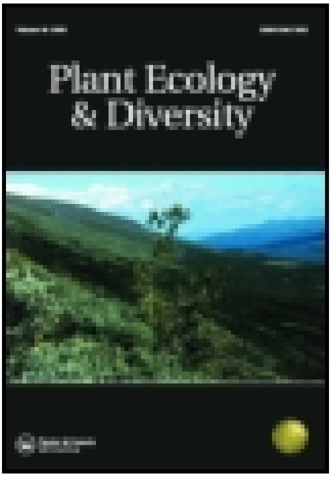

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III. Notes on the number of Stomata of some Indigenous and Cultivated Plants in Belgium

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majora from those of the *folia minora.* Indeed I have taken all the care that the importance of the subject in my regard seemed to require.

III. *Notes on the number of Stomata of some Indigenous and Cultivated Plants in Belgium.* By M. Ed. Morren. Translated by G. M. Lowe, Esq.

It is well known that vegetable tissues communicate with the atmosphere by means of stomata; and that it is by the intervention of these organs that gases and vapours pass in and out of the interior of plants, circulate in the vessels, and dissolve or decompose in the cellular juice. They are most abundant on the leaves, but are also found upon other aerial organs of plants, such as herbaceous stems, perianths, fruits, &c.; they are rare upon underground organs, and are altogether absent upon submerged parts, where, owing to the absence of the epidermis, they are not known to exist,—the whole surface of aquatic plants subserving the office of stomata.

Most elementary manuals are faulty with regard to the true structure of stomata. The two reniform cellules, which, by the contact of their extremities constitute these little mouths, are often surmounted by a fold of epidermis projecting from their edges, which, by drawing itself down, constitutes a little ante-chamber (*Vorhofspalte*), situated above the osteole. There also exists behind the osteole, independent of the pneumatic cavity, a posterior chamber (*Hinterhof*), hollowed out in the parenchyma, corresponding to the stomata.

The organisation of stomata has been elucidated by Hugo von Mohl,* with the habitual sagacity of that celebrated anatomist. The generality of authors agree in stating, that the functions of absorption and exhalation are performed by the stomata. These functions are not known to be carried on in any other part of the more or less thickened or suberose epidermis which covers the whole surface of plants, excepting where it is perforated by stomata. Observation reveals numerous relations between their osteole, pneumatic chamber, intercellular passages of the paren-

* Bot. Zeit. 1856, p. 697. Ann. Sc. Nat. t. vi. 1856, p. 162.

chyma, the aeriferous canals, and the vascular system in general. Upon most dicotyledonous leaves which have a reticulate venation, the stomata are distributed irregularly over the intervening spaces left by the veins ; in monocotyledonous parallel-veined leaves, on the contrary, they are arranged in linear series. *Apropos* to this, the following observation may be mentioned:—"M. Unger was one day attempting to inject the air-passages of plants, with the assistance of his pupil Dr Leitgeb, when the idea struck him of insufflating them strongly with air. Holding one end of a leaf of *Allium fistulosum* under water, and blowing in at the other extremity, he saw bubbles of air come out from the whole of the submerged surface, which became more numerous when the pressure was increased. He repeated the same experiment with equal success upon the leaves of *Allium Cepa* and Iris, the stems of Equisetum, Hippuris, and many composite and umbelliferous plants; thus demonstrating in a most simple manner the permeability of the aeriferous canals, and their immediate connection with the stomata."* It is asserted, that it is also through the stomata that fungi penetrate into the parenchyma of organs exposed to their devastations ; their mycelium, and especially their sporiferous branches, coming to the light through these openings.

A question which has been much discussed is, whether stomata open or shut under the influence of different stimulants, such as light or darkness, heat or cold, moisture or dryness, &c. If the alternate opening and shutting of stomata was positively proved, a certain periodicity in their functions would be decided. This question, apparently so insignificant, would then have very considerable practical consequences. Most contradictory assertions have been brought forward, but not only are we ignorant of the causes which regulate the opening and shutting of stomata, but even whether these movements really exist.

Sir Joseph Banks asserts that the stomata shut during a dry, and open during a moist season. According to Moldenhauer and Amici, the contrary takes place.

