*The Effect of Light on the Transpiration of Leaves.**

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The method employed is essentially that described in my paper† "On a Method of Studying Transpiration," where it was applied to the investigation of the relation between the relative humidity of the air and the loss of water by leaves. The stomata of the plants used were closed by vaseline or cocoa-fat rubbed in, and the leaves were then incised to allow of transpiration. No attempt was made to subject the plants to light of known intensity. My object was to compare the transpiration occurring in a dark room with that in a north light at a laboratory window. The rates of transpiration were estimated either by weighing or by means of a potometer, and the general plan was to subject the plant to alternate light and dark periods of something like an hour.‡ The psychrometric condition of the laboratory air and that of the dark room was estimated by the wet and dry bulb thermometer, and the transpiration rates corrected for any differences, in the manner described in the paper above referred to.

The first experiment was made by a plan which has some merits, but was afterwards replaced by the simpler method of moving the apparatus from the window to dark room and back again to the light.

Experiment 1.—December 9, 1909. *P. laurocerasus.*

Branch fitted to potometer December 8 and the lower surfaces of the leaves greased; leaves cut about 10 A.M., December 9.

Placed under a bell-jar through which a current of laboratory air is drawn

* It is not easy to find any recorded experiments on the transpiration of leaves in light and darkness, in which the action of the stomata is absolutely excluded. In Bonnier and Mangin's experiments on the transpiration of fungi this is *ipso facto* the case (see 'Ann. Sc. Nat.,' 1884, vol. 17, p. 298). The average of the experiments on *Trametes suaveolens* is :—L/D = 119/100. For *Polyporus versicolor* the corresponding fraction is 127/100. The symbol L/D stands for the relation between the transpiration in light and darkness.

† 'Roy. Soc. Proc.,' this vol., p. 269.

‡ A few weighing experiments were, however, made on the effect of the natural darkening occurring at night. The average of eight experiments gave the proportion between transpiration in the day (L) and in the evening (D), as L/D = 129/100. Four experiments made with the potometer under similar conditions gave day (L)/evening (D) = 112/100. This subject, including the effect of continuous darkness, requires fresh investigation.

to keep the relative humidity (ψ) as constant as possible. The rates of transpiration are given as corrected. North light.

Time.	Rate corrected.	T.	ψ.
		° C.	per cent.
10.42 A.M.	24·8	14·2	65
10.54 „	24·7	14·2	64
11.1 „ }	Covered bell-jar with a black bag.		
11.5 „ }			
11.21 „	27·1	14·6	62
12.5 P.M.	22·1	14·6	63
12.30 „	Light: cloth bag removed.		
12.41 „	24·9	15·2	62
2.46 „	25·8	15·7	63
3.10 „	28·0	15·7	63
3.27 „	Dark: cloth bag replaced.		
3.43 „	25·0	15·9	63
3.57 „	25·4	15·8	63
4.11 „	26·0	—	—

Result.—The fall in transpiration-rate between 11.21 A.M. and 12.5 P.M. is 27·1 to 22·1 or 123/100. The rise in the next period is from 22·1 to 28·0 or 100/127; the diminution in the final dark period is 108/100. The average proportion between the transpiration in light and darkness (L/D) is 119/100.

Experiment 2.—April 11, 1911. *P. laurocerasus.*

Potometer: T 15·0-16·2° C. ψ 46–56 per cent. Transpiration corrected.

Time.	Rate.	Time.	Rate.
11.17 A.M.	164	11.55 A.M.	107
11.33 „	140	11.58 „	103
11.37 „	122	12.13 P.M.	108
11.41 „	116	12.28 „	95
	In dark room.	4.10 „	109
11.45 „	115	4.12 „	110

Transpiration was falling (in the light) from 11.17 to 11.41; the effect of darkness was to diminish rather than to increase the rate of fall. The total change in the dark is a fall from 115 to 110, or L/D = 105/100.

Experiment 3.—April 19, 1911. *P. laurocerasus.*

Potometer: leaves slit at 10.55 A.M. T 16·1–17·0° C. ψ 50–62 per cent. Transpiration corrected.

Time.	Rate.	Time.	Rate.
11.22 A.M.	159	11.55 A.M.	186
11.39 „	149	12.8 P.M.	168
11.45 „	153	3.8 „	187
11.50 „	In dark room	3.12 „	181

The transpiration had been steady for some time before the plant was placed in the dark room. The only clear effect was a *rise* in transpiration-rate from 153 to 181, or L/D = 100/118.

Experiment 4.—April 20, 1911. *P. laurocerasus.*

Potometer: leaves greased and slit 10.30 A.M. T 15·0–16·6° C. ψ 44–47 per cent.

