



IV. Observations on the Ipomæa Hifpida, and some other plants of the family of the Convolvulus

Felix Fontana

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three strokes in a minute, and gives about a half gallon into the cistern at each stroke. He adds, "I speak of what it did in the dryest part of last summer; when it supplied a large family, together with work-people, &c. with water for all purposes, in a situation where none was to be had before, except some bad water from a common pump, which has been since removed. But the above supply being more than sufficient, the machine is occasionally stopped to prevent wear, which is done by merely casting off the fring of the bucket valve."

P. S. I have just been informed that a drawing of the engine, which I had communicated to a person in this neighbourhood, was sent to a colliery near Swansea some months ago, and that it has already been applied to use there; it is not, however, sufficiently powerful for the coal-works in this neighbourhood.

The following Certificate accompanied these Letters.

I do hereby certify, that the water engine, constructed near my house under the direction of Mr. Sarjeant, has been eight months in use, and fully answers the purpose intended.

EDMUND L. IRTON.

Irton Hall, March 18, 1801.

I do also certify the above to be true.

ROBERT WILKINSON,

One of his majesty's justices of the peace
for the county of Cumberland.

March 13, 1801.

IV. *Observations on the Ipomæa Hispida, and some other Plants of the Family of the Convolvulus.* By FELIX FONTANA*.

I. **T**HE *ipomæa hispida*, and other plants of the *convolvulus* kind, have the property, as they grow up, of twisting themselves around bodies in the neighbourhood with which they come in contact. They exercise this singular property on every kind of body, whether vegetable or mineral, great or small, even when they are as slender as a thread.

II. The spirals formed by these plants are loose, and at a distance from each other, when the diameter of the body which they embrace is of a considerable size. If it decreases they become closer, and approach each other more, in such

* From *Mémoires de la Société Médicale d'Emulation. Quatrième année.* Paris 1801.

a manner

a manner that one is sometimes tempted to believe that they are in contact. I have presented to these plants metals, stones, and the branches of trees, sometimes green and sometimes dry, the figures of which were infinitely varied, and always observed that the spirals they form adhere, by immediate contact, to the whole length of these bodies. I tried to change the direction of these spirals, to make them ascend or descend from left to right, if they inclined before from right to left; and they always yielded to these changes with facility in a very little time.

III. When they are abandoned to themselves, and find no bodies near them to which they can attach themselves so as to climb around them, they creep along the ground, fall back on themselves, become interwoven in a thousand different ways, and force themselves into the ground: they extend to a great distance on every side, and form a net of spirals closely united.

IV. After having long studied the character of these plants, I must confess that I am acquainted with no mechanical principle by which the movements and singular properties which they exhibit can be explained. This kind of instinct, which makes them search for neighbouring bodies to assist them to rise; those spirals, which they constantly form as they grow up; those angles and those folds, which are found always proportioned to the figure of the bodies they meet with; the facility with which their stems, even when exceedingly hard and robust, can fall back upon themselves, and form angles so much the smaller as the bodies to which they attach themselves are slenderer: all these phenomena, absolutely contrary to the rectilinear progress affected by the fibres of plants, as well as by their vessels and the liquors they contain, make me suspect, in those which we examine, a new principle of sensation and life.

V. It must not be believed that the *ipomœa hispida* thus twists round upon itself merely because it is formed of spiral fibres, and that all its movements are only a necessary effect of its interior organization. Such an opinion is entirely void of foundation. It would indeed be fruitless labour to search for these pretended spiral fibres by the help of the microscope, for that instrument exhibits only rectilineal fibres and canals. Besides, I have always found by experience that the direction of these plants may be changed at pleasure; that, if the spirals they describe around any body are formed on the right, they may be immediately turned to the left, and *vice versa*. Their movements, therefore, can be ascribed neither to any peculiar

mechanism, nor to local circumstances; and they seem equally capable of moving on all sides.

VI. Ivy is the only plant, and perhaps the only body, with which they do not sympathize: they are not fond of uniting with it, or twisting themselves around it. If any external power unites them to that plant, and forces them to describe around it a certain number of circumvolutions, they endeavour to avoid it, to disembarass themselves from it, and they remove from it as soon as circumstances will permit.

