ON THE

CAUSE AND CURE

OF THE

DRY ROT,

&c. &c.

To Thos. Hope Esq
from the Auth

A

PHILOSOPHICAL INQUIRY

ON THE CAUSE,

WITH

DIRECTIONS TO CURE,

THE

DRY ROT

IN

Buildings.

By JAMES RANDALL, Architect.

Opinionum commenta delet dies, naturæ judicia confirmat. *Cicero.*

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PREFACE.

To treat a novel subject in a novel manner, appears, at first view, to follow as naturally as cause and effect; and bolder speculists would, no doubt, in the height of their frenzy, anticipate a success proportionate to their expectations.

Before the Author enters upon his subject, he thinks it necessary to state how far, and on what

grounds, he means to rest his pretensions to novelty. In the first place, the subject itself has some claim to this distinction, notwithstanding some essays that have been written concerning it; and, secondly, his manner of treating it, and the remedy proposed, will, he flatters himself, confirm the justice of his remarks.

The subject is one of those, which, of all others, has, perhaps, been the most neglected, and by those who were the best qualified, and the most capable of devising a

remedy; the consequence has been, that the Public have been, and still are without any adequate means of effectual assistance in cases of real danger. Under these impressions, and being himself of a profession, which often exposed him to the complaints of those affected by it, he undertook the present Treatise, with a hope of stimulating inquiry upon a subject, which is rendered of considerable importance, on account of the devastation produced, and still producing, in some of the finest buildings of the country. Having also observed the confusion existing among naturalists, and

others, respecting the cause of this phenomenon, and believing that no system can be useful, unless previously appreciated and defined, he instituted experiments, in order, if possible, to establish his facts; and he had the satisfaction to find, that his preconceived opinions were completely verified and confirmed by the event. These experiments were not made hastily, or at random, but were the result of a series of observations, made in different places, and under circumstances, that must have convinced the most sceptical and uninformed.

Respecting the mode of investigation adopted, his scientific Readers, he trusts, will offer no objection; as they will admit, that this phenomenon could no otherwise be satisfactorily, or fully explained, but by reference to chemical applications; a circumstance with which the more he considered it, the more he was convinced; and the first experiment that he made confirmed his opinions. Whether these opinions are just, or his success has been complete, must be left to the candour of intelligent men, and the evidence of time. To the impartial opinion of his

countrymen he humbly submits his theory, experiments, and facts; actuated by no other wish, in thus appearing before them, than that of promoting useful science, and contributing to the public welfare. With these considerations, he offers his little Treatise to their notice, "careless alike of censure or of praise."

No. 1, Upper Charlotte Street,
Fitzroy Square.

ON THE

CAUSE OF THE DRY-ROT.

THE Dry-rot presents a singular phenomenon to the eye of the attentive observer. From a careful examination of its appearances, the most extraordinary result is exhibited, no less curious in its nature than incomprehensible in its cause. To those who have heard of it, or witnessed its ravages, it must afford matter of astonishment, that, in the present improved state of arts and sciences, nothing yet has been done to analyse its properties, or arrest its destructive progress.

During the practice of my profession, I

have had an opportunity of examining and making some experiments, with a view to ascertain its nature and origin; and from these I was induced to believe, that *fungus* is a gaseous residue. Subsequent observations and experiments having convinced me that *fermentation* always takes place in the vegetable matter destroyed, previous to the appearance of fungus, it followed as a necessary consequence, that the liberated gases afford a direct germinating *pabulum* to this peculiar vegetation.

The *rot* is known to builders by the prodigious quantity of fungus formed on every part of the decaying wood. Its appearance often varies, depending wholly on the situation where it is engendered. That which is most commonly found is fleshy to the touch, adheres firmly to the wood walls, and every contiguous substance, and branches out into, apparently, strong fibrous roots. It occasions a gradual decomposition of the wood, beginning at

the surface, and, finally, proceeding through the whole mass. If any portion, however, remains exposed to the atmosphere, the destroying principle of the fungus is arrested. Thus, floors often appear perfect to the eye, when nothing is left undestroyed but the part immediately in view. Painted wood-work is wholly decomposed; the paint preventing a spontaneous oxydation of its surface.

As a means of repairing those places that are infected by the Dry-rot, I shall detail the plan adopted in the one above-mentioned, which fully exemplifies the inefficiency of the present remedy. On a removal of the boards, the whole superficies exhibited a complete area of fungus, the wood remaining only in the condition of fragments. It emitted a strong odorous scent, which so affected the workmen employed in clearing away, that they grew faint, complained of head-ache, with painful respiration, and were forced to discon-

tinue their labour. Approaching the spot, I experienced similar sensations. Upon letting fall some lighted shavings, the combustion instantly ceased. Although this followed almost as a matter of course, yet, nevertheless, from the symptoms and appearances that were exhibited, it shews that the *absence* of oxygen has no effect on this vegetation. After the fragments had been removed, the earth was taken out to the depth of eighteen inches, and it was suggested to cover the new surface with a stratum of lime core: this being done, the floor was renewed, leaving a vacuum beneath it and the lime, and making drains and perforations to admit the atmospheric air. Thus, the usual experiments were tried, with the addition only of the lime; but, a few months had scarcely elapsed, when the fungus again appeared protruding over the perforations made for admitting the air, and another alarming scene was exhibited on clearing it away. A lighted candle being forced into the va-

cuum was immediately extinguished, and upon following it with my hand, I felt a considerable heat, which was likewise apparent from the particles of water that were perceptible upon all the adjoining surfaces in contact with the atmosphere.

As these effects undoubtedly proceeded from fermentation, a circumstance of which I was fully convinced by further examination, and from the fungus being formed only on those parts that were immediately in that state, it was evident, that if, in the construction of buildings, fermentation could be prevented among the wood-work, fungus would not be formed, nor the Dry-rot appear.

Taking it then for granted, that fermentation is the cause, I conjecture, from this discovery, that the liberated gases are the essential materials from which the germination and fecundation of this plant are produced, as they are formed only when

circumstances have combined to produce this extraordinary phenomenon.

Some earths promote fermentation by the vapours they evolve; and the ground on which this floor was raised being artificially made, and abounding with vegetable matter, I conclude, that the liberated vapour adhered to the wood, and gave the first spring or impulse to fermentation; this, during its progress, destroyed the proportion of ligneous particles, and produced those new vegetable forms, which finding a *nidus* congenial with their nature, rapidly propagated, and diffused themselves over the parent matter.

