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ON

THE MEDICAL PROPERTIES

OF

THE NATURAL ORDER

RANUNCULACEÆ;

AND MORE PARTICULARLY ON THE

USES OF SABADILLA SEEDS, DELPHINUM STAPHISAGRIA,
AND ACONITUM NAPELLUS,

AND THEIR ALCALOIDS,

VERATRIA, SABADILLINE, DELPHINIA, AND
ACONITINE.

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BY A. TURNBULL, M.D.

PHILADELPHIA:
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1838.
PREFACE.

The greater part of the contents of the following pages has been already laid before the profession, and the object the author has in view at present, is to give a connected account of the new medical properties, which he conceives to reside in many of the plants belonging to the natural order Ranunculaceae, and more particularly as they are found in Sabadilla seeds, in the seeds of the Delphinium Staphisagria, and in the root of several species of the genus Aconitum. The properties alluded to, are those possessed by preparations of the plants above mentioned, when administered internally, of exciting sensations of heat and tingling on the surface of the body, and of producing similar effects locally when rubbed upon the skin, without, in most instances, giving rise to irritation of the vascular system; and when exhibited in either way in certain painful diseases, as Neuralgia, Rheumatism, and Gout, of alleviating or removing the pain, apparently by exerting a peculiar effect upon the nervous system, unattended by any narcotic influence.

These effects are more certain and exist in a higher degree of energy in the active principles obtained from the plants, and on this account the author has bestowed more attention on them, and, in most cases, would give them the preference as medicinal agents. He has also dwelt more fully upon the effects produced by them when applied to the surface, than when exhibited internally, because experience has shown, that by the former method, a quan-
tity sufficient to remove disease may be introduced into the system, whilst at the same time, in topical affections the remedy may in this manner be applied over the seat of the disease; but when the affection is more general in its character, the internal use, or both methods combined, will be found most advantageous.

The author would caution the profession against expecting too much from the employment of these remedies. In some cases they have given only a temporary relief, whilst in others they have had no effect: but generally speaking he has found them of much more advantage in the treatment of a very distressing class of affections, than any means hitherto discovered, and on this account he would recommend their use.

*Russell Square, June 1st, 1835.*
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ON THE MEDICAL PROPERTIES

OF THE NATURAL ORDER

RANUNCULOCACEÆ;

AND OF THE ALCALOIDS,

VERATRIA, SABADILLINE, DELPHINIA, AND ACONITINE.

Of the three plants, whose medicinal properties it is intended to
give an account of in the following pages, two, the Delphinium
Staphisagria and the Aconitum Napellus, belong to the extensive
family ranunculaceæ; and with regard to the third, the plant
which yields the Sabadilla seeds, little appears to be known, by
which its precise character and situation in botanical arrangements
can be determined. It has been supposed to belong to the class
Colchicaceæ, but as in some of its medicinal properties it is much
more allied to the ranunculaceæ, it is intended, for the sake of con-
venience, to speak of it as belonging to this latter class, until our
knowledge of it becomes more definite.

The natural family ranunculaceæ, as a whole, exhibits consider-
able uniformity; but nevertheless, some discrepancy occurs when
its parts are more minutely examined. Many of the individuals
are acrid and caustic in the highest degree, whilst others are aromatic,
as the Nigella Sativa, which in consequence of its taste is some-
times used as a pepper. In some again, the properties they possess
are owing to an active principle which can be separated by che-
metal processes; whilst in others, as for instance, in almost the
whole tribe of ranunculuses, these are destroyed by drying and
boiling, or even by simple infusion in water, whilst they are aug-
mented by acids, honey, sugar, wine, alcohol, &c.* The acrid Cle-
matis Vitalba is used as an article of food after being boiled, by
the country people in the north of Italy, and the Ranunculus
aquaticus is sometimes given to cattle after being deprived of its
acrimony by drying. The general properties of the family may be

* Decandolle Essai sur les Propriétés Médicales des Plantes.
thus stated; Aclid and vesicatory, e. g. many of the ranunculuses, Clematis recta, Knowltonia Vesicatoria, &c., which are used as blisters. Aclid, stimulant, cathartic, emetic, e. g. the roots of different species of Hellebore, Delphinium Staphisagria, &c. Bitter, tonic, antispasmodic, e. g. Zanthoriza apifolia, Hydrastis Canadensis, Peonia officinalis. Along with the acrid principle there exists a powerful narcotic property in the Aconites: some of the acrid plants, as the Ranunculus Glacialis, are sudorific, and others are diuretic and vermifuge.

In addition to these, there is another class of properties, which exists in the Delphinium Staphisagria, some species of the Aconites, and in the Sabadilla seeds, and in a more marked degree in the alkaloids prepared from these plants; namely, the Delphinia, Aconitine, and Veratolia; and there can be little doubt, that further investigation into the medicinal action of the ranunculaceae, will increase the number of the individual plants which possess such properties.

When preparations of the species above mentioned, or their alkaloids, are exhibited internally in small and repeated doses, they give rise to peculiar effects on the nervous system, but more particularly upon the nerves of sensation. These consist of heat, and tingling on the surface of the skin, beginning generally in the extremities, and extending themselves towards the trunk and head, and sometimes ending in perspiration; and in rheumatic and other painful affections, these sensations are attended by marked relief to the patient. The same effects are produced, but more locally, when the active principles and other preparations of the plants are applied by friction over the seat of the disease; heat and tingling are likewise induced; at first only in the part where the friction has been made, but afterwards extending itself over the skin. In affections which are topical in their nature, these peculiar feelings are also attended by great diminution in the severity of the symptoms, and often by a removal of them after every other means have failed.

It would be an interesting question, to determine in what manner such effects are produced: but as yet nothing has been made out, that is calculated to throw light upon the subject. All that can be said, is, that they are matters of observation, and it is quite sufficient for the purpose of the practitioner that they are so, for it is upon such evidence that a great part of our practice is founded. It is to this latter class of properties, then, that it is the author's wish to direct the attention of the profession; and in doing so he may be allowed to express his conviction, that if the directions and illustrations to be given, be sufficiently explicit to enable the profession to employ the remedies he recommends, the results will be satisfactory.
CHAPTER I.

Medicinal Properties of Sabadilla Seeds.

Considerable difference of opinion exists, as to the precise plant which yields the Sabadilla seeds. Some authors are of opinion that they are the produce of different species of *Veratrum*; the *V. Sabadilla*, *V. Ovbitia*, and *V. Officinale*—others, of the *Vellozia Squamata*; and lately the plant has been considered as a species of *Xerophyllum*, the *X. Sabadilla*. It is a native of Mexico; it has been placed amongst the *Colchicaceae*, but in some of its properties it appears more nearly allied to the *Ranunculaceae*; very little that is certain, however, is known regarding its history. The seeds are dark-coloured, rugous and slightly curved, and are contained in a light brown capsule about half an inch in length. They are without smell, but have an acrid burning taste. When given to animals in sufficient quantities to produce poisoning, their effects are marked by great irritation in all the mucous membranes, particularly in the intestinal canal, in the mucous membrane of which they excite inflammation by whatever manner the poisonous matter may have been introduced; and along with this effect, great disturbance of the nervous system comes on before death.

They have been used medicinally in the form of powder, ointment, and infusion for destroying pediculi, and internally for removing tenia, and for the cure of hydrophobia.*

I have employed two preparations; the tincture and extract, made from Sabadilla seeds, with considerable advantage in some cases. The tincture made use of is a saturated one, prepared by digesting for ten days a quantity of the seeds, freed from their capsules and bruised, in as much strong alcohol as will cover them. It forms a useful rubefacient in chronic rheumatism and paralytic cases, and has a tendency to bring out a slight eruption on the skin after it has been rubbed for some days. It produces, in a very marked degree, a tingling sensation, similar to that caused by Veratria; and friction with it ought always to be continued until this effect is brought about at each application.

When rubbed over the heart, this tincture has in some instances the effect of reducing the frequency and force of the pulse, in a marked degree, and has often appeared useful in cases of nervous palpitation.

The extract is prepared by evaporating the saturated tincture made as above directed, with a very gentle heat, to a proper consistence. When given internally in small doses, it has nearly the same effects

* Hardy's Travels in Mexico.

January, 1838.—B 2
as Veratria, and may be employed with advantage in painful rheumatic and neuralgic affections. One sixth part of a grain, made into a pill, and given three or four times a day, appears to be the proper dose, and it should be continued, and gradually increased in quantity according to circumstances. This preparation also induces sensations of heat and tingling on the surface of the skin, and sometimes acts as a diuretic.

**Preparation of Veratria.**

Veratria, the active principle of the Sabadilla seeds, was discovered by MM. Pelletier and Caventou, in the year 1819,* and about the same time in Germany by Meissner and Van Mons. In their subsequent investigations, the two first-named chemists detected the presence of a similar principle in the bulb of the *Colchicum Autumnale*, and in the root of the *Veratrum Album*: the substance obtained from the colchicum, however, has since been discovered by MM. Geiger and Hesse, to differ from Veratria in several important particulars, to be afterwards noticed, and they have in consequence considered it as a new principle under the name of *Colchicine*.† The true nature of the alcaloid extracted from the white hellebore, is still unknown; so that the Veratria of commerce may be considered as being obtained entirely from the Sabadilla seeds.

Until very lately, Veratria, as obtained according to the processes employed by its discoverers, was considered to be a simple body: but from the recent investigations of M. Couerbe, it appears to consist of four distinct substances, to which he has given the names Veratrine, Veratrin, Sabadilline, and Mono-hydrate of Sabadilline; and these are obtained separately in the following manner:—A concentrated tincture, made by digesting Sabadilla seeds with boiling alcohol, is slowly evaporated to the consistence of an extract, which is next dissolved in water acidulated with sulphuric acid, and the solution filtered, after being heated to the boiling temperature. The liquor obtained, holds dissolved in it the four substances above-mentioned, along with a quantity of colouring matter. By the addition of potass, they are all precipitated, and the precipitate is to be re-dissolved in alcohol, and the tincture thus obtained is evaporated to the consistence of an extract, and this again dissolved in acidulated water, as before. The addition of potass to this solution, throws down a light-coloured precipitate, which, when dried, is nearly white, and constitutes the Veratria of commerce. As thus obtained, it is acrid, alcaline, and forms incrystallizable salts with acids.

This substance, however, is still in an impure state, and is again to be dissolved in water acidulated with sulphuric acid. To this solution nitric acid is to be added, so as to throw down an abundant dark-coloured precipitate. The liquid is next poured cautiously off, and a solution of potass or ammonia is added, drop by drop, as long

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* Journal de Physique, 1819. † Journal de Pharmacie, 1834.
as any precipitate is formed. The precipitate is next to be washed with cold water, and dissolved in alcohol, and the tincture evaporated to the consistence of an extract.

By treating this extract with boiling water, the Sabadilline and Mono-hydrate of Sabadilline are taken up, and the other two principles left undissolved. The solution, on cooling, deposits the Sabadilline in crystals, and the Mono-hydrate is obtained by slowly evaporating the remaining liquid in vacuo. The portion of the extract left undissolved by the water, is next treated with ether, which takes up the pure *Veratrine*, and leaves the *Veratrin*.

The Veratria of commerce is then a very complicated substance; but as it is the only form which has yet been introduced into medicine, the remarks which are to follow are applicable, at least so far as we yet know, to it alone. It is prepared in the form of a fine subtile powder, varying in colour from light brown to nearly white; it is very sparingly soluble in water, but sufficiently so to communicate a sensibly acrid taste to the fluid. It is very soluble in alcohol and ether. It is insoluble in alcalis, but combines readily with acids, and forms incrystallizable salts. It restores the blue colour of litmus paper, reddened by acid. When heated, it melts, and has the appearance of wax; and on cooling, presents a mass of a brownish transparent appearance.

It is destitute of smell, but when brought in contact with the mucous membrane of the nose, it occasions violent sneezing; when applied to the conjunctiva, it excites considerable irritation, and causes an abundant flow of tears. Its taste is extremely acrid, but destitute of bitterness.

According to the experiments of MM. Magendie and Andral, Veratria acts on animals as a powerful irritant, occasioning rapid inflammation in the lining membranes of the cavities into which it is introduced; ending in tetanus and death.* There is some discrepancy, however, betwixt its effects upon the intestinal canal, as observed by M. Magendie, and those that have come under the author's observation, and which shall now be noticed.

**Internal Administration of Veratria and its Salts.**

The acknowledged value of colchicum autumnale in the treatment of a variety of diseases, appears to have given rise to considerable expectations that the discovery of the active principle of the plant would be of great advantage to medicine; and accordingly we find, that no sooner had MM. Pelletier and Caventou succeeded in obtaining Veratria, than a number of experiments were instituted, with a view to determine its action upon the animal economy. These were principally conducted by MM. Andral and Magendie, and agreed in proving it to be possessed of most energetic properties, and similar, though in a more exalted degree, to those

* Magendie, Journal de Physiologie, tom. 1.—Formulaire.
ascribed to white hellebore, sabadilla seeds, and colchicum, by Schabel, Orfila, Sir Everard Home, and other observers. Unfortunately, however, these properties appeared to be of such a nature as almost to preclude the possibility of Veratria ever being employed in medicine. From M. Andral’s experiments on animals, it was proved that when applied directly to any of the tissues, it produced rapid inflammation of the part; and that when introduced in small doses into the system, either through the medium of the veins or intestines, it occasioned violent vomiting and purging; and in larger doses, tetanus and death.

M. Magendie administered it internally in the human subject, and found that, in the dose of a quarter of a grain, it acted powerfully upon the intestines, and produced very copious dejections; and he recommends its employment on this account, as a convenient remedy in cases requiring a speedy action upon the bowels, particularly in old men, in whom he states his having used it with much advantage; he also advises its substitution for the preparations of colchicum, in the treatment of those diseases in which they had been employed. Such, however, was the dread inspired by the observed properties of the new alcaloid, that few practitioners ventured upon a trial of it; and much surprise was expressed that, with these before his eyes, M. Magendie should have ventured upon such a dangerous recommendation.

Veratria has hitherto been little employed internally in this country; but where it has been used, the effects produced have been nearly similar to those already recorded by practitioners on the Continent; and agree with them in proving it to be possessed of great activity as a purgative and emetic: so much so, indeed, that its administration appears to have been very generally abandoned, as being fraught with greater danger, from this circumstance, than could have been counterbalanced by any good effect that might have arisen from it. This was also the author’s opinion at the time his work on Veratria was published; and as the impressions he had received from the writings of others had to a certain extent been confirmed by his own experience, he considered it his duty to lay them before the public. Since then, however, he has employed pure Veratria internally to a considerable extent, in consequence of having observed that its salts produced none of those effects which had been ascribed to it, and in very few cases out of a great many in which it has been employed, even when given to the extent of four or six grains in twenty-four hours, has it produced the slightest purgative effect: it has often occasioned a degree of nausea, but this may easily be obviated by taking care that too large a dose be not given at one time.

To what are we to ascribe this great discrepancy in the operation of so powerful a substance? It may arise from one of two causes, or perhaps from both. Veratria, when first used, appears to have been obtained in part from the colchicum autumnale, and on this account differed in some material points from the alcaloid, as it is
now prepared from the seeds of the Veratrum Sabadilla: so much so, that it has been described as a new principle by MM. Geiger and Hesse, under the name of Colchicine— one of the most prominent properties of which, according to those gentlemen, is to produce violent purging and then vomiting.

Two counter-experiments are related by them: in one of which a small dose of Colchicine was given to a cat: at the end of an hour it was violently purged; vomiting next came on, and then death; and upon examination, it was found that violent inflammation had taken place in the stomach and intestinal canal, with sanguineous infiltration throughout their whole extent. The second experiment was made upon a younger cat, and a smaller dose of Veratria was administered: the animal died very speedily, but neither vomiting nor purging are mentioned as having been produced: and upon examination, it was observed that the superior part of the oesophagus was the only portion of the alimentary tract where inflammation had taken place; and it was remarked that this part had escaped injury in the animal which had been poisoned by the Colchicine. These facts might of themselves be sufficient to account for the great difference in the observed action of Veratria above alluded to; but it ought also to be kept in mind, that it is very probable the alkaloid, from the large quantity which has been lately brought into the market, may now be made in a state of greater purity, from that dexterity in its manufacture which practice alone can give. Whichever explanation of the circumstance may be adopted, it certainly appears that pure Veratria, or any of its salts, may be substituted for preparations of colchicum, not only with perfect safety, but with considerable advantage, provided an ordinary degree of caution be observed in its exhibition.