Time.	Rate.	Time.	Rate.
10.40 A.M.	757	12.2 P.M.	797
11.0 „	814	12.43 „	610
	Dark room.	12.45 „	Light.
11.4 „	902	12.48 „	493
11.24 „	897	12.56 „	550
11.51 „	816	3.30 „	559

In this experiment the effect of the dark room is doubtful, as the rate was not steady before darkness. If we assume that the fall in rate was due to darkness, we have the big effect of fall from 902 to 493 or 183/100. The subsequent rise in the light is from 493 to 559 or D/L = 100/113.

The average of the light and dark effects is L/D = 148/100.

Experiment 5.—April 22, 1911. *P. laurocerasus.*

Potometer: leaves greased and slit 10.31 A.M. T 19·6–21·1° C. ψ 41–52 per cent.

Time.	Rate.	Time.	Rate.
10.47 A.M.	210	11.54 A.M.	157
10.50 „	233	12.5 P.M.	162
10.52 „	208	12.13 „	154
10.58 „	213	12.21 „	162
11.0 „	In dark room	12.32 „	171
11.21 „	197	12.39 „	174
11.47 „	176	12.50 „	174
11.48 „	In light		

Transpiration was approximately steady before darkening and fell from 213 to 175, or from 121 to 100, during actual darkness; or, if we include the reading taken at 11.54, it fell from 213 to 157, or from 136 to 100.

There is the same doubt about the effect of subsequent illumination. If we compare the end of the dark period with the last reading taken in the light the effect is nil. If we compare reading at the beginning of the light (157) with that at the end (174) we get a rise of 100 to 111.

On the whole it is fairest to take the darkening effect as 136 : 100, the light as 100 : 111. The average of the light and dark effects is L/D = 124/100.

Experiment 6.—November 15–16, 1911. *P. laurocerasus.* Potometer.

Time.	Rate.	Time.	Rate.
Nov. 15.		11.30 A.M.	Light—at east window.
10.25 A.M.	Leaves slit.	11.40 ,,	146
11.18 ,,	In dark room.	11.54 ,,	134
Nov. 16.	,, ,,	12.1 P.M.	137
10.17 A.M.	Cut fresh surface to branch.	12.25 ,,	143
10.54 ,,	119	12.40 ,,	148
11.16 ,,	120	12.50 ,,	162
11.27 ,,	126	12.57 ,,	153

The effect of light may be taken as increasing the rate from 126 to 158 (the average of last two readings), or L/D = 125/100.

Experiment 7.—November 17, 1911. *P. laurocerasus.* Potometer.

Time.	Rate.	Time.	Rate.
10.15 A.M.	Leaves cut.	11.16 A.M.	In dark room.
10.18 ,,	192	11.28 ,,	317
10.34 ,,	316	11.40 ,,	292
10.39 ,,	325	12.0 NOON	294
10.50 ,,	300	12.37 P.M.	278
11.12 ,,	330	12.38 ,,	286
11.15 ,,	308	12.56 ,,	278

Shortly before the period of darkness the rate may be taken as = 320 (average of last two readings), at the end of the dark period it is 280 (average as above); this gives a diminution in transpiration equal 114 to 100, or L/D = 114/100.

The result of the above series is given in the following table; L→D means that darkness followed light, D→L indicating the opposite. The last column gives the effect as a percentage. Where, as on April 20 and April 22, there is a L→D as well as a D→ effect, the average is given :—

Experiment.	Date.		Effect of light or of dark.
1	Dec. 9, 1909 ...	L → D	123 → 100 }
		D → L	100 → 127 } 19 per cent.
		L → D	108 → 100 }
2	Apr. 11, 1911 ...	L → D	105 : 100 5 ,,
3	,, 19, 1911 ...	L → D	100 : 100 0 ,,
4	,, 20, 1911 ...	L → D	183 : 100 } 48
		D → L	100 : 113 } ,,
5	,, 22, 1911 ...	L → D	136 : 100 } 23
		D → L	100 : 110 } ,,
6	Nov. 15, 1911 ...	D → L	100 : 125 25 ,,
7	,, 17, 1911 ...	L → D	114 : 100 14 ,,
Average ..... L/D = 119/100.			

In some cases transpiration is but slightly affected by darkness, as in the ollowing experiments.

The material was supplied by small branches of laurel (*P. laurocerasus*), having, as a rule, four leaves, vaselined and cut (four incisions per leaf) in the usual way. A branch was fitted to a simple form of potometer consisting of a pipette graduated to 0·01 c.c. The pipette was fixed vertically and the branch attached to the lower end by rubber tube; as the plant absorbs water the descent of the meniscus is read with a lens, by which means errors of parallax are fairly well avoided.

