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REPORT

UPON SOME EXPERIMENTS UNDERTAKEN AT THE SUGGESTION OF PROFESSOR LINDLEY,

TO ASCERTAIN THE

COMPARATIVE EVAPORATING PROPERTIES

OF

EVERGREEN AND DECIDUOUS TREES.

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OF ROTHAMSTED.

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EVAPORATION OF EVERGREEN AND DECIDUOUS TREES.

In the month of December, 1849, I selected from a nursery garden three plants each, of the twelve kinds named below; they were fine healthy plants, of a size well adapted for transplanting; and although the three plants of a similar description resembled each other as nearly as it was possible to determine by the eye, the nature of their differences prevented any close agreement between plants of different descriptions. For instance, the Ash, Larch, Oak, and Sycamore, had each one stem of small branches, while the two Berberries, the Laurels, and the Yew were bushy shrubs. One plant of each sort was planted in a garden, another was reserved for the experiments to be recorded, and a third was weighed, after having the earth washed carefully from the root. The following Table will give some idea of the comparative size of the plants under experiment:—

	Weight of Plant.		Weight of Green Leaves.	
	In ozs. and grs.		In ozs. and grs.	
Spruce Fir	15	160		
Portugal Laurel... ...	18	...	3	350
Evergreen Berberry ...	3	160	1	132
Yew	22	330		
Holly	16	10	1	316
Common Laurel ...	24	260	9	121
Ilex	4	280	0	434
Larch	4	170		
Oak	2	370		
Deciduous Berberry ...	7	240		
Ash	4	40		
Sycamore	2	24		

Zinc pots, about 20 inches deep and 36 inches in circumference, were filled with good garden mould, mixed with loam, and a tree was planted in each on the 22nd of December: they weighed about 42 lbs. each; on the surface of the pot a zinc plate was fixed, having a hole to admit the stem; these plates did not fit very close, and a certain amount of the water evaporated is due to this cause. Towards the end of April a piece of oilskin was placed over the zinc plate, being fastened round the stem of the tree by India-rubber string, and also around the pot below the opening with an elastic band, which effectually prevented all escape of water except through the trees. The plants were placed in an open shed, protected from the rain, and were supplied with water from time to time as they seemed to require it; the weights were taken by means of the apparatus described in the 'Journal of the Horticultural Society' of January 1850. Upon referring to Table I. it will be seen that a considerable falling off in the water evaporated is apparent at the period when the oil-skin was put over the openings and the air perfectly excluded. Part of the pots were so covered on April 14th, and the remainder on April 24th; it appears to me probable that the reduction in the water evaporated is not entirely due to the water being prevented from escaping through the hole in the lid, but that it is partly due to an injurious effect upon the plants themselves, some of them having evidently suffered.

With the exception of the Ilex, which declined from the commencement, and appeared to be dead, or nearly so, in the spring, all the plants are alive at this time, but not equally healthy. The Yew has been perfectly healthy all the year; shoots about 2 inches long have been produced from each stem; it is quite as vigorous as one exactly similar planted in the garden. Evergreen Berberry, perfectly healthy, lost all its leaves in the spring, and produced fresh ones quite equal to that in the garden. Portugal Laurel, about the same as when planted, has not grown. Common Laurel, a great many leaves fallen at various times, which have not been reproduced; the garden plant much healthier. Spruce Fir produced young shoots about 2 inches long, which are now green, but the remainder of the plant is brown, and I should think would die if not removed. Holly very healthy, a little grown, quite equal to the garden plant. Larch grew well at first, but in the summer the leaves were covered with spots of turpentine, and the colour of the leaves was unhealthy; I should doubt whether it would live another year. Sycamore tolerably healthy, but some of the leaves mildewed. Oak and Ash about the same, tolerably healthy. Berberis D. healthy all the year.

Table No. II., in which the amount of water evaporated is divided into periods of four months, shows very clearly the comparative characters of Evergreen and Deciduous trees. Of the six Evergreen plants, the amount of water evaporated during the first four months was 44 per cent. of that evaporated during the following four months; while in the Deciduous plants it was only 14 per cent.: this would account for the large percentage of loss when evergreens are transplanted in winter. In Table IV., where the amount of water evaporated is divided into three portions, the comparative characters of the two descriptions of plant are still more clearly shown.

Table I.

Loss of Water, obtained by Weighing various Plants during a Period of Twelve Months.—Actual Results of Loss in Grains.

