



XXXVII. On the physiology of vegetables

Mrs. Agnes Ibbetson

To cite this article: Mrs. Agnes Ibbetson (1816) XXXVII. On the physiology of vegetables , Philosophical Magazine Series 1, 48:221, 173-189, DOI: [10.1080/14786441608637639](https://doi.org/10.1080/14786441608637639)

To link to this article: <http://dx.doi.org/10.1080/14786441608637639>



Published online: 27 Jul 2009.



Submit your article to this journal [↗](#)



Article views: 2



View related articles [↗](#)

XXXVII. *On the Physiology of Vegetables.* By Mrs. AGNES IBBETSON*.

To Mr. Tillock.

SIR,—THE strange *inconsistencies* that subsist in the few facts that have been acknowledged to be true in the physiology of plants, must show that they are in many respects false, since they contradict each other. Thus, plants are supposed to perspire, and also to give out oxygen. It is well known that the water they take in is decomposed, and reduced into its component parts for the purpose. How then can they give it out in oxygen and water also, when that water has been changed to air? But they also admit that the cuticle takes in nutriment, and *all from the same skin*. This is really giving the cuticle more offices than Nature can perform, especially as they are all contradictory. Then it is supposed that the blood circulates,—though the juice is evidently expended, as it rises, in forming the parts it is ordained to complete. If it does circulate, it must do so in absolute *opposition* to the whole order of Nature; since even no *animal* *respires* by a particular organ, except those that have a real circulation: for even in animals or insects there is no circulation where there is not a single heart, to which the blood constantly returns, as the vessels that contain the liquid are so disposed, that it cannot arrive at the other parts till it has passed through the lungs. This of course cannot take place in vegetables, which have no heart, nor in animals that have several hearts.—See the admirable Cuvier.—Again, in the herbaceous plants they may be generally opened close to the root, and the flowers discovered aggregating there:—How then can the flower but be formed at the top of the plant, and come out in a few days also, without any preceding bud? And in trees and shrubs, if the flower-buds are all cut off when first appearing, a quantity will very soon succeed;—cut these away also, and *another set* will reappear: this may be done *two or three times*. Is it possible that all these flowers can proceed, or *be formed*, in the few buds that were found at the exterior in *that place*? No: they are merely the vehicle through which the flowers in trees are introduced to the exterior; and the first flowers are there detained in the bud till the weather is sufficiently favourable to permit them to pass outwardly. This is only learnt by dissecting progressively, and pursuing the various facts throughout all their appearances.

There is certainly a great difference between the tree and

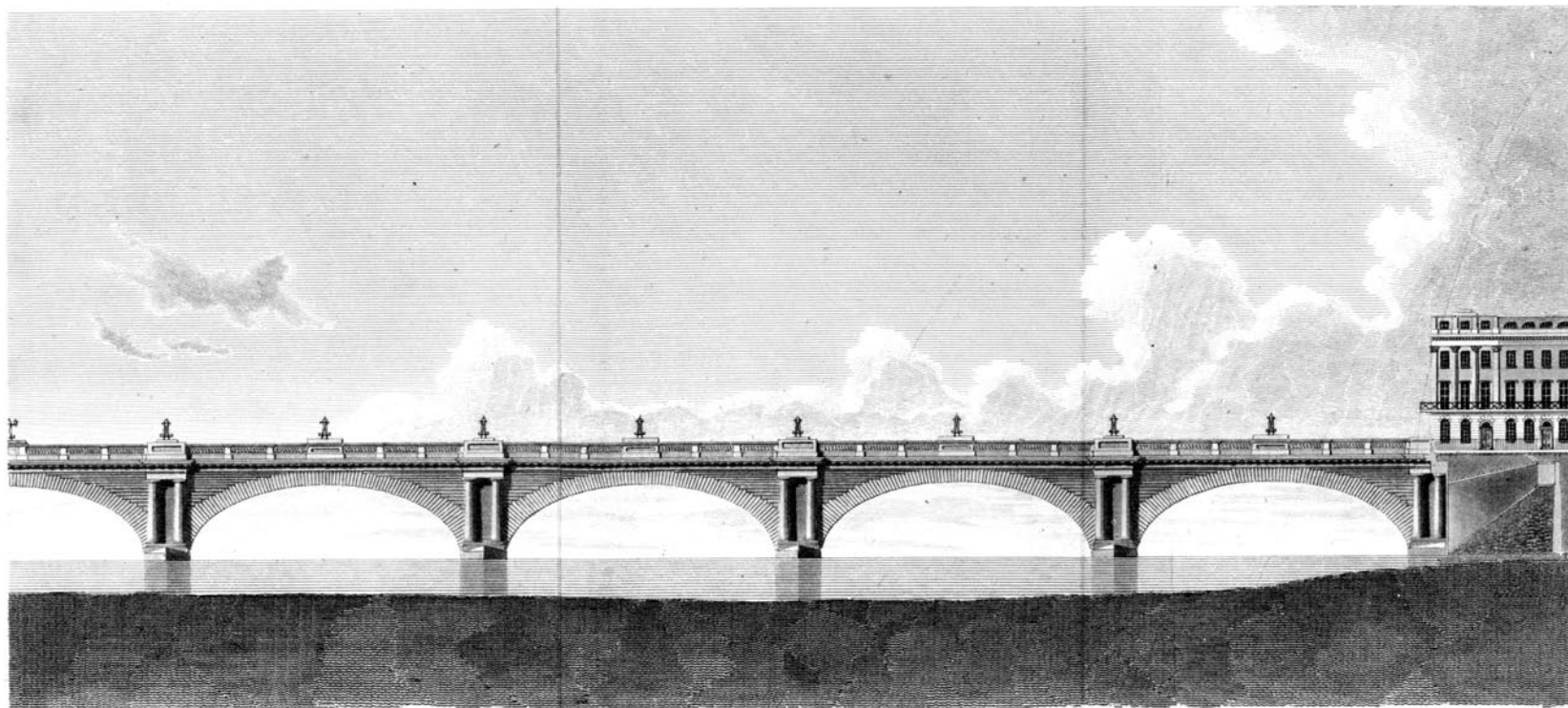
* ERRATUM.—In Mrs. Ibbetson's paper in our last number, in the title, for the word "*substitute*" read "*elucidate*."