The best form of administering it is that of pill; and the following prescription is the one I generally make use of:

\[
\begin{align*}
R &- \text{Veratria} & . & . & . & . & \text{gr. ii.} \\
\text{Pulv. Rad. Glycyrrh.} & . & . & . & . & \text{gr. xii.} \\
\text{Ext. Hyoscyam} & . & . & . & . & \text{gr. vi.}
\end{align*}
\]

M. fiat mass. in pilul. aequal. duodecim. divid. quarum sumat unam ter in die.

For the two last ingredients it will sometimes be found advantageous to substitute a few grains of compound rhubarb pill, especially when there is a tendency to costiveness. This prescription I have found very useful in the treatment of painful spasmatic affections, rheumatism, gout, &c. It has also been used in diarrhea with considerable effect; and in this disease one pill ought to be given after each stool, until the relaxed state be removed. After a few doses have been taken, the patient generally experiences a sensation of warmth in the stomach, which extends over the abdomen, chest, and upper and lower extremities: this is succeeded by a feeling of tingling in various parts of the body, and frequently a degree of perspiration is induced.

Veratria has been combined with several acids; but the only

* Jour. de Pharmacie, Mars 1834.
products as yet obtained that are fit for administration, are the sulphate, tartrate, and acetate.

According to Professor Turner, and M. Courbe, they are crystallizable, when prepared from pure Veratria; but the difficulty in obtaining them in this state must, for some time at least, render it necessary to make use of the more common and more easily prepared form. In this condition they have, when solid, very much the appearance of resins; they are friable, and can be reduced to a fine powder, which is of a brownish aspect. They are all very acrid when applied to the tongue, and leave a sensation of heat and tingling in the part of the mucous membrane with which they may have been brought in contact.

When given in the doses to be presently mentioned, like Veratria itself, they in general give rise to the following effects: a sensation of warmth in the stomach, which gradually extends itself over the abdomen and lower part of the chest: after the dose has been repeated once or twice, the same feeling is experienced in the lower extremities, and particularly in the feet; the upper extremities and head become also affected in the same manner: and if the medicines be pushed further, a sensation of tingling, exactly similar to that caused by frictions with Veratria ointment manifests itself in various parts of the body, and sometimes over the whole surface of the skin; this is generally accompanied by considerable perspiration, and some feeling of oppression, and all these effects are augmented by heat, or by the use of warm diluents. To this succeeds a sensation of coldness; and should their administration be still continued, the stomach becomes affected, and a degree of nausea takes place, followed by vomiting. In a few instances only have they acted as diuretics, and in still fewer as purgatives. No narcotic effect has been observed to arise from their use.

In their action upon disease, the salts of Veratria, when given internally, are possessed of powers very similar to those exercised by the base when rubbed upon the skin. The particular diseases in which they appear to be of most service, are tic douloureux, gout, and rheumatism, especially in the two first named. In the treatment of these, any of the salts may be employed; but the tartrate is upon the whole to be preferred, as it is less liable than the others to give rise to irritation of the stomach; either of them, however, may be had recourse to with safety. The best method for exhibiting them is the form of pill, made according to the following prescription:

\[
\text{R—Tart. Veratriæ . . . . . . . . . . . . . gr. ii.}
\text{Pulv. Rad. Glycyrrhiz. . . . . . . . . . . . . gr. xii.}
\text{Mucilag. Acacæ . . . . . . . . . . . . . q. s. Misce}
\text{optime et divide in pilulas aequales duodecim, quærum sumat unam tertia quaque hora.}
\]

The dose of the tartrate ordered above is sufficient to begin with, and it may be augmented, until the quantity given amounts to a grain and a half, or two grains in the course of the day: beyond
which it will not be necessary to push the medicine, as its peculiar effects in general show themselves before that quantity is used. Should the sulphate or acetate be preferred, the doses administered ought to be rather less, as these act more readily upon the stomach than the tartrate. M. Magendie has suggested the form of solution for the employment of the sulphate, but it is a very objectionable one, both on account of its taste, and from the disagreeable sensations left by it in the mouth and pharynx, which often are of such a nature as to occasion nausea and vomiting.

In any case in which it may be desired to make use of the salts of Veratria, the plan that appears the best to be followed, is to administer a pill every three hours, until the sensation of heat and tingling manifests itself, and when this takes place, some alleviation of the pain will in general be observed; but should this not be the case, the treatment ought to be persevered in, until it has had a fair trial, the dose being at the same time augmented accordingly as the patient can bear it. In some instances, it has not been found necessary to continue the pills above a few days, whilst in others, a week or two has been required to produce their full effects; and in almost every case, it has been requisite to regulate the bowels, by means of gentle aperients, to obviate the constipation which often comes on during their use. When the disease occurs in regular paroxysms, the pills ought to be resumed an hour or two before the expected time of attack.

External Application of Veratria.

Veratria may be applied externally, either in solution, in alcohol, or made into an ointment with hog’s lard: the latter form is the one which has been most generally employed; but where unctuous applications are objected to, an embrocation made by dissolving from ten to twenty or more grains of Veratria, in an ounce of boiling alcohol, if applied in the same manner as the ointment, will prove equally efficacious.* The ointment may be made with similar proportions of the alcaloid to an ounce of lard, and of this, a piece, the size of a large nut, may be rubbed with the hand from five to fifteen minutes, night and morning, as nearly as possible, over the seat of the disease, until relief from the urgent symptoms be experienced; care being taken to observe that the skin over which the friction is to be made, be free from injury, otherwise considerable irritation of the part will ensue: and for reasons already given, the person who applies either form, must be careful not to insert even the smallest quantity under the eyelids.

M. Magendie appears to have been the first person who suggested the external application of Veratria in rheumatism, gout, and anasarca; but his proposition does not seem to have been complied

* In cases where the skin is irritable, the proportions of Veratria employed, must be smaller than those now given.
with, neither does he himself appear to have been fully aware of its importance in a medicinal point of view; and indeed, the weakness of the preparations recommended by him, even had they been made use of, must have prevented the striking effects produced upon certain diseases by the Veratria, when more freely employed, from coming under his observation.

The skin over which the ointment has been rubbed, in general shows no mark of irritation, even after the friction has been continued for some length of time: sometimes an evanescent blush pervades the surface, and in rare instances a quantity of eruption has appeared upon the part, but these bear only a small proportion to the cases in which no such effects are produced. When a small quantity of the ointment is rubbed in, the patient generally experiences a considerable degree of warmth and tingling in the part, and until this takes place, the peculiar effects of the medicine never manifest themselves; the circumstance, therefore, is one worthy of attention, and may serve as a criterion whereby to estimate the extent to which the friction may be carried without producing inconvenience, and also to judge of the degree of purity of the Veratria employed; for when, as is sometimes found to be the case, the medicine is mixed with impurities, these sensations are not produced, and its action is by no means either so certain or powerful as when it is free from adulteration. This last observation appears necessary to prevent the practitioner from laying a charge of failure against it in cases where the impure Veratria may have been made use of in compounding the prescription.*

After the ointment has been applied a sufficient length of time to put the constitution completely under its influence, the feeling of heat and tingling extends itself from the place where the friction may have been made, over the whole surface of the body, and produces sensations similar to those which have been already described as arising from the internal use of Veratria and its salts.

The sensibility of the parts over which the application has been made, is increased so as to render them peculiarly susceptible of the presence of certain stimuli, particularly electricity or galvanism; these agents have in some instances been applied along with the Veratria ointment, but have given rise to sensations so acute as to render their further employment almost insupportable, and that without the slightest perceptible alteration of the surface.

Such are a few of the more remarkable effects resulting from the application of the Veratria to an entire surface, and in the great majority of cases these will be found sufficient for every purpose which

* Pure Veratria is entirely soluble in alcohol, and burns without leaving any residuum; but, perhaps the simplest and best test is to dissolve four grains in a drachm of alcohol, and to rub a small quantity of this solution on the wrist or forehead; when the Veratria is good, the heat and tingling manifest themselves after the friction has been continued for two or three minutes, and the length of time required to produce this effect affords a tolerably correct estimate of the efficacy of the medicine.
they are intended to serve: in some affections, however, in which the symptoms are more severe, or which are seated in parts only thinly covered by integuments, the attempt has been made to apply it directly to a part denuded of the cuticle, but although the effects upon the disease were much greater than when the surface remained unbroken, yet the extreme irritation which followed the practice rendered its repetition impossible.

**External Application of Veratria in Affections of the Heart.**

When any of the preparations of Sabadilla or Veratria are administered in repeated small doses by the mouth; besides exerting their peculiar effects upon the nerves of sensation already mentioned, they act also upon the circulating system. In many instances the force and frequency of the pulse are remarkably diminished by them, and the circulation is rendered more regular; whilst in others, a contrary effect is produced. This appears to be the result of the influence exerted by the medicine on the nervous system, for it takes place chiefly in those whose nerves are easily excitable; in some cases, also, in which organic disease of the heart has been present, the internal exhibition of one or other of the preparations has afforded the patient considerable relief, but apparently, not so much by acting upon the nervous system, as upon the kidneys, and thus removing some effusion existing in the chest, and which was the immediate cause of the aggravated symptoms.

Precisely the same effects are produced, when Veratria ointment, or the tincture of Sabadilla, are rubbed over the region of the heart, though perhaps not in so great a degree. This latter method, however, of employing Veratria, is upon the whole the preferable one, as in many cases the stomach might be incommoded by the internal use of it, and in addition to its action on the heart, there is also another exerted, when it is applied to the skin, namely, the tingling, which of itself appears to have a beneficial effect, especially in nervous cases, probably by acting as a counterstimulant, whilst the quantity absorbed during the friction is sufficient to produce its other effects on the system.

From the observations which I have made on the action of Veratria in affections of the heart, I have been led to conclude, that there are some cases in which the symptoms may be removed by its use, though of a class that might have been considered as indicating confirmed organic disease; amongst the following, will be found instances of this kind, and others could have been given: these have occurred in patients in whom a gouty or rheumatic diathesis has been present, and this fact may perhaps afford some explanation of the effects of the remedy.

There are, then, three states of disease, in which the ointment may be tried: namely, simple nervous palpitation; in the same affection occurring in gouty subjects; and as a diuretic in cases of organic disease, though of course in instances of this kind any
relief which it may give, can at best be only temporary; it has, nevertheless, given relief, and if it should do no good it will at least do no mischief.

The application best adapted for this class of affections, consists of fifteen or twenty grains of Veratria, made into an ointment with an ounce of lard, and of this a piece the size of a nut, should be rubbed over the region of the heart for five minutes every night, and it may be continued according to the effect produced.

CASE I.

A LADY, fifty-five years of age, was attacked seven years ago with what her medical attendants considered to be an inflammatory affection of the lungs, and for which she was profusely bled, and otherwise actively treated. The violent symptoms were by these means removed; but there still remained a degree of weakness and affection of the chest, sufficient to confine her almost constantly to her room for nine months afterwards. Since that time, she has recovered considerably, but has been under the necessity of remaining in an apartment, kept at an equable temperature, during the winter; and with the prospect of being obliged to continue the same regimen for the remainder of her life.

Throughout the whole seven years she has had constant cough, attended with scanty mucous expectoration: a difficulty of breathing so great, as to prevent her sleeping at night, or even remaining in the recumbent posture for any length of time without bringing on distressing fits of coughing: respiration very much hurried, and the lips of a purplish hue: pulse so small, rapid, and irregular, as to render it difficult to ascertain the number of its beats. Over the region of the heart, and over a great part of the anterior surface of the thorax, there was a very perceptible undulatory motion, altogether different from ordinary pulsation; and the ear, applied to the chest over the same region, distinguished the heart's action to be extended, indistinct, and undefined in character. Along the whole length of the left arm, from the shoulder to the points of the fingers, she complained of pain and a feeling of numbness, which rendered the extremity almost useless: this symptom had lasted about four years. There was no very marked derangement in the digestive organs. The bowels were regular, the appetite pretty good; but there existed a slight degree of flatulence, not however so great as to occasion much inconvenience, and there was nothing very particular in the appearance of the tongue.

The patient had previously been under almost every variety of treatment, but without receiving any benefit. Upon the supposition that there might be some accumulation in the bowels sufficient to aggravate the symptoms, she was directed to use aperient medicine for a few days, but without producing any alleviation. She was then put under the influence of small and repeated doses of the
tartrate of antimony, and along with this treatment, frictions with croton oil were applied over the chest and down the left arm, until a pretty free eruption was brought out. Under this plan the patient, for the first time from the commencement of her illness, experienced decided relief; and it should certainly have been persevered in until a fair trial had been given to it, had not such a degree of debility supervened, as to give rise to considerable doubt whether or not it could be continued with safety; the cough and difficulty of breathing had very much diminished in severity, but the pain in the arm remained unabated, and at the end of ten days she would not consent to the further employment of the remedies, and they were in consequence given up.

Before the time at which this patient came under treatment, the very striking effects which the Veratria, when applied externally; exercises upon the pulse, in removing irregularities and intermissions, and in diminishing its frequency, had presented themselves to observation; and although it was not anticipated that very great benefit could arise from its use in a case so apparently hopeless, it nevertheless appeared probable that, at least, a temporary relief from the violence of the symptoms might be procured, if the medicine only acted upon the circulation, without inducing such a degree of general debility as had resulted from the means previously had recourse to. A piece, as large as a nut, of an ointment composed of fifteen grains of Veratria and an ounce of hog’s lard, was accordingly directed to be rubbed twice a-day over the chest and along the affected arm five minutes each time, and the result very far exceeded the expectations formed. The first application relieved the chest symptoms considerably. The cough and breathlessness, to a certain extent, subsided, and the pulse and action of the heart were greatly improved: the most decidedly beneficial effects however were produced upon the extremity; the pain and numbness had not altogether disappeared, but these symptoms were so much alleviated, as to induce the patient to state that, comparatively speaking, she had recovered the entire use of her arm. From this time the ointment was directed to be used every evening for about ten days, and then only occasionally, as it might be found necessary.

In about a fortnight from the first application of the Veratria, the patient was able to leave her room and walk up and down stairs with facility; and the general improvement of her health was such, that she ventured into the open air, but in consequence of incautious exposure, the symptoms returned two or three times, though by no means with the same severity as before; and when such an occurrence took place, one or two rubbings with the ointment afforded complete relief. She is now in comparative health; her general appearance is good, the pain and numbness of the arm have entirely disappeared, the circulation is much more regular than it has been for a great length of time, the cough and difficulty of respiration are almost gone, and she can now remain in the recumbent position,
and enjoy a good night's rest; and the last time I saw her, she had walked about four miles without any inconvenience.

CASE II.

Mr. B., aged thirty-six, of sedentary habits, and by profession a banker's clerk, was seized about ten years ago, without any apparent cause, with palpitation on the left side of the thorax, which was followed by pain and a sensation of tightness and anxiety over the region of the heart; his pulse became irregular and intermittent; his breathing, however, has not been to any great degree disturbed, and he has been able to take free exercise, and with some benefit. During the course of his illness he has had no cough, but has had occasional sighing.

The digestive functions have been considerably impaired, the appetite bad, the bowels disordered, and an almost constant tendency to flatulence has been present. The nervous system has also been for some time under much derangement, marked by tremors in the hands, irritability of temper, disturbance of the mental powers, particularly of the memory, which has suffered a good deal in its integrity; for some time past he has experienced a disinclination for exertion, and has gone through his business more as a matter of duty than of pleasure. His sleep has been disturbed and unrefreshing; and he has laboured under great depression of spirits, from the belief that his complaint, from the number of remedies he had tried without advantage, was incurable.

Under these circumstances, and considering from the account he had given, that to attempt a cure by the means usually employed in such cases, would only be a waste of time, and also in consequence of the success which had attended the previous trials made with the Veratria, it was determined at once to employ it in his case; and with this view he was directed to take a little opening medicine, a practice always necessary to be pursued during the time the Veratria is in use; and an ointment of the same strength as that applied in the preceding case, was ordered to be rubbed on, night and morning, over the region of the heart. As the patient lived at some distance he did not present himself again until the end of a week, when he returned to announce that he was quite well. The palpitation and nervous symptoms had entirely vanished, and he was then in the enjoyment of the best health and spirits. I have seen him once since that time, and he has not had the slightest return of his complaint.

CASE III.

Mrs. L., a lady thirty-six years of age, and of a spare habit of body, residing in Bristol, has been suffering for five years from palpitation of the heart, attended by considerable difficulty of breath-
ing. She dates the commencement of her disease from a severe inflammatory affection of the chest, occasioned by cold caught during her confinement. To relieve the chest symptoms, bleeding and other antiphlogistic measures were had recourse to; but the palpitation continued to such a degree, as to render her incapable of taking any exercise without materially aggravating her symptoms. She has had many exacerbations arising from slight causes, and yet so severe as to render venesection necessary to alleviate the violent throbbing in the left side of the thorax. Her eyes are suffused, her memory impaired, and she has a considerable degree of nervous irritability. Her breathing is difficult, accompanied by slight cough and a sense of partial suffocation, along with pain across the region of the heart and down the left arm, and these feelings are materially increased by walking or any other exertion. Her pulse is irregular and quick; bowels costive; feet generally cold; and her sleep interrupted by the palpitation.