Hugo von Mohl (*loc. cit.*), after his experiments on the stomata of *Amaryllis formosissima*, acknowledged that the

* Bull. de la Soc. Bot. de France, t. v. pp. 155–157.

sphincters enlarged the stomatic osteole by their turgescence, and restricted it by their contraction. But he stated, at the same time, that the sphincters, in consequence of their relation with the neighbouring cellules, had not always freedom of motion. He observed, that the stomata of indigenous orchids, and of the lily, opened under water; those of grasses, on the contrary, shut with great rapidity when placed in similar circumstances. He admits, in short, that the sphincters dilate under the influence of light and heat, and contract in the dark, but doubts whether these two agents favour the opening of stomata.

M. Ad. Weiss,* who is occupied with this interesting problem, denies that stomata have the faculty of opening or shutting alternately; he only acknowledges that the sphincters dilate and contract in contact with water.

We have been occupied several years in investigating the relations which exist between plants and the elements of the atmosphere, and have noted experimentally the influence of gases, in various proportions, which were found normally or accidentally present in the air. These experiments show that noxious gases—sulphurous acid for example—are absorbed by the leaves at night as well as during the day; consequently, we are led to suppose that stomata remain open during darkness. All our experiments lead us to conclude that absorption of air by the leaves takes place by means of stomata; that it is by these openings only that sulphurous acid, mixed with the atmosphere in very small proportions, penetrates into the plant and acts on the parenchyma. Absorption is not effected by the superior surface of leaves when they do not bear stomata; neither does it take place when the inferior surface is covered by an impermeable coat, such as wax. In addition to this, we believe that we have discovered that the energy of absorption is proportional to the number of stomata; in other words, that the sensibility of plants to the action of noxious gases is, for the same natural group, directly proportional to the number of stomata with which the leaves of those plants are provided. This very simple law establishes a relation between the number of stomata of a leaf and the changes which the contact of noxious gases excites in its tissues.

* Bull. de la Soc. Bot. de France, t. v. pp. 123-125.

We have undertaken to determine the number of stomata among a certain number of species. The science possesses but few calculations on this subject,—by Thomson, Lindley, Unger, Kroker, Sprengel, Humboldt, Kieser, &c., relating chiefly to plants not generally known. We have condensed, under the form of a table, the information found disseminated in the different authors. These data have all been reduced to the uniform type of square inch, English or German measure, according to the nationality of the observer.

The contributions of Thomson are those which are found reproduced in part in nearly all the elementary manuals.

TABLE I.—*Older Observations relating to the Number of Stomata.*

No.	Name of Plant.	Name of Observer.	No. of Stomata upon sq. in.		
			Superior Surface.	Inferior Surface.	Total.
1	Abies Picea	Kroker .	...	300	300
2	Agave americana	,,	...	1,560	1,560
,,	— —	Humboldt	...	600	600
3	Alisma Plantago	Thomson	12,000	6,000	18,000
4	Aloe	Lindley	25,000	20,000	45,000
5	Alstrœmeria	,,	...	20,000	20,000
6	Amaryllis Josephinæ . .	Thomson	31,500	31,500	63,000
7	Andromeda speciosa . . .	,,	...	32,000	32,000
8	Arum Dracontium . . .	,,	8,000	16,320	24,320
9	Asclepias Curassavica . .	Kroker .	...	12,000	12,000
10	Brassica Rapa	Unger .	21,564	41,964	63,528
11	Cactus speciosissimus (stem)	Lindley	...	...	15,000
12	Cobæa scandens	Thomson	...	20,000	20,000
13	Crinum amabile	Lindley	20,000	20,000	40,000
14	Daphne Mezereum . . .	Thomson	...	4,000	4,000
15	Dianthus Caryophyllus . .	,,	38,500	38,500	77,000
16	Epidendrum	,,	...	4,800	4,800
17	Gaertnera	,,	1,000	142,750	143,750
18	Hydrangea quercifolia . .	,,	...	160,000	160,000
19	Hypericum grandiflorum .	,,	0	47,000	47,000
20	Ilex	,,	...	63,600	63,600
21	Iris germanica	,,	11,572	11,572	23,144
22	Lilium album . . . . ,	Sprengel	...	1,872	1,872
,,	— —	Kroker	...	3,312	3,312
,,	— —	Edwigh	...	6,924	6,924
23	Mesembryanthemum . .	Lindley	30,000	40,000	70,000
24	Nymphea cærulea . . .	. .	26,592	...	26,592
25	Olea europæa	Thomson	...	57,600	57,600
26	Pæonia	,,	...	57,600	57,600
27	Phaseolus vulgaris . . .	Kieser	...	24,000	24,000