herbaceous

herbaceous plant, in the progress of the flower-bud. They both form it in the root; but in trees and shrubs they make several stages,—in herbaceous plants but two.

The first of the propositions selected for this letter, and which I engaged it should in a manner prove, *was*, “that the flower-bud was formed in the root, and of course that the root was the laboratory of plants;” since I before showed that the seeds were also *protruded there*. There are so many curious dissections appropriated to this subject, that it is *peculiarly* by *specimens* I must prove the truth of the fact. I shall first show therefore, by a series of prints (taken in progressive order from the plants), how the flower-bud passes in trees and shrubs, from the moment of its formation to its decay; that the reader may be as capable of judging as if he had the plants before him, in regular succession; since the specimens are the exact *prototypes* of the interior of the vegetable from which they are taken. And though every single specimen will not be given, on account of their number, yet I shall show the principal points of most of them, as they succeed each other.

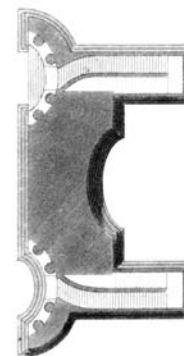
A soft ball appears in the middle of the root traced regularly from its first formation, by opening a fresh plant every third day. This ball is then in a little time seen to pass up the line of life (a circle of cylinders discovered between the pith and wood), and which only enlarges at the flowering season for this purpose. This is never observed till a month or six weeks before or after flowering time. By degrees each specimen shows the ball moving up towards that aperture from which it is to break; while the cylinders naturally swell, and increase in size, according to the quantity of buds ready to pass up (Plate I. fig. 1.) When they reach the part of the line of life from whence they are to be ejected from their place of concealment, the cylinder then opens, and one or two buds protrude, just opposite the ready made scales in the bark, which is in future prepared to receive them, when they shall have passed the *lignum* part. It is now they begin their passage through the wood, drawing a long string behind them (see fig. 2.). This may be seen, and disposed in different specimens in so many various ways, that a person must be blind or incredulous in the *extreme*, not to be convinced. In the first specimen the bud may be caught moving on, and drawing a string behind *through the beginning layers of wood*: then by cutting fresh specimens *horizontally*, and keeping them on the table a few hours, the bud, if then placed *under the microscope*, will pass (while under your eye) out of the wood. In a specimen of new wood, if the bark is taken off *gently*, all the buds (being still incased in the wood) are left there, and the scales alone remain in the bark; and in fig. 3,
the



John Rennie, Civil Engineer, F.R.S. &c.

S. Porter sculp.

*A Plan and Elevation of the Waterloo Bridge of nine Arches Erected over the
RIVER THAMES near Somerset Place in the Strand.*



Scale of Feet: 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300 310 320 330 340 350 360 370 380 390 400 410 420 430 440 450 460 470 480 490 500 510 520 530 540 550 560 570 580 590 600 610 620 630 640 650 660 670 680 690 700 710 720 730 740 750 760 770 780 790 800 810 820 830 840 850 860 870 880 890 900 910 920 930 940 950 960 970 980 990 1000

REFERENCES { Arches 120^{ft} span each. | Width of the Bridge within the Parapets 42^{ft}
Piers 20^{ft} thick each. | Width of the Foot-paths 7^{ft} each.....
Width of the Roadway 28^{ft}.....

the division between the bud and the wood, occupied by the juice, is plainly seen preparing its way: and every person on viewing this figure, and who is apt to notice what they see, will *recollect* this perpetual mark in the wood (o), which is nothing more than the passing flower-bud: but the bud (as I have before shown) does not force its passage, for the juice precedes it, and has the power of bending the wood twigs both ways from the bud, forming a *complete covered way* for it, that with the help of the liquid it may pass without pressure: but as soon as the bud has passed, the wood part recovers its usual situation, and is restored, by the help of the returning action of the muscles, to *its usual position*. There is scarcely indeed a more curious process in the formation of plants *than this*: “that so soft a body should be able to pass (*without injury*) through so hard a substance, is most wonderful! But does not the basket-maker wet his twigs before he attempts to bend them? and do not the sticks (if a wet sponge is placed between them) soon by a curve leave each side of the sponge hollow, as the twigs have done at fig. 3? and does not the juice before mentioned act for the same purpose? Thus all is *in nature*. Before the bud reaches the end of the wood (which it is some time in doing) the cradle or winter bud (which is still empty) becomes covered with a thick and *glutinous liquid*, *varnishing* her scales, to defend the interior (or that which will soon become so) from the cold. This I have generally found to be the signal “that the embryo of the flower-bud has entered her case.” Several specimens must be taken about this time, each day, that the flower-bud may be well ascertained to have entered her new habitation: her string will still attend her, for she loses all power of continuing her journey *if it breaks*. Much pains appears to be taken to prevent the bud being hurt at this time; for though it is much covered with scales, it must still be more exposed than it can be in the interior of the plant. I have repeatedly cut specimens perpendicularly, when the bud was preparing to pass within its new habitation and to arrange itself *there*; and no part of the process can be plainer: in some plants a part of the wood *accompanies the bud*, and does not permit the bark to approach it:—this is the case in the *marvel of Peru*. No alteration is discovered in the next few dissections: the flower-bud remains for a short time perfectly torpid in outward appearance, though the interior of the bud is preparing for its next change. Then is formed that curious specimen exhibited in my last letter, and in this at fig. 4. This part must be pursued with great exactness, taking up a fresh plant every day for dissection. It will then be observed that the bud is again moved, and thrown up into the new shoot. I should never have discovered this, had I not observed the buds throw