The experiments were made alternately in a dark room and at the north or east window of the laboratory.* Readings were generally continued for an hour before the change from light to darkness, or *vice versâ*, was made. The results, *i.e.* the amounts of water absorbed per hour in light and darkness were corrected for psychometric differences. The dates of the experiments summarised below were April 21, 22, 23, 28, 29, May 1, 2, 3, 1913.

The results were somewhat irregular and are therefore given in the form of an average. A single experiment is, however, given in detail.

* In a few cases in a dark room which could be illuminated by opening the shutter. The room was to the south and care was taken to avoid sunshine.

Experiment 8.—April 28, 1913. *P. laurocerasus.*

Leaves, five in number, vaselined and cut into strips at 9.40 A.M. Vertical potometer, 60 cm. from window of dark room, shutter open. T 15·2–16·2. ψ 63–65 per cent. Transpiration corrected for ψ. Dull day.

Time.	Reading	Rates per hour.
	c.c.	c.c.
9.51 A.M.	0·080	
10.0 „	0·103	0·156
10.15 „	0·142	0·152
10.34 „	0·190	0·151
10.45 „	0·217	0·147
10.50 „	Shutters closed.	Dark.
10.50 „	0·233	0·192
11.0 „	0·254	0·126
11.15 „	0·292	0·152
11.30 „	0·326	0·136
11.45 „	0·361	0·140
	Shutters opened.	Light.
12.0 NOON	0·394	0·132
12.15 P.M.	0·430	0·144
12.30 „	0·463	0·132
12.45 „	0·497	0·136
12.46 „	Shutters closed.	Dark.
2.30 „	0·715	0·125

I have usually estimated the transpiration by taking the average of the two last readings in each period, Light (L) or Dark (D), as the case may be. But in Experiment 8 the first L reading should clearly be the average of the last L and the first D reading, *i.e.* 170. The other averages are D 138, L 134, D 125; they are included in the general average.

The results of the above-named eight experiments show considerable irregularity and no clear impression is gained by inspection. I have therefore taken the average of 31 readings from the series, 18 representing transpiration in light, and 13 in dark. They are as follows:—

Light.	Dark.	Light.	Dark.
153	155	134	125
214		200	157
186	183	161	141
216		224	181
170	166	212	152
130	122	170	138
120		149	
96	118	110	100
170	138	104	

Average 162 : 144
or 113 : 100 } L/D = 113/100.

Another series of similar experiments was made by Miss Pertz on *P. laurocerasus*, using a Ganong potometer.*

The following example shows a definite light and dark effect, in spite of a good deal of irregularity. The figures are corrected for relative humidity, which varies between 56 and 60 per cent., while the temperature lay between 15·5° and 16·1° C.

Experiment 9.—May 3, 1913.

Time.	Transpiration.	Average.	Time.	Transpiration.	Average.
	Light.			Light.	
10.49 A.M.	150		12.0 NOON	157	
11.1 „	163		12.5 P.M.	144	
11.11 „	167		12.10 „	133	
11.26 „	164	170	12.15 „	142	149
11.35 „	176		12.20 „	156	
	Darkness.		12.35 „		
11.43 „	172				
11.50 „	139	138			
11.59 „	137				

In the third column is given the average of the last two readings in the three periods Light, Dark, Light; thus the result of the experiment of May 3 is L 170, D 138, L 149.

The following table gives the results of the series, May 3 to May 12, 1913, Experiments 9 to 15 :—

Date.	Expt.	L.	D.	L.
1913.				
May 3	9	170	138	149
„ 5	10	110	100	104
„ 6	11	134	107	134
„ 7	12	144	121	132
„ 8	13	113	109	103
„ 10	14	70	65	67
„ 12	15	77	60	67
	Sum	818	700	756
	Or as	117 :	100 :	108

Or taking the average of the two *light* readings, we have—
L/D = 113/100

* 'Plant Physiology,' by W. F. Ganong, 1908. The instrument is supplied by Messrs. Bausch and Lomb.

The following experiments were made in an improvised laboratory having a bright north light; but the dark room was not perfect and the plants could not be exposed to absolute darkness. The potometer used was of the Kohl type, having a horizontal tube 0·95 mm. internal diameter. The march of the meniscus was generally timed over half a centimetre. The meniscus is brought back to zero by turning a tap and allowing water to enter, as in the instrument designed by Prof. Ganong.

The rate of transpiration is corrected for ψ (relative humidity).

Experiment 16.—May 7, 1913. *P. laurocerasus.*

May 6.—Branch, with seven last year's leaves, gathered at night.

