

Observations on the Girth-increase of Trees in the Royal Botanic Garden, Edinburgh.

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PART II.—CONIFERÆ.

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THE Coniferæ under observation have not thriven so well as the Deciduous trees, not from a faulty selection, but owing to general causes affecting all of the tribe in the Garden. Poverty or incompatibility of soil may be the main cause, but not improbably increasing influences of town atmosphere contribute to the evil. That the nature of the soil is not the only cause is indicated by some pines having attained a size and beauty, when our observations began more than twenty years ago, such as none of the younger trees now coming forward give promise of reaching; and that the Coniferæ are extremely sensitive to Edinburgh atmosphere, so that they might possibly be affected even by the present comparatively slight town-surroundings, seems proved by the almost total absence of pines in the city gardens, and the miserable appearance of the few that are to be seen. Another contributory cause, in some of the pines under observation, has been overcrowding in the Pinetum, which, owing to the stress of more necessary work in rearranging the Gardens of late years, could not be dealt with in time to prevent injury.

The only species that has thriven well in the past, and continues to thrive well still, is the yew, but not a few other species have fared not badly up to and from the 15th to the 25th year of life, some individual trees to even a considerably greater age. To these, therefore, I shall mainly confine my attention, beginning, as in the Deciduous class, with the history of the species separately, although, unfortunately, except with a few, it is not possible to follow them out in the same manner, tracing the old trees from decade to decade and comparing them with younger sets in the second decade, because nearly all the Coniferæ of the first decade disappeared or became ineligible near or soon after the expiry of that period, and because there was no such difference in age between the sets in the Coniferæ as in the Deciduous class.

I. ANNUAL RESULTS.

A. General History of the Species separately.

PINUS EXCELSA.

No. in List.	Girth at 1st Observation.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	Total.	Ann. Av.	Girth at last.
2	2·60	·90	·90	1·20	1·20	1·20	1·25	1·15	·90	1·20	1·05	10·95	1·09	14·90
11	3·70	..	..	1·00	1·30	1·00	1·35	1·00	1·25	1·30	1·40	9·60	1·20	14·50

Two older trees of this species stood in the first decade on the former terrace in front of the hot-houses. No. 24, much damaged by frost in 1878, became stunted, and the rate of girth-increase was only 0·24. In the second decade it declined to 0·18, and the tree when cut down in 1894 girthed only 34 inches. No. 26, taller and better proportioned, but rather scraggy, had a rate of 0·50 in the first decade, and kept it up in the second, but was not thought worth transplanting when the terrace was removed. It attained a girth of 40 inches.

Two infant trees, Nos. 2 and 3, were selected in 1887; but No. 3, choked by its neighbours, proved useless. Its rate was only 0·38. That of No. 2 was 1·09, the range being only ·90 to 1·25. No. 11, when an infant, had been transplanted to the "Triangle," and quite recovered in 1889. It continued to thrive with a rate of 1·20 for eight years when in 1897 it was again transplanted to the Pinetum, west of the Rock Garden, from the effects of which it had not recovered in 1900. It had the moderate range of 1·00 to 1·40 during the eight years.

PINUS LARICIO.

In 1887 this was one of the largest pines in the Garden, with a girth of 5 feet 8 inches, and it had grown at the rate of 0·41 in the previous decade; in the next nine years the rate fell to 0·35, and in 1896 it was cut down, while still slightly enough, with a girth of 6 feet and a height of 60 feet.

The other species of *Pinus* did so badly that they may be very briefly noticed.

Pinus sylvestris. The failure in this is remarkable, because the species can thrive in the Garden, as one tree in the Arboretum was 7 feet 10 inches in girth when cut down a few years ago. None now living are much over 4 feet. They have poor heads, and they have ceased to increase in girth.

Pinus Murrayana. The best of two had a rate of 0·67 for ten years, and was cut down in 1897 when only 20 inches in girth and unsightly.

Pinus Pinaster, a handsome infant, increased at the rate of 0·80 for seven years, but for the next four it fell to 0·55, and the tree is now a scraggy weed.

Pinus Lambertiana and *P. Cembra*. Two of each also proved utter failures.

ABIES DOUGLASII.