While labouring under these symptoms she was put under the influence of small doses of tartrate of antimony and blue pill; and at the same time an embrocation of eroton oil was ordered to be rubbed over the chest and down the affected arm, until a free eruption was produced. So long as the patient continued this plan of treatment, and remained quiet, she experienced great relief; but the palpitation returned nearly as violent as ever, upon slight exertion, and she now began to complain of a degree of debility which she had not before been subject to. Under these circumstances, she was ordered to have an ointment prepared with twenty grains of Veratria to an ounce of lard, rubbed in the usual quantity over the region of the heart for five minutes night and morning; and owing to the severity of the pain in the arm, frictions with the eroton oil were ordered to be made along it, until a raw surface was obtained, and over this the Veratria ointment was applied.

On the night after the first application the symptoms were very much diminished in intensity, but the Veratria had occasioned a degree of heat and tingling in the arm, so great as to prevent her sleeping; the pain, however, never afterwards returned. In three or four days she began to take exercise without inconvenience; from this time she gradually improved, and at the end of three weeks left town, and returned home quite well.

**CASE IV.**

Mr. J., a clergyman, fifty years of age, has been affected with severe palpitation for the last seven years, accompanied by quickness and irregularity of the pulse, difficulty of breathing, loss of voice, cough, expectoration, and a distressing sense of anxiety; has sometimes been seized in the pulpit with giddiness, succeeded by throbbing in the neck and confusion of intellect, and these symptoms have occasionally gone on to such an extent as to oblige him to de-
sist from his duties for two or three months at a time: his bowels are regular, and his digestion generally good.

He was ordered to take small doses of tartar emetic, and to have a blister applied over the chest; and this treatment was pursued with considerable advantage for the time, but when it was remitted he soon returned to the same state as before. As this seemed a fair case upon which to make trial of the Veratria, it was ordered to be rubbed on in the manner already described. By making use of the frictions once every night he became gradually better; and at the end of a week considered himself quite well; he was advised, however, to continue the ointment for a little longer, and then to leave it off by degrees: this was accordingly done about a year and a half ago, and he has remained ever since in excellent health, free from his old complaints, and able for the discharge of the functions of his office.

CASE V.

Mr. W., aged fifty-eight, has been affected for seventeen years with palpitation, which, during the last seven of that period has been attended by great difficulty of breathing, occurring in paroxysms, and coming on especially whilst taking exercise on foot. The dyspnoea at these times has been so severe, and has been accompanied by such extreme pain across the chest, as to compel him to lay hold on the nearest object for support. The pain, during the fit, extends down the left arm; and is of such intensity, that in the words of the patient, "no language can describe it."

For these and other symptoms he has, during the last ten years, applied to all sources for relief, and almost every possible remedy has been tried without procuring for him any case. At the time he came under treatment, he had, besides the symptoms mentioned, a purple blush upon his face, and more particularly over his nose and lips; his voice was weak and quivering. Upon applying the ear over the region of the heart, a tremulous, confused, irregular pulsation was heard: the pulse was irregular and very intermittent: the left side of the chest appeared much larger than the right, and the ribs over the cardiac region seemed pushed out as if to afford a larger space for the heart's action. There was considerable distension of the abdomen, along with a very evident degree of enlargement on the right side, immediately under the margins of the ribs; his bowels had been for some time in a very torpid state, and required active medicines to operate upon them; the lower extremities were a little swollen, and the urine deficient in quantity. His sleep was unrefreshing, and often disturbed by fits of coughing, which generally ended in great exhaustion.

As it was evident, that in a case of such severity and duration, little more could be done than merely to relieve the sufferings of the patient, by endeavouring to mitigate the symptoms as much as possible, the treatment followed was addressed to that end. A course
of medicine was prescribed, consisting of purgatives combined with antaëtics, for the purpose of clearing out the bowels and removing the distension of the abdomen. These means were employed alone, for about a week, and then, with the addition of a little squill to the pills previously ordered, it was persevered in for a fortnight longer; at the end of which time he felt considerably better. The swelling in the legs had diminished, the digestion was improved, and, altogether, he was in a more favourable state of health than before.

During the previous treatment of this case, counter-irritation, by means of blisters, issues, tartar emetic ointment, &c., had been freely employed, and with so little effect, further than bringing about a temporary alleviation, that the patient would, on no account, consent to their repetition now, and he was therefore recommended to make use of the Veratria ointment, but certainly without any great expectations of its producing a beneficial effect.

An ointment of the usual proportions was ordered to be rubbed, for five minutes, night and morning, over the region of the heart; and, in the course of three days, the feeling of pain and constriction across the chest had disappeared. As the pain in the left arm still remained, he was ordered to use frictions with the ointment to it also, and almost immediate relief from that symptom followed the application. In the course of a fortnight from the time the Veratria was had recourse to, the most decidedly beneficial effects had been produced upon the disease: the pulse and action of the heart had become much more regular and natural, the difficulty of breathing had very much diminished, the complexion was completely changed, and exhibited signs of an unimpeded circulation; and this improvement went on gradually, under the occasional use of the ointment, along with a little medicine to act upon the bowels, so that, in about six weeks he could walk about, and go up and down stairs without inconvenience. As this case was one in which a cure could not be expected, the patient was left to himself with directions to rub the ointment whenever a return of pain or uneasiness rendered its employment necessary. This, he accordingly does, and by its means, is enabled to pursue his avocations with ease and comfort. Before taking leave of this case it is proper to state, that it was one of those in which the Veratria exerted its peculiar diuretic effects; for, during the first week it was used, no less than six pints of urine a day were evacuated by the patient.

CASE VI.

Mrs. C., a lady betwixt fifty and sixty years of age, has been ill about nine years. During the first three she suffered from dyspepsia and irregularity of the bowels, and, for six years, she has been affected with almost constant palpitation and difficulty of breathing; which symptoms she describes as having been on the increase, until at last she was obliged to confine herself to one floor of the house,
from inability to ascend or descend the stairs, and to refrain from walking, under the impression that the exertion might prove fatal.

She has violent pulsation over the region of the heart, along with an irregular and intermittent pulse, and complains, at times, of severe pain across the chest, and stretching down the left arm: her lips are of a purplish colour; her eyes dull; her countenance sallow; and she labours under considerable nervous irritability, accompanied by impairment of the memory! she has a degree of fulness in the right side, under the margin of the ribs, and her feet are generally cold, and a little swollen. For these symptoms she had previously been treated by bleeding, blistering, purgatives, and indeed, every thing possible appeared to have been done, without procuring any abatement of the disease.

From the disordered state in which the digestive organs evidently were, she was put under a plan of treatment similar to the one pursued in the preceding case, for about three weeks, but no diminution of the symptoms took place; and then the Veratria ointment of the usual strength, was ordered to be rubbed over the left side of the chest, and down the arm, every night. The first application afforded great relief to the palpitation and difficulty of breathing, and the pain in the arm was also considerably alleviated. In the course of a few days all the symptoms were nearly gone; the ointment was, however, directed to be applied occasionally, for about a month: and at the end of that time, the patient could walk with ease, three miles at a time, and returned home quite well, and has had no return of the disease since.

CASE VII.

The following case is given for the purpose of showing the effect which the Veratria has upon the circulation, in a disease attended by symptoms of great development of the heart’s action, occasioned by simple hypertrophy of the walls of the left ventricle. Every one must have remarked the difficulty which there exists of moderating the pulsation of the heart and arteries, in this disease, and that, in consequence, it is no easy matter to procure even a temporary relief from the distressing sensations experienced by those who are affected by it. The cases of this kind, in which the ointment has been resorted to, are not sufficiently numerous to warrant the assertion, that decidedly beneficial effects will result from its application in every instance; but it will, nevertheless, be allowed, that the subject is worthy of attention, from the fact of its having already proved successful in doing so.

Mrs. S., a lady about sixty years of age, has, during the last five years, suffered much from violent beating of the heart, attended by strong pulsation in the neck, throbbing and giddiness in the head, and a continued whizzing noise in the left ear, along with feelings of anxiety, and considerable nervous irritability.
The action of the heart is strong, constant, and concentrated in a space over the situation of the apex, and communicates a powerful impulse to any thing placed on it; the pulse is very full, throbbing, and incompressible; the carotid arteries beat violently, and the patient complains much of the noise in her ear, and of giddiness; she has also confusion of ideas, and a feeling of heat and fulness in the head. She has considerable anxiety, and her sleep is interrupted by palpitation. There is some pain in the region of the heart; and all these symptoms are materially augmented by exertion; but this, from the sensation of lassitude which she almost constantly labours under, cannot be made to any great extent.

The bowels are generally costive, and require the employment of active purgatives, which are the only medicines capable of removing the uneasy feelings of the patient, to any degree; the digestive functions are very active, and the appetite preternaturally great. She complains neither of difficulty of breathing, cough, nor pain in the arm. In the previous treatment of this case nothing had been found useful, and as it did not appear that any bad consequence could arise from the external application of the Veratria, it was ordered to be rubbed over the region of the heart, in the usual manner, after purgatives had been administered, for a few days, to regulate the bowels.

After the first or second friction with the ointment, all the symptoms were materially diminished in intensity; the palpitation had greatly subsided; the pulse had become much softer and weaker; the anxiety, the pulsation in the head, the feeling of giddiness, the confusion of intellect, and the sensation of whizzing in the ear, had all disappeared, and the general health and appearance of the patient were much improved; but still some of the symptoms remained, not, however, to such a degree as to occasion inconvenience, and she is now in a comfortable state, and able to follow her household employments; though exertion, to any great extent, cannot be used without aggravating her complaints. From the manifest benefit experienced from the Veratria ointment, she uses it herself whenever, from any cause, an increase in the symptoms takes place, and with the effect of procuring immediate relief.

CASE VIII.

A GENTLEMAN, aged about sixty, of a weak constitution, of sedentary habits, and given to mental occupations, has laboured, for seven years, under slight palpitation, accompanied by feelings of anxiety and general languor, coming on at intervals, and increased by exertion; his pulse is feeble, rapid, and intermittent; palpitation over the lower part of the left side, not excessive, but attended with a painful sensation in the region of the heart, which is so augmented by walking, especially against the wind, as to compel him to stop and support himself on the nearest object. Respiration generally
unimpeded, except under these circumstances. The circulation in
this patient is peculiarly languid, the face pallid, and the surface of
the body cold. The nervous system is easily excitable, and he
finds that continued exertion of mind very much aggravates all his
symptoms. Appetite good, digestion easy, but occasionally ac-
companied by flatulence; bowels rather costive.

In the previous treatment of this case the same measures
were employed as in those already related, but without the least
effect. He was ordered to take a little opening medicine for a
week, and then to apply the Veratria ointment over the region of
the heart as usual. On the night after the first friction had been
used, the patient got no rest in bed from the excessive nervous
irritation which it had given rise to; his feelings of anxiety, and
palpitation were so much augmented, that he would on no account
repeat the application: these symptoms continued unabated for two
days, at the end of which however the disease began to decline, and
went on afterwards to do so until every vestige of it had disappeared,
although no curative means whatever had been employed after the
first application of the Veratria; and he still continues well.

CASE IX.

A lady, about sixty years of age, was seized with a fit of fainting
about sixteen years ago, in which she continued for an hour and a
half, and ever since that occurrence she has been affected with pal-
pitation of the heart, accompanied by frequent returns of the syn-
cope. She now complains of palpitation, and difficulty of respiration,
along with deep sighing, occasioned by a sensation of constriction,
which she describes as extending over the chest, but unattended by
cough; and the angles of the mouth are slightly bluish in appearance.
The action of the heart is violent and irregular, and she complains
of oppression and weight over the lower part of the left side of the
thorax. The pulse is intermittent and irregular, and does not at
all times correspond with the intensity of the heart’s pulsations. She
complains of occasional shooting pains in the arm, reaching to the
points of the fingers; she is sometimes nervous, and low-spirited,
and at intervals nearly free from all those symptoms; but not for
any length of time, for they return again from very slight causes.

The appetite in this patient is at all times pretty good, but the
digestion is not performed with a corresponding degree of facility,
which renders a careful selection of the articles of diet, as well as
attention to their quantity, necessary; and notwithstanding that
these precautions are attended to, there is considerable flatulence
and pain in the stomach during the process. The bowels are
habitually costive, and require the employment of active purgatives
from time to time, to keep them easy; and the lower extremities
are generally cold.

Almost every form of treatment that could be devised, had in
this case been resorted to, during the long continuance of the disease; but the palpitations and faintings never ceased, although the general health by great care had been preserved tolerably good. To relieve the disordered state of the stomach and bowels, the patient was now directed to take opening medicine, combined with antacids, along with small doses of blue pill, for a week; and by these means the dyspeptic symptoms were, to a certain extent, removed, but the affection of the heart still remained nearly as violent as ever. The Veratria ointment was then prescribed of the usual strength, and ordered to be rubbed every night over the left side of the thorax. She did not return till the end of a week from this time, and from her own account, as well as from examination, she then appeared very much better. During the interval the palpitation and syncope had been much relieved, and indeed the latter had not returned. The feeling of tightness and oppression was quite gone; the pulse was materially improved in character, but still rather irregular. She was directed to persevere in the application of the ointment; her health and appearance became gradually amended, and at the end of a month from the time at which the Veratria was had recourse to, she was quite well.

External Application of Veratria in Neuralgic Affections.

In no class of diseases have the beneficial effects of the Veratria ointment been more strikingly manifested than in that which it is now proposed to bring under consideration; for in none are the symptoms productive of more distress to the patients, and by no other means can the same degree of relief be afforded in so short a period.

The external application of the Veratria has been made use of in neuralgic affections situated in every part of the body; it is, however, in tic-douloureux that the most remarkable and speedy change is effected in the state of the patient, for sometimes during the continuance of the first friction the paroxysm is brought to a termination, and does not again return; and if this be not the case, the following interval is at least of greater length than any that may have previously occurred, and the next accession of pain is less severe, and more easily removed.

The principal considerations to be attended to in the employment of Veratria in tic-douloureux are connected with the part of the face, and the extent of surface, in the which the pain is situated, and the length of time the patient has laboured under the disease. With regard to the first of these, it has been found that in cases where the affection is not confined to one particular point, but has extended itself along the ramifications of the nerve in which it has its seat, the symptoms may be removed much more speedily, and by means of an ointment containing a smaller quantity of the Veratria than when the contrary is the case; and this probably arises from the circumstance of their intensity in such instances being
much less, and from the surface under which the disease is actually situated being greater than where one spot only is affected, thereby affording an opportunity of making the application over a number of affected points at the same time.

In cases, too, of long duration, there is more difficulty experienced in performing a complete cure, than in those of a more recent date; but this does not appear to arise from the ointment having less power in removing the existing paroxysm in these instances than in others, for it almost always affords immediate relief, but from the habit of recurrence at stated intervals which its previous long continuance seems to have impressed upon the disease: even this, however, may be broken through by a little perseverance; and a recovery be effected, if not as quickly, at least as certainly, as in less obstinate cases.

For those forms of the disease which have been characterised as occupying the branches of the affected nerve, an ointment, made with twenty grains of Veratria to an ounce of lard, must be rubbed during the paroxysm, over the whole seat of the pain for fifteen or twenty minutes, or what is better, until the heat and tingling caused by the friction have been so great as to produce an impression on the feelings of the patient equal to that arising from the disease itself;* and when such an effect has been brought about, the friction may be discontinued for a short time, to allow the irritation occasioned by it to subside, so as to enable the patient to form a judgment of the relative intensity of the pain now, compared with what it was before the ointment was had recourse to. In many instances the paroxysm will be found to have been cut short; but if any degree of uneasiness remain, the part must be again rubbed with the ointment until the peculiar sensations arising from its use again show themselves, and this second application will, in general, be succeeded by a remission of the pain. Should an instance, however, occur of such obstinacy as to resist this repetition, the patient should still persevere, until the paroxysm be subdued.

In the great majority of cases to which this form of treatment has been applied, the removal of the paroxysm has been readily effected; and those in which a continuance of the friction, in the manner now recommended, is found necessary, are almost without exception cases in which the affection has been confined to one point.

For the purpose of obtaining the full effect of the Veratria as soon as possible in such instances, it has been used in the proportion of forty grains to an ounce of lard, and this may be done either from the very beginning of the treatment, or the quantity of the alkaloid may be augmented by five grains in each prescription until it attain to that amount. The former method is upon the whole to be preferred, because by it an immediate check is put upon the paroxysm in severe cases, without the necessity of continuing for a length of time the employment of weaker applications.