Dates.	Number of Days.	Number of Grains Evaporated.	Loss per Diem.	Mean Temperature of Day; Fahr.	Hygrometer.
SPRUCE FIR.					
Dec. 22 to Jan. 3	12	4,620	385·0	30·50	1·18
Jan. 3 to Jan. 13	10	1,415	141·5	32·15	0·06
Jan. 13 to Jan. 23	10	2,645	264·5	28·20	0·86
Jan. 23 to Feb. 3	11	2,320	210·9	31·18	0·24
Feb. 3 to Feb. 13	10	3,195	319·5	40·95	1·40
Feb. 13 to Feb. 23	10	3,645	364·5	44·20	2·00
Feb. 23 to Mar. 5	10	2,660	266·0	41·65	1·60
Mar. 5 to Mar. 15	10	3,140	314·0	39·80	3·70
Mar. 15 to Mar. 25	10	3,330	333·0	35·35	4·76
Mar. 25 to Apr. 4	10	6,160	616·0	40·40	5·46
Apr. 4 to Apr. 14	10	3,110	311·0	49·35	2·03
Apr. 14 to Apr. 24	10	2,505	250·5	47·75	2·50
Apr. 24 to May 4	10	3,295	329·5	45·60	9·66
May 4 to May 14	10	2,480	248·0	47·40	3·00
May 14 to May 24	10	2,880	288·0	52·75	4·30
May 24 to June 3	10	4,550	455·0	56·30	5·13
June 3 to June 13	10	5,520	552·0	59·10	8·80
June 13 to June 23	10	8,800	880·0	56·55	9·86
June 23 to July 23	30	17,670	589·0	61·96	4·61
July 23 to Aug. 22	30	11,300	376·6	62·13	2·10
Aug. 22 to Sept. 21	30	11,260	375·3	53·90	4·97
Sept. 21 to Oct. 21	30	11,680	389·3	49·21	2·21
Oct. 21 to Nov. 20	30	4,530	151·0	43·86	1·18
Nov. 20 to Dec. 31	41	1,640	40·0	38·57	0·18
PORTUGAL LAUREL.					
Dec. 22 to Jan. 3	12	3,960	330	30·50	1·18
Jan. 3 to Jan. 13	10	1,300	130	32·15	0·06
Jan. 13 to Jan. 23	10	1,840	184	28·20	0·86
Jan. 23 to Feb. 3	11	1,760	160	31·18	0·24
Feb. 3 to Feb. 13	10	3,550	355	40·95	1·40
Feb. 13 to Feb. 23	10	3,400	340	44·20	2·00
Feb. 23 to Mar. 5	10	3,010	301	41·65	1·60
Mar. 5 to Mar. 15	10	3,440	344	39·80	3·70
Mar. 15 to Mar. 25	10	5,190	519	35·35	4·76
Mar. 25 to Apr. 4	10	4,230	423	40·40	5·46
Apr. 4 to Apr. 14	10	4,740	474	49·35	2·03
Apr. 14 to Apr. 24	10	3,320	332	47·75	2·50
Apr. 24 to May 4	10	3,900	390	45·60	9·66
May 4 to May 14	10	3,510	351	47·40	3·00
May 14 to May 24	10	5,080	508	52·75	4·30
May 24 to June 3	10	8,540	854	56·30	5·13
June 3 to June 13	10	9,120	912	59·10	8·80
June 13 to June 23	10	11,160	1116	56·55	9·86
June 23 to July 23	30	30,390	1013	61·96	4·61
July 23 to Aug. 22	30	31,840	1061·3	62·13	2·10
Aug. 22 to Sept. 21	30	26,670	889	53·90	4·97
Sept. 21 to Oct. 21	30	18,520	617·3	49·21	2·21
Oct. 21 to Nov. 20	30	5,660	188·7	43·86	1·18
Nov. 20 to Dec. 31	41	2,270	55·3	38·57	0·18