No.	Name of Plant.	Name of Observer.	No. of Stomata upon sq. in.		
			Superior Surface.	Inferior Surface.	Total.
28	Philadelphus coronarius .	Thomson	...	20,000	20,000
29	Pinus halepensis	Kroker	...	228	228
30	Pittosporum Tobira . . .	Thomson	...	160,000	160,000
31	Portulaca oleracea (young leaves)	Kroker	...	12,480	12,480
,,	Do. (adult leaves) .	...	...	1,560	1,560
32	Potamogeton natans . .	Unger	7,800	...	7,800
33	Prunus Lauro-cerasus . .	Lindley	...	90,000	90,000
34	Pyrus	Thomson	...	24,000	24,000
35	Rheum palmatum . . .	...	1,000	40,000	41,000
36	Rudbeckia	...	8,000	41,000	49,000
37	Rumex acetosa	...	11,088	20,000	31,088
38	Sempervivum tectorum .	...	10,710	6,000	16,710
39	Sium angustifolium . . .	Unger	8,400	120	8,520
40	Syringa vulgaris	Thomson	...	160,000	160,000
41	Tradescantia	...	2,000	2,000	4,000
42	Tussilago Farfara . . .	...	1,200	12,500	13,700
43	Victoria regia	Unger	21,600	...	21,600*
44	Yucca	Lindley	40,000	40,000	80,000

These numbers do not agree well among themselves, and few general conclusions can be drawn from them. Thus it is shown that the stomata among trees are condensed on the inferior surface of the leaves; and the same condition also exists among many herbaceous plants (such as *Cobœa*, *Asclepias*, *Epidendrum*, *Lilium*, *Solanum*), whilst among a great number of plants under this category (*Aloe*, *Amaryllis*, *Arum*, *Brassica*, *Crinum*, *Dianthus*, *Iris*, *Mesembryanthemum*, *Rheum*, *Rudbeckia*, *Rumex*, *Sempervivum*, *Sium*, *Tradescantia*, *Tussilago*, &c.) stomata are found upon both surfaces, sometimes in equal quantity, sometimes even in greater number upon the superior surface. Floating leaves always have their stomata upon that surface in contact with the air.

M. Duchartre has stated, that no relation exists between the number or size of stomata and the quantity of gas disengaged by the leaves under the influence of light. It is said, besides, that this disengagement does not operate exclusively by the stomata, but also traverses the cellular walls of the dermis and epidermis, which are permeable to gas. But the cuticle does not appear to be penetrated by

* This gives 1,055,333,880 stomata to a single leaf.

these liquids. According to M. Garreau, this membrane is not even endosmotic. Rain-water, dew, and artificial watering, are each absorbed exclusively by stomata.

Our observations and experiments have shown us the unequal sensibility of plants to the noxious influences of certain gases which have been brought in contact with them. We think that absorption of these gases by the leaves is in relation with the number of organs by which absorption operates, that is to say, with the stomata.

Here is the result of our observations, divided into three tables. In the first, the plants are arranged in natural groups; in the second and third they are placed respectively, according to the increase of the number of stomata upon an equal surface of leaf and upon an average leaf.

