On the Exact Measurement of Trees (Part 4.) The Influence of the unfavourable Season of 1879 on the Growth of Trees

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- Phyteuma hemisphæricum*, *L.*
humile, *Schleich.*
pauciflorum, *L.*
orbiculare, *L.*
Campanula pusilla, *Hänk.*
rotundifolia, *L.*
rapunculoides, *L.*
Trachelium, *L.*
thyrsoides, *L.*
barbata, *L.*
Epilobium angustifolium, *L.*
Fleischeri, *Hochstetter.*
montanum (collinum), *L.*
organifolium, *Lam.*(=alsinefol : *Vill.*)
alpinum, *L.*
Ononis repens, *L.*
Medicago falcata, *L.*
lupulina, *L.*
Melilotus officinalis, *Desrousseaux.*
Trifolium pratense, *L.*
medium, *L.*
alpinum, *L.*
caespitosum, *Regnier.*
badium, *Schreber.*
Phaca astragalina, *DC.*
Oxytropis campestris, *DC.*
Hippocrepis comosa, *L.*
Hedysarum obscurum, *DC.*
Onobrychis sativa, *Lam.*
arenaria, *DC.*
Vicia cracca, *L.*
Sepium, *L.*
Alchemilla vulgaris, *L.* (subsericea).
alpina.
Dryas octopetala, *L.*
Geum montanum, *L.*
reptans, *L.*
Fragaria vesca, *L.*
Potentilla anserina, *L.*
argentea, *L.*
Tormentilla, *Sibtherb*
aurea, *L.*
Rosa alpina, *L.*
Sedum annuum, *L.*
villosum, *L.*
dasyphyllum, *L.*
acre, *L.*
Sempervivum Wulfeni, *Hoppe.*
montanum, *L.*
arachnoideum, *L.*
Sempervivum Braunii, *Funk.*
Saxifraga aizoon, *Jacq.*
cæsia, *L.*
oppositifolia, *L.*
aspera, *L.*
bryoides, *L.*
aizoides, *L.*
stellaris, *L.*
Clusii, *Gauan.*
planifolia, *Lapeyr.*
exarata, *Vill.*
muscoïdes (compacta), *Wulfen.*
stenopetala, *Gaud.*
Seguieri, *Spreng.*
Astrantia minor, *L.*
Bupleurum stellatum, *L.*
Meum Mutellina, *Gärtner.*
Linnea borealis, *L.*
Valeriana tripteris, *L.*
tripteris (integrifolia), *L.*
Knautia sylvatica, *Dub.*
Scabiosa columbaria, *L.*
Adenostyles albifrons, *Reichb.*
hybrida, *DC.*
Aster alpinum, *L.*
Bellis perennis, *L.*
Erigeron uniflorus, *L.*
alpinus, *L.*
Inula montana, *L.*
Gnaphalium sylvaticum, *L.*
Hoppeanum, *Koch.*
Leontopodium.
dioicum, *L.*
Achillea nana, *L.*
moschata, *Wulfen.*
atrata, *L.*
millefolium, *L.*
Chrysanthemum leucanthemum, *L.*
alpinum, *L.*
Aronicum scorpioides, *Koch.*
Senecio cordatus, *Koch.*
viscosus, *L.*
abrotanifolius, *L.*
carniolicus, *Willd.*
saracenicus, *L.*
Doronicum, *L.*
Cirsium acaule, *All.*
Carlina acaulis, *L.*
Crepis aurea, *Cassin.*
Hieracium Pilosella, *L.*

On the Exact Measurement of Trees. (Part 4.) The Influence of the unfavourable Season of 1879 on the Growth of Trees. By Sir R. CHRISTISON, Bart.

(Read 8th January 1880.)

It was my hope and intention to present at the present time, in continuation of former notes on the "Exact Measurement of Trees," a contribution of facts relative to the growth of the common oak in this country. I have already accumu-

lated some observations of interest on this subject. But I have the prospect of others which are likely to increase the value of those now at my disposal. It is better therefore to postpone this topic; and I do so the more willingly, because I can substitute a different one, of more immediate interest, and which has arisen incidentally from the measurements of numerous trees of various species during our last most ungenial season. This subject is the influence of that season on the growth of tree-wood.