TABLE I.—*continued.*

Dates.	Number of Days.	Number of Grains Evaporated.	Loss per Diem.	Mean Temperature of Day; Fahr.	Hygrometer.
EVERGREEN BERBERIS.					
Dec. 22 to Jan. 3	12	1,810	150·8	30·50	1·18
Jan. 3 to Jan. 13	10	745	74·5	32·15	0·06
Jan. 13 to Jan. 23	10	810	81·0	28·20	0·86
Jan. 23 to Feb. 3	11	875	79·5	31·18	0·24
Feb. 3 to Feb. 13	10	1,860	186·0	40·95	1·40
Feb. 13 to Feb. 23	10	2,940	294	44·20	2·00
Feb. 23 to Mar. 5	10	1,670	167	41·65	1·60
Mar. 5 to Mar. 15	10	2,180	218	39·80	3·70
Mar. 15 to Mar. 25	10	3,320	332	35·35	4·76
Mar. 25 to Apr. 4	10	2,660	266	40·40	5·46
Apr. 4 to Apr. 14	10	2,620	262	49·35	2·03
Apr. 14 to Apr. 24	10	3,040	304	47·75	2·50
Apr. 24 to May 4	10	2,330	233	45·60	9·66
May 4 to May 14	10	1,640	164	47·40	3·00
May 14 to May 24	10	2,870	287	52·75	4·30
May 24 to June 3	10	5,950	595	56·30	5·13
June 3 to June 13	10	9,020	902	59·10	8·80
June 13 to June 23	10	7,750	775	56·55	9·86
June 23 to July 23	30	31,160	1038·6	61·96	4·61
July 23 to Aug. 22	30	26,180	872·7	62·13	2·10
Aug. 22 to Sept. 21	30	22,510	750·3	53·90	4·97
Sept. 21 to Oct. 21	30	17,170	572·3	49·21	2·21
Oct. 21 to Nov. 20	30	5,540	184·7	43·86	1·18
Nov. 20 to Dec. 31	41	1,700	41·5	38·57	0·18
YEW.					
Dec. 22 to Jan. 3	12	3,720	310·0	30·50	1·18
Jan. 3 to Jan. 13	10	1,795	179·5	32·15	0·06
Jan. 13 to Jan. 23	10	1,985	198·5	28·20	0·86
Jan. 23 to Feb. 3	11	2,420	220	31·18	0·24
Feb. 3 to Feb. 13	10	3,650	365	40·95	1·40
Feb. 13 to Feb. 23	10	4,630	463	44·20	2·00
Feb. 23 to Mar. 5	10	4,300	430	41·65	1·60
Mar. 5 to Mar. 15	10	4,800	480	39·80	3·70
Mar. 15 to Mar. 25	10	5,370	537	35·35	4·76
Mar. 25 to Apr. 4	10	7,480	748	40·40	5·46
Apr. 4 to Apr. 14	10	7,090	709	49·35	2·03
Apr. 14 to Apr. 24	10	8,160	816	47·75	2·50
Apr. 24 to May 4	10	8,700	870	45·60	9·66
May 4 to May 14	10	4,450	445	47·40	3·00
May 14 to May 24	10	7,020	702	52·75	4·30
May 24 to June 3	10	9,750	975	56·30	5·13
June 3 to June 13	10	8,505	850·5	59·10	8·80
June 13 to June 23	10	9,555	955·5	56·55	9·86
June 23 to July 23	30	30,370	1012·3	61·96	4·61
July 23 to Aug. 22	30	24,285	809·5	62·13	2·10
Aug. 22 to Sept. 21	30	21,845	728·2	53·90	4·97
Sept. 21 to Oct. 21	30	20,060	668·6	49·21	2·21
Oct. 21 to Nov. 20	30	6,590	219·6	43·86	1·18
Nov. 20 to Dec. 31	41	730	17·8	38·57	0·18

TABLE I.—*continued.*

Dates.	Number of Days.	Number of Grains Evaporated.	Loss per Diem.	Mean Temperature of Day; Fahr.	Hygrometer.
HOLLY.					
Dec. 22 to Jan. 3	12	1,800	150·0	30·50	1·18
Jan. 3 to Jan. 13	10	610	61·0	32·15	0·06
Jan. 13 to Jan. 23	10	845	84·5	28·20	0·86
Jan. 23 to Feb. 3	11	1,125	102·2	31·18	0·24
Feb. 3 to Feb. 13	10	2,070	207	40·95	1·40
Feb. 13 to Feb. 23	10	2,760	276	44·20	2·00
Feb. 23 to Mar. 5	10	1,820	182	41·65	1·60
Mar. 5 to Mar. 15	10	2,640	264	39·80	3·70
Mar. 15 to Mar. 25	10	3,200	320	35·35	4·76
Mar. 25 to Apr. 4	10	2,590	259	40·40	5·46
Apr. 4 to Apr. 14	10	2,620	262	49·35	2·03
Apr. 14 to Apr. 24	10	1,700	170	47·75	2·50
Apr. 24 to May 4	10	2,300	230	45·60	9·66
May 4 to May 14	10	1,400	140	47·40	3·00
May 14 to May 24	10	2,130	213	52·75	4·30
May 24 to June 3	10	3,225	322·5	56·30	5·13
June 3 to June 13	10	2,915	291·5	59·10	8·80
June 13 to June 23	10	2,370	237	56·55	9·86
June 23 to July 23	30	9,140	304·7	61·96	4·61
July 23 to Aug. 22	30	10,100	336·6	62·13	2·10
Aug. 22 to Sept. 21	30	7,150	238·3	53·90	4·97
Sept. 21 to Oct. 21	30	7,820	260·6	49·21	2·21
Oct. 21 to Nov. 20	30	3,780	126	43·86	1·18
Nov. 20 to Dec. 31	41	1,500	37·6	38·57	0·18
COMMON LAUREL.					
Dec. 22 to Jan. 3	12	2,718	226·5	30·50	1·18
Jan. 3 to Jan. 13	10	1,802	180·2	32·15	0·06
Jan. 13 to Jan. 23	10	1,895	189·5	28·20	0·86
Jan. 23 to Feb. 3	11	2,415	219·5	31·18	0·24
Feb. 3 to Feb. 13	10	3,715	371·5	40·95	1·40
Feb. 13 to Feb. 23	10	3,895	389·5	44·20	2·00
Feb. 23 to Mar. 5	10	3,250	325	41·65	1·60
Mar. 5 to Mar. 15	10	4,270	427	39·80	3·70
Mar. 15 to Mar. 25	10	4,910	491	35·35	4·76
Mar. 25 to Apr. 4	10	4,890	489	40·40	5·46
Apr. 4 to Apr. 14	10	5,460	546	49·35	2·03
Apr. 14 to Apr. 24	10	4,220	422	47·75	2·50
Apr. 24 to May 4	10	7,160	716	45·60	9·66
May 4 to May 14	10	8,240	824	47·40	3·00
May 14 to May 24	10	12,375	1237·5	52·75	4·30
May 24 to June 3	10	13,795	1379·5	56·30	5·13
June 3 to June 13	10	12,590	1259	59·10	8·80
June 13 to June 23	10	11,590	1159	56·55	9·86
June 23 to July 23	30	37,450	1248·3	61·96	4·61
July 23 to Aug. 22	30	26,640	888	62·13	2·10
Aug. 22 to Sept. 21	30	22,940	764·6	53·90	4·97
Sept. 21 to Oct. 21	30	16,520	550·6	49·21	2·21
Oct. 21 to Nov. 20	30	6,110	203·6	43·86	1·18
Nov. 20 to Dec. 31	41	2,030	49·5	38·57	0·18