* It is of the greatest importance to attend to this caution, as the ointment has no effect whatever in removing the disease unless these sensations are induced.
It may not be out of place to repeat here the caution already given, against allowing even the most minute quantity of the Veratria to come into contact with the conjunctiva, an accident which may easily happen during the application of the ointment in affections situated in the face; as such a circumstance, although it may not be followed by danger, is nevertheless productive of so much irritation as to make it an object to guard against its occurrence.

The general instructions which have now been given regarding the plan to be pursued in the treatment of tic-douloureux, are equally applicable to cases of neuralgia, situated in other parts of the body. These last, however, are not so difficult of removal; and do not, so far as has been hitherto observed, require the ointment made use of to contain more than twenty grains to an ounce of lard. There is a form of this affection occurring in the loins, and extending down the thighs of women during the menstrual period, in which the application of the Veratria is found of great service, as affording an easy and expeditious means of removing it.

CASE I.

A lady, fifty-five years of age, has been affected for the last thirty-six years with tic-douloureux in the cheek, and in the forehead above the eyebrow on the left side. From the commencement of the disease, she has had a paroxysm generally once a week, and at no time does she remember the interval to have been greater than fourteen days. Her sufferings during the continuance of the attack have been extreme, and have compelled her to confine herself to bed until its termination, and it has never lasted a shorter time than two days. In the intervals, however, she has been perfectly free from pain, and her general health has all along been tolerably good.

It appeared from the history of the case given by the patient, that throughout the long course the disease had already run, almost every kind of medical treatment had been put in practice without giving rise to any permanently good result; and in consequence of this circumstance, and as the symptoms appeared to admit of nothing but slight alleviation, if even that could be procured, she was ordered to keep the bowels open by the use of an aperient pill, and at the commencement of every paroxysm to take a small dose of acetate of morphia, and to repeat it every hour until the pain abated. She persevered in these means for two months, and experienced considerable relief; but although the violence of the symptoms was moderated, neither any diminution of the length of the attack, nor any change in the duration of the interval, could be observed.

Under these circumstances, and as the general health of the patient was beginning to suffer from the employment of the morphia, it was ordered to be discontinued; and she was directed to take small doses of strychnia, for the purpose of removing, if possible, a
paralytic affection of the levator muscle of the upper eyelid, and of the left side of the face, which had come on during the previous existence of the disease. This course was persevered in, until the convulsive twitches, brought on by the medicine, became as strong as the patient could bear them, but without producing any effect upon the paralysis.

Her health was now much weaker, but her sufferings continued unabated; and as it became a duty to call into use any means which might afford even the slightest prospect of relieving the violence of the pain, she was directed, after the manner already stated, to rub over the forehead and on the side of the face, a portion of ointment, made with twenty grains of Veratria to an ounce of lard, till every uneasy sensation was gone. In about fifteen minutes this effect was produced; but the paroxysm again made its appearance within two hours, and by a renewal of the friction for a few minutes it was again extinguished, instead of continuing two days, as usual.

To this there succeeded an interval of perfect ease for ten days, when the attack again returned, but not by any means so violently as before. On this occasion the same plan was pursued as in the preceding paroxysm, and the relief afforded was still more marked, for the pain was entirely removed by the first application. From this time the patient had only one or two very slight accessions, but these were at once cut short by the use of the ointment for a few minutes, and the disease entirely left her.

Not the least remarkable circumstance in this case was the change which took place upon the paralysis, for immediately after the first friction had been made use of, it was observed to have diminished considerably; and by the time the patient was cured of the tic-douloureux, it had disappeared, and has not since in any degree returned.

CASE II.

Mr. C., aged forty, has laboured for sixteen years under tic-douloureux over the right side of the face and forehead, but particularly along the lower jaw as far as the mesial line, where it terminated; and when the paroxysms were severe, the pain also extended itself to the same side of the tongue. During the whole course of the disease, this patient has hardly ever been free from pain; and when an interval of ease did take place, his sufferings were renewed by the slightest causes, and more especially by mastication, which seldom failed to bring on an accession; his general health and appetite have been good, so much so, that he has frequently brought on an attack by inattention to proper rules for regulating his diet and regimen.

In the previous management of this case, under the supposition that the pain might depend upon decayed teeth, the patient had had several extracted without affording any relief. He was then
bled, generally and locally; blisters and embrocactions were repeatedly employed, but still no abatement in the severity of the symptoms took place. Along with these means he had also used large doses of carbonate of iron, arsenic, mercury, opium, morphia, sulphate of quinine, nux vomica, &c., without effect; and when he came under treatment, he had been taking prussic acid in a quantity sufficient to affect the nervous system, and with as little success as from the measures which had before been resorted to.

As it appeared, from the history of the case, that the patient had been in the habit of indulging his appetite for food and drink to a considerable degree, and as his digestive organs appeared somewhat deranged, he was directed to take small doses of blue pill with Epsom salts; and along with these means the Veratria ointment was prescribed, of the same strength as in the preceding instance; and from the fact of there being no distinct interval observable betwixt the paroxysms, he was directed to rub it over the seat of the pain twice a day, and to renew the friction at any other time should the attack come on.

In the course of four or five days he returned very much improved in every way. His general health appeared better; the disease had been greatly relieved, for instead of being almost always present, as had been the case for so long a time, it had been broken up into distinct accessions, and these were attended with comparatively little pain: he was therefore directed to discontinue the regular application of the ointment, and to employ it only when threatened with a renewal of the paroxysm: soon after this, he gave up the use of the internal medicines which had been prescribed for him, and he went on gradually improving under the influence of the Veratria alone; the intervals became longer, and the fits less and less painful, until at the end of four weeks from the time he came under treatment, he returned home perfectly free from pain, and I believe has been so ever since.

CASE III.

A lady, forty-eight years of age, has been affected with severe tic-douloureux, situated in the middle of the left side of the face, for a period of twenty-two years. She has made use of every possible medicine, particularly of carbonate of iron, which she had taken for three months in very large doses, but without experiencing any benefit.

The paroxysms are irregular in their duration, but never shorter than twelve hours, and they return generally at the end of three days, sometimes at the end of a week, but seldom longer; and during the interval she is not altogether free from pain.

A short time before this patient came under treatment she had an attack of paralysis; from which, however, she had recovered, with the exception of a slight palsied appearance of the countenance. There were no very marked symptoms of derangement in the diges-
tive organs, but it was thought advisable to put her under a course of medicine for a few days, similar to that made use of in the last case; and the Veratria ointment, of the same strength, was ordered to be rubbed on in the usual manner when the next paroxysm occurred. This was accordingly done; and after the friction had been continued for a quarter of an hour, the pain ceased entirely, and never came on afterwards in the shape of a regular attack.

During five weeks from this date, the disease appeared occasionally in the form of slight twinges of pain in the part previously affected, but these were at once removed by rubbing on a little of the ointment, and at length completely disappeared.

CASE IV.

A lady, about thirty-five years of age, has suffered most severely and almost without intermission for the last eighteen months, from tic-douloureux in the cheek and side of the forehead. She has, during all that time, been put under the effects of nearly every variety of medical treatment that could be suggested, without producing any effect whatever upon the disease; and the only remedy which has in any degree alleviated her sufferings is galvanism, but this also has failed in producing any permanent benefit.

This patient appeared to enjoy very good health: so that, without any other treatment being put in practice, it was determined upon at once to try the effects of the Veratria ointment. She was therefore ordered to rub over the affected part in the usual manner an ointment made with twenty grains of Veratria to an ounce of lard, which she accordingly did, and in ten minutes from the commencement of the friction, every vestige of the pain had disappeared, and it has never since returned.

CASE V.

A lady, twenty-five years of age, has been for the last seven years affected with severe tic-douloureux, confined to one point, exactly in the situation of the supra orbital foramen of the right side. The paroxysms have varied in duration, from sixteen hours to two days; and intervals, extending from ten days to three weeks, but never longer, have intervened between the attacks of pain, and these, when short, have generally been followed by a recurrence of the symptoms in two or three days.

In this, as in the preceding cases, almost every means of cure appeared to have been already had recourse to, but, as usual, without procuring any permanent alleviation of the sufferings of the patient, except that small doses of acetate of morphia administered during the paroxysm, sometimes caused an immediate cessation; but it was attended with this inconvenience, that if it did not pro-
duce the desired effect, all the symptoms were immediately aggravated to a great degree.

The digestive functions in this patient appeared to be considerably impaired, her circulation languid, and her extremities cold, especially during the attack. On these accounts she was put under a course of laxatives, combined with blue pill, for about a week, which was the means of removing these symptoms, but without producing any change on the disease itself. As it appeared that carbonate of iron was almost the only medicine which she had not previously made use of, it was prescribed in pretty large doses, and persevered in until it evidently appeared to exercise no effect whatever upon the symptoms; it was then given up, and about six weeks afterwards the Veratria was applied.

At the commencement of one of the accessions, she rubbed over the eyebrow and forehead of the affected side, part of an ointment made with twenty grains of the Veratria to an ounce of lard; and after the friction had been continued in the usual manner for about twenty minutes, the paroxysm was cut short. During the interval she was directed to apply, in the same way, an ointment made with morphia and hog's lard, in the same proportions as the other, twice a day, in order to prevent a return of the attack, but without producing the intended effect, for it again made its appearance in ten days.

With the view of making a decided impression at once upon the disease, an ounce of ointment containing forty grains of Veratria was ordered to be employed as before, whenever a new accession of the pain took place; and in a few minutes after its first application, there followed a great increase of the symptoms, which continued for about two hours, and then subsided, leaving no trace of the affection behind, neither has any renewal of it taken place.*

CASE VI.

A lady, aged twenty-six years, who has been subject to occasional attacks of hysteria since her fifteenth year, has also since that period suffered from tic-douleureux, situated in the left eyebrow and extending itself up the forehead, in the course of the ramifications of the frontal nerve. The paroxysms in general take place once a month; but if the patient happen to expose herself to sudden alternations of temperature, she is almost certain of experiencing a violent attack on the following day, and in either instance it continues with unmitigated

* In this instance the Veratria has completely failed in giving permanent relief. The case was drawn up about the beginning of 1834, and the patient was at the time in the state above described; shortly afterwards, however, the disease again showed itself, and has ever since continued to come on at intervals. After repeated examinations, I have been unable to detect any organic disease; and although the other remedies mentioned in this volume have likewise been tried, no permanent benefit has been derived from them.

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severity for about twelve hours, and not unfrequently terminates in sickness and vomiting, occurring at intervals for two days after, along with a considerable degree of intolerance of light.

As no plan of treatment which she had hitherto made trial of, had had any effect upon the disease, she was, without any other means being employed, directed to rub at the beginning of one of the accessions, part of an ointment of the usual strength, and in the manner already described, over the seat of the pain, and to continue the friction until relief was obtained. She did so, and in less than half an hour from the time the ointment began to be used, the paroxysm entirely left her.

On account of the presence, in this case, of considerable visceral derangement, the patient was treated by gentle laxatives, for a short time in the way recommended in those previously mentioned, and she was ordered to repeat the friction with the Veratria whenever the pain returned; but it has, I believe, never since been found necessary.

CASE VII.

A lady, thirty years of age, has been for several years labouring under tic-douloureux, seated in the right orbit, and extending along the course of the frontal nerve as far as the top of the head. The paroxysms have been so violent as generally to confine her to bed for a day or two at a time, and have made their appearance with the greatest severity at the menstrual period, but in other respects she has all along been in the enjoyment of good health. She was ordered to rub the Veratria ointment, when the attack came on, over the whole surface occupied by the pain until relief was experienced: this she accordingly did on the first appearance of it: in a few minutes it was cut short, and never afterwards returned.

CASE VIII.

A gentleman, aged thirty-five, of a spare habit of body, subject to nervous feelings, and accustomed to sedentary occupations, has for the last seven years been seized with excruciating fits of pain, confined to the right half of the head, and returning by regular paroxysms at the end of about every third week. A short time before each attack comes on, he suffers much from restlessness and irritability, his pulse becomes augmented in frequency, and he complains much of impairment of memory; and after it has ceased, he does not return to his usual state of health for two or three days.

For this affection he was directed, during the paroxysm, to make use of frictions with the Veratria ointment, of the usual strength, over the seat of the pain; he first applied it to the forehead, and one rubbing was all that was requisite to remove the pain in that situa-
tation, but it still continued unabated in violence in the remainder of the affected region: to this part he was also ordered to apply the ointment; and the pain there, in like manner, yielded to one application: no return of the symptoms has taken place, and he is now in good health.

Along with the hemicrania, there existed in this patient a considerable degree of irritability of the heart; but a few frictions with the same ointment, made over the left side for five minutes every night, along with an occasional aperient pill, sufficed to remove this symptom permanently.

CASE IX.

Mrs. F., about thirty-eight years of age, had for the period of four years suffered from intense pain, confined to one spot in the loins, and which was not increased by motion. It came on in paroxysms, so frequent in occurrence, and of such duration, that she never experienced a longer interval than two days betwixt them; and her sufferings were augmented to such a degree during the period of gestation, that she was compelled to confine herself to bed for a great part of the time.

To bring about the removal of this affection, the patient had previously submitted to bleeding, generally and locally; and blisters, tartar emetic ointment, frictions with stimulating embrocations, along with plasters of various kinds, but without in any degree alleviating the pain: she had also taken internally almost every medicine calculated in any way to procure an abatement of the disease, but still no relief could be obtained.

When this patient first put herself under treatment, several of the remedies previously had recourse to were again employed; and along with these, frictions with croton oil were ordered over the seat of the pain, until a free eruption came out, but without effect. As a last resource, the Veratria ointment made with twenty grains to an ounce of lard, was directed to be applied in the usual way, and in a very few minutes every vestige of the pain had disappeared. She has been since entirely free from it, and is now in the enjoyment of the best health.

CASE X.

A young lady, about twenty-four years of age, has been affected with most violent pains in the loins and thighs, during the menstrual period, for about eight years. The pain has in general continued, without intermission, for three days, and has then subsided of its own accord.

Many attempts have been made in this case to effect a cure; the patient has taken opium, preparations of morphia, Dover's powder,
and other sedative remedies, but without experiencing any permanent benefit; for at each monthly period the pain has manifested itself with the same severity as before. From the effects which the Veratria had been already observed to have upon similar diseases, an ointment made with twenty grains of the alcaloid to an ounce of lard, was directed to be made use of over the loins, with the effect of immediately removing the pain, and it has not again returned.

CASE XI.

The eleventh case happened in a lady about thirty-three years of age; and except that the disease had in this instance continued for nine years, its previous history, course, and termination, were so precisely similar to those of the preceding case, that any more particular relation appears unnecessary.

CASE XII.

An elderly gentleman, rather corpulent, and of sedentary habits, had suffered severely for nine months from a fixed pain seated in the lower part of the spine. It had continued during the whole time almost without intermission, and at last nearly prevented him from remaining in the erect posture. The Veratria ointment was directed to be rubbed over the affected part, and immediately removed the pain; the patient was, however, ordered to apply the frictions, night and morning, for two weeks, to prevent a return, and he has since had no symptoms of the complaint.

CASE XIII.

Mrs. A., a middle-aged lady, has suffered severely for about five years from a painful affection in the situation of the os coccygis, which is much increased by sitting, or riding on horseback. For the cure of this disease, she has been under every variety of treatment, both internal and external, and has spent much time at the principal watering-places, but the pain has continued. She was directed to make use of friction with the Veratria ointment over the affected part, and the first application afforded complete relief. At the end of twelve hours the pain again came on, but was a second time as easily removed; and as there seemed to be a tendency to a recurrence of the symptom, the ointment was ordered to be repeated night and morning, until the disease had ceased again to appear. In the course of ten days the patient was quite well, and has since continued to be so.
External Application of Veratria in Rheumatism.

From what has been said in the foregoing chapter on the subject of the external employment of Veratria in neuralgia, it will not be requisite to introduce here any further remarks, except such as are exclusively applicable to the effect produced by it upon rheumatism in its various forms.

In the acute form of the disease, the Veratria ought not to be employed, if there be active inflammation going on in the affected parts; as it is much better to treat the acute symptoms in the usual manner; but when these are on the decline, the ointment may be had recourse to with advantage.

From the extent of surface affected in acute rheumatism, and from the quantity of ointment which is on that account required for the friction, the proportion of Veratria ordered in the prescription should not be so great as in the diseases already treated of; for in this, as in other affections, the strength of the ointment should always bear a certain relation to the space over which it is to be applied.

In cases where the rheumatism is general, or where it is seated in several joints at the same time, ten grains of Veratria to an ounce of lard will make an ointment sufficiently powerful for every purpose;* but where it is confined to one or two joints, or where it has assumed the chronic form, the quantity employed may be varied according to circumstances, from ten to twenty or more grains, and the friction may be continued in either case as long as the patient can bear it; or if it be requisite to specify a fixed portion of time—as a general rule, it may be stated, that in the earlier stages of the disease fifteen minutes, and in long standing examples twenty, will be enough to remove the existing pain.