In my Paper of 1888 a full account is given of the first tree of the species in the Garden, the progenitor of all that are now in it. In 1837 it girthed 4 inches at $4\frac{1}{2}$ feet above ground. For the next 37 years its rate was fully an inch and a half, and in 1878, when nearly 50 years old, the tree was nearly $5\frac{1}{2}$ feet in girth and crowded to the ground with branches. After the severe frost of 1879 it began to lose its handsome appearance, the increase never exceeded 0·40, and it was cut down in 1887 when 67 inches in girth, 54 feet in height, and according to the rings 55 years old. None of its descendants have at all equalled, or give promise of equalling it.

No.	Girth, 1st Obs'n.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	Total.	Ann. Av.	Girth last Obs.
66	7·90	..	..	1·20	1·25	1·10	1·10	1·45	1·00	·95	1·05	..	9·10	1·14	17·05
6	4·35	·95	80	·40	·55	·65	1·00	1·25	·90	1·30	1·15	·85	9·80	·89	14·25
	7·80	..	..	1·20	1·20	1·05	1·10	1·10	1·30	1·20	·95	·75	9·85	1·10	17·65

None of these has ever recorded an inch and a half in a single year, a rate which their parent maintained for 37 years. No. 99 already has a scraggy look; No. 6 looks only moderately well; and No. 66 has been transplanted, so that it remains to be proved how it will do.

ABIES LOWIANA.

Of two specimens observed in the first decade one perished almost immediately. The other, No. 31, girthed 15 inches in 1876, and its annual average was 1.11 for 12 years, with a maximum of 1.40, but it then rapidly degenerated and was cut down in 1888, girthing 27 inches.

No.	Girth.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	Total.	Av.	Final Girth
8	4.65	1.95	1.50	1.85	1.90	1.65	1.70	1.85	1.50	1.05	1.20	16.15	1.61	20.85
92	3.95	1.95	1.65	.30	1.00	1.00	1.80	2.60	1.75	2.30	2.80	17.15	1.71	21.15

The two younger trees, Nos. 8, 92, show a better rate, up to a girth, however, not much above that of No. 31 when it began to fail. Their conduct, too, has been erratic. No. 92 had the high average rate of 2.22 for the five years 1892-96, but next year it dropped to .95, and the tree looked so ill that it was cut down. In No. 8 the rate fell off from a ten years' average of 1.61 to 1.12 in 1896 and 1897. It was then transplanted. The range in No. 8 was 1.05 to 1.95, but in No. 92 was no less than .30 to 2.80. The remarkable minimum of .30 happened in 1889 from some unknown cause which did not affect No. 8.

ABIES GRANDIS.

No.	Girth.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	Total.	Ann. Av.	Final Girth.
91	3.00	1.25	1.15	1.65	1.25	1.60	2.10	2.50	2.25	1.85	1.95	1.65	19.20	1.74	22.20

In No. 91 the rate rose prettily steadily from infancy to a maximum of 2.50 in 1893, and although it declined to 1.65 in 1897 the tree is still one of the most thickly-clothed pines in the Garden. The increments were at first taken 2 feet above ground, and the points were raised to four and then to six feet, as the tree grew. The measurements in the Table are at 2 feet; but as it is a matter of some interest, I subjoin a Table of the rates at all three points for the four years 1893-96, showing that there was no great difference at the three points. The tree was well

clothed with branches between all the points. The general results to 1899 are placed at the end of the Table. They show that for the last three years the increase at the three points was all but identical.

Girth.	INCREMENTS.							Girth.	Inc. for 3 more years.	Total Inc. for 7 years.	Av.	Girth.
	1892.	1893.	1894.	1895.	1896.	Total.	Ann. Av.					
At 2 ft.,	12.65	2.50	2.25	1.85	1.95	8.55	2.14	20.60	4.55	13.10	1.87	25.15
At 4 ft.,	7.75	2.30	2.05	1.50	1.75	7.60	1.90	15.35	4.40	12.00	1.71	19.75
At 6 ft.,	6.65	2.25	2.10	1.60	1.80	7.75	1.94	14.30	4.50	12.25	1.75	18.80

ABIES HOOKERIANA.

No.	Girth.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	Total.	Ann. Av.	Girth.
24	9.00	.60	.60	.70	.55	.50	.0	.55	.50	.55	.50	.45	6.00	0.54	15.45

This shrub-like tree grew at a somewhat better rate for the first three years, when overcrowded, than afterwards when opened up. It has suffered from pressure on one side, but is generally well clothed. The range has been from .45 to .70, but for the last seven years it was only .45 to .55.