TABLE I.—*continued.*

Dates.	Number of Days.	Number of Grains Evaporated.	Loss per Diem.	Mean Temperature of Day; Fahr.	Hygrometer.
ILEX.					
Dec. 22 to Jan. 3	12	980	81·7	30·50	1·18
Jan. 3 to Jan. 13	10	370	37	32·15	0·06
Jan. 13 to Jan. 23	10	820	82	28·20	0·86
Jan. 23 to Feb. 3	11	580	52·7	31·18	0·24
Feb. 3 to Feb. 13	10	240	24	40·95	1·40
Feb. 13 to Feb. 23	10	1,350	135	44·20	2·00
Feb. 23 to Mar. 5	10	580	58	41·65	1·60
Mar. 5 to Mar. 15	10	1,130	113	39·80	3·70
Mar. 15 to Mar. 25	10	2,600	260	35·35	4·76
Mar. 25 to Apr. 4	10	1,020	102	40·40	5·46
Apr. 4 to Apr. 14	10	1,130	113	49·35	2·03
Apr. 14 to Apr. 24	10	160	16	47·75	2·50
Apr. 24 to May 4	10	330	33	45·60	9·66
May 4 to May 14	10	240	24	47·40	3·00
May 14 to May 24	10	260	26	52·75	4·30
May 24 to June 3	10	650	65	56·30	5·13
June 3 to June 13	10	234	23·4	59·10	8·80
June 13 to June 23	10	296	29·6	56·55	9·86
June 23 to July 23	30	480	16	61·96,	4·61
July 23 to Aug. 22	30	600	20	62·13	2·10
Aug. 22 to Sept. 21	30	180	6	53·90	4·97
Sept. 21 to Oct. 21	30	800	26·6	49·21	2·21
Oct. 21 to Nov. 20	30	140	4·6	43·86	1·18
Nov. 20 to Dec. 31	41	360	8·8	38·57	0·18
LARCH.					
Dec. 22 to Jan. 3	12	640	53·3	30·50	1·18
Jan. 3 to Jan. 13	10	100	10	32·15	0·06
Jan. 13 to Jan. 23	10	125	12·5	28·20	0·86
Jan. 23 to Feb. 3	11	215	19·5	31·18	0·24
Feb. 3 to Feb. 13	10	610	61	40·95	1·40
Feb. 13 to Feb. 23	10	1,070	107	44·20	2·00
Feb. 23 to Mar. 5	10	450	45	41·65	1·60
Mar. 5 to Mar. 15	10	1,040	104	39·80	3·70
Mar. 15 to Mar. 25	10	2,040	204	35·35	4·76
Mar. 25 to Apr. 4	10	1,440	144	40·40	5·46
Apr. 4 to Apr. 14	10	1,580	158	49·35	2·03
Apr. 14 to Apr. 24	10	2,260	226	47·75	2·50
Apr. 24 to May 4	10	960	96	45·60	9·66
May 4 to May 14	10	720	72	47·40	3·00
May 14 to May 24	10	1,270	127	52·75	4·30
May 24 to June 3	10	1,680	168	56·30	5·13
June 3 to June 13	10	2,160	216	59·10	8·80
June 13 to June 23	10	3,000	300	56·55	9·86
June 23 to July 23	30	16,690	556·3	61·96	4·61
July 23 to Aug. 22	30	26,050	868·3	62·13	2·10
Aug. 22 to Sept. 21	30	24,850	828·3	53·90	4·97
Sept. 21 to Oct. 21	30	21,580	719·3	49·21	2·21
Oct. 21 to Nov. 20	30	3,320	110·6	43·86	1·18
Nov. 20 to Dec. 31	41	450	11·0	38·57	0·18