May 7, 10 A.M.—Finished vaselining and making incisions in the leaves. Fresh surface made to branch; apparatus at an east window; dull morning. ψ between 65 and 82 per cent. T 12·7–16·8° C.

For each period, light or dark, the average rate of transpiration is given.

Time.	Rate.	Time.	Rate.
	Light.	12.18 P.M.	Dark.
10.20 A.M. }	302	1.47 „ }	187
10.40 „ }		1.51 „ }	
10.47 „	Dark.	1.52 „	Light.
11.10 „ }	229	2.16 „ }	255
11.18 „ }		2.22 „ }	
11.19 „	Light.	6.53 „ }	195
11.50 „ }	277	6.55 „ }	dull light.
12.9 P.M. }			

Omitting the last reading (as giving the effect of dull light), we have the average rates: Light = 278, Dark 208, or L/D = 134/100.

Experiment 17.—May 12, 1913. *P. laurocerasus.*

9.45 A.M.—Cut fresh surface to a branch which had been in water since May 10. Dull sky. ψ 80–88 per cent. T 12·6–13·8° C. The average rate of transpiration for the light and dark periods is given as before:—

Time.	Rate.	Time.	Rate.
	Light.	2.36 P.M.	Dark.
10.41 A.M. }	179	3.52 „ }	114
10.56 „ }		3.55 „ }	
10.57 „	Dark.	3.56 „	Light.
11.45 „ }	129	6.9 „ }	129
11.54 „ }		6.13 „ }	
11.56 „	Light.		
1.1 P.M. }	172		
2.34 „ }			

The average of the three light readings is 160, of the two dark ones 122 or L/D = 160/122 = 131/100.

If the L reading or 6.9–6.13 P.M. is omitted, which is fairer owing to the fading of the light, we have L/D = 176/122 = 144/100.

Experiment 18.—May 14, 1913. *P. laurocerasus.*

10.20 A.M.—Branch, bearing last year's leaves, vaselined and fitted to potometer.

11.2 A.M.—Incisions made in leaves. North window, fair light. ψ 71–78 per cent. T 15·2–15·9° C.

Time.	Rate.	Average.	Corrected for ψ.
	Light.		
11.45 A.M.	223	228	228
11.46 „	228		
11.48 „	231		
11.52 „	231		
11.53 „	Dark.		
12.19 P.M.	184	182	208
12.25 „	180		
12.28 „	Light, fairly bright.		
4.44 „	202	196	190
4.46 „	191		
4.51 „	194		

The average of the two L periods is 209, which is practically equal to the transpiration in the D period. This result is not explicable, as the light was good at 4.44. Nor was there any evidence of the wood-vessels being blocked, as sometimes occurs in potometer experiments.

Average: L/D = 209/208 = 100·5/100·0.

Experiment 19.—May 17, 1913. *P. laurocerasus.*

Fresh surfaces cut to the branch on May 15, May 16, and May 17.

9.30 A.M.—ψ between 76 and 82 per cent. T 13·7–14·4° C.

Time.		Time.		Time.	
	Light.		Dark.		Light.
10.39 A.M.	168	*Circa* 10.45 A.M.	105	11.34 A.M.	221
10.42 „		11.19 „		2.0 P.M.	
		11.30 „		2.20 „	

The average of the two light periods is 194. L/D = 194/105 = 185/100.

The following experiments were made by Miss Pertz on *P. laurocerasus* growing at the Botany School, Cambridge:—Shoots bearing five to seven

leaves of the current year were cut under water, and fitted to the Bausch and Lomb (Prof. Ganong's) potometer. The leaves were vaselined and cut as usual, the incisions being usually four in number. The surface of the branch was always carefully greased.

The first column gives times of observation. The second the number of seconds occupied by the absorption of one degree of the potometer, *i.e.* of 0·01 c.c. The third column (R = rate) gives the reciprocals of the time readings (Column 2) multiplied by 10,000. Thus the hourly rate of absorption (R) is expressed in units of 0·0036 c.c. The fourth column gives the rate R corrected for ψ.

Experiment 20.—June 9, 1913. *P. laurocerasus.*

Seven leaves. Relative humidity (ψ) varying between 58 and 63 Temperature between 16·5 and 18·3.