VII. If a branch of the plants in question be suspended in the air, it continues to descend in a perpendicular direction, unless it be very slender. In that case, it abandons the straight line which it followed, and bends itself contrary to the laws of gravitation, raises itself up, and returns to its own stem, that it may describe around it the usual spirals.

VIII. Sometimes the extremity of these plants, after having twisted itself several times around different neighbouring bodies, abandons the spirals it had begun to form, and recedes several inches; especially if deranged in its progress, either on purpose or by the effect of some local circumstances: but, by a very wonderful mechanism, it almost always falls back towards those bodies which it embraced, searches for them as if by natural instinct, and again twists itself around them, following the spirals it described before. These spirals are situated in a direction from the top to the bottom, or from the bottom to the top, according to the position of the point which terminates them. Indifferent to every kind of direction, they constantly follow that given to them, without obeying either the laws of gravity, or those by which other plants seem to be regulated.

IX. All these phenomena cannot be explained by simple mechanism: they seem to be the effect of a principle of sensation and life; a principle which I discovered several years ago in the *tremellæ* of Dillon, and some other smaller plants, as yet little known, of the family of *liferons*, and of which I have demonstrated the existence by evident proofs, as may be seen in my different works. These proofs have never yet been contested by any observer or philosopher.

X. Life and sensation are found to be obscured among certain animals which have very little analogy with man and with common animals, and to become the less apparent as their organization differs from ours. Sometimes, even, it is difficult to believe that they enjoy real life; and this discovery can be made only by the laborious researches of the philosophic observer. Several of these animals are destitute of
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the organs of hearing, sight, taste, and smell. There are whole families which have not the organ of voice, that powerful mean for discovering sensation; and the sense of touch itself is sometimes so obscure by the absence of those sensible movements and violent agitations manifested by other animals in consequence of any stroke, that it cannot be known whether it is produced by sensation, or by any other principle unknown, and merely mechanical. Even the organs of digestion, which in other animals are internal, can be supplied in the family of the polypes by the external organs, and even by the skin itself. It is well known that these animals form a kind of elongated bag, if they are turned, like the finger of a glove; the stomach becomes skin, and performs the functions of it, while the skin becomes stomach, and digestion continues.

XI. It was formerly thought that, to ascertain whether an organized being belonged to the animal or vegetable kingdom, it was sufficient to divide it into several parts; but at present we are acquainted with a multitude of animals which may be divided without destroying them, and which even multiply, like some plants, in proportion as they are divided.

XII. The little analogy, therefore, which exists between our organs and those of plants, and even the absolute privation of certain organs, will not permit us to obtain certain and evident proofs of the life and sensation of vegetables. For, if we suppose that all plants are endowed with sensation, and that it is even much more exquisite than our own, how can we ascertain whether their mode of living and feeling be different from ours, if their organs have no relation to our organs, and if they are entirely deprived of those which could act upon ours? But though we cannot prove directly, and in an evident manner, that plants feel, it by no means thence follows that plants are incapable of feeling as well as animals, and even in a much more exquisite manner. We cannot without temerity, and without exposing ourselves to the danger of falling into error, refuse to nature a power which she exercises, perhaps, over all organized beings.

XIII. Motion, perhaps, is the most certain character by which animals are distinguished, and that which rarely abandons them: without it we should be obliged to consider as inanimate an infinite number of beings in whom life is manifested in the most evident manner by the rapid movements of their different parts; movements which can in no manner be ascribed to mere mechanism, but which are necessarily produced by sensation; and yet these movements sometimes become so slow, and so obscure, that they are capable of ex-

haunting the patience, the sagacity, and the talents of the most indefatigable philosophic observer.

XIV. But if the vital movements are obscure in a very great number of animals, they become almost imperceptible in plants. I do not here speak of those movements, so well known, of the sensitive plant, the *bedysarum gyrans*, and the stamina of several others, which, as soon as touched, move and contract themselves. It would be difficult to prove that these movements are really vital, and that they arise from sensation: they appear to me to be purely mechanical, though we may be ignorant of the real mechanism which produces them; and they have a great analogy to those which depend on the elasticity or spring of certain machines which, when once wound up, unbend themselves, and continue to move as long as the force and principle by which they were put in action exists.