throw off their scales as they passed up under the screw (fig. 4.) which divides the new from the old wood: any one may see the scales fall off, and again renewed as soon as the bud has passed up into its place in the new shoot. Hence probably the reason why the new wood of every tree is always grooved, whether the old wood is so or not. The peduncle, after throwing up the bud, generally gets incorporated with the stem: but if the bud is torn down some time after, it again stops at the same place from which it proceeded, by tearing down to that place, or at least in an exact line to that part of the screw under which it dipped: the flower has then only to protrude a common flower-stalk, as soon as it has quitted the bud, and to open; and this ends its whole history, at least that which belongs to the flower-bud of the tree and shrub.

I now turn to the bud of the annual and herbaceous plants, or those which rise each year from the earth. The difference is essential; since, instead of having a settled bud apparently visible for months, and as a promise of future flowers, the bud does not appear in general till just as it is going to break into flower, and till it has travelled to the top of the plant. Can it be supposed then that Nature, which in the tree makes the perfecting the flower a long process, should in the herbaceous plant complete it directly, without preface and without preparation, though it has literally the *same process to fulfil*? Does this appear natural, or even probable? thus to form the whole, and bring it forth without any time to mature its buds and juices? Impossible! Is it not strange that the curiosity of botanists should not have tempted them to tear open a plant from one end to the other, to seek the time when these flowers are formed, when they have already discovered the flower in the *bulb*, and that in the water-lily it leaves the root when quite large, and is to be seen with the naked eye? And in the *saxifraga crassifolia* it is quite as visible as in the crocus; and in the violet the flower-bud comes out of the root so much finished, that no person can doubt what it is, *if they will but look*. Its manner of mounting in yearly plants, yields specimens of *uncommon beauty*. Unlike the tree, the whole texture of the plant is *infinitely looser*, yet still consisting of innumerable cylinders one within the other; instead of being stretched tight, as at fig. 11, forming one only: the thin matter doubles in, and produces innumerable apertures at fig. 19, these folds afford a place of refuge for many flowers, indeed for whole bouquets: and if an herbaceous plant is cut horizontally with a very sharp razor, and then laid on the table for a few hours, the flowers will stand up *above the cylinders*, and thus exactly *distinguish the difference* between the cases and the buds, which from the extreme thinness and delicacy of the

the matter, is not *easy to do*; for the cylinders are so folded in double or treble folds, that to an eye unused to the sight, they would *all appear like the most beautiful papier maché flowers*, only *extremely small* and delicate, and perfectly *without colour*. But I have found another means of distinguishing the case from the *real buds*: it is the dark or *black shade* always attending the cylinders alone, as they are seen in contrast to the apertures, which being then empty, most plainly appear: but when the flowers mount them, they fill up the holes so thoroughly as to leave no *dark shadow* to set them off. I shall give a specimen of cylinders without flowers (see fig. 6); and flowers without cylinders, at fig. 7; also fig. 13, joining both together, and *showing (though very badly)* the apertures up which the flowers mount. When you cut perpendicularly, and happen to remove the soft covering sufficiently to leave the flowers open to view, then they show *admirably*; for they are generally torn enough to remove the thin matter, leaving the various sorts of vessels discoverable between the cylinders. Of these vessels I can say nothing, but that I have most exactly copied them; but what they are for, except to support the flowers, I cannot tell; but we must truly imitate till we can *understand*. These large bouquets of flowers adorned with hanging spirals, and adding grace and beauty to the picture, I have truly delineated. But I must observe that they are *too small* to show all the *defects the tearing* might produce, though sometimes observable; and only exhibit the beauties arising from pressure, &c. which the *opening and closing flowers produce*. The most perfect pattern-drawer would be *left far behind* in this case: for so excessive is the *variety*, and so astonishing the beauty of these bouquets, that I in vain endeavour to *do them justice*. When some corollas half open, they appear like finished flowers: see fig. 8, 9, 10. The *cenanthé*, the *angelica*, and the *hieracium spondylium*, will give an idea of some of these *pictures*: but to complete it I must show the different *specimens* from which each part is taken in the plants, as fig. 8*, fig. 9*, and fig. 10*, are a sextant of each specimen, just cut at the top of the root, that the reader may be a proper judge of the *curious manner* in which the flowers are arranged even in that situation. The root must be cut slanting. It must be remembered, that when the first specimen is observed, and when the flower-buds (in trees) *leave the root*, they run directly into the cylinders of the line of life. This is the same in the plants that rise each year from the earth: they also run into the same vessels, and are formed and conducted so far in the same manner;—but here ends the resemblance.