Time.	Time in seconds.	R.	Corrected.
10.14 A.M.	Leaves greased. Cut: placed at east window.		
10.18 ,,	96·0	104·0	108·0 (bright day)
10.26 ,,	102·0	98·0	98·0
10.35 ,,	105·0	95·2	102·0
10.52 ,,	92·5	108·0	115·0
11.1 ,,	100·0	100·0	100·0
11.11 ,,	107·0	93·5	93·4
11.16 ,,	107·0	93·5	93·4
11.18 ,,	Placed in dark room.		
11.30 ,,	128·0	78·1	85·4
11.42 ,,	141·0	70·9	77·5
11.55 ,,	160·0	62·5	68·3
12.3 P.M.	161·0	62·1	70·0
12.15 ,,	175·0	57·1	62·4
12.20 ,,	Replaced at east window, rather dull.		
12.27 ,,	135·0	74·0	76·0
12.37 ,,	126·0	79·4	81·0
12.44 ,,	110·0	90·9	94·9

If we take the last (corrected) reading in each period we get—

	Light.	Dark.	Light.
	93·4	62·4	94·9
or	150	100	152

Average: L/D = 151/100.

The rest of the experiments are given in abbreviated form, *i.e.*, merely the rate R corrected for difference in ψ.

Experiment 21.—June 6, 1913. *P. laurocerasus.*

9.30 A.M.—Cut a shoot with nine leaves of current year and fitted to potometer after vaselining and cutting. At east window. Dull day. ψ 59–62 per cent.

Time.	R.	Time.	R.
10.34 A.M.	61·0		
10.37 „	98·5	11.42 A.M.	In dark room.
10.52 „	81·3 (lighter)	11.48 „	41·9
		12.3 P.M.	44·8
11.15 „	69·0	12.20 „	37·7
11.40 „	54·3	12.38 „	29·3
Result: L/D = 185/100.			

Experiment 22.—June 7, 1913. *P. laurocerasus.*

10 A.M.—Young shoots, six leaves. At east window. Dull day. ψ 62–74 per cent.

Time.	R.	Time.	R.
10.15 A.M.	49·5		Placed in dark room.
10.25 „	48·0	11.39 A.M.	49·8
10.51 „	75·0	11.52 „	48·0
11.7 „	66·7	12.12 P.M.	40·1
11.22 „	59·4	12.24 „	38·3
11.30 „	58·8		
Result: L/D = 154/100.			

Experiment 23.—June 12, 1913. *P. laurocerasus.*

11.50 A.M.—Young shoot, seven leaves, vaselined but no incisions made. ψ 52–63 per cent. T 17·9–20·3.

Time.	R.	Time.	R.
June 13, 1913.		11.7 A.M.	107·0
9.30 A.M.	Fresh surface to branch cut under water.	11.13 „	97·4
		11.25 „	88·7
9.50 „	25·8	11.39 „	87·8
10.0 „	24·3	11.48 „	89·2
10.1 „	Cut leaves, *i.e.* usual incisions made.	11.54 „	89·9
		11.55 „	Replaced at east window.
10.6 „	69·6	12.2 P.M.	85·5
10.10 „	85·5	12.12 „	99·8
10.36 „	109·0	12.29 „	96·9
10.42 „	113·6	12.38 „	105·0
10.47 „	113·6	12.47 „	105·0
10.55 „	117·6	12.50 „	108·0
10.56 „	Placed in dark room.		
Result: Light 131, Dark 100, Light 120. Average: L/D = 126/100.			

Experiment 24.—June 13, 1913. *P. laurocerasus.*

June 13, 1913.—A shoot with nine leaves, none very young; vaselined June 14, 10.5 A.M. At east window. ψ 63–61 per cent. T 18·4–20° C.

Time.	R.	Time.	R.
10.19 A.M.	23·9	11.32 A.M.	128
10.24 ,,	26·5	11.38 ,,	131
10.26 ,,	Cut up leaves.	11.47 ,,	126
10.28 ,,	95·2	11.56 ,,	129
10.34 ,,	126·6	12.11 P.M.	118
10.37 ,,	140	12.12 ,,	Replaced at east window.
10.50 ,,	150	12.18 ,,	128
11.3 ,,	160	12.23 ,,	137
11.10 ,,	154	12.30 ,,	138
11.15 ,,	156	12.36 ,,	134
11.16 ,,	Placed in dark room.	12.52 ,,	140
11.23 ,,	144		

Result :—Light 132, Dark 100, Light 119. Average: L/D = 126/100.

Experiment 25.—June 16, 1913. *P. laurocerasus.*

Shoot with seven leaves, none very young. Vaselined and placed at east window.