XV. The indefatigable botanist Dillon studied with great care the *small tremella*, but he did not discover those movements which it constantly manifests to the eye of an attentive philosophic observer. Adanson went still further, but without observing in it any thing that depends on a real principle of life and sensation. Having become the object of my researches, it exhibited to me a great number of movements still unknown, and of the greatest importance. After having carefully examined, and, as I may say, analysed them, it appeared to me, as may be seen in my works, that they might conduct to a real principle of life altogether different from mere mechanism. But I must confess there are only two plants the life and sensation of which I was able to demonstrate in an evident manner, and so as to leave no doubt; and these two plants are very small, and even microscopic. They have little if any analogy with other plants; and though they exhibit all the properties by which vegetables are characterized, some even may class them in the animal kingdom. But whatever may be the case, and however important the question may appear, it cannot destroy truths founded on facts and observations. It is much to be wished, for the progress of science, that the life and sensation of common plants could be proved, and that it were possible to show that these qualities, so wonderful, and at the same time so obscure, do not exclusively belong to animals, but that they are extended to all organized beings.

XVI. I opened the entrance into this laborious and difficult path by some observations, which were indeed very imperfect, on the *convolvuli*; a kind of plants which are very large, and well known to every body. Animated solely by
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a desire to be useful, observers abler than myself, and more favoured by circumstances, will no doubt finish what I have only sketched out.

XVII. To encourage them, and show them the probability of the most brilliant success, let me be permitted to say a few words respecting two properties equally common to animals and vegetables, from which life and sensation seem to flow—I mean generation and respiration, so necessary to these two kinds of organized beings.

XVIII. Air is an element so necessary to animal life, that it becomes weakened, and is at length extinguished, when entirely deprived of it; and from my own observations I am induced to believe that no animal can live without air, and without a quantity, more or less considerable, of oxygen; though we are but imperfectly acquainted with the manner in which it acts, how it is respired by the different animals, and by what means they are able to separate it from the different substances with which it is united, and which can more or less alter its purity.

XIX. What is certain is, that small eels, susceptible of being recalled to life, die if deprived of air, or if care be not taken to renew it; and it would be lost labour to attempt to reanimate them, if the water in which they are immersed is not in contact with respirable air. They live only a very short time in every kind of water deprived of that air. They die in hydrogen and nitrogen; though these gases are not prejudicial to them of themselves; and do not occasion to them sudden death, like the greater part of the other gases, without even excepting carbonic acid gas. It appears, then, that oxygen contains the vital principle; and the principle it has of maintaining and preserving life, induces us to believe that if it does not communicate it directly, it can at least awaken it, and put it in action. The small animals above mentioned are an irrefragable proof of this assertion. They remain dead as long as they are deprived of oxygen, but its presence immediately restores them to life and motion. It may therefore be said that it contains the direct principle of life, which it infuses into them; or that their vital organs, in order to be reanimated, stood in need only of this aliment, of which they were deprived.

XX. The absolute need which plants have of air in order to vegetate and be preserved, renders it highly probable that it serves for the same purposes among animals; and that it ought to be considered in these two classes of beings as a principle from which life flows, in the same manner as an effect from its cause. Besides, vegetables are organized as

well as animals; they increase also by nutrition; and though this function in both follows laws different in their details and application, we may however assert, that plants have in general more resemblance to our small eels, than the latter have to common animals. A plant, indeed, may be dried to a certain degree, some even may be reduced to a state of perfect desiccation, without losing the property of vegetating as before; whereas the slightest desiccation of animals is, in general, sufficient to deprive them of life for ever. The diversity of these phenomena is, no doubt, owing to the simplicity of the organs of plants and of our microscopic eels, and, above all, to the facility with which the latter can be dried, which prevents the corruption and dissolution of their organs; while this dissolution is unavoidable among common animals which have a very complex organization, and whose humours naturally tend to corruption. This, however, in no manner destroys the great analogy which exists between these two species of beings; an analogy founded in particular on the circumstance of both having equal need of oxygen for their existence.

XXI. Generation, that mystery, so obscure in its principles, which belongs no less to plants than to animals, forms the second kind of analogy between the two classes of organized beings, and induces us to believe, that where the organs are the same, and have the same uses, we ought to find also an identity of wants. Vegetables and animals have distinct genital parts of separate sexes, male and female organs in different individuals, and exhibit efforts in these different sexual parts to consummate the act of fecundation. Since the sexual organs, and the manner of reproducing themselves, are common to the two grand families of organized beings, do they differ in sensation? And this difference, so improbable between beings so like in other respects, and the only one of the kind, perhaps, that can be found in nature, on what is it founded? Is it on our organs and mode of sensation not being in harmony or unison with that of plants? Was there ever any reason weaker, or less philosophical?

