.377092
1899	6	6	6	6	24	11	.20	6.56	20.608896	.628320
1900	6	6	6	6	24	11	.24	6.8	21.36288	.727392
..	..	..	..	..	..	..	3.39	..	..	..

## LIRIODENDRON, No. 6.

Diam. Inct. for 21 years=3.17.

Diam. in 1899=28.

Diam. in 1878=24.83.

Year.	N.	S.	E.	W.	Sum.	Average.		Diameter	Circumference.	Circumference Increment.
						Vulg.	Decimal.			
1879	△	△	△	△	31	3/4	.21	25.04	78.665664	.6597.6
1880	△	△	△	△	31	3/4	.19	25.23	79.262568	.596904
1881	△	△	△	△	31	3/4	.17	25.40	79.796640	.534072
1882	△	△	△	△	31	3/4	.15	25.55	80.267880	.471240
1883	△	△	△	△	31	3/4	.16	25.71	80.770536	.501.656
1884	△	11	△	△	31	3/4	.19	25.90	81.367410	.596904
1885	△	△	△	△	31	3/4	.17	26.07	81.901512	.534072
1886	△	△	△	△	31	3/4	.17	26.24	82.435584	.534072
1887	△	11	△	△	31	3/4	.21	26.45	83.095320	.659736
1888	△	△	△	△	31	3/4	.13	26.58	83.503728	.408408
1889	△	△	△	△	31	3/4	.1	26.68	83.817888	.314.60
1890	△	△	△	△	31	3/4	.19	26.87	84.414792	.596904
1891	△	△	△	△	31	3/4	.17	27.04	84.948864	.534072
1892	△	△	△	△	31	3/4	.14	27.18	85.389888	.339824
1893	△	△	△	△	31	3/4	.16	27.34	85.891344	.502656
1894	△	△	△	△	31	3/4	.14	27.48	86.331168	.439824
1895	△	△	△	△	31	3/4	.14	27.62	86.770992	.439824
1896	△	△	△	△	31	1	.12	27.74	87.147984	.376992
1897	△	△	△	△	△	3/4	.07	27.81	87.367896	.219912
1898	△	△	△	△	31	3/4	.07	27.88	87.587808	.219912
1899	△	△	△	△	31	1	.12	28.0	87.964800	.376992
..	..	..	..	..	..	..	3.17	..	..	..



## QUERCUS CERRIS, No. 63.

Diam. Inct. for 12 years=2.05.

Diam. in 1899=22.2.

Diam. in 1887=20.15.

Years.	N.	S.	E.	W.	Sum.	Average.		Diameter.	Circumference.	Circumference Increment.
						Vulg.	Decimal.			
1888	♂	♂	♂	♂	37	♂	.15	20.30	63.774480	.471240
1889	♂	♂	♂	♂	54	1	.12	20.42	64.151472	.376992
1890	♂	♂	♂	♂	34	♂	.18	20.60	64.716960	.565488
1891	♂	♂	♂	♂	37	♂	.15	20.75	65.188200	.471240
1892	♂	♂	♂	♂	54	♂	.15	20.90	65.659440	.471240
1893	♂	♂	♂	♂	35	11	.20	21.10	66.287760	.628320
1894	♂	♂	♂	♂	35	11	.20	21.30	66.916080	.628320
1895	♂	♂	♂	♂	37	♂	.15	21.45	67.387320	.471240
1896	♂	♂	♂	♂	34	♂	.21	21.66	68.047056	.659736
1897	♂	♂	♂	♂	34	♂	.21	21.87	68.706792	.659736
1898	♂	♂	♂	♂	37	♂	.15	22.02	69.178032	.471240
1899	♂	♂	♂	♂	34	♂	.18	22.2	69.743520	.565488
..	..	..	..	..	..	..	2.05	..	..	..

## QUERCUS CONFERTA, No. 54.

Diam. Inct. for 12 years=4.54.

Diam. in 1899=14.5.