These appearances following so quickly after the restoration of the new floors, manifest that the first cause of this phenomenon was owing to a removal of the top of the earth; a circumstance more fully confirmed by the quantity of gas liberated from its new surface. This gas consisted

of carbonic acid and hydrogen, the latter of which, meeting with the oxygen of the atmosphere, burned, and produced water. But if more atmospheric air had been present, the oxygen, in my opinion, would have predominated, and, although water might have been formed, the remaining hydrogen, with a portion of the carbonic gas, would have been burned or destroyed. Hence, a derangement of the elementary particles would have taken place, and prevented the vegetation of this fungus, the other fecundating principles being absorbed and dispersed, and leaving no pabulum behind. This actually took place when more atmospheric air was admitted, for a final stop was put to the fermentation, and, consequently, to the germination of the fungus.

In all those cases that fell under my inspection, wherever the atmospheric air was introduced, it was admitted to act thoroughly; for, without this precaution,

I can assert, from experience, that it will tend rather to *promote* than correct the rot. Something useful on this subject may be collected from Dr. Franklin's Essays on Chimneys. The Doctor having there described the proper mode of admitting air in those cases, the same may be adopted in its admission to floors; for, as he philosophically proves, that currents are absolutely necessary to supply the waste occasioned by a continual discharge through the chimneys, so it is equally necessary that similar currents should be introduced for the purpose of burning and dispersing the different elements that are instrumental in promoting the germination and fecundation of this vegetable. It is also necessary, that the supply of air should be constant and equal to its waste and dissipation, or not the smallest benefit will be produced.

Although this, when properly admitted, may be safely employed, it is of too des-

perate a nature to be introduced into houses, so as to ensure effectual success; for which reason it will be unnecessary to enlarge upon it, especially as a remedy that is free from these inconveniencies will, hereafter, be described.

It would add little, either to an establishment of facts, or an elucidation of the nature of this vegetable, to investigate minutely the various opinions entertained by naturalists, concerning its origin and production. They have, for the most part, materially differed, and their researches not being directed towards the fungus that is protruded among buildings, which evidently undergoes various impressions in consequence of its peculiar situation, it will not be correct, or proper, to form any conclusion from their opinions. Nevertheless, in order to demonstrate the general notions entertained on this subject, I shall state the opinions upon which these notions have been formed.

The first, and indeed the most natural hypothesis is, that they are propagated by seeds. It was difficult, however, to explain this propagation; the plants possessing neither flowers nor leaves; it was therefore boldly asserted, that they were deposited in the earth by rains, and afterwards absorbed into the roots and branches by the capillary attraction that takes place in raising the sap. This opinion, however, did not pass without contradiction; and Marsigli, a modern naturalist, observing that fungi were often without roots and branches, imagined that they grew in places where they met with an unctuous matter, formed of oil mixed with nitrous salt, which, by fermentation, produced heat and moisture, and insinuated itself between the fibres of the wood. Lancisi supposed that this production owed its existence to the putrefaction of vegetables. This spontaneous origin was likewise believed by our own countryman, Dr. Darwin, who, when describing the green vegetable matter

floating on stagnant lakes, observes, " the mucus, or mouldiness, that is seen on the surface of all putrid vegetable and animal matters has, probably, no parent, but a spontaneous origin from the congress of the decomposing organic articles, and afterwards propagates itself." This, as Dr. Priestley expresses himself, " is neither more nor less than supposing the production of organized bodies from substances that have no organization, as plants and animals, from pre-existing germs of the same kind, plants without seeds, and animals without sexual intercourse." Nevertheless, the seed origin is still adhered to; which may, in some measure, be accounted for, from the nature of the subject examined; for fungus is found attached to so many different substances, and the examination of these being confined to appearances only, it is evident, that whatever inference may be deduced from one is quickly destroyed by another, and a very limited view alone obtained on the subject.

Hence, I believe, that so far as relate to the fungus in buildings, that these inquiries, although ingenious, are wholly hypothetical, and have been promoted merely to conceal an ignorance of what still remains an impenetrable secret. I am, nevertheless, far from denying the existence of seeds, Nature employing so many secret and extraordinary means of accomplishing her various purposes.

If these plants, however, are propagated from seed, they must be deposited by the atmosphere, or exist in a state of mechanical suspension in the sap of the wood; and with this view, fermentation appears to be absolutely necessary to give the first impulse to the cotyledon; yet, were this the case, these plants would be found only on the parts that had undergone that process, and other parts would be affected only in proportion to the force and extension of the vegetation; for fungus produces decomposition only on the part on which

it grows. In places, however, that have been infected, this is so far from being the case, that those parts that are remote, and where it could scarcely have existed in a state sufficient to impregnate the seeds of fungus, roots of this plant have been often found. Hence, *I conclude, that the liberated gases escape from one part to another in a state of fermentation, carrying with them the direct pabulum of the embryo plant; the seed of which having been, by the atmosphere, previously deposited on the wood, germinates, appropriating its cohesive particles to its support.*

New buildings always experience fermentation in a greater or less degree. There are, however, some peculiar agents essentially concerned in its production and support. These, while the atmosphere is present, it destroys by ignition and absorption; and, in order fully to comprehend this property of the atmosphere, it is of

considerable importance to notice the changes that take place in the vegetable matter occupied by the fungus plant, and the alterations in the air itself, as these observations will lead us to a knowledge of their chemical properties.

No alteration is observable in the wood, until the root be firmly attached; neither is any plant formed except in places where the fermentation has derived all its advantages from the agents concerned in its production and support, and completed the final putrefaction of the sap. At this period begins a new arrangement of vegetable materiality, which, from a white mouldy film, proceeds to long fibrous roots, adhering firmly, and producing the same apparent change in the wood as mastication, or distillation, by depriving it of its adhesive qualities, and terminating in a complete decomposition, which *cæteris paribus* follows in proportion to the growth of the plant. This decomposition is, in

some instances, effected so rapidly, that I have seen new wood in a few weeks utterly destroyed, leaving nothing but dust, as a proof of its existence.