I have shown how different the formation of the line of life is, and how much looser all the matter as given at fig. 11*, the

variety of cuticles being divided into layers, and each showing such a number of *apertures*, through which the *flowers shoot* (see AA), instead of a plain and regular set of *sheets* (OO) as in *trees*. But there is often, as I before observed, a *thing* which seems to confine this flexible *matter*, and give the part the appearance of different shaped vessels, as at fig. 8, 9, and 10. This I cannot well understand; but I have given each exactly as it *appeared to me*; subjecting both copy and original to the opinion of many, who confirmed and reassured me as to the truth of the likeness. However, when the flower rises above the root, in herbaceous plants, each separate division shows again a more marked line of life; and if then the round stem is *cut* a little *slanting*, this vessel will appear again with its bouquets, as it has passed from the root upwards, (see fig. 12). After remaining a time in this *situation*, a large collection of flowers begins to gather in the middle of the stem, and you gradually see those of the line of life begin to empty: it generally takes five or six increasing specimens to complete the whole process; it is then discovered that most of the flowers have left the vessels of the line of life to gain this repository, (*bb*). But it is not one only, but *two or three*, according to the size of the plant. Here they receive their seeds and pollen, and visibly increase in size, and then rise into perfect flowers by the growth of the stem (*ccc*.) Their passage from *aaa* to *bbb* is most plain, and easily traced, for the first hour after you have cut the plant; but it requires the eye to be accustomed to the microscope, to see it well; and the moment the seeds enter the seed-vessels, they prove them the flowers.

Can I then by any labour, or in any way, trace this series of facts in a more *convincing manner*? These specimens were all taken from plants of the same kind in a series, as they appeared a few days older than the preceding; and the progressive motion from bud to flower, from flower to fruit, is not plainer without, than it is in the *interior*. The difference between the tree and herbaceous plant is just sufficient to account for the *winter bud* in the former. It will be remembered that this is the fourth year I have taken up plants in this manner:—The first year I cut eighty-six trees; the second, seventy-eight; and so on: and such loads of herbaceous, beginning long before they appeared above ground, that I have learnt all *their winter process*. I am sure I have cut many thousands within the last two years, subjecting every part to the microscope. Does there appear then any room in this picture for self-imposition or mistake? I well know how false reasoning is; but I reason not, I only trace a series of pictures presented in regular gradation by Nature: and though exhibiting so many different parts, which it would seem almost impossible

impossible to conciliate; yet, when joined together, they appear so consistent as not once to contradict or confuse each other:—the God of Nature alone could do this. That I have in vain for the last two years gone over and retraced every part:—the more I dissect, the more absolute my belief becomes. And where are the facts strong enough to make us sufficiently incredulous to deny our eyesight? Nowhere, but in a few *mutilated propositions*, most of them showing their *falsehood* by contradicting each other.

It is impossible to give to the public a complete series of facts, copied from Nature, and which forms a quarto in itself, in a more disadvantageous manner than the present, since the first letter is forgotten before the second is read, especially as these facts (like a mathematical problem) all hang on each other, and depend much on their *general consistency* for the proof of their truth:—but I have already sacrificed sixteen years, and to hazard fortune on the publication also, is too much. Before I close my proposition respecting the flower-bud, I must add one proof, which I have shown to many. When a quantity of young buds have just appeared above the stalk (suppose in umbelliferous flowers), if the first set are cut off, the aperture in which the flowers are rising up, is often so hollow and clear, that, look down near half a line, and you see the other flowers and buds coming up to supply the place of the dilapidated ones, or those which have died away. Sure this also cannot be vain; it must prove the flower is formed below, or all Nature is a deception! But we prefer gaining by reasoning, rather than by our eyes; the latter often much *more just*, and more to be trusted to. I must add, that experiments made on the *living tree* (if it is to stop any *vessels*, or *alter* the course of nature) are *not to be trusted*. I experienced this in cutting off half a bean, and replacing it in the earth: the root, instead of coming out at the top, at the same orifice as the stem (as it always does), took a shorter road, and left the bean at the place it was cut. In this manner Nature will deceive us—if the proper passage is stopped, it will form a new one for itself. But *watch her*, and she will *ever* be found the same: and if I only lay open a plant (without attempting to stop *its vessels*), it will, though languidly, continue its motions for near an hour, because its functions are all lengthways; and I shall not have impeded any of its actions, but only displayed them. The flowers therefore will continue to rise for a short time, owing to the motion of the muscles.

I now turn to my second proposition; “That the leaves are the lungs of the plant.” This is universally allowed; yet I never heard a reason given “*why they are so*.” For the leaves

