Note on South-African Orchids. By W. Mansell Weale. (Communicated by Sir J. Lubbock, Bart., M.P., and abridged.)

[Read December 19, 1878.]

According to the observations of Mr. Weale made on living plants in South Africa, he finds that structurally *Mystacidium* and *Polystachya* do not agree in those generic characters pointed out as characteristic of them by botanists. Thus *Mystacidium* in the fresh state and with the parts *in situ* shows that the so-called two-legged caudicles are essentially free and not adherent. By slight manipulation with a horse-hair or fine pin, the two pollinia are seen twisted round and widely separated—a position unattainable had the caudicles been united as represented in Harvey's 'Thesaurus Capensis,' and moreover under the circumstances the pollen never would have fertilized the plant. In the case of *Polystachya*, of the four pollen masses said to be grouped in pairs, the fresh plant shows that each waxy pollen mass is partially cleft, *not* divided, and is attached by a very short caudicle to an ovate viscid disk common to the two pollinia.

On the Absorption of Rain and Dew by the Green Parts of Plants*. By the Rev. George Henslow, M.A., F.L.S., F.G.S.

[Read November 7, 1878.]

1. *Introduction.*

The subject of this paper has been a matter of controversy for 150 years; but it is hoped that at last the question whether moisture of any kind is absorbed or not by the aerial parts of plants will be set at rest for ever, and answered in the affirmative.

The many and varied experiments I have made, extending over some years, have convinced me that such is the case; and they corroborate entirely the conclusions of M. Boussingault and other modern physiologists. M. Boussingault's researches have proceeded simultaneously with my own, but quite unknown to me, until they appeared in the 'Annales de Chimie et de Physique'

* This paper as originally written embodied an historical *résumé* of experiments and views on the subject, extending over the last 150 years. I had also added a good many more of my own experiments than are now recorded in the text. As, however, the conclusions had been to some extent anticipated by M. Boussingault and others, agreeably to the recommendations of the Council, I have omitted nearly the whole of the historical part and recast the experimental, retaining a few only of each series of my experiments.

(Mars 1878); and while our conclusions are identical, our respective experiments really supplement each other; so that although his results have now been published, it is thought advisable to publish a selection of mine also as corroborating those of M. Boussingault.

Hales, in 1731, and Bonnet, in 1753, alike *inferred*, but did not actually *prove*, that plants absorbed rain and dew.

De Candolle, Meyen, and Treviranus and others, however, objected to Bonnet's conclusions, asserting positively, but apparently without experimental evidence in support, that the leaves which he laid on the surface of water kept fresh for lengthened periods solely because transpiration was assumed to be arrested. Had they fixed watch-glasses on the surfaces of the leaves, as I have done, transpiration would have been easily detected.

Notwithstanding these objectors, a general belief seems to have been held until 1857, when M. Duchartre performed his experiments; and although he had himself been previously of the opinion that if plants could not absorb vapour (which Boussingault has now proved to be the case) they could at least imbibe dew and rain, yet he was led to abandon this view; and he is responsible for the opposite one being generally held till now by vegetable physiologists. It should be observed that practical horticulturists have never abandoned the idea that plants can and do absorb water by their leaves.

As this change of view has been somewhat of an obstruction to the progress of vegetable physiology, and, as far as I am aware, no serious attempt has been made to refute M. Duchartre's conclusions, I do not think it out of place to try and expose their fallacy.

He commences* his paper by objecting strongly to experimenters using cut leaves or shoots instead of growing plants in their entirety; but he gives no grounds for raising this objection. On the other hand, it is easy to prove that all the functions of a leaf *are* carried on when detached as when growing: transpiration can be readily detected; and M. Garreau found in his experiments on respiration that "detached leaves gave the same results as those which remained attached to the plant" †; and if a green shoot

* "Recherches sur les rapports des plantes avec la Rosée," Bull. de la Soc. Bot. de France, t. iv. p. 940; "Recherches expérimentales sur les rapports des plantes avec la rosée et les brouillards," Ann. des Sc. Nat. 4me sér. xv. p. 109.

† "De la respiration chez les plantes," Ann. des Sc. 3me sér. xv. p. 12 (1851).

be plunged into water the evolution of oxygen can readily be seen. Moreover M. Duchartre compares a shoot to a detached limb of an animal, to which it is obviously not comparable; for there is no such mutual dependance between a shoot or a leaf and the main stem as in the case of an animal's limb. The one can be detached and made to strike root and grow into an independent plant; not so the other.