TABLE I.—*continued.*

Dates.	Number of Days.	Number of Grains Evaporated.	Loss per Diem.	Mean Temperature of Day; Fahr.	Hygrometer.
OAK.					
Dec. 22 to Jan. 3	12	660	55	30·50	1·18
Jan. 3 to Jan. 13	10	150	15	32·15	0·06
Jan. 13 to Jan. 23	10	125	12·5	28·20	0·86
Jan. 23 to Feb. 3	11	155	14·1	31·18	0·24
Feb. 3 to Feb. 13	10	190	19	40·95	1·40
Feb. 13 to Feb. 23	10	200	20	44·20	2·00
Feb. 23 to Mar. 5	10	390	39	41·65	1·60
Mar. 5 to Mar. 15	10	790	79	39·80	3·70
Mar. 15 to Mar. 25	10	2,110	211	35·35	4·76
Mar. 25 to Apr. 4	10	1,290	129	40·40	5·46
Apr. 4 to Apr. 14	10	900	90	49·35	2·03
Apr. 14 to Apr. 24	10	1,550	155	47·75	2·50
Apr. 24 to May 4	10	10	1	45·60	9·66
May 4 to May 14	10	210	21	47·40	3·00
May 14 to May 24	10	270	27	52·75	4·30
May 24 to June 3	10	1,220	122	56·30	5·13
June 3 to June 13	10	1,590	159	59·10	8·80
June 13 to June 23	10	2,390	239	56·55	9·86
June 23 to July 23	30	11,710	390·3	61·96	4·61
July 23 to Aug. 22	30	17,650	588·3	62·13	2·10
Aug. 22 to Sept. 21	30	17,730	591	53·90	4·97
Sept. 21 to Oct. 21	30	13,950	465	49·21	2·21
Oct. 21 to Nov. 20	30	4,460	148·6	43·86	1·18
Nov. 20 to Dec. 31	41	890	21·7	38·57	0·18
DECIDUOUS BERBERIS.					
Dec. 22 to Jan. 3	12	820	68·3	30·50	1·18
Jan. 3 to Jan. 13	10	155	15·5	32·15	0·06
Jan. 13 to Jan. 23	10	190	19	28·20	0·86
Jan. 23 to Feb. 3	11	185	16·8	31·18	0 24
Feb. 3 to Feb. 13	10	530	53	40·95	1·40
Feb. 13 to Feb. 23	10	825	82·5	44·20	2·00
Feb. 23 to Mar. 5	10	375	37·5	41·65	1·60
Mar. 5 to Mar. 15	10	1,240	124	39·80	3·70
Mar. 15 to Mar. 25	10	2,460	246	35 35	4·76
Mar. 25 to Apr. 4	10	3,350	335	40·40	5·46
Apr. 4 to Apr. 14	10	1,080	108	49·35	2·03
Apr. 14 to Apr. 24	10	530	53	47·75	2·50
Apr. 24 to May 4	10	2,370	237	45·60	9·66
May 4 to May 14	10	3,180	318	47·40	3·00
May 14 to May 24	10	5,895	589·5	52·75	4·30
May 24 to June 3	10	9,105	910·5	56·30	5·13
June 3 to June 13	10	9,514	951·4	59·10	8·80
June 13 to June 23	10	10,236	1023·6	56·55	9·86
June 23 to July 23	30	31,870	1062·3	61·96	4·61
July 23 to Aug. 22	30	30,020	1000·6	62·13	2·10
Aug. 22 to Sept. 21	30	32,990	1099 6	53·90	4·97
Sept. 21 to Oct. 21	30	28,770	959	49·21	2·21
Oct. 21 to Nov. 20	30	3,770	125·6	43·86	1·18
Nov. 20 to Dec. 31	41	550	13·4	38·57	0·18