forming oxygen by the decomposition of water, is no reason at all for such an appellation; and it is certain that the leaves contain vastly less air in their interior, than any other part of the plant, and are not therefore a vehicle for air. But though they have no air within, they still merit the name they have acquired, by being the constant cause of the motion of air at the exterior; so that the very oxygen the leaves give out would probably remain almost stationary, on account of its weight, under the trees, rather than circulate around, were it not for the innumerable little fans that by their incessant motion produce an excessive circulation, which is rarely stopped, and is most violent in the lowest spots, and where the general stagnation of air is most likely to exist. But the motion of the leaves not only changes the gases (which descend from the higher regions by the help of the currents of air), but increases also the natural evaporation of the leaves. How exquisitely beautiful is then the arrangement of the lungs of the plant, when they are considered as set in motion by the spiral wire or muscles of the plant, in order to disperse the oxygen! and that motion, exactly proportioned by Nature to the situation of the ground, and the necessities of the sort of country in which they are placed! On the high hills of Scotland or Sweden, where no putrid air is discoverable, the firs grow, which give but little oxygen; for they have no swamps to rectify, no animal breathing to purify: the natural motion of the air is therefore exercise enough for them, and to disperse their pollen. Hence the firs have no spiral wire in their leaves, and in their leaves no motion, and fewer muscles (except in their wood) than any other plant. But behold the contrast:—The low and swampy grounds loaded with aquatic plants and trees, where constant motion is necessary to the purifying of the air—Here Nature not only bestows a quantity of oxygen (which its trees emit continually), but she has loaded the peduncle of the leaf with a quantity of spiral wire, which keeps its leaves in perpetual motion. View only the *abele*, or the black poplar. It is not because its leaf-stalk is broad one way and thin the other (see fig. 14), that the leaf is for ever moving: this shape would cause its constant action, when the wide part of the leaf was facing the wind. But what (but the muscle) could keep it constantly in that position? The muscles alone could do this, by contracting and dilating it, according to the dryness or moisture of the wind that blows. It is by this means the leaf-stems of all the poplars are a trifle more or less turned to the wind, and in this position they will ever be found. Those plants have most spiral wire which grow in swampy grounds; those trees have most motion that are buried in low valleys, where both

both air and water at times would almost become stagnate if it were not for the spiral wire in the leaves. But so beautifully has Nature contrived her laws, that the very moisture of the water, by causing constant motion in the leaves, gives also increased motion to the water, and that water additional freshness to the air; while the deep valleys, which have quantities of aquatic plants, want (more thoroughly than any other) to have the oxygen mixed with all other gases, to purify the atmosphere. How exquisite then is this continual interchange of benefits!—how delightful then the discovery, “that not only the quantity of oxygen is doubled in those vegetables found in low grounds, but the spiral wire is also increased in an equal degree!” Thus botanic physiology perfectly agrees with atmospheric chemistry, to *enforce the welfare* and establish the happiness of each animal that lives and breathes; and not only of those whose scent and wholesome breathing is thus *secured*; but of those inanimate beings who receive health and nutriment from the very spoiled air that is thus drawn off, and imbibed by them for their benefit. Hydrogen and fixed air being in small degrees serviceable to plants in general, though they will not grow in that air alone, their absorption is of the utmost use to man and animals. Thus, if the spiral was not the muscle of the plant, how could all this be brought about?—how could the leaves be moved in stagnate situations?—how could the oxygen get thoroughly mixed in the higher regions? It would remain under the trees, to do harm to the vegetable world; and so far from curing the bad vapours in low morasses, they would be left in their putrid state, to give death to those who entered the valley. As the moist winds act on the leaf of the poplars, so do they also on the corolla of flowers, turning the back of the *antirrhinum* and pea-flower to defend the pollen from the moist winds. How exquisitely sensible are the muscles of the plant! If a moist wind blows, they will lengthen more and more, till they have lost all the twist of their spiral wire:—if a dry north or east wind is felt, the muscle will *contract to half its length*. If there is no muscular contraction, what makes the *malva* flower in certain dry winds push off the whole of its corolla, by contracting the calyx to such a degree as absolutely to *pinch off* the petals altogether? I have often seen above twenty flowers thus forced off, one after the other, in an over-dry season. Those who do not look on the spiral wires as the muscle of the plant, but as sap-vessels, *should show us* how a flower is opened and shut; how the tendrils *twist*, both *within* and at the exterior of the flower; how those *tendrils twist*, that cover the whole *surface of a plant in the way of hairs*;—but particularly how the *wood warps*. They

proceed evidently all from one cause. What power acts on it? What action remains so long after the death of the tree? We do not believe in witchcraft, and *an action must have a cause*. A being dies: all motion ceases after death, *except one*, which is *involuntary muscular motion*. The wood warps after death, it is full of spiral wire: it is *this* which most *evidently causes its motion*, since, if you take a part of it out, all motion ceases, and that *part taken out moves continually*. If this is the case, it must be the *muscle of the plant*: and the warping is at once accounted for, being the only part of the animal which moves after death: it is also the only part of the vegetable which *retains its action after the vital power is extinct*. We are not to judge a living being by the *laws of non-existing matter*; that matter which is made and joined molecule to molecule, may increase by *heat*, which divides *these parts* by *separating them at a greater or smaller distance*. Thus *iron* is increased by the quantity of caloric introduced between *each molecule*. But how can this law be carried into a *living body*? Vitality is actuated by a totally different power, and partakes completely of the animal in this respect, increasing in continuity; and forced to action by the power of the *muscles only*, after vitality should be dissolved.

I think I have so exactly marked the difference (with the help of Mirbel's ingenious idea) between the animal, vegetable, and mineral, that they can no longer be considered as flowing into each other, or making a series of steps, but perfectly disjointed, and different from each other, and peculiar in all their parts. The animal having *life, brain, nerves, muscles, voluntary and involuntary motion*. The vegetable *life*, but neither *brain nor nerves*, but irritability of muscle even superior to animal life*, these serving instead of nerves. Hence in death the *vegetable* cannot be considered as a being to be contracted or dilated, as *iron or water*, and which is removed by heat molecule *from molecule*; but as a *living creature*, which has muscles to move, and which, when dead, can only be subservient to the action of the muscles for a time, and which are, like all vegetable muscles, set in motion by the powerful change of light and moisture, but subject to no other contracting or dilating power. And if in such full proof we want an additional one, to show that the spiral

* This irritable or contractile power, is that property by which muscles recede from stimuli; it is independent of the nerves, and so little connected with feeling, that upon cutting away all the *nerves* and stimulating the muscle with a sharp-pointed instrument, or a caustic, or directing the *electric spark* through it, the muscles instantly contract, as does also the vegetable.

is the muscle of the plant, we shall find it in the great discovery of HALLER, in stimulating the muscles of animals by *caustics* and sharp-pointed instruments: the spiral wire being equally affected by *both*, retiring (if quite fresh and in health) from the accession or touch of either.