When the case to be treated is decidedly chronic in its nature, much perseverance is requisite, particularly if extensive organic changes in the parts have taken place; the best directions are, to rub the affected joints every night for the time specified, until the pain has disappeared; and at any future period, when from change of weather, or other cause, it again returns. In slight acute affections, arising from cold, one or two applications, continued until the heat and tingling manifest themselves, often effect a cure.

The directions which have now been given will, in most cases, prove sufficient to enable the practitioner to make use of the Veratria ointment in the more topical forms of rheumatism, as well as in those already pointed out; and little more appears requisite than simply to enumerate such as it may be applied in with the most evident advantage.

In lumbago, sciatica, rheumatic affections of the muscles over the

* In this form of the disease, it will be found advantageous to administer some one of the preparations of Veratria, already recommended, at the same time that the frictions are used.
chest, or in other parts, the symptoms may be relieved almost immediately by the first friction; and in more obstinate cases, a few more will, in general, have the desired effect.

CASE I.

Mr. G., a gentleman about forty-eight years of age, had been for some time subject to occasional severe attacks of acute rheumatism, affecting chiefly the joints of the extremities, and attended with a considerable degree of general fever. For several days before he came under treatment he had been labouring under very acute symptoms of the disease; he had had a good deal of fever, a quick throbbing pulse, much heat of skin, and the joints of the elbows, wrists, knees, and ankles were swollen red, and so very painful as to render motion to any extent impossible.

In this case the most active measures had already been put into practice. Venesection had been freely employed, he had used large and repeated doses of purgatives, of various diaphoretic medicines, and colchicum; and along with these means the antiphlogistic regimen had been carefully pursued since the commencement of the attack, but no abatement in its violence had taken place.

As everything likely to effect a cure in the usual way appeared to have been resorted to, the previous internal treatment was ordered to be persevered in, and at the same time an ointment, consisting of ten grains of Veratria and an ounce of lard, was directed to be rubbed upon the affected joints, for ten minutes at night, and again the following morning. When the patient was visited next day, his rheumatism was nearly gone. The ointment had occasioned a considerable increase in the heat of the parts, but the inflammation and swelling were greatly diminished, and the pain almost removed; he could now use the affected joints with perfect ease, and there was no return of the symptoms for some days. He then experienced a slight renewal of the complaint in one of the ankles; and at the very first appearance rubbed the ointment, of his own accord, over the inflamed surface for the usual time, but although it produced sensations of heat and tingling as usual, yet no amelioration of the pain took place: the friction was therefore ordered not to be repeated till twelve hours had elapsed, and at the end of that period one application entirely removed it.

CASE II.

A boy, twelve years of age, and of a delicate habit of body, had been labouring for three or four days under an attack of acute rheumatism, attended by a good deal of febrile excitement; the pulse was quick, the skin hot, and the tongue dry, and slightly furred; both his ankles and knees were swollen to a considerable degree,
had a red and inflamed appearance, and could not be moved, on account of the pain.

On the second day of the disease, leeches and fomentations had been applied to the affected joints, and internally he had taken colchicum and diaphoretics, but with very little benefit. He was therefore ordered to have an ointment made with twenty grains of Veratria to an ounce of lard, freely rubbed over the seat of the pain, for about fifteen minutes at bed time.

Next morning the patient was almost well. During the night the pain and fever had disappeared, and he could walk about and move his limbs with perfect ease; the inflammation and swelling had to a great degree subsided, and the joints were restored to nearly their natural appearance. In two days afterwards, although the ointment had been only once applied, no trace of the affection was left.

CASE III.

Mr. G., forty-five years of age, and of a robust constitution, was in consequence of exposure to cold and wet seized with a rheumatic attack, which was confined to the knee and ankle of the right side, and accompanied with some degree of fever; he was ordered on the evening following the accession of the disease to take antimony combined with calomel; but next day the symptoms did not appear at all to have diminished. The affected joints were swollen, inflamed, and painful, and the quickness of pulse, and heat of skin still continued the same.

Part of an ointment made with twenty grains of Veratria to an ounce of lard, was now directed to be rubbed over the seat of the pain for the usual time; and on the morning after the first application, the patient could walk about the house; the pains, inflammation, and swelling had almost disappeared, and the febrile symptoms were gone: by continuing the same treatment for two days longer, he was able to follow his business, and no relapse afterwards occurred.

CASE IV.

Mr. S., a stout gentleman, aged about fifty, had been in the early part of his life much exposed to cold and moisture, which brought on an attack of lumbago, and since that time he has had many returns of the disease. In addition to this, he has also been affected with chronic rheumatism, confined principally to the joints of the hip and knee of the left side. The motion in both is very much impeded; over the hip-joint there is an evident fullness, and when any extensive movement is impressed upon it there is a distinct crackling noise elicited, and a similar feeling is communicated to the patient.

The knee is also the seat of considerable swelling, and pain which
is increased by pressure, but particularly by attempts at motion, and the same noise and sensation are present when it is bent and extended as in the hip-joint. The swelling in both situations is white in appearance, puffy, and somewhat elastic. The sufferings of the patient are much aggravated by change of weather; and attempts at motion in the affected joints are attended with so much pain that he is compelled, in walking, to lift the whole extremity without bending it, by exerting the muscles of the opposite side.

For the removal of the disease, he had previously resorted to most of the remedies in common use. Besides having taken internally every thing that appeared likely to afford relief, he had employed to the parts themselves, bleeding, counter-irritation by means of blisters, &c., and embrocations of every kind; all of which had failed in procuring any other than a temporary abatement of the symptoms.

Under these circumstances this case first presented itself, and with the view of giving a fair trial to external applications, the affected parts were ordered to be rubbed with eron oil twice a day, until a very free eruption came out, and this plan was followed with considerable success for about six weeks, during all of which time the irritation was kept up by repeated frictions with the oil. Even this, however, at last began to lose its effect; and the pain, which had at first diminished considerably, now appeared to be rapidly on the increase, and as there was no objection to the application of the Veratria, it was prescribed.

An ointment made with twenty grains of the alcaloid to an ounce of lard, was ordered to be rubbed for twenty minutes twice a-day over the knee and hip of the affected side; and after it had been made use of a few times, the troublesome symptoms began to decline. The pain went quite away, and the swelling and the rigidity became rather less: so that at the end of ten days or a fortnight, the patient could bend both the diseased joints, and could walk almost without inconvenience. The disease itself is, of course, not removed; but he can now take exercise on foot, and move the articulations with freedom.

In changeable weather a slight return of the pain sometimes takes place, but this is at once removed by rubbing the part with the ointment for a few minutes; and the patient is now in a comfortable condition.

CASE V.

Mr. B., a gentleman about forty-five years of age, was seized two years ago with an attack of rheumatism which terminated in a chronic affection of the joints of the right arm and hand. He experienced great difficulty in making use of the muscles of the shoulder from the pain which always attended upon any efforts at motion: the elbow-joint was stiff and painful, and he was obliged to carry the fore-arm in a sling. The articulations of the fingers were
swollen, and also gave pain on motion, so that the patient could not use them in writing; but had been, in consequence, in the habit of employing the left hand for that purpose.

This patient had previously applied many remedies, without obtaining benefit from them, and he was now ordered to rub the affected joints twice a day with the Veratria ointment; and in a day or two all uneasiness had left the shoulder and elbow, and he could now move the arm with facility. The disease in the joints of the fingers was also much relieved, but the swelling appeared nearly the same; he was directed to continue the application of the ointment to them occasionally, until it produced some effect. He returned at the end of about six weeks, and at that time the pain and swelling had disappeared, and he had recovered the entire use of the hand.

CASE VI.

Mrs. P., about fifty-two years of age, has been for the last twelve years affected with chronic rheumatism in the joints of the inferior extremities, but particularly in the hip and knee of the right side. Her sufferings for a considerable time have been augmented by variations in the state of the weather; and, for the last five years, the joints in which the disease is situated have been so painful and rigid, as to oblige her to make use of supports in walking; the knee is much swollen, and gives a sensation of crepitus when moved.

In the previous treatment of this case also, remedies of every description had failed to do good; and in order to try the effects of the Veratria, it was directed to be rubbed on twice a day in the usual manner, and to be persevered in for some time. At the end of a fortnight the symptoms were much relieved, and she could move the limbs with some degree of ease; she went on improving, and after six weeks could walk three miles at a time with little difficulty, and without support.

CASE VII.

Mr. K., a gentleman thirty-five years of age, has been the subject of repeated attacks of lumbago, for several years, and the pain has occasionally been such as to confine him to bed for a fortnight at a time. When the disease first made its appearance the patient was bled and blistered repeatedly, and took many remedies internally, but particularly colchicum, and these means were always followed by relief.

During the two attacks which had occurred previously to that in which the Veratria was used, he had supplied sinapisms to the seat of the pain, and taken large doses of colchicum, with the effect of removing the symptoms; but not till the plan had been continued for about three weeks.
One evening he had a return of the affection, and when visited next day, he was lying in bed in great pain, and could not be moved in any direction. An ointment, made with twenty grains of Veratria to an ounce of lard, was immediately ordered to be rubbed across the loins for fifteen or twenty minutes, and to be repeated at night; and in the event of the second friction failing to procure relief, he was directed to take fifteen grains of Dover's powder, with thirty-eight drops of vinum colchici, at bed-time; this last prescription, however, he did not find it requisite to make use of, and next day he could move himself about freely, and without experiencing any pain. To guard against a recurrence, he persevered in the use of frictions night and morning for a few days; he then discontinued them, and has since been quite free from the complaint.

CASE VIII.

This case was one of severe sciatica, occurring in a gentleman about thirty years of age, and bearing a considerable resemblance in its history to the foregoing: the previous treatment pursued was much the same, and in like manner freed the patient from the existing attack; but did little towards establishing a permanent cure. The Veratria ointment in one application removed the pain, and in a few more completed the recovery of the patient.

CASE IX.

A gentleman, thirty-three years of age, had, about eight years ago, an attack of acute rheumatism, during which the larger joints became affected, and after the violence of the disease had been subdued, there still remained a degree of pain and swelling around the articulations of the tarsus and ankle, of both sides; and to these symptoms there has latterly supervened so much rigidity as to disable the patient almost entirely from walking. When an attempt at motion is made, he is compelled to raise the feet from the ground without bending the ankle joints, and he experiences great pain in pressing upon the ball of the great toe.

In this case, the patient was directed to rub the Veratria ointment over the diseased parts twice a day; at the end of a fortnight the pain was gone, and the attack completely removed.

External Application of Veratria in Gout.

In the treatment of gout, Veratria, both internally and in the form of friction, is a remedy of considerable power. When administered by the mouth, its action upon the disease is not at all unlike that of colchicum, but rather more mild; and in cases where
the affection appears to be more general in its nature, much benefit will be found to arise from its exhibition in this manner, as well as from the ointment. During the height of an acute attack, the friction should not at once be resorted to; for in this disease, as in rheumatism, the local remedy will be found most advantageous after the violence of the constitutional symptoms has been removed, by other treatment: in some instances, however, it has been of much service when made use of at the time an attack was threatened, by warding it off, or making the subsequent stages less severe.

The general directions for applying the Veratria ointment in gout, are nearly the same as those already given for its use in rheumatism. Fifteen or twenty grains of Veratria to one ounce of lard, will be sufficient to begin with, and the friction should be continued until the tingling sensation be freely produced: indeed, the quantity of ointment used, and the duration of the friction, are of little moment without attention to this circumstance.

In a late work, Sir Charles Scudamore has made some very judicious remarks on the effects of Veratria ointment, and on its manner of application in gout. His experience, in most essential particulars, confirms what I have myself observed, and as illustrations of the utility of the remedy, I shall avail myself of three of the cases he has given, and shall here insert them.*

CASE I.

"A lady, aged forty-four, subject to severe attacks of regular gout, in an unusually severe paroxysm, derived great benefit from the internal medicines which I prescribed; but she remained entirely lame, from the tender, swollen, and rather painful state of the ankle-joint and foot. I directed the Veratria ointment, in the strength of ten grains to the ounce; and the good effects of the application were very quickly shown. She described that she was in considerable pain at the commencement of the friction, but that it abated at the end of twenty minutes, and was exchanged for strong prickings like those from electric sparks, and a remarkable warmth, rather agreeable than the contrary. These sensations lasted about an hour. On the following morning the swelling of the ankle and foot was much reduced, and allowed of standing. A further perseverance with the remedy proved very beneficial; and this lady, by means of it, and further general treatment, recovered in the most favourable manner."

CASE II.

"A gentleman, aged sixty, one of the greatest martyrs to gout that I ever saw, was seized with sciatica and lumbago, at the same

* Principles and Treatment of Gout, 1835.
time that he was affected with sharp gout in the knee. There was much error in the state of the biliary system. I prescribed mercurial evacuants, sudorifics, and sedatives. After six days of this treatment, although improved in his general condition, he complained of continued suffering from the sciatic nerve, and great, though not equal, distress from the knee. The Veratria ointment was rubbed in upon each affected part. It produced the sensations of heat and electric-like prickings for nearly an hour, and very decidedly relieved the complaint. It was repeated three or four times with complete success. The skin became irritated, as if by a strong rubefacient, but no sore followed. The patient was highly gratified by the effects of the remedy."

**CASE III.**

"Another patient, too anxious for the quickest relief, used the remedy on the second day of an attack of acute gout in the foot, the part not being so exquisitely tender as to prevent moderate friction. Active evacuants had been taken at short intervals with full effect. The proportion of the Veratria was ten grains to the ounce. No particular sensations ensued from the friction, and no apparent benefit resulted. Five grains of Veratria were added, and the friction was followed up for a longer time. Now the patient became very sensible of the peculiar sensations before mentioned. On the following day, there was a very manifest abatement of the gout; and the patient acknowledged the improvement. In conjunction with its further use, I prescribed the mild colchicum aperient draught and alteratives. The recovery was uninterrupted, and a favourable convalescence was established in the course of a fortnight."

**External Application of Veratria in Dropsy and Paralysis.**

Besides the diseases mentioned in the preceding chapters, I have employed the Veratria ointment in two others, Dropsy and Paralysis. In my account of Veratria, several cases of these are mentioned in which friction with the ointment appeared to have been of great service; but although the Veratria most certainly acts as a diuretic, as well as a powerful stimulant of the nervous system, subsequent consideration has made it appear doubtful whether or not the amount of effect produced, was not augmented by the other treatment pursued at the same time. The subject, however, is open to investigation, and on this account I shall give such general directions for the use of the ointment in these diseases, as may be sufficient for such as may wish to try its effects, leaving it to future experience to decide upon the utility of the treatment.

In dropsical cases it is indispensably necessary before the Veratria be applied, that every attention should be paid to all the organs, upon a derangement of which, either in structure or friction, the
effusion may depend, otherwise the anticipated effects may not be produced.

If, after a careful examination, nothing wrong, of importance, can be detected, the ointment may then be had recourse to; but if the contrary be the case, the diseased state, whatever that may be, should, if possible, be first removed, and then the treatment may be proceeded with.

The same rule before laid down, as to the relation which the strength of the ointment ought to bear to the extent of surface over which it has to be rubbed, and to the state of the patient, must here be kept in mind. But as the frictions should, if possible, be made over the whole surface under which the effusion exists, and as this must vary with the situation and extent which it occupies, it is evident that no prescription applicable in every instance can be given, except that the quantity of the ointment rubbed in each time, should not, in adults, contain less than two, nor more than four or five grains of Veratric; and the friction should be continued for about twenty minutes, and repeated once or twice a-day. If the plan of treatment is to be of service, the diuretic effect will probably show itself in a few hours, and the repetition of the friction must be regulated by the effect produced.

As an illustration, the following case may be introduced, leaving it for others to judge whether the rapid disappearance of the watery effusion was the result of the large quantity of diuretic medicine the patient had previously taken, or whether it arose from the action of the Veratric.

J. Burnell, Esq., of Theresa Lodge, Pocklington, near York, aged thirty, came under treatment in the summer of 1830. About a year previously, he was attacked with ascites, which proved so very obstinate that, although he was put under almost every plan of treatment which could be devised by his medical attendants, during nearly the whole time, the disease suffered no abatement, but on the contrary appeared to be increasing rapidly. At the time he presented himself, the dropsy had become general; his lower extremities and serotum were swollen to an enormous size; the abdomen was completely distended with fluid; and the organs within the chest were much impeded in their functions. There was great difficulty of breathing, attended with cough and slight watery expectoration; the pulse was small and intermittent, and the patient was unable to remain in the horizontal posture for one minute, without experiencing the most distressing sense of suffocation; the distension of the legs increased to such a degree that serous fluid oozed from them; and altogether, the case was one of the most severe ever witnessed.

