THE SCIENCE

OF

HORTICULTURE.

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THE SCIENCE
OF
HORTICULTURE:

COMPRISING
A PRACTICAL SYSTEM
FOR THE
MANAGEMENT AND TRAINING OF FRUIT-TREES,
EXEMPLIFIED BY
SKETCHES FROM TREES ACTUALLY TRAINED.

ALSO A
Comparative Investigation
OF THE
FOUNDATION AND APPLICATION OF THE PHYSIOLOGICAL PRINCIPLES OF MR. KIRWAN, SIR HUMPHRY DAVY, MRS. IBBETSON, AND MESSRS. HITT, FORSYTH, AND KNIGHT.

SECOND EDITION.

TO WHICH ARE ADDED,
AN ESSAY ON THE CULTIVATION OF THE PINE-APPLE,
DESCRIBING AND EXEMPLIFYING BY SKETCHES,
An Improved Arrangement for furnishing every necessary Degree of Heat by Steam, and of applying it to every required Purpose:
THE RESULTS OF A COURSE OF
EXPERIMENTS IN GROWING PEACHES AND NECTARINES, IN POTS, IN A CONSERVATORY;
With an Explanation of a new Mode of training Trees for this purpose, exemplified by Sketches: and a Description of a liquid Manure adapted to all Plants, and the Manner of applying it.
AND
AN ESSAY ON THE NATURE AND PROPERTIES OF HEAT,
DIFFUSED BY THE INTRODUCTION OF A CURRENT OF WARM AIR, HEATED BY STEAM.

By JOSEPH HAYWARD.

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TO THE

HORTICULTURAL SOCIETY

OF LONDON.

MY LORDS AND GENTLEMEN,

You publicly describe yourselves to be associated for the purpose of improving Horticulture in all its branches, and under this character you are incorporated: having paid considerable attention to experimental gardening as an amusement, I was enabled to make improvements that were thought to be important, and feeling desirous of contributing my efforts to establish the object you profess to have in view, I made, and long persisted in making, attempts to obtain your attention and co-operation, but in return was treated with neglect and injustice, and after a long and evasive correspondence on your part, being led to believe that the opposition I met with arose principally from individual influence, I determined on laying my observations and the result of my experience before the public, and this I did in a treatise on the Science of Horticulture, published by Messrs.

Longman and Co. in 1818; and feeling every confidence in your public professions as a body, and every regard for so respectable an association of noblemen and gentlemen, I dedicated my work to you, knowing it to be a prevailing opinion, that practical gardening could not be learnt from books, I submitted to your consideration the outlines of a plan and prospectus for establishing an experimental garden, which was returned to me without comment. A short time after this, being informed that you were about forming such an establishment, I wrote to ask if such was the case, and received for answer, that I had been misinformed. Four years then elapsed, and although I was not aware that during this time any one had attempted to controvert my opinions, to deny my demonstrations, or to refute my conclusions, I had reason to believe that the practical application of my principles was doubted, and that my system of management, as explained and shewn by my sketches, was considered to be merely theoretical. Some of your members, indeed, although they had never seen my garden or trees, I know had expressed themselves to this effect: confirmed therefore in my former opinion, that nothing but ocular demonstration could do away those erroneous impressions, and remove prejudice; and well aware that you possessed the full public patronage, and consequently that without your aid and concurrence any individual attempt to raise the requisite establishment must be abortive, and at the same time being flattered by the unequivocal expression, by every person, without exception, who allowed me to shew them my garden and explain my principles of practice, of their conviction of the correctness of my representations, and their admiration and approbation of the result of my practice, among whom were several of your most respectable members, I again endeavoured, by letter, to prevail on your Society to put my principles and plans under a course of practical demonstration, or to send a deputation of your members to inspect the results of my experiments in my garden, and to favor me with their report; to this I received the following answer from your Secretary: "It is an established rule of the Society, to which they always adhere, never to give an opinion as a body upon any subject of nature or art that comes before them, and that, consequently, they cannot depute any part of their body to examine your garden." Not considering this to be an explicit answer to my propositions, I wrote again to that effect, when I received the following answer from the same Secretary: "I am ordered to hold no further communication with you on the subject." As it possibly may be inferred that such an abrupt reply was induced by some offensive language on my part, it may be necessary I should state that I am not aware of any such having been used; indeed within a short time of this I was favoured by the same Secretary with a polite note, requesting I would give to the Society an explanation of the principles and results of some experiments I was making of growing peaches and nectarines in pots, and the nature and properties of the liquid manure which I used; but after the treatment I had experienced, I of course could feel little inducement to comply. Now, you publicly avow that you give medals and other acknowledgements to those who make discoveries and improvements in Horticulture, or in other respects promote the object of your association. May I not then ask, is not this an expression of your opinion as a body? and is not the public led to believe that every real improvement offered to the Society will be acknowledged or rewarded? or at least those of the greatest merit; and that consequently any new system offered to you, and failing to obtain youı sanction, must be considered as fallacious, and undeserving your attention? or is it to be understood, that you are associated for the purpose only of collecting mere objects of curiosity and casual production, to the exclusion altogether of matters which relate to *the science* of Horticulture? This I cannot suppose, but believe that a comparative few only of your members interfere with, and determine, the particular arrangement of your proceedings; to the others, therefore, and to the public I now appeal. Can it be asked of what value is the science of Horticulture? and which must necessarily include the science of Agriculture. Can people consider themselves to be well instructed, or duly qualified to judge of cultivation, who have no correct notion of the relation of effects to their causes in the process of vegetation? It is justly observed by an eminent author, that "every thing which is wrought with certainty, is wrought upon some principle; if it is not, it cannot be repeated." Also says, "the value and rank of every art is in proportion to the mental labour employed in it, or the mental pleasure produced by it." To these I may likewise add the well-known axiom, that "to be happy the mind must be occupied." As a science calculated to sustain this, Botany has been long considered as worthy the attention of the higher classes of society; but the garden has been left to the controul of the lower classes, in whom little other ability has been required than that of imitating their predecessors. And even with these limited qualifications, the gardener is generally permitted to reign lord paramount of his domain, the proprietors acquiescing in a complete dependence on his will and caprice, for whatever may be the produce. And whilst every expence is lavished in importing and fostering even the worthless weeds of foreign countries, our conservatories, as well as gardens and orchards, are too often found to be little better than exhibitions of deformity, distortion, disorder, and premature decrepitude. If it be thought worth while to enquire what is the cause of such a state of things, may it not be answered, that Botany is generally understood to comprise nothing more than a knowledge of the exterior construction and the classification of plants; and that it therefore affords no other occupation for the mind, than the study and application of dry rules and tables; that the garden is considered as administering to the animal functions only; and that its productions are regulated and determined by a mysterious art, a knowledge of which can be attained only by a laborious attention to coarse and unpleasant masters, and is, therefore, unworthy the occupation of a delicate and cultivated mind. But whatever may be said of Botany, it must surely be admitted, that such an opinion of Horticulture is founded on a most deplorable error. What science presents a more extended and varied occupation for the mind than the Physiology of Plants? and grounded on a knowledge of this, what a more healthful amusement than their cultivation? and what can afford a more delightful and independent gratification than their productions? However elaborate and conclusive may have been the works of Phytologists; and however successful in their productions, the practical gardeners, it must be sufficiently obvious, that these two departments of Horticulture are very imperfectly connected; for although original principles or causes may be well understood and explained, and the most satisfactory effects partially produced, can a due knowledge of Horticulture be said to exist, unless the process or laws of nature, which lead from cause to effect, and connect the one with the other, be understood and elucidated? Is it not to be desired that theory and practice be united? and if it be so, are my endeavours to supply this connecting link, by removing those obstacles to improvement, and the existence of natural beauty, ignorance and prejudice, and to establish the practice of Horticulture on the fundamental principles of true science, deserving no better treatment from your Society than the affectation of silent contempt? It may be denied that I have any claim upon the notice of your Society; but it is clearly obvious, if I am correct, that the common practice of Gardening must be egregiously wrong. Then have I not, on the grounds of your claiming and possessing a monopoly of the public patronage, of the authority you assume of influencing and leading the public opinion, and your having refused to investigate or acknowledge the correctness of my representations, and the principles upon which they rest, a right, on the part of the public as well as myself, to ask an explanation of such conduct? or is it to be inferred from your silence, that you will not affirm, and cannot deny, my claims?

TO THE

PRESIDENT AND MEMBERS

OF THE

HORTICULTURAL SOCIETY OF LONDON.

MY LORDS AND GENTLEMEN,

ALTHOUGH I have the honour of being personally known to a very small number only of the Members of your excellent Society, the Philanthropy and National Spirit which dictate the liberal Principles of your Association, cannot but command my admiration and respect; and under the impulse of this feeling, united with the natural wish of obtaining the patronage and support of superior talents and acknowledged authority, to a Work prepared for the same purpose for which you are associated, that of improving and generally diffusing the Knowledge of Horticulture, I cannot resist the desire of doing myself the honour of dedicating the annexed Treatise to you.

Possibly it may appear to some, that from the very flattering attention which your Society have been pleased to bestow on such Papers as I have occasionally taken the liberty of submitting to your inspection at various times during the past eight or ten years, your offer of publishing them among your Transactions, and your professed desire of making Extracts for your public Readings, ought not to have been resisted. I could not be insensible to the honour thus intended me, and felt extreme regret at being obliged to decline it; but the Regulations of your Society, excluding all further right of an Author to Papers so published, was altogether incompatible with my views of future revision and experiment.

The study of Horticulture and Experimental Gardening has been my most pleasing amusement, and commanded my attention from my childhood. I am, however, not so vain as to imagine that the Work I now lay before the Public is so complete as to be free from error, or incapable of improvement.

I am old enough to know that every thing connected with the human mind is progressive; succeeding generations will improve upon the present; and I may live to make improvements, and more perfectly to arrange even my own system.

We have the declaration of one of our most distinguished Philosophers, that "Science was extending with such rapidity, that even while he was preparing his Manuscript of Agricultural Chemistry for the press, some alterations became necessary."

And indeed, I flatter myself, that such of your Members as have perused my former papers, and will do me the honour to peruse the present Work, will find, that, in the short interval that has elapsed, I have been enabled to make some important additions.

I must further add, that I feel your very polite suggestion, that if I chose to publish my work by Subscription, many of your Members would become Subscribers, to be particularly entitled to my grateful acknowledgements, and an additional inducement to offer you the best testimony in my power, of my sincere admiration and esteem, by dedicating to your truly respectable Society the present Work; and by requesting your acceptance and protection.

And am,

MY LORDS AND GENTLEMEN,

Your most obedient,

And very humble Servant,

JOSEPH HAYWARD.

PREFATORY

EXPLANATIONS AND REMARKS.

THE numerous works that have already been laid before the Public, on the subject of Horticulture, may possibly raise an expectation that I should offer some Apology, or give some explanation of the motives which induce me to aspire to public favor.

About twenty years since, Hitt's Treatise on Fruit Trees, published in the year 1750, was put into my hands. After I had read and contemplated this work, I could not but consider all Trees trained in the common manner, as deformed, distorted, and disordered objects. And having at the time a number of young trees that had been planted a year or two, I immediately reduced them to a proper state for training, after his method; but I very soon found it a difficulty bordering on impossibility, to produce the effect described by him, by the application of his principles, in the manner directed, and conformable to the precise Figures he exhibits; yet, by a due attention to Nature, I was enabled to proceed with considerable success.

To this Author I acknowledge myself indebted for the first ideas of establishing fixed principles for the general management of Fruit Trees: previously, however, to the perusal of his work, I had paid considerable attention to the training and pruning of Trees, and had established the principles of training the Vine, published in the London Horticultural Society's Transactions.

Ten years since I was flattered in the success of my experiments and improvements, and felt convinced of the possibility of reducing that, which was in its general practice no more than an uncertain and mysterious Art, to a clear and delightful Science; but I had not the vanity to believe I was myself equal to this arduous task. I therefore courted the attention and assistance of several eminent characters; but from causes unknown to me, my applications were not attended with the desired effect.

Still, however, wishing for investigation and discussion, I repeatedly appealed to superior authority, but no one has ever attempted a refutation of any of my Principles or Theorems.

Before therefore I am condemned as self-conceited in thus claiming public attention, I hope those efforts to obtain correction and assistance will be allowed their due weight.

Devoted to the study of Nature, and attending at all times more to her Laws than the Rules of Art, I make no pretensions to the merit of a polished style of writing; and if to any it should appear that I have indulged in harsh expressions, or in too much freedom or severity in my Comments on the labours of others, I trust the zeal arising from the warm pursuit of a favorite object, and a strong desire to elicit Truth, are considerations that will plead my Excuse.

The difficulty of acquiring a knowledge of training and managing Fruit Trees from Books, has been remarked and deplored by all the different writers on the subject, to whom I have thought it necessary to refer in the course of my work; *viz.*—Bradley*, Miller, Hitt, Forsyth, Mr. Knight, and

* Miller — " And here it may be necessary to make an apology for adding to the number of books on this subject, which of late have been very much increased; so that many persons have thought it useless to write any more on the science. When their works are narrowly examined, it will appear that some of the most popular authors have done little more than changed the language, or artfully transposed the sense of those who wrote long before them, without taking the least notice to whom they were indebted for their works."

Bradley — " As there is no subject of more general use and advantage than the cultivation of land, and the improvement of the vegetable world, so there is none which has been treated of more largely, and fallen under such variety of pens of all kinds. The public, which is generally so good-natured on this occasion as to accept and encourage any thing that looks towards the bettering their fortunes, has never been so much baulked in their expectations as in books of Agriculture."

" Authors have generally transcribed one another without the least acknowledgements of their thefts, or adding one single improvement to the knowledge of their forefathers."

Hitt — " I am apprehensive this Treatise will meet with the

the Encyclopædia Britannica; and although this insufficiency has been thus early and generally noticed, the present state of the Art proves how little has been done to remedy the defect. Without a correct knowledge of the Cause, no one can possibly be certain of success in producing or preventing an Effect.

A reference to those authors will show how trifling has been the improvement in Horticulture, since Bradley and Miller, and the reason is obvious; however acute their observations, and ingenious their description of certain Effects, they do not appear to have had a correct comprehension of the Cause.

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fate of many others; that is, of being despised by some readers." Again, "which work I am afraid will be neglected by several practitioners who despise books, and take a pleasure in rendering them useless to others."

Forsyth — "Of books I have never availed myself farther than as they might tend to assist in perfecting my catalogue of Fruits; for at a time when I did once begin to read, with a view to improvement of my practice, I soon found myself more bewildered than instructed, and have never since resumed the task."

Encyclopædia Britannica — "Pruning, though an operation of very general use, is nevertheless rightly understood by few, nor is it to be learned by rote."

Mr. Knight — "I have been induced to believe that none of the forms in which Fruit Trees are generally trained, are those best calculated to promote an equal distribution of the circulating fluids, by which alone permanent health and vigour and power to afford a succession of abundant crops can be given."

Feeling convinced of this, and of the necessity of adopting a different course from that pursued by my predecessors, I have on all occasions reverted to Nature, and to original and elementary principles or causes; and hence, tracing effects by regular demonstrative experiments, I have been enabled to deduce and arrange a System of Practice which has produced the most desirable results.

However, I am not disposed to arrogate authority, nor so self-sufficient as to wish my assertions to be taken for granted, but feel it due to every person, to be allowed a fair opportunity of forming their own judgment, and of being convinced, by the fair means of explanation and illustration, that their long established practice is insufficient, before they are required to give it up in favour of a new mode.

With this view I have adopted the plan of a Commentary on the different Authors I have thought it necessary to refer to, and where their observations and opinions could be compressed in my own language, without the possibility of misconstruction, I have done it to the best of my ability; but in cases where this could not be done, I have thought it a justice due to those authors, to quote literally; and, for the sake of a more ready comparison, I have also given Sketches of their different Figures.

Perhaps nothing can more clearly evince the imperfect state of Horticulture, or afford a more substantial proof of the absence of scientific principles in its general practice (at any rate of that part which forms the principal subject of the present work), than this general opinion, that a correct knowledge of the Art of Gardening cannot be obtained from books.

When, indeed, any art rests upon a bare mechanical movement, grounded on the casual and contracted observation of effect only, it must be impossible to diffuse a general knowledge of it by writing.

And when, instead of reverting to original and demonstrative principles, those who write on any subject, ground their systems upon a preceding author, who perhaps was led away by some favorite untried theory; the difficulty of applying rules thus formed to existing circumstances, cannot but raise a strong prejudice against books.

When the peculiar Laws or Elements upon which a process is founded and carried on, are correctly ascertained and demonstrated, and by clear Explanation and Elucidation are reduced to Scientific Principles or Rules, a correct knowledge is readily conveyed by writing; therefore, although occasional disappointments have occurred, when expecting to derive correct information from books, we ought not to condemn them altogether; this would be placing an effectual bar, not only to the immediate diffusion, but to the farther progress of knowledge.

There are indeed many instances where an author has been happy in a discovery, and successful in forming and describing its Theory, and applying it to practice to a certain extent, but pursuing it beyond the point of its correct application, he has bewildered and confused his subject; and when this is the case, a person taking up such a book, intending to pursue it as a study, and to profit by the Rules of Practice there laid down, finding himself disappointed in many of the results of his application, naturally concludes that the work is inadequate to his purpose, and he throws it aside.

Thus Bradley discovered and gave a clear description of the nature and effect of the sexual system of plants, correctly stating that the accidental coupling of the blossoms of different plants, and their consequent interchange of Farina, creates variety in the seeds or their produce; and that repeatedly propagating from the seeds, gives birth to plants of a constitution adapted to the vicissitudes of the climate they are raised in.

And this has been most successfully and profitably sustained by the laudable attention and extensive practical experiments of many eminent Horticulturists, to whom the world are indebted for many most valuable varieties of Fruit, Pulse, and esculent Vegetables. But Bradley also states, that the promiscuous distribution of the Farina of one fruit tree with another, not only blends the nature of the two fruits in the seed, but it likewise compounds and depreciates the flavor of the fruits of the different trees and plants by the admixture. The fallacy of this conclusion is clearly demonstrable, and its effect evidently prejudicial.

GENERAL INTRODUCTORY

OBSERVATIONS AND COMMENTS.

THE study of the Physiology of Plants, by dissection, microscopical examination, and chemical analysis, has of late much occupied the attention of our Horticultural Philosophers; particularly Mr. Knight and Mrs. Ibbetson (a lady who has studied the Organism of Plants, aided by a powerful Solar Microscope, and whose observations are published in a series of papers in Nicholson's Philosophical Journal); but in their attempts to apply their theories to practice, they do not appear to have been successful; they have overlooked those simple habits or laws, which lead to the grand object of horticulture; and, consequently, their labours have not been productive of any great improvement to the practical gardener.

Hitt appears to have had a clearer conception of the course or flowing of the Sap in Trees, than any other author, and grounding his practice on this, he has commenced his instructions for training them, on correct principles; but his Plates exhibit such figures as are not conformable to the laws of nature, and to such precise forms as are depicted by his sketches, it has been found impossible to train Trees, so as to produce the effect, and in the time, described by him.

Forsyth, by giving Trees their full extent of growth, succeeded, no doubt, in furnishing handsome-looking Trees, and to produce in them an early fructiferous state ; but after four or five years, Trees trained in his manner must be found to grow extremely unequal, and out of bounds ; and I am inclined to think, that those who have followed Mr. Knight's plan, will have experienced no advantages superior to those suggested by either Hitt or Forsyth.

Miller says, " And there is no surer guide to a curious artist than Nature, from whence a gardener should always be directed in every part of his profession, since his business is to aid and assist Nature, where she is not capable of bringing her productions to maturity, or where there is room to make considerable improvements by art, which cannot be otherwise effected than by gently assisting her in her own way."

In those ideas I perfectly agree with Miller, and by strictly conforming to such principles, I shall endeavour to establish a system free from those errors and defects, which have occasioned the failure of other authors, and at the same time explain in a manner sufficiently clear and perspicuous, the mode of obtaining the utmost advantages that are held out by any or all of them.

As to compiling a Catalogue of Fruits, I think it would be extending a work, and adding to its expense for a trifling purpose.

On this subject I cannot but agree with Bradley, who, speaking of Apples, says, "To set down the several and various names of Apples would be a work almost impossible, seeing how many various kinds are yearly produced from kernels, in almost every county of England, and where they happen to prove good, either for making of cyder or table use, they have names given to them, according to the mind of the person that raised them." And if such was the case in Bradley's time, what must it be now? Any person referring to Forsyth's Treatise will find that, although he gives a catalogue of upwards of two hundred sorts of Apples, occupying, by his description, thirty-nine pages of his book, there are still a great many unnoticed, and his description is not sufficient to direct any person in the choice of fruit.

Although the variety of other fruits may not have increased in the same proportion as Apples, yet, a considerable number are to be found, not described, or they are given under such names as they are not known by; the public, therefore, after all, must depend upon their own selection, or that of the nurseryman.

The System of Vegetation is most harmoniously and uniformly arranged by the Great Author of Nature, and its various processes regulated and determined by unerring and immutable laws. In her general progress of reproduction, Nature is ever inclined to make an exuberant return for an exuberant supply; thus giving to man the opportunity, by availing himself of this propensity, to increase and forward the most valuable qualities of those productions, which are more peculiarly adapted to his use and enjoyment.

But although we may, by occasionally exercising our controul over the sexual intercourse of vegetables, and by increasing, withholding, or diminishing a supply of food, induce them more readily to contribute to variety; and by confining a Tree within a convenient space, or generally by encouraging or obstructing particular habits, make it more conformable to our wants and pleasures; we are not permitted to overstep the bounds prescribed by the laws of Nature with impunity; for whenever this is attempted, privation and disappointment must be the consequence; therefore, before we proceed to the arrangement of a system of management, it will be necessary to take a distinct view of the material parts of Plants, or at least in their most important divisions, and to consider their separate use and offices, and the laws by which they are governed.

ON THE ROOTS OF PLANTS.

The Root is the commencement and foundation of trees: by what particular power it is impelled forward into the earth, is of trifling importance to the practical gardener; and whether it may be accounted for on the principles of gravitation or attraction, it is not necessary for my present purpose to determine: it is progressive in its growth, similar to the branches, but in an inverted direction. As the branches of a tree are formed by a very tender and succulent point pushing upwards into the air, so the root penetrates downwards into the earth; but as it has to make its way through the pores, or between the particles composing the soil it is planted in, which is often close and tenacious, its first projecting points are wisely adapted to the purpose, by being much more minute and compliable, which enables it to advance almost as readily as water. After a Root has effected a passage, it is endowed with considerable expansive and repulsive powers, and thereby enabled to make its way, by pushing off, on all sides, the encumbering soil; when the soil is but partially submissive, the Root accommodates itself to the cavity admitting its increase, however rugged and irregular.

Roots are, notwithstanding, impatient of resistance, and at all times evince a partiality for that soil which is most accommodating, and run most evenly and luxuriantly where they meet with the least resistance and the greatest support.

The office of the Root is to collect and apply the food, which forms and determines the growth of the Plant and Tree; and the constitution and habit of the Roots determine those of the branches. If the Roots grow luxuriantly, the branches will also; and the reverse.

From hence it must be concluded, that in planting trees, two essential objects present themselves for our consideration: first, to ascertain the soil best adapted to afford a sufficient and accommodating body, bed, or space for the Roots to repose and range freely in, and induce and support such habits as are most desired; and next, that it contains or will admit the application of a supply of food, of a proper quality, and in due quantity. And to determine this, due attention must also be paid to the situation or elevation of the Roots, in comparison with the surface of the soil. In a deep tenacious soil or clay, Roots can only find a free passage through fissures or clefts which are formed by its occasional contraction. And as these openings are not very close together or numerous, the Roots do not divide much or become fibrous; but those which strike into them, range wide and deep, and getting beyond the general influence of the sun and air, collect their food or sap from a source ill adapted to fructification; and consequently Fruit Trees under such circumstances are generally found to be of a cold, aqueous, and unprolific nature.

On the contrary, when a soil is light, porous, and shallow, the Roots, meeting no obstruction, divide and form a great number of fibrils, which ranging horizontally, and being more exposed to the effect of the sun and air, incline a tree more to become fructiferous, than to an increase of wood or an extension of branches. And in such a situation, the greatest supply of food being appropriated to the production of fruit, the tree grows but little in size.

It is remarked by Hitt on this part of the subject: "I have made observations on the productions of most kinds of soil, and found the most healthy old Peach and Nectarine Trees growing on a brown-coloured loam, with a rock about a foot from the surface of the borders. From this I conclude, that it will be a good method to lay a floor of broad stones or planks under the Roots of Fruit Trees, where there is not a natural rock, which will prevent the Roots from sinking too much below the surface; for the tap or downright Roots may produce vigorous shoots, yet they are but seldom well furnished with blossom-buds. When all the Roots of a Tree are near the surface of the borders, it blossoms best, being well furnished with small branches, which are not so subject to suffer by the honey-dews as thicker ones."

Mr. Knight, in his Treatise on the Apple and Pear, says, " The strongest and most highly flavoured liquor which has hitherto been obtained from the Apple, is produced by a soil which consists of a shallow loam on a limestone basis."

Miller, speaking of Fruit Trees, says, " And it sometimes happens that the Roots of Trees are buried too deep in the ground, which, in a cold or moist soil, is one of the greatest disadvantages that can attend tender Fruits; for the sap, which is contained in the branches, being by the warmth of the air put strongly into motion early in the Spring, is exhausted in nourishing the blossoms, and a part of it perspired through the wood-branches, so that its strength is lost before the warmth can reach to the shoots, to put them into an equal motion in search of fresh nourishment to supply the expense of the branches, for want of which the blossoms fall off and decay. And the shoots seem to be at a stand until the further advance of the warmth do penetrate to the Roots, and set them in motion, when suddenly after, the Trees which before looked weak and decaying, do make prodigious progress in their shoots, and before the Summer is spent, are furnished with much stronger branches than those Trees which have the full advantage of sun and showers, and that are more fruitful and healthy; which must be certainly owing to the former observations, as also to their drawing in a great quantity of crude moisture, which, although productive of food, is yet unkindly for Fruit."

He also says, "Some authors who treat of the qualities of the earth, say that it ought to be of the same quality, three or four feet deep, for Trees, which, if they have not that depth, will languish and decay after they have been planted six years. But this is not true in fact: for most Trees will thrive very well if they have two feet depth of good earth, especially Fruit Trees, which produce the most generous Fruits when their Roots spread near the surface of the earth."

Whether we consider the effects here stated to be produced by the Roots being kept more within the influence of the sun and air, or by the peculiar nature of the food supplied by the soil in that situation, it operates in support of one and the same principle, *viz.* that it is necessary the Roots should be kept near the surface; for whether that which supplies the food of Plants be a red, a black, or a brown loam, or sand or clay, the proper quality of food to induce fructification, and produce the highest flavoured fruits, can only be furnished within a certain depth from the surface, or within the proper influence of the sun and air.

Mrs. Ibbetson has given a Theory which directly opposes those Practical Observations and Conclusions; when speaking of the Roots of Plants, she says, "The endeavours I have made to collect facts sufficient to prepare myself to give an exact account of the laws by which the Root is regulated, the powers which govern it in its exterior as well as interior form, the parts which compose, and the mechanism which moves it, has at length given me courage sufficient to venture on my task, and if I do not thoroughly satisfy my readers, I shall still show many things perfectly unknown, and at a further time, I shall hope to add circumstances that may render it more complete and more worthy the attention of the public, at least I can promise that I shall advance nothing but what all may ascertain the truth of, nor enter into any detail that may not be proved to be just and true, by those who will take the trouble of seeking both in dissection *and practical Gardening*, that knowledge which constant labour and watching has procured me."

I certainly do not possess the powers of examination, or perhaps of dissection, to justify any criticisms on Mrs. Ibbetson's representations *of what she has seen;* but as the connection, application, and use of the different parts as seen and described by her, are in a great measure conjectural, I may perhaps, without presumption, venture to offer a few remarks *on her opinion* of the process of nature. She says, " It is the Tap Root which always forms the leading shoot of the tree, and if it is cut, it will without doubt spoil that part, by forming two middle stems to the tree, at least I have generally found this to be the case; and as the beauty of the tree depends much on the perpendicular height of its single pillar, the custom they have in most nurseries of curtailing the Tap Root is a most vicious one."

She also says, "What is the use of the Tap Root? by shooting perpendicularly down to fix the tree firmly to the ground and keep it straight in that position."

This appears to me a conjecture, neither supported by the observations of nature, nor the principles of science.

What person possessing the least knowledge of mechanics, could ever expect that a pole, with any substance fixed at its top, exposing a large surface to the winds, could remain straight in its perpendicular position when set in the earth, without horizontal fixtures? Indeed the elm, one of the tallest-growing trees, is seldom if ever found with a Tap Root, but is supported straight in its perpendicular position wholly by horizontal or lateral Roots. The authoress proceeds, "Thus it is surrounded by radicles which perpetually pump up from every different soil as it proceeds in depth, what other Roots cannot attain, matter, which mixed with what the higher grounds bestow, serves to bring a variety to compound the different ingredients required for the various nourishment of the tree; probably minerals are wanted to form the juices of the bark; and I doubt not that the deep descent of the Tap Root is most necessary to the health and vigour of the tree. How improper then is the custom of cutting it, and curtailing also many of the other Roots, each of which has its appropriate branch, which will of course suffer in decay, for the dilapidations produced by the ignorance of the gardener. But the loss of the Tap Root can never be remedied, it can no longer serve as a deep well to gain not only a quantity of moisture from the number of rills it may meet with in its descent, but also matter from a variety of soil, and innumerable productions it passes in its way. The Tap Root then is only like the radicles, only a large pump to collect and throw up all that it can select of water and other juices, the second part of the Root (which she describes to be the place where the root joins the Trunk,) is the reservoir for collecting the materials, and the third part is the laboratory for forming each different gas and juice necessary for the health and habits of the tree; I may well add a fourth, for the radicles are the collectors sent out on every side to seek fresh provisions, to augment the stores, and increase the riches of this little habitation."

Again, "That a Tap Root or any Root that is injured should be cut off, there can be no doubt, since the danger of the rot is greater than any other inconveniencies; but the greatest care, when trees are to be transplanted, should be taken not to hurt the Roots, and if any radicles can be preserved by wrapping them up in fresh earth, it should be done, for if they will live a little time, it will be a great gain to the tree; and here is the advantage of having the pit ready dug, and removing the plant with all the earth round it; it preserves the few radicles alive, and enables them directly to perform their office of pumping moisture and nourishment from the earth. But if the tree is taken out some hours before it is replaced, all the radicles are sure to die. And if the Tap Root also is injured, no wonder they never make fine trees, or that those planted by nature are always found superior. The reason that throwing a quantity of water into the pit has been found serviceable is, that it supplies moisture and quickens the growth of the new radicles, and what is still more advantageous, and should be constantly done, a large barrow of good mould should be thrown on the Roots and about the radicles; for a young and tender Root, if it has to pierce through the clods of earth in its sickly state, will certainly fail."

These observations, as they respect trees in their native soil and climate, may generally apply; but when it is considered that the business and art of a nurseryman and gardener is to render the nature and habits of trees as subservient as possible to every variety of soil and situation, and the experience and observation of all show that the Tap Root is prejudicial to fructification, I cannot but think that the terms "*ignorant and vicious*," as they respect the general operation of cutting off or changing the course of the Tap Root in young Plants, and particularly of Fruit Trees, are ill applied; but when attached to the too general practice of breaking off and reducing the Roots on every transplanting, neither those nor any other words can be too severe.

That a Tap Root or any other Root is peculiarly adapted to supply any particular branch or part of a tree, I very much doubt; but should this be the original arrangement in the system of nature, experience proves that it is not an invariable law, for if a part of the branches of a tree be lopped off, the sap which those would have consumed, is given to the remaining branches, and they are proportionally increased. Whenever part of the Root is taken off, it does not affect any particular branch, but the whole of the branches are equally affected by the privation and loss; and although cutting off the Tap Root may, by lessening the supply of moisture, produce the same effect as an extended surface of branches, and incline a tree to vary the vertical growth of its branches at an earlier period, yet it is proved in every nursery-ground that all young Plants of erect-growing Trees, are inclined to form their strongest branches in a perpendicular position, and if not obstructed, to throw out its whole strength into one stem, until it attains a height proportioned to its nature and supply of food, and this even after the Tap Root is removed.

The effect intended by pouring water into the pit on transplanting, as here explained, is undoubtedly desirable, but it will seldom be produced by such means.

A great quantity of water poured on will often cement or encrust the earth, and render it so close and adhesive, that it will obstruct the emission of fresh radicles, or the progress of the old ones, and the Plant in consequence will be much injured.

Water in those cases should be applied a little at a time and often; this will afford sufficient moisture, and keep the soil loose.

Mould may be a good thing thrown into the pit in the quantity here mentioned, about the Roots of Forest Trees when planted, but it must be improper for Fruit Trees; for by retaining a large portion of moisture, it will oppose fructification, and endanger their health, or by affording a luxuriant supply of food, the Roots may be made to increase rapidly in size, but form few in number. A few large Roots running deep and spreading wide, may be necessary to produce a large Timber Tree, but it will be prejudicial to a Fruit Tree, for, as before observed, those trees are always more prolific when the Roots are much divided or fibrous, and kept near the surface of the soil.

ON THE FOOD OF PLANTS.

The Food of Plants has for a long time excited an anxious enquiry, and a great variety of conjectures have been formed as to what it consists of, or in what state it is taken up by the Roots. It has been an object of research with men of the greatest talents and learning, and to aid them, the powers of chemistry have been exerted and applied in a variety of ingenious experiments. The earth, as well as vegetables and animals, has been analysed and variously described, and accurate observations have been made and stated; but as yet no one has been able to describe a theory that has obtained general concurrence, or to establish a clear and practical rule for ascertaining the quantity and quality of the Food of Plants furnished by particular soils, nor the means of giving fertility, or restoring it when exhausted, by regulated proportions.

Although the earth appears capable of affording and sustaining a spontaneous produce in vegetables and fruit, her powers of production or principles of fertility are found to be limited, and possessed in different degrees by different portions; and it has been clearly proved that they are sooner or later exhausted by the growth of particular vegetables, according to the nature and situation of the soil; it therefore became an object essential to the Arts of Horticulture and Agriculture, to ascertain the nature of vegetables and the composition of the soil most congenial to their different productions, in order to be enabled to remedy defects, remove opposing matter, and supply deficiencies, or, in other words, to sustain, increase, or diminish, the powers of production, or principles of fertility.

Vegetables, like animals, vary in their nature and habits, and like them have their peculiar food, for although the Food of Plants may generally be composed of the same elements, it varies in the proportion of its composition, and thereby becomes adapted to different purposes; thus we find, that a soil which will furnish only Food enough to support one Plant of a peculiar kind, will at the same time furnish sufficient to sustain many others of different species.

Bradley, in the work I have before noticed, says, "Land animals may be likened in general to those Plants which are called Terrene, for that they live only upon the earth, such as oak, elm, beech, &c.; amphibious animals, such as otters, beavers, tortoises, frogs, &c. which live as well on the land as in the waters, may be compared to the willows, alders, minths, &c. The fish kind, or aquatic race, whether of the rivers or the sea, are analogous to the water plants, such as water lilies, water plantains, &c. which live only in the fresh waters, or the fuci, &c. which are sea or salt water plants, and not any of these will live out of its proper element; from whence we may conclude how improper it would be to plant a water lily on a dry sandy desert, or an oak at the bottom of the sea, which would be just as reasonable as if we propose to feed a dog with hay, or a horse with fish; however this rule of nature has been so little observed, even by some of our greatest planters, that we can hardly boast of good success in one out of five plantations that have been made."

He also says, "I shall beg leave to remark, that as the several land animals have their respective diets, so have the Terrene Plants their several soils from whence they derive their nourishment, as some animals feed on flesh, others on fish, &c. so do Plants love, some clay, others loam, sand or gravel; nor is this all we ought to observe, we must consider likewise how beneficial to every Plant is a right exposure, whether in a vale, the sides or tops of hills, exposed to the south or north winds, whether inland or near the sea, for it is a proper exposure that keeps a Plant in health."

Bradley, Hitt, and Miller, consider the Food of Plants to be salts, which every species of earth, more or less, contains within itself; and that according to the proportion of salts contained in each kind of soil or manure, will its prolificacy be.

That all soils, and all vegetable and animal matter, may be found to produce salts, under certain chemical processes, I have no doubt; but this does not prove it to be necessary that every substance, or any substance containing the basis or elements of salts, should undergo this process, and be formed into salts, before it can be in a state to constitute Food fit for the reception and nourishment of Plants.

Salts are various in their nature and general effects, when placed in contact with other substances.

I have made many experiments with sea salt, nitre, soda, barilla, &c. &c. and feel myself justified in concluding, from the results, that salts are not in any degree an essential in the Food of Plants.

The opinions of Drs. Smith and Pearson on this subject, appear rational: they say, that salts, as they operate in promoting vegetation, are analogous to mustard, cinnamon, ginger, &c. which are not of themselves at all, or necessarily nutritious, but contribute to render other things nutritious by exciting the action of the stomach, and other organs of digestion and assimilation. Dr. Pearson also says, — "I have no doubt of the truth of the position, that no living thing, neither Plant nor Animal, can grow or live in a state of visible action, without supplies of matter that has been alive; in other words, living Animals and Vegetables can only live on dead Animals and dead Vegetables; no Plant nor Animal has ever been known by experience, nor in the nature of things does it seem reasonable, that they can be nourished by mere water and pure air, as some persons have asserted."

Notwithstanding all that has been said to establish the opinion that salt is a valuable manure, I am convinced it never can, as an article of food, contribute to the increase of any vegetable, but as a chemical agent, by destroying and hastening the decomposition of animals and vegetables, and by its deliquescence, it may in many instances increase the fertility of soils.

Mr. Kirwan, in an Essay on Manures and the Food of Plants, as applicable to Agriculture, takes a very correct and comprehensive view of his subject.

Sir Humphry Davy also has favoured the world with a very luminous work on agricultural chemistry.

Both those eminent chemists appear to have maturely considered the nature of Manures and the Food of Plants, and, no doubt, have explained their opinions and detailed their experiments with great clearness and perspicuity.

Were it possible for me, in a work like this, to convey an adequate idea of the information contained in either of those works, it may appear conceited and presumptuous to attempt it; but as I could not claim the merit of having done my best to elucidate my subject, without a reference to such splendid authorities, and finding it difficult to explain their arguments, experiments, and results, in any language equal to their own, I trust I shall be excused in making considerable literal extracts. Although in the general opinions and principles of those eminent chemists there appears to be a great coincidence, I trust it will be admitted that there is a sufficient difference to shew, that the subject cannot be considered as finally arranged, or at rest, and that I may be justified in offering a commentary, and an explanation of my own ideas.

Mr. Kirwan observes, " The first essential requisite to a fertile soil is, that it contain a sufficient of the three or four simple earths, and of the soluble carbonaceous principle: the other requisites are, that the proportion of each and general texture of the soil be such as to admit and to retain as much water as is necessary to vegetation and no more."

Sir Humphry Davy says, " The surface of the earth, the atmosphere, and the water deposited from it, must either together or separately afford all the principles concerned in vegetation; and it is only by examining the chemical nature of these principles, that we are capable of discovering, what is the Food of Plants, and the manner in which this food is supplied, and prepared for their nourishment."

He also says, " By methods of analysis, dependent upon chemical and electrical instruments discovered in late times, it has been ascertained that all the varieties of material substances may be resolved into a comparatively small number of bodies, which, as they are not capable of being decompounded, are considered, in the present state of chemical knowledge, as elements. The Bodies incapable of decomposition, at present known, are forty-seven; of these, thirty-eight are metals, six are inflammable bodies, and three, substances which unite with metals and inflammable bodies, and form with them acids, alkalies, earths, or other analogous compounds. The chemical composition of Plants has, within the last ten years, been elucidated by the experiments of a number of chemical philosophers, both in this and other countries, and it forms a beautiful part of general chemistry, if the organs of Plants be submitted to a chemical analysis; it is found that their almost infinite diversity of form, depends upon different arrangements and combinations of a very few of the elements, seldom more than seven or eight belong to them, and three, constitute the greatest part of their organised matter."

"All the varieties of substances found in Plants are produced from the sap, and the sap of Plants is derived from water, or from the fluids in the soil, and it is altered by, or combined with, principles derived from the atmosphere."

"Soils in all cases consist of a mixture of differently divided earthy matter, and with animal or vegetable substances in a state of decomposition, and certain saline ingredients. The earthy matters are the true basis of the soil; the other parts, whether natural, or artificially introduced, operate in the same manner."

Sir Humphry also says, "What may be our ultimate view of the laws of chemistry, or how far our ideas of elementary principles may be simplified, it is impossible to say — We can only reason from facts, we cannot imitate the powers of composition belonging to vegetable structures, but at least we can understand them, and as far as our researches have undergone, it appears that in vegetation, compound forms are uniformly produced from simpler ones; and the elements in the soil, the atmosphere, and the earth, absorbed and made parts of beautiful and diversified structures."

Kirwan states, " All Plants, (except the subaqueous) grow in a mixed earth moistened with rain and dew, and exposed to the atmosphere; if this earth be chemically examined, it will be found to consist of silicious, calcareous, and argillaceous particles, often also of magnesia in various proportions, a very considerable quantity of water, and some fixed air. The most fertile also contain a small portion of oil, roots of decayed vegetables, a coaly substance arising from putrefaction, some traces of marine acid, and gypsum. On the other hand, if vegetables be analysed they will be found to contain a large portion of water and charcoal, also of fat and essential oils, resins, gums, and vegetable acids, all which are reducible to water, pure air, inflammable air and charcoal; a small portion of fixed alkali is also found, some neutral salts, most commonly Epsom, tartar vitriolate, common salts and salt of sylvius."