By means therefore of the muscle of the plant throwing the leaf into action, the leaves are most properly denominated lungs to the plant. But this is not all the office of this part of the vegetable. In the leaf is mixed that juice of the bark by chemical affinity which contributes to altering the colour of the blood of the plant, so changing by means of the oxygen the dark resinous thick blood into a fresher liquid of a more florid colour, and thus reducing it also into a thinner juice, which enables it to run with speed down the inner bark vessels at the bottom of the leaf, which lead directly down to the bark. The first part of this is exactly what our lungs do; and this alone would enable the resinous juice to flow with ease to the bark, when first made in the leaves of the vegetable.

I shall now turn to the third and last proposition I am to give in this letter, which is equally new, and taken from the dissection of plants. It is "that the corolla of a *flower* is formed by bubbles of water placed in rows, and owes all the beauty and lightness of its tints to the refraction and reflection of the sun on the balls of water which compose its pabulum."

The corolla, to be known, must be taken to pieces. There is some art required to do this; for, if the petals are at all pressed, they are destroyed; they soon break their bubbles and spill their liquid, and thus spoil the whole specimen (as may be seen by pressing one). But it is possible to take the petal of each different corolla, and, splitting it, draw off the upper and under cuticle, and, leaving only the middle part to be examined, "that is the pabulum," to gain the most exact result;—since the different cuticles will then (if placed in the microscope) properly so arrange themselves (according to their true and focal distance), that, though there are several separate layers, yet they are so little divided, each will rise to its proper height, and enable the eye to distinguish them from each other, and not in any manner confuse their parts together. Taking the corolla in this manner, the pabulum is soon discovered to be balls of water laid in rows; and this even the naked eye in some flowers will show; and these bubbles of water (covered only by an extremely thin skin) lined by an impervious one, so clear as often scarcely to appear to the naked eye.

The petals of most flowers differ from leaves in many respects, but particularly in one essential point:—in leaves, the coloured

skin is within, the *white* is *without*. But in flowers, the pabulum is *white*, and the upper and under cuticles *coloured*. To the pabulum the petals of flowers are indebted for their brilliant appearance, and not to the juice which inflates them (which is generally of a dull and livid colour); but the bubbles receiving the rays of the sun, and returning them to the retina through these colours, paint them with a *vivid glow* impossible to express in words; but easily shown by throwing the light of the sun through a small glass bubble on the dullest colour imaginable, and it immediately returns the brightest of tints. Thus these bubbles receiving the rays of the sun (which strike each drop of water) are enlivened and enlightened by the reflection and refraction of that bright ray of light seen in every bubble, and striking the retina, by which means the whole flower would become a *blaze of light* too violent for the eyes, had not Nature, to soften it, covered it with a cuticle of a gauze-like texture, which, refracting each ray, gives it a *softness and beauty* seen only in flowers. This being their form, it must stand to reason, that, in spite of the upper cuticle, much heat must be evolved; and yet it did not occur to me to measure it, till I received a letter from Sir J. E. Smith, in answer to one I wrote to him, respecting the raising the thermometer during the fructification of the seeds; when he requested me to see whether the polished surfaces of the petals were not the cause of heat still more than the seeds. This immediately set me to work;—the only trial I have ever seen on the subject was one made by the excellent Mons. Hubert in the island of Bourbon; but it is given by Mons. St. Vincent in so strange a way, that I cannot make it out. In the first place he says that the maximum of the heat was at sunrise. “That Madame Hubert, who was blind, was much struck by finding the plant *feel hot* to her hand; and that when the thermometer was applied to the spadixes of the plant, it rose to 30° of Reaumur, the standard thermometer being 18°.” Now this in Fahrenheit would be 50° and 62°. Now how could Madame’s hand, which even supposing her *seventy*, could not be less than 75° in that climate, feel 62° *hot to her hand*; when it was thirteen degrees cooler than her own flesh, and would therefore be cold to it?

I cannot help thinking that there was so much handling, and cutting, and placing the plant round the instrument, that the hand must have communicated much of the heat it possessed to the vegetable it held. It certainly was neither the corolla nor the seeds that gave it; since the male and female were cut to pieces and disposed round the thermometer, and all motion must soon have ceased in thus dismembering the plant. However, we are

are not fair judges without trying the same plant the same way. When he tried the common *arum* in the interior of the corolla in the sun, it gave 6 or 7 above the state of the atmosphere. I never got Hubert's account till after my own trials were completed; but I have since tried to cut the spadixes of the *arum*, and place them in the manner directed; but it had no effect on the thermometer.