Time.	R.	Time.	R.
June 17, 1913.	Cut fresh surface to branch under water	10.36 A.M.	102·0
9.35 A.M.	Placed at east window.	10.45 ,,	105·0
	ψ 56–66 per cent.	11.4 ,,	105·0
	T 21·9–25·8	11.5 ,,	Placed in dark room.
9.59 ,,	19·8	11.21 ,,	75·3
10.0 ,,	Cut up the leaves	11.30 ,,	76·1
10.4 ,,	67·1	11.42 ,,	78·6
10.10 ,,	95·5	11.50 ,,	76·7
10.14 ,,	105·0	11.52 ,,	Replaced at east window.
10.23 ,,	109·3	12.23 P.M.	106·0
10.30 ,,	103·0	12.33 ,,	106·0

Result: Light 138, Dark 100, Light 137. Average: L/D = 138/100.

Weighing Experiments (Laurel).

In a few experiments the transpiration was estimated by the loss of weight of a cut branch (laurel) in a bottle of water covered with a layer of olive oil. The branches had each six leaves, which were carefully vaselined and cut in the usual way. The stem and all buds also vaselined with care.

The experiments took place in the laboratory above referred to, in which darkness was not absolute.

The specimens weighed from 100 to 130 grm., and were only weighed to within 5 mgrm.

Experiment 26.—May 10, 1913. *P. laurocerasus.*

8.52 A.M.—At bright north light. ψ 71–88 per cent. T 11–13·6° C.

Time.		Loss.	
		Per hour.	Corrected for ψ.
		grm.	
9.37 A.M. – 10.21 „	Light	0·252	219
10.32 „ – 11.21 „	Dark	0·114	127
11.21 „ – 12.3 P.M.	Light	0·180	167
12.3 „ – 1.3 „	Dark	0·107	122
1.3 „ – 1.59 „	Light	0·244	217 (sky very bright.)
2.0 „ – 3.3 „	Dark	0·113	129
Result, average L/D = 201/126 = 159/100.			

Experiment 27.—May 22, 1913. *P. laurocerasus.*

Leaves vaselined, but not incised until May 23.

May 23.—Light clouds. ψ 75–86 per cent. T 14·2–18·2° C.

Time.		Loss	
		Per hour.	Corrected for ψ.
		grm.	
9.44 A.M. – 10.43 „	Light	0·249	271
10.47 „ – 11.52 „	Dark	0·134	167
11.52 „ – 12.44 P.M.	Light	0·294	254
12.44 „ – 1.44 „	Dark	0·250	208
1.44 „ – 2.51 „	Light	0·242	242
2.52 „ – 4.15 „	Dark	0·236	197
Average: L/D = 256/191 = 134/100.			

Experiment 28.—May 24, 1913. *P. laurocerasus.* ψ 77–88 per cent. T 15·1–18·5° C.

Time.		Loss.	
		Per hour.	Corrected for ψ.
		grm.	
9.34 A.M. } 10.27 „ }	Light.	0·328	290
10.27 „ } 11.44 „ }	Dark.	0·129	153
11.44 „ } 3.59 „ }	Light.	0·321	273
3.59 „ } 5.0 „ }	Dark.	0·195	163
5.0 „ } 6.48 „ }	Light.	0·217	217
Average: L/D = 245/158 = 155/100.			
Or, omitting the last L period: L/D = 325/162, or 201/100.			

Experiment 29.—May 25. *P. laurocerasus.* ψ 76–83 per cent. T 17·8–20·5.

Time.		Rate.	Corrected for ψ.
9.26 A.M. } 10.38 „ }	Light	231	231
10.38 „ } 11.44 „ }	Dark	155	162
11.44 „ } 12.51 „ }	Light	264	264
12.51 „ } 4.10 „ }	Light	257	236
Average: L/D = 244/162 = 151/100.			

The results of the series of four weighings are:—

L/D = 159/100; 134/100; 201/100; 151/100. Average L/D = 161/100.

Experiments on Ivy (Hedera helix).—*July*, 1913.

In the following experiments by Miss Pertz the specimens were cut at night and placed in water, and on the following morning a fresh surface was cut under water.

The leaves and stems were then carefully vaselined and four incisions per leaf were made.

In all cases the transpiration rate is corrected for ψ.

Experiment 30.—July 1, 1913. Ivy.

10.20 A.M.—Shoot with seven leaves vaselined, no incisions made.

July 2, 9.30 A.M.—In potometer at east window. Dull. During the day day ψ 60–70 per cent. T 18–19·6° C.

Time.	R.	Average.	Time.	R.	Average.
9.38 A.M.	27·8		10.43 A.M.	77·0	
9.41 ,,	27·8		10.53 ,,	71·9	
9.43 ,,	Cut up leaves with scalpel, 4 cuts each leaf.		11.4 ,,	78·2	
			11.11 ,,	74·6	76
9.47 ,,	75·8		11.18 ,,	76·9	
9.51 ,,	82·0		11.19 ,,	Replaced at east window.	
10.0 ,,	96·2		11.22 ,,	75·8	
10.17 ,,	91·3		11.27 ,,	82·0	
10.26 ,,	112·0		12.43 P.M.	91·0	
10.32 ,,	124·0	115	12.46 ,,	91·0	95
10.35 ,,	106·0		12.52 ,,	99·0	
10.35 ,,	Placed in dark room.				