So far, things are merely reduced to compounds, and the opinions of these great men accord; but Sir Humphry, farther says "If any fresh vegetable matter which contains sugar, mucilage, starch, or other of the vegetable compounds soluble in water, be moistened and exposed to air, at a temperature of from 50 to 80, oxygene will soon be absorbed and carbonic acid formed, heat will be produced, and elastic fluids, principally carbonic acid, gaseous oxyde of carbon, and hydro-carbonate will be evolved, a dark coloured liquid of a slight sour, or bitter taste, will likewise be formed; and if the process be suffered to continue for a time sufficiently long, nothing solid will remain except earthy and saline matter, coloured black by charcoal.

"Animal matters are in general more liable to decompose than vegetable substances, oxygene is absorbed, and carbonic acid and ammonia formed. In the process of their putrefaction they produce compound elastic fluids and likewise azote; they afford dark coloured acid and oily fluids, and leave a residuum of salts and earths mixed with a calcareous matter, the ammonia given off from animal compounds in putrefaction, may be conceived to be formed at the time of their decomposition, by the combination of hydrogene and azote; except this matter, the other products of putrefaction are analagous to those afforded by the fermentation of vegetable substances, and the soluble substances formed, abound in the elements which are the constituent parts of vegetables, in carbon, hydrogene, and oxygene." *

Again, "The circumstances necessary for the putrefaction of animal substances, are similar to those required for the fermentation of vegetable substances, a temperature above the freezing point, the presence of water and the presence of oxygene, at least in the first stage of the process. He likewise says, "It is probable that as yet we are not acquainted with any of the true elements of matter."

It however appears that both animal and vegetable matters are reducible to the same principles, and so far simplified as to be clearly capable of the different combinations required to reproduce and sustain both animals and vegetables.

Kirwan observes, "Hence we see on the last analysis the only substances common to the growing vegetables, and the soils in which they grow, are water, coal, different earths and salts: these therefore are the true Food of Vegetables; to them we should also add, fixed air, though by reason of its decomposition it may not be distinctly found in them, or at least not distinguishable from that newly formed during their decomposition."

Sir Humphry adds, "Vegetable and animal substances deposited in the soil, as shewn by universal experience, are consumed during the process of vegetation, and they can only nourish

* Animal matter containing nitrogene, which vegetable matter does not.

the Plant by affording solid matter capable of being dissolved *by the fluids in the leaves of vegetables;* but such parts of them as are rendered gaseous and that pass into the atmosphere, must possess a comparative small effect, for gases soon become diffused through the mass of the surrounding air.

"The great object in the application of manures should be to make it afford as much soluble matter as possible to the Roots of the Plant, and that in a slow and gradual manner, so that it may be entirely consumed in forming its sap and organized parts."

So far the component parts of the Food of Plants seem to be generally understood and admitted; and on the medium of its application and consumption, Kirwan observes, "The agency of water in the process of vegetation, has not till of late been distinctly perceived: Dr. Hales has shewn, that in the summer-months a sun-flower weighing three pounds avoirdupois, and regularly watered every day, passed through it or perspired 22 oz. each day, that is, half its weight. Dr. Woodward found that a sprig of common spearmint, a Plant that thrives best in moist soils, weighing only 28.25 grs. passed through it 3004 grs. in 77 days, between July and October, that is somewhat more than its whole weight each day. He did more, for he found that in that space of time the Plant increased 17 grs. in weight, and yet had no other food but pure rain water, but he also found that it increased more in weight when it lived on spring water, and still more when its food was Thames water. Secondly, that the water they thus pass nourishes them merely as water, without taking any foreign substance into account, for 3000 grs. of rain water, in Dr. Woodward's experiment, afforded an increase of 17 grs., whereas by Margraaf's experiments, 5760 grs. of that water contain only ⅓d of a grain of earth: but, Thirdly, it also follows that water contributes still more to the nourishment of Plants, besides the service it renders them in distributing the nutritive parts throughout the whole structure, forming itself a constituent part of all of them, may be understood from modern experiments. Dr. Ingenhouz and M. Senebier have shewn that the leaves of Plants exposed to the sun produced pure air. Now water has of late been proved to contain about 87 per cent. of pure air, the remainder being inflammable air; WATER IS THEN DECOMPOSED BY THE ASSISTANCE OF LIGHT WITHIN THE VEGETABLE, ITS INFLAMMABLE PART IS EMPLOYED IN THE FORMATION OF OILS, RESINS, GUMS, &C. ITS PURE AIR IS PARTLY APPLIED TO THE PRODUCTION OF VEGETABLE ACIDS, AND PARTLY EXPELLED AS EXCREMENT."

This last Theory will be found to accord with every practical observation, and must form the groundwork of every system of Horticulture, arranged on demonstrative principles that can be expected to be sustained with success.

Kirwan further states, " To Mr. Hazenfraz we owe the discovery, that coal is an essential ingredient in the food of all vegetables; though hitherto little attended to, it appears to be one of the primeval principles, as ancient as the present constitution of our globe, for it is found in fixed air, of which it constitutes above one fourth part, and fixed air exists in lime stones and other substances which date from the first origin of things.

" Coal not only forms the residuum of all vegetable substances that have undergone a slow and smothered combustion, that is, to which the free access of air has been prevented, but also of all putrid vegetable and animal bodies, hence it is found in vegetable and animal manures that have undergone putrefaction, and is the true basis of their ameliorating powers; if the water that passes through a putrifying dunghill be examined, it will be found of a brown colour; and if subjected to evaporation, the principal parts of the residuum will be found to consist of coal; all soils steeped in water communicate the same colour to it, in proportion to their fertility, and this water being evaporated, leaves also a coal, as Hazenfraz and Fourcroy attest."

Sir Humphry Davy says, " *No substance is more necessary to Plants than carbonaceous matter*, and if this cannot be introduced into the organs of Plants, except in a state of solution, there is every reason to suppose that other substances less essential will be in the same case. I found by some experiments made in 1804, that Plants introduced into strong solutions of sugar, mucilage, tanning principle, jelly, and other substances died, but that Plants lived in the same solutions after they had fermented. *At that time I supposed that fermentation was necessary to prepare the Food of Plants, but I have since found that the deleterious effects of the recent vegetable solutions were owing to their being too concentrated, in consequence of which, the vegetable organs were wholly clogged with solid matter, and the transpiration of the leaves prevented;* * the beginning of June in the next year, I used solutions of the same substances, but so much diluted that there was only about one two-hundredth part of solid vegetable matter in the solutions. Plants of Mint grew luxuriantly in all those solutions, but least so in that of astringent matter; I watered some spots of grass in a garden with the different solutions of jelly, sugar, and mucilage, which grew most vigorously, and that watered with the solution of tanning principle grew better than that watered with common water."

This experiment certainly shews the fertilizing powers of those vegetable substances, but as the decomposition of such substances spontaneously takes place in so short a time, I think it most probable, that Sir Humphry's first idea was a correct one, and that they were reduced by fermentation to the common state of manures, before they became ap-

* A very singular conclusion this.

plicable, and that with the concentrated solutions the accumulated gas resulting from the fermentation destroyed the vegetables; or as Kerwan remarks, "Vegetables not only require Food, but that this Food be duly administered to them, a surfeit being as fatal to them as absolute privation."

And further, "Hazenfraz and Fourcroy attest, that shavings of wood being left in a moist place for nine or ten months, began to receive the fermentative motion, and being then spread on land, putrefied after some time, and proved an excellent manure. *Coal however cannot produce its beneficial effects, but inasmuch as it is soluble in water,* the means of rendering it soluble are not as yet well ascertained, nevertheless it is even now used as a manure and with good effect."

"In truth, the fertilizing power of putrid animal and vegetable substances were pretty fully known even in the remotest ages, but most *Speculatists* have hitherto attributed them to the oleaginous, mucilaginous, or saline particles then developed, forgetting that land is fertilized by paring and burning, *though the oleaginous and mucilaginous particles are thereby consumed or reduced to a coal,* and the quantity of mucilage, oil, or salt in fertile land is so small, that it could not contribute the 1000th part of the weight of any vegetable, whereas coal is not only supplied by the land, but also by fixed air combined with the earths, *and also by that which is constantly let loose by various processes, and soon precipitates by superiority of its specific* *gravity, and is then condensed in, or mechanically absorbed by soils,* or contained in dew."

This corroborates my preceding observations, and exhibits a difference in the opinions of those authors, but it is of no great importance, as Sir Humphry Davy also says, " Mucilaginous, gelatinous, saccharine, oily, and extractive fluids, and solution of carbonic acid in water, are substances that in their unchanged states contain almost all the principles necessary for the life of plants ; *but there are few cases in which they can be applied as manures in their pure forms,* and vegetable manures in general contain a great excess of fibrous and insoluble matter, which must undergo chemical changes before they become the Food of Plants."

I cannot think any case ever existed where such fluids were taken up as Food in an unchanged state, but that the fluids as well as the fibrous parts, must previously undergo chemical changes.

On earths Kirwan says, " The next most important ingredient to the nourishment of Plants is earth, and of the different earths the calcareous seems the most necessary, as it is contained in rain water, and absolutely speaking many Plants may grow without imbibing any other. *M. Ruckert is persuaded that earth and water, in proper proportions, form the sole nutriment of Plants.* But M. Giobert has clearly shown the contrary ; for having mixed pure earth of alum, silex, calcareous earth, and magnesia in various proportions, and moistened them with water, he found that no grain would grow in them, but when they were moistened with water from a dunghill, corn grew in them prosperously—hence the necessity of the carbonaceous principle is apparent."

He also says, "Earths cannot enter into plants but in a state of solution, or at least only when suspended in water in a state of division as minute as if they really had been dissolved; that siliceous earths may be suspended in such a state of division appears from various experiments, particularly those of Bergman, who found it thus diffused in the purest waters of Upsal; and it is equally certain that it enters copiously into vegetables. Both his experiments, as especially those of Macie, establish this point beyond contradiction. Argillaceous earth may also be so finely diffused as to pass through the best of filtres; so also may calx, as appears from the quantity Margraaf found in the purest rain water."

On this part of the subject, after reciting a number of experiments, Sir Humphry Davy observes, "The general results of this experiment are very much opposed to the idea of the composition of the earths by Plants, from any of the elements found in the atmosphere or in water."

He also says, "As the evidence on the subject now stands, it seems fair to conclude *that the different earths* and saline substances found in the organs of Plants *are supplied by the soils* in which they grow, and in no cases composed by new arrangements of the elements in air or water."

Here again is a difference in the opinion of those great chemists, but as it may be considered as theoretical, it is of little importance; the grand principle seems admitted to be demonstrated, *viz.* that earths are a necessary ingredient in the composition of plants, that no substance can be taken into the system but in a state of solution, and that all the earths, siliceous, calcareous and argillaceous, are not only capable of solution, but are contained in all waters in the common state.

Carbonic acid seems also to be considered as an essential article of Food; and Kirwan further remarks on this subject —

" *That plants do not thrive, but most frequently perish, when surrounded by an atmosphere of fixed air*, has long been observed by that great explorer of the most hidden processes of nature, Dr. Priestly; *but that fixed air, imbibed by the roots, is favorable to their growth*, seems well established by the experiments of Dr. Perceval of Manchester, and fully confirmed by those of M. Ruckert. This last-mentioned philosopher planted two beans in pots of equal dimensions, filled with garden mould; the one was watered almost daily with distilled water, the other with water impregnated with fixed air, in the proportion of half a cubic inch to an ounce of water; both were exposed to all the influence of the atmosphere except rain — the bean, treated with ærated water, appeared overground nine days sooner than that moistened with distilled water, and produced 25 beans, whereas the other pot produced only 15; the same experiment was made with stock July flowers and other plants with equal success. The manner in which fixed air acts in promoting vegetation seems well explained by Senebier; he first discovered that fresh leaves exposed to the sun in spring water, or water slightly impregnated with fixed air, always produce pure air as long as this impregnation lasts; but as soon as it is exhausted, or if the leaves be placed in water out of which this air has been expelled by boiling, they no longer afford pure air, from whence he infers, *that fixed air is decomposed, its carbonic principle retained by the plant, and its pure air is expelled. It appears to me also, by acting as a stimulant, to help the decomposition of the water.* Hazenfraz, indeed, denies its decomposition; but his arguments do not appear to me conclusive, for reasons too tedious and technical to mention here."

Sir Humphry Davy admits that the presence of fixed air is necessary to preserve health and sustain the vigorous growth of plants, but he seems to consider it more as a necessary sustenance to be taken into the system *by the leaves, than as Food by the Roots.*

He says, " When a growing plant, the roots of which are supplied with a proper nourishment, is exposed in the presence of solar light, to a given quantity of atmospheric air, containing its due proportion of carbonic acid, the carbonic acid after a certain time is destroyed, and a certain quantity of oxygene is found in its place; if new quantities of carbonic acid gas be supplied, the same result occurs, *so that the carbon is added to plants, from the air, by the process of vegetation in sunshine, and oxygene is added to the atmosphere.*" He adds, "This circumstance is proved by a number of experiments made by Drs. Priestly, Ingenhouz and Woodhouse, and M. T. de Saussure, many of which I have repeated with similar results. *The absorption of carbonic acid gas, and the production of oxygene, are performed by the leaf.* And leaves recently separated from the tree effect the change, when confined in portions of air containing carbonic acid, and absorb carbonic acid and produce oxygene, even when immersed in water holding carbonic acid in solution."

The opinion that fixed air is consumed by plants, seems to be unanimous, and to those who believe in the doctrine of the circulation of the sap, it may appear necessary to support their theory, that the carbonic acid should be absorbed by the leaves. But Kirwan's observations do not lead us to conclude that it is at all necessary that the leaves should possess such powers, and I shall hereafter endeavour more clearly to show that this is the fact, when treating of the leaves of plants.

Animal and vegetable manures, when placed in contact with plants, in a recent or undecomposed state, are generally more productive of evil than good; for if death or disease does not immediately ensue, the plant grows to such a gross and bloated state, as to be very far from prolific; indeed, experience proves that the most productive and perfect state of plants is produced and sustained by a mixture of animal and vegetable matter that has been perfectly decomposed, and which has been for a long time (say twelve months at least) turned over and exposed to the sun and air.

I am inclined to infer from these and other observations, that nitrogene in combination is the injurious principle, and that before manure can be reduced to a wholesome state, this must be expelled. To corroborate this idea it may be mentioned, that gum appears to be the only vegetable substance which contains nitrogene, and gum is the production of disease.

It is well known that fermentation reduces animal and vegetable manures to a more wholesome and immediately nutritive state than a cold and aqueous putrefaction; and that during fermentation ammonia is created and passed off; and as ammonia is formed of nitrogene and hydrogene, this again corroborates the idea that nitrogene is poisonous to plants, and that any method of facilitating its escape is more requisite than that of its retention; and therefore the suffering manure to remain on the surface of the soil, until it is reduced to a proper state to be carried to the roots as food by water, must be much more conducive to health and fructification, than burying it before it is perfectly decomposed; and it shows that that which is by some supposed to be a loss by evaporation is in fact a gain.

ARRANGEMENT

OF

CHEMICAL PRINCIPLES AND PRACTICAL DEDUCTIONS.

Although this subject has engaged the attention of so many eminent philosophers, none of them appear to have established a theory, that will generally accord with actual observation, or from which we can form a scientific arrangement of practical rules; but the following elementary principles, which are universally admitted, enable us to trace effects, ascertain causes, and to draw conclusions, that will be found applicable to every existing case or positive result.

All things that constitute animated nature, are reducible to the same primitive or elementary principles, *viz.* oxygene, hydrogene, nitrogene, carbon, and earth. The three first are permanent elastic fluids, the fourth a permanent substance; and although the earths are proved by Sir Humphry Davy, to be compounds of highly inflammable metals and oxygene, it does not appear that they are found in any other state, than as such compounds, in vegetables or animals, nor that it is necessary they should be further subdivided, either for the reproduction, or sustenance, of vegetables or animals. I shall therefore take the liberty, in the arrangement of my system, to consider the earths as elementary principles.

Oxygene is the vital air of life, the principle of combustion, and the vehicle of heat, the pure air of Kirwan.

Hydrogene is the basis of inflammable air, and is the lightest of all ponderable things, the inflammable air of Kirwan.

Nitrogene, or azote, is the opposite of oxygene, and is incapable of supporting combustion and animal life.

Carbon is the basis of common charcoal, divested of all its impurities.

Atmospheric air is compounded of the two different permanent substances oxygene and nitrogene in certain proportions, rendered aerial by the expansive power of heat.

Water is composed or formed of hydrogene and oxygene in certain proportions, and, in its common state, always holds a portion of earth in a state of solution, and generally of carbon also.

Vegetable substances are reducible to oxygene, hydrogene, carbon, and earth.

Animal substances are reducible to oxygene, hydrogene, nitrogene, carbon, and earth.

With these elementary principles in view, tracing the composition and decomposition of animals and vegetables, it will clearly appear, that matter, in the general composition and continuation of the world, is indestructible, and as far as we are enabled to comprehend, that the animal and vegetable parts are continued and sustained by transmutation, and that the general process of nature is to create or compose, by destroying or decomposing.

Thus animals forming the superior part of the creation, are endowed with the powers of destroying, masticating, digesting, and decomposing, the substance of both animals and vegetables.

Vegetables, which are more delicately formed, seem peculiarly designed to act in unison with animals, in continuing the animated world, by bringing the divided substances again into action and union.

Animals devour both animals and vegetables to support themselves, and by this they are at the same time made instrumental in preparing the Food of Plants, by facilitating the decomposition of both animals and vegetables.

From the peculiar organisation of vegetables, their food can only be taken up in a state of liquid, and water is the only vehicle by which it can be administered.

Whatever therefore constitutes the grand invigorating or accumulating principle in the Food of Plants, must be reducible to a soluble state, or be held in solution. Although water, in its pure state, contains hydrogene and oxygene only, as it is necessarily brought in contact with, or made to pass through, animal and vegetable substances, which are always scattered over the surface or contained in the soil, before it can come within reach of the roots, it dissolves and carries with it the carbonaceous and earthy matter.

Plants possess the power of decomposing water, and in the composition of their own various substances, of retaining and applying the carbon, hydrogene, and earth, and a portion of oxygene, and at the same time of emitting the superfluous oxygene as excrementitious.

Animals, by respiration, decompose the atmospheric air, retaining part of the oxygene, and emitting the other part united to carbon, (forming carbonic acid gas) and the nitrogene.

Animals and vegetables, when deprived of life and left to spontaneous decay, are decomposed by fermentation, and by this process carbon and earth are deposited; and oxygene, (which is increased by absorption or attraction) is disposed of, by part forming carbonic oxyde, and part carbonic acid gas; the hydrogene and nitrogene are emitted as simple gas, or united as ammonia.

Carbonic acid gas, or fixed air, is formed by a certain portion of carbon being dissolved and held in solution or combination by oxygene, and is more ponderous than atmospheric air.

These elements, being thus separated, are again combined by the various processes of nature.

By the combustion of electricity, the oxygene gas, emitted by vegetables, and the hydrogene gas, by putrescent animal and vegetable matter, are united and form water.

By natural affinity, oxygene gas is combined with the nitrogene gas thrown off by the respiration of animals, and atmospheric air formed.

Carbonic acid gas from its density is readily brought in contact with calcareous, carbonaceous, and metallic substances, and also with water, and by these absorbed or decomposed.

ON THE

COMPOSITION OF SOILS,

AND THE AGENCY OF THE EARTHS IN VEGETATION.

ALTHOUGH the Earth is in fact a variable compound, as it respects vegetation, we need not pursue it farther than the following simple division; *viz.* Calx, or the calcareous principle; Silex, or the silicious; Clay, or the argillaceous; Magnesia, or magnesian; and Carbon, the carbonaceous, or, as it is commonly called, Mould.

The first four substances are what Miller properly calls the containing part or body, bed or couch, and the fifth substance, or mould, (which is the result of decayed animal and vegetable matter) the part contained.

It is clearly proved that neither of the four substances, calx, clay, magnesia, or silex, in a pure state, whether separate or combined, will support a plant; and the vegetative power of every part of the earth is determined by the quantity of mould, or animal and vegetable matter it contains.

Earth is proved to be an essential part of vegetables; but the quantity discovered in them is so small, and of such a nature, as to be contained in and conveyed by water.

Too great an accumulation or concentration of vegetable and animal matter, or mould, renders it as a soil unfit for the propagation and sustenance of most vegetables: we therefore find it is in the course of nature divided and diluted, by the intervention and admixture of the other primitive substances, and in this state or combination it forms what is called loam.

Every part of the surface of the globe, that supports vegetables, consists of an admixture or covering of loam, of greater or less depth, and the depth and proportion of the admixture, the degree of exposure to the sun and air, the nature of the substrata, and the quantity of water supplied, determine the produce of the general substance or soil.

It is a very general opinion that carbonic acid gas, or fixed air, constitutes the principal Food of Plants, but this is not demonstrated. Carbonic acid gas, which is composed of carbon held in solution by a large portion of oxygene, is no doubt constituted of the two grand principles of vegetation; but it does not appear to me probable or necessary that it should, in a combined or gaseous state, be applicable as Food; but being decomposed by calcareous earths, the acid neutralized, or the superabundant oxygene withdrawn, by forming some other union, and the carbon united with water, it is then converted into Food.

It may perhaps be necessary that carbon should be reduced to the same state, as when capable of uniting with oxygene to form carbonic acid gas, before it can be held in solution by water, and consumed and appropriated by plants.

Every observation proves that a superabundance of oxygene is detrimental to plants; it is also certain, that the formation and emission of carbonic acid gas, either by the soil or the plant, reduces its prolificacy.

The most fertilizing manures are found to be such as are produced from the decomposition of animal and vegetable matter, by such processes as oppose or prevent the formation of carbonic acid gas.

Without an excess of water in a continued state, carbon stops short of that degree of oxygenation which is essential to form it into an acid, and is then said to be converted into carbonic oxyde, and this appears to me to be the state in which it is most convertible to the Food of Plants; hence we find, that stagnant water is detrimental to Plants.

Unless the soil be previously charged with a sufficient quantity of alkali or acid, to neutralize each other, or be so subdivided, by the intervention of the siliceous and calcareous earths, as to oppose concentration, the addition of either makes a soil sterile, and detrimental to vegetation.

Fermented liquors, such as beer, containing a great quantity of fixed air, or carbonic acid gas, when applied to the roots of plants in a common soil, retard and obstruct their growth; and stronger acids, such as the acetous or vinegar, brought into immediate contact with the roots, destroy vegetable life.

It is observed that Plants, when growing in the shade, give out carbonic acid gas, but when exposed to the rays of the sun, they give out oxygene only; by this we are not to conclude, that carbonic acid gas has been taken up ready formed, by the leaves or roots as food, and again emitted in that state, but that a carbonaceous solution in water is taken up as food, and that the sun enables the Plant to digest this food, which consists of water holding in solution earth and carbon, and apply it to its various uses; and thus, by facilitating the escape of oxygene, preventing the formation of carbonic acid gas, and the consequent loss of its carbon, its grand material; and when the sun is excluded, the decomposition or digestion is incomplete: the food is then expelled undigested, as carbonic acid, and the Plant becomes weak, unhealthy, and diseased.

Carbon cannot be produced by art in a state of purity, without the application of excessive heat approaching to fire; and there appears good reason to suppose, that it cannot be prepared to admit of the required solution in water, or be reduced to a state fit for the Food of Plants, without the aid of the sun's rays, digestion in the bowels of animals, the heat consequent to fermentation or fire; for we find, that animal or vegetable substances buried in an organized state, and decomposed under the earth, furnish very little wholesome Food for Plants, whilst excluded from the sun, fire, &c.; but being at any period afterwards exposed to the action of the sun and air, or brought in contact with such heat, with calcareous earths, or with absorbent and caustic substances formed by fire, they are reduced to a state to fertilize the earth, or to become the Food of Plants.

By the urine and excrement of animals, by the application of fire to vegetable and animal matter, and by exposing it to the sun, and an excess of water, alkaline salts are produced, and the natural decomposition of animals and vegetables, by fermentation, is found to produce acids, carbonic acid gas, carburetted hydrogene gas, ammoniacal gas, &c.; and hence it is supposed by some, that these form the grand principle of food and substance of vegetables, but it is proved, that neither alkaline or other salts, nor acids, will of themselves sustain or produce an immediate increase in Plants.

Rank and gross vegetables are sometimes found to grow where the different gases are emitted in large quantities, and appear to devour the solutions of decomposing substances in the most impure state; this is clearly demonstrative in the cabbage tribe when grown for the table, and particularly in sea kale; for when this is grown in a soil richly manured, it retains so strong and rank a flavour, as to be scarcely eatable; but when it is grown in pure loam, or in a soil in which the manure had been for some years, it is sweet and delicious.

Such Plants as grow rapidly, and luxuriantly, are often diseased, and seldom prove fructiferous. The cause is obvious, the substances which afford the gas are in union with a large portion of water, and by this a large supply of Food for Plants is furnished, but it is in such a state or proportion, so diluted, aqueous, and impure, as to require the exposure of a larger surface of stalk and leaf, to the influence of the sun and air to reduce it to a fructiferous state, than annual Plants can sustain; consequently these fall to the ground.

When trees and shrubs overshadow each other, the rays of the sun are excluded from some, and by those a great part of their carbon is emitted in combination with the oxygene, as carbonic acid gas; they are then left in a debilitated state, and devoid of the needful stamina, which is often followed by disease, putrefaction, and death.

A soil that, by exposure to the sun and air, or the operation of fire, or by being composed of the calcareous, siliceous, and argillaceous earths in due proportion, is so constituted as to modify the decomposition of vegetable and animal products, by passing off superfluous water, and preventing the formation and escape of carbon, as carbonic acid gas, and carburetted hydrogene gas, produces and sustains the most healthy Plants, and renders them most prolific in seeds and fruits.

In addition to the foregoing comments it may be remarked, that Jethro Tull, in his treatise on Horse Hoeing, published in 1733, advanced the opinion, that minute earthy particles supplied the whole nourishment of the vegetable world; that air and water were chiefly useful in producing these particles from the land, and that manures acted in no other way, than by ameliorating the texture of the soil.

And Van Helmont, in 1610, believed that he had proved, by decisive experiments, that all the products of vegetables were capable of being generated by water.

It is demonstrable that an immense quantity of water is raised from the earth by evaporation; and in conformity with this, and the opinion that nourishment is absorbed and furnished by the leaves of Plants, and from them conveyed through the system, it is remarked by an eminent agriculturist and writer of the present day, J. C. Curwen, Esq., that ploughing and stirring up the earth facilitates and increases such evaporation, and that when this process takes place among Plants, *their growth is quickened and increased by the vapour which is consumed by their leaves;* although neither of those doctrines can be supported by demonstration, the observations of these eminent men are by no means groundless, but well worth attention; for notwithstanding their theories or opinions, as to the grand operating cause, are fallacious, the beneficial effects which arise from the practical application of their favourite process, in the general cultivation of land, are undoubted.

Van Helmont's ideas, that all the products of vegetables were capable of being generated by water alone, are not strictly just; but it is certain, that without water, vegetables cannot grow; and indeed, that their growth is regulated, if not entirely dependant upon the supply of water to the Roots.

Jethro Tull's opinion, that the native soil in itself contains all that is necessary for the sustenance of vegetables, is refuted by every year's experience of the gardener and farmer; but his method and principle of cultivation will always be found to increase fertility; and Mr. Curwen's conclusions, that the vapours arising from the soil, when stirred up, affords additional sustenance to Plants, by being absorbed and taken into the system by the leaves, is equally fallacious; for if such be the case, the vapour arising from the earth, being so light as to be wafted by the most gentle current of air, those vegetables growing on the land, which is lying alongside that which is hoed or stirred up, must be benefited; but this is not found to be so; still the operation is undoubtedly beneficial.

The true principles upon which the whole is sustained appear to be the following:

Water holding in solution certain substances furnishes the sole Food of Plants.

The Roots of Plants having extracted and consumed that part of water which is adapted to their purpose, the residue becomes useless and obnoxious, and, unless removed, engenders disease.

Therefore, to keep up a constant and regular supply of food, and to preserve health, a change or circulation of water is as necessary to vegetables as a circulation or change of air is to animals.

Earth by itself (as subjected to the influence of cultivation) is in no other respect requisite for the sustenance of Plants than as a laboratory, and bed or couch, to prepare the food, and for the roots to range, feed, and repose in.

Earth of every kind is capable of holding a certain portion of water by capillary attraction, and, according to its texture, of admitting a rapid or slow passage of water through it.

The gravity of water falling on the surface of the earth, in rain or otherwise, occasions its descending motion or filtration, and when the surface is heated by the sun, the water there is rarified, raised again, and passed off in vapour: and thus the attraction being increased, an ascending motion is created.

Water, in its ascent and descent, being brought in contact with the carbonaceous matter contained in the earth, dissolves a portion, and is thereby replenished with the food required for the sustenance of vegetables, and thus passing among the roots it is distributed.

It is demonstrated by analysis, that the most fertile soils are those, which are so compounded, as to admit of the greatest, most minute, and most immediate division, expansion, and dissemination of water, in its passage through them; and which contain a sufficient proportion of the soluble carbonaceous principle, and of calcareous earth, to correct acidity and putrefaction.

And, consequently, the most effectual modes of making all soils prolific must be such as produce and sustain those essential qualities.

This is the true cause of the benefits resulting from the horse-hoeing of Tull and Mr. Curwen.

The more perfectly divided the soil, the more perfect and uniform will be the ascent and descent of the moisture; and the more minutely divided and disseminated, the carbonaceous or grand principle of fertility, the more readily dissolved and incorporated will it be with the water, and the more perfectly prepared and brought within reach of the Roots of Plants.

It may further be observed, that upon those principles rest the beneficial results of the agricultural processes of draining, irrigation, calcareous dressings, keeping the surface clear from weeds, and properly exposing it to the action of the sun, the air, &c.

From the preceding observations, we must also conclude, that not only the composition of the bed or couch requires particular attention, but that the nature of the substrata on which it rests, is also very material and important: for if this be so constituted and formed, as to retain the superfluous water, and occasion it to stagnate about the roots, it will produce sterility, disease, and death; and if it be too open and dry, it will, by permitting the water to drain off too rapidly, and by its incapacity to return it, rob the soil of its carbonaceous principle, and render it sterile.

No doubt, with vegetables as with animals, the quantity and quality of the food, and the protection and support afforded, determine their capacity and produce; therefore, in the course of cultivation, all arrangements must be made to accord with the object in view; and in this, our desires must conform to our means: it will be wasteful folly to provide a bed or couch, and food sufficient for a large tree, when we have space or room only for the trunk, branches, &c. of a small one, and the reverse.

ON THE

SAP OF TREES,

ITS RISE AND CIRCULATION.

Upon what principles, and by what application of power, the rise of the Sap from the Roots, and its distribution and transformation into the different parts and produce of the Tree, is conducted, is a question that has long been in agitation, and which has given rise to much speculation, argument, and difference of opinion, among the learned.

Many describe the Sap in vegetables as circulating, like the blood of animals, through an appropriate system of vessels, whilst others deny the possibility of such circulation, or even the existence of such vessels.

Bradley says, " The many curious observations which have been made concerning the structure of animal bodies, and what Dr. Grew, Malpigius, and myself have remarked, in the structure of vegetables, may ascertain to us that life, whether it be animal or vegetable, must be maintained by a due circulation and distribution of juices in the bodies they are to support." And proceeds to explain his opinion, " That the Sap circulates in the vessels of Plants, much after the same manner, as the blood doth in the bodies of animals." And after a variety of abstruse argument, he says, " In fine, a Plant is like an Alembic which distils the juices of the earth; as for example, the Roots having sucked in the salts of the earth, and thereby filled itself with proper juices for the nourishment of the Tree, these juices then are set in motion by the heat, that is, they are made to evaporate into steam, as the matter in a still will do when it begins to warm. Now as soon as this steam or vapour rises from the root, its own natural quality carries it upwards to meet the air; it enters then the mouths of the several arterial vessels of the Tree, and passeth up them to the top, with a force answerable to the heat that put it in motion: by this means it opens little by little, as it can force its way, the minute vessels, which are rolled up in the bud, and explain them by degrees into leaves; thus when we give a forcing heat to the root of a Plant, it grows quicker than when it has only a moderate heat; but as every vapour of this kind, when it feels the cold, will condense and thicken into water, so when the vapour which I mention to rise through the arterial vessels, arrive at the extreme parts of them, *i. e.* the buds of a Tree, it there meets with cold enough to condense it into a liquor, as the vapour in a still is known to do; in this form it returns to the root down the vessels which do the office of veins, lying between the wood and the inner bark, leaving, as it passeth by, such parts of the juices as the texture of the bark will receive and require for its support."

Miller says, " The notion of the circulation was entertained by several authors much about the same time, without any communication one to another, particularly M. Major, a physician at Hamburgh, M. Peracelt, Mariotte, and Malpighi: it has met however with some considerable opposers, particularly the excellent M. Doddart, who could never be reconciled to it.

" M. Doddart, instead of the same juices going and returning, contends for two several juices, the one imbibed from the soil, digested in the root, and from thence transmitted to the extremes of the branches, for the nourishment of the Plant; the other received from the moisture of the air, entering in at the extremes of the branches, so that the ascending and descending juices are not the same." And he further says, " In opposition to the notion of circulation of Sap in Trees like to that in animal bodies, the Reverend Mr. Hales, in his Vegetable Statics, presents us with various experiments."

Forsyth is evidently an advocate for the circulation of Sap: he says, " The Sap will always find its way first to the extremity of the shoots, and the spurs will only receive it in small proportion, as it returns from the end of the branches."

Mr. Knight is also an advocate for the doctrine of circulation, and has published a variety of papers, reciting a number of experiments that he has made, and which he considers to confirm the fact; and Sir H. Davy conforms to his opinions. He says, "In all plants there exists a system of tubes or vessels, which in one extremity terminate in the roots, and at the other in leaves. It is by the capillary action of the roots, that fluid matter is taken up from the soil. The Sap, in passing upwards, becomes denser, and more fitted to deposit solid matter; *it is modified by exposure to heat, light, and air, in the leaves; descends through the bark;* in its progress produces new organized matter, and is thus, in its vernal and autumnal flow, the cause of the formation of new parts, and of the more perfect evolution of parts already formed."

But Mrs. Ibbotson, who appears to possess ample means, and sufficiently extensive powers, for ascertaining the fact, by dissection and examination with a very powerful solar microscope, after explaining a variety of observations which induce her to conclude that the Sap does not circulate, says, "How strange, then, to alter all this beautiful arrangement, justified, indeed taught, by dissection, in order to find a place for *Sap vessels,* that cannot possibly require any; *for why must they have returning vessels?* — Is there not a great difference between an animal, which after the first few years has no increase, and a being that increases from every joint, and is supposed, therefore, to draw up only those juices necessary for that increase; especially as the Sap is the liquid of the earth, not the blood of the Tree, as is easily proved by adding nurture to the ground, when the Sap fails, which soon restores it? Besides, how is the circulation to be effected in the eternally increasing branches of a Tree, whose every additional twig must make a variation in the quantity of juices wanted?"

"Whereas it is naturally decreased as it mounts, by throwing out new shoots and branches, which expend the liquor as it rises."

After a variety of further argument, she proceeds: —

"And I believe I may say, that I am now so well acquainted with all the different vessels of a Tree, that I can no longer fail from ignorance; but here, except the inner-bark vessels, all proceed in a different direction, either round the Tree, or from the centre to the circumference: how is it possible that such large and powerful parts should be invisible?

"The use of dissection is to correct the use of imagination, or those experiments which have that effect, forcing the juices into channels foreign to that which Nature has appointed for them. I have before said, that I have ever found Nature disposed to such resources, in case of any unnatural impediment. I have myself proved it."

Here I must again remark, that I do not doubt this lady's powers of investigation, or the justness of her description of what she has seen; but her argument, that the Sap is not the blood of the Tree, but the liquid of the earth, because, by adding moisture to the earth when the Sap fails, it is thereby replenished, is rather singular. Does not the moisture added constitute, or extract, dissolve, and carry with it into the roots the food of the plant? And when blood is taken from an animal, is it not restored again by food and moisture taken in by the stomach? But if blood is not to circulate, I do not see why it should be supposed to exist in a plant.

The effect of grafting, shows that the Sap does not circulate, or at any rate, if it does circulate, that it undergoes no change by the ascending and descending motion; and this also establishes the fact, that every part of a Tree possesses the power of selecting and transforming the portion of fluid destined to its use, as it passes up.

A graft or bud is united by the Sap alone, which is formed into the different substances, as it passes through the various parts of the Tree, and the two parts are joined, like two metals, such as iron and steel, by welding, and like them, although adhering together as one, retain each their peculiar properties. If a graft or a bud of a coarse-grained spongy wood be engrafted on a fine close-grained stock, and both have grown on one stem or trunk, supporting a head for any length of time, even for a century, each will maintain its original and peculiar properties, as well as habits, in the wood; and the junction is always visible, the graft generally projecting to a larger size than the stock, immediately at the point of junction, which may be seen in most old orchards. And if any number of grafts of different sorts be placed one above another, each will retain its proportion of Sap, and appropriate the same to its own peculiar nature.

If the Sap is passed through the body of the Tree to its leaves, and there prepared and returned back, that part which is uppermost, and producing one variety of wood and fruit, must possess the power of preparing the fluids, for the production of every other sort below it, unless the Sap be supposed to pass up, and return in the same state, which amounts to a superfluity of motion, and an excess of exertion, seldom found in nature.

This subject has always been one of controversy; but notwithstanding the great variety of ingenious and elaborate experiments that have been made, none seem to have been sufficiently conclusive, to produce unanimity of opinion. The subtle and prolix arguments that have been adduced on both sides of the question, have not only failed to contribute much to the benefit of the practical gardener, but the principle, as explained by Mr. Knight, must operate as an obstacle to knowledge, and a bar to perfect practice, which will be seen by a reference to the description of his own method of training; and also by the manner they have been acted upon by Mr. Maher, and explained by the secretary of the Horticultural Society, hereinafter noticed; and also by Sir Humphrey Davy. As to many of Mr. Knight's experiments, I agree with

Mrs. Ibbotson, they may have been conducted with ingenuity and accuracy, but the results, as explained by him, cannot be generally conclusive.

To show the powers of Nature in continuing her functions, even after the apparently complete destruction of her apparatus or systematic arrangement, I state the following facts. A person* having a green bergamot pear tree, that seldom produced any fruit, removed the bark three-fourths of the circumference, which was about twenty-seven inches, and the width of half an inch. A neighbour, for a joke, removed the remaining fourth part of the bark in the same manner, so that a circle of bark, of half an inch, was removed completely round the trunk: the tree, in consequence, was expected to die; but, to the astonishment of many who examined it, the tree lived, and produced fruit, and is now alive, although the operation was performed five or six years since. Supposing that in this case the bark had not been completely severed, and that a small part might have escaped observation, I made the experiment accurately, by removing the bark, quite round the branch of a pear tree, and with it the last annual layer of wood; a shoot was thrown out above the incision, which produced and ripened a pear, before the bark had formed a junction, which it did not accomplish until the third year.

* Mr. William Whitmarsh, of Wilton, in Wiltshire.

ON

THE OFFICE AND USE

OF

THE LEAVES OF PLANTS.

THE office and use of the Leaves of Plants are nearly connected with that of the sap, and has also been a subject of much intricate argument, but, like that, discussed with very little practical effect; and as it is an object of much more importance than is generally considered by gardeners, I shall, as before, give the opinions of the several authors upon it.

Miller, speaking of the peach tree, says, "In pruning of those trees, you should always observe to cut them behind a wood bud, (which may easily be distinguished from the blossom buds, that are shorter, rounder, and more turgid than the wood buds,) for if the shoot have not a leading bud where it is cut, it is certain to die down to the next leading bud, so that what fruit may be produced above that will come to nothing, there being always a necessity of a leading bud to attract the nourishment; for it is not sufficient that they have a leaf bud, as some have imagined, since that will attract but a small quantity of nourishment. *The great use of the leaves being to perspire away such crude juices as are unfit to enter the fruit.*"

In another part, after giving directions for pruning, he says, "When these rules are duly executed, there will be no occasion to pull off the leaves of trees to admit the sun to the fruit, which is too often practised; *for if we consider that the leaves are absolutely necessary to cherish the blossom buds, which are always formed at the foot-stalks of the leaves*, so by pulling them off before they have performed the office assigned them by Nature, is doing great injury to the trees, therefore I caution every one against this practice."

This author also says, "The Rev. Mr. Hales, in his excellent treatise of Vegetable Statics, speaking of the perspiration of Plants, gives an account of the following experiment; *viz.*

"That in July and August he cut off several branches of apple trees, cherry trees, pear trees, and apricot trees, two of a sort; they were of several sizes, from two to six inches long, with proportional lateral branches, and the transverse cut of the largest part of the stems was about an inch in diameter.

"That he stripped off the leaves of one bough of each sort, and then set the stems in several glasses, pouring in known quantities of water.

"The boughs with leaves on them imbibed, some fifteen, some twenty, twenty-five, or thirty ounces, in twenty hours, day, more or less, in proportion to the quantity of leaves they had; and when he weighed them at night, they were lighter than in the morning.

"While those without leaves imbibed but one ounce, and were heavier in the evening than in the morning, they having perspired little.

"The quantity imbibed by those with leaves decreased very much every day; the sap vessels being probably shrunk at the tranverse cut, and too much saturated with water to let any more pass, so that usually in three or four days the leaves faded and withered much.

"He adds, that he repeated the same experiments with elm branches, oak, ozier, willow, sallow, ashen, currant, gooseberry, &c.; but none of these imbibed so much as the foregoing, and several sorts of evergreens very much less.

"He adds also another experiment: on the 15th of August he cut off a large pippin with two inches of stem, and its twelve adjoining leaves; that he set the stem in a little phial of water, and marked the quantity it imbibed and perspired in three days.