XXII. The movements of the male organs of plants which perpetuate their species, and the manner in which they prepare for that grand work, seem to me to deserve particular consideration, and further research. I propose to undertake this labour, or rather to continue it; for I have already been employed on this object under various circumstances, and I am of opinion that the sum of my observations is sufficiently decisive to enable me to assert, with some foundation, that the movements by which different beings reproduce

duce themselves, are not the result of mere mechanism, but that the grand act of generation is executed by a principle of sensation which regulates and directs it: it, however, appears that this sensation abandons plants as soon as the end of nature is accomplished. Thus we see different kinds of animals die when they have ensured the reproduction of their species.

XXIII. It is then highly probable that plants as well as animals enjoy a principle of life and sensation, whatever be the nature of that principle, and notwithstanding the difference it exhibits in these two families of organized beings; a difference which is necessary, since their structure is not the same. The absolute need of oxygen, which is equally felt by both; the similitude of their organs; the analogous movements in the use of these organs; and, in the last place, the inconvenience there would be to refuse life and sensation to other plants, while we are obliged to acknowledge it in the two microscopic plants which I examined, besides those alluded to in this memoir; are all proofs on which the life and sensibility of plants are founded. It must, nevertheless, be confessed, that the little analogy which there is between their organs and ours, will not permit us to establish these proofs on facts, and to give them the evidence of demonstration. It appears, however, very surprising that nature grants to vegetables a force and an energy which it seems to have refused to animals. I allude to the property which the former possess, not only of decomposing every kind of bodies, but of collecting the elements to form new compounds, and thus to produce fossils and even metals. Animals are destitute of this property, or at least enjoy it only in a weak degree.

XXIV. Life and sensibility, however, in different animals exhibit degrees so various and different, become weaker, and decrease by gradations so insensible, that the philosophic observer can scarcely fix their limits, and ascertain where they begin and where they end. It even appears that sensibility, to judge at least by its effects, is not altogether of the same nature in the different kinds of animals. The numerous observations and experiments, which I have made for years, on the sensibility of animals, particularly the cold-blooded, and on the return of some of them from a state of death to that of life, leave no doubt that there are a great many of them in which the severest wounds occasion neither sensation nor pain. For example, if the head of a fly* be

* The naturalist and real philosopher will not be surprised to see the author fix his attention on a fly, an insect considered by the vulgar as contemptible. The smallest insect enjoys life and sensation as well as the

be cut off, it continues to fly about, to walk, to leap, and to climb as before; its regular and uniform motions, sometimes slow and tranquil, sometimes quick and animated, exhibit nothing convulsive, nothing that resembles those violent agitations which accompany pain. In a word, the number and rapidity of these movements, as well as the time that these flies can live, are subject to no fixed rule.

Let us stop for a moment to consider the movement of their legs; they are equally various and wonderful as those by which they can move the whole of their body.

XXV. To appreciate properly the different movements performed by an animal in a state of health or of disease, it is necessary to have an exact idea of the circumstances in which it is placed, of the motives and impulses which in general induce it to move; in a word, we must be acquainted with its nature and character. This being premised, it is easy to observe, that of the nine kinds of movement to which those executed by flies in a state of health may be reduced, eight still subsist even after they have been deprived of the head. Scarcely has a fly been decapitated when it is seen to move its hind legs for a long time, and at different periods to cross them, either standing up or flying, to rub them along its body, to hook the one into the other in the form of a wheel, and to agitate them in a thousand ways with wonderful rapidity and regularity. All these movements, which constitute the first kind here treated of, are absolutely similar to those performed by a fly, when, possessing perfect health, and being harassed by no fear or want, it appears to move only for its own pleasure. These movements, then, seem to be produced in these two states, so opposite, by the same principle, that is, sensation and volition.