All that can be called injurious to a shoot when detached for experimental purposes lasting for a short time only, is that the supply of water is cut off. The shoot may become flaccid and slightly enfeebled; but in no sense are its functions impaired. And I maintain, making due allowance for that fact, whatever results a cut shoot or detached leaf gives in the matter of absorption and transpiration, they *are* legitimately applicable to a growing plant. Those who assert it to be otherwise must bear the burden of the proof.

M. Duchartre's experiments were made with plants growing in pots, the latter being carefully protected from imbibing any moisture by a mechanical contrivance. The plants thus prepared were weighed at 6 or 6.30 P.M., then subjected all night to dew. They were again weighed at 6 or 6.30 A.M. on the following morning, with the dew still upon them. The leaves were then carefully wiped one by one till the whole plant was dry. It was then again weighed; and the result was that the weight was almost exactly the same or more generally a little less than it was the evening before. Duchartre consequently came to the conclusion that in our climates dew is *not* absorbed directly by plants, but that it contributes to their nutrition indirectly only, (1) by reducing the nocturnal transpiration to nothing, and (2) by the intervention of the soil, which absorbs the dew.

The fundamental objection that I raise against his conclusion is that he has not considered the difference that exists between the statical or nearly statical conditions of the internal flow of water in a plant at night, with the dynamical or active flow ever taking place as soon as transpiration and evaporation are perfectly resumed in sunlight and heat.

He has shown it to be true, though not so absolutely as has been often asserted, that transpiration is greatly checked when the surfaces of the transpiring organs are thoroughly wetted, or when in darkness. Darkness and superficial moisture combined, as on a dewy night, must therefore reduce this vital act to a minimum. The internal flow upwards from the root, however, is not at the same time equally checked; for the temperature of the soil is not lowered to the same extent as that of the air.

Hence every thing tends to bring the juices to as high a point of saturation at night as possible. Under these conditions one would hardly expect dew to be imbibed in any appreciable quantity, *unless the leaves and herbaceous stems were exceptionally flaccid.*

Now Duchartre always weighed his plants early in the morning after this statical condition was fully attained; so that it is not at all surprising to find that he could not detect any increase of weight; hence his experiments seem to prove conclusively that *at night* dew is not usually absorbed in any appreciable degree.

Dew, however, does not disappear suddenly from leaves at sunrise; and it is only after sunlight and heat begin again to affect leaves that the other function of dew is now carried on, its actual absorption. Herein, however, is involved a practical difficulty; for the balance will no longer help us. But I believe that as soon as transpiration recommences, then any part that may be the first to become dry will now begin to transpire, and so cause an indraught of dew in any neighbouring spot where it may have been retained; so that there will be an influx and efflux accompanied by the usual root-supply, which probably furnishes the main source of water for transpiration. Hence it will be seen that it is generally impossible to detect the absorption of dew or rain by leaves with mathematical accuracy or to prove it to demonstration. On the other hand, the "proof" that such is the case may be arrived at indirectly by accumulating probabilities, based upon observed facts. Such is the method I have attempted by aid of the following experiments.

The conclusion I have arrived at is that, while there is no objection that I know of which cannot be met, there are ample reasons for believing that dew and rain are, under certain circumstances, absorbed and utilized to supplement the normal root-supply.

2. *Experiments illustrating the Power of Absorption of Water by the Epidermis of Herbaceous Internodes.*

A shoot of first year's growth of Elm had three internodes wrapped up in saturated blotting-paper on June 12, 1876. By the 15th the leaves were flaccid and nearly faded; but the terminal bud and a leaf adjacent to it remained quite fresh. By the 20th all four leaves were almost dead, with the exception of the bases of the blades. The terminal bud remained perfectly fresh until the 29th, when the whole was dead. Duration 17 days. A similar specimen not moistened totally perished in 2 days.

When herbaceous plants, especially those with tolerably large leaves, as *Borago officinalis*, *Rumex crispus*, *Sisymbrium Alliaria*, *Lychnis dioica*, &c., have only their internodes wrapped up in saturated blotting-paper, the leaves generally soon wither and perish, but the internodes remain green and fresh for long periods.