TABLE II.—*Determination of the Number of Stomata.*

No.	Name of Plant.	Surface of Leaf.	Number of Stomata found at each observation.												Mean.
			1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	
	Rosaceæ.														St.
1	Prunus armeniaca,	Inferior, . .	55	58	59	80	58	63	...	...	...	...	...	...	62·160
		Superior, . .	0	0	0	0	0	0	...	...	...	...	...	...	0·000
2	Cratægus Oxyacantha, . .	Inferior, . .	43	43½	35	28	25	39½	...	...	...	...	...	...	35·660
		Superior, . .	0	0	0	0	0	0	...	...	...	...	...	...	0·000
3	Cerasus vulgaris,	Inferior, . .	52	61	64	58	63	55	...	...	...	...	...	...	58·830
		Superior, . .	0	0	0	0	0	0	...	...	...	...	...	...	0·000
4	Cerasus Mahaleb,	Inferior, . .	65	59	57	63	67	76	66	58	59	61	53	56	61·666
		Superior, . .	0	0	0	0	0	0	0	0	0	0	0	0	0·000
5	Prunus Laurocerasus, . .	Inferior, . .	36	43	49	30	38	...	...	...	...	...	...	...	39·200
		Superior, . .	0	0	0	0	0	...	...	...	...	...	...	...	0·000
6	Amygdalus persica,	Inferior, . .	38	75	40	32	42	77	...	...	...	...	...	...	50·660
		Superior, . .	0	0	0	0	0	0	...	...	...	...	...	...	0·000
7	Pyrus communis,	Inferior, . .	19	24	21	21	22	30	33	...	...	...	...	...	24·830
		Superior, . .	0	0	0	0	0	0	0	...	...	...	...	...	0·000
8	Pyrus Malus, .	Inferior, . .	41	78	75	63	78	...	...	...	...	...	...	...	67·000
		Superior, . .	0	0	0	0	0	...	...	...	...	...	...	...	0·000
9	Prun. domestica Claudiana, *Pers.*,	Inferior, . .	49	87	102	70	36	82	57	...	...	...	...	...	69·000
		Superior, . .	0	0	0	0	0	0	0	...	...	...	...	...	0·000
10	Rosa damascena,	Inferior, . .	35	25	31	32	26	36	...	...	...	...	...	...	30·830
		Superior, . .	0	0	0	0	0	0	...	...	...	...	...	...	0·000
	Amentaceæ.														
11	Betula alba, . .	Inferior, . .	22	16	13	24	14	16	24	20	21	24	18	19	19·250
		Superior, . .	0	0	0	0	0	0	0	0	0	0	0	0	0·000
12	Carpinus Betulus,	Inferior, . .	49	45	36	24	46	52	38	29	54	48	37	44	41·833
		Superior, . .	0	0	0	0	0	0	0	0	0	0	0	0	0·000
13	Quercus Robur, .	Inferior, . .	102	116	96	64	112	68	81	102	92	108	109	81	94·250
		Superior, . .	0	0	0	0	0	0	0	0	0	0	0	8	0·000
14	Fagus sylvatica, .	Inferior, . .	68	56	84	64	48	58	72	76	52	94	39	60	64·250
		Superior, . .	0	0	0	0	0	0	0	0	0	0	0	0	0·000
15	Juglans regia, . .	Inferior, . .	90	91	85	77	76	81	81	90	79	61	63	69	78·583
		Superior, . .	0	0	0	0	0	0	0	0	0	0	0	0	0·000
16	Populus virginiana, *Desf.*, .	Inferior, . .	32	39	41	29	22	18	24	28	20	35	15	46	29·083
		Superior, . .	11	13	12	12	7	15	9	11	7	10	11	16	11·166