I shall now explain the trials I made both before and after I received Sir J. E. Smith's letter: every thing that could be done to guard the plant from receiving any heat from the hand was done. Having arranged the approaches round the flowers to be tried the evening preceding, a stick was placed to which the thermometer of comparison was affixed, and a contrivance which enabled me to slip on or off a paper cover, when I wished to try the seeds, that I might not, when the pericarpium was below the flower, be obliged to pass the instrument through the corolla, but into the seed-vessel at once, without the bulbs being exposed to the atmospheric air: some sticks were so placed that I could run the thermometer into the flower without injury, by the help of a pair of long pincers, and the whole was covered with a large umbrella to be turned off and on, as *required*. I began at seven o'clock in the morning.

	Therm. of Comp. In the Sun.	Therm. of Trial.		Therm. of Comp. In the Sun.	Therm. of Trial.
Iris ..	57 $\frac{1}{2}$	63 $\frac{1}{2}$	Arum ..	53	61
Arum ..	55 $\frac{1}{2}$	64	Hyacinth ..	56	62 $\frac{1}{2}$
Arum ..	55 $\frac{1}{2}$	67 $\frac{1}{2}$	Iris ..	59	68
Hyacinth ..	49	58	Rose ..	57	64
Rose ..	57	64 $\frac{1}{2}$	Honeysuckle	55	63 $\frac{1}{2}$
Honeysuckle	55	63 $\frac{1}{2}$	Arum ..	59	66 $\frac{1}{2}$

Seeds flower in Paper.

Seeds flower in Paper Cover.

Arum ..	55	57 $\frac{1}{2}$	Arum ..	55	56 $\frac{1}{2}$
Rose ..	58	60 $\frac{1}{2}$	Iris ..	59	61 $\frac{1}{2}$
Iris ..	57	59	Rose ..	63	65 $\frac{1}{2}$
Honeysuckle	59	62 $\frac{1}{2}$	Hyacinth ..	49	51 $\frac{1}{2}$
			Lily ..	61	63 $\frac{1}{2}$
			White lily ..	60	63 $\frac{1}{2}$

When I tried the seeds, the bulb was placed in the midst of them, without passing through the corolla. The result may, I think, therefore, be fairly stated; that the greatest part of the heat (which was supposed to result from the seeds only) certainly comes from the corolla: for, cover the thermometer when taken from the open air by any thing, and it will rise nearly one degree;

degree; the seeds gain only $2\frac{1}{2}$; if indeed it is any thing, the quantity of caloric must be *very small*, and only at the time of fructification, which may arise from the quicker motion of that season; since it is certain that at no moment the seed is liable to so hasty a revolution, as when the inside of the heart first forms itself. But the heat the corolla gives is a decided heat; and it is to be discovered in every *flower* that will admit the bulb; and I should suppose intended to accelerate the fructification of the seeds, the completion of *the juice* of the pistil, which for the purpose above mentioned may require to be raised to a certain temperature before it is fit to pass down the pistil into the seeds. I always shaded those flowers that were afterwards to be exposed to the sun, till two or three minutes before the experiment began, or probably the heat would have been higher. But it is not certainly owing to the *polished surfaces of the petals*, for nothing can be less smooth in the *microscope*: but it is owing to the balls of water that compose the pabulum, which reflects heat from each bubble of water and light; and if the sun is hot enough to decompose the water (which it certainly does in those petals that have hairs), it of course must reflect *great heat* from the pabulum; and this may always be increased by taking off the upper cuticle. But it is not to one sort of form the corolla is confined, though, except the *Everlasting*, the *pabulums* are all formed of bubbles of water. But there are wet petals, such as the hyacinth, which, though they are so filled with liquid, it is quite wonderful how the skin can keep it from oozing, yet detain the liquid in such a manner as not to wet the hand on which it reposes. This is really a wonderful thing, and shows in how great a perfection Nature has made these *skins*, which not only may be so filled with liquor as to be greatly inflated, but also so thin as to appear perfectly transparent, yet cover the water sufficiently to keep it from too great an evaporation, and enough to allow it to decompose water, which the corollas that have hairs certainly do.

There are still more curious corollas, one sort in particular, which we have so exactly imitated in forming velvet, that it is impossible not to be struck with the similarity of the formation. The upper coloured cuticle is formed of a vessel carried up and down in scollops, and then cut at the top;—this appears to prolong the ray of light which falls on it, instead of absorbing or repelling it suddenly. It is thus it acts on feathers, it is this which gives them so exquisite a softness. It is this also in miniature-painting which makes a stroke so much softer than a dot. It is this on the cheek of beauty when the soft down shades it, which is so exquisite to behold, and *which paint* so wholly *destroys*. The thick petals, which are mostly flowers belonging to

to a hot country, have probably their corolla formed of greater consistency, that the water may not too soon evaporate in the bubbles. When the corolla is thick or thin, it is the *increase* or *decrease* of their pabulum only to which that circumstance is owing,—every other part is *the same*.

The Everlastings have the pabulum made of powder instead of water, and certainly give *no heat* whatever, but retain their form and beauty for a long time, not fearing the general enemy of flowers evaporation,—dust being their only destroyer.

But the most curious plant in respect to dissection is the *ranunculus ficaria* and *bulbosus*, which have their pabulum covered with a brilliant white powder, which seems not only to refract great light and *heat* from the bubbles, but from the powder also. But such was the badness of the weather, that I have not been able to try the heat they give; the flower is indeed almost too small to introduce the bulb of the thermometer.