A branch of Borage having two internodes was wrapped up on June 8th, 1876. On the next day the leaves were much faded, but the stem was quite firm. On the 10th the upper part of the leaves was brown, brittle, and dead, but no change had taken place in the stem. By the 12th the leaves were entirely withered, excepting a small portion at their bases. On the 13th the leaves were quite dead. The internodes remained firm, green, and fresh. They thus continued until July 10th. They then decayed slowly. Duration 5 weeks and 3 days.

A similar specimen not wrapped up was perfectly dead in 2 days, the previously juicy stem being now dry and collapsed.

The long time during which the leaves remained green, of the first described of these specimens of Borage, clearly proves that the supply of water must have been obtained through the epidermis of the internodes to balance the transpiration.

Symphoricarpus, or Snowberry.—A shoot had one internode wrapped up, with four leaves *beyond* it exposed. After 3 days the lower pair of leaves were dying, but the upper pair were fresh. After 8 days all the leaves were dead; but the internode remained fresh several days longer.

A second and similar specimen had also four leaves exposed; but they were *below* the internode which was wrapped up. The order of decay was in this case reversed; the two lowermost or furthest from the wet internode died first, those nearest to it last.

The above are selected from a large number of experiments to illustrate the fact that herbaceous internodes readily absorb moisture in the endeavour to supply the leaves with water for transpiration, but that the demand is usually much greater than one or a few internodes can furnish: hence the leaves soon begin to die back from their apices to their bases. In addition to such supply as they can for a time give to the leaves, the experiments prove that moisture applied to internodes arrests death and decay in the stems and axillary buds for variously prolonged periods; for efforts to develop axillary buds were frequently made, as well as adventitious roots, these being apparently special instruments for absorbing superficial moisture.

3. *On the Absorption by Leaves attached to Branches, and their Power of Nourishing the Rest of the Leaves on the Shoot.*

On July 23rd, 1878, a shoot of this year of *Corylus Avellana*, with a subherbaceous stem, had three leaves lying with their *lower* surfaces only on water. The shoot bore two large and two small leaves sustained in the air. The whole shoot was perfectly fresh and vigorous at the end of a week. On Aug. 3rd the larger leaves began to die back from their apices, while the terminal small ones were dead. Hence it was far from entirely perishing after 10 days.

A similar specimen had two large leaves with their *upper* surfaces only lying on water, the remaining leaves as before in air. Like the preceding, the whole kept perfectly fresh for the same time. The apical leaves began to die about Aug. 3rd, or after 10 days.

A similar specimen to these two, without water, was dead in two days, the leaves being brown and brittle.

Shoots of Lime, Elm, &c. treated as above gave similar results, showing that the presence or absence of stomata is immaterial, the upper surfaces of the above having none at all.

These experiments entirely corroborate the results of Hales, Bonnet, Baillon, Duchartre, Boussingault, &c., the general conclusion being that the duration of life in the specimen thus treated depends upon the supply being equal to the demand. The absorbing-power is incontrovertible; but the amount of foliage exposed varies the demand upon the power of imbibition.

To prove that the absorption and evaporation is not merely mechanical like a sponge, the following experiment will suffice. On the 10th of June, 1876, a cut specimen of *Nepeta Glechoma* had two leaves wrapped up in saturated blotting-paper. One internode was exposed, bearing two other leaves also exposed to the air. By the 16th the latter was much discoloured. On the 22nd they were nearly dead; but the buds in their axils had been developing, as well as smaller ones in the axils of the absorbing leaves. By the 27th both buds had borne four leaves each. One absorbing leaf was now dead. On July 10th the other absorbing leaf perished; consequently the buds immediately died. Duration 4 weeks and 3 days.

4. *Experiments to show the Power of Absorption by Leaves and Internodes to nourish lower Leaves on the same Shoot.*

The possibility of an internode when wrapped up in saturated blotting-paper nourishing leaves below it has been shown in the case of *Symphoricarpus*. The following are instances in which the leaves alone or with the internodes did the same.

A frond of *Nephrodium Filix-Mas* had the terminal portion wrapped up on July 3rd, 1876. No sign of shrivelling occurred through that intensely hot month until Aug. 22nd, when a few pinnules began to turn brown. Leaving town, the specimen was neglected. Duration of observation 7 weeks.

The terminal leaflet of *Berberis aquifolia*, as those of *Dahlia*, *Polemonium*, *Wistaria*, &c., all nourished the basal leaflets well for various lengths of time.