Fir wood is more often attacked by this vegetation than oak, to the latter of which it is seldom so destructive. Except when contiguous to the former, it never exhibits a fibrous appearance, but a grey kind of mould, which is decomposed in the same manner as the fungi, though not so rapidly, being frequently confined to a single joist, and sometimes only to a part. The plants of this class (cryptogramia) are constantly produced in all situations, and during every season; and as Cit. L. Reynier says, "whose form is constantly determined by the nature of the substance on which they grow, and is constantly the same in similar circumstances, although they do not appear at stated seasons, like other vegetables, also present new facts." It is not long since Cit. Vantenant observed a boleta, of a new

and singular shape, on a human body. From this fact it is evident, that the seeds for this plant float in the air, and constantly pervade all matter, vegetating wherever *they* find a *pabulum* and an elevation of temperature, these being the essential agents necessary for their development.

As this phenomenon appears to be the result of temperature and liberated gases, it will be necessary to examine the changes that they undergo in places infected with fungus rot. These changes being considerable, and owing to a volatilization of some of the vegetable principles, or of their parts, and these being very pernicious and assuming various aspects, arising either from an absorption of part of the oxygen, or a combustion of the hydrogen, or probably from the formation of a certain quantity of carbonic gas; while these processes are going on, a part of the hydrogen may escape, carrying with it a small quantity of carbon, which being divided

into minute particles by the aeriform solution, burns either at the same time or immediately afterwards. Thus the air, at the last term of its alteration, may be entirely deprived of its oxygen, contain also, a large portion of water, the greater part of which, not being preserved in a dissolved state, is precipitated, and becomes charged with a portion of vegetable matter in a state of vapour. Hence the formation of fungus, *which this vapour impregnates in greater or less abundance, according to the quantity of seed that is present.* This theory is sufficiently confirmed by inspecting and examining the state of this vegetation. Water, for instance, is always present, hanging about in particles, and the air (as before observed) is entirely deprived of its oxygen. Thus the vegetation of fungus appears to differ from that of all other plants, which owe their existence, in a more or less healthy state, to the presence and absorption of this gas: fungus, on the contrary,

grows more rapidly, and is more healthy in its absence: for the gases liberated from the wood, during its putrefaction and decomposition, being mostly carbonic acid and hydrogen gas, which, by their union, afford a direct *pabulum* for the germination of the seed. From their rapid increase, it is reasonable to conclude, that this plant possesses the proper organs for appropriating its own constituent principles; and from the change experienced by the wood in the production of this new vegetation, which parts with all its original properties; the new substance increasing in health and vigour in proportion to the rapid alteration in its composition, I conjecture, that a part of the liberated carbonic gas, is spontaneously decomposed; and it is this supply of carbon that affords such a rapid source of vegetable materiality to these plants. This will not be thought an extravagant supposition, considering the quickness of their growth, and that every other species of vegetation is produced in consequence of plants pos-

sessing a power of appropriating carbon from water,* air, &c. to the various purposes of leaves, flowers, and fruits.

During the course of my observations, I have had an opportunity of witnessing the complete growth of a fungus, under the following circumstances:—several pieces of fir-wood having been promiscuously thrown together in a damp situation, and left there only a few weeks, upon accidentally removing a part of them, they were found to be in a high state of fermentation, and almost wholly enveloped in a white film of mould, which, on further examination, appeared to be a complete fungus. An opportunity was now afforded to ascertain, from actual demonstration, the effect of this vegetable on wood previously prepared, of which I availed myself, and shall hereafter describe the result. Although so short a time had

* M. Chaptal says: "La décomposition de l'eau est prouvée, non seulement dans le végétal, mais dans l'animal."

elapsed since these planks had been thrown together, a decomposition had taken place on all the wood occupied by the fungus, and I am convinced that, in a few days, a fungus would have been produced from the whole of the mould. To this phenomenon I paid particular attention, as it so immediately confirmed my opinion of the Dry-rot, in all cases, arising from a previous state of *fermentation;* and I think that the most sceptical would have been equally convinced.

Entertaining, as I do, no doubt on the subject, I shall, therefore, consider it as so produced, and that it owes its first spring, or motion, to the various causes that are constantly affording the essentials to this phenomenon. Such are, first, a superabundance of sap in the wood; other new materials; exhalation, and, in fine, any other cause capable of affording the necessary quantities of air and water; both of these (to a certain degree) being absolutely necessary to its production and support.

This fatal destroyer proceeding only from one cause, it may be removed by means of an artificial preparation; and, as it should act not only on the sap, but the wood also, it appeared to me, that the most effectual remedy would be *oxydation*. With this view, I oxydated several pieces of wood, both with nitric acid and fire, and placed them in the most favourable situation among this pile. Portions of the same plank, and of similar dimensions, were placed constantly near them. During the first twenty days, no particular change was visible in either of the pieces. At the expiration of this period, on removing one of the unoxidated portions, I discovered particles of mould forming between the lamella of the wood, but not the least alteration was perceptible in the others, although surrounded by wood covered with and producing fungus. In sixty days, the pieces, and all that were near them, excepting the four previously oxidated, were entirely decomposed, ex-

hibiting nearly the same appearances as have before been detailed.

From these facts, it is obvious, that *oxydation* is a certain remedy for the Dry-rot; these experiments having been made under the most favourable circumstances. In order, however, to ensure its complete success, it will be necessary to oxydate the whole of the wood; that is, the ends as well as the other parts; for having, in a subsequent experiment, neglected this precaution, and there being also some vents in the wood, the fungus seed germinated, and produced a partial decomposition; beginning at the ends and in these vents. As there will be a difficulty in oxydating the wood thus venting, and an uncertainty likewise, in other respects, attending timber in this state, it would be better not to use it in *whole* pieces, or in situations where *danger* may be anticipated. With respect to spontaneous oxydation, or volatilization of the wood and sap, this will have no ef-

fect in preventing its fermentation or future fluidity; the volatilization only rendering the one brown and the other concrete. This concretion may, from local or extra neous causes, acquire sufficient moisture to afford and encourage fermentation; it is, therefore, necessary, that the wood be rendered indestructible by an antiseptic remedy, and this appears to be completely obtained by oxydation; which not only deprives it of its fluid particles, but, likewise, so prepares its surface, that nothing can vegetate upon, or stimulate the concreted sap, so as to render it elastic; for it is this elasticity that gives the first impulse to fermentation, which is followed by an elevation of temperature, or, more properly, a disengagement of latent caloric, and, finally, a complete fungus. This effect may be produced, from the causes above stated, in wood known to workmen, either as seasoned or unseasoned; for although this wood be perfectly dry, it consists of the same identical materials as it