TABLE I.—*continued.*

Dates.	Number of Days.	Number of Grains Evaporated.	Loss per Diem.	Mean Temperature of Day; Fahr.	Hygrometer.
ASH.					
Dec. 22 to Jan. 3	12	1,290	107·5	30·50	1·18
Jan. 3 to Jan. 13	10	110	11	32·15	0·06
Jan. 13 to Jan. 23	10	100	10	28·20	0·86
Jan. 23 to Feb. 3	11	100	9·1	31·18	0·24
Feb. 3 to Feb. 13	10	690	69	40·95	1·40
Feb. 13 to Feb. 23	10	390	39	44·20	2·00
Feb. 23 to Mar. 5	10	280	28	41·65	1·60
Mar. 5 to Mar. 15	10	830	83	39·80	3·70
Mar. 15 to Mar. 25	10	1,830	183	35·35	4·76
Mar. 25 to Apr. 4	10	1,290	129	40·40	5·46
Apr. 4 to Apr. 14	10	650	65	49·35	2·03
Apr. 14 to Apr. 24	10	340	34	47·75	2·50
Apr. 24 to May 4	10	345	34·5	45·60	9·66
May 4 to May 14	10	535	53·5	47·40	3·00
May 14 to May 24	10	1,560	156	52·75	4·30
May 24 to June 3	10	5,560	556	56·30	5·13
June 3 to June 13	10	7,850	785	59·10	8·80
June 13 to June 23	10	10,360	1036	56 55	9·86
June 23 to July 23	30	30,210	1007	61·96	4·61
July 23 to Aug. 22	30	25,500	850	62·13	2·10
Aug. 22 to Sept. 21	30	21,500	716·6	53·90	4·97
Sept. 21 to Oct. 21	30	2,400	80	49·21	2·21
Oct. 21 to Nov 20	30	840	28	43·86	1·18
Nov. 20 to Dec. 31	41	720	17·6	38·57	0·18
SYCAMORE.					
Dec. 22 to Jan. 3	12	620	51·7	30·50	1·18
Jan. 3 to Jan. 13	10	240	24	32·15	0·06
Jan. 13 to Jan. 23	10	140	14	28·20	0·86
Jan. 23 to Feb. 3	11	160	14·5	31·18	0·24
Feb. 3 to Feb. 13	10	250	25	40·95	1·40
Feb. 13 to Feb. 23	10	610	61	44·20	2·00
Feb. 23 to Mar. 5	10	890	89	41·65	1·60
Mar. 5 to Mar. 15	10	1,280	128	39·80	3·70
Mar. 15 to Mar. 25	10	2,380	238	35·35	4·76
Mar. 25 to Apr. 4	10	1,430	143	40·40	5·46
Apr. 4 to Apr. 14	10	1,650	165	49·35	2·03
Apr. 14 to Apr. 24	10	80	8	47·75	2 50
Apr. 24 to May 4	10	200	20	45·60	9·66
May 4 to May 14	10	210	21	47·40	3·00
May 14 to May 24	10	720	72	52·75	4·30
May 24 to June 3	10	4,420	442	56·30	5·13
June 3 to June 13	10	6,360	636	59·10	8·80
June 13 to June 23	10	8,070	807	56·55	9·86
June 23 to July 23	30	27,410	913·6	61·96	4·61
July 23 to Aug. 22	30	27,990	933	62·13	2·10
Aug. 22 to Sept. 21	30	26,890	896·3	53·90	4·97
Sept. 21 to Oct. 21	30	19,150	638·3	49·21	2·21
Oct. 21 to Nov. 20	30	1,580	52·7	43·86	1·18
Nov. 20 to Dec. 31	41	680	16·6	38·57	0·18

TABLE II.

WATER EVAPORATED in periods of Four Months, by various Plants—Grains

	December 22 to April 24.	April 24 to August 22.	August 22 to December 31.
Spruce Fir	38,725	56,595	29,110
Portugal Laurel	39,740	104,040	53,022
Evergreen Berberis ...	24,530	85,910	46,920
Yew	55,400	102,635	49,225
Holly	23,780	33,580	20,250
Common Laurel	43,440	129,840	47,600
Ilex	10,970	3,090	1,480
Larch	11,570	52,530	50,200
Oak	8,510	35,050	37,030
Deciduous Berberis ...	11,740	102,190	66,080
Ash	7,900	81,920	25,470
Sycamore	9,730	75,380	48,300

TABLE III.

WATER EVAPORATED in Twelve Months, by various Plants—Grains.

	Water supplied to Soil.	Water obtained from Soil.	Total Evaporated.
Spruce Fir	91,400	33,030	124,430
Portugal Laurel	156,400	40,502	196,902
Evergreen Berberis ...	123,900	33,460	157,360
Yew	171,400	35,860	207,260
Holly	61,400	16,210	77,610
Common Laurel	181,400	39,480	220,880
Ilex	13,400	2,100	15,540
Larch	87,400	26,900	114,300
Oak	57,400	23,190	80,590
Deciduous Berberis ...	137,400	42,610	180,010
Ash	102,400	12,890	115,290
Sycamore	97,400	36,010	133,410

TABLE IV.

TABLE showing the Periods of the year in which Evergreen and Deciduous Plants Evaporate 100 Parts of Water.

	Evergreen.	Deciduous.
Four months to April 24	23	8
" August 22	$52\frac{1}{2}$	56
" December 31	$24\frac{1}{2}$	36
	100	100

Note upon the Preceding Experiments.

The evaporating power of the leaves is one of the most important properties of plants, for on the healthy performance of this function depend not merely the vigour and development of the plant, but also, indeed, its very existence. Every new fact, therefore, which in any way tends to elucidate the chemical or physiological nature of the leaves, or which throws light upon the mode in which they act, and the effects produced by the various agents to the influence of which they are naturally subject, is highly interesting. The preceding experiments were undertaken with a view to ascertain the ratio which exists between the evaporating power of different leaves, contrasting together in particular those of Evergreens and those of Deciduous plants. Before making one or two remarks which these experiments suggest, it will, perhaps, not be out of place to say a few words respecting some former investigations on the same subject.

It is more than a hundred and fifty years since Dr. Woodward published, in the twentieth volume of the 'Philosophical Transactions of the Royal Society,' an account of some experiments on vegetation, having for their especial object to determine the evaporating power of the leaves. These experiments were curious, and excited a good deal of interest at the time the results were published. Some of the conclusions drawn from them were tolerably accurate, but from the vague and uncertain views which were then generally entertained respecting the growth and nourishment of plants, the very facts themselves became, to a very great extent, mystified and confused, so that their practical value was greatly diminished.