	L.	D.	L.	
Result	115	76	95	Average: L/D = 138/100.
or	151	100	125	

Experiment 31.—July 4, 1913. Ivy.

11 A.M.—Shoot, 12 leaves, cut and vaselined.

July 5, 10 A.M.—In potometer at east window. ψ during day 63–68 per cent. T 16·7–18·4° C.

Time.	R.	Average.	Time.	R.	Average.
10.15 A.M.	32·0		11.17 A.M.	121·0	
10.19 ,,	29·7		11.40 ,,	106·0	
10.22 ,,	Cut up leaves with scalpel, 4 cuts each leaf		11.51 ,,	102·0	103
			11.59 ,,	104·0	
10.25 ,,	108·0		12.0 NOON	Replaced at east window.	
10.31 ,,	122·0		12.8 P.M.	115·0	
10.41 ,,	126·0		12.18 ,,	123·0	
10.52 ,,	137·0		12.33 ,,	125·0	
11.1 ,,	139·0		12.42 ,,	127·0	
11.9 ,,	147·0	147	12.47 ,,	123·0	
11.11 ,,	147·0		12.51 ,,	131·0	133
11.12 ,,	Placed in dark room		12.53 ,,	134·0	

	L.	D.	L.	
Result	147	103	133	Average: L/D = 136/100.
or	143	100	129	

Experiment 32.—July 7, 1913. Ivy.

11 A.M.—Shoot cut, 10 leaves (current year) vaselined.

July 8, 9.55 A.M.—In potometer at east window. ψ during day 54–64 per cent. T 15·2–17·1° C.

Time.	R.	Average.	Time.	R.	Average.
10.5 A.M.	21·5		11.2 A.M.	115·0	
10.9 „	20·7		11.18 „	111·0	
10.11 „	Cut up leaves, 4 cuts per leaf.		11.25 „	118·0	
			11.31 „	120·0	119
10.13 „	85·5		11.35 „	118·0	
10.17 „	100·0		11.35 „	Replaced at east window.	
10.24 „	109·0		11.46 „	133·0	
10.32 „	125·0		11.52 „	133·0	
10.39 „	127·0		12.2 P.M.	138·0	
10.47 „	125·0	129	12.12 „	140·0	
10.49 „	132·0		12.19 „	140·0	139
10.50 „	Placed in dark room.		12.24 „	138·0	

	L.	D.	L.	
Result	129	119	139	Average : L/D = 113/100.
or	108	100	117	

Experiment 33.—July 9, 1913. Ivy.

10 A.M.—Shoot having 13 leaves of current year, cut and vaselined.

July 10.—In potometer at east window. ψ during day 65–73 per cent. T 16·7–19·2° C.

Time.	R.	Average.	Time.	R.	Average.
10.11 A.M.	Cut up leaves, 4 cuts each leaf.		11.51 A.M.	120	121
			11.56 „	121	
10.17 „	96		11.57 „	Replaced at east window.	
10.26 „	110		12.4 P.M.	150	
10.38 „	130		12.9 „	154	
10.47 „	147		12.16 „	157	
10.51 „	143		12.22 „	152	
10.57 „	135	140	12.27 „	154	
10.59 „	145		12.32 „	151	
11.0 „	Placed in dark room.		12.35 „	159	
11.11 „	112		12.38 „	149	153
11.49 „	123		12.39 „	157	

	L.	D.	L.	
Result	140	121	153	Average: L/D = 121/100.
or	116	100	126	

Experiment 34.—July 10, 1913. Ivy.

Shoot having nine leaves, six being of current year, vaselined.

July 11, 10.20 A.M.—In potometer at east window. ψ during day 66–69 per cent. T 17–18·9° C. Dull morning.

Time.	R.	Average.	Time.	R.	Average.
10.29 A.M.	22·6		11.52 A.M.	71·0	
10.31 „	Cut up leaves, 4 cuts each leaf.		12.6 P.M.	75·0	75
			12.18 „	74·0	
10.34 „	88·0		12.20 „	Replaced at east window.	
10.40 „	83·0		12.26 „	80·0	
10.49 „	85·0		12.32 „	91·0	
11.7 „	98·0		12.44 „	89·0	
11.22 „	93·0	95	12.59 „	95·0	
11.25 „	97·0		1.7 „	94·0	
11.26 „	Placed in dark room.		1.12 „	103·0	101
11.34 „	82·0		1.18 „	98·0	
11.40 „	76·0				

	L.	D.	L.	
Result	95	75	101	Average: L/D = 131/100.
or	127	100	135	

Experiment 35.—June 22, 1913. Ivy.