Various notices have appeared in newspapers and periodicals as to the influence of the unpropitious season of 1879. In some respects the statements of fact are somewhat conflicting. There is a general agreement, however, that the foliage of trees was abundant, or even luxuriant, but that their fructification was very defective; and some statements represent the annual shoots to have been of the usual length. According to my own observation in the country around Edinburgh, and also in the district of the Tay between Blair-Athole, Loch-Tummel, and Aberfeldie up-stream, and Dunkeld below, the foliage of most trees was rich and healthy. But there were exceptions. Not universally, but in many places in both counties, the beech and elm were decidedly deficient in foliage, and especially the elm. On the contrary the oak and sycamore struck me as luxuriant in that respect. As to the fruit, it was observed that the sycamore parted with most of it not long after its formation; and the elm, which drops it always early, did so after an unusually brief existence. The same was probably the fate of other unobserved species. A singular concordance was noticed in the case of the cherry; which in three gardens within my observation gave promise of an abundant crop, till the fruit was a little bigger than cherry-stones, when they almost all dropped off, without wind, frost, or any other atmospheric hardship.

It also deserves notice, though bearing but slightly and collaterally on the object of this paper, that the lateness and coldness of the summer season appeared to exert no injurious effect on the flowering of annual herbaceous plants, whether indigenous or of the hardy introduced kinds. Among the former, I was particularly struck with the splendour of the fox-glove in all quarters of Strath-Tay, even on the bare,

exposed, southern slopes of Ben Vrackie, at 1700 feet above the sea-level. Nor were they defective in fruit,—except indeed that those, which do not usually ripen until late in autumn, such as the bramble-berry, had scarcely time to reach maturity, at least had not done so in Strath-Tay on the 2d of October. I may add, as a circumstance of probably very rare occurrence, that on the same day, in a garden seven miles above Dunkeld, 250 feet above sea-level, with a gentle slope and fine exposure towards the south, I gathered, ripe and of good quality, strawberries, raspberries, red currants, and red gooseberries, though they had not been subjected to any means of artificial retardation. The little indigenous ornaments of our Highland mountains underwent a chequered fate. *Erica cinerea* and *E. tetralix* showed flower in profusion; but the more abundant *Calluna vulgaris* was not only very late, but also defective in flowering. Of the berry-bearing hill plants some fruited well, and others were unproductive. In many rambles I found no fruit on the crow-berry, very little on the bear-berry, but abundance on the bil-berry at the Falls of the Bruar, and on numberless elevated slopes a profusion on the whortle-berry, the *Vaccinium Vitis Idæa*.*

Returning from this digression, I repeat that, in spite of the inclement spring and summer of 1879, the foliage of most trees was abundant, or even rich. But I doubt the statements made by some in print, that the annual shoots of trees were of average length. In no instance has comparative measurement been given; and mere eye-measurement with comparison by memory merely, can go for very little in such a question. Were I to trust that method of investigation, I should say that the hawthorn shoots in October were very much under the average in length, and that the pine-tribe generally, though not invariably, showed more or less of the same inferiority. In regard to the *Araucaria* there can scarcely be a mistake, on account of the usual length and sharp definition of its internodes. Each internode in most trees marks two years of growth. It is easy to observe everywhere around Edinburgh, that the newest growth for 1879 is much under one-half, and often

* In the Highlands this is often gathered as the cran-berry, the fruit of a much less common species, *V. uliginosum*.

barely reaches one-fourth of the lower internode in length. I have no measurements, however, to test accurately these eye-observations.