Veronica Chamædrys, *Vinca major*, &c. all illustrated the same fact, that upper leaves can act as absorbents to supply lower ones on the same shoot, the lowermost leaves, *i. e.* those furthest from the absorbing ones, always dying first. *Vinca major* developed very vigorous axillary shoots from the axils of its absorbing leaves, similarly to the *Nepeta Glechoma* described above, the whole lasting 6 weeks.

5. *On the Nourishment of one Part of a Leaf by the Absorption of Water in another Part.*

The objection having been made by Duchartre that when leaves are laid upon water so that the edges are not touching it the absorption is merely *local*, and that water is not transmitted to the border, which consequently dries up, I have tried a large series of experiments, placing (1) the apex only, (2) the basal part, but not the cut end of the petiole, (3) the middle of the blade, plunging *both* surfaces beneath the water in every case. Again, I have taken the same parts, but placed (1) the upper side only, (2) the lower side only on water. The results gave every degree imaginable in the power of absorption. In some cases, e. g. *Ipomæa purpurea*, with the lower surface of the apical portion in water the part in air rapidly perished, as this leaf is particularly thin. In the majority of instances, however, it was at least two days, generally many more, before the edges were dead; and in many cases they remained fresh for prolonged periods, even for weeks.

Nor is the result constant with the same kind of leaf. Some old Lilac-leaves had but feeble powers to nourish the parts in air when the apical parts only were laid on water; whereas leaves taken off the same shoot with the apical part completely immersed, or else with the middle part only in water, supplied the remaining parts sufficiently.

As a contrast to the leaf of the *Ipomœa* mentioned above, another leaf, placed with the upper surface of the apical half in water, nourished perfectly the basal part in air, as well as a long stalk.

Two leaves of Borage were laid, one with the under surface, the other with the upper surface of the apical parts in water; but they could only nourish the midrib of the part in air; the sides dried up as far as the rib.

Both the upper and and under surfaces of *Digitalis purpurea* nourished the parts in air perfectly.

In this and other corrugated leaves, the water runs into all the minute channels over the ribs and veins by capillary attraction and thus irrigates the entire surface. Garreau has noticed how, these channels, as well as the one very commonly occurring down petioles, are particularly advantageous for absorbing water.

The conclusion I have arrived at is that the objection raised is really of no consequence. In the majority of instances it is some days before the margins dry up where the central part only is wet. Moreover similar leaves not kept wet always perish far sooner altogether. This shows that even in leaves least capable of transmitting water laterally, they can do it to some extent; and if the leaves be thick, this is easily effected; and with corrugated surfaces the transmission is not only within, but without as well, so that the whole leaf becomes bathed with water, though the apex alone may be actually in it.

Now, when it is remembered that dew forms all over and on both sides of leaves, they are never in this artificial condition of being wetted only in part, at least at first; but as the dew dries up in one part of a leaf and transpiration has recommenced in sunlight, the above experiments thoroughly establish the right to believe that an influx will be set up to balance the renewed efflux caused by transpiration.

6. *On the Power of Absorption by detached Leaves laid on the Surface of Water.*

Of the preceding experiments, the results were solely judged of by the general appearance as presented to the eye. Such, however, clearly proved that leaves can readily act as absorbing organs in the absence of roots, not only to nourish themselves, but other leaves on the same shoot, especially if the stem be herbaceous.

In the following experiments the leaves were left as stated below from July 30th to August 3rd, 1878. They were all carefully weighed to the 5000th part of a gramme, then again at the latter date. The losses are reduced to percentages of the original weight of the specimens respectively.

Plant.	Proportional no. of stomata.	Surface on Water.	Loss per cent.	Apparent condition.
Berberis aquifolia......	[0	Upper.	26·31	Fresh.
„ „	50	Lower.	13·38	Fresh.
„ „	In air.	......	49·10	Withered.
Ficus Carica	0	Upper.	1·52	Fresh.
„ „	100	Lower.	5·23	Fresh.
„ „	In air.	......	73·95	Dry and brittle.
Ligustrum vulgare......	0	Upper.	7·93	Fresh.
„ „	25	Lower.	1·73	Fresh.
„ „	In air.	......	53·33	Flaccid.
Prunus Laurocerasus...	0	Upper.	13·72	Fresh.
„ „ ...	20	Lower.	4·51	Fresh.
„ „ ...	In air.	......	21·39	Fresh.
Aucuba japonica	0	Upper.	5·97	Fresh.
„ „	50	Lower.	9·82	Fresh.
„ „	In air.	......	27·84	Slightly puckered.
Hedera Helix............	0	Upper.	10·82	Fresh.
„ „	45	Lower.	16·64 (gain)	Fresh.
„ „	In air.	......	10·26	Fresh.