TABLE II.—*Continued.*

No.	Name of Plant.	Surface of Leaf.	Number of Stomata found at each Observation. 1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	Mean.
	Amentaceæ.														St.
17	Populus pyramidalis, . . .	Inferior, . .	42	41	31	42	36	42	25	42	51	46	44	45	40·583
		Superior, . .	11	11	9	7	9	11	13	9	12	16	12	14	11·166
18	Populus nigra, .	Inferior, . .	32	33	37	31	34	36	27	32	28	25	32	29	31·333
		Superior, . .	5	8	6	9	4	6	5	3	5	6	4	4	5·416
19	Populus canescens,	Inferior, . .	41	52	46	48	44	56	92	84	68	88	49	96	63·666
		Superior, . .	0	0	0	0	0	0	0	0	0	0	0	0	0·000
20	Pop. Caroliniana,	Inferior, . .	24	59	27	29	42	44	42	39	39	47	48	46	40·500
		Superior, . .	37	26	32	33	29	34	26	18	25	23	11	22	26·333
	Trees, &c.														
21	Acacia Pseudo-acacia, . . .	Inferior, . .	39	42	36	31	37	34	29	37	32	41	27	32	34·750
		Superior, . .	0	0	0	0	0	0	0	0	0	0	0	0	0·000
22	Buxus sempervirens, ...	Inferior, . .	37	38	39	39	32	...	...	...	...	...	...	...	37·000
		Superior, . .	0	0	0	0	0	...	...	...	...	...	...	...	0·000
23	Fraxinus excelsior,	Inferior, . .	41	39	52	54	37	34	34	48	39	45	56	44	43·583
		Superior, . .	0	0	0	0	0	0	0	0	0	0	0	0	0·000
24	Ilex Aquifolium, .	Inferior, . .	44	41	43	43	41	...	...	...	...	...	...	...	42·400
		Superior, . .	0	0	0	0	0	...	...	...	...	...	...	...	0·000
25	Hedera Helix, . .	Inferior, . .	49	46	56	56	54	59	...	...	...	...	...	...	53·330
		Superior, . .	0	0	0	0	0	0	...	...	...	...	...	...	0·000
26	Syringa vulgaris,	Inferior, . .	53	40	79	75	62	...	...	...	...	...	...	...	61·800
		Superior, . .	0	0	0	0	0	...	...	...	...	...	...	...	0·000
27	Philadelphus coronarius, . . .	Inferior, . .	23	25	25	21	...	...	...	...	...	...	...	...	23·500
		Superior, . .	0	0	0	0	...	...	...	...	...	...	...	...	0·000
28	Vitis vinifera, .	Inferior, . .	36	42	46	47	34	42	26	40	56	43	48	46	42·167
		Superior, . .	0	0	0	0	0	0	0	0	0	0	0	0	0·000
	Herbaceous Plants.														
29	Beta vulgaris, .	Inferior, . .	32	30	29	32	31	31	31	29	34	33	34	30	31·333
		Superior, . .	18	13	17	16	19	19	20	27	22	26	23	25	20·416
30	Faba vulgaris, var. equina, .	Inferior, . .	21	16	26	18	18	21	21	16	15	16	17	20	18·750
		Superior, . .	9	10	9	9	12	11	10	7	11	10	11	13	10·166
		Inferior, Surface of Stipules,	6	5	7	6	6	8	12	15	17	17	13	19	10·083
		Superior, Surface of Stipules,	2	3½	4	4	1	2	5	3	4	4	2	4	3·208
		Epidermis of the Stalk,	0	2	3	3	1½	2	0	1	2	4	0	2	1·708
31	Helianthus annuus,	Inferior, . .	72	59	67	58	64	61	76	68	73	66	65	63	66·000
		Superior, . .	42	36	44	35	39	34	37	33	37	35	37	39	37·333
32	Humulus Lupulus,	Inferior, . .	71	85	78	72	69	88	68	64	46	66	67	63	69·750
		Superior, . .	0	0	0	0	0	0	0	0	0	0	0	0	0·000
33	Apium Petroselinum, . . .	Inferior, . .	33	30	28	35	32	33	31	36	42	30	35	40	33·750
		Superior, . .	0	0	0	0	0	0	0	0	0	0	0	0	0·000
34	Solanum tuberosum, ...	Inferior, . .	68	68	52	84	72	92	69	84	54	76	62	80	71·750
		Superior, . .	0	0	0	0	0	0	0	0	0	0	0	0	0·000
35	Trifolium pratense,	Inferior, . .	82	74	85	108	88	92	76	96	84	104	92	115	91·330
		Superior, . .	64	68	63	68	60	56	36	60	43	68	44	48	56·500
		Epidermis of the Stalk,	15	24	16	15	18	15	16	18	19	11	18	14	16·583
	Cereals.														
36	Avena sativa, . .	Inferior, . .	6	6½	8	8	8	9	7	7½	8	8	6	5	7·250
		Superior, . .	11	13	10	11	9	12	9	11	12	10	13	10	10·916
		Exterior, of Sheath,	9	7	12	11	8	9	11	11	10	5	7	8	9·000
		Interior, of Sheath,	2	3	0	1	4	1	3	1	2	3	1	0	1·750
		Epidermis of Stem, . .	11	8	9	12	14	12	10	11	13	15	12	15	11·833
		Exterior of Glume, .	5	4	7	6	6	5	9	11	3	6	5	10	6·417