did before it became so; and this drying being, as before observed, nothing more than the volatilization, or burning of its hydrogen by the oxygen of the atmosphere, which renders the wood brown and the sap concrete; the latter, receiving a sufficient quantity of moisture, either by the union of gas or otherwise, may regain its original elasticity; for unless it possesses elasticity or fluidity, it cannot ferment, and that it does so, after its spontaneous concretion, is evident from the circumstance of fungus being protruded on its surface. If we, likewise, take into consideration the numerous causes that concur to produce this stimulus in buildings, where exhalations are constant, it will appear rather a matter of chance than otherwise, that they are not oftener destroyed by this vegetation; for, instead of leaving their interior parts exposed, so that the materials may be volatilized of their gaseous particles, they are, frequently, covered up, and immediately enclosed with as much care

as is taken to render them *elegant* in the finishing. Thus the timber is exposed to the reception of the fermenting stimuli which are attracted from the adjoining walls; and in all cases where the Dry-rot does not follow in consequence of this inconsistency, it is owing to the atmosphere finding its way through some channel to counteract and disperse the putrefaction.

Having so far stated the facts attendant on this phenomenon, I shall further describe the most simple and easy methods (from actual experiments) both of preventing its formation in *new*, and removing and curing it in *old* buildings. Aware of the apparent difficulty of this undertaking, to *those* who, instead of attempting a cure, think *only* of restoring, it may be necessary to observe, that restoration, in those places already in a state of *vegetation*, tends only to promote the vegetation of fungus, by affording it fresh materials for its support.

Country houses experience the Dry-rot in their basement and ground stories. When it reaches the latter, it may be considered as only an extension of the power of vegetation, promoted by the former. In these places, it most generally arises from the ground being thrown up round the walls, to extend the landscape, as far as the cills of the ground-floor windows. In such a situation, it is sufficiently obvious what affords the stimulus to the fermentation. It is the continual moisture which the earth gives out to the adjoining wall, and which is transmitted to the wood in contact. Thus a decomposition rapidly takes place, and sometimes produces vegetation in the course of a few weeks.

In the construction of basement stories, where the landscape cannot be dispensed with, an alteration might be made by an area, or a vacuum, about two feet in diameter round the story, leaving a sufficient number of air-holes with iron registers. I

have seen this precaution adopted in one or two instances, with the desired success; and it will always add considerably to the warmth of the story, by rendering the wall comfortable and dry.

The principal timbers in a building, on the soundness of which so essentially depend both the lives of its inhabitants and the property of the landlords, and the plates and girders, being most generally the first infected, it would be a prudent and salutary precaution, to submit them invariably to the process of oxydation, together with all the parts inserted in the walls; these being generally the first to receive the stimulus. As the state, however, in which timber is used for the different purposes of building, prevents an easy mode of oxydating by the first natural process, and as this might, perhaps, rather intimidate as hazardous than be adopted as useful; and further, as wainscoting, dadoes, &c. could never be sub-

mitted to this process without spoiling them, it became necessary to inquire what other method could be adopted, to produce the same effect, without a similar inconvenience. This leads me to an explanation of the acid process of oxydating by affinity.

It is well known to chemists, that most acids possess this power in proportion to the force with which they retain their oxygen; and as this force is overcome whenever the oxygen meets with a base to which it has a greater affinity, it is evident, from the quick separation of oxygen, and the consequent oxydation of wood by the nitric acid, that this effect is produced by its superior affinity to the constituent principles of the vegetable only. Although the vegetable matter is more powerfully excited by this acid, yet I have found that the sulphuric may be employed with equal success, and will certainly be more economical, and less liable to any objec-

tion in practice. What renders them more useful in preserving from further mischief and expense, the buildings infected by the Dry-rot, is, that they may be employed, with few directions, by common workmen; but with girders, or other large timbers, it will be better to apply the common process of oxydation. In order to facilitate the operation, they should be previously prepared, by washing them with a solution of nitre; this would render it not only more certain, but likewise more complete. I am induced to recommend this method, from a knowledge that this kind of timber is generally prepared for its respective uses in places where no danger is to be apprehended from the experiment.

Such numerous facts and so many circumstances have concurred to convince me that oxydation is a *certain* remedy for this pestilential phenomenon; and knowing the great expense and trouble annually incurred in many edifices in this country,

where nothing but repair after repair is repeated, producing no other effect than eventually to endanger their equilibrium, and deprive the country of some of its best specimens of architectural beauty, the duty I owe to society, and the attachment I feel for such embellishments, have led me to communicate the result of those experiments that have proved efficacious and certain.

Respecting the process of oxydation, nothing would have prevented its being sooner introduced into practice, but the difficulty of succeeding upon all the variety of wood-work necessary in our manner of finishing buildings. They who were aware of its efficacy by the common method, had, probably, no idea that a similar effect could be produced by the powerful acids. My experiments have established the fact, and the anti-vegetating surface of the wood, after their application, affords a conclusive proof.

The indestructibility given to wood by this operation, arises, according to Dr. Bancroft, "from its absorption of oxygen, in which state it will resist the combined action of sun, air, moisture, &c. for hundreds of years;" so that all decay, however anticipated or expected, may be entirely prevented by this previous preparation. There is one precaution necessary in effecting this by the acids, that is worthy of notice, namely; that the surface of the wood, submitted to the operation, should be wrought, or planed. This is indispensible, unless a great quantity of the acid be employed. As the same beneficial effect, however, may be produced with a much less quantity, and a proportional diminution of expense, I presume that no one will object to this preliminary measure.