"And that at the same time he cut off from the same tree another bearing twig of the same length, with twelve leaves, no apples on it, and marked the quantity it imbibed in the same three days.

"That about the same time he set in a phial of water a short stem of the same tree, with two large apples on it, without leaves, and marked the quantity it imbibed.

" And says, that in this experiment the apples and leaves imbibed four-fifths of an ounce, the leaves alone about three-fifths, but the two large apples imbibed and perspired about one-third part so much as the twelve leaves; then the one apple imbibed but one-sixth part of what was imbibed by the twelve leaves, therefore two leaves imbibe and perspire as much as one apple; whence their perspirations seem to be proportional to their surfaces, the surfaces of the apples being nearly equal to the sum of their upper and under surfaces of the two leaves.

" Whence it is probable, that the use of these leaves (which are placed just where the fruit joins the tree) is to bring nourishment to the fruit.

" And accordingly he observes, that the leaves next adjoining to the blossoms are in the spring very much expanded, when the other leaves on barren shoots are but beginning to shoot, and that all peach leaves are very large before the blossom goes off.

" And that in apples and pears the leaves are one-third or half grown before the blossom opens; so provident is Nature in making timely provision for the nourishing the yet embryo fruit.

" He also adds another experiment. He stripped off the leaves of an apple-tree branch, and then fixed the great end of the stem in the gauge; it raised the mercury two inches and a half, but it was subdivided, for want of the plentiful perspiration of the leaves, so that the air came in almost as fast as the branch imbibed water.

" And as a further proof of the influence of the leaves in raising the sap, he also made the following experiments.

" On the 6th of August he cut off a large russet pippin, with a stalk one inch and a half long, and twelve adjoining leaves growing to it.

" He cemented the stalk fast in the upper end of the tube, which tube was six inches long, and one-fourth of an inch in diameter. As the stalk imbibed the water, it raised the mercury four inches high.

" That he fixed another apple of the same size in the same manner, but first pulled off the leaves, and it raised the mercury but one inch; that in the same manner he fixed a like bearing twig, with twelve leaves on it, but no apple, and it raised the mercury three inches.

" He then took a like bearing twig, without either leaves or apple, and it raised the mercury one-fourth of an inch.

" So a twig, with an apple and leaves, raised the mercury four inches; one with leaves, only three inches; one with an apple without leaves, one inch."

Miller further remarks, " These, and many more experiments of the Reverend Mr. Hales, that curious enquirer into the causes, state, and progress of vegetation, evidently shew the great perspiration of the leaves of plants, and their great use in raising the sap, and other functions of vegetable nature."

The same reverend author, in his treatise of Vegetation, says, "It is plain, from the many experiments and observations before mentioned, that leaves are very serviceable in this work of vegetation, by being instrumental in bringing nourishment from the lower part, within the reach of the attraction of the growing fruit, which, like young animals, is furnished with proper instruments to suck it thence; but the leaves seem also designed for many other noble and important services, for Nature admirably adapts her instruments so as to be at the same time serviceable to many good purposes."

The justness of this author's conclusions is not only doubted, but the fact positively denied by Mrs. Ibbetson, who cites a number of experiments she made to prove that plants do not perspire; she, however, admits, that plants continually give out oxygene while the sun shines; and in this particular all naturalists and physiologists agree.

If, then, as before explained, we suppose the food of plants to be water, holding in solution carbonaceous matter, and that the roots take up this liquid, and that plants have the power of decomposing it; water being composed of oxygene and hydrogene, the hydrogene and carbon might be compounded in different proportions with a portion of oxygene, and formed into the different substances of the plant, and the remainder given out as gas, and then we have only to believe that the leaves are essential to the process; and the fact cited by Hales, *that plants absorb and dispose of water*, will be sustained, and many jarring opinions will be reconciled.

The peculiar value and absolute necessity of the leaves for sustaining and maturing the fruit, is easily and clearly proved by a trial of the fact; by removing the leaves from a branch and leaving the fruit, in which case it will not come to maturity.

Some of our modern philosophers have gone so far as to suppose they have discovered that the leaves are a kind of laboratory, wherein the whole sap of the tree is received, and being there divided, separated and concocted, and in every respect prepared for the various purposes of the plant, is returned back, in its several qualities, by an appropriate set of vessels; whilst others, with equal authority, deny that the leaves either contain vessels for perspiration, elaboration, or circulation.

Admitting that a plant receives food to sustain and extend itself in the various forms required by nature, and that, in this respect, it is similar to animals, may we not suppose, that, as no animal is known to appropriate the whole of the food it takes into the stomach to the increase of its permanent substance, a considerable portion being thrown off as excrement, *plants also appropriate a part only, and throw off the remainder as excrementitious?*

And if so, what part of a plant appears so likely to be prepared for this purpose as the leaves? The food being taken up as a liquid, and duly applied to the needful purpose, the superfluous part might be passed off in vapour or gas, or incorporated with the leaves, and with them annually thrown off. If the excretionary organs of animals be obstructed and disabled, the stomach refuses more food, and disease, and decline in health must ensue; and this is, in a great measure, the case with a tree: destroy its leaves, and its produce and increase is obstructed and changed; its fruit in particular is prevented from attaining perfection, and on branches where there are no leaves beyond or above the fruit, it will fall off long before it is ripe.

Miller also quotes a question, as put by the Rev. Mr. Stephen Hales, in addition to some queries by Sir Isaac Newton. "And may not light also, by freely entering the expanded surfaces of leaves and flowers, contribute much to ennobling the principles of vegetables?" Which must certainly be answered in the affirmative, if by the ennobling vegetables is to be understood their being put in a proper state to produce blossoms, fruit, and seed, in maturity.

It is not only obvious that without light, vegetables will not produce blossoms or seed, but that in proportion as plants or any parts of plants, from being crowded together, overshadow each other, so will they be deficient in produce.

The most simple appearance and habits of every plant, clearly demonstrate the absolute necessity of light, to stimulate and sustain the generating faculty, which is the grand object of our labour and study, in that part of the art or science of Horticulture under our immediate consideration.

As to the observations of Mr. Knight in the paper before quoted, "on the influence of gravitation on the descending sap of trees," I must confess, I cannot see how they can practically apply. And the only attempts at illustration, which I have seen made by others, appear to me to be completely fallacious.

Sir Humphry Davy, in alluding to Mr. Knight's theory, observes, "By making trees espaliers, the force of gravity is particularly directed towards the lateral parts of the branches, and more sap determined towards the fruit buds; and hence they are more likely to bear when in a horizontal, than when in a vertical position."

And in Nicholson's Journal, Supplement to 1812, is a paper by Mr. John Maher, F. H. S., wherein, after detailing an experiment of bending down the branches of some apple trees, by affixing balls of clay at the points, he says —

"The sap being thus directed from its natural mode of ascending and descending, every bud almost became a blossom bud."

As, by these authors, gravitation is supposed to accelerate and increase the descending sap only, they of course do not consider the ascending and descending sap to be the same in its nature or composition; or that, that which supplies the fruit, and that which supplies and furnishes the branches, can be alike.

Are we to understand then, that gravitation, in consequence only of the change of position in the branch, also changes the nature and original preparation or purpose of the sap?

And that, that which before was the ascending, is changed in its nature, as well as in description, to the descending, and the reverse?

If so, it remains to be explained, upon what chemical principles this change is effected.

Or if this be not their meaning, but that the channels of the sap being placed in a declining position, this fluid, like water, flows more rapidly, (and consequently in greater quantity) down than upwards, and that therefore the buds are more bountifully supplied.

How is it to be accounted for, that by this additional supply of the ascending sap, occasioned by its flowing down the descent, the elongation and increase of the branches are not continued from the wood buds at the extremities of the declining branches? which has never been found to be the case, in any espaliers of the apple, pear, or any erect growing tree.

Or how is it, that the sap which has been prepared in the leaves, and by them to be returned to the fruit, can be facilitated and increased by gravitation, when the position is changed from their natural descending to that of ascending?

Mr. Maher also says, " The branches of a Lombardy Poplar, accidentally left in my master's orchard, after being loaded with clay balls, *became as pendulous as those of a weeping willow.*" And to this is annexed the following note of the Secretary of the Horticultural Society of London. *

" Our President has shown, in the Philosophical Transactions of 1806, the extensive influence of gravitation upon the motion of the sap of plants, and his experiments perfectly support this author's conclusions."

Now the only conclusions I can draw from this is, that the clay balls alone were impelled towards the earth by gravitation, and by their weight or gravity, forcing down the pliant branches, and placing the tops of the branches lower than the base, the flow of sap was of course changed from ascending to descending, and the reverse (if there be any circulation). But if the branches had been fixed with a bit of cord, the effect would have been the same. What, then, had gravitation to do with the motion of the sap in this instance?

If you take a dry stick, and liquify the concrete sap, by heat or immersion in water, and fix it in any position for a time, or until it becomes cold and hard again, it will remain in the same position.

And so it is with the branches of a tree; the wood already formed resists the pressure, by a constant effort to obtain its original position, and will

* R. A. Salisbury, Esq. F.R.S.

not remain in the new position, after the weight or restraint is removed, unless it has been fixed long enough for the sap to have been transformed to wood and hardened, when it will remain in the position fixed.

But this partial force will not affect the natural or general flow of the sap, in erect growing trees, such as the apple and the poplar; for although the branches which were forced down, remained in the pendulous position, *no new branches were ever formed in that position*: the usual channels, through which the principal part of the sap flowed, being perverted, it was forced out through the buds, that offered the most vertical channel, and there formed into the strongest branches. And thus the subsequent supply of the roots was applied to restore the vertical surface lost by the perverted branches; and even the diminutive shoots thrown out by the depressed branches, grew from their upper sides, and in a perpendicular position.

What, then, had gravitation to do in the prolificacy stated? And with what justness can the partial and forcible depression of a few branches of the poplar, be assimilated to the natural pendulous growth of the weeping willow? or this partial effect of confinement by force, be considered a proof that the general flow of the sap in trees is determined by *gravitation?*

As I have before remarked, no tree will produce blossoms or fruit, until it be furnished with a surface of branches and leaves, proportioned to the quantity of fluids supplied by the roots: thus the branches being forced down by the clay balls, the usual quantity of sap would no longer flow into them; consequently, the quantity of sap being lessened, the same effect was produced as by an enlarged surface, and they were made fruitful.

It may also be necessary to observe here, that although bending down, and fixing in a pendulous position the young strong branches of an apple-tree, makes them fruitful, the sap will not flow into them in sufficient quantity to increase their growth, and to enable them to produce fine fruit, for any length of time, but will force its way out, through the most vertical buds, and there appropriate its strength in the formation of new branches; therefore, to render a tree trained in this manner annually productive, it will be necessary to cut out the old pendulous branches periodically, and bring the young branches down in their places.

As a further elucidation of those principles, I will remark, that if two trees are planted, one in a rich and luxuriant soil, and another in a poor light soil, the supply of food collected by the roots of the one in a rich soil will be large, and consequently the roots, branches, and leaves will be large. The supply furnished by that in a poor light soil will be small, and the surface of the stem, branches, and leaves will be small. And thus the surface of the trunk, branches, and leaves will, in each place, be in due proportion to the annual produce of fluids; and provided each be alike exposed to light and heat, each will alike, in point of time, attain maturity, and produce fruit.

Trees planted close together grow tall, which is occasioned by a natural propensity to spread and expose a large surface to the sun and air, each continuing to grow more in height than the other, until it is beyond obstruction; hence those trees growing on the outside of a close plantation, or clump of trees, are always the shortest: having the full benefit of an exposure, they are soon satiated, and allow the others to top them, which gradually rise to the centre, until they become the tallest.

If, in the operation of grafting or budding, a bud or branch, which has been formed on an extended trunk and branches for fruit, be annexed to a stock, furnished with a luxuriant supply of juices, it will extend itself by strong shoots, before it will bear fruit; but if the supply of fluids be in proportion to those of the branch from whence it was taken, it will retain its original functions, and produce fruit. And if a branch of an engrafted tree that is growing too much to wood to produce fruit, be deprived of a due proportion of its supply of juices, it immediately becomes fructiferous.

This principle is clearly evinced in transplanting a tree, by which its roots being curtailed, the supply of sap is lessened.

Also by fastening down a branch from a perpendicular to a horizontal position, as in the espaliers of Sir Humphry Davy, or the experiment of Mr. Maher; for in this case, a great part of the usual supply of sap is prevented entering the depressed branches, and is driven into the next buds or branches that offer the most vertical channels, where it is expended in forming new shoots.

Likewise by ringing or depriving the base of a branch, of half or more of its bark, by which, as half of the vessels will be cut off, the supply of sap will be lessened.

And the same effect is produced by cutting short the long roots of a luxuriant growing tree.

On the principle, that the evaporation and inspissation of a fluid are determined by the extent of surface exposed to the action of heat, the preparation of the fluids, in a plant for fructification, appear to be governed. Thus, if a vessel be deprived of one half of its contents, the remaining half will be evaporated or inspissated in the same time that the whole would have been, if placed in a vessel exposing double the extent of surface.

As it appears that the food of vegetables consists of water holding certain substances in solution, and that all vegetables, and vegetable products, are composed of oxygene, hydrogene, carbon, and earth, in due proportions, and that vegetables, when exposed to the action of the sun, possess the power of expelling oxygene, we may suppose, that with this power they are enabled to arrange all the required proportions of their different elements, to compound their various matter.

And this idea is supported by the facts, that the proportion of oxygene in water, is much greater than in any of the vegetable products. *

We may therefore conclude, that as it is the law of nature, that in an open vessel, containing a liquid, the greater the surface of the liquid exposed, the greater will be the quantity evaporated, in a given time.

So is it with vegetables; the greater the surface of leaves and branches exposed to the light, the greater the quantity of oxygene expelled.

And consequently the greater the quantity of fluid disposed of by being digested, appropriated, or expelled, the greater the quantity raised by capillary attraction or otherwise.

And the greater the quantity and richer the quality of fluid or juice supplied, the greater the quantity of matter furnished, to be retained and appropriated by every part of a tree to its various purposes of generation, and substantial increase.

* Water is composed of 85 parts oxygene.

Water	85 parts	oxygene.
	15	hydrogene.
Oil	79	carbon.
	21	hydrogene.
Sugar	28	carbon.
	8	hydrogene.
	64	oxygene.
Gum	23	carbon.
	11	hydrogene.
	65	oxygene.
	1 part	nitrogene and lime, &c.

The fruit of a plant may be considered as composed of its very essence; and we may trace the progress of nature to this effect, on the foregoing principles, more clearly than by the doctrine of circulation, gravitation, or any other theory that has hitherto been suggested.

These principles also lead us to a more rational mode of suppressing or checking the growth of trees, or of forming dwarfs, and at the same time continuing a tree in health and vigour, than is generally practised.

The usual method of pruning and training is, to suffer nearly all the branches to grow during the summer which are furnished by the tree, and in winter simply to cut away or shorten such branches as grow out of bounds, and where they are not wanted; but this is evidently in opposition to the principles here laid down, and consequently must mar its own object: for not only the greater part of the wood furnished by Nature to increase the powers of production is cut and thrown away, but that which is left, is altered in its nature and original purpose; for although formed as part of a large surface, produced during the summer for fructification, it is (by the diminution) now made too small a surface in proportion to the roots, and forced to change its original destination, for the purpose of recovering the lost surface, and consequently fruit cannot be produced either in abundance or perfection.

It is with vegetables as with animals, required to sustain health, that the grand machinery be preserved uninjured and complete; and in conformity with this, if we wish to limit the size or surface of a tree, we must withhold the food: this is the only check or restraint Nature will admit of.

That her great work of creation and propagation may not be obstructed and retarded in vegetables, by the accidental privations they are subject to, from being made subservient to the use of animals, Nature, all-bountiful in her provision, and ever fertile in resources, has given them the power within themselves, to a great extent, of repairing and retrieving their losses; and to this end, every plant and every branch is furnished with more buds, than are required for the immediate formation of branches or blossoms; so that if one be destroyed, another may be ready to take its place, and prevent a waste of time or surface: thus we find that the efforts of a plant, from the seed forwards, are to attain and acquire the surface proportioned by its nature to the supply of food necessary to enable it to fructify and propagate its species; and until it has obtained this required extent, the juices by which it is sustained flow to the extremity of the leading branches.

In those trees which grow erect, the sap is always impelled forward in the most unobstructed and perpendicular channel until they attain a height proportioned to their situation; it there forms the head in a shape best calculated to present an uniform surface to the influence of the sun and air, which is generally found to be conical or spherical; and that this may be effected, whenever a growing tree is curtailed in its branches, by the removal of any of them, the sap which those would otherwise have required is thrown into the remaining buds, in addition to what would have been their natural share; and they are in consequence increased proportionally in length and bulk, thus furnishing a surface equal to what the whole would have done, if suffered to remain.

In all plants there is a power of raising the sap, different to that of rarification or gravitation, which is evinced by the foregoing observations; and it has been the want of a due attention to this fact which has puzzled and confused all the different authors on the cultivation and management of fruit trees. In making their comparisons, therefore, and in forming their maxims of practice, I must request my readers will bear those observations in mind.

GENERAL

OBSERVATIONS AND COMMENTS

ON THE ART OF PRUNING.

As most of the more valuable fruits, cultivated in this country, are the natives of a warmer climate, it has been found requisite to protect them from cold currents of air, and to assist them by an accumulation of heat; and as the means of effecting this are attended with great expense, it has necessarily led to the study and observance of the most advantageous and economical mode of cultivating and managing fruit trees, so as to enable them to flourish and produce the greatest quantity of fruit within a limited space or compass; and for this purpose they have been fixed to walls, frames, &c.; and the mode of conducting the process constitutes the Art of Pruning or training fruit trees, and forms the great object of the different authors I have quoted, which the following extracts will shew; and also how far their instructions are equal to the end in view.

The reader will perceive that most agree as to the value of certain effects, but fail in describing any certain means for producing them with uniformity and success, from the want of a correct knowledge of the cause.

Bradley, in his general observations, says, " I have taken notice in this and my other writings, that while the juices of plants are green and undigested, such plants shoot vigorously into large branches without any show of bearing fruit; but, on the contrary, when the sap of a plant becomes more ripened and sedate, that plant will produce smaller shoots, which will set for blowing or fruit-bearing.

" As to the consistency of the juices in the vigorous shooting plants, and in the slow shooters, or those which are come to fruit-bearing, it is in the first like the most fluid liquid, in comparison with the second, which is more dense or thick, as if it had gum mixed with it; when, therefore, we observe vigorous growing plants, and the reverse of them, we may know that the juices required to render a plant fruitful must be of a less active nature. I am more particular on this head, because it is impossible for any one to prune a tree with any tolerable success, unless he has regard to these considerations."

So far this author is correct in his observations of the effect; but as to the cause, his conclusions are abstruse and erroneous.

He further says, " This however must be always considered with my doctrine of the circulation of sap in plants, whereby it appears, that when any one particle of sap happens by extraordinary heat to be forwarded in its motion, every part of the sap contained in the vessels of the same plant will also be quickened and become more lively, so that the juices of the whole plant will move alike in every part, instances of which we find in the trees planted against my late invented fire-walls."

Here is another instance of an author's indulging in a fallacious theory: and that such assertions are groundless, may be seen in most hot-houses or vineries; for if a branch of a tree be introduced to the heat, it will immediately throw out leaves and shoots in a limited degree, whilst that part of the plant which is still exposed to the cold will remain apparently unaffected.

He also says, "In grafting or budding of stone fruit, I have observed that such trees as are inoculated near the root of the stock, are much more apt to shoot out unprofitable luxuriant branches, than those which are budded or grafted five or six feet from the root. I find the latter to make fruit-branches in such plenty, that hardly any barren shoots are found upon them, which seems to happen for the same reason I have mentioned elsewhere, that too great plenty of nourishment is ever a hinderance to the bringing forth of increase as well in animals as in vegetables, and that a luxuriance of growth in either must always be checked to make them prolific. To the length of passage in these standards which the sap takes in its ascension from the root through the stock, before it reaches that part where it is to alter its property in the bud of the peach, must, I think, contribute to weaken it, and rob it of that luxuriance which it would have had, if it had been permitted to push out branches near the root, when it was undoubtedly more strong and vigorous."

Here again, although this author's observations are correct in the main, his reasoning is abstruse, and his conclusions erroneous: he evidently had not a perfect comprehension of the laws of Nature.

Miller, in his general observations, says, "There are many persons that suppose, that if fruit trees are but kept up to the wall or espalier, during the summer season, so as not to hang in any great disorder, and in winter to get a gardener to prune them, it is sufficient; but this is a very great mistake, for the greatest care ought to be employed about them in the spring, when the trees are in vigorous growth, which is the only proper season to procure a quantity of good wood in the deficient parts of the tree, and to displace all useless branches so soon as they are produced, whereby the vigour of the tree will be entirely distributed to such branches only as are designed to remain, which will render them strong and more capable to produce good fruit; whereas, if all the branches are permitted to remain which are produced, some of the more vigorous will attract the greatest share of the sap from the tree, whereby they will become far too luxuriant for producing fruit, and the greatest part of the other shoots will be starved, and rendered so weak, as not to be able to produce any thing else but blossoms and leaves; so that it is impossible for a person, let him be ever so well skilled in fruit trees, to reduce them into any tolerable order by winter pruning only, if they are wholly neglected in the spring.

"It must be also remarked that peaches, nectarines, apricots, cherries and plums, are always in the greatest vigour when they are the least maimed by the knife; for when these trees have large amputations, they are very subject to gum, and decay, so that it is certainly the most prudent method carefully to rub off all useless buds, when they are first produced, and pinch others where new shoots are wanted to supply the vacancy of the wall, by which management trees may be so ordered as to want but little of the knife in winter pruning, which is the surest way to preserve those trees healthful, and is performed with less trouble than the common method."

These observations and ideas are undoubtedly correct; but here is no fixed principle or rule to enable a person to determine which are the useless buds and branches, or how a tree is to be confined within prescribed bounds.

Hitt, in his general observations on the Pruning and Management of Trees, says, "I shall now give some directions for keeping trees in the most healthful state, productive of good fruit, in the greatest quantity, and as early after planting as possible, without injuring them for the future, to effect which many endeavour by various ways, and especially by immoderate pruning, though without effect; for when the knife is most made use of, there is commonly the least success, though there is absolute necessity of lessening the number of branches at the time of transplanting or soon after, yet they ought to be lessened in such a manner that those left on, and such as proceed from them, may extend themselves in the least time, so as to fill the space of wall assigned them, and that all the trees planted may, one with another, cover the whole wall, without having their branches too near each other, but that each may receive equal advantages from the sun, air and dews, the stronger being confined in such a position that the young ones may issue and be obtained from them when wanted.

"But before I show the method of pruning trees designed for walls or espaliers, I shall make some observations on those kinds of standard fruit trees that are natural to our climate, for I think in these, Nature best shews us the time and manner of pruning.

"If there are two apple, pear, plum or cherry trees, equal in health and strength at one year old, after grafting, let them remain some years after in the same stations, having sufficient space to extend their branches in; and one of them be pruned and the other not, but suffered to grow in a shape quite rude and natural, the latter will produce fruit much earlier than the other, though perhaps its branches will not be in so regular a position as those of the former; hence it may be reasonably inferred that premature pruning retards bearing, and that pruning a healthy, strong standard, in what manner soever, before blossoming, will keep it longer back from a bearing state than it would be, were it left unpruned to the direction of Nature alone; for shortening the branches takes away the buds from the extremities, which always blossom first, and if some of them be quite cut off, the vigour of those remaining will be increased, and the more vigorous the branches are, the longer it will be before they blossom; for it is observable, that those kinds of standards before mentioned produce most fruit near, but below, such parts of their branches as were once the end of a year's shoot, and on such as are horizontal or declining, for which reason I think it best to leave vigorous standards unpruned till they have blossomed, or only to take out some of the upright branches that would gall others.

"Perhaps it may be said, that if two of those trees were left, the one cut and the other uncut, the former would produce better fruit when it bears than the latter: I grant it will, were the latter never cut at all; and that pruning after blossoming, as I hinted before, is very serviceable to standards in the following cases, which are manifest signs of their want of it.

" First, when they blossom much, but bear no fruit, which shows that they are too weak, and that part of their branches ought to be cut off, by which those that are left will receive a greater quantity of sap, and produce as good fruit as others of the same kind, that have been often pruned.

" Secondly, when the fruit which they bear is small, and some of the branches that formerly bore are covered with moss, or are dead, then, in order to enlarge the fruit, those mossy and dead branches should be taken out.

" Thirdly, when trees put forth young branches out of some of the old ones which have borne, it shows they want to be relieved by taking out the old ones, and enabling them to produce their fruit upon others that are young.

" From what has been said, I think it appears very plain that cutting of standard trees, before they bear, is injurious, though afterwards serviceable; *i. e.* of the cherry, plum, pear, and apple.

" *I never saw apricots, peaches, or nectarines, bear without cutting;* but the almond, which nearest resembles them, bears plentifully, and produces part of its fruit upon branches made the year before, and part upon studs proceeding from branches of two years old; both of them are furnished with buds at their ends, which produce leaves, and a good shelter to the blossoms and fruit.

" It is observable, that this tree bears most fruit at the ends of its branches, and for this reason the ends of branches ought not to be taken off, neither from this tree nor any other nearly like it, and those are which I have just before mentioned. But the apricot sometimes produces shoots in the autumn from the ends of those shoots made in the summer; these latter-made shoots generally die in the winter, therefore should be taken off at the next time of pruning.

" Though I have shewn the ill consequence of pruning standards before blossoming, except at the time of planting, yet trees planted against walls should be pruned in a proper manner, in order to reduce their branches to a just number; for were all to be left on, there would be too many to place against a wall without being too near each other, or at least than those would be upon the same tree, if it was a standard, for there is great difference between one and the other.

" Most standard trees grow naturally in the shape like a cone, or hemisphere, so that if one tree be a standard, and another planted against a wall, and their branches extend in height and breadth alike from the stems, yet that which is a standard fills a place more than double to that of a tree planted against a wall, consequently more than half of the branches or buds which put forth from the latter ought to be taken off; this is the best reason I can give for pruning of wall trees before they have borne, but afterwards, it is requisite to take those branches out, and leave young ones to succeed them ; but there is no want of shortening branches in any kind of old fruit trees to increase their number, for young ones will naturally proceed from those that are nailed horizontally.

"There are many that prune all kinds of wall trees immoderately twice in the space of a year ; first, in the winter they shorten all the branches, under the pretence of getting new wood to cover the walls ; secondly, in summer they cut a large quantity out of the trees, because, as they say, the wood is too strong, or that there is too much left.

"To cut in winter to gain wood, and to cut wood out in the summer, because forsooth it is too strong, is, I think, acting contrary to Nature, and spending sap unnecessarily ; for as the strength of the wood, and the growing of the branches too near each other, are entirely owing to the winter cutting, if the branches were then placed horizontally on the wall, there would be no occasion to cut out too much in the summer, and the sap which the roots collected from the earth would form new branches more fit for the production of fruit, and in such places where they might continue ; so by this method the trees will bear, and the walls will be covered sooner than by any other.

"It may be objected, that leaving the branches to so great a length, as not being cut at all, will weaken trees, or, in other terms, exhaust the sap from the roots, but the contrary may be easily proved.

"Admit both sides of a tree have at first an equal number of branches, and let either of the sides be cut at pleasure, and observe by the buds what number of shoots may be produced from the remaining branches on that side which is cut short; then let the whole branches be left on the other side, in proper places, and the useless buds taken off till their number on each side be equal, by this management it may be reasonably expected that there will be an equal number of new branches on each side.

"Now if no more shoots be produced by leaving the branches longer on one side than they are on the other which was cut short, how can one method weaken a tree more than another?

"The consequences, indeed, of leaving the branches long, will be this, they will have produced shoots at more proper distances, and cover the wall sooner with such as will earlier bear than those on the other side, which we cut short; besides, there will be no occasion to thin them so much in summer on that side where the branches are left in full length in winter, and the useless buds disbudded.

"I have seen nectarines and peaches that have been planted against walls ten or twelve years, which have been annually cut in winter, in order to make them strong, and trimmed in summer, according to the usual custom, that the fruit may be larger and not too much shaded; excellent reasons and management, whereby two-thirds of the branches are either cut or shortened, and at the same time a third part of the wall is uncovered.

"Had the branches shortened in the winter been left their full length, so as to cover the wall, and in April all their buds rubbed off, except some to produce shoots in proper places, then there must certainly have been more fruit and fewer branches to be taken out in the summer, for the quantity of sap which supported them might have supported as much fruit as would have been equal to them in weight.

"Besides, I have known by experience that trees, by this short cutting, are not so apt to bear.

"At the request of a certain gentleman, I shortened the branches of a peach tree on one side according to the rules laid down by the best authors; but the other side I nailed to the wall, without shortening one branch, which is a method I have practised many years. The crop of fruit, as well as the number of young branches on that side of the tree where the shoots were not shortened, were so greatly preferable to those on the other, that the gentleman was thoroughly convinced by this and other instances given him, that shortening of branches was an ill practice, both in the peach trees and many others.

"The fig tree, of some kinds, bears plentifully upon standards, if their branches be never shortened; and I have seen fruit ripen well upon them in England, where the soil was dry and mixed with stones, in such places where they were sheltered from the winds; but in others, where the fruit is exposed, it is commonly beaten off by the winds before it arrives at maturity, as it always grows very near the end of the branches, and on no other part except the present year's shoots, or the upper ends of those of the last year; therefore, these shoots ought not to be ended in the winter; and there is no necessity of shortening to procure young branches, for there is always a sufficient stock of them rising yearly from the roots, which when the trees are planted against walls, may be trained up to succeed others, and if they grow to the top of the wall, may be taken out close to the ground."

The clear, simple, and candid observations of this author might have been expected to convince every person, of common understanding, of the gross impropriety of the general practice of the nurseryman and the gardener; but it seems to have effected very little, if any, improvement.

It is difficult to conceive how things could have been more unnaturally or ignorantly conducted in Hitt's time, than in the present age; and if such was the case, how is it to be accounted for, that his book should have effected so little in a field where so much was to be done?

I can only suppose that the attention of his readers being caught by the singularity of his sketches, and finding it in the course of a season or two, to be difficult, if not totally impossible, to maintain a tree in such a precise form, upon the principles laid down, suffered themselves to be prejudiced against the whole of the work, and therefore threw it aside.

I must however remark, that in his comparison of the surface of a standard and a wall tree, and stating the impracticability of extending the surface of the latter in proportion with the former, without pruning, as being the only reason he could assign for pruning or cutting out, Hitt discovers rather a contracted understanding of his subject; for it will always be found, that what a wall tree loses in thickness and number of branches, may be (and where Nature is properly attended to, is) made up in length of branches, and thereby cutting is rendered as unnecessary in the one case as the other.

DESCRIPTION OF PLATES,

AND

PARTICULAR PRACTICE OF HITT AND OTHERS.

HITT is the first author I have seen who has given drawings or sketches, representing his trees in the different stages of their growth, to elucidate his principles and mode of training.

This method affords a clear and perspicuous elucidation, and most readily directs the mind to its object; and from observing its utility, no doubt it has been adopted by Mr. Knight and Mr. Forsyth, and is so by myself. And as a comparison of those different sketches will afford the greatest aid in forming a judgment of their respective merits, I have placed them together; and that they may be more clearly understood, I shall annex their own descriptions.

Hitt's description of Plate 3. is as follows:— "Figure 1. is the shape of a tree that is properly strong; what I call properly strong, is, one that has two or three branches of a yard in length or more; one that has its branches less than two feet in length, I call weak, which has been grafted a year, and taken up in order to transplant it, whether it be an apple, pear, or plum, or cherry tree, for they all have nearly this shape at the age aforesaid.

" Figure 2. is the same, planted against a wall, and cut in the manner directed by all authors that I have read on this subject.

" Figure 3. represents the same tree with the shoots it would probably make if it were properly taken up and planted in a proper soil.

" Figure 4. is the same, transplanted, as figure 1. being cut and nailed after the method which I have practised many years.

" Figure 5. is the same, with the increase of branches made the first year after planting, and nailed as intended for the winter order.

" Figure 6. is a tree when grown to the height of the wall, and the breadth allowed to each tree. Suppose it to be a pear upon a free stock, as may be proved by the scale, if by it the space of wall it covers is measured; for it is the same as is before allowed for pear trees upon such stocks.

" Plate 4. represents either a peach, nectarine, or apricot tree, at different ages.

" Figure 1. is one taken from the nursery.

" Figure 2. is the same, cut according to custom.

" Figure 3. is the same as figure 2. with the branches it may be supposed to have made in one year.

" Figure 4. is the same as figure 1. when cut and nailed after my method.

" Figure 5. is the same as figure 4. after it has been planted one year. On one side of this tree there are all the branches it was suffered to make; on the other side, it is cut and nailed for the winter order.

"As appears, the side A. B. has fewer branches upon it than there are upon the part A. C.; for the former has more than one half of its collaterals taken off, about an inch from the horizontals.

"My reason for not cutting these collaterals close to the part they proceed from, is to procure a greater number of bearers the next year, there generally being on the lower end one bud, and sometimes more, which produce shoots after cutting.

"At this time of dressing, I think it is better to leave the bearers about six inches asunder, nailed in an upright position, with long and narrow shreds, for broad ones are apt to spoil the beauty of the fruit, and short ones to pinch the branches.

"The upper ends of branches are the most certain to produce fruit, and should therefore never be taken off, if alive; for the upper bud of every healthy branch always puts out leaves, which shelters those blossoms nearest them.

"The side A. C. in the figure last mentioned, appears stronger than the side A. B. by its having produced more strong horizontals, one of which is placed from K. to I. and fills the first space betwixt the stems. And when one side of a tree is much stronger than the other, its stem should be laid lower, and that side which is weakest must be raised more upright.

"The first branches that I chose to take off from the side A. C. are H. and Y. which were left for bearers when the tree was planted, and in figure 4. are marked G. and H. The next that are to be examined, are those at L. and M. or any others that may chance to be near those places; for there ought not to be any branches left in them, but what are of a proper size for bearers.

"What has been already said relates only to such trees as have two stems at the time of planting; and when there is but one stem, it must be placed against the wall in the same manner as one of the others; and a new one must be raised as soon as possible from one of the lowest buds, which are very apt to shoot strongly when their stem is planted so much leaning, as A. B. or A. C.; and in all other respects it must be managed as in figures 4. and 5. of this Plate.

"Figure 6. is a tree full grown."

Forsyth's description of plates 1. 7. 8. —

Figure 1. represents an old apricot tree, after the last pruning in summer, in the fourth year after heading down.

a. a. a. a. The cicatrices of the four different years heading, which should be performed at the time of the winter or spring pruning.

b. b. b. Forked shoots which are laid in in the summer, and cut off at b. in the winter pruning, that the leading shoots may be always left without forks.

As the small shoots, c. c. c. from the stem advance, the larger forked shoots should be cut out, as at d. d. d. to make room for them to be trained horizontally. Peach tree much the same.

Plate 8. d. d. The foreright shoots, as they appear before they are cut off at e. in the autumn or spring pruning.

d. The manner of tucking in the foreright branches.

f. f. &c. Cicatrices of the different headings, which cause the leading shoot to produce horizontal shoots.

Plate 7. represents an old decayed pear tree, with four stems, which were headed down, and the young wood trained in the common way, or fan fashion.

Mr. Knight, on the peach tree, says, "My peach trees, which were plants of one year old only, were headed down, *as usual*, early in the spring; and two shoots only were trained from each stem in opposite directions, and in an elevation of about five degrees. And when the two shoots did not grow with equal luxuriance, I depressed the strongest, or gave a greater elevation to the weakest; by which means both were made to acquire and to preserve an equal degree of vigour,

"These shoots, receiving the whole sap of the plants, grew with much luxuriance, and in the course of the summer each attained about the length of four feet. Many lateral shoots were of course emitted from the young luxuriant branches, but these were pinched off at the first or second leaf, and were in the succeeding winter wholly destroyed, when the plants, after being pruned, appeared as represented. See the corner of Hitt's Plate 4. where one half of each tree is sketched, the other half may be supposed to be the same.)

"This form, I shall here observe, might with much advantage be given to the trees whilst in the nursery; and perhaps it is the only form which can be given, without subsequent injury to the tree.

"It is also a form which can be given with very little trouble or expense to the nurseryman.

"In the succeeding season, as many branches were suffered to spring from each plant as could be trained conveniently, without shading each other, and by selecting the strongest and earliest buds towards the points of the year-old branches, and the weakest and latest near their basis, I was enabled to give to each annual shoot nearly an equal degree of vigour; and the plants appeared in the autumn of the second year nearly as expressed in figure 2. The experienced gardener will here observe, that I exposed a greater surface of leaf to the light, without placing any of the leaves so as to shade others, than can possibly be done in any other mode of training; *and in consequence of this arrangement, the growth of the trees was so great, that at two years old some of them were fifteen feet wide*, and the young wood in every part acquired the most perfect maturity.

"In the winter, the shoots of the last season were alternately shortened and left their whole length, and they were then prepared to afford a most abundant and regular blossom in the succeeding spring.

"In the autumn of the third year, the trees were nearly as represented in figure 3. the central part of each being formed of very fine bearing wood, and the size and general health of the trees afford evidence of a more regular distribution of the sap than I have witnessed in any other mode of training.

"In the preceding method of treating peach trees, very little use was made of the knife during winter; and I must remark, that the necessity of winter pruning should generally be avoided, as much as possible; for by laying in a much larger quantity of wood in the summer and autumn than can be wanted in the succeeding year, the gardener gains no other advantage than that of having a good choice of fine bearing wood to fill his walls; and I do not see any advantage in his having much more than he wants; on the contrary, the health of the tree always suffers by too much use of the knife through successive seasons."

I must here take leave to observe, that had this author stated, that by taking off the strongest and earliest *branches*, instead of *buds*, &c. his description would have been consistent with my observations of the result of such an operation, although inconsistent with his sketch, and with his observations on the too frequent use of the knife.

But if we are to understand that by rubbing off the buds, he produced an equal distribution of the sap, I can only say that I never found rubbing off the buds produce this effect on a branch fastened horizontally; for with me, one bud being removed, the next that was best placed for the purpose took its supply of sap, and grew proportionally strong. And the sketch, figure 2. represents this effect; the shoots at the point and at the base being in the proportion of 4 to 1, which is, indeed, what I have generally found to be the result of such an operation.

But these figures, of course, cannot be meant to represent those very luxuriant trees, which extended fifteen feet wide in two years; for in this case, the second year's shoot from the point must have been within six inches as long as that of the first year, which would have formed a very different figure. And if we calculate the shoot at the base of the horizontals to have grown four times the length of the shoot at the point, (three feet and a half,) which I have ever found to be the case when a branch is laid horizontally, and which is the proportion represented by the figure, we must consider those trees to have made a most extraordinary growth. It is, indeed, a circumstance very far exceeding any thing that has ever come within my notice, and it is to be regretted that the author had not described the soil or other cause which produced this unusual increase.

Mr. Knight further says, "But I shall take this opportunity of offering a few observations on the proper treatment of luxuriant shoots of the peach tree, the origin and office of which, as well as the right mode of pruning them, are not at all understood, either by the writers on gardening of this country or the continent."

He also says, "Now a wall tree, from the advantageous position of its leaves, relative to the light, probably generates much more sap, comparatively with the number of its buds, than a standard tree of the same size; and when it attempts to empty its reserved sap in the spring, the gardener is compelled to destroy (and frequently does so too soon and too abruptly) a very large portion of the small succulent shoots emitted, and the aphis too often prevents the growth of those which remain; the sap in consequence stagnates, and appears often to choak the passages through the small branches, which in consequence become incurably unhealthy, and stinted in their growth; and Nature then finds means of employing the accumulated sap, (which, if retained, would generate the morbid exudation gum,) in the production of luxuriant shoots. These shoots, our gardeners, from Langley to Forsyth, have directed to be shortened in summer, or cut out in the succeeding spring; but I have found great advantages in leaving them wholly unshortened, when they have uniformly produced the finest possible bearing wood for the succeeding year; and so far is this practice from having a tendency to render naked the lower or internal parts of the tree, whence those branches spring, that the strongest shoots they afford, universally issue from the buds near their basis. I have also found that the laterals that spring from those luxuriant shoots, if stopped at the first leaf, often afford very strong blossoms and fine fruit in the succeeding season; *whenever, therefore, space can be found to train in the luxuriant shoot, I think it should rarely or never be either cut out or shortened; it should, however, never be trained perpendicularly when this can be avoided.*"

In these remarks Mr. Knight is correct: all the different authors I have quoted, except Hitt, direct the strong branches to be cut out or shortened; and it is now the general practice, because (I presume) they found them uniformly produced from the most vertical buds in the centre of the trees; and therefore could not find room to train them in, but by nailing them upright; and when this was done, the strongest branches again formed on the upper ends of these, and soon grew out of bounds; and where there was room to train them in, they were shortened, in order to keep the young shoots as near the centre or root as possible.

After three or four years, I think Mr. Knight must find it difficult to get room to train in the luxuriant branches that will rise from the centre of his trees, unless he trains them perpendicularly; but which he particularly (and no doubt correctly) observes, ought not to be done. If, therefore, such shoots are continually produced, (and which, from the peculiar position of the branches in his method of training, I think they must be,) he has no alternative, but must do as the others have directed, cut them out, or shorten them.

Although, therefore, Mr. Knight might correctly estimate the value of luxuriant branches, he has not pointed out the means of directing their growth in such places where they are wanted, and where they might be trained in with advantage.

DEDUCTION AND APPLICATION

OF THE

LAWS OF NATURE,

ORDAINED FOR THE SUPPORT AND GOVERNMENT OF VEGETABLES.