The previous treatment of this case had been as active as possible; diuretics and drastic purgatives of almost every kind had been employed, without producing any other effect than weakening the patient; and a course of mercury, continued during some time, had been equally unsuccessful. The flow of urine was less than an En-

January, 1838.—E
glish pint in twenty-four hours; and could not by any means be made to exceed that quantity.

For six weeks after he came under treatment, the plan pursued was similar to the one already described. Mercury, squill, the acetate and super-tartrate of potass, digitalis, colchicum, spirit of nitrous ether, juniper, broom seed, &c. were all had recourse to without the slightest benefit, and the same want of success attended the exhibition of elaterium, gamboge, and other drastic purgatives; these last produced large watery stools, but without bringing about any apparent diminution of the swelling. There now appeared no hope of recovery: all the means likely to procure relief had been put in force, and had only added to the distress and debility of the patient, so that it became necessary to abandon them, and look out for some other means of cure.

In this emergency it was resolved upon to make trial of the Veratria externally, and a box of ointment, made with four grains of the alcaloid and an ounce of lard, was accordingly directed to be rubbed over the surface of the abdomen at bed-time. The whole quantity was applied; and in the course of the night, and following morning, the patient evacuated no less than eight pints of urine, which had caused a marked diminution of the swelling, both in the abdomen and extremities, and was attended with considerable relief to the breathing and circulation; but, along with these effects, the medicine had caused such an alarming prostration of strength as to render the administration of stimulants absolutely necessary, for three days before the ointment could be repeated; at the end of that time, when the patient appeared somewhat recovered from his weakness, a fresh quantity was prescribed, in which, however, a less proportion of the Veratria was used, owing to the violent constitutional symptoms caused by the first. On this occasion, two grains only were rubbed on, yet the diuretic effects were scarcely less marked than before; and these were again accompanied by a degree of debility which, although not so great as in the preceding instance, still made it a matter of necessity to repeat the stimulants, and to delay the third application for five or six days.

On both occasions, after the first effects of the ointment had subsided, the quantity of urine diminished considerably, but the swelling became daily less in magnitude, and the patient went on improving in a manner that could not have been anticipated. On the fifth or sixth day from the second rubbing, a third, with an ounce of ointment containing two grains of Veratria, was directed to be made use of, as before; and from this time the dropsy rapidly disappeared; the patient gained strength sufficient to enable him to take active exercise; and at the end of three weeks from the first application of the Veratria, he was completely cured, and has since had no return of the disease.

The only collateral treatment employed in this case, along with the Veratria, consisted in the daily exhibition of purgative medicine, not with the view of producing any change upon the disease by its
means, but only for the purpose of obviating the constipating effects of the remedy.

In paralysis, the Veratria is worthy of a further trial; but my late experience with it does not warrant the assertion that it is a decidedly useful remedy. In partial paralytic cases it might be used, and probably with some degree of advantage, but in severe cases it appears to be of as little service as other remedies.

The friction ought to be made along the course of the affected nerves, two or three times a day, until the tingling is produced; but, as a general direction, fifteen or twenty grains, to an ounce of lard, will be strong enough; and frictions of ten to twenty minutes' duration each, will be sufficient for the purpose of giving it a trial. The tincture of Sabadilla, however, is a much better remedy and certainly deserves the preference.

Properties of the Constituents of the Veratria of Commerce.

It has been already stated, that M. Courbe has succeeded in obtaining four alcaloids from the Veratria of Commerce, viz., Veratrine, Veratrin, Sabadilline, and the Mono-hydrate, or Gum Resin of Sabadilline; we have also described the processes by which these substances may be procured separately, and shall now give a few further particulars of their history and properties.

Veratrine.—M. Courbe considers Veratrine as the pure active principle upon which the properties of Sabadilla seeds depend. It is white, solid, and friable; insoluble in water, but very soluble in alcohol and ether, and forms crystallizable salts with acids. Its medical properties, may be considered precisely similar to those of Veratria.

Veratrin.—This substance has a brown colour, it is insoluble in water, and differs from the preceding in being insoluble in ether. It is soluble in alcohol; with nitric acid, it forms oxalic acid. Its medicinal action has not been tried, but may be inferred to be similar to that of Veratria.

Sabadilline.—When in a state of purity, Sabadilline is white and crystalline; it is very acrid to the taste, it is completely soluble in water and in alcohol, but insoluble in ether; it combines with sulphuric acid, and forms a crystallizable sulphate. It is distinguished from Veratria by its solubility in water, by its insolubility in ether, and by its forming crystals. The Sabadilline which I have employed, is in the form of a fine light brown powder, and not so pure as that obtained by M. Couerbe. In this state it is very soluble in water and alcohol, but insoluble in ether, and has the following properties.

Its taste is acrid but not bitter, and it produces a slight sensation of cold when first applied to the tongue; when applied to the nostrils it irritates the mucous membrane and occasions sneezing, but not so violently as Veratria. When administered internally in the dose of one-sixth part of a grain, every two hours, it gives rise to effects very similar to those produced from the administration of
Veratria and its salts, though in a much less degree. It excites a little heat in the stomach, but does not act upon the bowels, and after several doses have been taken it occasions sensations of tingling in the extremities, but very slightly. Internally it has effects on disease similar to those of Veratria, but it is much inferior as a medicinal agent.

When used in the form of embrocation or ointment, Sabadilline has more powerful effects. It excites a peculiar feeling of heat and pulsation in the part where it is rubbed, and this is accompanied by a sensation, as if the part had been severely bruised, which continues often for some hours.

The ointment employed may contain from fifteen to twenty grains to an ounce of lard, and may be rubbed for fifteen or twenty minutes, or until the heat and pulsation show themselves; sometimes a slight eruption comes out on the skin where it is rubbed, but it is not attended with an inconvenience. I have used the ointment of Sabadilla in friction, in neuralgic affections, and in rheumatism, gout, &c. Its effects are similar to those of Veratria, but not so beneficial. It cannot, however, be said that the remedy has had a fair trial, as very little of it has as yet been made, and what I have used has not been in a state of purity.

Mono-hydrate of Sabadilline differs nothing in general character from Sabadilline, except that it has a yellowish colour, and is incrystallizable; it has nearly the same chemical constitution, and indeed M. Courbe considers the two substances as differing in nothing, except that Sabadilline has two atoms of water of crystallization, whilst the mono-hydrate has only one. From their similarity in these respects it may be inferred that they have similar medical properties, although the mono-hydrate has not hitherto been used.

The only thing connected with this part of the subject which remains to be noticed, is the use of the salts of Veratria externally. Several of these have been employed, and appear to be possessed of effects very similar to those of the base itself. Either the sulphate, acetate, or tartrate, may be used, in the proportion of from ten to fifteen grains to an ounce of lard; they make an ointment that occasions a powerful sensation of heat and tingling, when rubbed upon the skin, and may be resorted to, and perhaps with advantage, when Veratria, as sometimes happens, has become less efficacious from continued use.

CHAPTER II.

Medicinal Employment of Delphinium Staphisagria, and its Active Principle, Delphinia.

Stavesacre, a biennial, Polyandria Trigynia, Linn. Ranunculaceæ, Juss. Maltisiliquæ, Linn. a native of the south of Europe.
The Delphinium Staphisagria, and its active principle Delphinia, are the next substances possessed of properties similar to those of Veratria, of which I shall give an account. The seeds of the plant are the part used in medicine; they are of the size of small peas, triangular, and sometimes four sided; they are rough, wrinkled, and slightly curved, dark coloured externally, and yellowish white within; their smell is disagreeable, and their taste bitter, acrid, and burning.

Stavesacre seeds in some quantity, act upon animals as an acrid irritating poison; their effects are chiefly confined to the mucous membrane of the stomach, in which they sometimes excite inflammation; but the nervous system appears to suffer most, especially if death come on soon after the poison has been administered. In the human subject, when taken internally, they excite vomiting and purging, and act also as general irritants and sialogogues.

Stavesacre was at one time employed as a cathartic and anthelmintic, but is now laid aside, on account of the violence of its effects. It is still, however, used externally in infusion for the treatment of skin diseases, particularly scabies, and, in powder or ointment for destroying pediculi. In the form of a concentrated tincture, I have employed it as an embrocation in the treatment of rheumatic affections, with considerable advantage. It causes sensations of heat and tingling, very similar to those arising from the use of Veratria, and should be rubbed until these effects show themselves.

Preparation of Delphinia.

Delphinia was discovered in the seeds of the Delphinium Staphisagria, by MM. Lassaigne and Feneulles, in the year 1819.* It may be obtained by several processes, but that recently given by M. Couerbe appears to afford the purest result. It is as follows. A saturated tincture of Stavesacre seeds is to be evaporated to the consistence of a thin extract, and treated with water, acidulated by sulphuric acid: this solution, when filtered, is to be precipitated by ammonia. The precipitate, after being freed from its water, is to be taken up with alcohol, and again reduced to the consistence of extract, which is likewise to be dissolved in acidulated water; to this solution, when filtered, a small quantity of nitric acid is to be added, as long as any precipitate falls: the liquid freed from this precipitate is again to be thrown down by ammonia, and the powder dried. This is the Delphine of Commerce; but, like Veratria, it is a compound substance, and consists of resinous matter, Staphisaire, and Delphine: the Delphine is separated by treating the powder with ether, which takes it up and leaves the Staphisaire.

When in a state of purity, Delphinia is white, pulverulent, and without smell; but, like Veratria, when applied to the mucous membrane of the nose, it occasions sneezing, along with an abun-

* Annales de Chimie, tom. xi. xii. 5*
dant secretion of mucous; its taste is at first bitter, and afterwards acid; and it acts upon animals in the same manner, but more ener-
ggetically than the seeds from which it is prepared.

When heated it melts, and somewhat resembles wax in appear-
ance; and on cooling, it becomes brittle like resin. It is very
sparingly soluble in water, but yet in sufficient quantity to commu-
nicate a bitter taste to the fluid. In alcohol and ether it dissolves
readily, and these solutions have the property of rendering syrup
of violets green, and of restoring the blue colour of litmus, when
reddened by the addition of a portion of acid. It combines readily
with acids, and forms neutral salts, which are possessed of much
bitterness and acridity, and it may be precipitated from solutions
of these in the form of a jelly, by the addition of an alkali.

Internal Administration of Delphinia and its Salts.

Pure Delphinia has little effect upon the mucous membranes of
the stomach and bowels. It may be administered in some cases to
the extent of three or four grains a day, in doses of half a grain
each, without exciting vomiting; in this quantity, however, it
sometimes operates upon the bowels, but causes very little irrita-
tion. In most instances it acts as a diuretic, and occasions a con-
siderable flow of pale urine. When taken to the extent of a few
grains, it gives rise to sensations of heat and tingling in various
parts of the body, similar to those which are produced by rubbing
it upon the skin, and its other effects are very nearly the same as
those of the salts of Veratria. The salts of Delphinia act much in
the same manner, but there is nothing to give them a preference to
the alcaloid itself; both have been used in the same diseases as the
preparations of Veratria, and appear to exercise a similar action.

External Application of Delphinia.

Delphinia, when in a state of purity, is entirely soluble in al-
cohol and ether; but neither of these circumstances can be relied
upon as a test of the efficacy of the medicine; for, like Veratria, it
may have the appearance of being almost chemically pure, and yet
be possessed of little activity in the removal of the affection, for
which we may wish to apply it. The test already laid down, with
regard to Veratria, is the one which should in this instance be re-
sorted to; namely, that unless a solution of Delphinia in alcohol, in
the proportion of four grains to a drachm, occasion a distinct sensa-
tion of heat and prickling, when rubbed for three or four minutes
upon the forehead, the specimen ought not to be used, for if this be
not attended to, no beneficial effect will arise from its application.

There are a few points in which Delphinia differs from Veratria,
in its action upon the skin, which require to be shortly noticed.
Veratria, when rubbed upon the cuticle, produces a strong sensa-
tion of tingling, or rather a feeling similar to that produced by re-
eriving a succession of small electric sparks on an uncovered part of the body; whilst Delphinia gives rise to a sensation of burning, not unlike that which manifests itself a short time after the application of a blister; but not to an unpleasant degree, unless the friction have been carried too far. They differ also in the duration of the effect produced, as that caused by Delphinia is generally more powerful and durable than when Veratria is used.

In the great majority of instances, Veratria may be rubbed upon the skin for the usual time, without causing any great degree of redness on the part; but in almost every case, a blush pervades the surface, over which the Delphinia has been applied, and this continues during a length of time, varying from a few minutes to an hour or two, but in no instance, as yet observed, has it gone on to eruption. This property of stimulating the capillaries of the surface of the skin, may add much to the power of Delphinia, particularly in paralytic cases.

So far as the comparative merits of the two substances have been examined, they appear to be of nearly equal value as medicinal agents, for in most instances they seem to have the same power in removing similar diseases. There are one or two particulars, however, in which they differ, and which in certain instances may give a preference to the Delphinia. The diseases in which it has been chiefly employed, are tic-douloureux, paralysis, and rheumatism. In the first of these, when the affection is seated in the tongue, or at the point where the infra-orbitary nerve escapes from its foramen, the use of the Delphinia is to be preferred, because it can be applied to the tongue, or rubbed on the gums without occasioning irritation of the mucous membrane, a circumstance of great importance in the treatment of these forms of the disease. It appears also, upon the whole, better adapted to the treatment of paralytic cases than the Veratria, but principally on account of the property just mentioned, which it possesses, of exciting the circulation in the diseased part.

The manner of applying Delphinia is the same as that already recommended for Veratria. It may be used either in the form of ointment, or in solution in alcohol, and the proportions to be employed in either case, may vary from ten to thirty or more grains to the ounce, according to the severity of the affection, in the treatment of which it is to be prescribed. The duration of the frictions, also, should be nearly the same; that is to say, from ten to twenty or more minutes, or what is better, until the pungent sensation produced by the rubbing shows itself. In short, the two substances are so nearly alike to each other in their effects upon the system, and in the manner of their application, that the instructions which have been already given in regard to Veratria, are equally applicable to Delphinia, except that the latter may be with safety applied in affections seated in the parts within the cavity of the mouth. For this purpose a solution in alcohol is preferable, as being less objectionable on the part of the patient, and it ought to be rubbed
upon the mucous membrane, over the seat of the pain, until this be removed, or at least until the peculiar sensation produced by it be as powerful as can be borne; and the friction should be repeated two or three times a-day, according to circumstances.

As an illustration of the action of Delphinia in removing disease, the following case has been selected. It is also interesting, as in its treatment both remedies were resorted to; and because it proves the utility of frictions with Delphinia when employed within the mouth.

**CASE.**

Feb. 8th, 1834.—Mr. J. Sears, Bride Terrace, Liverpool Road, Islington, aged 60, was about seven years ago seized with an acute pain seated in the course of the frontal nerve, on the left side; about four years since the affection extended itself to the infra-orbital nerve, and for the last twelve months the portio-dura has also become the seat of the disease. Since the commencement of the attack the pain has continued with great severity, and with occasional intermissions of a day or two, but the sum of these has not amounted to above a month in the year.

All attempts which had been made to give him relief had failed, and for three years he had been compelled to relinquish his occupations, on account of the severity of his sufferings. For three weeks before he came under treatment, he had of his own accord made use of frictions with the Veratria ointment over the seat of the pain, and he states that under its influence he has experienced considerable relief, and that at times he is quite free from pain, although the disease is not yet subdued. He was ordered to continue the frictions whenever the pain showed a tendency to return, with the following ointment:

R.—Veratriæ... . . . gr. xvi.
Axung. . . . 3 ss. M. ut fiat unguent.

13th.—The patient has made use of the ointment as directed, and the pain has now disappeared from the temple, eyebrow, and side of the face, with the exception of a point exactly over the infra-orbital foramen, where it still continues severe, and from whence it occasionally darts to the other parts which were previously affected.

As the progress made since he was last seen was so far satisfactory, in order to try the comparative effects of the Veratria and Delphinia, he was ordered to discontinue the former, and to use in the same manner the following:

R.—Delphiniae... . . . gr. xvi.
Axung. . . . 1/2 ss. M. ut fiat unguent.
EMPLOYMENT OF THE GENUS ACONITUM.

17th.—Since last report he has been improving, the pain in the seat of the infra-orbitary foramen has become less and less severe, and he is at present quite free from it. He was ordered to use the Delphinia ointment if the pain should return.

20th.—The pain has never appeared except at the point already mentioned. The same prescription to be continued, with this difference, that the frictions are to be confined as nearly as possible to the skin over the seat of the pain.

23d.—The patient is better to-day than he has yet been; there is still, however, a tendency to a recurrence of the pain; he was directed to discontinue the external use of the Delphinia, and instead of it, to rub a portion of the same ointment inside of the mouth, along the angle formed by the gum and cheek, as nearly as possible to the situation of the infra-orbitary foramen, and to continue the friction until the pain was removed, or as long as the application could be borne.