The indestructibility of vegetable oxide, or charcoal, has long been known. That the ancients were acquainted with it, it is

obvious, from the piles on which the famous temple of Ephesus was built, having been thus previously prepared; nor have there been wanting instances of its anti-destructive, or preservative powers, within our own knowledge. "The beams of the theatre of Herculaneum were converted into this oxide, by the lava which overflowed that city; and, during a lapse of eighteen hundred years, they have remained as entire as if they had been oxydated but yesterday; and they will, probably continue so to the end of the world." Many other instances might be adduced, but from their similarity, they are, I conceive, unnecessary to be mentioned. In the oxydation by the acid process, what renders it of more essential importance in practice is, that it may be used for timbers that are already in buildings (provided they are not yet infected by fungus). Considering this advantage, it must be evident that a great saving may be made in the repairs by a judicious selection of such as

are not seized on by the fungus, or in a state of decomposition; as these parts may readily be oxidated by the diluted acid. This is not the only beneficial effect resulting from the oxydation of beams by acids, as may be gathered from the following remarks of Huber,* who says, that the vapour of sulphuric æther, placed under a recipient of atmospheric air, prevents seed from growing without altering the quantity of oxygen in the air. The same happens with camphor, oil of turpentine, assafœtida, vinegar, and ammonia. Hence it appears that æther, evolved from these fluids, prevents germination; and as there is always some æther disengaged from the acids, in their separation and fixation, I conjecture that this disengaged æther may, by its volatility, produce the most salutary effect in repairs for the Rot.

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* Bull. des Sci.

Having thus far described a series of facts and experiments which have come within my own observation, I shall, as a farther illustration of this phenomenon, collect the opinions advanced, and the remedies adopted, by others; beginning with the house belonging to the Society of Arts, &c. This building, as I am informed, was not long since attacked by the Rot, and its consequences having been represented to the Fellows of the Society, they directed Dr. Higgins to examine, and adopt such precautions against its ravages, as he should think proper. I have been subsequently informed by a gentleman, who, at that period, was a member (although I can find no minute made of the transaction, in the Society's Annual Register,) that Dr. H——— completely succeeded in, not only, stopping its progress, but, likewise, in effecting a perfect cure, by the following singular antidote. After having restored such timbers as had been attacked by the plant, he directed

them to be washed with a solution of caustic ammonia. I did not hear of this till after I had applied the nitric acid; but it must appear obvious, that the effect produced on the wood will be similar. At any rate, the Doctor seems fully aware of its being the *nidus* for the seed's developement, and that by burning its surface, he prevents its formation, and destroys its growth.

As the ammonia possesses no particular advantage that may not be fully obtained by the nitric acid, excepting a more copious disengagement of æther, and its expense being much greater, it will, I conjecture, diminish its comparative claim to general use.

There are some circumstances attending the buildings in the Adelphi, which, in some measure, may elucidate the nature of this vegetation. They may be divided into two: first, their situation; and, se-

condly, their locality, which rendered it necessary to construct a basement story lower than was convenient for domestic purposes. It was, therefore, appropriated to stables, and other uses belonging to the river. Hence one of the essentials to this vegetation was supplied by the dung and exuviæ; and this too in the very place where, from its effluvia, it could diffuse the necessary *pabulum*, and, probably, the seed, to the superstructure of the buildings.

As the moisture of the place, must in a greater or less degree, have produced a state of fermentation among the wood, it must be referred to these two causes only. It may be objected to this hypothesis, that if the effluvia of the dung and exuviæ form the *pabulum* for the seed, that the fungus would be found on all the wood exposed to it. This would certainly be the case, were it not for the access and egress, and the influence of the atmosphere. Ad-

mitting, however, that these objections were removed, an elevation of temperature is necessary to give a spring to the cotyledon. As the temperature, in this situation, can never be regular, or of sufficient duration, to give the stimulus to the vegetation, unless in parts where the fermentation cannot be checked by a constant supply of air; in such it is common, and often more destructive than in other places. If a review be taken of its nature, and the causes of the germination and fecundation of its various species, it will be found, that elevation of temperature is an essential requisite; nor will it be difficult to prove, that no developement whatever takes place without it. Considering the variety of this vegetable, and the causes which concur in its reproduction, I cannot avoid imagining, that the original seed is the same in all; and that its *apparent* variety arises wholly from the different matter in which its radicle fixes itself. Instances of which are to be found in agri-

culture, and in some parts of the country more than others, where, especially at particular seasons, the corn is destroyed by a species of fungus, which, from its appearance, and its mode of attack, is precisely the same as that of all others. As Mr. Kerby's remarks on it will farther illustrate this similarity, and, in some measure, lead to a more general knowledge of its habit and mode of attack, I shall submit these in his own words:—" I have seen more than one half an ear of corn affected by this fungus, where the other half was sound and good. Sometimes it injures all the stems that spring from the same root; at other times, part of them escape. I never could discover any diseased appearance about the root. The ear is often affected before it emerges from the *solium vaginus*, or hose." * In this instance the plant is liable to those vicissitudes that characterise

* Linnean Society's Transactions.

other living substances, and the result is similar. These plants exist and germinate on vegetable matter only: they extract, by the extremity of their vessels, the juices that nourish them, elaborating and assimilating them to their own substance. It must be obvious, that this extraction and elaboration cannot proceed beyond the powers of the fungus vessels; and these juices being but scantily supplied in an ear of corn, the plant must be proportionally weak in its vegetation and effects; but in the instances of buildings in which there is a *nidus*, abounding with all the juices necessary to promote the full power of its organs, its results are proportionally great, and its mischief extensive. The opinion that this mischief is occasioned by insects, cannot be supported by a single fact, and appearances militate strongly against such an hypothesis; for were this the case, the whole of the seed, or the part attacked, would suffer, leaving only the cortical part as a proof of its existence; for insects, like

birds, never destroy more of this part than is necessary to enable them to obtain access to its saccharine contents. The subsequent experiments, however, of this ingenious divine, have set the matter at rest, as far as relates to this subject. He says: "I happened to take some dust from branded grains; I think last year; which I laid by for future inspection. After I had begun this paper, I strewed some of that dust upon a piece of fine glass, and putting it under a very strong magnifier, over a reflector, was highly gratified with observing, that every particle of brand was a globular seed; not the least variation in shape or magnitude was visible amongst them." There can be no doubt of the accuracy of this experiment, and the discovery thereby made places the subject in an obvious point of view, as it refers to its origin. From the above experiment, it is evident, that this *perpetuation* is to be deduced from seeds (and not, as Dr. Darwin conjectures, "from the congress of de-