But in regard to the growth of tree-trunks by their annual

	1878.			1879.	
	May.	October.	Increase.	October.	Increase.
Birch, weeping, near entrance	55·25	55·50	0·25	55·55	0·05
Beech } each side of E. walk at S.E. corner {	71·25	72·45	1·20	73·40	0·95
Beech } of the original garden	60·35	61·55	1·20	62·40	0·85
Beech } Aboretum, S. walk of Inverleith {	75·65	76·25	0·60	76·85	0·60
Beech } House grounds	60·15	60·75	0·60	61·20	0·45
Beech, Craigiehall, on river bank	116·35	117·15	0·80	117·75	0·60
Beech } Craigiehall, very tall and slim in a {	71·85	71·55	0·70	73·05	0·50
Beech } deep dell on the river bank	61·75	62·35	0·60	62·65	0·30
Lime, in middle of garden	75·95	76·45	0·50	76·60	0·15
Lime, near N.W. corner	42·55	43·25	0·70	43·65	0·40
Chestnut, Sweet, close to Amaryllidaceæ	70·65	71·75	1·10	72·65	0·90
Tulip-tree, near W. end of pond, 20 yards	75·55	76·55	1·00	77·15	0·60
Horse-Chestnut, S.E. corner of original {	48·60	49·35	0·75	49·85	0·50
garden					
Hawthorn, E. walk, half-way S. of Museum	37·85	38·65	0·80	38·75	0·10
Flowering-Ash, N. of Labiatae	75·15	75·75	0·60	76·15	0·40
Sycamore, smoothed-barked, near N.W. {	58·45	58·95	0·50	59·15	0·20
corner					
Oak, Common, Craigiehall, largest in E. park	120·35	121·35	1·00	122·15	0·80
Oak, Common, Craigiehall, river-side, near {	69·45	70·10	0·65	70·60	0·50
Hermitage gate					
Oak, Common, Cammo, S. gate	131·15	131·90	0·75	132·65	0·75
Hungary Oak, near E. end of Winter Garden	23·45	25·25	1·80	26·05	1·70
Turkey Oak, opposite weeping birch	41·75	42·35	0·60	43·00	0·65
American Red Oak, near middle of garden	30·65	31·15	0·50	31·55	0·40
Hornbeam, lowest part of the W. walk	44·35	44·75	0·40	45·10	0·35
Douglas Pine, close to Liliaceæ	55·95	56·55	0·60	57·00	0·45
Douglas Pine, oldest, clump of Pinaceæ, W. {	64·15	64·95	0·80	65·40	0·45
walk					
Corsican Pine, N.W. corner of Palm-house {	64·15	64·55	0·40	64·75	0·35
lawn					
Scotch Fir, Arboretum, largest, half way {	94·15	94·45	0·30	94·45	0·00
between house and S.W. corner					
Scotch Fir, Arboretum, N.E. clump	52·40	52·65	0·25	52·95	0·30
Scotch Fir, Arboretum, clump E. of house	52·80	53·05	0·25	53·05	0·00
Scotch Fir, Cammo, bowling-green	121·35	121·55	0·20	121·75	0·20
Pinus excelsa } terrace in front of the chief {	30·75	31·10	0·35	31·30	0·20
Pinus excelsa } range of hot-houses	32·55	32·95	0·40	33·15	0·20
Sequoia gigantea } at E. and W. ends of hot- {	23·95	25·10	1·15	25·90	0·80
Sequoia gigantea } houses' terrace	23·95	25·70	1·75	27·35	1·65
Sequoia gigantea } two of a clump in old {	18·95	20·80	1·85	22·30	1·50
Sequoia gigantea } Horticultural Garden	23·85	25·10	1·25	26·80	1·70
Deodar, slender tree, W. walk, low down	26·10	27·20	1·10	27·90	0·70
Deodar, oldest, W. walk, clump of Pinaceæ	64·00	65·00	1·20	65·60	0·60
Picea Lowei, upper end of Picea pinetum	15·00	16·40	1·40	17·65	1·25
Cedrus Atlantica, S. from tulip-tree, 20 yards	27·55	29·20	1·65	30·60	1·40
Araucaria imbricata, E. end of terrace	18·10	18·70	0·60	19·20	0·50
Araucaria imbricata, W. walk	20·20	20·70	0·50	21·60	0·90
Yew, W. walk at an iron seat	34·10	34·60	0·50	34·75	0·15
Yew, at Linnean monument, 200 years old	67·45	68·05	0·60	68·65	0·60

addition of woody layers, numerous measurements made for other purposes than testing the influence of season, incidentally supply proof, which leaves no doubt of the baneful influence of the inclemency of last year's growing months. I present in evidence the foregoing tabular view of all the measurements yet taken which are comparative. The trees measured were 53 in number, and comprised the lime, beech, sycamore, sweet chestnut, horse-chestnut, hawthorn, flowering-ash, tulip-tree, walnut, hornbeam, common oak, Hungary oak, Turkey oak, and American oak, among trees with deciduous leaves,—and, among those with evergreen leaves, the Ilex, Scotch fir, Douglas pine, Corsican pine, *Pinus excelsa*, *Sequoia*, *Deodar*, *Picea nobilis*, *Picea Lowei*, Cedar of the Atlas, *Araucaria*, Cypress, and Yew. The trees examined are chiefly in the Botanic Garden; and all those are so whose site is not marked. The others are either in the Arboretum, or in the grounds of Mr Hope-Vere of Craigiehall, or on the adjoining property of Mr Campbell of Cammo. All have been marked with zinc-paint, as recommended in my first paper on tree measurements; so that the observations may be continued by myself or others.