SEQUOIA GIGANTEA.

No.	Annual Inc. 1st Decade.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	Total.	Ann. Av.	Girth Last Obs.
25	.81	.65	.70	.85	.80	.75	.90	..	..	..	..	4.65	.76	36.70
27	1.41	.90	.70	1.00	1.00	.80	1.50	..	..	..	..	5.90	.98	44.00
1	1.37	1.35	.90	1.25	1.25	.90	.95	.90	.65	.95	.45	9.55	.96	42.25
2	1.28	1.05	.90	1.05	.85	.70	.90	..	..	..	..	5.45	.90	42.10

All these trees—Nos. 25, 27, standing free on the former terrace, Nos. 1, 2 in a small grove of the species—in 1878, when from 18 to 24 inches in girth, were symmetrically clothed and crowded with branches to the ground; but they soon began to thin and

to acquire the disproportionate thickness of stem below and sinuous top characteristic of all the species in the Garden past infancy. These faults progressed with a diminution in the rate of girth increase respectively, from '81, 1'41, 1'37 and 1'28 in the first decade to '76, '98, 1'10 and '90 in the first six years of the second. Three were then cut down, and No. 1, the survivor, now standing clear by the thinning of the grove, has not benefited by the change, as its rate has still further diminished—from 1'10 to '74 in the last four years.

ARAUCARIA IMBRICATA.

The best of several of the species observed in the first decade had a rate of 0'70 and attained a girth of twenty inches, but like all the others of its time in the Garden it had suffered seriously from the frost of 1860. Gradually deteriorating, it was cut down in 1887.

No.	Girth.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	Total.	Ann. Av.	Girth.
64	7'25	'65	'60	'35	'55	'55	'60	'50	'75	'40	'50	'30	5'75	'52	12'70
65	14'45	'60	'60	'55	'65	'65	'60	'70	'75	'50	'65	'70	6'95	'63	22'00

Nos. 64, 65, selected in 1887, grew in a small grove of the species, unlike the earlier tree, which stood free on the former terrace. They look healthy though not close-branched, and No. 64 is overshadowed by 65, which may account for its inferior rate. No. 65, standing at a corner, is comparatively free. The range of No. 64 was '30 to '75; that of 65 only '50 to '75.

CEDRUS AFRICANA.

No.	Annual Inc. 1st Decade.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	Total.	Ann. Av.	Girth Last Obs.
39	1'51	1'30	1'20	1'30	1'20	1'20	1'50	1'25	1'10	'50	'50	11'05	1'10	53'55

No. 39 was very handsome and densely crowded with branches, and girthed two feet in 1878, but by the end of the first decade

the branches were rather sparse, and this fault has become more prominent since. The rate, 1·51 in the first decade, fell to 1·10 in the second, and as in the last two years it was only ·50 the tree would seem to have passed its prime when only 4½ ft. in girth.

CEDRUS DEODARA.

No.	Av. Rate, 1st Decade.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	Total.	Ann. Av.	Girth Last Obs.
29	·88	·90	1·00	1·00	·85	·55	·80	·65	·30	·85	·50	7·40	·74	42·00
30	·60	·50	·65	·75	·35	·45	·55	·60	·15	·50	·30	4·20	·48	74·80
1	1·02	1·15	·30	·75	·80	·40	·55	·90	·20	·80	·15	6·00	·60	30·35
2	1·06	1·25	1·20	1·10	·85	·80	1·10	·80	·70	·70	·20	8·70	·87	35·25

No. 30 was a fine tree, nearly five and a half feet in girth in 1878, but soon got thin at the top and assumed, gradually, a rather stunted look. Its rate in the first decade was ·60. In the second it fell to ·48, with further degeneracy in the aspect of the tree. It has now the respectable girth of a trifle upwards of six feet. The much younger No. 29 has shown the same faults, and its rate has fallen from ·88 to ·74, the girth in 1897 being only three and a half feet. Both of these grew free, but Nos. 1, 2, have always been in the middle of a rather dense grove of their species. They are both still shapely, but their rates have fallen off from 1·02 and 1·06 in the first decade to 0·60 and 0·87 in the second.

LARIX EUROPEA.

Two young larches were selected in 1887 and looked well for some years; but one, after growing at the rate of 1·31 for seven years, became diseased and died in 1895. The other, in apparent health for three years with a rate of 1·03, rapidly degenerated, its rate falling to ·30 in the last seven years, and was cut down in 1898.