25th.—The friction occasioned no irritation in the mucous membrane; it gave rise, however, to a sensation of tingling, accompanied with some degree of salivation, and the pain has almost disappeared. Yesterday the patient had no attack, but to-day it has slightly returned. He was ordered to use the frictions to the inside of the cheek and gum, when the pain showed itself, with the following ointment:

\[ R. - \text{Delphiniae} \quad \text{gr.} \ x. \]
\[ \text{Axung.} \quad \text{ii.} \]
\[ \text{M. ut fiat unguent.} \]

March 11th.—The last prescription was not made use of, as the patient has continued to be quite well. The slight pain he experienced when last seen, disappeared of itself; and with the exception of a little feeling of uneasiness, which lasted only a minute or two, he has had no symptom of his former disease. He has resumed his employment after an interval of three years—has exposed himself to drafts of cold air, and to all those causes which used formerly to bring on severe paroxysms of pain, but up to this date (June 1835) he has not had the slightest appearance of a return.

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CHAPTER III.

Medicinal Employment of the Genus Aconitum, and its Active Principle Aconitine.


The genus Aconitum has been divided by De Candolle into four
sections,—*Anthora, Lycocotonum, Cammarum,* and *Napellus.* Several species have been introduced into medicine in different countries, and at various periods. An unknown species appears to have been used by Avicenna, the celebrated Arabian physician, in the treatment of skin diseases; but since his time, down to a comparatively recent period, no further notice seems to have been taken of it. The person who may be said to have introduced Aconite into practice, was Dr. Störk; and he recommended its employment in the form of inspissated juice, prepared from the fresh plant, in the treatment of Gout, Chronic Rheumatism, Amaurosis, Syphilis, &c.*

Considerable difference of opinion has prevailed as to the precise species made use of by Störk. He himself names two:—the *Aconitum Napellus* and *A. Neomontanum.* The latter of these is the one determined by Willdenow; but De Candolle is of opinion that it is a variety of *A. Paniculatum,* to which he has given the name *Störkianum,* to distinguish it as the species employed by Störk. Besides these, however, the *A. Cammarum* and *A. Anthora* have found a place in several continental Pharmacopoeias.

Each of our Colleges has given a formula for the preparation of an inspissated juice from the fresh leaves of the monkshood; but in addition to this, the powder of the leaves, the wine and an alcoholic and two ethereal tinctures, are made use of on the Continent: all of these are employed internally, but are very inconstant in their operation, as might easily have been anticipated from their manner of preparation; and this circumstance shall be presently noticed. Very recently, M. Lombard, of Geneva, has recommended the use of an alcoholic extract of Aconite in the treatment of acute rheumatism, and has given a process for obtaining it. This, though a much less objectionable one than any of those above-mentioned, gives a product that is still inconstant in its effects; for he states that he has given with success from half a grain three times a-day, to a drachm and a half in the twenty-four hours.† It appears that there are several causes why the preparations of Aconite at present in use are liable to inconstancy; they are all prepared either from the fresh plant or from the expressed juice: in the first instance they must vary in power, according to the state of the plant, and the time when it is gathered; and the extracts made by evaporating the expressed juice must also vary, as in the very act of expression a change in the activity of the product appears to take place, and a still further alteration must ensue during the process of evaporation. I have tried several different extracts made in this way, and have found them almost inert. The process employed by M. Lombard consists in carefully evaporating the expressed juice of the plant, and treating the extract with alcohol; then filtering and evaporating the tincture with a very gentle heat. In this way, the active matter contained in the inspis-

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* Störk, Spielegium Observationum de Aconito, 1788.
† Gazette Médicale, Juin, 1834.
sated juice may be procured in a more concentrated form, but still the process is liable to some of the objections already stated.

Another objection to these preparations is, that they are all obtained from the least active part of the plant, for the root certainly contains a much greater proportion of the peculiar properties of the Aconite than any other part, and is consequently that which should be used. From these considerations, and from the difficulty of procuring the active principle, I was led to employ a tincture and alcoholic extract, prepared from the powder of the root carefully dried. The tincture is made by digesting one part by weight of the powder, in six parts by measure of strong alcohol, for seven days, and filtering through paper; and the dose for an adult ought not to be more than eight or ten drops three times a-day to commence with, but it may be augmented to twenty; beyond which, however, few patients will bear it to be carried. With regard to the extract, I have never exhibited it internally, but have employed it with great benefit in the manner I shall immediately mention.

When Aconite is administered internally, in any form, and in a small dose, it acts as a diuretic and diaphoretic, and accelerates the pulse: if it be pushed still farther, it begins to affect the nervous system, and occasions headache, nausea, weakness of the joints and muscles, slight confusion of intellect, and a remarkable sensation of tingling in various parts of the body, particularly in the head, face, and extremities. This latter circumstance was remarked by Dr. Duncan, jun., as always accompanying the relief afforded by the internal exhibition of extract of Aconite in cases of Sciatica.* If the dose be still augmented, aberration of mind, dimness of vision, and convulsive movements, come on. A few cases are on record, where such symptoms have shown themselves when the Aconite had been swallowed accidentally; and they have, in some of these, been followed by fainting, vomiting, stupor, and death.

The diseases in which Aconite has been administered, are chiefly those already enumerated; and I have also found much benefit from its employment in tic-douloureux, and other painful nervous affections; but from all that is unknown of its internal use, it does not appear that the benefit to be derived from this method of exhibition is at all to be compared with that which arises from its administration by the Endermic Method, either as regards the amount of effect produced, or the perfect safety with which, in this latter mode, it may be used.

Processes for preparing Aconitine.

There are three forms in which the Aconite may be employed externally, namely,—the active principle Aconitine; impure Aconitine, as contained in the ammoniated extract; and, thirdly, in the

* Edin. New Dispensatory, 1830.
form of tincture, or solution of the active principle in alcohol; and of these it is now proposed to give a short account.

M. Peschier, of Geneva, appears to have been the first experimenter who detected the presence of Aconitine, during a chemical examination of the *Aconitum Napellus* and *A. Paniculatum*: he describes it as a peculiar alkaline substance, capable of forming crystallizable salts with acids.\* It appears again to have been detected by M. Brandes, in the *A. Neomontanum*; but no particulars regarding it are mentioned. In 1825, M. Pallas described the Aconitine as an alkaline substance, which he had obtained in scales of a yellowish colour.†

In the year 1832, M. Geiger, from the result of his physiological experiments with different Aconites, came to the conclusion, that the acrid Aconites contained a narcotic substance different from their acrid principle; and this opinion led M. Hesse to analyse the *Aconitum Napellus*; and from this he obtained a peculiar body, to which he has given the name Aconitina. The process for obtaining it consists in precipitating a decoction of the dried leaves by hydrated magnesia, washing the precipitate with water, drying it, and then treating it with boiling alcohol, which dissolves the Aconitine and deposits it on cooling.‡

It is described as being incrystallizable, white and granular, or in a colourless mass, transparent, and having the lustre of glass. It is alkaline, inodorous, and has a bitter acrid taste. This acridity, however, does not belong to the Aconitine, but disappears if the base be several times combined with acids, and the salt formed decomposed. When deprived of this acrid principle, it is poisonous in the highest degree, a twelfth part of a grain being sufficient to destroy a little bird with the rapidity of lightning. Aconitine is very fusible: it is little soluble in water, but very much so in alcohol and ether. Its solutions are alkaline, and it neutralizes acids; but its salts are not capable of being crystallized. Such is the account of the substance obtained by MM. Geiger and Hesse; but the elementary analysis has not yet been accomplished.

I have made several attempts to obtain Aconitine from the Parisian chemists, for the purpose of employing it in medicine, but have never hitherto succeeded. It is now, however, prepared in town, and may be had in sufficient quantity for present use, by those practitioners who may wish to make trial of its properties.§ Either of the following processes will yield it: the first is the easier to manipulate, but the second yields a much purer result, and is upon the whole to be preferred.

A quantity of the fresh root of the *Aconitum Napellus* must be procured, and care should be taken that it be sound, and that the

\* Trommsdorff Neues Journal der Pharmacie, vol. 84.
† Journal de Chimie Médicale, tom. 1—193.
‡ Journal de Chimie Médicale, Août, 1834.
§ Aconitine is at present prepared by Mr. Morson, chemist, Southampton Row.
root be that of monkshood; for sometimes other roots are sold for it. Let it be carefully and cautiously dried, and then reduced to powder; this latter operation is not unattended by danger, especially if a part of the fine dust which rises from it be inhaled. One part by weight of the powder, and two parts by measure of strong alcohol, are to be digested together in a gentle heat for seven days, and the tincture, while warm, is to be filtered. It is then to be reduced to the consistence of an extract, by careful evaporation, at a low and well-regulated temperature; the object of this is to prevent the destruction or expulsion of the active principle, which would very probably ensue, if the temperature employed were higher than barely sufficient to carry off the alcohol. To the extract thus prepared, liquid ammonia is to be added, drop by drop, and mixed well with it, to precipitate the alcaloid; and in this part of the process care must be taken that too much be not added, as in some instances the product appears to have been decomposed by inattention to this circumstance. It is difficult to give a precise rule as to the quantity; but enough will have been added, if the extract give out the odour of ammonia, when stirred.

The mass now consists of impure Aconitine, mixed up with a quantity of extractive and other matters, soluble in water; and it may be taken up either with boiling alcohol, or sulphuric ether; or the soluble matter may be removed, by repeated washings with small quantities of cold water, which will leave the Aconitine. This latter process is the one we have generally employed, and is performed by pouring a little water on the extract, and mixing them carefully together, then allowing the undissolved part to subside, pouring off the fluid, and repeating the operation, as long as any soluble matter is taken up, a quantity of light brown or grey powder is left, which may be purified by subsequent solution in alcohol. This powder contains the active properties of the Aconite, in a high degree of concentration. A grain of it was dissolved in a drachm of alcohol; and twenty drops of the solution put into the mouth of a guinea-pig occasioned death in a few minutes. Other experiments have been performed, all of which prove the extreme energy of the substance.

The second process consists in dissolving the alcoholic extract, prepared as before, without the addition of the ammonia, in as much cold water as will take it up, and carefully decanting the solution from the insoluble part, and then filtering it. To the filtered solution liquid ammonia is to be added, drop by drop, as long as it occasions any precipitation. When the precipitate has subsided, the supernatant fluid should be carefully poured away, or drawn off by means of a syphon; and after the precipitate has been deprived of as much of the fluid as possible, it should be purified by a sufficient number of washings with small quantities of cold water, or, what is better, it may be dissolved in as much alcohol as will take it up, and the solution thrown into cold water; and the precipitate thus

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formed is to be carefully dried. The product obtained by this process is white.

External Application of Aconitine.

It has already been stated, that if a grain or two of Veratria or Delphinia be mixed up with a little lard, or dissolved in a drachm of alcohol, and a small quantity be rubbed upon the skin of the forehead or other tender part, a sensation of heat and tingling will be experienced, after the friction has been continued for a minute or two. If the same procedure be followed with the Aconitine, a similar result will be obtained. The sensations produced by the three substances differ, however, in a few particulars. When Veratria is employed, it produces a strong sensation of tingling or rather a sharp feeling, similar to that produced by receiving a succession of electric sparks on an uncovered part of the body; whilst the Delphinia gives rise to a sensation of burning, not unlike that which manifests itself a short time after the application of a blister, but not to an unpleasant degree.

The Aconitine is possessed of an action similar, in some respects at least, to that of Delphinia. When a small quantity of it, either made into an ointment, or dissolved in alcohol, is rubbed for a minute or two upon the skin, a sensation of heat and prickling is experienced; to this, succeeds a feeling of numbness and constriction in the part, as if a heavy weight were laid upon it, or as if the skin were drawn together, by the powerful and involuntary contraction of the muscles beneath. This effect lasts from two or three, to twelve or more hours, according to the quantity rubbed in. So small a portion as the one-hundredth part of a grain has produced a sensation that has continued a whole day; but the alcoloid, in this instance, was in a high degree of purity.

The action of the Aconitine upon the cutaneous vessels, appears to be less than that of either Veratria or Delphinia; for in no case hitherto observed, has it produced a greater degree of vascular excitement than might easily be accounted for by the friction itself; and in one instance where the Veratria ointment did occasion irritation, the Aconitine has been employed without giving rise to any. The diseases in which I have chiefly employed the Aconitine externally, are Tic-Douloureux and Neuralgic affections generally, and in gouty and rheumatic cases; and its success has fully answered the anticipations that had been formed of its utility. It may be employed in the form of solution in alcohol, in the proportion of one or more grains to the drachm, and in ointment, made according to the following prescription:

R. Aconitine, gr. ii.
   Alcohol, gtt. vi. tere optime
   et adde, Axung, ʒ i. ut fiat unguent.

The object of adding the alcohol, is to prevent the Aconitine from
forming a thick compound with part of the lard, which renders it difficult to make a proper ointment.

The proportion of the alcaloid in this prescription will, in general, be sufficient to begin with, but it may be augmented to four or five grains to the drachm, if necessary; and in one case of Tic-Douloureux of unusual severity, as much as eight grains to the drachm were prescribed with the most marked benefit. The best manner of applying the ointment, is simply to rub a small part of it over the whole seat of the affection, till the pain be either for the time removed, or until the full effect upon the cutaneous nerves above described be brought about; and the friction should be repeated three or four times, or more frequently in the day, according to the effect produced upon the disease. The proportion of the Aconitine ought to be increased at every second or third friction; and the same rule elsewhere laid down, in regard to the action of Veratria and Delphinia, also holds good in the present instance,—namely, that unless the friction occasion a full development of the peculiar impressions caused by the Aconitine when rubbed on the skin, no benefit whatever is to be looked for from its employment. It is almost needless to remark, that an application of such activity should not be resorted to, if there be the slightest abrasion of the surface of the skin, and that it should be carefully kept from coming in contact with any of the mucous membranes.

External Application of the Ammoniated Extract of Aconite, &c.

The next preparation that requires notice, is the ammoniated extract of Aconite; this is probably the best appellation for the substance, although it be in reality a mixture of all the active principles, along with extractive and other matters. It is made by evaporating very carefully, and at a low temperature, the tincture of the dried root of the plant, prepared as already directed in the process for obtaining the Aconitine, to the consistence of an extract. To every drachm of this, eight or ten drops of liquor ammoniac should be added; and after the mixture has stood a short time in a very gentle heat, to drive off the excess of ammonia, it is to be used in the form of ointment, according to the following prescription:—


This, from its dark colour, may be a less agreeable application than the Aconitine ointment: but it appears to me, to be at least as efficacious, and it has the advantage of being easily and cheaply prepared: and on these accounts it is better suited for hospital practice. The proportion of the extract may be increased two or three-fold, according to circumstances.

When this ointment is rubbed upon the skin, it occasions sensations in the part, similar to those which are produced by the Aconitine ointment; they are, however, rather more pungent in their
character; and this probably arises from the extract containing what is called the aeryid principle of the plant, as well as the alkaloid itself; and it is absolutely necessary that with this preparation also, these sensations should be induced, in order to its having a full effect on the disease for which it is applied.

In less severe cases, the simple saturated tincture of the dried root, with or without the addition of a little ammonia, may be used; it has similar properties, but in a much smaller degree of development, with the two preparations above mentioned, and the same instruction as to its use ought to be attended to.

Severe Case of Neuralgia in the Finger, treated by Preparations of Aconite.

The following case has been selected as affording the most conclusive evidence possible of the efficacy of preparations of Aconite in removing Neuralgia. It is one of the most severe and obstinate on record; and during a period of above two years, had resisted every means that could be devised for its removal. The previous history and treatment are taken from a very able lecture on Neuralgia by Dr. Elliotson, which was published in the Lancet of December 8th, 1832.

Samuel Best, residing No. 7, Somers Street, Liquorpodd Street.

"This man was a journeyman printer, aged 32, and had been ill two years. He first of all had pain of the legs, arms, and wrists, and when he came in, the pain was confined to the middle-finger of the left-hand, on each side, along the course of the nerve. The other fingers of the same hand were benumbed—were without any great degree of feeling, but the thumb was unaffected. Originally he had had pain on the right side of the face—that is on the opposite side of the body, and the pain then commenced in the sub-maxillary nerve, and extended upwards, so as partly to affect the second branch of the fifth pair, as well as the third. It is therefore to be recollected, that he had had Neuralgia in another part of the body. All this, however, had ceased a month before admission, at which time he had only pain on each side of the middle-finger, and after that had existed some time, the other fingers had become benumbed.