These specimens illustrate the fact that, unless the difference be very pronounced, the eye cannot judge of the amount of water a coriaceous, or even not always a herbaceous, leaf may have lost; secondly, that the loss is not entirely dependent upon, nor proportional to, the relative amount of stomata on the surface. In some cases, certainly the more often, there is less loss when the *lower* side is on the water; but even then this may not be referable to the stomata more than to a less cuticularized condition of the surface.

In the next series, in each case one specimen was partly plunged in water, the cut end (as in every experiment), as well as some leaves, were elevated in the air. They remained thus from July

30th to August 3rd. They were all weighed before and after the experiment, as before, in grammes to three places of decimals.

		Loss per cent.	Apparent condition.
Cedrus Deodara	Partly in water.	·09	Fresh.
" "	In air.	·57	Dry and deciduous.
Hedera Helix	2 leaves in water, 4 in air.	10·28	Fresh.
" "	In air.	10·26	Fresh.
Syringa vulgaris	4 leaves in water, 6 in air.	3·11	Fresh.
" "	In air.	67·20	Dead and crisp.
Thuja, sp...............	Partly in water.	6·19	Fresh.
"	In air.	21·97	Fresh.
Taxus baccata	Partly in water.	4·52	Fresh.
" "	In air.	23·92	Fresh.
Ilex aquifolia	Partly in water.	1·84	Fresh.
" "	In air.	13·33	Fresh.

These examples, taken from many others, show clearly that the leaves in air on the branches which have other leaves in water are easily and well nourished by the latter. In the case of Ivy but little difference is seen between the two percentages. This is due to the fact that, the transpiring surface of four leaves being greater than that of the absorbing, the supply was not equal to the demand.

The following specimens, weighed when gathered, were left without water for a day. They were then weighed again, their losses per cent. being given below. They were then partly immersed as before. They were once more weighed on the following day, after having been carefully dried.

Corylus Avellana,	first loss	per cent.	49·60,	subsequent gain	per cent.	57·20
Berberis aquifolia	"	"	37·64	"	"	13·42
Syringa vulgaris	"	"	35·70	"	"	18·80

In these three the foliage had faded to a considerable extent; consequently the gain per cent. is very large.

Hedera Helix,	first loss	per cent.	10·76,	subsequent loss	per cent.	7·30
Ilex aquifolia	"	"	13·93	"	"	9·04

In these two the transpiration exceeded the absorption; but the smaller loss after immersion, as compared with that before it, indicates that these coriaceous leaves had freely imbibed water.

Buxus sempervirens,	first loss	per cent.	23·95,	gain	per cent.	6·10
Aucuba japonica	"	"	17·28	"	"	4·58
Prunus Laurocerasus	"	"	22·35	"	"	12·12
Prunus lusitanica	"	"	18·49	"	"	·36
Thuja, sp.	"	"	14·93	"	"	6·84
Cedrus Deodara	"	"	26·85	"	"	45·57
Taxus baccata	"	"	20·92	"	"	25·46
Viburnum Tinus	"	"	38·15	"	"	44·21

In these specimens the gain varies according to the amount of foliage exposed to the air, and the consequent loss by transpiration, all tending to establish the general conclusion that the retention of freshness visible to the eye, or the variable amount of loss or gain as proved by the balance, depends solely upon the respective conditions of "supply and demand."

7. *On the Absorption of Dew.*

In the following experiments the leaves were gathered between 4 and 5 o'clock in the afternoon of September 10th, 1878. They were then exposed at an open window to the full light of the sun until it set. After two and a half hours the herbaceous ones showed obvious signs of loss of water, having become more or less flaccid. The loss was not *visible* in the case of the coriaceous leaves. They were all weighed at 7 P.M. A bright moonlight night followed, and an exceedingly heavy dew began to form at 7 P.M. The specimens were all spread out upon a grass-plot. At 7 A.M. on the 11th, before the sun was visible, in consequence of a very heavy mist, the specimens were carefully dried with a soft cloth so as to remove all trace of dew with which they had been entirely covered. They were then weighed. In every case there was an actual *gain*, as seen in the following Table. But besides the proof afforded by the balance, the stems and leaves had perfectly recovered the freshness and rigidity which they had lost on the previous evening.