[TABLE.

TAXUS BACCATA.

No.	Annual Av., 1st Decade.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	Total.	Ann. Av.	Girth.
41	·47	·40	·60	·40	·55	·45	·45	·55	·40	·55	·20	4·55	·45	78·85
42	·26	·20	·30	·35	·30	·30	·5	·40	·15	·20	·05	2·30	·23	39·05
48	·48	·60	·30	·55	·45	·40	·50	..	..	..	..	2·80	·46	44·80
49	·45	·45	·45	·55	·35	·40	·55	·45	·25	·50	·25	4·20	·42	32·25
50	·37	·35	·30	·25	·25	·30	·25	·45	·35	..	..	2·50	·31	39·15
53	·25	·10	·30	·30	·25	·10	·35	·20	·20	·00	·05	1·85	·18	36·05

In my Paper of 1888 the history of No. 41 is fully given. Traditionally, an age of at least 213 or possibly 260 years is assigned to it, but the observations show that its rate has been nearly half an inch for the last twenty years, and taking the same rate for its whole life, and it is not likely to have been less, the age would be reduced to 170 years, with a girth of nearly six and a half feet. The rates in the two decades are nearly the same, and would have been still nearer but for the sudden drop in 1897 to '20. This seems to have been due to the transplantation of trees around, which formerly closely sheltered it, and resulted also in a sickly look, which has not yet (spring, 1899) disappeared; but as in that year it once more grew '40, or nearly its average, it is to be hoped it will again prosper.

No. 48, an equally vigorous grower, died in 1894 from having its roots pruned in preparation for transplantation. No. 50, always rather weakly, was cut down in 1896. The three survivors, Nos. 42, 49, 53, all fell off, but not much, in the second decade. Although looking equally vigorous, and not differing much in size, their rates in the second decade varied as much as from '18 to '44.

Nos. 48, 49, 50, were known to be 77 years old in 1896, and allowing 7 years for growth to the measuring point, their life-rates have been '68, '45, and '57, and the girths attained were 44, 32, and 36 inches.

CUPRESSUS LAWSONIANA.

No.	Girth.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	Total.	Annual Av.	Girth.
9	24.50	.40	.35	.45	.60	.50	.80	.80	.85	4.75	.59	29.35
10	22.20	.40	.20	.50	.70	.55	.55	.65	.85	4.40	.55	26.60

These cypresses were fairly handsome and grew at a rather increasing rate, averaging rather more than half an inch for the eight years, and above three-quarters of an inch for the last three, when, being badly injured by frost, they were cut down.

THUJA GIGANTEA.

No.	Girth.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	Total.	Ann. Av.	Girth.
12	20.80	.53	.70	1.15	1.10	.65	.80	.85	.60	6.35	.79	27.15
13	9.90	.50	.80	.70	.60	.40	.60	.55	.45	4.60	.57	14.50

The larger of the two, standing close together, had much the better rate. Both were handsome, when they suddenly failed in 1894, ceased to increase for the next two years, and were cut down in 1897.

RETINOSPORA OBTUSA.

No.	Girth.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	Total.	Ann. Av.	Girth.
14	4.30	.45	.25	.60	.60	.40	.65	.55	.60	..	4.10	.51	8.40
90	3.05	.45	.20	.10	.10	.20	.20	.50	.50	.50	2.75	.31	5.80
15	9.60	..	..	..	.30	.25	.70	.65	..	..	1.90	.47	11.50

The results in these are little reliable. Nos. 15, 90, became scraggy and were cut down as not worth transplantation, and No. 14, four years after transplantation, has scarcely added to its girth and looks unhealthy.

B. Aggregate Annual Results.

I shall now give in a series of Tables some of the General Results of the Annual Observations on the Coniferæ.

a. COMPARISON OF THE BEST SINGLE TREES OF 10 SPECIES IN TWO PERIODS OF FIVE YEARS EACH, 1887-91 AND 1892-96.