composing organic particles"), and the minuteness of their size could alone have occasioned them to escape the attention of those naturalists who have held a contrary opinion. M. Neckar, treating of their generation, says, " they are always formed when the parenchymatous, or cellular substance, has changed its form and function." Hence we must conclude, that it is the degeneration of that part which produces these bodies; but can degeneration, putrefaction, or any other state incident on the decomposition of vegetable matter, create an organic substance? Do not we know that these seeds, from their minutiæ, must be dispersed through the air? and does it not follow that they will germinate, whenever they find a *pabulum*, or a convenient *nidus?* In answer to the advocates of spontaneous origin, Dr. Priestley uses the following convincing observations: " Still, completely organized bodies, of specific kinds, are maintained

to be produced from substances that could not have any natural connexion with them, or particular relation to them; and this I assert is, nothing less than the production of an effect without any adequate cause. If the organic particles, from which an oak is produced, be not precisely an acorn, the production of it, from any thing else, is as much a miracle, and out of the course of nature, as if it had come from a bean or a pea, or, absolutely, from nothing at all; and if miracles be denied (as they are, I believe, by all the advocates for this doctrine of equivocal generation), these plants and animals, completely organized as they are found to be, as well adapted to their destined places and uses in the general system as the largest plants and animals, have no *intelligent causes* whatever, which is, unquestionably, atheism; for, if one part of the system of nature does not require an intelligent cause,

neither does any other part, or the whole."*

That the spontaneous origin was adopted by its advocates, only from the difficulty of accounting for the growth of these plants in places wholly deprived of the apparent sources of fecundation, is sufficiently obvious, and must have been the sole cause of these conjectures. But as the seeds are invisible without the assistance of a powerful magnifier, their suspension in the air is certain, and I *suspect that they continue in this situation until their specific gravity be changed, either by adhering to other matter in the same state, or by absorption.* As they must be dispersed in the months of summer, and, for the most part, plentifully; and as, at this season, fermentation and putrefaction are constant, and these states produce not only an elevation of temperature, but likewise an evolution

* American Society Paper.

of gas, owing to the change that they experience, the *pabulum* for their developement must be referred to this cause.

Experiments, and the facts deducible from them, being the sole foundation and effectual establishment of all philosophical inquiries, it follows, that these facts, and their natural phenomena, must be of essential importance in the present investigation. Under this impression, I shall select some extracts from the papers, which, at different periods, have been sent to the Society for the Encouragement of Arts and Commerce, in consequence of their endeavours (by the offer of premiums) to stimulate enquiry into this phenomenon, and thereby to benefit the public, by the discovery of a tried and practical preventitive of the Rot. Although this object may not have been, hitherto, fully attained, yet some of the papers already received contain many useful facts; and most of them having occurred in places, and under

circumstances, highly favourable to the investigation, I trust, that, in selecting a few of the most remarkable, it will be believed, that I have no other object in view than of rendering useful the synopsis of this inquiry.

The Society having repeated their premium, Mr. Batson, who was repairing the mischiefs occasioned by the Rot, during this period (1793), in a part of his house, communicates the following particulars:—"The Dry-rot having taken place in one of my parlours in such a manner as to require the pulling down part of the wainscot every third year, and perceiving that it arose from damp stagnant air, and from the moisture of the earth, I determined, in the month of June, 1783, to build a narrow closet next the wall, through which the damp came to the parlour, which had the desired effect: but though it put a total stop to the Rot in the parlour, the evil soon appeared in the closet. Fungi,

of a yellow colour, arose to a great degree in various parts of it. In the autumn of the year 1786, the closet was locked up for about ten weeks: upon opening it, numerous fungi were observed about the lower part of it, and a white mould was spread by a plant, a vine, or sea weed; and the whole of the inside, china, &c. was covered with a fine powder, of the colour of brick-dust. It being then cleaned out, I soon perceived what, indeed, I did not expect, that the evil had impregnated the wood so far, as to run through every shelf therein; it had also seized upon and destroyed, a moveable board for breaking sugar upon. I therefore (in the year 1789) determined to strip the whole closet of lining and floor, and not to leave a particle of the wood behind; and also to dig out and take away about two feet of the earth in depth, and leave the walls to dry, so as to destroy the roots, or seeds, of the evil. When by time, and the admission of air and good brushing, it had become suf-

ficiently dry and cleansed, I filled it of sufficient height for my joists, with anchor-smith's ashes, knowing that no vegetable would grow in them. My joists were sawed of their proper lengths, and fully prepared; they and the plates were well charred and laid upon the ashes; particular directions being given, that not any scantling, or board, might be cut or planed in the place, lest any dust or shavings might drop among the ashes.

" My flooring boards being very dry, I caused them to be laid close, to prevent the dust getting down, which I thought, in a course of time, might bring on a vegetation.

" The framing for lining the closet was then fixed up, having all the lower pannels let in, to be fastened with buttons only, that in case any vegetation should arise, the pannels might, with ease, be taken out to examine them. This having now

been done upwards of six years, and no vegetation or damp appearing, the whole of the pannels remaining in the same state as when first put in."

That these facts are certainly valuable needs no illustration. The fungus vegetation, however, must have been expected when the air was thus excluded from the closet; for in a place like this, the action of the atmosphere could alone preserve it, unless some previous precaution had been taken with the wood. It is evident from Mr. Batson's observations, that moisture was the original stimulus to the vegetation; and although this new erection of a closet might have had the desired effect of preventing vegetation on the wainscot, by the formation of a vacuum; yet experience convinced him, that no such effect was produced on the closet itself, nor could it be expected, when the constituent parts and fibres of the wood were considered; for it would be found that they would

seize and absorb this moisture; and, consequently, experience a change. As the first alteration that vegetable matter undergoes by such absorption, is fermentation; and as this state, from the *evolution* of its *pabulum*, must have been the continual source of the destruction of the wainscot, it could not have happened otherwise than that the shutting up of this closet should have promoted it; inasmuch as the presence of the atmosphere tended to derange the equilibrium for its production, the atmosphere having a particular effect upon all wood; and, under certain circumstances, tending more to its preservation than almost any other power.