For whatever purpose we suppose vegetables to be created, it is clearly the order of Nature, that all kinds advance by progressive degrees in their growth to attain the fructiferous state; and as it is in the perfect accomplishment of this that fruit trees become valuable to mankind, and the seed or fruit being the chief object for which they are cultivated, the attention of an artist, in training and pruning, must be principally directed to the means required to *assist Nature* in the attainment of this her purpose.

To arrange therefore a system of raising, training, and pruning fruit trees, in a scientific manner, it will be necessary, first, to lay down and explain those laws, or principles of Nature, which are ordained for their support and government, and more particularly of those plants or trees that form the peculiar subject of the present work; and with this view I shall reduce them to the eight following theorems.

First. The roots of plants are gradually extended and impelled forward into the earth, and annually collect, absorb, and dispense an increased quantity of food, so long as they grow unobstructed.

Second. Water, holding in solution certain animal and vegetable matter, and earth, constitutes the food of plants, and a current, change, or circulation of water in the soil, is necessary to sustain the life and preserve the health of plants.

Third. The food of plants is taken up by the roots in a state of fluid, and is digested and impelled upwards through the stem, branches, &c.; and as it passes, each part of the plant selects and appropriates the portion adapted to its use, and the residue, or that which is excrementitious, is thrown off by the leaves.

Fourth. Whether the supply of food be great or small, the fluids taken up must flow, or spread over a proportionate surface of trunk, branches, and leaves, and be duly exposed to the action of light, heat, and air, before a tree can attain a perfect fructiferous state.

Fifth. All trees are furnished with many more buds than they can sustain to form fruit and branches; the position of the buds determine their office, and those formed for wood buds, occupy the most eligible situation for extending the branches; the others form fruit buds, or lie dormant, until wanted to supply the casual loss of any wood buds above them.

Sixth. The loss of any part of the buds or young branches of a tree, (provided its constitution be not destroyed or injured) will not retard the action of the root; but the same supply of food will be taken up and appropriated to the restoration of the leaves and branches lost.

Seventh. In all erect growing trees, placed in an open situation, and where the light falls equally, the flow of sap is vertical, and the strongest or leading branches will form in this position, until the stem or trunk acquires a certain age or elevation, which is determined by the soil, situation, and nature of the tree; but in places where the light is obstructed on any side, the flow of sap inclines towards the light.

Eighth. If a bud, formed and placed for a leading branch, be removed, or the vessels connected with it are contracted or injured, and the usual passage of the sap obstructed, the wood bud occupying the next best position, will take its supply and perform its office; and when from any number of buds, formed to receive a quantity of sap, a part be taken away, the share of sap, which that part would otherwise have received, is given to those remaining, and they are extended proportionally.

The first principle, *viz.* the roots of plants are gradually extended and impelled forward into the earth, and annually collect, absorb, and dispense an increased quantity of food, so long as they grow unobstructed, is acknowledged by all the different authors here noticed, although none of them appear to have known how to avail themselves of its proper application.

For different purposes, it has been found desirable to suppress the luxuriant growth of trees, or to confine them within a limited space; and to effect this, the practice of all is to curtail and cut back, or prune, the head or surface of branches.

Although by these means, branches may be made to grow where wanted, and by cutting out what are called superfluous, or those which are produced beyond what can be disposed of at proper distances, an appearance of due proportion may be exhibited during the winter; the increased quantity of sap, furnished by the roots the following summer, will again obtrude itself in branches, still more luxuriant and numerous: and although a due distribution of light, and exposure to the sun and air, may be made by again cutting these out, this is evidently a robbery, or waste of food and sap, instead of an equal distribution of the circulating fluids, by which alone, as Mr. Knight justly observes, permanent health, and vigour, and power to afford a succession of abundant crops, can be given.

This general practice of cutting and curtailing, exhibits the singular circumstance of an artist's attempting to prevent an effect by means which directly establish the cause.

An equal distribution of the circulating fluids can be promoted only by properly proportioning the soil a tree is planted in, or its supply of food, to the space allowed for the trunk, and head, or branches to occupy; and so to direct the branches, that they may be permitted to extend their full length. An exact adjustment of these may be difficult; but where a plant is found to be too weak, or deficient in its growth, to fill the space required, its strength and increase may be promoted by the addition of food or manure, and when it is found to exceed its bounds, its exuberance is readily checked and prevented by cutting off some of its large and deep-growing roots.

The second principle, *viz.* water, holding in solution certain animal and vegetable matter, and earth, constitutes the food of plants, and a current, change, or circulation of water in the soil is necessary to sustain the life, and preserve the health of plants, has been demonstrated by direct experiment, and is fully sustained by general observation and practice; but its operation has been frequently misunderstood, and imperfectly described.

It is obvious that in planting trees, with a view to a profitable return, the bed must be adapted to the peculiar nature of the tree, as to whether it requires a cold and retentive, or a light and dry soil.

It has been remarked by the most experienced gardeners, that the most healthy trees, and those producing the greatest quantity and finest quality of fruit, are found growing in a shallow, light soil, on a lime-stone rock.

Whether this is occasioned by the influence of the sun and air on the roots, or whether the food collected in this situation possesses the peculiar quality of producing this effect, is not easily demonstrable; but as in either case it must depend upon the same state of things, this is of little importance.

When the soil is open, and the food near the surface, it is readily brought in contact with water, and equally distributed among the roots, which then naturally divide, become fibrous, and run parallel with the surface, so that both the roots and the food are alike within the influence of the sun and the air.

It has been before observed, that the food of plants is water, holding in solution the produce of decomposed animal and vegetable matter, and earth; but exactly in what state of preparation, proportion, or combination, the food is taken up by the roots, it may be difficult to ascertain; it is however obvious, that time and exposure are required to effect the necessary conversion.

As before remarked, fermentation is detrimental to plants, when it is produced by substances in contact with the roots, stems, or branches, and often either by the heat occasioned, or effluvia emitted, causes disease and death.

Dung, when placed in contact with the roots, either fresh, or in large proportion, sometimes produces a great increase of wood and foliage, but it generally retards fructification, or disinclines a plant to mature its fruit or seed.

When in a state of nature, dung or manure seldom comes in contact with the roots; but being exposed on the surface of the earth, it there undergoes the needful process and change; and as it becomes soluble in water, and fit for food, it is conveyed between the particles composing the soil, or through the cavities occasioned by worms, &c.

It may be remarked, that trees growing in a light and shallow soil are most exposed to the effect of drought, and consequently more liable to casual deficiency, and never attain so large a size as in a deep soil, and that under such circumstances, the food being confined in a narrow space, is soon exhausted; but this depends upon the substratum, and such deficiencies are easily remedied. Dung thrown on the surface of a shallow soil, will, as it undergoes the needful change, and is prepared for food, be readily conveyed to the roots by water, which is easily supplied.

On the other hand, it has been truly said, that trees which are luxuriant, whether occasioned by the roots running deep, by a large portion of rich mould or dung placed immediately in contact with them, or by a superfluity of moisture, are not only not fruitful, but frequently diseased, so that the strong luxuriant shoots, which are formed in summer, become cankered and die in the winter.

And further, when the roots run deep, they are not affected by the sun and air in the same equal degree, nor so early at the changes of the seasons, as the branches, consequently the sap in the trunk and branches being put in motion in the spring, before that of the roots, it is soon exhausted, and the blossoms are weak; but immediately upon or after the setting of the fruit, the sun affecting the roots, sap is furnished in superabundance, and the blossoms or fruit are cast off.

The third theorem, *viz.* the food of plants is taken up by the roots in a state of fluid, and is digested and impelled upwards through the stem, branches, &c. and as it passes, each part of the plant selects and appropriates the portion adapted to its use, and the residue, or that which is excrementitious, is thrown off by the leaves — is fully supported by the concurrent testimony of the most eminent of the authors I have quoted, which is seen by what has been said on the office and use of the leaves of plants, and particularly by the experiments cited of the Rev. Mr. Hales, where the branches with leaves were proved to have absorbed and dispensed twenty times more water than those without leaves.

And whether we consider the process of nature in the consumption and appropriation of food by plants, to be complicated and incomprehensible, or conducted on the simple principles of decomposition, evaporation, and inspissation, which are applicable to every visible object and effect; one thing is clear and absolutely certain, *viz.* that the leaves are necessary to sustain a plant healthy and prolific, for without them, fruit in maturity cannot be produced; and hence it may be concluded, that the leaves never should be removed from the branches bearing fruit, or from those intended to produce fruit the next year.

An exposure to the sun gives the beautiful colour and fine poignancy of flavour to most fruits; but a shelter from cold and drying winds is equally necessary to insure a fine proportion of size and shape, and to produce a mellowness of pulp; all which qualities are desirable, and may be obtained by permitting the fruit to remain covered by the leaves until it has acquired its full size or growth, and then so to dispose the leaves as to admit the full force of the sun, which may generally be done without taking them off.

The fourth, fifth, and sixth principles are —

Fourth. Whether the supply of food be great or small, the fluids taken up must flow or spread over a proportionate surface of trunk, branches, and leaves, and be duly exposed to the action of light, heat, and air, before a tree can attain a perfect fructiferous state.

Fifth. All trees are furnished with many more buds than they can sustain to form fruit and branches, the position of the buds determining their office; and those formed for wood buds occupy the most eligible situation for extending the branches; the others form fruit buds, or lie dormant until wanted to supply the casual loss of any wood buds above them.

Sixth. The loss of any part of the buds or young branches of a tree (provided its constitution be not injured or destroyed) will not retard the action of the roots, but the same supply of food will be taken up and appropriated to the restoration of the leaves and branches lost.

The existence of these laws or principles must be too obvious to escape the observation of any gardener, and yet we see that the general practice is in direct opposition to them; for instead of encouraging and forwarding the extension and enlargement of the surface of the trunk, branches, and leaves of a tree, to induce fructification, it is reduced and retarded as much as possible by shortening and pruning the branches.

It appears as if rich borders were formed, and poor ones manured, to facilitate the increase and growth of branches in the summer, for the purpose of cutting off and wasting them in the winter.

The general instructions of the different authors are, to cut out all luxuriant and superfluous branches; but these terms are either very much misunderstood or misapplied,

Superfluous branches are generally considered to be those which are too luxuriant to bear fruit immediately, and such as grow beyond the prescribed bounds, or in situations where they cannot be allowed room to be fixed in; but if trees are in the first instance properly managed, very few young branches will prove to be superfluous, or too luxuriant.

When the first branches of a young tree, or an old one cut back, are placed in a proper position, and those wood buds removed that are disposed to form branches where they are not wanted, all other branches may be suffered to grow and remain their full length, and the whole of the sap furnished by the roots will be thus appropriated to an increase of the surface of the tree, which being in due conformity with the laws of Nature, will bring it to a fructiferous state at a much earlier period, than when cut back and shortened.

Branches cannot well be too luxuriant, if growing in a proper place and position; for although these may not bear fruit, they will produce the branches that bear the finest fruit, and by furnishing a larger surface in less time, will produce fruit in less time than weak ones.

A great variety of methods are resorted to, to lessen the supply of sap in particular parts of a tree to induce fructification; but how can it be expected, that a part of a tree forced into a fructiferous state prematurely, by a partial starvation, should produce fruit or seed equal to that of a tree in its full natural vigour, with all its functions complete, and appropriating the whole of a liberal and generous supply to one of the grand purposes for which it was created — the propagation of its species?

It may be said, that by Forsyth's and Knight's methods, the branches that are early fastened in a horizontal position are not weak; but although they may not be at the time comparatively weak, being young branches, and fixed so early in this position, the sap will inevitably form fresh channels, and flow into the more perpendicular branches, so that being deprived of a due supply, as they grow old, they must become weak.

The heading back, and shortening branches, is also recommended as a means *of preventing* the exhaustion of the soil, and premature decline of the tree: the first principle establishes the fallacy of this idea; the gardener who commences the operations of the first season, by lopping off and shortening the branches, will find, that so far from diminishing their number in the places where they are thus shortened, he has produced an increased quantity of branches to cut out and throw away the succeeding season.

If by exhaustion is meant, consuming to waste the stores of the earth, surely the practice thus recommended to prevent most completely operates to the contrary, and promotes exhaustion.

A tree naturally rises from the earth with a single stem, and in its progress to attain a fructiferous state, is annually divided, multiplied, and extended in branches; a gardener therefore ought, in his first arrangement of the branches of a tree, to look forward, and keep in view the form he wishes it to attain and to preserve, when full grown, and the space he is desirous to fill; and so to dispose of the branches, the first season, as to establish a foundation to sustain and support the structure he wishes to raise on it.

The seventh and eighth theorems are —

Seventh. In all erect growing trees placed in an open situation, and where the light falls equally, the flow of sap is vertical, and the strongest or leading branches will form in this position, until the stem or trunk acquires a certain age or elevation, which is determined by the soil, situation, and nature of the tree; but in places where the light is obstructed on any side, the flow of sap inclines towards the light.

Eighth. If a bud formed and placed for a leading branch be removed, or the vessels connected with it are contracted and injured, and the usual passage of the sap obstructed, the wood bud occupying the next best position will take its supply and perform its office; and when from any number of wood buds, formed to receive a quantity of sap, a part be taken away, the share of sap which that part would otherwise have received is given to those remaining, and they are extended proportionally.

These will be found always to determine the figure of the tree, which is an object of the first importance, both in its produce and appearance; but it seems never to have been thought worth attending to.

Hitt appears to have conceived a more correct idea of those principles than any other author, and yet his system has evidently failed, from the want of a due observance of them in his practice; but his mode of serpentining the stems of trees promotes a more equal division of the sap, and is better calculated to forward an extension of the surface of leaves and branches, within a given space, than any other mode of training published, and is conformable to the principles which I have laid down.

The stems being raised and fixed to an elevation of 45 degrees, equally draw and propel the sap upwards; and then the points being first fixed perpendicularly, and turned from a bud to an angle of 45 degrees, that bud is placed in a more vertical position, and the bending of the vessels of the stem presenting also some obstruction to the flow of sap up the stem at that point, the bud is furnished with a greater share of sap than it would have received if the stem had remained erect: but Hitt's horizontal branches, from being so early and so abruptly fixed in that precise position, are so much opposed to the flow of sap, as to prevent it from reaching their points, and in consequence they cannot be extended in length; and the branches left on the upper sides of his stems, as marked G. and F. in figure 4. of his plate 4., representing a tree of the first year's training, will in most instances be found to grow so luxuriant, as to take the sap away from the upper part of the stem, and prevent its further extension.

The branches growing in this position, as marked O. O. Y. M. &c. in figure 5. and H. K. in figure 6., will, from the same cause, draw too great a portion of sap, and impoverish the upper parts; nor will the branches formed for bearers grow of equal strength.

This effect must be so clearly evinced in pear trees, trained as he directs on one stem, as to render it an obstacle almost insurmountable to the producing a tree such as his plate represents at the age of six years.

And in his peach trees trained with two stems, this principle will operate as powerfully against his mode of providing fresh bearers by shortening every alternate one to one bud: the branches which are not shortened, or the buds near the stem, will take the principal flow of sap, and many of the stubs will not shoot at all.

By referring to the sketches of Forsyth and Knight, as well as Hitt, it will be seen, that they direct the shoots of one year old to be fixed in a precise horizontal position, or to be fastened in that position the first season, by degrees, as they grow; and they represent the point bud as forming the strongest shoots, and without this it is clear the trees could not be made to extend in the manner described by their figures, and to cover such a space in so short a time; but the fact will always prove to be as follows.

Whenever a young luxuriant branch is fixed in a precise horizontal position, the bud occupying the most vertical position at the base will form the strongest shoot, and the point bud the weakest, which indeed will scarcely grow at all.

When such a branch is fixed in a perpendicular position, the sap will invariably flow to the extreme or point bud, which will be the most vertical, and there form the strongest shoot, leaving all below it in a diminutive state.

If it be fixed in a reclining position, on an angle of about 45 degrees, all the buds on the upper side, and the point bud, will push out and form branches of nearly the same strength.

But when a branch or stem is two, three, or more years old, the vessels are not so liable to injury from being forced out of their natural position; and after this age, that part which has been kept free from buds may be bent with a gentle curve to almost any position, and the sap will continue to flow in its usual channels towards the extremities.

Forsyth's plan of training, either with one perpendicular stem and horizontal branches, or in the fan fashion, is very well calculated to bring a tree into an early state of bearing; but it is no better calculated to continue it in such a state than Hitt's.

By selecting and limiting the number of first shoots, and training them at full length, the sap is applied conformably to the third principle; but as trees furnish a much greater quantity of wood than can be properly disposed of in the space allowed by him, and are naturally inclined to attain a much greater height before they spread their branches, the greatest flow of sap will be up the perpendicular stem, and the strongest branches annually forming at the top, will leave the horizontals without the means of extension.

As fine fruit cannot be produced on weak branches, or on any of more than four or five years old, (which he acknowledges,) those horizontal branches will soon be worn out, and there will be no means of renewing them, but by heading back in the manner he directs for old trees.

I believe few who have adopted his plan have found themselves so fortunate in the result as to obtain such a quantity of pears as he represents to have been produced in so short a time after amputation*, and therefore will not be willing to repeat the experiment.

Any person who has trained trees on either of those plans must, after the first four or five years, have found an annual deficiency, instead of an increase, both in quality, number, and size of the fruit in every part of the tree; the extremes of the horizontals producing the best; and as the little sap supplied to them must be continually wasted in shoots near the stem, even those become smaller and weaker every year.

Forsyth directs the fore-right wood shoots on pear trees to be shortened at particular buds to about four inches; but this will inevitably produce other strong shoots from those buds, and by short-

* Forsyth says, "On the 20th of June I headed several standards that were almost destroyed by the canker; some of them were so loaded with fruit the following year, that I was obliged to prop the branches, to prevent their being broken down by the weight of it."

ening these again and again, those bunches of stubs, which he and others so much deprecate, will be produced.

Although Knight's plan bears a little resemblance to Hitt's in the drawing, it will be found more exactly to resemble Forsyth's in effect; but as neither he nor Forsyth has adopted Hitt's mode of serpentining the stems, in so much will both prove inferior.

From the bending of the stem, the sap will always be more inclined to flow freely into the horizontals, and these in consequence may at all times be renewed with greater certainty; but as the sap in an upright stem will always flow to its top, and there form the strongest branches, the horizontals will draw but a small quantity only of the sap; and in consequence they will, in a few years, be impoverished and worn out, as they cannot be renewed but by amputating the head of the tree, and commencing anew.

And further, by laying the first branches of a plant in a horizontal position, the first year, or as they grow from the bud, they may be prematurely brought to a fructiferous state, but they cannot attain strength or length after this: the flow of sap being, as before observed, in a vertical course, throws itself out in shoots near the base or stem; and these being cut out or fixed in the same horizontal position, the second season, the same effect is produced the third.

And in every succeeding year, as the branches must be more inclined to the perpendicular, the sap will flow, and the branches form more towards the upper end each year; and when near the centre, the strongest branches will form at the top, leaving the lower part naked. Hence it will generally be seen that the lower part of a wall is covered with wood too weak and old to furnish fine fruit, or a renewal of young wood, while the middle is either naked or filled with old wood, or that which is too young and too gross to bear fruit, and all the finest wood growing at the top.

Even when a handsome selection of branches is made, in the manner Mr. Knight recommends, by cutting out the smallest and the largest, these are so changed from their natural and original destination, by being left to receive the whole of the sap in the following season, and the surface so much curtailed, that they are mostly incapable of producing fruit in its highest perfection, as they become mere vehicles for the same superfluous produce of branches the next season which those were that had been cut out the last.

COMMENTS

ON

THE GENERAL MODE

OF

RAISING AND MANAGING

FRUIT TREES OF THE NURSERYMEN.

In the removal or transplantation of Trees, gardeners and nurserymen are generally very careless and inattentive in taking them up, and care not how much the roots are broken or lessened in number, provided they have enough left to keep the tree alive: the consequence is, that although the branches left on may remain alive, there is so great a deficiency of sap, from the loss of roots, that the vessels cannot be filled the following spring; therefore they contract and become inflexible, and after one or two seasons are incapable of extension; so that when in the course of time the roots are restored, and the sap supplied in the usual quantity, it is, from being restricted in its former course, impelled through the nearest vertical and accommodating buds that offer.

Hence it will be seen, that in almost all trees trained in the common way, the first branches which were trained in, and are the most horizontal, are the smallest and weakest, and in consequence incapable of bringing fruit to perfection; and as these occupy the best part of the wall, the strongest and most luxuriant shoots, by being trained erect, quickly grow out of bounds, and are annually cut away.

Thus the strength of the tree is wasted, and the continued efforts of Nature to produce fruit, in proportion to the age and capacity of the roots, is obstructed, instead of being forwarded and assisted.

It is this effect that induced the practice of heading back young trees, on transplanting; and under such circumstances it is certainly a proper and necessary method.

Trees that are not headed back, after the usual mode of transplantation, such, for instance, as half-trained and full-trained trees from the nurserymen, are found to throw out their strongest shoots immediately about the stem or trunk; and notwithstanding these are removed, this and every other attempt to force the sap into the old branches is vain, — its nature will remain the same; and a vigorous head cannot be restored, but by a removal of the old branches.

This shows the impropriety of the common practice of heading back and training trees in the nursery ground.

As it is a general custom for those who plant fruit trees to rely on the nurseryman for the production of their plants, it becomes an object of the greatest importance to enquire how far their general practice is adapted to public utility. And I feel no hesitation in stating, that this business is conducted upon such imperfect principles, that it is almost impossible to find one plant in twenty that is worth transplanting.

It is obvious, that unless the original plan or foundation be good, a perfect superstructure cannot be raised.

From the deformity and disorder produced in the nursery ground, almost all our gardens and orchards exhibit in their trees a complete contrast to the beautiful simplicity and bountiful produce provided for by Nature.

Before, therefore, any thing like perfection can be attained by the gardener, a reformation must take place in the practice of the nurserymen.

The first operations of the nurseryman I will consider to be the transplanting his stocks for engrafting and budding; and in performing this, his only object is, that they grow and produce some kindly luxuriant branches; but as to how or where, or in what manner, either these or the roots may grow, he is perfectly indifferent.

Whether the bud or graft produces one or more shoots it matters not; the whole are cut off short, or, as it is termed, headed back, the following winter; and such as accidentally produce four or five branches, so placed as to be fastened, to form a flat side, are fixed to stakes or a wall, in the form they are usually trained; and as if further to insure premature old age, decrepitude, and deformity, they are afterwards several times taken up and transplanted in the same careless manner.

The roots are broken or cut off at random, and generally either diminished more than one half, or they are doubled back and distorted, and if there be enough left to keep the plant alive, it is thought quite sufficient; and by these means the appearance of blossoms and fruit being prematurely produced, those stinted and deformed plants are sold as half, or full-trained trees for four times the price of others; and when sold, they are again taken up, and the roots treated and diminished in the same careless manner.

Miller, Forsyth, Knight, and others, uniformly direct that trees from the nursery ground be cut down, or headed back, to two or three eyes, the next spring after planting; and, with such plants as are here described, there cannot be a better mode of treatment, but this is evidently losing time, and wasting its produce.

Whenever the roots of a tree are diminished on transplantation, the supply of sap must be proportionally lessened; for if the branches of a tree, under such circumstances, are left at full length, the sap-vessels, for want of a due quantity to distend them, become bark-bound and inflexible; and when the roots are restored, and furnish a luxuriant quantity of sap, this, from being obstructed in its former channels, forms new ones through the buds that offer the most perpendicular position next the stem or trunk; and although these shoots may be rubbed off, still they form again in the same place, and it will be in vain to attempt supporting the original branches.

A regular head cannot be formed, but by a removal of the entire old one; and frequently the vessels of the trunk itself become so fixed and stubborn in the bark, and particularly in standards, as to force the sap out into luxuriant branches near the root.

It has often been made a question, and a subject for argument, whether it is better to transplant from a rich to a poor soil, or the reverse; but as the transplanting from a rich to a poor soil, even were the roots entire, must cause the bark or sap-vessels to contract, for want of the usual supply of food, and be productive of the same consequences as curtailing the root, the doubt is easily solved.

It may further be remarked, that however diminutive a plant may be from poverty, provided the vessels have always been free from contraction, they will readily expand through all the usual channels, and receive and regularly dispose of every additional supply of sap, however great it may be.

INSTRUCTIONS

FOR THE

MANAGEMENT OF FRUIT TREES

IN THE NURSERY.

The period of life allotted to us, compared to the growth of a tree, is short; and every person who plants fruit trees with a view to enjoy their produce must consider the saving of a year, or the being enabled to enjoy the fruits of their labour and expence a year earlier, and consequently a year longer, (and this without lessening the future productive powers of a tree,) a most desirable object, and which may readily be attained.

If plants are raised in such a manner that they may be removed with the whole of the roots entire, and without being curtailed or injured, the full benefit of a needful age, and progressive growth and extension of branches, may be transferred from the nursery ground to the garden or orchard, and no loss of time incurred; and this is easily effected when the soil is light, or it might be provided for, either by having the beds or borders prepared with a stratum of light open earth, for the roots to run in, as hereafter described, or more perfectly by raising the plants in pots.

When the stocks or seedlings are planted with a view to transplantation, great care should be taken that the roots be drawn out even, and not crossed or bended; for if the roots are not first placed in a right posture, they seldom grow straight, or can be taken up perfect.

If apricots, peaches, plums, and all dwarf trees, are raised in pots of about fourteen inches diameter and depth, such trees may be trained two or three years to the full extent of their growth, and in proper shape, and be then transplanted, without receiving any check, or occasioning loss of time.

This process may be attended with a little more trouble and expence, but it would certainly give the nurserymen a better claim for double the sum than the price now charged for trees of more than one year old. And if those who are about planting consider their interest, they will rather pay twice the sum for trees raised in this manner, than what is now charged for those which are called trained trees, raised in the common way.

A peach or nectarine tree thus raised, and trained as hereinafter directed, may be removed the third autumn after budding, and the following summer produce several dozens of the finest fruit; the next year, (the fourth,) twice the number; and the fifth year, upwards of forty dozen; and these are certainly advantages sufficiently great to counterbalance a trifling additional expence.

It will also answer as good a purpose to raise apple trees in the same manner; for when the roots of those trees are diminished or injured, they require along time to recover the loss, — indeed few more so, —and after repeated transplantation, they seldom form handsome or healthy trees.

A standard tree of three or four years' growth from the graft near the ground, or one year from a stem of due height, removed with its roots entire and uninjured, will make greater progress towards forming a handsome tree, produce more fruit, and in orchards get out of the reach of cattle, in less time than those raised and transplanted in the common way will do, of six or eight years old.

The shape or figure which the different trees should be trained to, I have represented by sketches.

As to the mode and manner of performing the different operations of budding, or inoculating and engrafting, &c. I shall not attempt to suggest any improvement of the general practice; but it will of course be necessary, that the stock should be sufficiently recovered from its transplantation, and have taken good root, before it is operated upon.

All plants that are intended to be trained with two stems from the buds, such as peach trees, &c. should have two buds inserted opposite each other, and the stocks should be carefully looked over the spring next after budding; but if only one be inserted, or one only should grow, as soon as this begins to shoot, its top must be nipped off, to occasion it to throw out two branches of equal strength. As these grow, they must be carefully protected from being broken or injured; should one branch grow stronger than the other, the strongest must be fastened in a proportionally reclining position, which will give the weakest a larger portion of sap, and forward its growth.

Should those branches during the first summer grow so fast or large as to endanger their breaking, when fastened down in the winter, which they sometimes will do, they may, during the summer or in the autumn, be fastened in a reclining position, proportioned to their size; but if not in this shape, and of a less height than four feet, they may remain until the next season.

All collaterals or shoots springing from the sides of the stems, must be stopped immediately above the first bud, as they grow out, as this will incline them to grow more in height than in size, and render them more compliable.

Those intended for the simple horizontal plan, as Plate 2. must be managed in the same manner, until the branches are six or eight feet long; and also such as are intended for one serpentined stem, until of a proper height.

Plants that are intended for spiral espaliers must be headed back, and managed so as to produce four or five branches of equal strength on a stock or stem of about six inches from the earth, and those permitted to grow erect, removing all collaterals, until they are from four to eight feet long, unless, as before remarked, they grow so large and luxuriant as to endanger breaking; in which case they must be fastened in a reclining position, more or less, according to their strength, during the season of their growth.

Should the leading branches of any of those plan be by any casualty stopped, several buds will probably shoot; in this case, only one shoot must be permitted to grow, to continue it; all others must be removed as soon as perceived.

When budded trees are intended for standards, one shoot only must be suffered to grow, and this carefully trained up, so as to continue rising from the point bud; and when stocks are grafted for standards, such grafts should be selected as have the point bud perfect, and the shoot produced by this should be carefully trained up and continued from the point bud.

When necessary to shorten the graft, previous to its insertion, it should be done from the lower or largest end; and if the grafts that are used have not the point bud, one shoot only should be suffered to grow, and this fixed as perpendicularly and straight as possible from the graft.

When grafts have taken to the stock, and have grown a few inches, they should be unbound and fastened, if necessary, to stakes, to prevent their being blown off, and all shoots except the leading one taken off.

If no accident occurs, these will require no other labour for two or three years; the point buds will naturally keep the lead, and in most kinds of trees form a straight and handsome stem.

Whilst the leading branch maintains the ascendency, the side branches of the second year should remain on; they serve to strengthen and increase the size of the stem in a conical shape, until it has attained its utmost height, which should be about six feet, and this it will generally do the second or third year.

When a tree has attained its proper height, all the side branches below those intended to form the head, should be removed close to the stem; and when the stem is grown to its due height, which, if left to Nature, will be determined according to the soil and situation in which it is placed, the buds that rise immediately about the point of the annual leading shoot will generally form a circle of branches at the end of each year's growth; and those branches naturally arranged in regular tiers, and at proper distances, are best adapted for bearers of their different kinds of fruit.

Therefore with trees raised in this manner (see figure 2. plate 3.) no branch will ever require to be shortened; the plant will progressively increase, and, as soon as it attains its proper extent of surface and age, will bear fruit; and which will generally take place much earlier than with trees that are headed back.

As the central or leading buds and branches are liable to be broken by accident, or destroyed by insects, it will be necessary to look over the grafts occasionally; and if two or more shoots are contending for the lead, all must be removed, except the one that is best situated for continuing the stem; or if any of the leaders grow reclining, they must be fastened in a proper position to stakes.

ON SOILS,

AND

THE PREPARATION OF BEDS,

OR

BORDERS FOR FRUIT TREES.

WHEN the soil of a garden wherein fruit trees are to be planted is not naturally conformable or congenial to the first principle, it must be made so.

The forming new beds or borders will perhaps be thought too troublesome and expensive, but it is of the utmost importance in determining the future produce of the trees; and it should be considered that this first expence is not like common manuring,—it will never require to be repeated; and although at first it may appear great, yet if it be divided, and placed to the account of so many years as its profitable effects will be experienced, it will bear no comparison with every other expence attending the planting and training trees.

As to any particular form or substance of which walls for sustaining fruit trees should be built, I do not consider it of any very material consequence; it however is of material importance, that the top of the wall be so formed as to throw off water; for otherwise it will generally be damp, which renders the trees unhealthy; and when the substance, against which the branches are fixed is dry, the temperature on all sides will be more equal.

In preparing beds or borders, due attention must be paid both to the soil and subsoil, as each equally affects the health and fruitfulness of trees, and principally as it retains or discharges water, stagnant water being at all times particularly detrimental to the fructification of trees.

If the elevation and composition of the substratum be such as to prevent a lodgment of water, and the soil on the surface be a good working loam, it will require little or no alteration, and the trees may be planted in it from nine to twelve inches deep; but if the situation be low and wet, or the substratum of a nature to retain water, means must be taken to prevent the roots from running into it.

In the first place, therefore, where the situation will admit of it, drains must be made to take off and prevent stagnant water; but if this cannot be done, the borders must be raised above it, and in either case, a sound bottom or substratum must be formed at the depth of eighteen inches, or two feet, of such materials as will prevent the roots from penetrating, or water from rising through it, and this must be laid sufficiently shelving to admit water to drain off; and along the edge of the border a drain should be made to carry away the superfluous water: and this may be done by removing the upper soil to the proper depth, and making a stratum of chalk, lime-stone, or lime rubbish, or either, mixed with ashes well forced together: or a more effectual method will be, to form a kind of floor with stone or bricks; but in this case, the joints must be well closed, with hard binding mortar or cement, as otherwise the roots will penetrate, and render the defence ineffectual.

For peaches, nectarines, &c. a border of ten or twelve feet wide will generally prove sufficient.

In cases where the soil has been too close and retentive, and the roots apt to grow deep, I have found the following composition and formation of beds or borders most effectually to answer the desired purpose:—

On the substratum lay a stratum of six inches of the common soil of the garden, and then form a stratum of about six inches for the roots to run and repose in, composed of two-third parts of fine drift sand, (the scrapings of a public road, that has been made or repaired with flints, I have found to answer best) and one-third part of rich vegetable mould, well mixed together; and the better way to perform this, is first to lay on about three inches of the composition, and on this place the roots of the plant, and over them spread the other three inches, and cover the whole down with from nine to twelve inches of the common soil of the place.

Where it is not found necessary to form an artificial substratum, it will be sufficient to remove the soil to the depth of fifteen or eighteen inches, and there form the stratum for the roots, covering it down with a foot or nine inches of the common soil.

This composition or principle of forming borders, will prove in every respect conformable to the nature and supply of the food of plants, and their consequent growth, as before explained; and if it be desirable to force the trees to a luxurious growth, they may be supplied with manure in any quantity; by placing it on the surface of the border, whence it will be carried within reach of the roots, in its proper state by water, and the injurious effect of a too great detention of moisture consequent on placing dung in contact with the roots, be avoided; and by forming borders shallow, and placing the roots at a short distance from the surface, trees may be kept fruitful, and within a very narrow space.

DIRECTIONS

FOR

PLANTING AND TRAINING THE PEACH.

In planting trees, the root or stem should be pressed close down on the soil, so as to place the roots in a horizontal direction; and all the roots, large and small, should be carefully drawn out straight, like a fan, or rays verging from a centre to a semicircle (see figure A. plate 1.), and the remainder of the soil to be thrown evenly over. The tree should not be shaken up and down after the earth is thrown on the roots, as is too generally practised; for, when a tree is thus raised up, the small roots, or fibres, will be drawn out; and when the stem is thrust down again, the roots, being too weak to force their way back into the soil, will be doubled up, which often occasions them to knob and throw out suckers; neither will the earth require to be trodden down hard: if it be dry, it may be watered with a pot from a rose; this will force it close enough together.

The suggestions offered for the reformation of the nursery, will serve as directions for the choice of trees; and if a plant be raised of a proper shape, and with the root entire, it will not require to be headed back.

When plants are raised in pots, the roots will, of course, be intermixed and entangled; but if they are carefully turned out of the pot, and the earth shaken from them, the roots may readily be separated, and drawn out free and even.*

Should any root be broken, it must be cut off at the broken part; and when plants have their roots much diminished, by being lacerated and broken in taking up, or otherwise, or should the roots be injured, or a large portion destroyed by too long exposure, when taken out of the earth, the plant should be headed back to those buds, which are best placed near the root, to cause them to throw out branches that will form the figure required, or the foundation of the future tree.

When plants are raised in pots, they may be transplanted at any season; but when they are raised in beds or borders, they should be taken up in the month of November; and if the places, where they are to be planted, are not then ready to receive them, they may again be laid in the ground, and the roots lightly covered: after this, they may be removed, and planted, at any convenient time during the winter, or early in the spring; for, as in taking up, some of the roots will

* A good method of disentangling the roots is, to place the whole, earth and all, as it comes out of the pot, into a tub of water, and thus wash out the earth; the roots may then be arranged without injury.

probably be torn, the wounds will require some time to cicatrize or heal, which must take place before fresh roots can be formed; and thus time will be saved, and the tree better prepared for the spring.

It is well known that the roots of a tree extend and increase annually, and, in proportion, the branches are also extended; if, therefore, the branches are found to exceed the space allotted, and to be too luxuriant to bear fruit, it must not be expected that the cutting those off will prevent the same excess the following season, and when the means of such produce are increased.

In planting, we must either adapt the soil to the space allotted to each tree, or allow each tree a space proportioned to the soil.

A tree should not be cut back but from its beginning; if, therefore, a small space only can be allowed for the trunk or stem, and branches, the soil must be reduced accordingly; and when the soil is rich, and the space ample, a tree should be allowed a space equal to its utmost growth.

The peach tree, in rich and well watered borders, will fill sixteen feet square of walling; but Hitt calculates that twelve feet square is as much as a dwarf peach or nectarine tree will annually cover with bearing wood; and in the borders I have described, this will be found pretty correct.

Those trees, therefore, which are intended to be trained with two stems, and planted in such a soil, should be planted twelve feet apart, if against walls of twelve feet high, and if lower, at a proportionate distance; but if against walls of a less height than eight feet, this plan of training is not so well adapted as the simple horizontal method, which will be explained, and is represented by plate 2. *

A tree being obtained, presenting two branches of the last year's growth, as represented by fig. A. plate 1., and which form the foundation of the future tree, and are called stems, let them be fixed in the position represented by figure B., which it will be observed is placed more perpendicular the first year than afterwards; and this is done that the whole supply of the sap may go to the upper ends of the stems; and all the buds that are not three feet above the lower end being rubbed off, the course of sap will be more regular and fixed, which will then be less inclined to throw out shoots below, and where they are not wanted, than when fixed more horizontally.

If the stems are four feet long, or more, let them be fixed to the wall, near a bud, on the outer side, which is about three feet and a half from the end or fork (see *a.* figure B.), and then turn the top inwards to a curve or angle of about forty-five degrees; this will place the bud *a.* in a position nearly as vertical as the end of the stem, and it

* On further experience, I find this method is in no respect equal to that shewn by figures 1, 2, 3, 4. plate 1.; for in the plan, figures 2, 3, 4. plate 2., the new horizontals will each year be stronger, and the sap will not be equally divided.

will in consequence obtain a large share of sap at the bud *b.* on the inner side; and about six inches distance fix the stem again, and turn it on the same curve outwards (see *b. b.* figure B.), and let this be continued from side to side, forming a serpentine line as the tree advances to its utmost height. See figures 1, 2, 3, 4.

By these means the side branches or horizontals (on the principles before explained) will obtain an equal share of sap, and be continued to fill the space allotted, regularly up the stem, with equal luxuriance.

As peach or nectarine trees bear their fruit on shoots of the last year, or one year old, of a moderate strength, these side branches, by being fixed in a horizontal position, will constantly furnish such; and as the sap will naturally flow into the buds on their upper sides, each will have its regularly allotted space, and which may be kept uniformly covered with bearing-wood; and by shortening, cutting out, and fixing these in a proper position, the bearing-wood will be regularly and annually renewed.

If the branches of a plant intended for stems are not long enough to produce buds at the distance stated, they must remain nearly perpendicular until they are so, and before they are curved; when they are of sufficient length, all the buds being rubbed off, except three on each stem, as marked *a. b.* figure B., each of these will form a shoot of three or four feet long the following year, and the second year, in October; the whole should be fixed in the position represented by figure 1., and the stems brought down to an angle of about 30; it must be observed, that if the horizontal branches were brought down to a precise flat horizontal position from the stem, they would be furnished with branches for bearers of very unequal strength, for the bud nearest the stem offering the first vertical channel, would take the greatest share of sap, and be too gross to bear fruit, and from being thus robbed, the other branches would diminish towards the point, and be too diminutive and weak to bear fruit; to prevent this inequality, and at the same time to give the bearer next the stem sufficient strength to take place of and renew the horizontal when required, the end of the horizontal next the stem is first fixed sufficiently elevated to enable the first buds to draw the necessary portion of sap, to form a branch strong enough for a new horizontal, and then sufficiently depressed, or laid horizontal, to occasion an equal division of the remainder of the sap amongst the other bearers, and to furnish all those of nearly the same strength to the point: and this is done by forming a curve, rising from a horizontal position to 30 or 40 degrees elevation, as represented.

In the spring all the buds on the stems must be rubbed off, except those marked *b. b. b.*; these will then form the basis of the bearers or horizontals, which will be placed from twelve to fifteen inches apart.

All wood buds must also be taken off from the horizontals, except those which grow on the upper sides, and as these will then receive the whole of the sap, drawn by the horizontal, they will form bearers of proper strength and length, and when nailed as represented, will fill the spaces between the horizontals with regularity.

It must be observed, that the disbudding should not be performed till the buds are grown a quarter or half an inch, which will generally be by the end of April or beginning of May.

Proceeding thus, the tree will be like the figure 2. the second winter, figure 3. the third, and figure 4. the fourth winter; and the following summer the bearers will throw out young wood, as well as produce fruit, which may be regulated so that the old bearers may be taken out the following winter, and the young wood brought down to fill its place.

Should the horizontals at any time be destroyed, or the buds or branches removed from the stem, during their growth, they may be replaced by inarching, or grafting by approach, which may be done by taking any young branch that is conveniently placed, and cutting off a slice from the side of the branch, about half its thickness through, and an inch in length, and then removing a similar piece of bark and wood from that part of the stem where the graft is required to grow, place them together so that the edges of the bark of each may come in contact, and bind them with matting, &c.; this may be done either in the spring or at midsummer, and they will unite by the winter, and the graft may then be severed and the bandage removed.

In places where branches cannot be obtained convenient for the purpose of engrafting, buds may be inserted in the usual manner of inoculation.

If in the course of the spring or summer, any or all the bearers should be deprived of their fruit by frost, blight, or other casualities, or are otherwise injured and rendered useless, they may be immediately cut back, or taken clean out, so as to favour the young shoot, that is best placed to fill the space as a bearer, the following season; and such shoots being so favoured, by the whole sap and space being given to them, will be proportionally stronger for succeeding bearers. If the horizontal itself be rendered weak or imperfect, beyond the first bearer, it may be cut out, and the bearer, which will by this be made strong enough, be brought down in its place.