1. TREES IN WHICH THE GIRTH-INCREASE DIMINISHED IN THE SECOND PERIOD.

No. in List.	Species.	Average Annual Increase.		Girth.
		1887-91.	1891-96.	1896.
8	<i>Abies Lowiana</i> - - - -	1.78	1.48	In. 20.80
66	„ <i>Douglasii</i> - - - -	1.18	1.11	17.05
24	„ <i>Hookeriana</i> - - - -	.59	.52	15.00
1	<i>Sequoia gigantea</i> - - - -	1.16	.87	41.80
2	<i>Cedrus Deodara</i> - - - -	1.07	.82	35.05
39	„ <i>africana</i> - - - -	1.26	1.11	53.05
49	<i>Taxus baccata</i> - - - -	.46	.43	32.00
		7.50	6.34	

It is shown in this Table that there was a marked falling off in *Sequoia*, *Cedrus Deodara*, and *Abies Lowiana*, at girths of 42, 35, and 21 inches, a less marked decline in *Cedrus africana* and *Abies Hookeriana* at girths of 53 and 15 inches, while *Abies Douglasii* and *Taxus* showed a very slight loss at girths of 17 and 32 in.

2. TREES IN WHICH THE GIRTH-INCREASE INCREASED IN THE SECOND PERIOD.

No. in List.	Species.	Average Annual Increase.		Girth.
		1887-91.	1891-96.	1896.
91	<i>Abies grandis</i> - - - -	1.49	2.13	20.55
2	<i>Pinus excelsa</i> - - - -	1.08	1.11	14.90
65	<i>Araucaria imbricata</i> - - -	.61	.64	21.30
		3.18	3.88	

In this Table only *Abies grandis* shows a very marked increase in the second period, up to a girth of 20 inches, while in *Pinus excelsa* and *Araucaria imbricata* the difference is little appreciable at girths of 15 and 21 inches.

In the aggregates the loss in average annual increase in seven species was 1.16 in., and the gain in three was .70; the nett loss being thus .46.

b. RANGE OF THE AGGREGATE ANNUAL GIRTH-INCREASE.

The range of the 19 Coniferæ of 9 species under observation in the first decade, 1878-87, was very great, as shown below, being from 9.60 to 16.60 inches in the whole, and from 5.03 to 8.27 taking species averages. As fully detailed in former Papers, the maximum, 8.27, was in 1878, and was followed by a decline in the three eminently unfavourable succeeding years to 6.16, but the minimum, 5.03, was not reached, after a rally in 1882, till 1883, and after a second rally for two years a third fall took place in 1887 nearly to the minimum.

1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.
8.27	6.45	7.05	6.16	7.05	5.03	6.41	6.93	6.68	5.80

In this decade-list we can see distinct evidence of a prolonged depression after the three bad seasons. The standard of 1878 was never again nearly reached, and after some fluctuations the final year was not far off the minimum. A detailed inquiry shows that five species, *Pinus excelsa*, *Abies Douglasii*, *A. Lowiana*, *Pinus sylvestris*, and *Araucaria imbricata* had their girth-increase

permanently diminished after the three bad seasons; that two, *Cedrus Deodara* and *Taxus baccata*, were affected, but not permanently; and that two, *Cedrus africana* and *Pinus austriaca*, were unaffected.

In the remarkable and unaccountable second depression of 1883, in which the Deciduous trees were nearly or quite unaffected, all the deodars (4), all the sequoias (4), and all the other pinaceæ except the yew had a diminished increase.

Unfortunately, as most of the trees in this list completely failed early in the second decade, it is not in my power to give a Table of comparative results for the same trees in the two periods. The most I can do is to give the results of a new set, including a few of the old ones, in Table IX., comprising 17 trees of ten species.

Here the range proves to be actually greater than in the set of the first decade, being no less than from 6'85 to 12'30. This depends upon an abnormally high ratio in 1893 and an abnormally low one in 1897. Withdrawing these the range for the remaining eight years is reduced to from 7'70 to 10'60.

To check these results as far as possible, I give in Table X. a larger number of trees, including some additional species, treated in the same way, for the five years 1889-93. Here eleven species and twenty-six trees are dealt with. The range is from 7'45 to 9'80, and on the whole the fluctuations agree with those in the corresponding years in Table IX., 1893 in particular being decidedly the best year in both.

I have also found it possible to deal with 12 species and 23 trees for the eight years 1889-96, in Table XI. Here the range is from 10'20 to 13'00, and the agreement with the fluctuations in Table IX. is pretty close. The decided maximum is again in 1893, and the only marked difference is the comparatively small proportion of 1889 in Table IX., which, however, was almost entirely due to a single tree, *Abies Lowiana*, whose increase in that year fell 1'25 below that of 1888.