The next circumstance that strikes me as worthy of observation in this ingenious and valuable paper, is the novelty and importance of ascertaining and appreciating the singular phenomenon that occurred from the introduction of the anchor-smith's ashes. That the cure, in this place, was

entirely owing to their use, there can be no doubt; especially as there had been no previous measures taken to prepare the wood (excepting the plates and joists), or to obviate the percolation in the walls. This percolation, in the first instance, was evidently the cause of the fermentation, by producing a change of state in the sap of the wood; and the ashes could have prevented this by no other means than by a superior attraction. Mr. B. observes, "I filled it with anchor-smith's ashes, knowing that no vegetable would grow in them:" but the vegetable never did grow any where but on the wood; so that it must be referred to their effect on this and the air present, and not to them as an anti-vegetating *nidus*.

My opinion is, that the whole of this phenomenon arose from the oxydation of the metallic particles of the ashes, and the gases liberated from them; and that this attraction occasioned a new arrangement, which is obvious from the effect produced.

Indeed, there is no way of fully accounting for this, but by anticipating their superior affinity for their vegetating principle. That iron possesses this affinity for oxygen is certain, from its attracting this principle from air, water, &c. &c. Its attraction for it is so considerable, that it will seize it from almost every other substance, however combined, and the result is the production of an oxyde and an evolution of hydrogen.

That this principle in the iron, of taking the oxygen and evolving hydrogen, was fatal to the vegetation, is certain from the effects that were produced; and it is also certain, that hydrogen alone is fatal to all germination. This has been shewn by Dr. Carradori,* who says, "Achard, in the first place, and, after him, other philosophers, have shewn, that germination

* *Journal de Physique.*

does not take place in any mephitic air; as, for example, inflammable or hydrogen air, phlogistic or azotic air, which are known to contain no oxygen; whence it was necessarily concluded, by a legitimate inference, that of all the atmosphere which we term the air, the oxygen is the only portion necessary to germination;" and although the specific levity of the hydrogen might have anticipated its immediate escape through the crevices of the floor, it must be recollected, that a considerable portion of carbonic gas must, likewise, be present, and the difference of its specific gravity must have detained the hydrogen in a carburetted state. As all germination is stopped in this gas, I conjecture that it was the gas, and the superior affinity only, that prevented the vegetation.

This antidote is certainly valuable, and its success may be relied on as certain in all situations similar to that in which it was employed by Mr. Batson. Nevertheless,

in a general point of view, it is liable to one formidable objection, and, particularly, as it refers to its application to superstructures. To those who are at all aware of the construction of floors, however artfully done, it must be obvious, that, although it might not be necessary to fill up the whole vacuum between the joists, any weight of the magnitude that ashes would require to occupy all the intermediate space in the area of a floor, would derange its necessary equilibrium; and as this derangement would not be confined to the timbers only, it is evident, that they are inapplicable to such places. As iron possesses this property in the air of attracting its vegetable stimulus, I concluded that a compound of it, in a state of solution, might be employed with equal success. Impressed with this idea, I prepared wood with a sulphate of it, and found, upon introducing it into a place where fungi vegetated, that a most extraordinary phenomenon took place, which, I was at first in-

clined to attribute to the very reverse of what proved, from another experiment, to be the fact. Every plant within its influence, that extended several feet in the area of a circle, was so affected, that it withered away, and a stop was put to the vegetation: nor did it, even after a long exposure to the influence of the plant, lose its anti-vegetating principle. From this experiment a new fact appears, viz. that the sulphate of iron is a destroyer of fungi, and hence its importance may be conjectured in correcting of them, particularly in places where it is impossible to remove all the wood attacked by them. The value of this antidote, in such places, will, upon trial, appear sufficiently obvious.

The chemical phenomenon, however, that attended this process, is the reverse of what was produced by the iron itself; for, instead of seizing the oxygen, as was the case with the latter, it absorbs the nitrogen only. But it must be observed, that these are the two predominating ingredients of

which the atmosphere is composed;* and, therefore, although the vapour only, which it held in solution, was decomposed by the iron, yet no decomposition is effected by the sulphate solution of this metal; it is the nitrogen alone that it absorbs, and which would be restored entire, were a third body, of superior attraction than either of the former, to intervene. It appears very probable, that to this absorption may be attributed its power of destroying vegetation. This may be accounted for in two ways; first, on a supposition that the atmosphere, from this reduction of its nitrogen, possesses too stimulating a power for the assimilating organs of the plant: or, secondly, to the avidity with which they absorb the solution itself; which, from its over-proportion, may become a poison. That some such phenomenon does take place, is evident from their quick dissolution.

* In the proportion of 0,22 of oxygen gas, and 0,78 of nitrogen.

This vegetation then, having a stimulus peculiar to its nature, which appears to be fully demonstrable to our view, it becomes a subject of curious investigation; and as my purpose is to endeavour to counteract its injurious effects, I shall select another paper from the same source, as a farther illustration of this important operation.

Mr. Johnson says: "Some time between 1771 and 1773, I went, at the request of a friend, to the chapel of the Lock Hospital, through curiosity to examine a pew there, that had frequently been repaired for damages by the Dry-rot. After a close investigation, we found that it was the operation of a plant, whose leaf resembled that of the vine; wherever it had touched, the effect of its poisonous quality got through the wood to the paint, which I have seen a mere skin. I proposed to cover the floor with bricks, laid in mortar, which was accordingly done. I called twice since; the last time about seven years ago, and had reason to think that it had

never appeared again. The next opportunity of examining it carefully, was at Mark Hall, in Essex. In a parlour there were three pillars, of about ten inches diameter, the outwood of which was between two and three inches thick. Two of them were eaten through in less than seven years, from the basis, about two feet upwards within the hollow, and were as rotten as if it had been the effect of a hundred years standing.

" At another time, I saw it in a house at Whitehall, built by Sir J. Vanbrugh. The house is, I think, only two stories high; the plant had ascended to the upper story, committing devastation on the wainscot all the way. It will destroy half-inch deal in a year. I have had it twice in houses I inhabited; one in Suffolk, and the other in Gloucestershire. I bore with the first; in the other case, I undertook, and did stop it eventually. The cause is from the floor being laid on the earth, which has

been, where I have observed, of a gravelly or sandy loam, the moisture from a water-course at hand, or a northern aspect, where the outer walls stand in a garden bed, so that rain percolates, are great encouragers, it requires moisture." After a few more observations nearly similar to the preceding, on a case at a botanist's, and the surprise he felt on being told that it was a visit from a plant, he observes: "In my own case, I removed the original soil, near the part affected, and supplied its place with sand. I then placed pieces of tiles over, putting them under the wainscot, so that it had no communication with the joist or floor. Pillars, in like manner, should be kept from the earth."