Diam. in 1887=9.96.

Ye r.	N.	S.	E.	W.	Sum.	Average.		Diameter.	Circumference.	Circumference Increment.
						Vulg.	Decimal.			
1888	11	11	11	11	21	7	.43	10.39	32.641224	1.350888
1889	11	11	11	11	21	11	.40	10.79	33.897864	1.256640
1890	11	11	11	11	21	1	.62	11.41	35.845656	1.947792
1891	11	11	11	11	21	1	.50	11.91	37.416456	1.570800
1892	11	11	11	11	21	11	.53	12.44	39.081504	1.665048
1893	11	11	11	11	11	11	.57	13.01	40.872216	1.790712
1894	11	11	11	♂	21	7	.43	13.44	42.223104	1.350888
1895	11	♂	11	11	11	11	.74	13.78	43.291248	1.068144
1896	11	11	♂	♂	21	11	.29	14.07	44.202312	.911064
1897	♂	♂	♂	♂	21	♂	.15	14.22	44.673552	.471240
1898	♂	♂	♂	♂	11	11	.11	14.33	45.019128	.345576
1899	♂	♂	♂	♂	11	11	.17	14.50	45.553200	.534072
..	..	..	..	..	..	..	4.54	..	..	..

## TILIA, NO. 2.

Diam. Inct. for 20 years = 1.74.

Diam. in 1899 = 26.

Diam. in 1879 = 24.26.

Year.	N.	S.	E.	W.	Sum.	Ave. age.		Diameter.	Circumference.	Circumference Increment.
						Vulg.	Decimal.			
1880	♂	♂	♂	♂	11	1	.12	24.38	76.592208	.376992
1881	♂	♂	♂	♂	11	♂	.09	24.47	76.874952	.282744
1882	♂	♂	♂	♂	11	11/16	.10	24.57	77.189112	.314160
1883	♂	♂	♂	♂	11	11/16	.14	24.71	77.628936	.439624
1884	♂	♂	♂	♂	11	11/16	.10	24.81	77.943096	.314160
1885	♂	♂	♂	♂	11	♂	.07	24.88	78.163008	.219912
1886	♂	♂	♂	♂	11	♂	.07	24.96	78.382920	.219912
1887	♂	♂	♂	♂	11	11/16	.10	25.05	78.6970.0	.314160
1888	♂	♂	♂	♂	♂	♂	.06	25.11	78.885676	.188496
1889	♂	♂	♂	♂	♂	11/16	.03	25.14	78.979824	.094248
1890	♂	♂	♂	♂	♂	11/16	.07	25.21	79.199736	.219912
1891	♂	♂	♂	♂	11	♂	.09	25.30	79.482480	.282744
1892	♂	♂	♂	♂	11	♂	.10	25.40	79.796640	.314160
1893	♂	♂	♂	♂	11	♂	.09	25.49	80.079384	.282744
1894	♂	♂	♂	♂	11	11/16	.11	25.60	80.424960	.345576
1896	♂	♂	♂	♂	11	11/16	.08	25.68	80.676288	.251328
1896	♂	♂	♂	♂	11	♂	.09	25.77	80.959032	.282744
1897	♂	♂	♂	♂	11	11/16	.10	25.87	81.273192	.314160
1898	♂	♂	♂	♂	11	♂	.09	25.96	81.555936	.282744
1899	♂	♂	♂	♂	♂	♂	.04	26.	81.681600	.125664
..	..	..	..	..	..	..	1.74	..	..	..

## TAXUS, No. 41.

Diam. Inct. for 28 years = 3.62.

Diam. in 1899 = 24.4.

Diam. in 1871 = 20.78.