In Table IX. the remarkable fall from 10'60 in 1896 to 6'85 in 1897 was due to some cause which affected all the species with the exception of *Cedrus atlantica*, but this exception was more apparent than real, as, in fact, it had already fallen the previous year from 11'10 to '50, the figure repeated in 1897.

TABLE IX.

AVERAGE ANNUAL GIRTH-INCREASE AND RANGE IN TEN SPECIES OF
CONIFERÆ FOR TEN YEARS—1888-1897.*

	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	Total.	Av.
<i>Pinus excelsa</i> (one) . .	.90	.90	1.20	1.20	1.20	1.25	1.15	.90	1.20	1.05	10.95	1.09
<i>Abies grandis</i> (one) . .	1.15	1.65	1.25	1.60	2.10	2.50	2.25	1.85	1.95	1.65	17.95	1.79
„ <i>Lowiana</i> (one) . .	1.55	.30	1.00	1.00	1.80	2.60	1.75	2.30	2.60	.95	16.05	1.60
„ <i>Douglasii</i> (one) . .	.80	.40	.55	.65	1.00	1.25	.90	1.30	1.15	.85	8.85	.88
„ <i>Hookeriana</i> (one) . .	.60	.70	.55	.50	.50	.55	.50	.55	.50	.45	5.40	.54
<i>Sequoia gigantea</i> (one) .	1.35	.90	1.25	1.25	.90	.95	.90	.85	.95	.45	9.55	.95
<i>Cedrus Deodara</i> (four) .	.95	.80	.90	.70	.55	.75	.75	.35	.70	.30	6.75	.67
„ <i>atlantica</i> (one) . .	1.30	1.20	1.30	1.20	1.20	1.50	1.25	1.10	.50	.50	11.05	1.10
<i>Araucaria imbricata</i> (two)	.60	.45	.60	.60	.60	.60	.75	.45	.55	.50	5.70	.57
<i>Taxus baccata</i> (four) . .	.30	.40	.40	.35	.30	.35	.40	.25	.30	.15	3.20	.32
	9.50	7.70	9.00	9.05	10.15	12.30	10.60	9.70	10.60	6.85	95.45	9.51

* When more than one tree of a species is given, the average for the species is taken.

TABLE X.

THE SAME FOR A LARGER NUMBER OF TREES AND SOME DIFFERENT SPECIES
FOR 5 YEARS—1889-93.

	1889.	1890.	1891.	1892.	1893.	Total.	Av.
<i>Pinus excelsa</i> (two) . .	1.10	1.25	1.10	1.30	1.05	5.80	1.16
<i>Abies Lowiana</i> (two) . .	1.05	1.45	1.30	1.75	2.20	7.75	1.55
„ <i>Douglasii</i> (three) . .	.90	1.00	.90	1.05	1.25	5.10	1.02
<i>Sequoia gigantea</i> (four) .	.80	1.05	1.00	.80	1.05	4.70	.94
<i>Taxus baccata</i> (six) . .	.35	.40	.35	.30	.35	1.75	.35
<i>Pinus Pinaster</i> (one) . .	.80	.60	.60	.80	.95	3.75	.75
„ <i>Murrayana</i> (one) . .	.75	.75	.55	.70	.80	3.55	.71
„ <i>Laricio</i> (one) . .	.40	.40	.35	.25	.25	1.65	.33
<i>Cupressus Lawsoniana</i> (two)	.45	.65	.50	.65	.70	2.95	.59
<i>Thuja gigantea</i> (two) . .	.90	.85	.50	.70	.70	3.65	.73
<i>Retinospora obtusa</i> (two) .	.35	.35	.30	.40	.50	1.90	.38
	7.85	8.75	7.45	8.70	9.80	42.55	8.51

TABLE XI.
THE SAME FOR TWELVE SPECIES FOR EIGHT YEARS—1889-96.