In these facts there is scarcely any thing new, except the mode of cure; and that this is different from that of the former is obvious; but the effect I believe to be uncertain, or at any rate applicable only to one situation; for of what service can the

application of sands, tiles, and mortar be, in roofs that are infected with this rot? That it often begins in them, there are numerous proofs, particularly in domes. It is a well known fact, that the great dome of the Bank of England, as originally built by the late Sir Robert Taylor, was destroyed by this Rot, while no other part suffered. The timber-framing of this dome was of good sound oak. I saw, when at Paris, upon examining the dome of the Pantheon, a fungus plant protruding between the crack in the covering, near its base, which on touching crumbled into dust, and was of that species found on oak. There were also several of these plants to be seen about the late dome of the Halle-au-Bled in the same city. I have seen floors of upper stories, in all aspects, destroyed by this Rot, when the ground story remained perfect; so that no inference can be drawn, as Mr. Johnson conjectures, from its being in the ground story and the two-pair at the same time,

that, therefore, the plant of the first had ascended there; for this plant is produced only when the stimulating phenomenon is present, and in each of those various places, it must have been present separately to produce the germination. The remedy adopted by Mr. Johnson may, in some places, prove of essential service; and, indeed, I know of one instance, where, after a great many repairs had been made, it was employed with the desired success; with this only difference, that the ground was covered with a floor of Yorkshire stone, as a preparation for the wooden one. That the exhalation from the earth was the stimulus in all Mr. Johnson's cases, is certain from the cures having been effected by its prevention: but I have seen an instance, in a ground-story, where it was not owing to this cause, but to the carelessness of the workmen, in leaving a quantity of shavings under the joists, in a humid state, which fermented, and produced large fungi protruding on the wood. In fact,

as it has already been observed, the remedy for this Rot, to be effectual, must counteract this phenomenon. But to return to the remedy anticipated by Mr. Johnson's method, which, from its not being applicable to all cases and situations, cannot, I conceive, be rendered generally useful; for, it is obvious, that it is adapted to exhalation only, and even here much must depend upon the materials employed, and the quality of the workmanship. Respecting the causes and prevention of percolation and exhalation, which promote by far the greater number of cases of Dry-rot fungi, Mr. Ramsden Bramley's remarks are both rational and scientific. He observes, that, " where houses are troubled with damp walls, near to the earth's surface, it is generally, if not universally, occasioned by the percolation of water from the higher adjoining ground, which, thus intercepted in its current, attempts to follow the general hydrostatic law, of ele-

vating itself, by the syphon line, to a height equal to that whence it had its origin. Thus in houses differently situated, we see the damp arising to various degrees of height on the walls, and those are probably all corresponding to the height at which the moisture circulates in the adjoining ground. At its first entrance to the building, and whilst the moisture is in small quantities, the excavated part of the foundation wall may absorb, and gradually quit such proportion; but the excess, as is generally the case in moist weather, exceeding that power, the foundation stones are then saturated in a more rapid proportion than the adjoining rarified internal atmosphere can evaporate. The watery particles then creep up, in degrees proportionate to the ascent from which they originally descended, excepting when prevented, or driven off, by the superior heat of the adjoining rooms, when, in addition to the disagreeable damp they

cause, they frequently occasion considerable damage to pictures, furniture, &c.

"Drains laid on ditto, athwart the ascending ground, with a very slight descent or fall, and made of the depth of one yard for each yard of ascent, and from the foundation until equal to the height that such damp ever rises, would, there is little doubt, completely secure the house and furniture from the inconvenience hitherto sustained, and prove an effectual preventitive to most cases of Dry-rot, where it originated in extreme moisture."

These remarks speak for themselves, and, in the cases referred to, would, most probably, effect what has been anticipated; but not being supported by actual experiment, they cannot be pursued; nor is it certain that it would succeed in preventing a vegetation of the fungi, although it might remedy the damages to which furniture, pictures, &c. are exposed. At any

rate, it is applicable only to the case of percolation. He further observes: "I am of opinion, that the fungus which pervades decaying wood, is not the first cause, but an attendant on the peculiar state to which such wood has been reduced by previous causes. The dissemination of the seeds find a proper bed, or *nidus*, like the mushroom or toadstool, and there fix their abode, and pervade the whole substance, thus accelerating the general law of Providence, which tends to make all matter re-productive.

"Cellars, or such other places, should be drained in the manner I have above mentioned, by taking off the percolating water previous to its gaining admission to, or contact with the walls; and it is probable that, in most cases, a single drain will have complete effect. It would, assuredly, were it not for the variation of the earth's internal strata, which is not easily discernible. If attention to this rule were paid,

previous to the building of any new streets in towns, it would prove essentially *useful.*" This is all that can be said for it in the present imperfect state of our knowledge concerning it. It certainly may be *useful;* but there are no facts upon which we can establish a position for general practice. This, however, is not the case with any of the previous antidotes, they being all supported by well substantiated historical evidence, and confirmed by facts deduced from actual experiments. Hence this Rot, however anticipated, may find its cure, in whatever situation it makes its appearance; but, as was before observed, the plant receives its *pabulum* from the fermenting wood, and, therefore, the cure for the Rot must depend wholly on obviating this state, or preventing its surface from becoming a *nidus* for the development of its seed. This phenomenon, although not distinctly alluded to, appears to have been anticipated by the methods recommended by those gentlemen who

have considered the subject; and, notwithstanding I differ from them in the mode of accomplishing my purpose, it is that I sought a remedy for general purposes; an event which, I think, will scarcely be produced by any of the cases that have, *hitherto*, been brought forward. I have little to add, except to repeat that *oxydation only* can be relied on, in all cases, as an effectual cure. So confirmed am I in this opinion, from the experiments I have made in houses that are infected (the publication of which is withheld only on account of the dislike entertained towards houses that are known to be thus infected, and their consequent reduction in value), that I hesitate not to offer it to the consideration of an enlightened Public. In what I have advanced, there is, doubtless, much of repetition, and many tedious details. This has, probably, arisen from the principal facts being almost all of a nature to lead to the same conclusions: for in an examination of cases,

where the appearances and results proceed from fixed and limited principles, whether in nature or art, some little variety in its treating should be, as a matter of course, allowed.

FINIS.

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