Dr. Woodward's experiments were made with weighed bottles of water, having a piece of parchment tied over their mouths, in which a small aperture was made, just sufficient to admit the stem of a plant, but not so small as to confine or impede its growth. As the water evaporated, fresh was added from time to time, a register being kept of the quantity added, as well as of that which was lost by evaporation. The plants were placed side by side in a window, where they were equally exposed to sunshine; and the experiment was continued from the 20th of July, 1691, to the 5th of October in the same year. The following was the result of one of these comparative experiments:—

	Original Weight.	Final Weight.	Water Evaporated.
	Grains.	Grains.	Grains.
Spearmint, in spring water ...	27	42	2558
Ditto, in rain water	28	45	3004
Ditto, in Thames water ...	28	54	2493
Nightshade, in spring water...	49	106	3708
Lathyris, in spring water ...	98	101	2501

Proceeding to compare together the increase in weight of the plant with the quantity of water it had given off, Dr. Woodward showed that in the case of the three plants of Spearmint, it was respectively as 1 to 170, to 171, and to 95; whilst in the instance of the Nightshade it was as 1 to 65, and in that of the Lathyris as 1 to 714. It is evident, however, that from such experiments no very satisfactory or accurate conclusion could well be drawn; they were repeated and varied in different ways, and similar results were obtained. One of the most curious of these experiments was an attempt to ascertain more exactly the precise effect of different kinds of water on the growth and evaporating power of the same plant; in this case six plants of Spearmint were suffered to grow in weighed bottles of water for eight weeks; the results were as follows:—

Spearmint.	Original Weight.	Increase.	Water Evaporated.	Ratio of Increase to Evaporation.
	Grains.	Grains.	Grains.	
1. In Hyde Park water	127	128	14,190	1 to 110
2. Ditto	110	139	13,140	1 to 94
3. Ditto, with ½ an oz. of soil ...	76	168	10,731	1 to 63
4. Ditto, with ½ an oz. of garden soil	92	284	14,950	1 to 52
5. Distilled water	114	41	8,803	1 to 214
6. Hyde Park water, concentrated by evaporation	81	94	4,344	1 to 46

It was the common belief of many naturalists at the time that the increase in weight of plants was in direct proportion to the quantity of water which passed through them, or rather to the proportion of it which became fixed in their organs in the process of being absorbed by the roots and given off by the leaves. In the experiments just mentioned, the last plant increased most in proportion to the quantity of water evaporated, but the fourth was the one which grew most luxuriantly, and it was also the one which absorbed the largest quantity of water in proportion to its weight. The plant fed with distilled water grew least of all, whilst that fed with spring water containing a portion of garden soil was by far the most flourishing.

These experiments of Woodward led Dr. Stephen Hales to make a number of curious and interesting observations on the evaporating power of the leaves of plants, which he published in 1727, in the first volume of his celebrated 'Statical Essays.' Those which more immediately relate to the present subject will be found in the first chapter, "on the quantity of moisture imbibed and perspired by plants and trees." Hales's most celebrated experiment was made in 1724 with a healthy full-grown Sunflower, more than a yard high, and which had been purposely planted when young in a suitable flowerpot. The mode in which the experiment was conducted is best given in his own words:— "I covered the pot with a plate of thin milled lead, and cemented all the joints fast, so that no vapour could pass, but only air, through a small glass tube, 9 inches long, which was fixed purposely near the stem of the plant, to make a free communication with the outward air and that under the leaden plate. I cemented also another short glass tube into the plate, 2 inches long, and 1 inch in diameter. Through this tube I watered the plant, and then stopped it up with a cork; I also stopped up the hole at the bottom of the pot with a cork."

Matters being thus arranged, the plant received a weighed supply of water, and being itself weighed twice a day for a fortnight, the rate of evaporation was easily observed. By another comparative experiment Dr. Hales ascertained the quantity of water evaporated every day by the porous earthen pot, and subtracted it from the whole daily loss sustained by the Sunflower. The result showed that on an average the plant evaporated 20 ounces, or 34 cubic inches of water, in a twelve hours' day; the maximum proportion being 30 ounces. This was certainly a very interesting and remarkable experiment, and it was rendered all the more so by the careful and minute details which accompanied its publication; including the bulk and length of the roots, and the exact size of the leaves. Hales also measured the rate of evaporation of a Cabbage, a Vine, a young Apple-tree, and a Lemon-tree. The result of these experiments is expressed in the following table:—

	Entire Surface of Leaves.	Water Perspired in 12 hours.	Ratio of Evaporation to Surface of Plant.
	Square inches.	Ounces.	
Sunflower ...	5616	20	$\frac{1}{165}$
Cabbage	2736	19	$\frac{1}{80}$
Vine	1820	$5\frac{1}{2}$	$\frac{1}{191}$
Apple-tree ...	1589	9	$\frac{1}{102}$
Lemon-tree ...	2557	$10\frac{1}{3}$	$\frac{1}{248}$

The practical conclusion drawn from these experiments was, that the Cabbage evaporated the greatest quantity of water, and the Lemon-tree the least. On repeating it with other plants Dr. Hales found that in all cases evergreens perspired less than those plants which shed their leaves in the winter, a fact which he endeavoured to explain by observing, that "as they perspire less, so they are better able to survive the winter's cold." At the same time that he made these experiments he also made a number of other highly interesting ones, on the force with which plants absorb water, and many similar points connected with this part of their economy.