Should it appear desirable at the autumn pruning, that the old horizontal with its bearers should remain another season only for the sake of its fruit, and then be taken out, the first bearer may be brought down across the other bearers, (see A. figure 4.) by which means it will be furnished with bearers in a proper manner, to take place of the old horizontal, whenever it is cut out, which, for the reasons before stated, may possibly be early in the spring, or in the course of the summer; and in this case, at the next winter nailing, the change will scarcely be seen, for all the sap intended for the old horizontal and bearers, will have been given to this new one.

As this part of the management constitutes the most valuable part of this mode of training, and is what I have observed to puzzle a gardener more than any other, I have given sketches of horizontals and bearers arranged in different manners. See figures 3 and 4.

Trees must be frequently looked over during the summer, and the branches depressed or raised, as it may appear necessary to decrease or increase the luxuriance of any particular part; and as often as any branches are rendered useless, either from a failure of fruit, or otherwise, they must be cut out, and the general cutting should be performed as early as possible, after being divested of its fruit, for the earlier this is done, the better will the wounds heal, and the buds form themselves for the succeeding season.

After the last cutting or pruning has been performed, the trees may remain loose until the spring, or such parts of them as are not in danger of being injured by winds.

Notwithstanding this time or season for cutting is opposed to the general practice, it is certain, all fruit trees are less liable to gum, or canker, when cut during the season of their growth, than when more at rest in the winter, and the advantages resulting from adopting this season of the year for those operations, are in other respects very great; in many instances, of repairing casual losses and injuries, it is equal to anticipating the produce of a future year.

When it is required to bend large branches or limbs, they will be found to submit more readily in autumn, and if done a week or two before the fall of the leaf, there will be less danger of producing gum or canker, as the sap at this time is sufficiently in motion to restore trifling fractures, or the strains of the bark and vessels.

This mode of training will be found more conformable to the third principle than any other; it will also be found to combine all the grand requisites, stated to be produced by the different authors I have referred to.

The stems, being two principal branches through which the sap will flow in equal portions from the root, to the length of three feet, before it is permitted to form collaterals, the same effect will be produced as if the whole sap was to pass up the single stem of a standard of six feet, which is justly observed by Bradley, "*to make fruit branches in such plenty, that hardly any barren shoots are to be found upon them.*"

It also is conformable to the idea of Hales, that "*Light also, by freely entering the extended surfaces of leaves and flowers, contributes much to the ennobling the principles of vegetables.*"

By avoiding the precise horizontal position in which Hitt directs the branches to be fixed, the sap is more regularly and uniformly disposed of, and there will be no necessity for waste pipes, nor for cutting branches short to form studs for producing bearers, nor to adopt the method recommended by Forsyth for furnishing bearers, that of repeatedly pinching off the tops, and shortening the leading shoots.

The whole of the sap will, by this mode, be expended in profitable and increasing production, and all the desirable effects which these authors describe to be attainable, will be produced in less time and with less difficulty.

By this mode also, it is possible to train a tree to its utmost extent, without ever using the knife for any other purpose than for removing worn out branches, or old bearers, nor need a branch ever be shortened.

It will be found likewise to support Mr. Knight's ideas, "*and expose a greater surface of leaf to the light*," in the shortest possible time.

It will also "*promote an equal distribution of the circulating fluids;*" and without cutting off the strongest and weakest branches, "*each annual shoot, as produced, will possess nearly an equal degree of vigour.*"

And as the horizontals will be formed of the most luxuriant shoots, they will find sufficient space to be trained in, and thus by "*proper treatment*," will, in due season, be found to "*have uniformly produced the finest possible bearing wood for the* *succeeding year*," and this without pinching off shoots.

Thus also, the same square of walling will be furnished with more bearing wood, in the third and fourth years, than can possibly be done by any other mode or principles published, and than can be effected by the common mode of practice, is less than eight or ten years.

ON

THE TRAINING AND MANAGEMENT

OF

APRICOTS, PLUMS, CHERRIES, &c.

Apricots, plums, cherries, &c. may be trained in the same manner as the preceding; but as these do not produce their young shoots with so much regularity as peaches and nectarines, and are more liable to injury from cutting and shortening; and also as they often bear fine fruit on buds growing from spurs of two or three years old, they do not require a renewal so often.

The young wood of those trees, therefore, must be allowed a greater space, and to run greater lengths, and to admit of this, the mode represented in Plate 2. is better calculated than the preceding.*

* By observations since made, I am convinced that the method recommended for the training peach trees, shewn by Plate 1. and described in the preceding chapter, is also the best plan for training pears, apricots, plums, cherries, &c.; for although it may be difficult to make those trees grow quite correct to the figures, it produces a more equal division of the

It will also be found to be the best mode of training dwarf pear trees, also for training apples and other fruits, as flat espaliers, varying the management of the bearers according to the nature of the tree.

This mode being founded in every respect upon the principles before explained, it will be observed, that the horizontals can only be raised with regularity, one on each side annually; but as each one will have the supply of sap which in the other mode would be divided between two, they will grow double the length; and as the bearers also will fill a double space, the horizontals may be laid at double the distance, which will furnish wood sufficient to cover a wall of twelve feet high in five years, the same as the other mode, and from twenty to twenty-four feet in length.

When the height is under twelve feet, the distance may be proportionally increased between the trees.

By elevating or depressing the horizontal branches, they may be made to extend at all points, or to throw more strength to the branches at the base, intended for the young horizontals or bearers, as may appear needful; and as all the bearers will be on the upper side of the horizontals, a clear and regular space will always be preserved.

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sap, and a larger surface in a given space, than can be by any other method; but a proportionate space must be allowed, say from 16 to 20 feet between the trees, according to the soil, &c.

As it will be necessary that the horizontals should be of sufficient length to reach the end, or fill the space allotted, if they are not of this length the first autumn, they should not be brought lower down than to an angle of from 45 to 60 degrees; and, indeed, unless they are so thick and strong as likely to be too stubborn to bend, they may remain nearly erect until they are of sufficient length, and in this case all strong shoots must be rubbed off the fore and under sides as they form, and particularly all those about the point buds; as in branches fixed in a perpendicular position, these generally grow the strongest.

However long and luxuriant the horizontals may be of one or two years' growth, they will extend very little in length after they are brought down to a precise horizontal position; and although whilst fixed in an erect position, the branches growing in the proper places to form succeeding horizontals may not be strong, by bending down the branch on which they grow to a horizontal position, the sap will be made to flow into them in much greater proportion, and they will soon extend.

If the branches are not of sufficient length, nor too coarse or strong, they should be trained in the same erect position the second or a third year, the tree will then be continued like the figures 2. and 3. S. until of proper length, when it must be brought down and fixed as figure 3. W., supposing figure 3. S. to represent the tree at the end of its summer's growth, and 3. W., as fixed in winter; proceeding thus, a peach tree may regularly be raised as represented by figures 4. and 5.; and plums, apricots, cherries, pears, &c., as represented by figures 1. 2. 3. and 6.

Apricots are very much inclined to produce their fruit on spurs, but the largest and finest fruit are generally produced on moderately strong shoots of the last year's growth, the same as peaches; therefore, whenever those shoots grow in a proper situation, they must be preferred to artificial spurs, and trained in the manner directed for peaches, or as those of figures 4. and 5.

All spurs that project from the wall, and are too short to be trained to it, should be taken off.

Natural fruit spurs on plum or cherry trees may remain, grow which way they will; and all wood shoots that project from the wall must be taken off close, and never shortened for the purpose of making spurs, as this is a practice more productive of injury than good.

ON

THE MANAGEMENT AND TRAINING

OF

PEAR TREES AGAINST WALLS.

Pear trees bear their fruit on short buds or spurs of one, two, three, or more years old, growing from the strongest branches; and the same studs or spurs will continue to produce fruit for a great length of time; but they do not often produce fruit until they have a surface of branches very large in proportion to the sap supplied by the roots. Thus we find, when pear trees are planted in deep rich soils, they grow rapidly, and therefore require a number of years to bring them to a fructiferous state; on the contrary, when growing in a light, or dry and shallow soil, they collect but a small quantity of sap, and require but a confined surface, which is produced in a short time, and they are consequently brought to a fructiferous state in a few years.

In planting pear trees, therefore, the soil must be duly considered, and the space allowed accordingly.

For dwarf pear trees, the preparation for borders recommended for peach trees, &c. is particularly well calculated; in such a soil they will produce the finest fruit at an early period after planting, and continue healthy and prolific.

A tree thus planted, should be allowed from twenty to thirty feet, and if trained as directed and shewn by Plate 2. it may be expected to fill such a space in five or six years.

Plants intended to be trained in this manner should have the two stems trained in an erect position at least two years, or until they are not less than from six to eight or ten feet in length, before they are fastened down.

All collaterals should be carefully removed as they shoot out, and for the first year or two after, they must not be brought down lower than on an angle of 45 degrees; from this, let them be brought down by degrees to a more precise horizontal position, as shewn by the figure 6. which represents a tree of five years' growth from the graft or bud.

All wood buds that throw out shoots in any other part but at the base, where they are wanted, must be rubbed off close; and as the two or three buds nearest the point bud generally form strong wood shoots, these must be particularly looked to, and early removed.

When pear trees are required to grow high and fill a large space, they do better trained on a single stem, and this should be six feet high, like a standard, before the head is formed, as represented by figure 1. Plate 3.

When the bearing spurs grow three or four inches long, or more, which they sometimes do, they must be fastened close to the wall, both above and below the horizontals, as they grow.

Wood shoots must never be shortened for the purpose of producing fruit spurs, for by cutting short one shoot, two or more are forced out the following season; and by shortening these again, more are formed, and large, unsightly, and unprofitable stubbed branches are the result.

All wood shoots that grow where they are not wanted, must be cut off close to the parent branch, as soon as perceived.

If at any time the horizontal branches are found too much depressed to continue and support a strong wood shoot from their points, they must be raised to a more perpendicular position, which will throw the sap more into the leading branch.

If, on the contrary, the horizontals are found to throw the whole or too great a portion of the sap to the point bud, and the backward wood shoots are in consequence weak, they must be depressed.

The principal variation in the mode I recommend, compared to those of the other authors, will be found in the position of the branches; in all but this, perhaps, better instructions for general management, cannot be given, than those by Hitt; but by attending to the position of the branches, and managing them as I have directed, the sap will be made to flow and extend itself through those buds, which are placed in the proper situation to extend the surface of the tree, and when this is the case, there can be no occasion for waste pipes, or other superfluous branches.

When any of the horizontals grow too old, or extend beyond the prescribed bounds, they may be removed by being cut back to the bearers best calculated to succeed them, which will supply their places.

Pear trees generally throw out one or two strong shoots from those buds that are the nearest to the point or leading bud of the horizontals or strong branches; in such cases, if the point bud be perfect, those must be removed early in the spring; but if the point bud be injured or destroyed, the next strongest shoot to it must be trained up in its place, and the others removed.

ON ESPALIERS.

The general system of pruning and managing Espaliers is exactly the same as that of wall trees, and in every respect exhibits the same defects, and is subject to the same objections. The explanations I have given, and the observations made on wall trees, will therefore equally apply to these trees.

Those branches, intended for horizontals, should always be permitted to grow to the length of from four to six feet before they are fixed in this position; and then they should not be brought down precisely horizontal the first year, but fixed on an angle of from 45 to 60 degrees; and when they are grown to a length sufficient to fill the space prescribed for them, or nearly so, they may be brought down directly horizontal.

All wood shoots, except those that grow on the upper sides, must be taken out quite close; but care must be taken to distinguish those from the fruit-spurs, which sometimes grow to the length of six or more inches. As these may be suffered to grow on all sides of the horizontals, the strongest wood-shoots, which grow on the upper sides of the horizontals, and where there is room to train them in, should be fixed down obliquely, and never shortened or stopped, so that they may grow freely between the horizontals without crossing.

By these means, as the fruit buds and spurs of pears, apples, cherries, plums, &c. are always formed on strong healthy shoots of from one to three or four years old, which grow their full length, the trees will be in a state to produce the greatest quantity and finest quality of fruit at the earliest possible period, after grafting or budding; they will also possess all those requisites which, Bradley justly observes, ought to be found in every well regulated Espalier, *viz.* there will be "branches bearing fruit, branches knotted for fruit, and branches forming for knotting in regular and natural succession."

I have been told that the training of Espalier trees round a circle of stakes, or trellis, in a spiral manner, is a common practice in France, but I have never heard of or seen this mode in any regular system published or practised in this country.* I shall, therefore, explain a mode by which trees may be made equally ornamental and productive, and

* Since the publication of this work, the Author has visited some of the first gardens and nursery-grounds in France, and he not only was convinced that this method has never been practised in France, but that the French have no idea of laying in branches their full length; their mode of training every tree is by cutting short the branches.

kept within a much smaller compass than by any other method.

This mode of training is best adapted for dwarf trees, or such as do not form coarse thick branches, nor range extensively, for this purpose. Apple trees should be such as are grafted on paradise stocks; and to keep them with greater certainty within prescribed bounds, and at the same time healthy and prolific, a bed or border should be made of a light and dry porous soil, not too rich, of the depth of nine inches or a foot, on a substratum impervious both to the roots and to water, on the principles recommended for wall trees.

The plants intended for this mode of training should have from four to six branches of equal strength, growing from a stem of from three to six inches from the ground, and may be planted from eight feet to any distance apart.

When the branches are from four to six feet in length, let three long stakes be driven into the earth, from one foot and a half to two feet from the stem of the tree, at equal distances, so as to form a triangle; the stakes may be from four feet to any height; then let two strong hoops, of a diameter to fill the space between the stakes, be fixed horizontally, one about one foot and a half from the earth, and the other two feet above it; between the stakes, fix to the hoops two small laths or stakes at equal distances, the branches must then be brought down to an angle of from 40 to 60 degrees, and fixed to the laths or stakes at equal distances, and each carried round the circle, rising in the same degree like so many cork-screws entwining one into the other. Small circular iron bars not only form much neater fixtures, but more durable; and the best method of fixing is to drive small oak plugs into the earth, with a hole in the centre to receive the bars. Three bars of three-quarter inch, placed in the earth triangularly, and three of quarter or half inch, at equal distances between, fixed to the hoops, will form a proper support.

As it regards the trees, a circle of stakes fixed in the earth would answer as good a purpose as hoops; but the hoops admit of more room for working the earth round the stem; and if large wire be used, and painted, it will produce a neater and more elegant effect.

To elucidate this description, I have given sketches in plate 3. figures A. 1, 2, & 3. Suppose the centre dot in figure A. to be the plant, with its branches as first fastened, the three large dots to represent the stakes, and the six smaller the laths. Figure 1. shews the manner in which the hoops and laths are fixed; and figure 2. represents a plant when first fixed; and figure 3. the second or third year after.

It will be seen that this mode is in every respect conformable to the principles upon which the system of training wall trees and common Espaliers is founded; and consequently trees trained in this manner will be, in every respect, productive of the same effect.

The branches being continued in the same elevation, and parallel with each other, they will always form their strongest shoots at the point buds, and may be carried to any height without running into confusion, or crossing.

If any strong shoots are formed near the base, they may either be fixed and carried on parallel with the stems, or cut clean out.

The bearers, which will be natural studs or spurs, may remain as they are formed, within or without the circle, or on the upper or lower sides; and if they grow out far, or long, they may be tied in.

This method is extremely well calculated to train vines in the open ground, and to ripen grapes, as it will easily admit of being covered with glasses.

It is also well calculated to train fruit trees in pots for occasional or constant forcing in the hot-house.

When Espaliers or dwarf trees are found to grow too luxuriant, and to exceed their bounds, the better way to check their growth is to open the earth two or three feet round the stem, and cut through one or more of those roots that grow the strongest, and that run deepest into the soil; by these means, the form and regularity of the tree will be altered, as it would be by shortening and cutting out the branches.

If trees are found to throw out too much wood towards the stem or base, and the point buds or leading shoots do not grow sufficiently strong to carry on the horizontal branches, these must be raised to a greater elevation.

The growth of these trees is determined by the elevation or depression of the branches, the same as that of wall trees.

ON STANDARD FRUIT TREES.

THE system in general practice, of raising and training standard trees, is as imperfect and deficient, particularly in shaping or forming their heads and its consequences, as that of wall trees, and is as capable of being improved.

Hitt has recommended the shape best adapted to every desirable purpose, but why his method has not been adopted, I am at a loss to guess, unless it is from his not having described a more simple mode of commencing the formation of his trees, or from the same cause that his wall trees failed, *viz.* his not having sufficiently attended to original and natural principles, in his directions.

Many of the objects described by different authors, as desirable, but difficult of attainment, are brought easily within the reach of every one, by the mode I shall explain.

Hitt recommends that the shape or figure should be conical, like the natural growth of the fir tree; and in this manner, almost all fruit trees are naturally inclined to grow to a certain height; but Hitt depresses the horizontal branches too much, as shewn by his figure, and as he does not particularly direct, that the graft from which the tree is raised, be inserted with its point or extreme bud perfect, he commences with a difficulty.

Mr. Knight observes, "Each variety of the apple tree has its own peculiar form of growth, and this it will ultimately assume in a considerable degree, in defiance of the art of the pruner."

In this observation he is correct, and the same may be applied to almost every kind of fruit tree; and it corroborates my opinion, that it is improper to prune or head back a tree at any period, or for any purpose, but to repair injuries.

When trees have been headed back, and have from three to five branches of nearly the same strength, it is difficult to give one the ascendency and at the same time to preserve a regular figure; but if trees are raised from the point bud, and they proceed uninjured, or unchecked, by accident or otherwise, in the manner I have before explained, the horizontals will naturally form and range themselves with regularity, immediately round the extremity of the annual shoot, and will thus prove to be at the distance, and in the position, best adapted to the nature of the tree, and the soil and situation it grows in.

A tree planted in a rich soil, and well sheltered, will attain a great height and size, and as it will require, so it will make shoots of great length, and the horizontals will form at great distances, so as to acquire a surface proportioned to its supply, and be in a fructiferous state in its usual time; and if planted in a poorer soil, its shoots will be alike proportioned to produce the needful surface, so that there will be no necessity for cutting or stopping, which operation always proves injurious to every tree, and more particularly so to a standard, as it retards its bearing.

A side bud should never be forced to form a perpendicular stem, but in case of necessity, from any injury or loss of the original. The buds which are naturally arranged round the extreme or point bud, will always grow the strongest, and regularly take the lead of all below, of the same age, and form the horizontals in regular tiers; it will therefore seldom be necessary to take off any of the side branches, for at least a year or two after they are formed; if they are suffered to remain they will incline the stem to grow stouter and more conical, which will give it more strength, and also keep it more within its natural growth; after a year or two, if they are found too many and too close, they may be thinned and regulated.

By training, or rather permitting a tree to grow in this manner, it will be found, that all the effects desired, and intended to be obtained, by the old methods of training and pruning, either young or old trees, will be gained, and with very little difficulty, at its commencement, during its progress, or towards its end.

Every particle of food consumed will be profitably applied, by the whole of the sap taking its free course, the tree will become fructiferous, in the shortest possible time, and the fruit will be so placed and sustained, as to attain the most perfect quality, and the greatest quantity.

Both the stem and the branches, by their conical shape, will be capable of resisting greater pressure from the weight of fruit, snow, wind, &c. and as large amputations will not be required, or accidental fractures so frequent, the health and progress of growth will be more regular and lasting.

And that which Mr. Knight justly states to be absolutely necessary to put a tree in a state of perfection, "an equal division and distribution of the sap to every part," will be, by this mode, obtained.

If by any means the leading or centre branch be destroyed or injured, so as to prevent its maintaining its position, it must be shortened to some bud, which will admit of being trained up in its place, or if this cannot be done, one of the strongest and uppermost horizontals may be raised up and fastened in a perpendicular position, and whilst young, this is easily done, by tying one end of a straight stick of sufficient strength, to the stem of the tree, a foot or more below the branch it is intended to support, and then fastening the branch above to it; being fixed in this position, it will soon gain the ascendency, and perform its office; but if the stem should be destroyed so low down, that the next horizontals will be too large to be brought up, a graft may be inserted in the stem, which will soon recover its place.

When it is desired to change the fruit of any young tree, it is better to insert one branch or graft only, in the stem, with the point bud perfect, unless for greater certainty, two be inserted, in which case, one should be removed as soon as the other has securely attached itself to the stock.

A single graft, if permitted to grow its full extent, without stopping, will not only form a regular and well disposed head in appearance, but it will also furnish as large a surface, and produce as much fruit, and in as short a time as if three or four had been permitted to grow in the usual manner; and this will, after a few years, be as free from danger of being broken by wind, snow, or otherwise, as if it had been grafted, and had grown from a stock near the ground.

With a large tree of one or more tiers of horizontals, it will be as well to insert a graft on each horizontal, as well as the stem; this will be gaining time.

Such kinds of fruit as naturally grow too much reclining, or pendulous, to raise itself to a straight stem, of sufficient height, and to form a handsome head, may be grafted on a tree already formed with horizontals in the manner last described.

The best shoots for this grafting, are those short and strong ones, which have a wood bud at the extremity, and are generally formed at the ends of the bearers.

Figure 2. in plate 3. is given as a representation of a tree with a head in its fourth year; it may be added, that when the elevation or depression of the first tier of horizontal branches is left to nature, very little attention or art will be required for their future regulation, for as the different tiers will grow parallel with each other, there will be no danger of crossing or confusion.

Hitt's explanation of his plate 7. is as follows:

"Figure 1. represents a tree whose head is supposed to be only one year old, with all the branches shortened, but none taken out, which is the customary way of pruning at the time of planting, and which causes trees, when they are old, to have too many strong parts, and to be full of old wood.

"Figure 2. represents a tree with branches two or three years old, and cut according to the common method, with all the branches shortened more than the length of the last year's shoots, and no other buds left on them but such as are either prepared or preparing to blossom. But this method causes many new planted trees to be three or four years before they make any shoots.

"Figure 3. represents a tree with five branches, either one, two, or three years old, and cut after the method I practise upon the head of a tree whose shoots are not more than two feet long.

"The branches left on are at their full length; that at A. is intended for an addition to the stem, and should be one of the strongest of those standing upright, but the other four must be chosen as much in a horizontal position as their natural manner of growing will allow.

" Figure 4. represents a tree when full grown: the way to bring a tree to such a shape is to make a straight stem, and preserve upon it four branches, at every place where a new sett of horizontals is required, A. B. C. D. which should not be nearer each other than two feet, and if the tree is of such a nature as to produce a straight, upright branch for a stem, then all others but those designed for horizontals must be rubbed off at their first appearance, for all branches of a standard fruit tree should grow in such positions as those of a silver fir tree."

DIRECTIONS
FOR THE
PRUNING AND MANAGEMENT
OF
OLD WALL TREES.

In the pruning and management of old trees, the principles I have laid down will be found equally to apply, as to the training of young ones; but as most will require considerable attention to reduce them to a proper state, I shall suppose a few cases, and explain the best mode of treatment.

Peach trees are generally trained in the fan fashion; and when of more than six or eight years old, their best bearing wood is formed at the extremities of the branches, and there not being room to fix them, they are cut away.

When a selection of branches is made, an appearance of decent regularity is given, and the space is sufficiently covered; but as in the performance of this, full one-half or perhaps two-thirds of the young shoots are removed, those that are left being the underling branches (or such as were made to fructify by starvation, instead of due exposure), are incapable of producing fruit in perfection.

From the peculiar position of the branches, the best bearing wood is formed in nearly the same place as the last year, and again cut out, and thus, by pursuing the same plan annually, the trees are continued in the same imperfect state.

To remedy these defects, and to rectify such trees as are here described, the most direct method that can be taken is to reduce them to the figures in plates 1. or 2.; and where the whole branches are pliable, to bring them down to a horizontal position; but, in doing this, great care will be necessary, as it will be difficult to avoid fractures.

Most trees will be found to bend better at the falling of the leaf than at any other season; but it frequently happens that very slight wounds or fractures at this season are followed by the canker and mortification, which is not the case in the spring, or when the sap is flowing; for these reasons, I prefer pruning old trees in the spring.

The most effectual and perfect method to renovate an old tree, would certainly be to cut off or back the whole of the head, and as it throws out young branches, to proceed as with a young one; but as this would be a certain loss of fruit for two or three years, most persons will prefer a reformation by degrees; and this is best done by forcing down the old branches as much within bounds as possible.

In doing this, such branches as are too stubborn may be cut half through, they will then split in bending, like the plashing in a quick hedge; this may be an eye-sore, but it will be only temporary, as it will most likely occasion a strong young branch to shoot and grow at its base, which may be trained down upon or across the old branches, in the same position as a young tree, and as if the old branches were not there.

The crossing of young branches over the old, or fastening these down upon them, will occasion no injury; the old branches being continued merely to produce fruit, until the young ones are sufficiently forward, may then be cut out, and thus a new tree may be raised almost imperceptibly.

When old trees are very subject to canker, the cause will generally be found either in the soil or subsoil, from its being too retentive of moisture, or from water stagnating from other causes.

In the first case, therefore, the soil must be carefully removed from the surface, so as to uncover the roots to their full length, or as nearly so as practicable, and then cut off such roots as appear to run downwards or grow deep; or if some extend beyond the good soil into bad, they must be shortened; then mix with the soil some coarse sand, fine gravel, or brick rubbish, or in case these are not at hand, some ashes, in a proportion sufficient to break its tenacity, or to make it open and free, and cover the roots again with this mixture.

If the subsoil only is in fault, or water stagnates from other causes, cutting off the downright roots, and making proper drains, will be found efficient.

When a tree blossoms much, but does not bear, the cause will be found generally to arise from poverty, or too much water, with too little of the carbonaceous principle, and a remedy will be found in laying dung on the surface, or watering it with a strong solution of the serum of blood or dung.

In some cases this defect will be caused by the branches being too many and too close, or overshadowed; to remedy this, they must be thinned out, and the sun admitted.

A tree will sometimes set its fruit, which will continue to languish on the branches for a while, but at length fall off by degrees, until very few are left, and those seldom attain size or flavour; this defect will often arise from a want of moisture, as well as from a deficiency of the carbonaceous principle in the soil.

Where a tree appears weak, in a dry open soil, on a gravelly substratum, dung should be laid over the surface of the bed or border, and water in liberal quantity be frequently poured over it; or if the soil be sufficiently rich, a good watering alone, every two or three days, will most likely prove sufficient.

Wherever canker or gum appears, the decayed or infected part must be cut clean out, and some soot wetted and rubbed over the wound; this will generally prevent its spreading further, and save the branch.

Apricots, plums, and cherries, and all stone fruits, are subject to the same defects and diseases, and from the same causes, as peach and nectarine trees, and in this respect require the same remedies; but as they bear their fruit on spurs or shoots of two, three, or more years old, they require to be trained in much the same manner as the pear and apple tree.

In cases of blossoming and not bearing, of canker and mortification in the pear and the apple tree, the same remedies are equally applicable and efficient as those recommended for the peach tree.

The greatest defect in old apricot, plum, cherry, pear, and apple trees, trained against walls or espaliers, is generally found to arise from unnatural stumps, which, from improper cutting, will in the course of time, form enormous wasteful and unproductive bushes, growing from all sides of the main branches; although these bushes sometimes answer in a trifling degree the purpose for which they were originally formed, and bear fruit, they are like the principle which directed their growth, unnatural and imperfect, and are more wasteful than productive.

Trees in such a state, when trained in the fan fashion, should have their large branches brought down in the manner directed for peaches, and al artificial or unnatural spurs, except those which grow on the upper side, be cut off close to the stem, and those which grow on the upper side must be so reduced as to leave only such shoots as can be fastened in between and parallel with the horizontals; as those must always be trained in at full length, no more must be suffered to grow than can be allowed space.

When branches are trained in this manner, the wood shoots will seldom form any where but at the extremity of each year's growth, the intermediate buds forming for fruit, and so continuing to grow in short and compact spurs; and as these, when properly attended to, will always be sufficient for fruit, all intermediate wood shoots must be cut off close to the leading branch. If such wood shoots are rubbed off in the spring, as early as they can be ascertained, it will (by giving the sap they otherwise would consume to the leading and bearing branches) forward and increase both branches and fruit.

When, from the erect position of the stem, the sap does not flow sufficiently into the horizontal branches, as in Forsyth's method of training, with one stem, nor break out in branches where wanted, it may in some degree be directed into the desired channel, by cutting a notch in the wood just above it.

When a shoot cannot be produced on such parts of a naked stem of the peach or apricot where wanted, one may be obtained by engrafting by approach; this may also be done in plums, cherries, pears, and apples, &c.; but when it is found necessary to cut back large branches, or to cut off the whole of the head of pear, apple, or plum trees, if a graft be attached, by inserting it between the bark and wood, it will be a much more certain and ready method of forwarding its re-production and growth in a proper form, than awaiting and taking the chance of a young shoot in the natural way.

If trees are found to grow too luxuriantly for the space allowed them, it will be to little purpose we attempt keeping them within compass, by cutting back and shortening the branches, as this in most cases will increase the evil; but if in the month of November, the earth be removed, and a proper proportion of the deepest growing roots cut off, the luxuriance of a tree may be checked in any degree, and rendered more fruitful; this operation may be repeated as often as required, without the least danger of disease or injury, as recommended for Espaliers.

DIRECTIONS

FOR MANAGING OLD STANDARD TREES.

As Standard Trees, both in gardens and orchards, are, like the dwarfs, cut, cramped, and distorted into the most imperfect and unnatural forms, it will be difficult, by any means, short of lopping off, or cutting back the whole of the branches or head, to reduce them to a proper shape; and as this would be the certain loss of fruit for two or three years, it may by most persons be considered as too great a sacrifice; but in cases where the trees are grown so weak and extended as to bear no fruit, but on the extremities of the branches, and those continually breaking from casual pressure, I am persuaded, that in the course of a very few years, the loss would be more than made good by such an operation, in the certainty of a crop, and improved quality of the fruit.

When trees are lopped or cut back, such stems or limbs as grow in places, to sustain leading branches in a proper position, should not be cut off close to the trunk, but left from one to two or three feet; and the one that is most erect should be left so as to stand a foot or two above the rest, to form a central stem; and a graft, either from its own branches, or some other variety of fruit, may be inserted between the bark and wood; but whether grafting be resorted to, or the tree left to throw out its own shoots, only the one which is rightly placed should be suffered to grow; and if this be sustained for a few years, until it is perfectly and firmly attached, it will, by its extra growth, form a handsome head, and bear more fruit, and in less time than two or more branches will do, when suffered to grow in the usual manner.

It is a common practice in pruning or dressing Standard Trees, when they are overgrown, and the fruit small, to cut away all the small branches in the middle of the tree: and when the object is an immediate improvement of the fruit, this is the most effectual method; but as by this operation the cause is not removed, the effect will soon be reproduced; and with this the bearers being thrown at a great distance from the trunk, they will be in greater danger of injury from winds, snow, &c. In a case of this sort, therefore, it will be a more complete method to divide the limbs or arms as much as possible into tiers, agreeable to the form recommended for young trees, by cutting out all intermediate limbs or branches.

And thus, by giving room for the admission of the sun and air to the small branches growing on those that are left, they would become fruitful; and taking up a large portion of sap, would not only prevent the expansion of the limbs or arms, but occasion their increase in size and strength, and thus afford additional security against casual injury.

Whenever trees are found to produce shoots, but no fruit, a remedy will generally be found in removing the earth and cutting off some of the deep large growing roots, particularly the tap root, when found.

ON THE VINE.

The stated opinions of Bradley and Hitt are, that a dry calcareous soil is the best adapted for Vines, as it furnishes the greatest produce in fruit, and gives the finest flavor.

It however appears, by recent experiments, that the Vine not only grows most luxuriantly, but also healthy and fruitful in a soil replete with animal manure.

Mr. Speechly, in a treatise on the Vine, recommends a compost made of one-fourth part of garden-loam, one-fourth part of rotten-turf, one-fourth part of sweepings and scrapings of pavements and hard roads, one-eighth part of rotten cow dung, and one-eighth part of vegetable mould from rotten leaves.

He also recommends that this compost should form a bed or border of two feet and a half deep on a bottom laid shelving outwards from the stem, with a sufficient fall to drain off water.

No doubt this system of preparing borders is a very good one ; but as Mr. Speechly correctly remarks, stagnant water is very prejudical to Vines, and for this reason, I think his compost is too close in its texture, and too retentive of moisture to be the most productive of fruit; for although the Vine requires a large supply of water, a frequent and fresh supply from the surface is more congenial to its nature than a constant retention of water by the soil, which must nearly approach stagnant water in its effects. I therefore recommend beds or borders for Vines to be formed on the principles I have before explained for the peach and other fruit trees, compounding the stratum for the roots of one-third part of the scrapings of a road made of or repaired with flint gravel, or coarse drift-sand, one-third part of rich garden-loam, or rotten-turf, one-sixth part of rotten dung, and one-sixth part of wood-ashes, or soap-ashes; this stratum to be covered with from six to nine inches of garden-loam, and on this to lay two or three inches of gravel.

When Vines are planted in this manner, the roots will not deviate from the stratum formed for them, unless, from great dearth of moisture, they are driven lower to find it, which is easily guarded against by a regular supply of water; and from the looseness of the soil, the consequences resulting from stagnant water will be more effectually guarded against.

It may be remarked that the fertile qualities of a loose gravelly or sandy soil is soon exhausted: but, by the method recommended by Mr. Speechly, of occasionally watering the border with the draining of a dung-hill, or vegetable and animal solutions or extracts, the carbonaceous principle is replenished and sustained in any degree.

Many different methods have been recommended for raising and planting Vines; but although the Vine is of rapid growth, there is no fruit tree more checked or retarded in its advance to the fructiferous state, by being injured and curtailed in its roots; and, consequently, to raise plants for transplantation, there is no mode in any respect equal to that recommended by Mr. Speechly, which is as follows:

Select a branch of the last year's growth, of rather a small than a large size; let the upper part be cut off sloping with a sharp knife, about a quarter of an inch above the eye; and about three inches below the eye cut off the wood horizontally, great care being taken to leave the wood smooth at the bottom; the other part, too, should be taken off with a clean stroke; the cutting being thus prepared, make a hole and insert it, placing it so that the eye may be covered about a quarter of an inch deep.

The cuttings may be taken off any time during winter, and laid in moist earth until the time of planting, the best season for which is March. And if then planted in pots filled with a light sandy loam, plunged in a hot-bed, and frequently watered, they will seldom fail to produce the best plants for transplanting.

It appears that whenever a Vine is deprived of its ususal supply of sap by the loss of roots, &c.

the bark and sap vessels contract and become inflexible; and when this is the case, although the roots recover, and furnish a luxuriant supply of sap, the old stem is incapable of expansion: thus it is often seen that a shoot of one year's growth far exceeds in size the stem from which it springs, although three or four years old.

When cuttings are planted of ten or twelve inches length in the usual way, they remain a year or two before a quantity of sap is supplied, and consequently the old bark and vessels become fixed; and notwithstanding they may throw out some strong shoots after this time, when taken up for transplanting, the roots are unavoidably reduced, and the supply of sap again lessened, and the vessels contracted.

And when plants are raised by layers in pots or in borders, they are suffered to remain connected with the parent plant a long time after they strike root, and being thus nurtured by both, furnish very strong branches; but these, on being separated from the old branch, are thereby deprived of half their supply of sap, and in consequence the vessels contract, become inflexible, and incapable of extension, like cuttings.

When plants are raised from a single eye, as recommended by Mr. Speechly, the roots form immediately round the eye; and the young stem striking directly from them is without old bark or old vessels, and being raised in a pot is readily turned out with all its roots entire and uninjured, and immediately taking to the soil, the shoot extends in proportion to the sap supplied; and thus, proceeding unchecked, will, the first year after transplanting, often form a shoot strong enough to produce fruit the following year; whilst the strongest plant that may be raised from a layer or cutting, in the usual manner, and transplanted, will not produce a shoot of half the strength the first year, and are seldom in a state to produce fruit in a shorter time than three years.

The Vine is a creeping plant, and requires support to enable it to arrive at maturity in the production of its fruit, and differs materially in its habits or nature from all the other fruit trees; and unless this is duly considered, and perfectly understood, it will be impossible to train it to the utmost advantage. I shall therefore state, in four propositions, or theorems, what I consider to be the laws of Nature, as explanatory of the mode of training.

First. The Vine bears its fruit upon shoots of the same year, produced by branches of the preceding year.

Second. The strongest and best ripened branches produce the largest quantity and finest quality of fruit.

Third. In whatever position the branches of a vine are laid, whether horizontal, oblique, or perpendicular, the strongest branches are always produced at the extremity of a last year's branch, and the two extreme buds generally form shoots of equal strength.

Fourth. Those branches which are the farthest from the root ripen the best, and are the most prolific.

A method of training the vine, conformable to those principles, was in the year 1808 transmitted by me to Mr. Knight, who caused it to be published in the transactions of the London Horticultural Society, and there stated to be taken from Hitt; but, on comparison, I think this method will be found much more conformable to the principles I have explained, than that of either Hitt or Forsyth, and calculated not only to produce an equal quantity of fruit for the first few years, but to continue for any length of time to cover the same space of wall or frame with the same quantity of fruit annually, and, at the same time, to extend it to any distance required.

The figures in plate 4. were those given to show the method above alluded to, but which is more peculiarly calculated for a long and low or shallow wall or frame; and a very slight observation must convince any person that Hitt's plan and principles are wholly inadequate to the production of such an effect.

I have annexed sketches of another mode that is better adapted for a narrow and high space, see plate 6. and 5.; however, these are merely by way of elucidation; the principle admits of an infinite variety of forms.

It will be seen that by adhering to the principles I have explained, the whole of the sap supplied by the roots, will be applied to the most profitable purpose, the strongest shoots will be formed on the ends of these shoots which were the strongest, and left to produce bearers the last year, and on the spurs left for the purpose; and as these will be the only wood branches on the root, the whole of the sap flowing to them will not only give them the utmost strength, but as it must pass the fruit branches, the fruit will in consequence be well supplied and supported.

From the peculiar direction of those branches, the position is not only the most congenial for the bearers, which have ample space allowed to be trained up perpendicularly between the horizontals; but the strongest shoots will be produced in the exact situation to form bearers for the next year, to fill the same space with fruit, which was so occupied the last year, and to extend the tree.

Those strong shoots or leading branches marked in the summer figures a. a. a. a., must be carefully fixed as they grow during the summer, and by no means be shortened; for if they are shortened or stopped during the summer or spring, those buds which would otherwise form the branches to produce fruit the following year, will burst prematurely, and the fruit be lost; the collaterals which are thrown out must be taken off from time to time, as they appear, not close, but pinched or cut off a little above the first joint; this attended to, and the branches trained into the most convenient place to be exposed to the sun, they will become sufficiently hard and ripened, without removing any of the leaves which cover the fruit buds. And it may be necessary to observe, that the leaves must not be removed or taken off on any account; for those buds which have been deprived of their leaves, seldom produce fruit.

The bearers as marked c. c. c. in the figures, being trained up perpendicularly, must be shortened by pinching or cutting off their tops, about two or three joints above the fruit, and all barren branches must be taken away, close to the old wood.

To perform these operations, the vines should be overlooked every fortnight during the spring and summer.

At the winter pruning, which I recommend to be performed as soon as the fruit is ripe and gathered, all the branches that bore the fruit must be cut off close to the old wood, and the strong wood branches or leaders, which have been fastened up and trained for the purpose, be brought down and fixed close upon the old branches, and shortened, so as exactly to fill the same space, with the bearers, the next year, which they did the former; see d. d. d.

On those principles, a tree being planted as A., and trained or fastened as 1 S. during summer, and as 1 W. at the winter pruning, will, the following year, be as represented by figure 2.; the short spurs marked f. f. f. are necessary to furnish two extreme buds to produce the two strong shoots, which will be wanted the next year; one to cover the old bearer, as marked d. in figure 2. and the other to be shortened, to form extreme buds, as f. for the following year.

Pursuing this method, any space may be filled, and when it is so, by cutting off the oldest branch close to the root, as at g. figures 3. and 4. and removing it, the tree will be the same as it was the last year, with the waste of one horizontal and bearers only.

If any prefer the upright mode of training in forcing houses, a system full as regular as those I have described may be adopted, as represented by the figures 1. 2. 3. plate 5. and in this the principal object must be to keep two strong shoots growing from the bottom every summer; the one to be fastened up alongside the old wood, and the other to be cut off, to produce two for the same purpose the next year; pursuing the principles explained, it will readily occur that a vine may be trained in almost any shape the imagination can devise; and to obtain the advantages resulting from an extended surface of trunk, with the upright mode of training, the lower figures in plate 5. are well calculated.

In this manner a tree may be continued to fill the same space, to present the same extent of surface, (and barring accidents and unfavourable seasons,) to produce the same quantity of fruit annually, for any length of time; the only encroachments upon the original space will be by the old wood or branches, and as these must be laid close, one on the other, this will be but trifling.

Forsyth's remark, that "the vines were trained upright, which caused them to grow so luxuriantly that the sap flowed into the branches, instead of the fruit," seems a very superficial idea, and expressed without much consideration; yet it is very generally acted on, and I believe is the grand cause why the grape vine is rendered so unproductive.

Many gardeners shorten all the branches indiscriminately, and pull off the leaves, *because if left they would shade and rot the fruit.*

And that the fruit may be larger and finer flavoured, vines are annually cut back close to the root, and curtailed so as to produce a small number of branches and bunches only, but these appear to be erroneous conclusions, and as contrary to reason as to nature.