I shall now touch, though gently, on the means by which these flimsy bodies (the petals of flowers) are sustained and strengthened, so as to bear much pressure and much ill usage, and to preserve their elegant shapes in spite of wind and rain. No one would for a moment doubt that the spirals governed the petals of flowers, if they would watch them for a few minutes as I have done for days, nay weeks together.—How often have I seen one of the petals contract its motions before the rest were at all sensible of the impulsion; twist and furl its sail-like wings, lay them fold on fold, exactly according to the drawing of the spiral! I know not any better means to show the muscles, and how completely the spiral is that part of the vegetable, than exposing them to a variety of temperatures—both extremes of heat and cold will act equally on them; they contract, then lengthen, and at last become vapid and dead,—lose all the stiffness of their spiral, which untwists and breaks, and the water immediately evaporates from the bubbles:—you then plainly see the skins in which the water was confined: and I do not think I ever was more surprised than to find that each bubble was opened and shut by a *spiral wire*; but they are not smaller than the eyes of many insects, in which so much *mechanism* is discovered.—But we are for ever to be reminded, that to Almighty power there is no small or great.

In the corolla Nature seems to have sported with a vivacity calculated to exhibit her powers: and beautiful is it to follow the pea or the bean in its various species, which discover a variety quite as astonishing; and when the simple direction of the muscles is not sufficient to manage its folds, a certain piece is formed like the strengthening piece of an instrument, being a treble fold of the pabulum, from which the vessels are allowed to take
their

their exit as from a centre, and it serves as a strong part to accelerate and fortify the powers before given to it by the muscular force. I think, any one who will examine the strength of the bean banner on the back of the red *antirrhinum* with care, can never attribute such force to any thing but a muscle pervading all vegetable life. The foldings of the last-mentioned flower are artful and powerful, and the springs so admirably contrived as to merit peculiar attention;—most of the flowers of that kind have *two side-springs* to connect the two parts of the corolla together; they are unusually strong muscles. Try their strength, and they will be found powerful; they lock one within the other: but when the flower is dead, if the spring is examined, all the spiral will be found dead and unwound, and broken in various places.

I shall in a future letter give some beautiful specimens of the mechanism Nature contrives in the opening and closing of the flowers. The mechanic power is *easily seen*, so plain and simple as to explain itself. I shall also give a guess, “why Nature does so at such different hours.” It is a curious subject: but a few general principles will be found to *disseminate their powers* in a such a manner throughout all *vegetable life*, as to be *fully competent* to manage *the whole*; and I hope by continuing my dissections, and trusting to Nature only to prove her own work, she will bring conviction of this important truth, and that I have nothing to do in it, but *obey and follow her*.

I am, sir,

Your obliged servant,

Dawlish, Sept. 1, 1816.

AGNES IBBETSON.

Sketch of the Plate.

Fig. 1. A specimen of the cylinders, which always enlarge at top and spread when cut; the flowers rising in them, and arranging themselves in a bouquet, when no longer pressed by the vessels.

Fig. 2. Dissection of the wood, cut perpendicularly, showing the buds AAA running to the bark.

Fig. 3. The bud in the wood, showing it running through the wood, with the juice surrounding it so as to guard it from being touched by the hard part.

Fig. 4. and 4*. Both showing the manner in which the bud is thrown up into the new shoot, and the cause of every new shoot being grooved.

Fig. 5. Manner in which the vessels of the line of life in trees are often formed, marking a great contrast in those of the herbaceous, which are in innumerable folds.

Fig.

Fig. 6 and 7.—6 being the manner in which the platform appears, or apertures through which the flowers pass; and fig. 7. shows the buds without the platform: and fig. 6 and 7 both together at AA.

Fig. 8, 9, and 10, are the three specimens, showing the very curious manner the folds of the thin matter will draw in: and fig. 8*, 9*, and 10*, are specimens of the root of the *œnanthe*, the *angelica*, and the *hieracium spondylium*; out of which the foregoing figures were taken.

Fig. 11. and 11* are the specimens showing the manner the line of life is formed, when folded in trees either so or in fig. 5: and 11* the manner it is folded in herbaceous plants.

Fig. 12. Manner in which flowers mount in the stem of herbaceous plants: first in little bouquets, then collecting in large, as at *eee*, when the stem lengthens, and they open.

Fig. 13, showing the apertures through which the flowers mount.

Fig. 14, the stem of the leaf of the poplars.

Perhaps I had most wisely avoided giving the figures described at figs. 8, 9 and 10, as carrying so little probability in their appearance;—but when I first began to dissect and imitate the vegetable tribe, I most absolutely determined that I would literally draw all I saw, without exaggeration and without diminishing the objects presented to my sight, let them be ever so extraordinary. No one had before taken a review of these objects,—all that was supposed to be known, was very little more than conjecture, except the seeds: no one had attempted to take the specimens *progressively*—what the interior was, therefore, “*was (till now) a secret*,” and after sixteen years constant dissection I cannot be accused of ignorance. With this observation I leave it to public opinion.

XXXVIII. On Sir H. DAVY's Safe-lamp for Mines. By JOHN GEORGE CHILDREN, Esq. F.R.S.

To Mr. Tilloch.

SIR, — I READ with some degree of indignation, in the Annals of Philosophy for July last, a paper by a Mr. Lougmire, calling itself *Remarks, &c.* on Sir Humphry Davy's Safe-lamp for the Colliers; and I addressed a letter to Dr. Thomson on the subject. That letter the learned Editor of the above Journal has thought fit to suppress;—nor should I have considered it worth while to take even this brief notice of so weak an attempt to injure one of the most important inventions with which enlightened genius has ever blessed the world, but have left it to perish in its own insignificance.