Of the 15 trees with deciduous leaves, the sum of their growth in girth of trunk was in 1878, a decidedly favourable year, 11·30 inches,—in 1879, 8·15 inches. This is equivalent to a reduction of 28 per cent., or a little over a fourth in 1879.

Of 17 evergreen trees, all belonging to the pine tribe, the sum of their increase in trunk-girth was 15·7 inches in 1878, and 12·5 inches in 1879,—a diminution in the latter year equivalent to exactly 20 per cent., or a fifth. [Since this paper was read I have been able to annex a similar observation from the section, now in the Botanic Garden, of a fine larch over 12 feet in girth, which was uprooted at Glamis Castle, the seat of Lord Strathmore, during the Tay Bridge storm of 28th December last. The annual layers being in general sharply defined, I took the width of those of 1878 and 1879 with great care with compasses, at twelve different points of the circumference, where I could measure them with confidence; the several widths were then projected on two parallel lines, and the result was 3·0 inches for 1878, and 2·22 inches for 1879. The

difference in radial growth thus indicates an inferiority of 26 per cent. during the latter year compared with the former. This exceeds the loss of other pines, but the larch is not evergreen.]

It appears then that evergreen trees suffered rather less than trees with deciduous leaves. A sufficient cause will be pointed to presently. But in the first place let me turn attention to a singular difference of the like kind among leaf-shedding trees themselves. I have placed together at the end of that list all the oak tribe, including the hornbeam, which is closely allied to the true oaks. This has been done to show their agreement in the property of resisting the influence of an unfavourable season, injurious to other trees with deciduous leaves. Of eight observations one may be excluded, as made on a Craigiehall oak which in 1878 must have been subjected to some special cause of inferior growth. The other observations were made on three healthy common oaks (*Q. pedunculata*), and one each of Turkey oak (*Q. Cerris*), Hungary oak (*Q. Pannonica*), American red oak (*Q. rubra*), and hornbeam (*Carpinus Betulus*). I regret that I had only one tree of the four last species at my command. But, using such opportunities as I possessed, it appears that the sum of these seven measurements, all very close to one another for the two years, is an increase of 5·70 inches for 1878, and 5·15 for 1879,—being a difference of a tenth only, or 10 per cent.

If we now separate the oak tribe from the other leaf-shedding trees, it will be found that the aggregate growth of trunk in the latter was for 1878 8·6 inches, and for 1879 5·05 inches,—being a reduction actually of 41 per cent., or between one-third and one-half. The effect of a bad-growing season is thus made very conspicuous on a considerable variety of species of our most common and familiar forest trees.

The cause, or rather the causes, of this inferiority of growth, are not far to seek. It may be said that, as there was generally in 1879 no material defect in foliage on which the growth of wood depends, there was no sufficient reason against its usual annual increase. But there was one positive cause against it, and two others extremely probable.

In the first place, the usual five months of growing

season were reduced by nearly an entire month. In 1878 a cold spring, not cold enough however to injure tree buds, or to prevent their gradual progress, was succeeded by much sun in the month of May, which, qualifying a rather low atmospheric temperature, soon clothed the woods with ample foliage; and the four following months were on the whole genial, yet by no means peculiarly so. But in 1879 a similar, and indeed colder spring, was followed by a cold, cloudy, uncomfortable May; and, as the result, the tree buds generally did not begin fairly to unfold till the beginning of June. Trees were therefore deprived of a fifth part of their usual season for growing.

But secondly, the temperature of the five growing months of 1879 was materially under that of 1878; and this was the case with each month separately, as well as of course for the general average of the whole. To illustrate this interesting fact, I refer to the following remarkable table, which has been kindly communicated by Mr Buchan, secretary of our Meteorological Society. The table, which is complete and most significant, presents both the average maximum temperature, and the average mean temperature, for each of the five growing months, and also for the month of April, which may be regarded as usually the budding month in this climate.