	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	Total	Av.
<i>Pinus excelsa</i> (two) . .	1.10	1.25	1.10	1.30	1.05	1.05	1.25	1.20	9.30	1.16
„ <i>Laricio</i> (one) . .	.40	.40	.35	.25	.25	.40	.30	.40	2.75	.34
„ <i>Pinaster</i> (one) . .	.80	.40	.60	.80	.95	.55	.55	.55	5.20	.65
„ <i>Murrayana</i> (one) . .	.75	.75	.55	.70	.80	.60	.55	.60	5.30	.66
<i>Abies Douglasii</i> (three) . .	.90	1.00	.90	1.05	1.25	1.05	1.15	1.05	8.35	1.04
„ <i>grandis</i> (one) . .	1.65	1.25	1.60	2.10	2.50	2.25	1.85	1.95	15.15	1.90
„ <i>Lowiana</i> (two) . .	1.05	1.45	1.30	1.75	2.10	1.60	1.65	2.00	12.90	1.61
„ <i>Hookeriana</i> (one) . .	.70	.55	.50	.50	.55	.50	.55	.50	4.35	.54
<i>Sequoia gigantea</i> (one) . .	.90	1.25	1.25	.90	.95	.90	.65	.95	7.75	.97
<i>Cedrus Deodara</i> (four) . .	.80	.90	.70	.55	.75	.75	.35	.70	5.50	.69
„ <i>africana</i> (one) . .	1.20	1.30	1.20	1.20	1.50	1.25	1.10	.50	9.25	1.16
<i>Taxus baccata</i> (four) . .	.40	.40	.35	.30	.35	.40	.25	.30	2.75	.34
	10.65	10.90	10.40	11.40	13.00	11.30	10.20	10.70	88.55	11.06

II. MONTHLY RESULTS.

Monthly observations on a considerable number of *Coniferæ* were not begun till 1882, and the results for the five years ending 1886 have already been given.¹ This set of comparatively old trees were then, perforce, given up, and a younger set were observed for a second five-years' period, 1887-91. As the results for these have also been published,² and as my monthly records of *Coniferæ* then ceased, I shall only give some of the general conclusions arrived at in these earlier investigations.

A. AVERAGE MONTHLY PERCENTAGE IN THE COMPARATIVELY OLD CONIFERÆ, 1882-86.

April.	May.	June.	July.	August.	Sepr.
8	22	26	24	18	2

¹ Trans. Bot. Soc., Edin., 1886-87.

² *Op cit.*, 1892.

The greatest percentages in the months were:—For April, 18 p.c. in *Pinus austriaca* and 16 p.c. in *Araucaria imbricata*; for May, 28 p.c. in *Abies Lowiana*; for June, 39 p.c. in *Sequoia gigantea*; for July, 30 p.c. in *Cupressus Lawsoniana*; for August, 30 p.c. in *Cedrus Deodara*; and for September, 8 p.c. in the same.

1. Proportional percentage of the first and second half-seasons of growth.

Excess in the first half was most marked in *Araucaria*, the proportions being 73 p.c. in the first and 27 p.c. in the second. The reverse was most marked in *Cedrus Deodara*, 34 p.c. in the first and 66 p.c. in the second.

2. Progressive increase and decrease in the growing season.

Abies Lowiana proved to be an exception to the normal seasonal progress, as its percentage, which was very large in May, 28 p.c., dropped in June to 18 p.c., rising again to 22 p.c. in July. *Cedrus Deodara* was remarkable for a steady rise to a maximum so late as in August.

3. Comparison with the Deciduous Group of the same period.

	April.	May.	June.	July.	Aug.	Sept.
Coniferæ - - - -	8	22	26	24	18	2
Deciduous - - - -	6	11	18	41	22	2

The Table shows that the increase was more equably distributed in the Coniferæ, and further investigation proved that this depended partly on the maxima of the species occurring in a greater variety of months, but partly also on a more equable distribution in the individual species.

B. AVERAGE MONTHLY PERCENTAGE IN THE YOUNGER CONIFERÆ, 1887-91, COMPARED WITH THE OLDER GROUP.

	April.	May.	June.	July.	Aug.	Sept.
Younger Group - - -	5.5	28	26.5	18.5	14.5	7
Older Group - - -	8	22	26	24	18	2

Compared with the older group there is a considerable difference in regard to the first and last months, the older group having a larger proportion in the first and a much smaller proportion in the last than the younger trees. But the difference is perhaps not greater than might be expected between two groups of different ages, to some extent of different species, and under observation at different periods, and difference almost disappears if we take the first and last two months together. In the older group the distribution is somewhat more equable and the maximum is attained later than in the younger trees.

1. Proportional percentage of the first and second half-seasons of growth.

The following Table shows that on comparing the two groups in this respect, the few species that occur in both have tolerably analogous results.