A third series of experiments was made by Mr. Miller in 1726, at the Chelsea Botanic Garden, at the suggestion of Dr. Hales, in which the subjects of experiment were a Musa, an Aloe, and an Apple-tree. The plants were grown in glazed earthenware pots, made without any holes at the bottom, so that there was no need to make any correction for the water lost by evaporation; the plants were weighed three times a day for some weeks, and the thermometer was noted at each weighing. The chief facts observed were, that the plants perspired more in the morning than in the afternoon; that they very often absorbed moisture by the leaves during the night; and that the proportion perspired was generally in direct proportion to the temperature of the day.

These simple experiments are, all of them, perfectly satisfactory, and, as far as they go, are no doubt quite trustworthy. It is remarkable that during the last one hundred and thirty years hardly a single new fact of much importance has been added to this department of vegetable physiology, and that our knowledge of this important branch of the economy of vegetation is very little extended beyond what it was at the time of Hales. One reason of this certainly is, that the observers who followed him began to refine upon the simple mode of experimenting which he employed, and introduced complicated and unnatural forms of experiment, the results of which are, for the most part, of but little value. Thus the numerous and laborious experiments of Bonnet, undertaken chiefly at the suggestion of Calandrini, to ascertain the relative power of absorbing moisture by the superior and inferior surfaces of the leaf, were far from satisfactory; because, though his object was to measure the power of absorbing aqueous vapour, his experiments in fact all had reference to a different point, namely, the power of the leaves to absorb water, when placed in contact with it, by the upper or lower surface. The experiments of Bonnet, even on the direct absorption of water, do not really give a true indication of the evaporating power of the leaves, because they were made on single leaves and not on entire plants; they consequently did not fairly represent the sound and perfect leaves of a growing plant.

The very numerous series of experiments, on the evaporation from leaves, detailed in the preceding pages, are highly valuable, because they extend over a considerable period of time, and therefore are less under the influence of the various interfering causes which generally introduce errors into such investigations. At the same time, however, they are by no means unexceptionable, for there are several matters connected with them which are open to doubt and uncertainty. The first great condition of all such experiments in every case is, that the plants must be brought into a healthy condition at the commencement of the experiment, and kept in a healthy state all through it; if the plant is rendered sickly and unhealthy by the conditions of the experiment, it is plain that, the circumstances being forced and unnatural, they cannot be expected to yield satisfactory results. Now, in the preceding experiments, the plants were unquestionably injured by the treatment they received, and, what is still worse, they were injured to an unequal extent, some of them being rendered far more sickly than the others. If means cannot be devised to prevent the evaporation of moisture from the surface of the soil without tying bandages round the stem, it is far better to calculate the amount of water thus lost, as Hales did, and subtract it from the total loss at each weighing. If all the other circumstances are perfectly similar, this loss would not vary much; it would be pretty nearly constant with each of the different plants. It is also to be remarked, that in thus absolutely preventing all evaporation from the enclosed soil, excepting that which took place through the leaves of the plant, the soil was altogether cut off from contact with the external air, and thus another, and by no means unimportant, condition was introduced.

In experiments of this sort it is very desirable not to commence them the very day the plants have been transplanted; some little time should be allowed to elapse before the experiment is begun, so that the plants may become accustomed to the new conditions under which they are placed; and in every case where possible two or three similar plants should be taken for each experiment, instead of single ones.

For the most part the experimental results are pretty nearly what might have been expected, though of course there are exceptions and irregularities, which must be attributed to special interfering causes. There would seem to be a remarkable difference between the several plants, as regards the relation existing between the temperature and the rate of evaporation, independently of the dryness or moisture of the air. On comparing the tables

together, it will be found that in the case of the Portugal Laurel, Holly, Larch, and Sycamore, the maximum evaporation occurs at the same time as the maximum of temperature, namely, between the 23rd of July and the 22nd of August. This, however, is not the case with the other plants. In the case of the Oak, and the Deciduous Berberis, the maximum evaporation occurs after the greatest heat; the greatest quantity of water being evaporated between the 22nd of August and the 21st of September, though the average temperature then was more than 8° lower than it had been during the previous four weeks. Exactly the reverse is the case with the remaining plants, for the maximum evaporation with the Spruce-Fir, Evergreen Berberis, Yew, Laurel, and Ash, in each instance preceded the maximum of heat. On referring to the table showing the evaporation from the Evergreen Berberis, it will be found that from the 23rd of June to the 23rd of July, when the average temperature was below 62°, the daily loss of water was 1038 grains, whilst in the following month, though the thermometer was then above 62°, the daily evaporation was only 872 grains. A similar effect may be observed with regard to the Yew. In July, with a temperature below 62°, the daily loss was 1012 grains; in August, with an average temperature above 62°, the daily evaporation was only 809 grains. It is evident, therefore, from these experiments, that evaporation is not a mere index of temperature, but that it depends on vitality, influenced by heat, light, and other causes.

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