<i>Mean of Daily Maxima.</i>							
	April.	May.	June.	July.	August.	Sep-tember.	Of Five Months.
1878 . .	52·7	59·0	65·2	69·3	66·4	63·4	64·7
1879 . .	46·5	54·2	58·4	59·8	63·4	59·2	59·0
<i>Mean of Daily Mean Temperatures.</i>							
1878 . .	46·0	51·4	56·8	61·0	58·8	55·8	56·8
1879 . .	40·6	46·2	52·4	54·4	56·4	52·0	52·3
<i>Mean Defect in 1879.</i>							
Maximum . .	6·2	4·8	6·8	9·5	3·0	4·2	5·7
Mean . .	5·6	5·2	4·4	6·6	2·4	3·8	4·5

No one can doubt the serious influence on vegetation arising from so great, so steady, and so lasting a want, as is here indicated, in the ordinary spring, summer, and autumn

heat. A natural result was that April failed to bring the buds as usual to the point of expansion in May; that a no less ungenial May, barely brought them to that point in the beginning of June; and that every vegetable function must have been more or less checked during the three subsequent months.

Thirdly, it is well-known that sun-light, apart from its heating power, has an important influence on the activity, and even the integrity, of various vegetable functions. I am not aware of any inquiry having been made into the question of its influence on the growth of tree-wood. But there is no reason for supposing this function exempt from such influence and at any rate it must be affected by the mere heating power of the sun's rays. Now, every one must have been struck with the extraordinary deficiency of sunshine during the growing months of 1879, and especially in the months of May and June. Meteorologists have not yet struck out a satisfactory method of registering the amount of daily sunshine. But the following observations are worthy of notice as supplying comparative results.

The *Times* newspaper gives the following observations made at Greenwich Observatory with an instrument which, during the daily progress of the sun, marks "bright sunshine" by discolouring or burning a card-board. Thus are obtained the monthly hours of sunshine for 1878 and 1879, as follows:—

<i>Monthly Hours of Bright Sunshine at Greenwich.</i>							
	April.	May.	June.	July.	August.	Sept.	TOTAL.
1878 . . .	150·4	166	183·4	163·9	160	127·5	950·9
1879 . . .	74·6	135·6	141·9	99·3	139·1	116·5	707·0
Loss per cent. .	51·3	20·0	23·0	39·0	13·0	9·0	25·0

The sun of Greenwich of course does not regulate the sunshine of the Lothians and Strath-Tay. But the indications of its register are conformable with what was matter of general observation all over Britain; and such meteorological data as are attainable in regard to this locality, show an inferiority of sunshine for Edinburgh in 1879, even considerably greater than in the neighbourhood of London.

The following Table is extracted from a register of sunshine kept for the Meteorological Society by their Edinburgh observer, Mr Blackwood, and kindly communicated to me by Mr Buchan. The daily hours of bright sunshine are put down by the observer from estimate. The results therefore are only approximate; but as the system of estimate is always uniform, these results must be at all events fairly comparative.

<i>Monthly Hours of Bright Sunshine at Edinburgh.</i>							
	April.	May.	June.	July.	August.	Sept.	TOTAL.
1878 . . .	127·3	198·7	198·1	215·2	138·0	147·0	1024·3
1879 . . .	23·3	120·9	111·3	95·6	156·6	124·0	631·7
Loss per cent. .	81·7	39·2	43·9	55·6	+14·0	16·0	41·1

Professor Piazzzi Smyth, Astronomer Royal, has also had the kindness to communicate to me a similar tabular view, deduced from observations made on the relative degree of cloudiness. The data are taken from daily general observation of the state of the hemisphere, complete obscuration by cloud being assumed at 1000. These data, says Professor Smyth, are derived from "a very rough and simple kind of observation, never intended for any grand meteorological purpose; but having been continued with regularity and honesty during a long period, they do seem now capable of some special results." It is to be hoped that the details of his results may find a fitter opportunity for publication by so able an observer. The only conclusions suitable in the present sketch are those which regard the relative seasons of 1878 and 1879. The mean cloudiness of the summer months of 1876-7-8-9 was 721; and that for 1879 was 854, or a ratio of nearly 100 to 120. In 1878 the mean of June and July was 704, and in 1879 it was 855·5, being a ratio of 100 to 121·5.