There are to every operative maxim, two extremes and a medium, and thus, although by lessening the number of bunches of grapes, in a certain proportion, we still obtain the weight of fruit; or in other words, supposing, that if four bunches of grapes were left on a tree, they would attain the weight of four pounds, or one pound each, and that if two bunches were removed, the other two would take the supply, and become two pounds each, or four pounds together; it is not to be concluded, that if three had been taken away, the remaining bunch would attain the weight of four pounds; for if two pounds be the utmost weight of a bunch, by taking away the third bunch we lose half the produce.

This principle will equally apply to the produce of the root in branches, for although by limiting the number of shoots, and directing the whole of the sap into them, we obtain great strength and luxuriance of branches, we cannot force Nature beyond her prescribed bounds; if we reduce the number of branches on a root to *four*, when from its age, and by the luxuriance of the soil, it is calculated, or found equal *to sustain eight*, we clearly throw away half its produce.

If the principles I have before explained, on training erect growing trees, apply also to the Vine, and I am well satisfied they do, *viz.*

That the root is annually extended, and annually supplies an increased quantity of sap;

That a surface of trunk, branches, and leaves duly proportioned to the quantity of sap furnished by the roots is necessary to produce and sustain the fructiferous state;

And that the farther from the root the greater the quantity and finer the quality of the fruit:

The methods of the different authors I have quoted, and more particularly Forsyth, must be imperfect and wasteful.

Multiplying the roots of a Vine, by dipping the main leading branch into the earth, at short intervals, as it proceeds along a wall, is a method very generally practised, and no doubt with a view to increase the produce in fruit, but the contrary must be the effect.

If instead of planting a number of Vines in hothouses, for the purpose of obtaining variety, one only was planted, and this engrafted with the different sorts required, I have no doubt but the crops would be much larger and more certain and regular.

Mr. Speechly describes the method of engrafting Vines as being successfully practised, and recommends the Syrian grape, which is of very large and luxuriant growth, as the best adapted for a stock to bear several sorts.

The Vine may be engrafted in the same manner as other trees, but engrafting by approach is the most certain method; the season for engrafting is the same as with trees generally, *viz.* a short time before the buds begin to swell. It is found, that the best time to graft is, when the young shoots of the stock have grown from six to nine inches; the sap is then not lost by bleeding.

Hitt describes his plate 5. as follows:

The figures in this plate exhibit Vines of different ages.

"Figure 1. represents a layer when first taken from the mother plant.

"Figure 2. the same when cut in the customary way.

"Figure 3. when planted and cut according to the method I practise, having one branch taken off, and the other shortened.

"Figure 4. is the same with two shoots, raised from the two buds left on, when under the representation of figure 3.

"Figure 5. represents the same Vine cut and nailed in the winter.

"Figure 6. is the Vine cut and nailed in the winter, by the common method.

"Figure 7. is one full grown with one of its sides cut and nailed in the winter, and the other remaining as it was nailed in the summer.

"Figure 8. is a long branch supposed to be made last year, and turned in winter to cover a bare part of the wall.

"Figure 9. is called the sow-gelder's horn, and is a method made use of by some of the best pruners to dispose of long branches."

ON FIGS.

Figs are not so generally cultivated as other fruits, but are nevertheless well worth attention, as they possess a flavour and quality which no other fruits do.

My observations and experiments in the cultivation of this fruit have not been so extensive as with others. I shall therefore quote Hitt's instructions at full length; but although his plan of training may do very well, as there is some uncertainty and difficulty in pursuing it, I shall add a few observations and describe a mode of training which will be found more simple and practicable. The Fig Tree very much resembles the vine in its natural propensities, and affects the same soil, but is of different habits in its growth and mode of bearing.

Like the vine, the Fig Tree is a very succulent plant, requiring a good deal of water; but stagnant water renders it unhealthy and unproductive; beds or borders for Figs should therefore be formed in the same manner, and of the same materials as recommended for vines, adjusting the proportions of the composition to the space allowed for training, and bearing in mind that it grows wide and luxuriant.

The Fig Tree when it has attained a surface of branches proportioned to the soil it occupies, produces its fruit at almost every bud which furnishes a leaf, but the fruit on the spring shoots is always the largest and finest; the figs however which grow on the Midsummer shoots, when they can be preserved during the winter, will become of a very delicious flavour, although small in size, and these will also ripen long before those on the spring shoots.

Unlike the vine, the Fig Tree throws its strongest branches from the most vertical buds; but, notwithstanding, it always pushes out shoots from the point buds of horizontal branches, and although these are short, the buds are close together, and generally very fruitful.

The farther the bearers are from the root, the more certainly productive they are. I therefore prefer training them in the manner of the morello cherry-tree, which also throws its shoots from the point buds, and produces fruit on the last year's shoots, in the manner represented by figure A. B. plate 6.; but it will be necessary to keep the bearers at the full distance of the length of a leaf, that they may not overshadow the fruit too much, which will prevent its ripening.

Hitt says, "Fig Trees (as I have experienced) prosper and bear best when planted in a dry soil, with a rock near the surface."

The explanation of his plate 6. and pruning of a Fig Tree against a wall.

"This plate shows the shapes of a Fig Tree of different ages. Figure 1. is either a tree just planted with three branches left on, or one that has been planted a year with three buds or more upon it, which has produced shoots.

"Figure 2. is a tree a year older than the first, brought to the shape it appears in, by displacing all other buds but those which produce the shoots.

"Figure 3. is a tree almost full grown, though it had the same shapes as the other two figures, when it was young, and the horizontal parts A. B. and A. C. were like A. and B. in figure 1.; but had they been laid horizontally when so short, they would not have reached near enough the outsides of the space designed for the whole tree, and as they would increase but slowly in length after, part of the wall would have continued a long time bare.

"As the roots of a Fig Tree are like those of vines, so must they be planted in the same way, though pruned differently.

"If the young shoots of a Fig Tree are not too near each other, they will produce almost as much fruit as leaves, both from the same places, but not all of them at the same time; for the leaves drop off the trees, when the fruit near the upper ends of the branches are only like small buds. And there are many others appear the next spring from leaves, where leaves were shed from in the autumn, that is, at the extremities of those shoots that are not killed by the winter's frosts.

"These small ones, and those that only appear in the spring, are the most certain to ripen; for those which are pretty large in the autumn are liable to be killed in the winter; but if any of them live, they ripen the earliest the following summer, and are the best fruit.

"Those which appear the largest at the time of the trees shedding their leaves, were such as put out earliest upon the new made shoots, but few of which ripen in this nation the first year, except some particular kinds, as the catalogue mentions, though I don't doubt but there are many which do in more southern climates, as in Barbary, Spain, and Italy, where I am informed they are in great perfection.

"I cannot think it proper to take off the live end of a branch in the spring, for that part is most certain to produce ripe fruit; neither do I approve the ending of young shoots in June, though it is practised by some people to procure a great number of branches, but they may be obtained by laying strong ones horizontally; and if they are old, make nicks on their upper sides, which will cause young ones to come through the rind. The spring, or what may be called winter pruning, I think the properest time for taking out large branches, which I generally do about the middle of March, when the weather is dry; then should all dead fruit be pulled off, and the young shoots that are left should be chosen with live ends, if possible; if not, the dead ends must be taken off, and the branches nailed up, at least the breadth of a full grown leaf from each other.

"As in the summer time there will be more branches put out than can be placed at the distance from each other required, let them be taken off at their first appearance, and the others kept close to the wall in the summer, by nailing them as they advance in length. This method will prevent their being injured by the winds, as they are subject to be, by reason of their large leaves. If at any time there be more branches put out from the horizontals than can be nailed upright at proper distances from each other, let them be taken off at their first appearance.

"As the upright branches advance in height, take all from the middle branches that would intercept them before they reach the top of the wall, and suffer no collaterals to remain upon them (at winter pruning) above two inches long.

"The wood of one year old in the uprights produces no leaves, which gives room for an annual succession of branches, admitting there be no long collaterals left on.

"I know there are many practitioners that only nail the strongest parts of a tree, and leave the collateral loose, though of a great length, and have many times plenty of fruit upon them.

"But they never ripen so early as those that are near the wall, and if they do at all, it is only such as would ripen on dwarfs or espaliers; and I think it wrong to bestow a wall upon such trees as would produce as much good fruit without it."

ON THE

CURRANT AND GOOSEBERRY.

Currants and Gooseberries, although of inferior consequence to most other garden fruits, are still of sufficient importance to claim attention; and notwithstanding those fruits are grown on bushes, which may appear to require but little care or art in their management, their produce as much depends on this as other fruits, and is in every respect as much influenced by the mode of cultivation, training, pruning, &c.

Currants and Gooseberries are easily raised from cuttings, which, if planted in the month of November, will seldom fail to take root, and form strong plants the following year.

When the plants are intended to grow ornamentally round borders, &c., they will have a more handsome appearance if raised on a single stem six or eight inches from the ground; in this state they are less incommodious to the gardener in working the borders, &c. round them; and they are easily raised of this form, by taking off all the buds the full length of the cuttings, below where the branches are desired, previous to planting.

But if plants are wanted for beds, to be grown for culinary purposes, the better way is to let them bush, or throw out their stems under or close to the ground, as in this state they are less liable to accident; and when injuries are occasioned, they are more readily made good.

The general management of Currants and Gooseberries, or the mode of pruning, &c. commonly practised, is opposed to Nature, and much time is lost in bringing them to a productive state.

The disposition of the branches being left to chance, from the random and promiscuous manner in which they are commonly cut, it is generally so irregular and confused, as to render it difficult to reduce them to a proper and uniform shape without much cutting out; and when this is resorted to, the young shoots often grow so luxuriant, as to be much larger than the old branches that produced them; and in this state they are so liable to be broken off by every slight motion or pressure, as seldom to have enough left at the winter pruning to form a handsome head. When properly attended to from their first planting, by regulating their branches, and placing them in such positions that they may advance in their growth without crossing and obstructing each other, those bushes will seldom require cutting back; and their branches being suffered to grow their full length, will not be so liable to accident, and will produce more fruit in two or three years after planting, than they can do in five or six years, when cut back and stubbed in the usual manner.

Both currants and gooseberries bear their fruit on the last year's shoots, and on short natural studs or spurs.

The gooseberry will continue to bear on the same buds or spurs for many years, when the branches are kept free, and duly exposed; the only care, therefore, those will require, is, that the branches be so disposed that they may be suffered to grow their full length; and this may always be done by the assistance of a few stakes to confine the branches the first years of their growth. The collateral shoots must always be taken off close to the place from whence they spring, and this is done with the least trouble and the best effect by rubbing off the shoots when they are two or three inches long, perhaps in April or May.

The same buds which produce currants one year, do not always produce them the next, particularly those on the collaterals, as these are often without leaf or wood buds, for unless there is a leaf or wood bud on the branch, beyond the fruit, it will not come to perfection; the mode of pruning those, must therefore be something different from gooseberries.

The first formation of the currant bush must be regulated much in the same manner as the gooseberry; but as the branches grow more erect, they will require more attention, and be more benefited by the use of stakes to fix them in a reclining position, and at sufficient distances from each other; the collaterals should not be taken off until about the month of July or August, and then they should not be rubbed off, like the gooseberries, but cut, so as to leave a stub or spur of two or three buds, which buds will not only bear fruit the next year, but throw out others, which (when the main branches are kept properly separated) will continue to form a close mass of fruit buds every year.

To make the most of both gooseberry and currant bushes, and to apply the whole produce of the roots to the formation of bearing branches and the finest fruit, and at the same time to keep them within a narrow compass and secure from accidental injuries, the most certain method will be to train them in the manner directed for spiral espaliers, as shewn in plate 3.

The stakes and tying will be an additional expence; but the additional produce, both in quantity and quality of the fruit, will more than overpay it, and with good profit.

OBSERVATIONS

ON

BLIGHT AND DISEASES OF TREES,

WITH A

COMMENTARY ON FORSYTH, KNIGHT, &c.

THE injuries and diseases to which fruit trees are subject are various, and often difficult to be accounted for; but unless in cases of obstruction or failure in their growth and produce, we can discover the cause, it will be to little purpose we attempt a remedy.

Blight is a term in very general use, but which is not easily defined.

Whenever a tree is obstructed in its growth, it matters not from what cause, it is said to be blighted; if the leaves, branches, blossoms, or fruit are cast off or destroyed by insects, it is said to be blighted; if it be checked or destroyed by frost, it is blighted; and if, from a stagnation of water about the roots, the trunk and branches become diseased, it is blighted; and, in fact, in all cases of failure, *blight* is the assigned cause; so that to attempt explaining a *general remedy* for, or preventive of *blight*, would be ridiculous and absurd.

It will be seen that Bradley, Miller, Hitt, Forsyth, and Knight, have bestowed considerable attention on this subject, but evidently without producing much general benefit.

I am not so vain as to believe that I can give a just explanation of every obstruction, or describe the cause of every failure; but I flatter myself by pursuing the plan on which I grounded my ideas of training trees, that of resorting to elementary principles, and adhering to Nature, and demonstrable facts, I shall be able to develope a little of the mystery at present pending, and by directing the attention to the different objects, in a divided and separate point of view, more clearly explain the means of prevention and cure.

The diseases of trees originate either in the root, from the soil and situation being ill adapted, or from some external injury.

The habits and constitution of vegetables, like animals, are generally determined by their food, lodging, (or texture of the soil they grow in,) exposure to the various changes of the atmosphere, and to the injuries of insects and animals; I shall therefore arrange my observations and ideas under these four different heads.

First, as to food; having already explained the nature of this, I shall only further observe, that the food of plants being taken into the system in a state of liquid, the regularity of supply must depend upon the quantity of water furnished, and its quality, or the nature of what it holds in solution.

None of the fruit trees under our consideration can endure stagnant water; when placed under such influence, generally, the roots rot and decay by degrees, and the branches and trunk become equally affected; and when but partially so, or for a time very wet and then dry, the growth of the trees vary in the same degree, often throwing out strong and luxuriant branches during the spring and summer, which gum, canker, and die in the winter.

The peach tree, under those circumstances, is also subject to the disease called mildew, and the curled or distorted leaf and branch; and this will peculiarly prove to be the case with trees, when planted against walls, where the dripping of an extensive roof are thrown in times of rain on their roots, and which rapidly drains off.

Trees planted in beds or borders formed in the manner I have directed, and protected against such drippings, will seldom be found injured by these diseases.

An uniform supply of water, given from the surface downwards, will furnish an uniform supply of food, which will produce a healthy and fruitful tree.

It will be seen by the extracts I have made, that the gum and canker, or morbid exudation, have given rise to considerable debate among the learned, and particularly between Messrs. Knight and Forsyth; the former considering those diseases as the effect of age, which is continued from the parent through all its offspring, or that it is hereditary in particular kinds of fruits; the latter as local disease only.

Both claim the authority of great experience in support of their different hypotheses, and perhaps both are entitled to the merit of ingenuity, but I fear both deal a little too much in extremes.

Mr. Forsyth, in asserting that the gum and canker, whenever visible, may be stopped, and a cure of *the particular part* effected, is certainly correct; and Mr. Knight, in stating that trees cannot be reduced to a perfect state by a local cure, and that particular trees are liable to this disease, and subject to its attacks in all situations, more or less, I believe also correct; the better plan, therefore, to insure success, will be to look for a medium, or a course of practice that will come between the two, and steer clear of both evils; for this purpose, in the first place, wherever circumstances admit, when planting trees, such sorts should be chosen as appear the least subject to those diseases, and next, to guard against those general causes of disease which I have enumerated, by the methods described.

And whenever blotches, canker, gum, or the morbid exudation appear, to cut away all the affected part to the quick, or sound bark and wood, and then (as the most simple application) rub over the wounded part with soot, mixed up with water like a paste; this will be found generally efficacious. It will prevent a further extension of the evil in that part; and if a very small portion of bark remains sound, the sap will extend it so as to support the part of the tree above it, and cover the wound.

Secondly, as to the bed, couch, or stratum that forms the lodging for the roots: although I have explained the general constitution and habit of the roots, and their influence on the trunk and branches of trees, it may be necessary further to describe a few peculiarities. The blistered and distorted leaf and branch are produced by rank manuring the beds or borders; this I have demonstrated by direct experiment; and observing some young cherry trees, which had grown luxuriantly for two years after planting in a large orchard, all dead in the spring following, I endeavoured to ascertain the cause, and I found that previous to planting, the ground had been richly dunged and trenched, the dung undermost, and this being buried, the roots did not reach it till the third year, when the trees were evidently poisoned.

To sustain a tree healthy and prolific, it will be necessary that the root, trunk, and branches should be equally under the influence of the sun and air, and in a like degree exposed to the changes of seasons and the weather.

Whenever the roots of trees are doomed to grow in a soil on which the sun never shines, the branches seldom ripen, and the fruit will be small, uncertain in quantity, and of inferior quality.

When the roots are partially exposed, a tree often produces a fine bloom, which sometimes sets for fruit, but it seldom arrives at maturity, the blossoms often falling off without setting, or the fruit dropping at an early period; this will also take place, and from the same cause, when the roots are planted or run deep, into a retentive or cold soil, or in such as is dry in the summer, but damp and wet in the autumn and winter.

Trees planted in beds or borders, formed as I have before directed, will seldom be liable to those evils; and the only effectual remedy for old trees will be, either to take them up and replant them in a bed properly formed, or to cut off the deep growing roots, and improve the soil above, in the manner I have before described, so as to encourage horizontal roots; and to prevent an excess of moisture by drains and shoots to carry away the drippings, and to improve or rectify the soil by a dressing of lime, &c.

Thirdly, trees are also subject to injuries and failures, when partially exposed to extreme changes in the atmosphere, which affect the trunk and branches, but not the root.

Trees that are brought forward by mild weather in the spring, and produce their leaves and blossoms early, often have them cut off by sharp frosts, or continued cold winds, and absence of the sun.

The remedy here must be, such a covering as will protect the tree from excessive cold, and although the means of effecting this in any way must be attended with trouble and expense, the certain preservation of a crop will generally be found to make ample amends, and particularly with wall trees, when the following simple mode is adopted, *viz.* let a pole or small post be driven into the earth, at each extremity of the tree to be protected, about nine inches from the wall, or boards may be affixed to the wall, projecting the same distance, and when firmly fixed, to stand as high as the tree or wall; then run a cord coarsely through the top and bottom of some Russia mats or cloths of a length and breadth to cover the tree, and affix the cord from pole to pole, so that the mats or cloths may be drawn backward and forward on the cord, top and bottom, like curtains on a rod; this method will require very little time to cover and uncover trees, and the coverings will not only be prevented from being blown against and rubbing the trees, but will also be left in a situation to run dry, and be preserved from rotting, without additional trouble.

Fourthly, as to diseases occasioned by insects and local injuries.

It is certain, insects of every description abound more some years than others, and their coming is sometimes supposed to be so sudden, as to give rise to the belief that they are brought by the winds, which was the opinion of Bradley, Hitt, and others; but this is clearly an unfounded idea.

When the nature and mode of propagation of the different insects which exist on vegetables are duly considered, there will appear no necessity for such a mysterious conveyance.

The wisdom and beneficence of the great Creator are in no way more completely exemplified than in the habits and power of insects.

The greatest injuries to vegetables are occasioned by the caterpillar tribe, at a time when in the caterpillar state, and by the aphis and coccus.

As each of the caterpillar tribe is alike in its nature, it will be perfectly useless in a work like this to attempt enumerating or describing the different varieties; all exist in four different states during the year, and undergo as many changes; and from the smallest maggot to the largest caterpillar, each passes from an egg to a larva, maggot, grub, or caterpillar, from this to a chrysalis, and from that to a fly, beetle, chaffer, moth, or butterfly.

We first discover a maggot or caterpillar of a peculiar kind, devouring particular vegetables, the largest of those being produced from an egg smaller than the smallest pin's head, is at its birth very diminutive, and consequently seldom noticed, till it has made very considerable progress towards maturity; and as during their growth they are constantly made the prey of birds and other insects, these little creatures are endowed with a wonderful instinct for self-preservation; most possess the means of quickly secluding themselves on the approach of danger, or of letting themselves down gently to the earth, or other support, by a web; and such as do not, are of such plain or variegated colours, as assimilate with the substance they feed on, and which thus deceive the eye.

However, as it is in the caterpillar state they are most easily discovered, and most in our power, and indeed when they are most mischievous, by devouring the leaves and buds, a gardener, when passing among his plants from spring to autumn, should seize every opportunity to destroy them.

I know of no species peculiar to the plum, peach, nectarine, &c., but there is to the cherry; these, in the winged state, are a small dark-brown moth, about half an inch in length, and are in activity when the fruit is about half grown; they then deposit their eggs on the new forming buds, and as the coverings of those are enlarged, they enclose the eggs, and completely shield them from injury until the following spring, when, as the buds open, the eggs are exposed to the sun, and, bursting into life, the caterpillars immediately commence their depredations on the young leaves and fruit.

These caterpillars have the power of bringing two or more leaves in close contact, and of fixing them together by a web, and thus forming a home, from whence they emerge in the night, and to which they retreat again before day; whenever, therefore, two leaves are seen sticking together, they should be examined, and the caterpillar or maggot destroyed; in doing this, some care is necessary, for, as if aware of meditated destruction, on the least disturbance, it slips from its cell, and drops to the earth, where it quickly hides itself until night, when it again ascends.

The apple tree is infested with an insect of a very similar description, and requires the same attention to protect it.

There is also another maggot, which preys on the young branches of the apple tree in a peculiar manner; it penetrates near the point of the young growing shoots, and eats its way down the centre or pith; the young shoot of course then withers and dies, and to a superficial observer, without any perceptible injury; whenever, therefore, this is seen, the top should be cut off, the hole of the maggot will then be discovered, down which it should be traced to its end, and destroyed.

These insects, as they often stop the growth of the leading branches, are a most obnoxious obstruction to the training of young trees, and therefore cannot be too carefully looked after; and it must be observed, that whenever one is discovered, although on an useless collateral, it should be destroyed, for if suffered to attain maturity, it may be the means of distributing hundreds of eggs the next year on the more important branches.

Those caterpillars or maggots make their appearance with the buds, but are at first very small;

as the leaves advance, they grow, and about the end of April, or beginning of May, become mischievous.

Although the looking over trees carefully, to destroy these depredators, must take up some time, it is indispensable to insure a handsome tree.

Whenever the leaves are seen folded or sticking together, pressing them between the thumb and finger will crush the insect, and in this manner a great number may be destroyed in a day.

A peculiar caterpillar is sometimes produced on the currant and gooseberry bushes in such numbers, that they devour all the leaves, let the number of trees be ever so great; on any sudden shock of the tree, they generally fall off, but unless then crushed or destroyed, they soon rise again; the most effectual method of effecting the destruction of such, is to spread a sheet or cloth under the tree, so that it may catch them when they fall; and then giving the trunk or branches a smart shock, by kicking against or striking them with a large pole or stick, the caterpillars will fall off upon the sheet, and are then easily collected and destroyed.

Mr. Knight observes, " an insect whose attacks on the apple tree are often almost entirely destructive of its fruit, is a small brown beetle; this insect, when very minute, and long before it assumes the winged state or form, penetrates the blossoms by perforating one of the petals, and having gained possession of its internal part, prevents its further expansion by means of its web, and destroys those parts of it on which the existence of the future fruit in a great measure depends."

Under the idea that in cold hazy weather, which frequently occurs at the time when the apple trees are in bloom, the fruit is destroyed by blighting insects, brought by the winds, it has long been a common practice to smother orchards with smoke, by burning weeds, wet straw, hay, &c. to the windward of the orchard, for several days and nights together, and this for the avowed purpose of driving off the blight.

I have certainly seen repeated proofs of the good and preservative effects of such smoking in an orchard which was annually subjected to the process, producing a good crop of fruit, whilst generally the crops have failed in the neighbourhood.

The idea that those blighting insects are brought by the wind, is evidently absurd; but there is no doubt that the observations of the experienced gentleman I have quoted, are correct; and although it may not appear possible that smoking can destroy the insects, when lodged, it is very probable that when the insects are on the wing to deposit their eggs, those that are in possession find the smoke so disagreeable, particularly when sulphur is added, as to be induced to quit their situation, and others, from the same cause, are prevented from coming to it; I therefore recommend this practice, as well worth the attention of all who have orchards.

I have seen peach trees devoured by a species of chaffer or beetle, which shelter themselves in the crevices of old walls or in the shreds during the day, and from whence they emerge in the night, and commit their depredations: these are easily discovered and destroyed.

Although those insects and the caterpillar tribes are very destructive, they are not so great a nuisance to the peach and nectarine tree as the aphis, or plant louse; the sudden appearance and rapid increase of these insects, and which are called blights, most probably gave rise to the belief that they were conveyed by the wind; at any rate, with a superficial observer, this may strengthen the idea; and as with such an impression it would be difficult to induce a person to adopt the only means which I conceive can operate as a remedy, I shall give the following extract from the Encyclopedia Britannica.

"The extraordinary nature of these insects has for some time past justly excited the wonder and attention of naturalists. They were long ranked among the animals which had been classed with the true androgynes, spoken of by M. Breyniers, for never having been catched copulating, it was hastily concluded that they multiplied without copulation; this, however, was but a doubt, or at best a mere surmise; but this surmise was believed and adopted by Mr. Reamur, and though he supported it by some observations peculiar to himself, the question remained still undecided, till M. Bonnett seemed to have cleared it up in the affirmative, by taking and shutting up a young aphis, at the instant of its birth, in the most perfect solitude, which yet brought forth in his sight 95 young ones. The same experiment being made on one of the individuals of this family, that had been tried with its chief, the new hermit soon multiplied like its parent, and one of this third generation, in like manner brought up in solitude, proved no less fruitful than the former; repeated experiments in this respect, as far as the fifth or sixth generation, all uniformly presenting the observer with *fecund virgins*, were communicated to the Royal Academy of Sciences, when an unforeseen and very strange suspicion, imparted by Mr. Trembley to M. Bonnett, engaged him anew in a series of still more painful experiments than the foregoing. In a letter which that celebrated observer wrote to him from the Hague, the 27th January, 1741, he thus expresses himself:—'I formed, since the month of November, the design of rearing several generations of pucerons (aphides), in order to see if they would all equally bring forth young. In cases so remote from usual circumstances, it is allowed to try all sorts of means, and I argued with myself, who knows but that one copulation may serve for several generations.'—This *who knows*, to be sure, was next to avouching nothing, but as it came from

Mr. Trembley, it was sufficient to persuade M. Bonnett that he had not gone far enough in his investigation. If the fecundity of aphides was owing to the secret copulation suggested by Mr. Trembley, this copulation served at least five or more successive generations. M. Bonnett, therefore, reared to the amount of the tenth generation of solitary aphides, and had the patience to keep an account of the days and hours of the births of each generation. In short, it was discovered, that they really are distinguished by sexes; that there are males and females amongst them, whose amours are the least equivocal of any in the world; that the males are produced only in the tenth generation, and are but few in number; that these soon arriving at their full growth, copulate with the females; that the virtue of this copulation serves for ten generations; that all these generations, except the first, (from the fecundated eggs) are produced viviparous, and all the individuals are females, except those of the last generation, among whom, as we have already observed, some males make their appearance, to lay the foundation of a fresh series. These circumstances have been confirmed by other naturalists: in particular we have a curious and accurate detail of them by Dr. Richardson, of Rippon, in the Philosophical Transactions," an extract of which is given in the Encyclopedia.

Although to a common observer, or gardener, the powers of investigation, as well as patient attention necessary to complete such experiments, may appear too great for them to attempt a demonstration, and perhaps too much to be credited by some, I believe none of them will be able to adduce a proof to the contrary, of what is here stated.

It can scarcely have escaped the observation of any attentive gardener, that during the first part and middle of summer, those insects increase rapidly on the plants where they first appear ; and that in the latter part of the summer, a winged and solitary aphis, resembling a small black fly, is seen at the foot of the leaf stalk of the peach tree, where no doubt it deposits its egg on or under the covering of the young bud, and as this increases, it completely shields the egg during winter, and which, (as has been noticed of some of the caterpillar tribe) on the opening of the bud in spring, is exposed to the sun and hatched.

On those parts the aphis is always found to make its first appearance on the peach tree, in the spring ; and at this time, although animated, it is scarcely perceptible to the naked eye ; its appearance is that of a small black speck, but if closely observed it will be seen to increase very fast in size, and before the blossoms are scarcely opened, to have produced another generation, and those proceed to multiply their numbers in the same rapid manner.

The important fact, therefore, that these creatures, like all others, are the offspring of parents, and engendered and bred on the place assigned for them, cannot be doubted, and their extreme rapidity of increase can only be prevented by an active attention, and application of some effective means of destruction, and which I shall describe.

Washing, brushing, and fumigation, are the methods generally recommended, and in use, but these are seldom efficacious; for however minute those offspring of the great Creator, they are not without the instinct and power of protecting and defending themselves against common annoyance.

The egg, in the first place, is deposited so intimately with the embryo bud, that the existence of the one depends on the other, therefore liquids, applied in a natural manner, cannot reach them, and if more forcible means are used, the bud is more readily destroyed than the egg.

When the insect bursts into life, it possesses the means of curling the leaf, or raising the sap in such a manner as to shield and protect itself; and a current of water or air, unless applied with a force sufficient to destroy the object of our care, the bud, cannot be made effectual.

But although water, smoke, or vapour, cannot be applied so as to come in contact with the insects, in their differently exposed haunts, a fine light powder, like drifted snow, will find its way into their most secluded retreats.

Tobacco dried is poisonous to most insects, and is so obnoxious to the aphis, that whenever it comes in contact with them, they immediately shift their quarters or die; and therefore tobacco in a fine dry powder, or common snuff, blown among the leaves, will find its way into every fold and corner, and by proper and repeated application, will seldom fail to effect a complete extirpation.

The best and most effectual mode of applying snuff, I have found to be by the spiral powder-bellows, or puff, an apparatus which was generally used by the hair-dressers half a century back.

It must be observed, that as the eggs escape unhurt, they will, after the destruction of one generation, produce another; it will therefore be necessary occasionally to repeat the application, and although the tobacco or snuff of itself will not injure the most tender bud or leaf, yet when left with the insects, and their exuviæ, it may form a kind of incrustation, and obstruct its growth; it is therefore best to give the trees a good washing, two or three days after applying the powder.

This application should not only be adopted as a cure, but as a preventive; therefore during the latter summer months, the powder should be lightly thrown on the young branches, particularly the points of the leading shoots, and it will prevent the moving aphis from distant quarters from fixing there and forming colonies, or of depositing the eggs for the future year; indeed, if an aphis remains undisturbed a short time only, its bite will prove so venomous as to obstruct the future growth of the branches, and to prevent this in the leading branches is of the utmost importance.

The honey-dew, or excrement of the aphis, often proves injurious to trees, this should therefore be washed off, which may easily be done by throwing soap-suds on and against the leaves, but this should afterwards be washed off with clean water; for when the soap is snffered to dry on the leaves, it proves almost as injurious as the honey-dew.

On the subject of the disease and decay in trees, occasioned by large wounds and fractures, it may be supposed that enough has been said by Messrs. Forsyth and Knight, to lead to a proper understanding and management; but I am inclined to believe, that the public have not been so much benefited by the discovery of Mr. Forsyth, as he had given reason to expect, and even in cases where it might have been beneficial, it has not been much attended to; and this I think has been chiefly occasioned by both his and Mr. Knight's having said more than correct observation and experience could warrant.

I consider it useless to enter into a minute examination of the arguments of those gentlemen, for or against the composition of Mr. Forsyth, and its effects, and shall therefore select one or two short passages only, from the works of each, by way of comparison and a ground of judgment.

Forsyth says, "In the course of more than thirty years' practice, in cultivating, pruning, and keeping of garden fruit trees, I have observed, that from natural causes, accidents, and unskilful management, they were subject to injuries of different kinds, which always diminished their fertility, and frequently rendered them wholly unproductive. All trees that bear stone fruit, are liable to emit a gum, which by producing a canker proves fatal to the health and vegetation of the trees. Most forest trees are also liable to what is called a bleeding, which proceeds from any injuries that obstruct the circulation of the juices; of those which suffer from bad management or accidents, some are injured by unskilful pruning, and lopping at improper seasons of the year, and others, by the violence of high winds, having boughs or limbs torn from their bodies, which being left in that state, exposed to all the inclemency of hard frosts, are often cracked or rent in the wood; or from heavy and soaking rains, the wounds imbibe so large a quantity of wet and moisture, as by causing a fermentation with the natural juices, brings on disease, and in time destroys the health and vegetation of the tree. These among other causes tend to produce decay and barrenness in fruit trees, as well as defects in timber, to the great loss of the public in general, as well as essential injury to the individual proprietor."

So far these remarks are just: he proceeds, "To remove those evils, and to prevent the ill consequences arising from the causes already described, I submit to the experience of the public, a remedy discovered by myself, which has been applied with never-failing success to all kinds of fruit-trees, and has not only prevented further decay, but actually restored vegetation, and increased fruitfulness, even in such as were apparently barren and decayed; it has produced also a similar effect on forest trees, by restoring them to soundness of timber, and heathful vegetation, and covering as it were visible nakedness, and increasing decay, with fresh and vigorous foliage. This remedy is a composition, formerly applied in the form a plaster, but now in a liquid state, and laid over the wounded or injured part of the tree, with a painter's brush: it is of a soft and healing nature, possesses an absorbent and adhesive quality, and by resisting the force of washing rains, the contraction of nipping frosts, and the effects of a warm sun or drying winds, excludes the pernicious influence of a changeable atmosphere. The discovery of it is the result of much reflection and study during a long course of years, and of a great variety of experiments, made at a very considerable expense, to ascertain the efficacious power of the application, nor shall I hesitate a moment to declare my firm belief, that whenever it shall be properly applied by the proprietors of gardens, orchards, and woods, it will be productive of all the advantage that can be derived from restoring, as well as preserving vigour and fertility in all kinds of fruit trees, and also for preventing decay, and promoting health and sound timber in every species of timber trees, &c."

The first composition is given thus:

"Take one bushel of fresh cow dung, half a bushel of lime rubbish of old buildings (that from the ceilings of rooms is preferable) half a bushel of wood ashes, and a sixteenth part of a bushel of pit or river sand, the three last articles are to be sifted fine before they are mixed; then work them well with a spade, and afterwards with a wooden beater until the stuff is very smooth, like fine plaster, used for the ceilings of rooms; the composition being thus made, care must be taken to prepare the tree properly for its application, by cutting away all the dead, decayed, and injured part, till you come to the fresh sound wood, leaving the surface of the wood very smooth and rounding off the edges of the bark with a draw knife, or other instrument perfectly smooth, which must be particularly attended to; then lay on the plaster, about an eighth of an inch thick, all over the part where the wood or bark has been so cut away, finishing off the edges as thin as possible; then take a quantity of dry powder of wood ashes, mixed with a sixth part of the same quantity of the ashes of burnt bones, put it into a tin box with holes in the top, and shake the powder on the surface of the plaster till the whole is covered over with it, letting it remain for half an hour to absorb the moisture; then apply more powder, rubbing it on gently with the hand, and repeating the application of the powder till the whole plaster becomes a dry smooth surface. All trees cut down near the ground should have the surface made quite smooth, rounding it off in a small degree as before mentioned; and the dry powder, directed to be used afterwards, should have an equal quantity of powder of alabaster mixed with it, in order the better to resist the drippings of trees and rains."

To the foregoing directions for making and applying the composition, it is necessary to add the following:

As the best way of using the composition is found by experience to be in a liquid state, it must therefore be reduced to the consistence of pretty thick paint, by mixing it up with a sufficient quantity of urine and soap-suds, and laid on with a painting brush. The powder of wood ashes and burnt bones is to be applied as before directed, patting it down with the hand.

When trees are become hollow, you must scoop out all the rotten, loose, and dead parts of the trunk till you come to the solid wood, leaving the surface smooth ; then cover the hollow, and every part where the canker has been cut out, or branches lopped off, with the composition ; and as the edges grow, take care not to let the new wood come in contact with the dead, part of which it may sometimes be necessary to leave, but cut out the old dead wood as the new advances, keeping a hollow between them to allow the new wood room to extend itself, and thereby fill up the cavity, which it will do in time, so as to make, as it were, a new tree. If the cavity be large, you may cut away as much at one operation as will be sufficient for three years ; but in this you are to be guided by the size of the wound and other circumstances. When the new wood, advancing from both sides of the wound, has almost met, cut off the bark from both edges that the solid wood may join, which, if properly managed, it will do, leaving only a slight seam on the back."

On the effect of this composition, he says,

"The first trials of its efficacy were made in some very large and ancient elms, many of which were in a most decayed state, having all their upper parts broken by high winds from their trunks, which were withal so hollow and decayed, that a small portion alone of bark remained alive and sound; of these trees I cut away at first a part only of the rotten stuff from the hollow of the tree, and then applied the plaster to the place where the operation had been performed by way of internal coat of the composition. In a short time, however, the efforts of Nature, with a renovated flow of the juices, were clearly discernible in their formation of the new wood, *uniting with* and swelling as it were from the old, until it became a strong support to that part of the tree where the composition had been applied; I then cut away more of the rotten wood from the inside, applying the plaster in the same manner with the same good effects, and continued to use the knife in proportion to the acquisition of new wood; *so that from the tops of these decayed and naked trunks, stems have actually grown of about thirty feet high in the course of six or seven years from the first application of the composition, an incontrovertible proof of its good effects in restoring decayed vegetation.*

"The acidity or corrosive quality of the juice of oak trees, when obstructed in their circulation, from any of the causes already mentioned, and fermenting with the wet and moisture imbibed by the wounds from the atmosphere, will bring on disease and promote decay; for, notwithstanding the hard texture of the oak, when once the principles of decay begin to operate, the acrimonious juices feed the disease, and accelerate its progress as much, perhaps, as in trees of a softer quality and texture; but when the diseased or injured part is entirely cut away to the sound fresh wood, and the composition properly laid on, as perfect a cure has been made as I have already related in the recovery of elm trees."

He further says,

"A lime tree about eighteen inches in diameter, whose trunk was decayed and hollow from top to bottom, to which, after cutting out the decayed wood, I had applied the composition, about sixteen years ago, was cut down last year, on purpose to examine the progress it had made in the interior part, and was found entirely filled up with new sound wood, *which had incorporated with what little old wood remained when I first took it in hand.*" And again, "When the wounds in the fruit trees are so large as not to heal up in the course of a twelvemonth, I renew the composition annually, *which on its application invigorates the trees, and seems to have the same effect on them as a top dressing of dung has on land.*"

Mr. Knight, remarking on Mr. Forsyth, says, "I had however previously examined many trees, to which Mr. Forsyth had applied his composition, in Kensington-gardens, and had observed *that it had not, in any one instance, produced the effects ascribed to it.*"

And, "the examination of the fruit trees in his Majesty's gardens there, perfectly satisfied me *of the total inutility of Mr. Forsyth's composition.*"

Again, "I had invariably answered that I had attentively examined the effect of Mr. Forsyth's composition, when applied to trees of different species; *and that his assertions respecting it were totally unfounded.*"

Now, in these strong and pointed assertions, I cannot but think Mr. Knight has gone too far; most people know that an exposure of wood to the effect of wind and wet, or the general change of weather, facilitates its decay, and that a covering of paint, &c. retards and prevents it; at any rate it preserves the surface or exterior; and this being the case with wood cut and dried, there cannot be a doubt but, that as Forsyth says, when wounds in growing trees imbibe a large quantity of wet and moisture, it causes a fermentation with the natural juices, which brings on disease and decay, and in time destroys the health and vegetation of the tree; and therefore any covering that can be applied to defend such wounds against these injuries, must operate as a preservative, and promote the health and natural growth of the tree.

It is well known that the wood of trees is formed by annual layers of sap, which first encircles the pith, and then by protruding itself between the bark, which proportionally expands, and the last year's layer or circle of wood, it gradually concretes or becomes wood: this is continued during the summer, and forms the periodical addition.

Whenever a tree is wounded by a part of the bark being removed, or a limb or branch amputated, the sap pushes out all around the wound during the season of its flow, and annually extends itself, by sliding over the old surface until it meets, when, if not obstructed, it unites; and afterwards the annual increase, or layer of wood is formed, in uninterrupted circles, the same as if no wound had been made.

As the flow of sap over an exposed wound may be compared to that of melted tallow poured on a surface, it is obvious that a rugged surface must very much retard, if not wholly prevent, its advance.

In this view Mr. Forsyth's practice of cutting away the obstructing dead wood in hollow trees will appear rational and proper; and when, by decay, the surface of a wound is sunk or hollowed, the extension of the sap is diverted, and prevented meeting and joining; and by its projecting above the wound and round, it forms a lodgment for the rain, and becomes in consequence a vehicle of putefraction, which extends itself through the tree.

If those observations are correct, although we may not approve the idea of his composition operating as a stimulant, and producing the effects on a tree which a top dressing of dung does on land, or of effecting the incorporation of new wood with the old, we may give Mr. Forsyth the credit of a remedy in its application, for many injuries which Nature, when left to herself, is inevitably exposed to, particularly internal decay from external exposure; but, notwithstanding we admit the efficiency of the composition in this respect, we may consider it as too troublesome and complicated in its preparation, and tedious and filthy in its application, to become of extensive use; and adopting Hitt's recommendation, of applying soot to the diseased part of *apricots*, and observing its effects, it will readily occur that as soot, like charcoal, is a powerful antiseptic and a preventive of the ravages of insects, it might, when mixed with oil, and *rubbed* over a wound, prove also a preservative against putrefaction and the injuries of the weather.

I have long since adopted this application, and found it completely efficacious; a quantity may at all times be readily collected and mixed up, so as to be laid on, like thick paint, with a brush, or rubbed over with a bit of cloth; and as very large wounds will require some years to enable the young wood to close over them, such parts should be covered or painted a second or a third time, at different periods, from six to twelve months, as the rain would otherwise find its way into the little clefts, occasioned by the contraction of the drying wood; and if drying oil, such as linseed, be used, it will prove more lasting and perfect in its effects.