TABLE II.—*Continued.*

No.	Name of Plant.	Surface of Leaf.	Number of Stomata found at each Observation. 1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	Mean.
	Cereals.														St.
37	Triticum sativum,	Inferior,	7	10	8	10	5	10	5	12	11	9	8	9	8·666
		Superior,	14	12	13	14	10	12	12	16	11	9	17	13	12·750
		Exterior, of Sheath,	10	8	11	14	8	9	13	11	12	8	9	8	10·083
		Interior, of Sheath,	0	1	0	2	2	1	0	0	1	0	0	1	0·666
		Epidermis of Stem,	12	10	14	17	15	9	13	12	18	10	12	10	12·666
		Exterior of Glume,	18	13	9	14	7	13	5	16	13	13	17	13	12·750
38	Secale cereale,	Inferior,	13	12	12	10	9	8	10	13	10	14	13	12	11·333
		Superior,	9	9	10	14	11	18	16	13	14	12	19	15	13·333
		Exterior, of Sheath,	10	11	9	11	10	10	9	5	10	8	9	8	9·166
		Interior, of Sheath,	2	3	1	0	2	1	1	3	0	2	0	2	1·416
		Epidermis of Stem,	12	10	11	17	19	10	11	15	9	15	23	14	13·833
		Exterior of Glume,	9	7	8	7	12	10	8	8	9	13	8	6	8·750

TABLE III.—*Determination of the Number of Stomata comprised in a Square Millimetre* of Surface.*

No.	Name of Plant.	Surface of Leaf.	Mean in Square Millim. of Surface.	Mean in Square Millim. upon both Surfaces of Leaf taken together.	Simple relation of the Numbers of the preceding Columns.†
			St.	St.	
1	Avena sativa,	Inferior, Superior,	26,607 40,062	66,669	0,773
2	Betula alba,	Inferior, Superior,	70,648 0,000	70,648	0,819
3	Triticum sativum,	Inferior, Superior,	31,804 46,792	78,596	0,899
4	Philadelphus coronarius,	Inferior, Superior,	86,245 0,000	86,245	1,000
5	Secale cereale,	Inferior, Superior,	41,692 48,932	90,624	1,049
6	Pyrus communis,	Inferior, Superior,	91,130 0,000	91,130	1,050
7	Faba vulgaris, var. equina,	Inferior, Superior,	68,812 37,309	106,121	1,230
8	Rosa damascena,	Inferior, Superior,	113,140 0,000	113,140	1,310
9	Apium Petroselinum,	Inferior, Superior,	123,863 0,000	123,863	1,436
10	Acacia Pseudo-acacia,	Inferior, Superior,	127,532 0,000	127,532	1,478
11	Cratægus Oxyacantha,	Inferior, Superior,	130,870 0,000	130,000	1,510

* The English inch corresponds to 25 millimetres.

† *Philadelphus coronarius* is taken as unity.