YOUNGER GROUP.			OLDER GROUP.		
	1st Half.	2nd Half.		1st Half.	2nd Half.
<i>Araucaria imbricata</i> (2)	75	25	<i>Araucaria imbricata</i> (3)-	73	27
<i>Cupressus Lawsoniana</i> (2)	73	27	<i>Sequoia gigantea</i> (4) -	66	34
<i>Pinus austriaca</i> (1) -	71.5	28	<i>Pinus austriaca</i> (1) -	64	36
<i>Retinospora obtusa</i> (1) -	70.5	29	<i>Cupressus Lawsoniana</i> (1)	63	37
<i>Thuja gigantea</i> (1) -	67.5	32	<i>Abies Lowiana</i> (1) -	56	44
<i>Pinus Pinaster</i> (1) -	62.5	37	<i>Cedrus africana</i> (1) -	48	52
„ <i>excelsa</i> (3) - -	55.5	44	<i>Taxus baccata</i> (4) - -	45	55
„ <i>Murrayana</i> (1) -	55.5	44	<i>Cedrus Deodara</i> (4) -	34	66
<i>Abies Douglasii</i> (3) -	54	46			
„ <i>Hookeriana</i> (1) -	51	49			
„ <i>Lowiana</i> (2) -	47	53			
„ <i>grandis</i> (1) - -	33	67			

That the species do follow a law in throwing the mass of their growth, some into the early others into the late part of the growing season, seems fairly well indicated by a list showing the percentage of growth in the first and last half-seasons in thirty-four Coniferæ, thirteen of the old and twenty-one of the new set, in my Paper in the Transactions of the Botanical Society of Edinburgh, 1892, p. 325. The list is drawn up in the order of greatest proportion in the first half-season, one example of *Araucaria imbricata* being at the head with 79 p.c. and one of the deodars at the foot with 24 p.c.

On analysing the list of 34 trees, it appears that the four araucarias are within eleven places of the top; the three deodars within five places of the bottom, and their near relative *Cedrus africana* separated from them only by a single place: the three each of *Abies Douglasii*, *Cupressus Lawsoniana*, *Sequoia gigantea*, *Abies Lowiana*, and *Pinus excelsa* within fourteen, thirteen, twelve, nine, and nine places respectively of each other. Taking a wider view, the seven trees of four species of *Abies* are all in the lower half of the list, and six of the seven trees of four species of *Pinus* are within thirteen places, in the middle of the list.

2. Distribution of the girth-increase over the growing season in the younger Coniferæ.

There was a considerable variety in the conduct of the species in this respect. Some showed a marked activity for only three months, others for four or five. As examples of a wide distribution over the growing season in undoubtedly healthy vigorous growers the following may be taken, the averages being for a period of five years:—

PERCENTAGES OF MONTHLY INCREASE.

No.		April.	May.	June.	July.	Aug.	Sept.
2	<i>Pinus excelsa</i> - -	8	21·5	26	21	14	9·5
11	Do. do. - -	8·5	17	27	17	17	13·5
91	<i>Abies grandis</i> . -	6	19·5	7·5	20	27	20

3. Progressive increase and decrease in the growing season.

Abies Lowiana again showed a deviation from the normal monthly rise to a maximum, as the percentage was slightly less in June than in May; this deviation also revealed itself in *Abies Douglasii*, *Pinus excelsa*, and *Thuja gigantea*, but above all in *Abies grandis*, the healthiest and quickest grower of all my Coniferae, where, therefore, disease or weakness cannot be suspected as a cause, in which the percentage was 19·5 in May and fell to no more than 7·5 in June, rising again in July to 20·0. Subsequent weekly measurements of this tree showed that there was a complete cessation of increase for at least a fortnight in June.

4. Comparison with the Deciduous Group of the same period.

	April.	May.	June.	July.	Aug.	Sept.
Coniferae	5·5	28	26·5	18·5	14·5	7
Deciduous	1·5	12	31	30	20·5	5

The increase is somewhat more evenly distributed in the Coniferae. It is greater than in the Deciduous Trees both in the first and last months, and if we take the first and last bi-monthly periods, it is much greater in the first and a little less in the last, whereas in the middle bi-monthly period the Deciduous class has considerably the best of it. The results agree fairly well with the comparison already made in the older groups.