By these means, disease and rottenness will be prevented; the old wood will continue sound and hard, and the surface being preserved smooth, the new wood will form close upon the old wood, and consequently wounds thus treated will never prove so detrimental to timber as when they are left exposed.

It might be observed that the soot, thus applied, will adhere to the surface, and in consequence, the new and old wood cannot unite or incorporate, "but must remain perfectly separate and distinct from each other, without union or adhesion;" this, no doubt, will be the case; and, according to Mr. Knight, this has been explained by Dr. Anderson, as all the effect he believed to be produced by Mr. Forsyth's composition, and all that he or Mr. Forsyth meant to assert it had produced.

There are, no doubt, instances within the scope of every one's observations, of tall, straight, healthy stems growing upon or from old wounded and hollow stumps, without the aid of art; but whenever it is desired to encourage and support the growth of trees in this manner, it is, as Mr. Forsyth observes, more effectually done by reducing all the branches to one, and from time to time removing all other shoots growing from the old trunk, and also all decayed or rotten wood, and applying the covering recommended to the exposed and wounded parts; this, by excluding the air and moisture, will prevent decay and the waste of sap by putrefaction, and the future growth of the tree will consequently be better sustained.

RESULTS OF EXPERIMENTS

ON

GROWING PEACHES IN POTS.

Being desirous of making some demonstrations as to the effect of different descriptions of soil and food, in the growth of peaches, nectarines, &c., it appeared to me that the most direct and decisive means would be to grow them in pots, and under glass, as thus circumstanced, they would be less exposed to casualty. I accordingly prepared a number of pots of about fourteen inches diameter and depth, and selected plants of peaches and nectarines, of one year's growth, from the bud; and as a basis for the soil or earth, in which these were to be planted, I took a strong black loam; this I divided into different portions; one portion I mixed with an equal quantity of the scrapings of a flint road; another with one half as much of the same scrapings; another with one fourth; and another portion I mixed with an equal quantity of brick rubbish, pounded as small as drift sand;

another with half the quantity of such rubbish; and at the bottom of some of the pots, I placed, by way of substratum, a layer of about four inches of strong yellow clay; to others a layer of four inches of chalk: having filled several pots with each of these preparations, I placed some of each of them under glass, in a conservatory; and others on a pavement in the open air. I also placed some pots in pans or dishes, and others on the bare ground. The next summer after planting, the difference in their growth was scarcely perceptible; but the spring following, a great difference appeared in the state of their health; those plants in the pots which were placed in pans or dishes, were much diseased, and particularly those which had a substratum of clay and chalk; at last, one half of the young branches of these were destroyed by the canker or livid mortification, and the blossom buds generally thrown off. One half of those pots containing the diseased plants I then removed out of the pans, and placed them on the surface of the earth; these the next year did not appear diseased, except those with the clay and chalk, which were but little benefited. I then turned those plants out of the pots, and removed the clay and chalk, and replacing them in the pots with the loam mixture only, kept them without pans, and they afterwards assumed a healthy and prolific appearance, and continued in such a state.

Those plants which grew in the mixture of one third brick rubbish, proved to be the most perfect in every respect; thence I conclude, that stagnant water is the cause of this destructive disease, and is also opposed to fructification.

After a season or two, observing my trees to decline in their growth, I commenced a course of experiments for manuring or feeding them; and to ascertain the best means of doing this, without disturbing the roots or the soil; for this purpose I prepared decoctions of various dried vegetable substances, extracts of different dungs, sugar bakers' waste, &c., and the blood of animals.

From a variety of observations I was induced to believe, that the effect of food, being given at one season or time of the year, or period of growth of a plant, was very different to that which was produced when given at another; and that the different state of the food when administered, also produced different effects. Those trees which had been supplied with a libera quantity of the extract of dung during the winter, and early in the spring, opened their wood buds, and extended their leaves before the blossoms, which subsequently declined, and fell off; those to which a strong decoction of sugar bakers' waste was given, were injured, and many destroyed by the roots rotting. Some plants were fed or supplied with a quantity of blood without separation, broken and mixed with a little water; these, with some of those which had been supplied in the winter with strong solutions of dung, were in the following spring affected very much with the blotched or blistered leaf and shoots. As a more perfect demonstration of these latter causes and effects, I suffered some of those trees which were diseased to grow the next year, without any additional supply of food, when they recovered their health. I also took others that were healthy, and treated them in the same manner as the former, and these became diseased like them.

Having from these and many other observations been led to believe, that dung or its extract, and blood, or other animal matters, when brought in contact with the roots of plants in a putrefactive or undecomposed state, obstructed both their health prolificacy; and knowing that blood, when suffered to remain undisturbed a short time, formed two distinct substances, the serous and the clotted, and that the serous was less likely to putrify, more divisible, and more readily diluted, and reduced to the required state of food for plants, I took a quantity of blood as it had been taken from animals, and suffered it to remain in a vessel for a day or two, until it was separated; I then poured off the serum, and diluting it with different portions of water, applied it as food, not only to my peach trees, &c., but to every description of plant I had growing, either in pots or out of them; and all those which were fed with a mixture of about one part of serum, to from three to six of water, by applying it in the usual manner and quantity as water, discovered a more immediate and improved appearance than I had ever seen by the application of any other substance whatever; but I found that this mixture applied either too frequently, or in too large quantities, produced disease.

It being obvious that a state of great luxuriance or increase of growth in a tree, is seldom accompanied by prolificacy in seed or fruit; and also that a state of poverty or sterility of soil is unequal to the production of a crop of fruit, I was desirous of ascertaining some means of modifying those extremes; and the above observations having furnished me with a clue, I proceeded to arrange a course of experiments. Different trees were supplied with certain quantities of food or diluted serum at stated periods, which evidently produced different effects; those trees which were fed liberally in winter, or early spring, made a luxuriant growth, but threw off their fruit; such as were supplied at a more advanced period of the spring, produced a larger spread of leaf, and luxuriant midsummer shoots, which of course rather obstructed than improved the growth of either the immediate fruit, or the wood for fruiting the next season. Those which were supplied at Midsummer, were forced into a fresh expansion of shoots and leaves, which, at so late a period, retarded the ripening of the fruit and wood; other trees I supplied with food or serum about the middle of the period, between Midsummer and the fall of the leaf, or from the beginning of August to the middle of September; and I observed that this in no respect injured the immediate fruit, but had the effect of increasing and forwarding the growth of the fruit buds, which were forming for the next year; and so much so, that the trees thus supplied came into bloom in the house at least a month earlier than others which were of the same sorts, and placed along side, but under different treatment as to feeding; and they sustained their fruit throughout, and ripened it at least a fortnight earlier.

The best mode and proportion of supplying this food to the peach and nectarine trees in pots, I found to be, to give about three pints in the year, mixed in the proportion of three parts of water and one of serum, divided and given at three different periods: that is to say, one pint at the end of August, one in the middle, and one at the end of September.

As I have in the former part of my work shown it to be demonstrative, that from the peculiar formation of the roots, and the general habits of plants, they cannot take in or apply their food, otherwise than in a state of solution, and that water is the only medium of supply, I need only further remark, that the peach tree requires a liberal supply of water; and that those in the house to which I gave, in the proportion of about one quart to each pot, every alternate day whilst in leaf, by pouring it entirely over the leaves and branches, I found to be the most healthy and prolific; and the evening after sunset appeared to be the best time for this operation.

A certain method of extirpating the aphis in a house is to fill it with tobacco smoke, which is easily done by setting fire to a small quantity of tobacco, and shutting the house close up during the night.

When trees are regularly watered over their leaves and branches, the red spider will seldom do much injury; nor will the mildew extend much; but when the mildew appears, it may be instantly checked by throwing over it a little dry powder of sulphur vivum, which is readily done with a hare's tail used as a powder puff.

In the application of heat I obtained the greatest quantity, and finest quality of fruit, under the following management: the house being heated by steam, with Hague's patent apparatus; the steam was got up in the morning by sunrise; and for the first month the temperature raised gradually, until the thermometer stood at 70 degrees Fahrenheit at mid-day. About the sun's setting the fire was banked up or withdrawn, and the heat suffered to subside during the night, taking care only that it did not get below 35 degrees. The second month the thermometer was raised to 80 degrees at mid-day, and gradually increased until the third month, when it was raised to 100 degrees, suffering the heat to decline at night during the whole time.

Being of opinion that a constant supply of fresh air must in every way contribute to sustain the grand object of the conservatory, I made arrangements on my steam apparatus to produce this, as is explained in my essay on the pine apple, and shown by the sketches in plate 13.; and I found it in every respect to answer my expectations.

To afford a more certain means of distributing water equally over the surface of the soil in the pots, and at the same time to support an equal evaporation, I placed a covering of small pebbles on them, which produced the desired effect, and preserved a neat appearance.

With the view to obtain the greatest quantity of fruit, and the greatest variety within a limited space, I tried various modes of training the trees; and having found the method represented by plate 13. decidedly preferable to every other plan, I conceive it useless to describe any other. By this mode, it must be obvious, no time is lost by cutting back in the first instance; the nourishment taken up is effectively appropriated, and with the least waste; the annual increase of the tree duly supported, and the surface of the leaves, and the fruit, all brought to the greatest possible exposure to the sun and air. Fig. 1. plate 13. represents the plant in its first stage. Fig. 2. the manner in which it is to be fixed or trained. Fig. 3. the second year; and fig. 4. the third year. The most complete steps for the branches are small iron rods painted, and fixed into wood stumps, driven into the soil. A reference to my former observations on the force and flow of the sap in trees will show the principle which determines the branches to grow as described by the sketches. The first summer after planting, some of my trees bore a fine fruit;

the second, all of them ; and the third, from two to four dozen each tree, and which were of the most delicate and perfect colour and flavour.

Although nurserymen are always ready to furnish trees of any name that may be asked for, I have never been able to obtain any so described, as to be generally acknowledged by gardeners. I shall therefore not attempt the recommendation of any particular sorts ; but one remark made to me by a gentleman, who grew fruit in greater perfection in the house than any other I ever met with, appearing to me to be well founded, I shall state it, *viz.* that those sorts of the peach and nectarine, which are furnished with blossoms of short and small petals, are more prolific than those which produce long and broad petals.

ESSAY

ON THE

CULTIVATION OF THE PINE APPLE, &c.

THE usual mode of cultivating the pine apple, in every way that it can be contemplated by a mind accustomed to the study of nature, must appear imperfect: the success that has attended its growth, under the varied and extraordinary treatment it has been subjected to, shows it to be a plant more tenacious of life, and more patient of injury, than almost any other; but notwithstanding the uncommon powers of endurance with which this plant is evidently endowed, it must be subservient to the three grand principles which govern and determine the progress through life of all animals and vegetables, viz. food, climate, and lodging, and a due application and supply of these must be requisite to enable it to attain perfection.

By a recent publication entitled "The different Modes of cultivating the Pine Apple, by a Member of the Horticultural Society of London," it appears that Mr. Knight has made some important experiments on this subject; and although the expectations of this compiler, as to the success of his mode of proceeding, are obviously not very sanguine, he strongly corroborates Mr. Knight's opinion, that the old method of growing the pine apple is far from being perfect.

The observations of Mr. Knight support the natural conclusion, that excess of bottom heat must be injurious to the growth and production of the pine apple ; and he has very judiciously placed this plant in a situation and under circumstances to prove the effect of the other extreme, and unless the two extremes are ascertained, a medium cannot be fixed.

Mr. Knight expresses himself to be " much inclined to agree with Mr. Kent," that the bark bed is " worse than useless," and in pursuing this idea, it appears he has made some important demonstrations; he has shown that the pine apple may be grown without a bark or any other hot bed, and that it will endure a temperature as low as 32 degrees Fahrenheit; he also seems to have established the fact, that the pine apple, like all other plants, exhibits a greater degree of health, under the natural difference in the temperature of the atmosphere, as it exists between day and night, than under the unnatural continuance of the same degree of heat.

Alluding to Mr. Knight's opinion and experiments, it is remarked by the compiler of the before mentioned work, " that the pine apple will grow without what is technically called bottom heat, is an obvious truth, since no plant in a state of nature is found growing in a soil warmer than the superincumbent atmosphere; but to imitate nature is not always the best mode of culture, for the more correct the imitation, the less valuable would be the greater part of her products, at least as far as horticulture is concerned. What would our celery, cabbage, and apples be, if this culture were copied from nature?" This appears to be a singular kind of argument to prove Mr. Knight to be wrong. What other means but those prescribed by the laws of nature could ever have enabled us to improve our cabbages, celery, and apples? Does not nature show her mode of producing luxuriance in plants, to be that of preparing by decomposition, and furnishing a luxuriant supply of food, and of adapting peculiar plants to peculiar soils and climates? And has she not spontaneously determined the effect of a select, as well as that of a promiscuous intercourse of the sexes?

The result of my experience and observation leads me to conclude, that a strict attention to, and support of, the laws of nature, have effected every improvement in vegetables of which we may have to boast, and that this alone can enable us to make any further improvements. The principles of nature cannot be improved; but it is a law of nature, that, to a certain extent, exuberance shall beget exuberance, and by availing ourselves of this, and encouraging and protecting certain habits and propensities, and preventing and removing obstructions and casual injuries, we may make plants more conducive to our pleasures. Cultivation would otherwise be an useless term: by establishing and administering to certain causes, we may accelerate and produce certain effects; but such causes are original or pre-existing, and consist of certain primitive principles or laws of nature; and effects are produced by the operation of those laws either simply or combined. Mankind possess not the power of altering such laws, or of making new ones: they are only permitted a certain influence in supporting, combining, applying, arranging, directing, or diverting them to peculiar objects.

In regard to bottom heat, although it can scarcely be supposed that in any case in the state of nature plants can be found growing in a soil exceeding the heat of the atmosphere so many degrees as they are made to do in the general mode of cultivating the pine apple, yet it often must exceed it considerably in a tropical climate, and so much, that were it not for the regulating medium of evaporation, the heat in such situations would be insupportable to vegetables; pines therefore raised and grown without bottom heat can scarcely be expected to produce their fruit in perfection. The principal difference in the practice and opinions, or in the skill of the growers of the pine apple, appears to be in the mode of forcing and checking its growth, and in the acuteness of their observation of the different indications of excess. Any method, therefore, that can be adopted to simplify or reduce the management of this part of the process to a greater certainty of effect, and by a more natural and steady course, cannot fail to be beneficial. Until the method of heating by steam was established, it must have been difficult to produce and maintain any thing like an equal degree of heat throughout a house, without the aid of fermenting substances; the application of bottom heat, therefore, seems to have been like many other inventions, the offspring of necessity; at any rate it is not easy to assign a reason for creating so high a temperature in the soil, and a noxious vapour or effluvia constantly rising from putrefying substances, or for supposing it necessary to sustain a plant.

Mr. Knight says, "It is contended in favour of the bark bed, that the soil in intertropical climates is warm, and that the bark bed does no more than nature does in the native climate of pine apples: and if the bark bed could be made to give a steady temperature of the air in the stove, I readily admit that the pine plants would thrive better in a compost of that temperature than in a colder; but the temperature of the bark bed is constantly subject to excess and defect; and I contend, and can prove, that the above-mentioned temperature is very nearly given in my stove." This stove of Mr. Knight appears to be heated by flues in the usual manner; and his pots placed on stages or brick walls, in the body of the house, so that they can have no other heat than is given by radiation, or such as is conveyed by the air.

The compiler of the work before quoted remarks on this, "It appears from nature, as well as from observing what takes place in culture, that the want of a steady temperature and degree of moisture at the roots of plants is more immediately and powerfully injurious to them than atmospherical changes. Earth, especially if rendered porous and spongelike by culture, receives and gives out air and heat slowly; and while the temperature of the air of a country or a hot house may vary twenty or thirty degrees in the course of 24 hours, the soil at the depth of two inches would hardly be found to have varied one degree. With respect to moisture, every cultivator knows, that in a properly constituted and regularly pulverised soil, whatever quantity of rain may fall on the surface, the soil is never saturated with water, nor in times of great drought burnt up with heat, the porous nature of the soil and subsoil being at once favourable for the escape of superfluous water, and adverse to its evaporation, by never becoming so much heated on the surface, or conducting the heat so far downward as a close compact soil. These properties of the soil, relatively to plants, can never be completely attained by growing them in pots surrounded by air, in this state. Whatever may be the care of the gardener, a continual succession of changes of temperature will take place in the outside of a pot; and the compact material of which it is composed, being a much more rapid conductor of heat than porous earth, it will soon be communicated to the web of the roots within. With respect to water, a plant in a pot surrounded by air is equally liable to injury: if the soil be properly constituted, and the pot be properly drained, the water passes through the mass as soon as poured on it, and the soil at that moment may be said to be left in a state favorable to vegetation; but as the evaporation from the surface and sides of the pot and the transpiration of the plant go on, it becomes gradually less and less so, and if not soon re-supplied, would become dry and shrivelled, and either die from that cause or be materially injured by the sudden and copious application of water. Thus the roots of a plant in a pot, surrounded by air, are liable to be alternately chilled or scorched by cold or heat, and deluged or dried up by superabundance or deficiency of water, and nothing but the perpetual care and attention of the gardener to lessen the tendencies to these extremes could at all preserve the plant from destruction.

The observations of both these gentlemen no doubt will be admitted to be just to a certain extent by every scientific person; but as to the grand object, that of ascertaining and establishing the causes of certain effects, and of describing and sustaining such laws of nature as constitute the process of cultivation in its progress from cause to effect, they seem to be in aberrance.

If Mr. Knight's plan and management should fail to excel all others, it will be found to arise in his not having pushed his imitations of nature far enough; in one respect only, he appears to have gone too far, that of keeping the temperature at mid-day lower when the sun is obscured than when in full action; but this may arise from his limited powers: his stoves being heated by fire flues, it is impossible to raise the temperature so high, and in an equal degree, throughout the house during the sun's absence, as when in its full refulgence; and his glass being air tight to keep in the heat, a change or circulation of air cannot be kept up without the consequences of a sudden depression or chill.

The arrangement that I am about to recommend has not, that I am aware of, been put in practice for the cultivation of the pine apple; and it may be objected, that theory, unsupported by practice, is of little value, but at the same time it may, with equal justice, be remarked, that practice, however successful, without the scientific principles upon which it may be understood, can be but of little value to any but the practitioner himself, as a correct knowledge of it cannot be communicated. It has been very justly observed by an eminent author, "Every thing which is wrought with certainty is wrought upon some principle; if it is not, it cannot be repeated." Unless the pine apple be exempt from the operation of those laws of nature which determine the growth and produce of all other plants, we may with propriety be guided by analogy in forming a judgment as to the principles of its cultivation. Four years since, availing myself of Mr. Hague's patent steam apparatus, I erected it in a small house for the purpose of making some experiments in the growing of grapes, and of peaches and nectarines in pots; and the production of healthy and prolific plants, and fruit of the most perfect colour, flavour, and general good qualities, being more an object with me than premature forcing, I determined on conforming to the course of nature more precisely, and particularly in the most favoured seasons, than has been usual in forcing houses; and it appearing to me, that the sun being obscured for several days following, attended by cold air during a particular period of fructification, has been the great and frequent cause of the falling off of whole crops of fruit, and constitutes what is vulgarly called blight; in the growing of peaches and nectarines, and of grapes, my endeavours have been to keep the temperature at mid-day, during cloudy weather, as high as at this period in full sunshine, which was from 80 to 100 degrees Fahrenheit, and upwards; and of suffering it to decline at night in the like proportion, as the natural atmospheric heat, which was generally so low as 40 degrees; and believing that the want of a due supply of air, as well as too high a temperature at night, was a frequent cause of the failure of impregnation in the blossoms, and also of the premature and unhealthy growth of plants into tall, long, and weak shoots and leaf-stalks, and of the insipidity and imperfect ripening of fruits, I introduced a constant flow or current of fresh air into the house, rarefied to such a degree (say from 100 to 150 degrees Fahrenheit) that in its diffusion it did not lower the general temperature, and the result perfectly answered my expectations, almost every blossom set for fruit. The trees which were planted in pots ripened from two to four dozens of peaches or nectarines each, and they were as beautiful in colour, and pungent and perfect in flavour, as any produced in the open air; and the trees and plants were as close, stout, and luxuriant in the colour and growth of their leaves, stalks, and branches, as any that had grown without the house. The grape vine was equally benefited both in its growth and fruit; and I am very much inclined to believe, that to the same causes may be ascribed the extraordinary produce of the pine apple, which Mr. Knight describes as follows:

"In the month of June I gave a couple of pine plants which had shown fruit at six months old, and were of small size and of no value, to a child of one of my friends, to be placed in a conservatory in which no fires were kept during the summer; in the second week of October one of the pine apples became ripe, having previously swoln to a most extraordinary size, comparatively with the size of the plant; and upon measuring accurately the comparative width of the stem, and of the fruit, I found the fruit to exceed that of the stem as seven and three-quarters to one. The taste and flavour of this fruit were excellent, and the appearance of the other, which is not yet ripe, and is of a larger size, is still more promising."

The practice of transplanting the pine apple appears to be very common, but this, like the application of bottom heat by fermentation, seems to be more the result of necessity, or economy, than the pursuit of any natural principle. Planting in pots certainly affords a ready means of ascertaining the extent, and of counteracting and checking injuries done to the roots, by exposure to the effect of fermenting heat; and that the roots of the pine apple under the common treatment are often partially, and sometimes wholly destroyed, seems pretty certain; indeed one of the oldest and, perhaps, most successful growers of the pine apple for the London market (Mr. Andrews of Vauxhall) declared to me his opinion that the pine-apple plant changed or threw off its roots annually; he also expressed his belief (to use his own words) "that it was oftener destroyed by fever than ague."

Agreeing with Mr. Knight, that the transplanting of fruit trees, although it brings them earlier into a fruiting state, occasions their next year's fruit to be smaller and less perfect, I also conclude it must affect the pine apple in the same manner. When the roots of all other plants have room for a free expansion, in a soil and on a subsoil perfectly adapted and congenial to their nature, they in all cases are found to be more prolific and exuberant in their produce; and why not the pine apple?

Among the growers of this fruit there seems to be no settled opinion, as to the composition of the soil it is planted in, or the best manure or food, or the proper times or seasons for dressing or feeding, nor indeed does there appear to be existing any regular system of management; but as it cannot be doubted that the pine apple, like all other fruits, must depend on these things, at least for its better qualities, I shall offer some observations on this part of the subject.

As I have elsewhere explained, it is the law of nature, that a plant shall attain a surface of stalk, branches, and leaves, proportionate to the food consumed or taken up by its roots, before it can attain a perfect fruitful state; thus it is found that a luxuriant supply of food produces a luxuriant plant, and a strong healthy plant produces large full fruit; but a luxuriant plant requires a longer time and larger space to extend itself in leaves and branches, before it becomes in a condition to fructify, than a stinted one. Reducing the channels of supply, or roots, is tantamount to curtailing the supply of food; and lessening the proportion of food, is the same in effect as extending the surface of the plant. On these principles, the effect of the general practice of transplanting, and curtailing the roots of the pine apple, may be accounted for; but although such operations are in general found to facilitate the fruiting of plants, they are unnatural, and must obstruct and prevent the attainment of perfection.

On transplanting and curtailing the root of the pine apple, a fresh soil and supplies of manure are generally given, with a view to prevent a loss of size and strength; but this again stimulates the plant to an increase of stalk and leaf, before it can be prepared for the fruit, which again renders it necessary to transplant and check its growth; and after all, when by such treatment fruit is produced, it is frequently surmounted by a crown of very large proportion, and this being considered a great imperfection, various means are resorted to, to check its growth: with a view to this, the plant is sometimes exposed for a time to the cold air, and (however incredible it may appear) I saw in one of the most splendid establishments in England, large pebbles placed on the crowns of the fruit, and this too by the head gardener.

Whatever success may attend such modes of cultivation, the process is evidently complicated, and dependent on the regulation of too many active principles, to be uniform in its results; this, indeed, seems demonstrated by the fact, that pineries differ in their appearance and produce almost as much as the gardeners who manage them do in their persons. In the cultivation of all other plants, I have ever found the best system of practice to be that which is founded on the laws of nature, and which, in its progress, is rendered the most analogous to the process of nature; and, conformably to this, it may be expected, that the most perfect method must be, first, to furnish a soil of proper texture, in which a due proportion of animal and vegetable manure or dung has been decomposed and incorporated, and made efficient by being laid together, and well mixed, and turned for two or three years; next, to place the plants immediately, as they are rooted, into this soil, either in the open bed, or in the pots where they are to remain to fruit, and to give them every advantage of heat and air; but no other supply of manure or food, than simple water, from the time of planting. Under this treatment, plants will be found to grow more rapid and luxuriant at the first; but when they have attained their due surface, they may be expected to form their fruit, and to sustain it with progressive increase to maturity and perfection.

The state and condition of plants may generally be known by certain indications or appearances in their leaves.

Excess of water is indicated by the leaves being of a light yellow colour, and tall and slender texture.

Excess of fresh or putrescent manure, by rank leaves of an orange or foxy hue; by a crumpling or curling of the leaves, and contraction of their ribs; and by the appearance of specks or blotches of gum or canker.

Injuries of the root, by excessive heat or putrefaction, will be followed by a drooping and withering of the younger part of the stalk and leaves before the old.

Deficiency of water in a rich soil, is shown by the leaves being short, and of a dry black green colour, with a mealy hue.

All plants deprived of air and light, will assume a yellow colour, and will grow long, slender, and weak; and more so, when at the same time they are kept in a high temperature, both night and day.

A luxuriant and healthy state is shown by a large substantial stocky stalk, and leaves of a dark green colour, with a purple or brown hue.

Excessive heat or cold in the atmosphere will be shown by a general stinted appearance in the growth of the plants, and by their being parched and withered at the tops of their leaves.

In the erection of a pinery, my first object would be to obtain as much light, and of the rays of the sun, as possible.

Secondly, to establish the means of keeping a temperature as high on cloudy days, or during the sun's absence, as during those of a clear and constant sunshine; and a bottom heat proportionate to the atmospheric heat, without the liability of its being raised much beyond it, or of creating obnoxious vapours.

Thirdly, to furnish a constant flow of fresh air into the house, rarefied to such a degree, that in its diffusion it may not reduce, or materially change, the general temperature; and in such quantity, that by its pressure, it may exclude and prevent the ingress of cold air.

Fourthly, to arrange and constitute such a bed for the roots, that the plant may grow with or without pots.

To establish the first object, the house should front the south, or as nearly so as possible; the width be about twelve feet, and the length of any extent that may be desired; the form and elevation of the roof as represented by fig. 1. plate 13.; the glazing of the north side to be close puttied, or what is better, copper lapped, to avoid many inconveniencies and injuries to which all the usual modes of glazing are exposed. I would have the panes of glass as long as possible, say from two to three feet, and laid so as to overlap each other without stopping, and the ends of the panes to be angular, as shewn by fig. 2. The two ends of the house and the front to be close glazed, as fig. 1.

Second. A brick wall to be raised nine inches withinside, the full length of the house, in the manner of a pit without ends, about eighteen inches, or two feet from the front and back walls of the house; the front to be about two feet high, and the back three feet; on these place bars of iron, of about two inches square, to reach from one wall to the other, in the manner of joists; and over these, by way of a floor, place Welsh slates of the largest size, in such a manner that the lower edge of the uppermost may pass under the upper edge of the next, lengthwise, (which will be the reverse of their usual position on a roof,) this will admit superabundant water to pass off each slate; the ends of the slates may be laid so as to join even, and be closed with cement underneath the slates, to range from one end of the house to the other; place rows of steam pipes of four-inch bore, continued by turns at the ends, and connected with the steam boiler, on Hague's patent principle, as shown by fig. 3. These pipes may be suspended from the iron joists; and as they will require a graduated declination to conduct the condensed steam back into the boiler, the conducting end may be placed three or four inches from the bottom of the stage, and made to fall about an inch in each length of the house.

As heat always ascends with much greater force than it descends, and Welsh slate is a good conductor of heat, there can be no doubt but that by this method, bottom heat sufficient may be produced and sustained; and as there will be a space of from four to eight inches of air intervening, which is a slow conductor, the heat will be equalized.

To raise the heat in the body of the house, as it may be wanted, let a row of six-inch pipes be laid all around the inside of the house, within two inches of the walls of the pit, and be independently connected with the boiler, as marked B B B, fig. 3.

Third. Air jackets or boxes to be placed at intervals of three or four feet along the front pipes, as marked C C, fig. 3., and C, fig. 4.: these will be found to furnish air sufficient at all times, without the necessity of opening the glasses; at any rate the front sashes may be fixed, and for a greater command of air in summer, casements or sliding sashes may be formed at intervals in the north side of the roof.

Fourth. Lay a bed of earth entirely over the glass or floor of slates, of from fourteen to eighteen inches deep; and in this place the pots, or the plants without pots. The distance apart of plants in the bed should always be such as to admit the leaves to spread their full extent, without the plants touching each other when full grown. Or if it be thought that tan bark contributes either to the health, size, or flavour of the pines, this may be placed over the floor of slates of a due depth, instead of earth, and the pots plunged into it.

The space under the slate floor may be profitably appropriated to the growth of mushrooms, asparagus, sea kale, &c.

ESSAY

ON THE

NATURE AND APPLICATION OF STEAM.

It has long since been demonstrated, that steam is infinitely superior to every other medium for diffusing an equal degree of heat through any given space. Fire applied by one furnace or boiler to circulate steam through a range of metallic pipes, chambers, or boxes, will communicate a more equal degree of heat, to the extent of a mile or further, than it could be made to do 500 times repeated by any other means. The number of accidents which have occurred from imperfect construction, bad arrangement, and carelessness, have impressed most people who have heard of steam engines, with ideas of danger in the appropriation of steam for any purpose; but the improvements made in the construction and arrangement of an apparatus by Mr. Hague, and for which he has obtained a patent, must convince every person who will give it consideration, that there is less danger attending this than any of the usual modes of applying steam or fire; and particularly in heating rooms and houses, and in boiling liquids.

Every operation required in a dwelling-house or manufactory to be effected by heat, may, by adopting this plan, be conducted by one fire, and which may be placed without, or detached from, the house or buildings. So that not only all annoyance from smoke, sulphureous vapours, ashes, &c. is avoided, but the danger from fire is materially lessened, and the hazard in insuring reduced.

It is well known, that by far the greater number and the most afflicting accidents, which have occurred from the use of steam, have been occasioned by boiling or evaporating the boiler dry, and, whilst hot, throwing in cold water, which, by producing a sudden contraction of the metal, or expansion of the water, has either fractured or burst it.

The peculiar value of Hague's apparatus, here recommended, consists in its returning the condensed steam back into the boiler immediately, and in proportion as the condensation takes place, without exposure to the atmosphere, or its being detained in any intervening vessel, and without requiring any additional force or labour: consequently, the boiler never can, by any accident or negligence, be evaporated dry; and, unless any steam be intentionally or carelessly wasted, the quantity of water at first put in, must remain undiminished for any length of time.

In this arrangement, the steam boiler need only be placed a few inches lower than the under part of the pipes, chambers, pans, boxes, or vessels to be heated, and all air being excluded from such pipes, &c., and all the water produced by condensation being returned into the boiler as fast as it takes place, the whole surface or expanse is kept clear for the full action of the steam, and the heat is thus constantly and regularly kept up and sustained without variation or partial ebullition; and the effect of this is, that water in any quantity may be kept boiling with the utmost equality, and a proportionate degree of heat kept up in any length of pipe or extent of chamber, box, or vessel, that may be required, with a pressure of steam below 6lb. per inch; but, if required, this principle and arrangement may be applied so as to be worked with the same facility and safety, under any degree of pressure however high. Another important advantage resulting from returning the condensed steam into the boiler as it takes place, is a very great saving of fuel; for the water that is carried off, by being converted into steam, being as rapidly returned, as, by giving out its heat, it is again converted into water, its temperature cannot be reduced more than a few degrees: consequently much less fuel will be required to convert it into steam again, than must be necessary when the steam is blown off and wasted, and its loss supplied with cold water. The temperature of the water returning from steam condensed in working a still charged with water, at a pressure of 6lb. per inch, is proved to be 211 degrees Fahrenheit.

The method of applying this principle to the boiling of liquids, is by attaching a double or hollow bottom to the pan or boiler, so constructed as to form a sufficient chamber or receptacle for the steam to expand over, and come in contact with, the full surface of the bottom. By these means, the action of heat is exerted on every part exactly at the same time, and precisely equal in degree. It is well known that heat, when in action, always ascends, and, consequently, a very slight comparison will clearly show the superiority of this arrangement over every other that has hitherto been adopted in the process of boiling; whether for the purpose of making decoctions, extracts, and solutions, as in brewing, dying, colour-making, &c., or for the purpose of evaporating and concentrating, as in the operations of drying, distillation, and crystallization, or for liquefaction, as in purifying oil, melting resin, tallow, &c.; for, by the common mode of applying heat, it is almost impossible to prevent the fire from drawing to one part of the boiler or pan more than another, and when this is the case, to bring the whole contents of a vessel to an uniform heat, that portion of the liquid immediately above, or in contact with the fire, is necessarily raised to a much greater degree of heat than would be required if the heat were equally diffused through the whole, that it may convey a due degree to the other portion; and this not only exposes the contents to the injuries of carbonising or burning, but it occasions a great waste of fuel, and requires twice the time that would be necessary to perform the operation, were the heat diffused through the full quantity uniformly, equally, and instantaneously. It may also be observed that, by this process, as the heat can be instantly shut off by the turning of a stop cock, all danger from boiling over of the liquid, is readily averted: but even if it should, from neglect, be suffered to boil over, it can be in no danger of taking fire.

The method of boiling, by passing steam through pipes coiled in the pan or boiler, is equally inferior; for that portion of the liquid which is not immediately above the pipes, can be brought to boil only by the heat slowly diverging from one part to another; and therefore to conduct the boiling either by this mode or the double bottom or chamber, where the steam is suffered to blow off, or waste itself, a very high pressure is required, or a great length of time. The method also of boiling, by blowing steam into the liquor, is liable to many, and still more important objections, viz. the steam on being first turned on, creates a vacuum, which is so suddenly acted on by the liquor, as to occasion violent concussions, and thus to injure and derange the apparatus: and further, as soon as the liquor is at a boiling heat, the greater part of the steam will pass through uncondensed, and thus as great a waste of water in the steam boiler will take place, and as great a quantity of fuel be required, as if the steam had been wholly blown off. Again, as at the first introduction of the steam, it must be condensed in the liquor it is intended to boil, this must be proportionably vitiated, and, as the inside of the steam pipes will oxydise, the oxyd will be forced into the liquor, which must thus be contaminated.

In the distillation of spirits, where the quality both in strength and flavour so much depends upon the degree of heat applied, and its equal diffusion throughout the liquor, it is impossible to conduct the process in any other manner, with such important advantages and perfect results; for whatever temperature be required, the heat, being applied over the full surface or bottom of the still almost instantaneously, and ascending and pervading the whole body in a perfectly uniform and equal degree, the full quantity of spirit contained in the liquor is separated and collected; and as the heat may be raised and depressed at pleasure, the most perfect division is made, and a state of the greatest strength and purity obtained.

In the making of extracts, the required degree of heat being produced and maintained with the greatest equality, precision, and facility, the excellence of this mode must be obvious, as too high a degree of heat will often extract more than is required, and too low a degree not so much.

Evaporation for crystallisation by the process here described, is produced and conducted with the utmost facility, without the least danger of carbonizing. Sugar is boiled to proof in twenty minutes.

In all stoves or chambers, which may be heated to any degree for drying any substance whatever, this mode is superior to every other, as, by it, the heat is perfectly diffused and equalised in every part; and as it affords the means of a rapid ventilation by supplying a constant flow of fresh air rarefied to a due degree, without the possibility of diminishing the oxygene, all colours in drying, are preserved and improved, and all injury from smoke, ashes, soot, &c., or from carbonising or burning, is effectually prevented.

Although the health and the comforts of mankind depend more on the heating and ventilating their houses and apartments, than on any other object, this, hitherto, has been, and perhaps now is, a subject very little attended to or understood. The grand medium for regulating this important process, is the atmospheric air; and to be enabled to judge correctly of its effect and influence, it will be necessary to investigate and comprehend its nature and properties, particularly as it affects us externally by heat and cold, and internally by respiration.

"Air is a thin, fluid, transparent, elastic, ponderous, compressible, dilatable, invisible body, surrounding the terraqueous globe to a considerable height."

The external effects of air are grounded on and determined by the following principles and properties. As air is rarefied by heat, and condensed by cold, its elasticity prevents its remaining stationary, or, in other words, a hot body being presented, the air, in immediate contact, absorbs so much heat from it, as to expand and become lighter. It therefore rises upwards, and its place being immediately occupied by the surrounding air, this also is heated and passed off, and thus a constant motion or circulation is kept up; and until all the air in a room becomes of a temperature equal to the hot body, the cold air will be continually playing against it, and extracting heat. Thus whenever we feel cold or chilled, it is occasioned by cold air, or some other cold substance being brought in contact with some part of our bodies, and from thence extracting heat, and not by cold being diffused through the body. These principles clearly show, that the common modes of heating rooms are very unequal and inefficient; for a fire being placed on one side of a room, with a chimney shaft, or flue, directly over it, the air in immediate contact is heated, and passes up the chimney, a small part only of the heat being thrown into the room by radiation. And, as the air of a room is drawn to the fire and passed off, the cold air from without presses at, and penetrates through, every crevice, to fill up the vacant space; and thus a cold current or draught of air, being kept up, the heat cannot possibly be equally diffused throughout a room, but that part of the body next the fire is often scalded, whilst the cold air extracts so much heat from the other part as to excite the opposite feelings. And this partial acquisition and loss of heat, in different parts of the body, occasions such an irregular and imperfect circulation of the blood as often to produce disease. This inequality of heat is, in some degree, prevented by stoves with closed flues: for when there is no opening or passage for the air, as it is rarefied or heated, it rises to the upper part of the room or ceiling, and forcing down the cold air, this presses against the hot stove, is rarified and sent up; and thus the motion is continued until the whole of the air within the room becomes of an equal temperature with the stove. But then follows (and this requires a most serious consideration) the important effect of air in respiration. Atmospheric air consists of an equable mixture of two distinct substances, called gases, of directly opposite principles, *viz*:

Oxygene, which is also called diphlogisticated air, empyreal air, vital air, &c.,

And nitrogene, also called phlogiston, azote, &c.

These form the grand component parts of atmospheric air; but there is likewise a portion of carbonic acid, or fixed air, generally mixed with atmospheric air, and also a quantity of vegetative matter and other adventitious substances, and these, when brought in contact with any body heated about 300 degrees, carbonise, or burn, and generate a noisome gas, which is often experienced in rooms heated by air made to pass over or between plates, cockles, or stoves heated by fire.

Oxygene gas is the principal supporter of combustion, and the vehicle of heat, and is absolutely necessary for the support of animal life.

Nitrogene gas is incapable of supporting combustion or animal life.

If an animal be compelled to respire pure oxygene gas, its pulse will rapidly increase, and inflammation and death must speedily follow: and if it be made to respire nitrogene gas, or fixed air, pulsation and circulation will instantly cease. The great beneficence of the Creator is here made evident, in causing these two gases, when disengaged from other substances, to blend or unite in such proportions as are proper to sustain animal life in a state of enjoyment; and as mankind withdraw themselves from the sphere of its free circulation, or adopt the means of destroying its equilibrium, they more or less injure their health.

The proportions which form atmospheric air, are 21 parts of oxygene, and 79 of nitrogene, in every 100 measures.

It is demonstrative, that in each act of respiration, a part of the oxygene is taken up by the lungs, and conveyed to the blood, and a part is ejected, combined with carbon, forming carbonic acid gas, or fixed air; and that in three times breathing, the whole of the oxygene is disposed of. Consequently, without a fresh supply of oxygene, or atmospheric air, death must immediately ensue.

Hence it is evident, that whatever absorbs or consumes oxygene, or has a tendency to lessen its supply, must proportionably obstruct and depress the animal functions, and engender disorder and disease. Fire cannot exist without oxygene; therefore in whatever form this is presented, oxygene must be absorbed, and, consequently, whenever atmospheric air is heated, by passing over any body made red hot, whether of iron or any other substance, it is deprived of more or less of its oxygene. Thus it is, that charcoal burnt in a close room, causes suffocation; for in a short time, the whole of the oxygene being absorbed by the charcoal, or converted into carbonic acid gas, there can be no other air to respire than nitrogene, and fixed air.

Whenever these gases exist in undue proportion, it must more or less operate as an obstruction to health. It is deficiency of oxygene which occasions a deficiency in the fine carmine colour of nature in the complexions of young persons who are confined to close rooms or large assemblies. The method of applying this apparatus to the heating and ventilating houses, apartments, &c., is by causing one or more columns or currents of fresh air to flow into the room or space to be heated, rarified to 100 degrees more or less, as may be required, by being made to constringe against metallic chambers that are kept hot by steam, and which cannot, under any circumstances, absorb the oxygene, or attain so high a degree of heat as to carbonize, or, in any other respect, contaminate the air; and in roots, where it is desirable to keep a fire, the current of fresh warm air thus introduced will prevent the intrusion of cold air, and afford such a constant supply of oxygene as will make it burn with increased brilliancy, and operate as a complete preventive of annoyance by smoke, sulphureous fumes, &c.

For heating conservatories, hothouses, and stoves for plants, this apparatus is found to be infinitely superior to every other method, as by it the heat may be raised to any degree at any time or season, and maintained with perfect equality throughout the space required to be heated, however large; it is also applied to furnish bottom heat for pine apples, melons, cucumbers, &c., in lieu of tanners' bark, dung, &c., and found perfectly efficacious.