TABLE III.—*Continued.*

No.	Name of Plant.	Surface of Leaf.	Mean in Square Millim. of Surface.	Mean in Square Millim. upon both Surfaces of Leaf taken together.	Simple relation of the Numbers of the preceding Columns.
			St.	St.	
12	Buxus sempervirens, .	Inferior, . Superior, .	135,790 0,000	135,790	1,570
13	Populus virginiana, .	Inferior, . Superior, .	106,734 40,979	147,713	1,712
14	Vitis vinifera, . . .	Inferior, . Superior, .	154,753 0,000	154,753	1,794
15	Ilex Aquifolium, . .	Inferior, . Superior, .	155,608 0,000	155,608	1,800
16	Fraxinus excelsior, .	Inferior, . Superior, .	159,950 0,000	159,950	1,854
17	Amygdalus persica, .	Inferior, . Superior, .	185,922 0,000	185,922	2,150
18	Populus pyramidalis, .	Inferior, . Superior, .	148,939 40,979	189,918	2,202
19	Beta vulgaris, . . .	Inferior, . Superior, .	114,992 94,927	189,919	2,270
20	Hedera Helix, . . .	Inferior, . Superior, .	195,720 0,000	195,720	2,500
21	Cerasus vulgaris, . .	Inferior, . Superior, .	215,900 0,000	215,900	2,224
22	Syringa vulgaris, . .	Inferior, . Superior, .	226,806 0,000	226,806	2,629
23	Populus canescens, .	Inferior, . Superior, .	233,654 0,000	233,654	2,709
24	Fagus sylvatica, . .	Inferior, . Superior, .	235,798 0,000	235,798	2,734
25	Pyrus Malus, . . .	Inferior, . Superior, .	245,890 0,000	245,890	2,850
26	Prunus domestica Claudiana, . . .	Inferior, . Superior, .	253,230 0,000	253,230	2,930
27	Humulus Lupulus, .	Inferior, . Superior, .	255,982 0,000	255,982	2,968
28	Solanum tuberosum, .	Inferior, . Superior, .	263,323 0,160	263,483	3,055
29	Juglans regia, . . .	Inferior, . Superior, .	288,399 0,000	288,399	3,343
30	Quercus Robur, . .	Inferior, . Superior, .	345,898 0,000	345,898	4,010
31	Helianthus annuus, .	Inferior, . Superior, .	242,220 137,012	379,232	4,397
32	Trifolium pratense, .	Inferior, . Superior, .	335,181 207,355	542,536	6,290

TABLE IV.—*Number of Stomata on an Average Leaf.*

No.	Name of Plant.	Absolute Surface of an Average Leaf.	Surface of the principal Veins of a Mean Leaf.	Surface of an Average Leaf deducting the principal Veins.	Number of Stomata on an Average Leaf *
		Square Cent.	Square Millim.	Square Cent.	Stomata.
1	Buxus sempervirens,	1·50	20	1·30	17,553
2	Rose (leaflet), . . .	4·00	45	3·55	40,165
3	Acacia (leaflet), . .	3·72	21	3·51	44,764
4	Betula alba, . . .	15·00	112	13·88	98,059
5	Cratægus Oxyacantha,	10·69	130	9·39	122,887
6	Secale cereale, . .	18·00	,,	18·00	162,943
7	Ilex Aquifolium, . .	12·00	60	11·40	177,393
8	Triticum sativum, .	25·00	,,	25·00	196,490
9	Philadelphus coronarius, . . .	29·00	120	27·80	239,761
10	Carpinus Betulus, .	19·00	180	17·20	264,066
11	Populus nigra, . .	23·89	107	22·82	307,771
12	Solanum tuberosum,	16·00	160	14·40	379,416
13	Prunus armeniaca, .	19·50	135	18·15	414,090
14	Syringa vulgaris, . .	21·00	90	20 10	455,880
15	Humulus Lupulus, .	44·00	210	41·90	1,072,565
16	Quercus Robur, . .	39·00	193	37·07	1,282,244
17	Vitis vinifera, . . .	94·00	420	89·89	1,389,682
18	Beta vulgaris, . . .	221·00	1,600	205·00	3,893,340
19	Helianthus annuus, .	171·93	500	166·93	6,330,520

We have employed for our observations a magnifying power of 300 times. This power gave us a very clear image, of which the real surface was approximately one-fourth of a square millimetre. The field of the microscope, estimated by the aid of the micrometer and calculation, was found to be comprised 3·67 times in a square millimetre. Thus, by multiplying the number of stomata found during a series of observations by 3·67, the number of stomata comprised upon the square millimetre of leaf surface was obtained. We have no doubt that the stomata are the organs of absorption and exhalation of aeriform fluids ; and we believe that the energy of these functions is proportional to the number of organs which perform them. The importance of stomata is not estimated by their size ; the smallest accomplish generally the most important organic phenomena. Thus it is that the operation of counting the stomata may give rise to most interesting deductions.

* *Leaflet*, where the leaf is compound.