XXVI. The second kind of movement results from their hind legs, which they raise up towards the interior edge of their wings; so that by these means they are elevated, and placed in different directions. The object of these movements, exceedingly varied, though constant, seems to be, to rub, beat, and polish their wings. Their hind legs can execute a third kind of movement, no less varied, when, conveying them above their wings, which they keep extended, they rub them, beat them, and polish them, as in the preceding case. Their middle legs also are often observed to be twisted around those behind, and to rub each other mutually; which forms two new kinds of motion different from those we have examined.

largest animals: these properties belong as much to microscopic and infusion animals, as to the elephant and whale. Nothing is contemptible in the eyes of the philosopher; every thing in nature is great and wonderful.

XXVII.

XXVII. They can also move their fore legs, and twist them in the form of a wheel; which forms a sixth kind of movement, so various and multiplied that the eye can scarcely follow them. The seventh and eighth kinds result from the union and interlacement of their middle legs with those before. What seems surprising is, that these eight kinds of movement are perfectly similar to those voluntarily performed by the animal, and as it were for pleasure, before its head is cut off, and when it enjoys perfect health and tranquillity. In the last place, flies perform a ninth kind of movement by conveying their legs and thighs around their head, which they rub and polish in various directions. It is evident that this movement cannot take place after they have been decapitated.

XXVIII. Flies certainly would not exhibit these phenomena if they experienced as acute pain as warm-blooded animals when subjected to decapitation, which is constantly followed by speedy death. Will it be said that these different movements suppose, on their part, neither pleasure nor recreation, but rather a need which they experience of rubbing and polishing their legs, their wings, and different parts of their bodies? But if this be the case, we must be forced to confess that decapitation does not prevent them from being sensible to small privations and old habits, which are by no means necessary to their existence; a manifest proof that it occasions no pain to them, or at least that it is exceedingly slight; otherwise they would not attend to things of so little importance.

XXIX. Cold-blooded animals could supply me with many examples of a similar kind; but I shall content myself with mentioning only one, furnished by the tortoise. If the head of this animal be cut off, or, what is still better, if its brains be scooped out with dexterity, it seems to be scarcely sensible of the operation; it continues to walk as before, it ascends and descends, avoids those obstacles which it meets with, turns itself to different sides, stands up on its hind paws, and performs movements of every kind; and though its paws are covered with a hard and scaly skin, if they are slightly touched even with a feather when it is walking, or has been a little irritated, it immediately draws them back, and remains some time at rest: in a word, its sensibility seems to be so little altered, that it feels the smallest impression made on its shell. Tortoises live in this manner five or six months without any change being observed in their movements or habits: there are even certain movements which they execute with more readiness and surety than in their state of integrity. Such is
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that by which they turn themselves on their belly, and stand up on their hind paws. They at length die at the end of six months; but it appears that their death ought to be ascribed rather to hunger than to the operation to which they have been subjected, since those on whom it has not been performed die in the same time if deprived of nourishment. If the tortoise in this state experiences real pain, were it even very slight, it would certainly not feel the weak impressions made on the shell which covers it; for it is well known that a very strong impression entirely effaces that which is very weak.

XXX. The facts I have established will, no doubt, find many opposers. This must be the case. They are surprising; have even something of the marvellous; and tend, in particular, to destroy errors hitherto considered as incontestable truths.

XXXI. We, however, know that sensibility is very weak in animals at the time of their birth; that it is gradually expanded with their organs; and, when come to its highest degree, it begins to decrease by insensible gradations until it is at length entirely extinguished, when the animal dies. It is easy to observe these different degrees of sensibility in animals attacked by diseases, or subjected to experiments of this kind.

XXXII. I might here add, that no naturalist is now ignorant that the small eels which have been the object of my observations, and which are found in different kinds of the gall-nut, can pass insensibly from the state of death to that of life; die again, to be afterwards revived, if circumstances admit; and that the number of these different resurrections is still indetermined. It is more than twenty-six years since I published, in different journals, the observations which confirm these truths; and I have demonstrated, in the most evident manner, that these small animals may be revived at pleasure; that they enjoy this singular faculty as long as they are hermaphrodites, but that at the moment when they assume a sex they return to the common law, and, when once dead, can no longer be revived. I have even found the means of giving them a sex at pleasure, and these means are those employed by nature for perpetuating their species*.

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* These truths and several others are explained and illustrated in a work, which I intend to publish, on the life, death, and sensibility of animals. This work, several fragments of which have been communicated, for more than twenty years past, to different learned men in Europe, will be enriched with above 200 engravings, and will form two large volumes.