The method of supplying fresh air to dwelling-houses has also been adapted to conservatories, &c., and its effect has been the most striking and desirable; under those circumstances, the grand cause of the failure of impregnation is removed, and the leaf stalks and young shoots of plants do not run out or grow longer than in the open air, and fruit attains as high a flavour and beautiful a colour as when grown without glass. The air of the conservatory is also kept so fresh and pure, as to be equal to that of an Italian climate, even throughout the winter; thus furnishing the means of enjoying the luxury of a perpetual spring, summer, and autumn, more equal to nature than can be furnished by any other means.

The saving of fuel by this process, compared with every other method of applying heat so as to produce equality in degree, is proved to be from one to two-thirds.

THE END.

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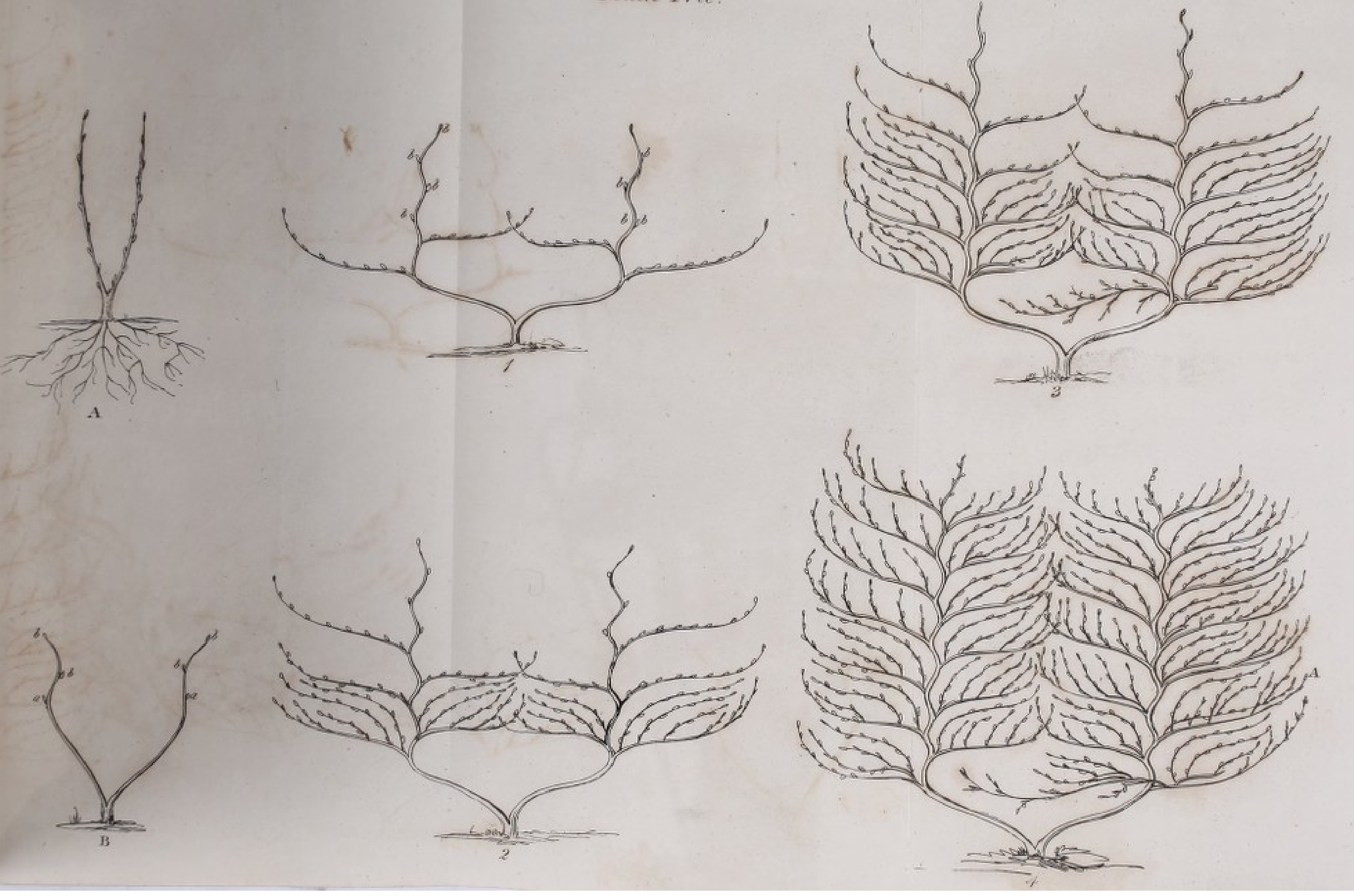
Peach Tree.

Plate 1



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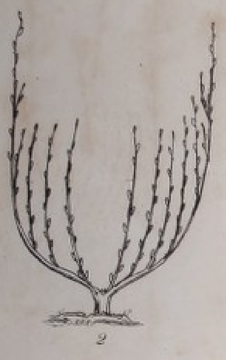

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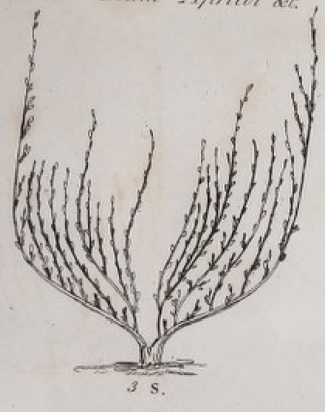
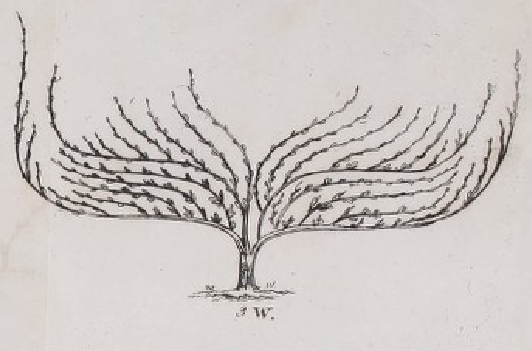


3 S.



3 W.

4

5

6 W.

Hill. Pear with Sketches of Forsyth.

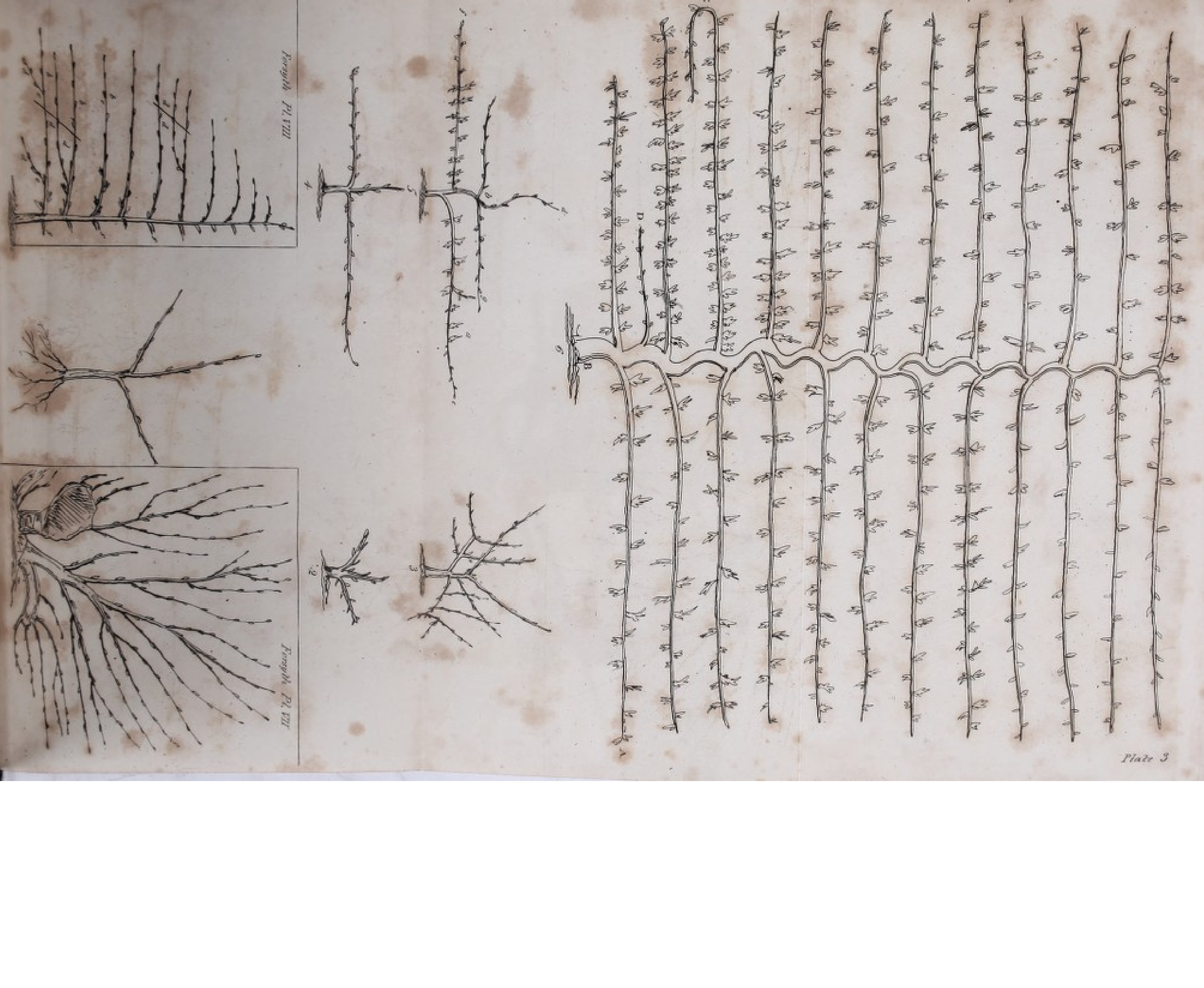
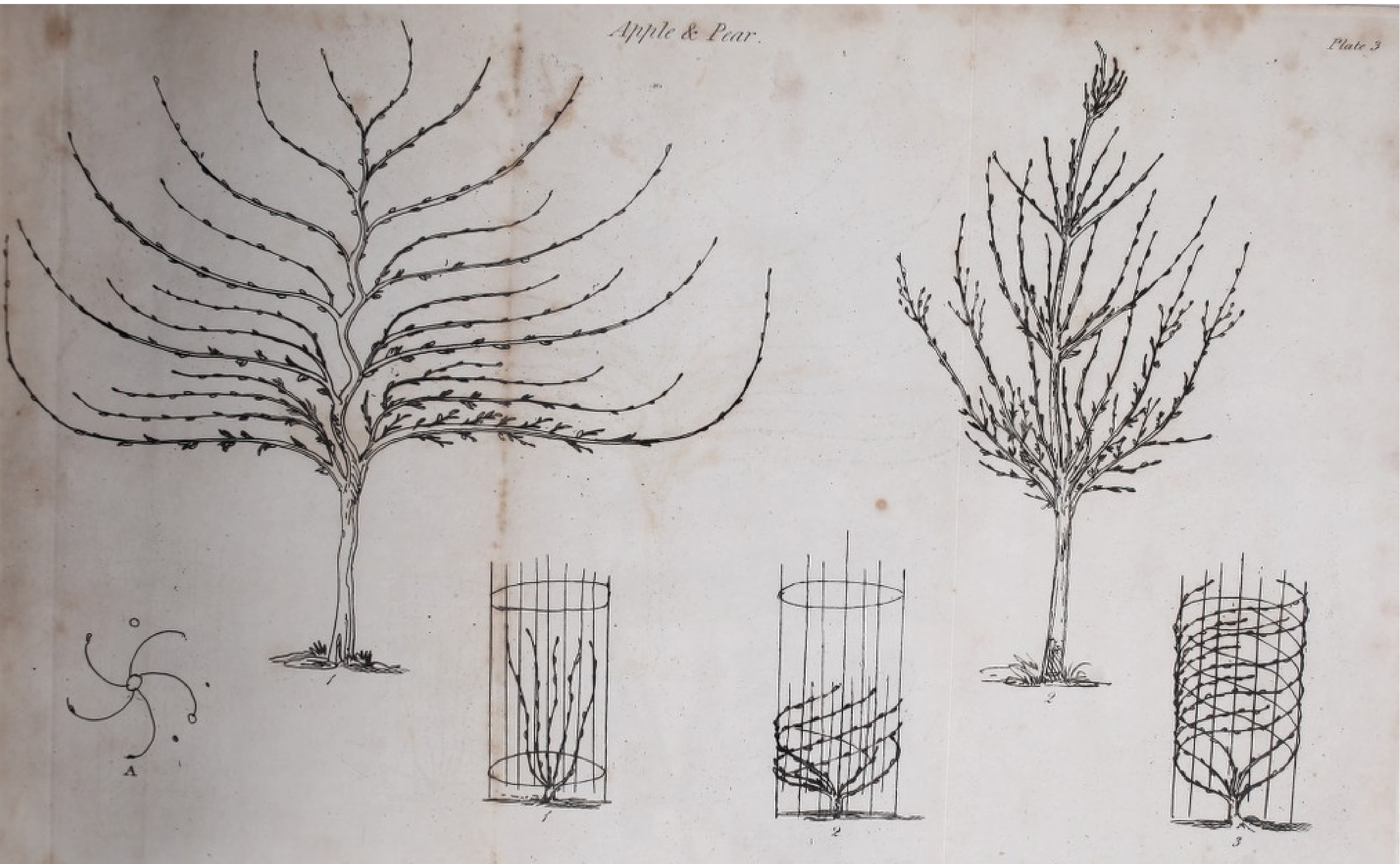


Plate 3


1
A
1
2
2
3

The Peach Tree. by Hill. with Sketches of Forsyth & Knight.

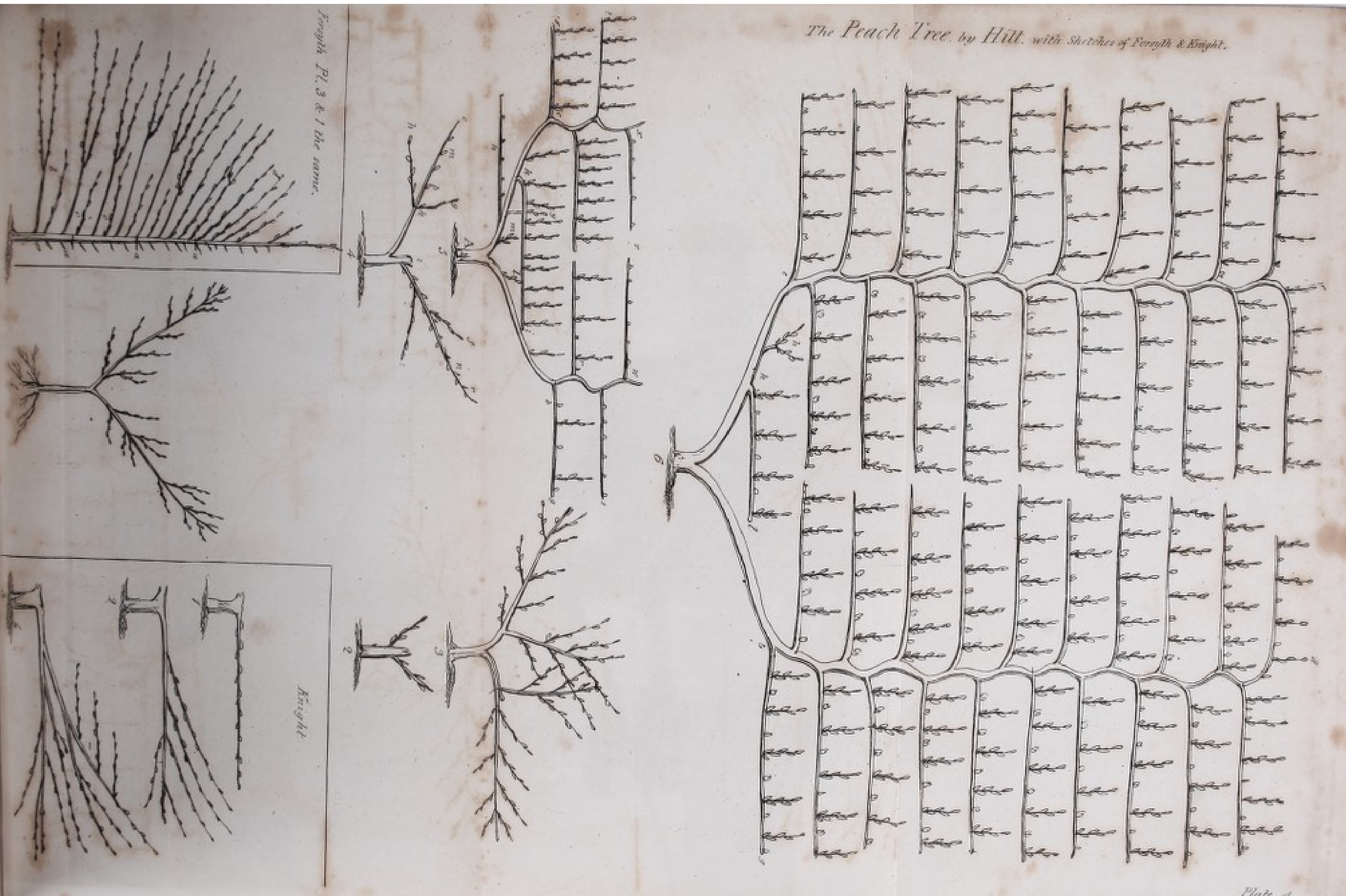
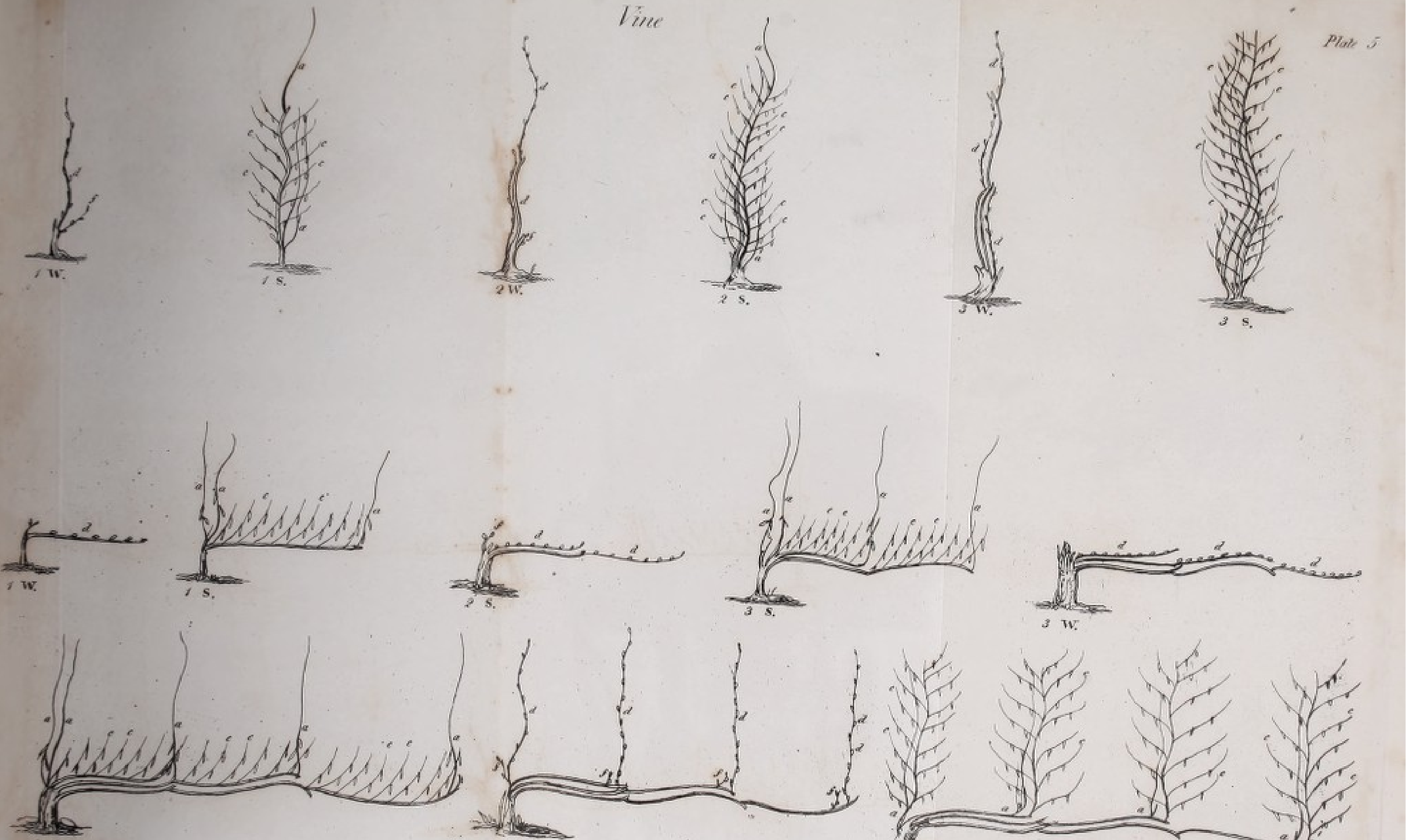


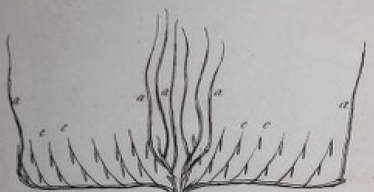
Plate 4.

Vine

Plate 5



A.



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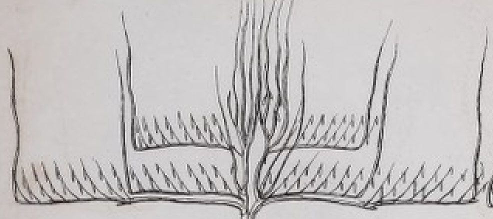
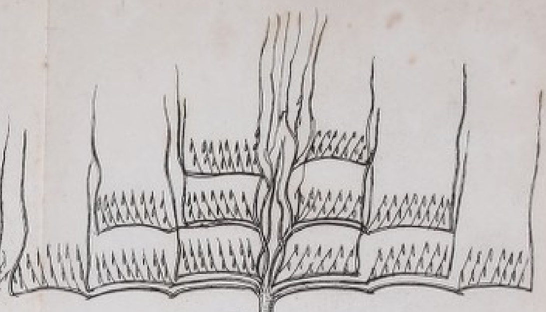


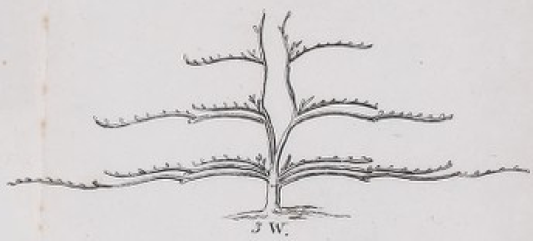
2 S



3 S.

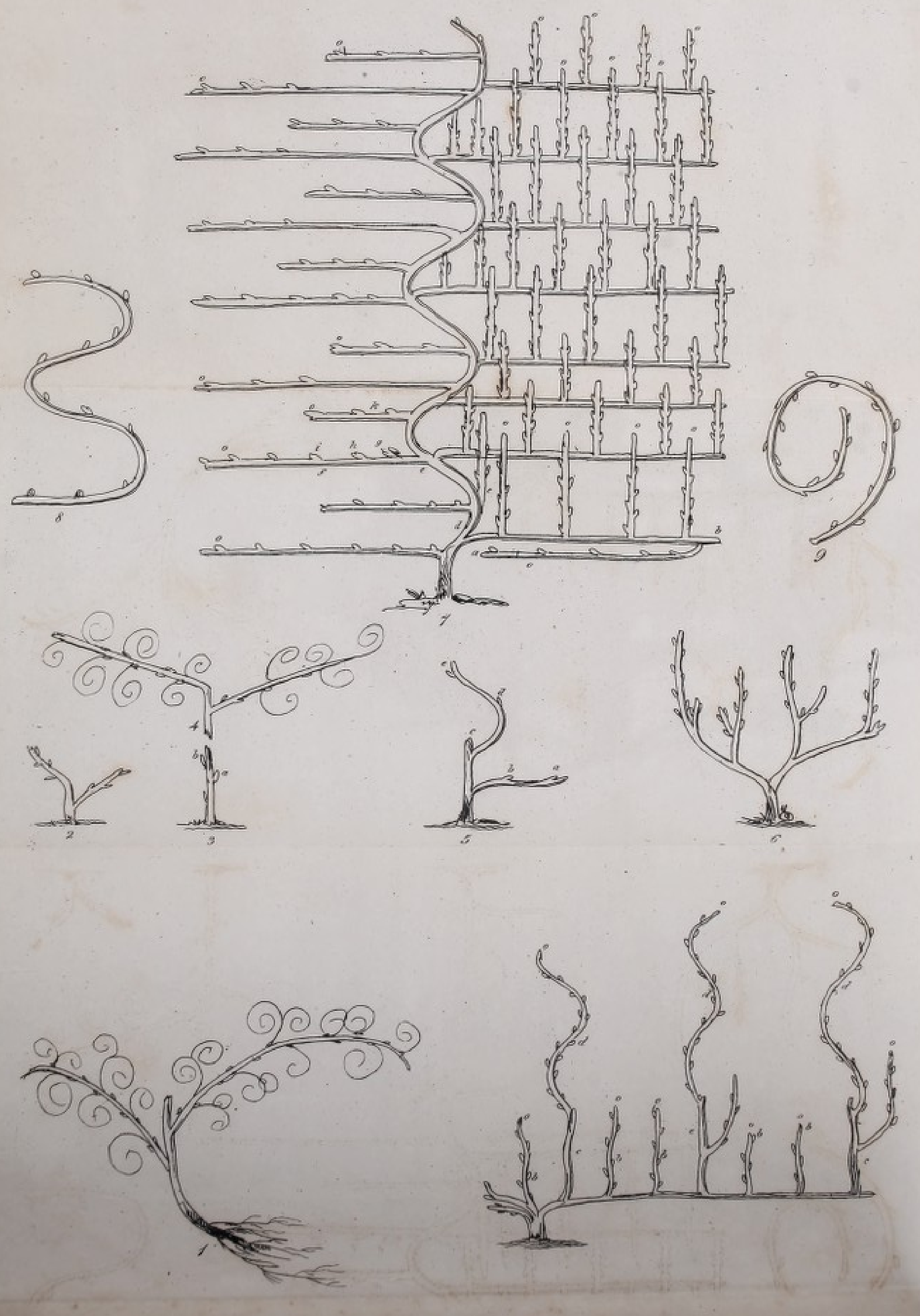
1 W.

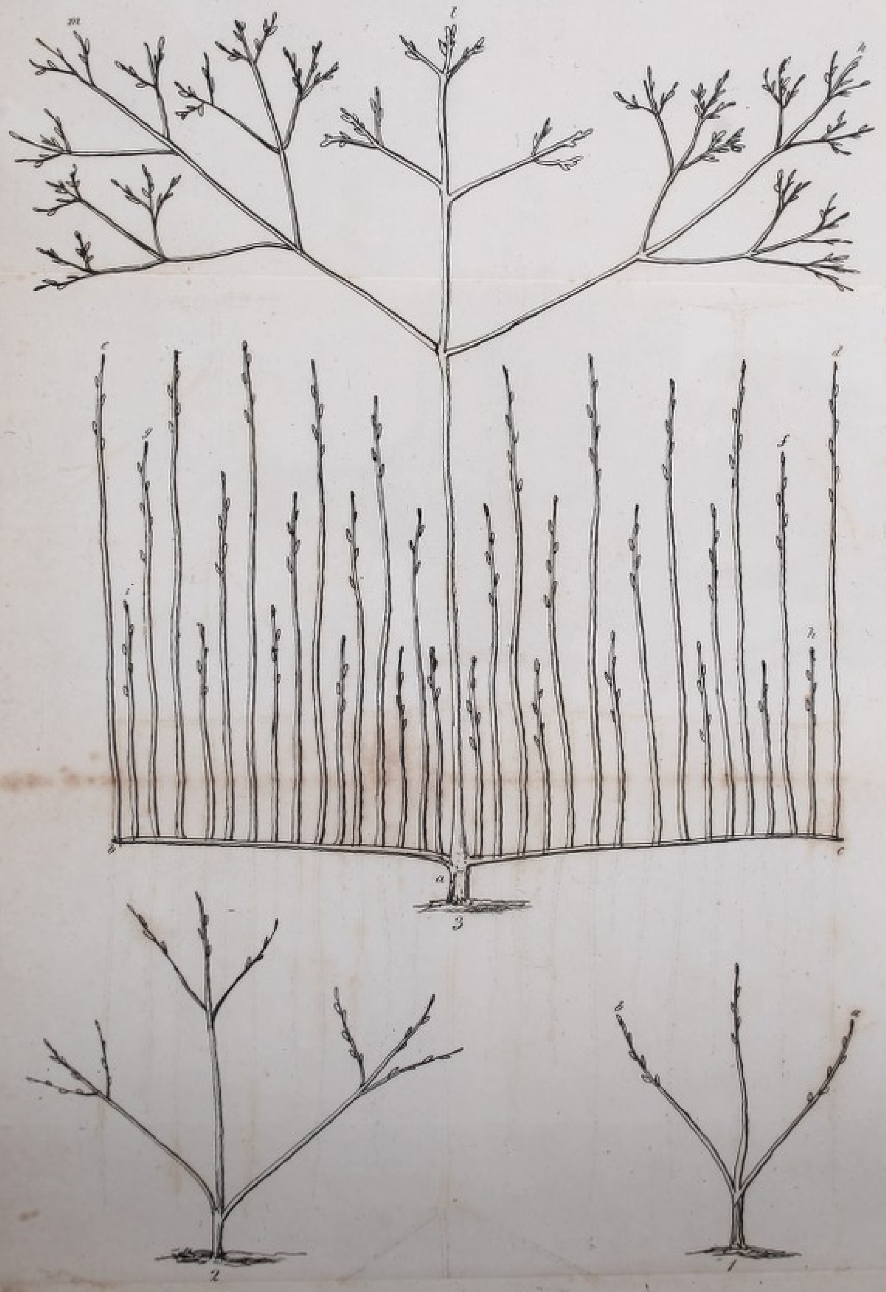
2 W.



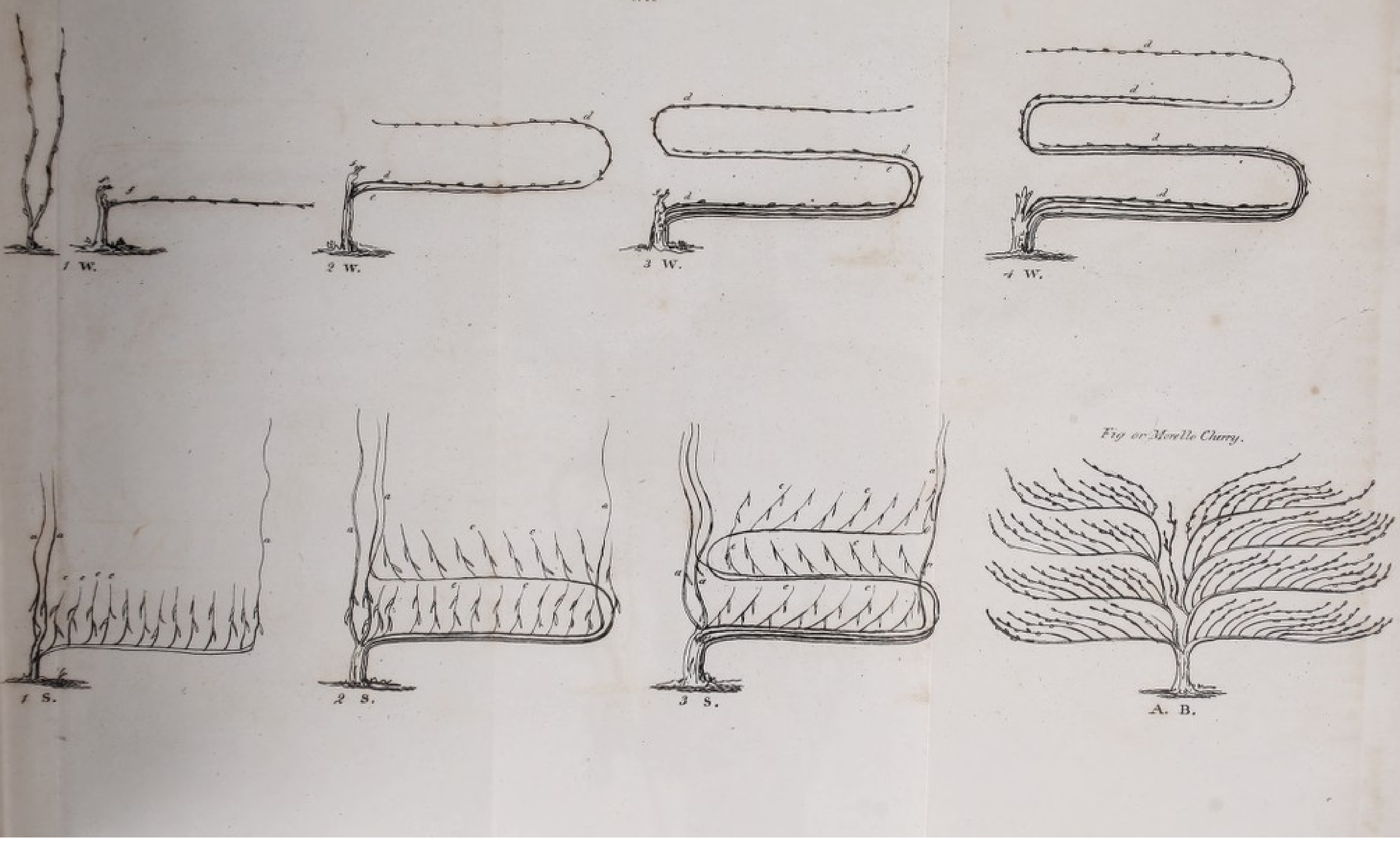
3 W.

Hill. Pl. 5

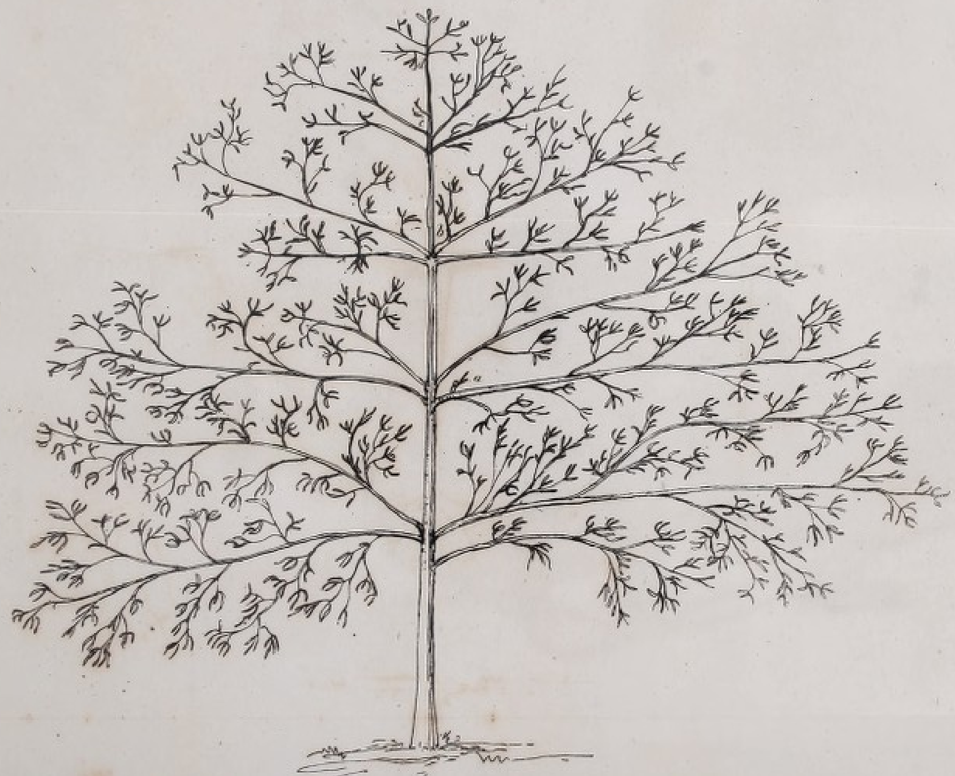




Vine



Hitt. Pl. 7



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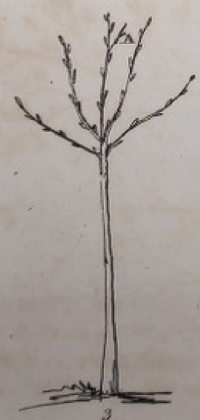
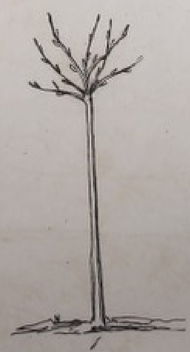
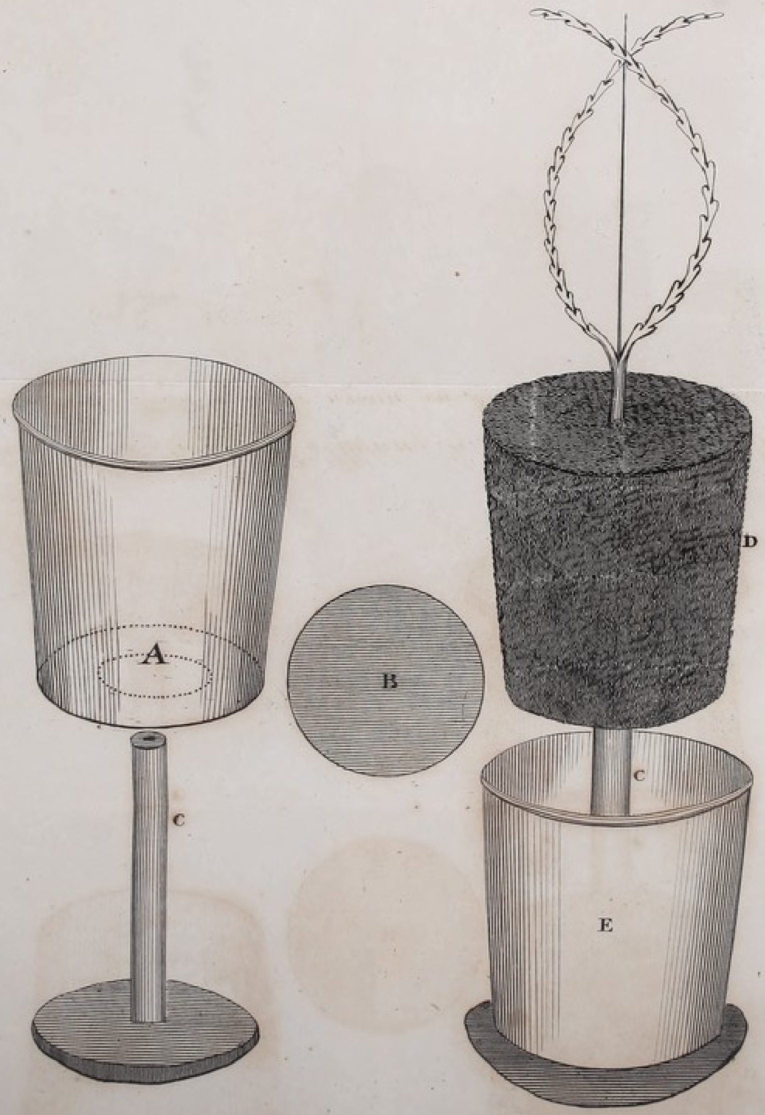


3

2



1



Description of an Improved Shifting Pot, invented by the Author.

The Hole at the bottom of the Pot to be made within an Inch or two (according to the size of the Pot) as wide as the bottom itself, see Fig. A a false Bottom or round Tile B to cover this opening. – to Shift the Plant, a Peg or small Post, may be fixed to a Board, so as to stand something higher than the Pot, like Fig. C the Pot being lifted & the false bottom placed on the Peg, it may be pressed down, when the Earth & Plants will remain on the Peg D leaving the Pot empty under it Fig. E.

Peach and Nectarine Trees

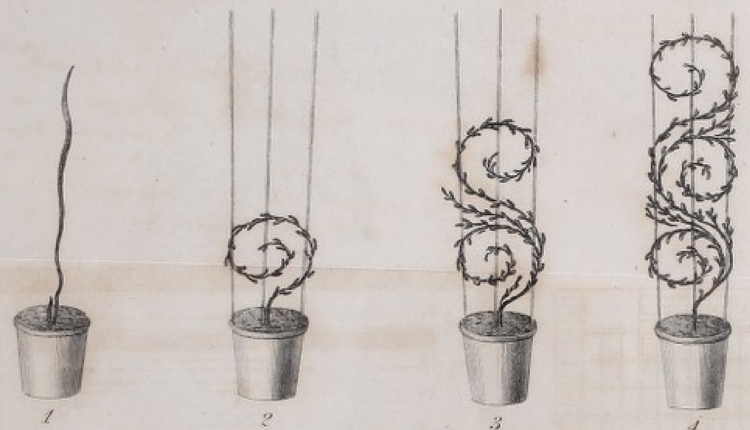


Fig. 2.

Fig. 4.

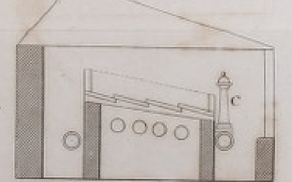


Fig. 3.

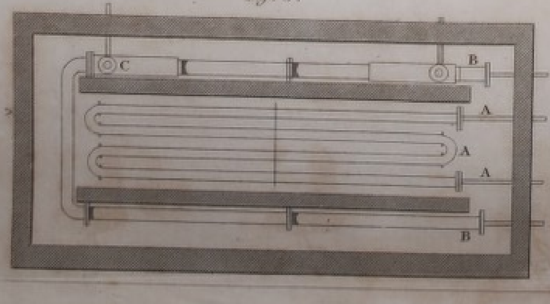


Fig. 1.