	Gain per cent.		Gain per cent.
Tilia	16·40	*Viburnum*	6·84
Quercus	6·40	*Bryonia* (old leaf)	16·49
Sambucus (old leaf)	15·58	,, (young leaf)	10·31
,, (young leaf)	3·56	*Rubus*	14·28
Geranium	11·32	*Carduus*	10·71
Urtica	27·31	*Nepeta*	8·89
Mercurialis	14·50	*Malva*	9·09
Tussilago	31·56	*Ligustrum*	3·36
Grass	35·00	*Pulmonaria*	8·42
Hyacinthus	2·56	*Trifolium*	31·16
Rumex	16·66	*Syringa*	10·60
Senecio	8·44	*Taxus*	1·94
Fagus	24·05	*Berberis*	0·57
Philadelphus	8·33	*Aucuba* (young shoot)	2·20

8. *On the Absorption of "Imitation-Dew."*

Finding that I could imitate dew very exactly by means of the "spray," I adopted this plan, so as to apply what I call "imitation-dew" to one, the upper or the under, surface of a leaf alone as required, or else to both surfaces at once, as it is in nature.

A large series of very various and freshly gathered leaves was experimented upon, the general result entirely corroborating previous conclusions. The loss per cent. was almost invariably *less* when the *lower* side only was covered with dew—which shows that absorption of dew by *that* surface is more readily effected than by the upper. Such, too, was the case, it will be remembered, with water.

The certain inference that we may draw is that dew (in nature) is absorbed from below to supply the transpiration from above.

Another series of some forty specimens consisted of leaves which were left three hours to become flaccid. They were then weighed; the loss per cent. from the original weight when freshly gathered was calculated. They were then treated with imitation-dew, there being three examples of each species; one had dew on the upper surface, another on the lower, the third on both sides. In more than half of them they *gained* weight after having been left to dry: the remainder had lost a very small fraction per cent. This was due to the fact that they had become quite dry some time before being reweighed; hence they had again begun to lose weight once more by transpiration.

Hence this experiment entirely corroborated the one mentioned above of the absorption of actual dew by slightly "wilted" leaves.

9. *On the Nourishment of Plants rooted in Pots by aid of their Leaves and green Internodes alone.*

A small healthy plant of *Mimulus moschatus* bearing three shoots was growing in a pot. I ceased to water it on June 4th, 1878. By the 8th the shoots showed signs of wilting; so I now placed the apices of two shoots only in water. On the 11th the leaves on the third and exposed shoot had all withered; but the small buds in the axils of the lowest pair of leaves but one remained vigorous, being about half an inch long. The smaller buds, a quarter of an inch long, were in the axils of the next pair of leaves. Lastly, the terminal bud and pair of leaves were quite fresh and green.

On the two stems which had their apices in water, the lowest leaves (in air) were more or less withered by July 2nd. The apex of the shoot in air and all its buds were now beginning to grow vigorously. Three blossoms were borne and expanded on these shoots with their apices only in water.

By July 7th a great quantity of adventitious roots had made their appearance from the nodes in water.

This Musk-plant thus grew slowly, but well, for more than a month; and on removing it from the perfectly dry soil, several subterranean buds were pushing vigorously.

One learns also from this experiment, as from previous ones, that it is immaterial to a plant which way the water may flow; for it was *downwards* in the shoots with their apices in water, but of course upwards in the shoot in air.

A similar plant left without water on the same day (June 4th) became flaccid in two days, and perished utterly in two or three more.

Other plants, such as *Lysimachia Nummularia* &c., gave similar results.

10. *On the Advantages of Syringing Plants in a Green-house.*

This is, of course, a universal practice; but if the roots be the sole absorbing organs, as has been supposed, why do not gardeners confine the water to the roots? According to M. Duchartre, one would infer that nature only rains upon plants and deposits dew upon herbs solely because it cannot be helped, but with no direct benefit to vegetation. But it would seem that, by syringing, practical experience has forestalled the scientific rationale. Gardeners have all along believed in its efficacy, though they may not have "proved" the actual leaf-absorption. The physiological experiments of Hales, Bonnet, and others, down to those of Boussingault and myself will now, it is hoped, give a complete proof of this fact; and we may thus sum up the advantages of syringing:—It keeps the leaves clean from dust, and helps to wash off insects. It moistens the cuticle, and so renders it more pervious to carbon dioxide (*Barthélemy*). It also renders it more capable of absorbing water (*Garreau*). It checks the loss by transpiration (*Duchartre*), and so enables the terminal shoots and young leaves of a plant to be well supplied with sap by drawing upon the reserve fluid in the stem. It keeps the air cool by evaporation; and, lastly, it is actually imbibed by the leaves and green parts of plants, and so helps to compensate for any loss from within the plant, and thus supplements root-absorption.