Year.	N.	S.	E.	W.	Sum.	Average.		Diameter.	Circumference.	Circumference Increment.
						Vulg.	Decimal.			
1872	3	3	3	3	12	11	.17	20.95	65.61652	.534072
1873	3	3	3	3	12	3	.15	21.10	66.28776	.47124
1874	3	3	3	3	12	3	.15	21.25	66.75900	.47124
1875	3	3	3	3	12	1	.12	21.37	67.135992	.376992
1876	3	3	3	3	12	1	.12	21.49	67.512984	.376992
1877	3	3	3	3	12	1	.12	21.61	67.889976	.376992
1878	3	3	3	3	12	3	.15	21.76	68.361216	.471240
1879	3	3	3	3	12	1/2	.13	21.89	68.769624	.408408
1880	3	3	3	3	12	3	.14	22.03	69.203448	.439824
1881	3	3	3	3	12	1	.12	22.15	69.586440	.376592
1882	3	3	3	3	12	1/2	.14	22.29	70.023264	.439824
1883	3	3	3	3	12	1/2	.14	22.43	70.463088	.439824
1884	3	3	3	3	12	3/4	.17	22.60	71.000160	.534072
1885	3	3	3	3	12	1/2	.13	22.73	71.408568	.408408
1886	3	3	3	3	12	3	.14	22.87	71.848392	.439824
1887	3	3	3	3	12	1/2	.11	22.98	72.193968	.345576
1888	3	3	3	3	12	1	.12	23.10	72.570960	.376992
1889	3	3	3	3	12	1/2	.16	23.26	73.073616	.502656
1890	3	3	3	3	12	3	.15	23.41	73.544856	.471240
1891	3	3	3	3	12	1/2	.13	23.54	73.953264	.408408
1892	3	3	3	3	12	1/2	.10	23.64	74.267424	.314160
1893	3	3	3	3	12	1/2	.13	23.77	74.675832	.408408
1894	3	3	3	3	12	1/2	.13	23.90	75.084240	.408408
1895	3	3	3	3	12	3	.10	24.00	75.398400	.314160
1896	3	3	3	3	12	1	.12	24.12	75.775392	.376992
1897	3	3	3	3	12	1/2	.11	24.23	76.120968	.345576
1898	3	3	3	3	12	1/2	.10	24.33	76.435128	.314160
1899	3	3	3	3	12	1/2	.07	24.4	76.655040	.219912
..	..	..	..	..	..	..	3.62	..	..	..

# INCREMENT OF TREES.

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## ULMUS MONTANA, No. 93.

Diam. Inct. for 15 years = 7.16.

Diam. in 1900 = 11.

Diam. in 1885 = 3.84.

Year.	N.	S.	E.	W.	Sum.	Average.		Diameter.	Circumference.	Circumference Increment.
						Vulg.	Decimal.			
1886	11	11	11	11	11	1/4	.58	4.42	13.885872	1.822128
1887	11	11	11	11	11	1/4	.54	4.96	15.582336	1.696464
1888	11	11	11	11	11	1/4	.53	5.49	17.247384	1.665048
1889	11	11	11	11	11	1/4	.69	6.18	19.415088	2.167704
1890	11	11	11	11	11	1/4	.55	6.73	21.142968	1.727680
1891	11	11	11	11	11	1/4	.58	7.31	22.965096	1.822128
1892	11	11	11	11	11	1/4	.43	7.74	24.315984	1.349888
1893	11	11	11	11	11	1/4	.5	8.24	25.886784	1.570800
1894	11	11	11	11	11	1/4	.38	8.62	27.080592	1.193808
1895	11	11	11	11	11	1/4	.30	8.92	28.023072	0.942480
1896	11	11	11	11	11	1/4	.5	9.42	29.593872	1.570800
1897	11	11	11	11	11	1/4	.46	9.88	31.039008	1.445136
1898	11	11	11	11	11	1/4	.40	10.28	32.295648	1.256640
1899	11	11	11	11	11	1/4	.37	10.65	33.458040	1.162392
1900	11	11	11	11	11	1/4	.35	11.00	34.5576	1.099560
..	..	..	..	..	..	..	7.16	..	..	..