The following experiment may be placed with the above, although transpiration was estimated by weighing instead of with the potometer. The method was the same as that described for laurel.

June 21, 4.30 P.M.—Branch cut under water and placed in water covered with a layer of oil. The lower surfaces of the leaves (of the current year) carefully vaselined, together with the stem.

June 22, 9.40 A.M.—Four or five incisions made per leaf. Placed in north window; the sky fairly bright. ψ from 72 to 80 per cent. T 16·6–19·2° C.

Time.		Rate corrected for ψ.	Time.		Rate corrected to ψ.
10.18 A.M. – 11.20 „	Light	295	12.34 P.M. – 1.37 „	Light	361
11.20 „ – 12.34 P.M.	Dark	187	1.37 „ – 2.41 „	Dark	190

The average transpiration L/D = 328/189
or L/D = 174/100

The average of the L/D results for ivy, viz., 138, 136, 113, 121, 131, 174/100, is 136/100.

Results.

§ 1. The method employed was to close the stomata by carefully rubbing the stomatal surface with cocoa-fat or vaseline, the intercellular spaces being afterwards put in communication with the outer air by means of incisions.

In the case of leaves not thus treated, it is well known that the closure of the stomata in darkness greatly diminishes the evaporating surface and *vice versâ*. In my method the evaporating surface is a constant.

§ 2. The following tables give the comparative effects of diffused daylight and darkness on the transpiration of *P. laurocerasus* and *Hedera helix* treated as in § 1.

P. laurocerasus.

Date.	Light.	Dark.	Date.	Light.	Dark.
1911.			1913.		
April 11	105	100	May 14	101	100
„ 19	100	100	„ 17	185	100
„ 20	148	100	„ 22	134	100
„ 22	123	100	„ 24	201	100
1913.			„ 25	151	100
April 21 ..... }	113*	100	June 6	185	100
May 3 ..... }			„ 7	154	100
„ 3	116	100	„ 9	151	100
„ 5	107	100	„ 12	126	100
„ 6	125	100	„ 13	126	100
„ 7	114	100	„ 16	138	100
„ 7	134	100	1911.		
„ 8	100	100	Nov. 15	125	100
„ 10	105	100	„ 17	114	100
„ 10	159	100	1909.		
„ 12	120	100	Dec. 9	119	100
„ 12	144	100			

Average L/D : 131·7/100, in round numbers 132/100 or 32 per cent.

* The average of eight experiments, see p. 286.

Ivy (*Hedera*).

Date.	Light.	Dark.	Date.	Light.	Dark.
June 22, 1913	174	100	July 7, 1913	113	100
July 1, „	138	100	„ 9, „	121	100
„ 4, „	136	100	„ 10, „	131	100

Average L/D : 136/100 or 36 per cent.

§ 3. The tables given under § 2 show a remarkable degree of variability : the extreme cases are : April 19, 1911, when the result was *nil*, and May 24,

1913, when the transpiration in light was double that in darkness. The average ratio for transpiration in light and darkness is: ivy, 136/100; laurel, 132/100. But between May 14 and June 16 the laurel gives an average 150/100, and, speaking generally, it cannot be doubted that the laurel reacts to illumination more in early summer than in spring. The winter experiments are not sufficiently numerous to justify any comparison with those obtained in summer.

It is at present impossible to form any conclusion as to the cause of the increased reaction in June. I have no evidence as to whether the increased permeability to water is a periodic effect, or connected with the age of the leaf, or with the brightness of the summer sky, as compared with illumination earlier in the year.

§ 4. With regard to the main fact that transpiration is increased by light or diminished by darkness, we may either accept the view of Wiesner,* viz., that in light the chloroplasts are warmed by the absorption of radiant energy, or we may believe that light produces an increased permeability of the plasmic membrane to water, a point of view to which the interesting work of Lepeschkin and Tröndle† on the increased permeability to dissolved substances produced by illumination may possibly give some support. Or we may combine Wiesner's theory with those of the other writers.

It is a pleasure to express my thanks to Miss D. F. M. Pertz for the valuable aid she has given me throughout the research.

* Wiesner, 'Sitzb. d. k. Akad. Wiss.,' 1877, vol. 74, p. 477.

† Lepeschkin, 'Ber. d. Bot. Ges.,' xxvi, *a*; Tröndle, *ibid.* xxvii.