What is true for syringing is, of course, equally true for rain.

11. *On the Preservation of Cut Flowers.*

Sachs, in his 'Text-book of Botany,' quotes the results obtained by Dr. Hugo de Vries on the withering of plants as follows*:—

"If rapidly growing shoots of large-leaved plants are cut off at their lower part which has become completely lignified, and are placed with the cut surface in water, they remain for some time perfectly fresh. But if they are cut through at the younger parts of the stem and are then placed in water, they soon begin to wither, and the more rapidly and completely the younger and less lignified the part where the section is made. This withering can be easily prevented by making the section under water, and taking care that the cut surface does not come into contact with the air, the conduction of the water through the stem then suffering no interruption. If care is taken that while the section is being made in the air the leaves and upper parts of the stem lose only a very small quantity of water by evaporation, withering does not begin till later, and increases only slowly after the cut surface is placed in water, and the leaves again transpire."

The cause of withering, Sachs then observes, is the interruption in the conduction of water from below. This agrees with Prillieux's observations†, that as soon as transpiration was checked in a faded shoot by placing it in a humid atmosphere, the water held in reserve in the stalk was drawn upon, and the shoot recovered. Similarly, Duchartre shows that withering results from one of two causes—either that the soil may not contain sufficient moisture to balance the loss by transpiration; or else the latter may proceed more rapidly than the water can be passed up the stem to keep pace with it, and so fail to retain the tissues in their normal state of turgescence.

Sachs and other observers, however, all allude to the cut end as *alone* being the place by which water is absorbed; and as its conductivity is rapidly impaired by exposure to air, it is recommended that a sufficiently long piece of the stem should be removed by a new cut above the first, but this time *beneath the surface of the water*. For a shoot about 8 inches long, 2 or 2½ inches should be cut off.

Now Bonnet's experiments and my own clearly show that absorption can take place through the surface of herbaceous stems and by leaves as well as the cut ends. This fact led me to presume that it would be judicious to retain one or more leaves upon a flower-stalk, as well as to allow the stalk itself to be of consider-

* P. 606, Eng. ed.

† "Expériences sur la fanaison des Plantes," Comptes Rendus, tome lxxi. p. 80, 1870.

able length, if the inflorescence was to be retained without withering as long as possible.

It was found, however, that if the flowers are well nigh at maturity, the additional impetus given to them by the extra absorbing surface hastened them too much, so that the petals would fall early; but, on the other hand, when the stem was ligneous, as of Lilac, or the inflorescence chiefly in buds, as of *Tradescantia* and Compositæ, then the advantage was apparent; so that instead of the buds perishing, they continued to expand successively.

A certain amount of judgment would therefore seem to be necessary in forming a bouquet, as to the desirability of retaining some leaves or not; but if the principle be understood that it is a question of "supply and demand," it will not be found difficult to discover to what extent it may be desirable to increase the absorbing surface in each case.

It is hardly needful to remark that the leaf must be in full vigour, and if it show any signs of decay, must be instantly removed. Moreover the leaves are apt, apparently through endosmotic action, to be after a time often coated with a kind of mucus, so that the water must be changed more often than when stalks only are inserted.

PS. Since this paper was read, a notice of it has appeared in a St.-Petersburg Journal*, *à propos* of making cuttings. M. G. Weidenberg believes that the reason of the frequent fading of cuttings before they have struck root is to be accounted for by the fact that, as a rule, the transpiration from the exposed leaves is greater than the amount of water which the cut end can supply. He recommends, therefore, that the cuttings should be longer than usual, and that some of the leaves should be buried as well, so that about one third of them may remain above ground. Those leaves in the soil will thus undertake the function of absorbing water. The ground (he adds) should be porous, to allow of free access of air, so that the roots may be formed rapidly before the leaves have time to decay. In this way Roses, Pinks, and other cuttings usually hard to strike, will make very good roots. (April 1879.)

* St. Petersburger Zeitung (Beiblatt), 20th Feb. 1879.