"The pain was of a very agonising character; a plunging, stabbing pain, as though you were running a penknife along the finger. Patients usually describe the pain in neuralgia as stabbing and plunging. The least touch gave him violent pain, like an electric shock. As the least touch produced such violent pain, he could not bear his nails to be cut, and the consequence was, that the nails of that hand had grown to a great length. He could not sustain the motion of the hand which the cutting of the nails necessarily produced, and the agony of the pain was such, that he bit the nails of the fingers of the other hand, so that the nails on the fingers of it were eaten down by him in his agony, as far as they
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could be. The appearance was certainly very remarkable; for on one hand the nails were, as I have just said, as short as they could be; and on the other hand, though they were not so long as they might be, yet they were of very great length. I believe whenever he had a very violent attack of pain, the nails of the affected hand became discoloured, and remained so for some time.

"I could detect no cause for this at all. I could connect it with no obvious morbid state, and therefore, what produced the pain I could not tell. I could only say there was a pain, and that the pain was clearly situated in the nerves—following the course of nerves, affecting other parts also exactly in the situation of branches of known nerves, and having the usual character of pain of the nerves, or at least, what it very frequently is, stabbing and plunging. There was no heat or inflammation of the fingers; nothing whatever to be seen; but yet there was agonising pain, and the slightest touch aggravated the pain when present, or brought it on at a moment when he scarcely felt any.

"Treatment.—One of the best remedies in this disease, but by no means a specific, and by no means so successful I think as in some other nervous complaints, is carbonate of iron. Its efficacy in this disease, so far as I know, was first pointed out by Mr. Hutchinson, a surgeon in the country, who, I believe, is now dead. * * *

"This man's complaint having lasted two years, and carbonate of iron being an innocent remedy, provided you keep the bowels regularly open, he took half an ounce three times a day; and when he had taken that for five days without any benefit whatever, he took the same quantity every four hours.

"Now this did him a certain degree of good. He was better. Still he had pain sufficient to keep him awake at night; and I gave him, in addition, a quarter of a grain of moriate of morphia. The benefit was but temporary; and I applied to the finger a solution of the cyanuret of potassium, which has been so much praised by the French. But it did not relieve him materially, and the solution was then made stronger than the French have recommended it. It was carried as far as twenty-four grains to an ounce of water. After a time it was suggested, that it was merely the cold which did him good, and I applied ether, to see if that would relieve him, and it did so, much more than the solution of cyanuret of potassium had done. Still, however, he was very little better. The amendment which he at first experienced on taking the iron ceased, and I was obliged to increase the dose of medicine, and likewise the moriate of morphia, for he obtained no sleep. He took a whole grain of the latter every night. The iron was then increased to the quantity of an ounce, and it was given every four hours. His health improved under it, and from being pale and thin, he lost his great paleness, and gained flesh, and thought himself quite another man, so far as his general health was concerned. The quantity of cyanuret of potassium was increased now, to a drachm in an ounce of water; but it afforded no relief. He still found more benefit
from ether. One could not expect a man to continue swallowing more than an ounce of iron every four hours. He would have taken it in any quantity, but it was necessary to consider his stomach, notwithstanding his good will to take the medicine. I therefore gave him another form of iron also, the sulphate. I do not know that the carbonate is superior to the sulphate in this disease, or in chorea, and the latter may frequently be taken the most easily. He began with five grains, in conjunction with the carbonate of iron, and took both every three hours. His agony was still extreme, and the sulphate was, therefore, increased to ten grains, and afterwards to fifteen. He received some degree of benefit, but it was only temporary.

"I thought now that the iron had had a very fair trial, and it was only relinquished on the 26th of July, he having begun to take it on the 8th of March, so that he had continued it for three months. This was a very fair trial, both with respect to the quantity of the dose, and the long continuance of its exhibition. * * * "I then relinquished the iron altogether, and endeavoured to apply strychnine to the finger. We attempted to blister the finger, and then sprinkled half a grain of the strychnine upon it. It was, however, with very great difficulty that we produced vesication; very imperfect vesication was effected, and therefore it was not very well managed. I still determined on trying whether the strychnine would do him good or not, and I therefore exhibited the twelfth of a grain internally. As strychnine is so powerful an agent, I never like to begin with a larger quantity than that. It was then increased gradually to the eleventh, tenth, ninth, eighth, and so on, of a grain. Still he was no better, and I was obliged to increase the muriate of morphia to two grains every night, one grain being said to be equal to four grains of opium. The man told me, with tears in his eyes, that the agony was such that he never slept.

"The strychnine was increased now to half a grain three times a-day, and I had the finger smeared with croton oil. He could not bear to have it rubbed in, and therefore it was gently smeared on the part, but produced no great irritation. His health now began to decline. He was taking on the 7th of August three-fifths of a grain of strychnine three times a-day, and two grains and a half of muriate of morphia, but he began to take the iron again. I gave it him without any hopes of its producing benefit, but for the purpose of improving his general health. He began with half an ounce three times a-day, which was increased to an ounce, and then to four times a-day. His health soon improved again, but the pain continued unabated, and the muriate of morphia was increased to three grains twice a-day. His pain was such, that I was obliged to give him an opiate in the day time as well as at night. The strychnine was not increased beyond three-fifths of a grain three times a-day, and as it did him no good, merely produced some twitching of the limbs, it was relinquished on the 21st of August, never having been of the slightest service. Arsenic has been known to
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be serviceable in some cases combined with an alkali as in the liquor arsenicalis. He commenced with this on the 21st of August, and began with small doses three minims three times a-day, not taking it on an empty stomach. This was increased gradually to nine minims, but without any effect on the disease, though it began to make him sick. Nine minims I consider a very full dose. It, however, disturbed his stomach, and to prevent the sickness he took two minims of hydrocyanic acid three times a-day, half an hour before the arsenic. This did not lessen the sickness, and I therefore was obliged to increase it to three minims, and went gradually on till I arrived at a dose of nine minims three times a-day. This entirely prevented the sickness arising from the arsenic. Hydrocyanic acid has the very valuable property of stopping vomiting, provided this does not depend on inflammation. Knowing the power that it has of tranquillizing the stomach generally, though it does not invariably produce relief in gastrodinia, I thought it would stop vomiting. I never heard that it had been used in such cases, but I thought it must do good. After employing it for two or three years, I thought it might prevent medicines from causing further vomiting. I tried it, and I found that it had that power in a very marked degree. Finding in this case that two minims had no effect, I gradually increased it, as I have before mentioned, to nine minims, and it then entirely stopped the sickness caused by the arsenic.

"All this time the arsenic did no good; he bore it very well, but it was of no service to him, and I therefore gradually increased it to the largest dose that I ever gave—viz. twenty minims three times a-day. He now began to look thin again—did not look so well as before. I could not, however, tell whether it was the result of the arsenic. It might merely have arisen from his extreme suffering, but still it was right that I should discontinue the medicine, and I did so without his having derived the slightest benefit from it during the whole period of its exhibition. As it was necessary to procure sleep, the muriate of morphia was gradually increased up to six, and at last to eight grains twice a-day. His agony was such, that the begged to have the opiate, and he also begged to have it increased, otherwise he said he could scarcely exist.

"He was taking, therefore, at last, eight grains of muriate of morphia, twice a-day, which gave him ease, (I got him to omit it once or twice, but he suffered so much, that he begged to have it again), and twenty minims of liquor arsenicalis, always taking before it nine minims of hydrocyanic acid. This he bore perfectly well, with the exception that he looked as ill as he did when he first came in, not worse, but just as he did before I gave him the iron.

"He now wished to go out of the hospital for a fortnight for a change, and he was supplied with a quantity of muriate of morphia to take with him till he came again.

"I attempted, during the time, other local measures. He once rubbed the extract of stramonium on his finger frequently every
day, and it relieved him for a time. He rubbed also the extract of belladonna, two or three times a-day, and this, he said, certainly produced relief for some time; but I am sorry to say, that at the very last he was nearly as bad as at first. He himself maintained that he was a great deal better; he did not allow it, but maintained it. I was afraid that he was not improved, but he assured me that he was better after he took the iron: that altogether his sufferings were not such as they were before he came to the hospital; but still they were dreadful. He appeared to be an excellent man, a man of a strong mind, but in his agony the tears were seen running down his cheeks.

"He will return, but I have no idea of medicine doing him any further good. We have given him the most powerful remedies, and these have been used in the most powerful manner, although with great care, but he is not materially better, and therefore, when he comes back it is to be considered whether or not he shall have his finger amputated. I have very little hope, however, in the operation, and for this reason—cases have occurred in which the operation has failed, the disease having reappeared in the corresponding nerves of the other hand, and in the trunk of the nerves the branches of which have suffered amputation. Still it may be right to make the trial. I have little hope of success, however, for another reason, because he has had the affection before in the nerves of the face."

This patient came under treatment, about the end of October, 1834, and in detailing his subsequent progress, I shall confine myself to a weekly report, in order to avoid repetition. The history which he gave of his case was substantially the same as that quoted above. He stated, that since December 1832, he had been suffering in an extreme degree, that he had been in the hospital about eighteen months subsequent to that date, and had been using every remedy that was likely to afford relief, but in vain. He stated, that the only ease he had, was from taking large doses of morphia, to the extent of from ten to twenty grains a-day; but that even these procured him only a few hours of broken rest.

The pain was seated in the fingers and wrist of the left hand, but particularly in the middle finger, through which, and along the wrist, it darted like a stab with a knife. He could not bear the slightest degree of motion in any of the joints, either of the fingers or wrist, without bringing on a violent paroxysm of pain, and for the same reason he could not suffer the middle finger to be touched. His nails were long and curved. The ring and little fingers were benumbed and painful, and a similar feeling extended up the arm as far as the shoulder. He had had no pain in his face for three months, but he stated that the pain in the hand, at times, almost deprived him of his senses. His appearance was wretched, and indicated the sufferings he endured.

First Week. Under these circumstances, he was ordered to rub the saturated tincture of the root of the Aconitum Napellus, pre-
pared as already directed, for twenty minutes, along the back of the hand and fingers. The friction at first gave him extreme pain, but towards the end of the time he could bear it better, and it gave rise to a sensation of heat in the affected finger, which was attended by a marked diminution of the pain. He was ordered to repeat the friction for ten minutes; twice a day, and to take six drops of tincture of Aconite, prepared for internal use,* every four hours, in water. The immediate effect of this treatment was, to enable the patient to do without his daily dose of twelve grains of acetate of morphia, which he had been in the habit of taking for many months before. The friction excited sensations of heat and numbness in the hand, and could be borne with greater ease at each successive application, and he could sleep three or four hours at a time without interruption. The dose of the tincture was gradually augmented in the course of this week, to ten drops every four hours, and the friction was ordered to be used till heat and tingling were produced, whenever the pain came on.

The pain was removed every time the tincture was applied, and the quantity taken internally occasioned tingling and numbness in the extremities, and acted as a diuretic. The patient slept six or seven hours at a time: he had intervals of perfect freedom from pain, with distinct paroxysms, varying in intensity: and on the seventh day, from the commencement of the treatment, he was so far recovered, that he could bear to have his nails cut, which had not been the case for nine months previously.

Second Week. During the next seven days the same treatment was continued. He took the tincture internally, in nearly the same dose, and rubbed it on the affected joints, whenever the pain came on. Under these means, the accessions of pain gradually diminished in intensity, and the intervals of complete relief became longer, so that at the end of this week he had little pain except on motion.

Third Week. This week he was directed to continue the same treatment, to use the affected joints as much as he could: this, however, brought on attacks of pain, but these were at once removed by frictions, continued until tingling was produced.

Fourth Week. On the first day of this week he was directed to substitute for the tincture the following ointment:—

R. Aconitæ, gr. ii.
Adipis. 5 i. ut fiat unguent.

and to rub it with whenever he had pain.

The tingling caused by this ointment was very considerable, and generally lasted three or four hours afterwards. He had occasion to use it three times a-day, and one grain of Aconitine was added to the second prescription, as the first began to lose its effect. In a day or two he discontinued the tincture internally, and was directed to use the ointment of the ammoniated extract of Aconite, made ac-

* Vide page 55.
cording to the formula already given, in order to try the comparative effect of this application. In this case it was found to produce a more powerful sensation in the parts than the Aconitine itself, and to be very useful in removing attacks of pain when they came on. He used nothing except the remedies mentioned above, and at the end of four weeks and three days from the commencement of the treatment, he was totally free of pain, and has continued to be so ever since. He can use his hand with perfect freedom, but complains of its not being so strong as the other, probably on account of his having been obliged to keep it for four years almost in the same position.

On the 6th of January last, he had an attack of pain in the right cheek, on account of his having been exposed to the effects of cold, this was, however, immediately removed by the Aconitine ointment; he has had no return of it, and is at present in excellent health.

ST. THOMAS'S HOSPITAL REPORT.

(From the London Medical and Surgical Journal of Saturday, December 13, 1834.)

"M. A. Huntingford, æt. 28, admitted into St. Thomas's Hospital, under the care of Dr. Roots, April 3d, 1834. She then stated that she had been subject to paroxysms of pain in the loins, thighs, and legs, for more than two years, which had gradually increased. She had been in the hospital, under Dr. Elliotson, in January last, by whom she was at first freely depleted; after which the disease assumed an intermittent form, and she then took large doses of quinine, and was slightly relieved by it, but left the hospital before she was well, and soon became worse.

"At the time of her second admission, her general health was not impaired. She was subject to paroxysms of pain, generally two every day, in the loins, hips, thighs, and legs, following the course of the sciatic nerve. The pain was of a severe, cutting kind, and attended by some twitching of the muscles. There was a tenderness on pressure of the lumbar vertebrae, and along the whole course of the sciatic nerve. The paroxysms of pain came on and ceased suddenly, and without any warning: they did not observe any regular intervals, and were of variable duration, often continuing for several hours; and in the intervals she was seldom free from un easiness. Has no symptoms of hysteria; menstruation regular.

"Quinae sulph. gr. v.
Ferri sub-carb. 3 ij.—6 ta. qua quo horá.
Empl. canth. sacro.

"April 9th. No change.

"Ferri. carb. 3 iij. extr. stramonii. gr. ss. 6 tis horis.

"On the 12th, the paroxysms were of rather shorter duration, but returned as frequently, and were quite as severe as ever. The
quinine was increased to gr. viij. and the iron to 3 iv. in each dose. On the 14th she had no pain, and only a little on the evening of the 16th. Quinine increased to gr. x. in each dose. The intermittent character of the pain continued to the 30th, and the paroxysms had gradually become less severe and of shorter duration. The stramonium was omitted on this day, as the sight had become affected by it.

"May 3d. The improvement had continued, and the quinine was increased to gr. xv. From the 9th to the 24th, she suffered from head-ache and sickness; but the medicine was continued, and the pain abated. On the 24th, the iron was increased to 5 vi.; and on the 28th, gr. ½ of muriate of morphia was ordered with each dose.

"June 11th. The pain still better and intermitting; but, in consequence of continued headache and sickness, all the medicines were omitted.

"Ung. veratri (Ω i. ad. 5. i.!) 5 i. ter. die. lumbis.

"On the 14th, the pain had become more severe, and the quinine, carbonate of iron, and muriate of morphia, were gradually resumed, and increased up to August 23d; at which time she was taking

"Quinæ sulph. Ω i.
Ferri subcarb. Ω i.
Morphie muriat. gr. ½, 6 tis horis.

"These medicines were omitted for four days, during which she took some creosote; but the pains returned immediately after the medicine was changed, and continued to increase. The old medicines were resumed, and she quickly improved, as before. She left the hospital on the 22d of September, of her own accord; the pain had diminished much in severity,—returned much less frequently, and not at any regular intervals. The pain soon increased, but never attained its original severity. She was again admitted into the hospital, under Dr. Roots, Nov. 21st. The pain was of the same character, and in the same situation as before; commencing in the loins, and afterwards affecting the gluteal muscles, and extending down the back part of the thighs to the hams and heels. The paroxysms usually came on about 7, p. m., and continued four or five hours. During the attack the muscles were firm and contracted. There was some tenderness of the gluteal muscles at all times. General health, good; pulse, seventy-five,— feeble. On the 25th, the following ointment was ordered:—

"Aconitæ, gr. ij.
Ung. cetacei. Ω i. ft. ung. et infricet pars sexta part.
dolent. nocte maneq.

"On the 28th, she stated that after each application of the ointment, the parts rubbed became hot, and smarted; but this was quickly followed by numbness. After the third application, the pain was a little relieved; and after the fifth, the amendment was
very remarkable. The paroxysms were much diminished in severity, and did not continue more than one or two hours. The pain, which had formerly been very acute, she described as being much less severe, and called it a "burning twitching." The parts were less tender on pressure, and she could sit up without causing pain in the gluteal muscles, which she could not do three days since.

"Infricet. unguent ter die.

"Dec. 2d. Two days since, in the morning, she had a more violent paroxysm of pain than she has had since her admission. After it had continued an hour and a half, the ointment was applied, and in ten minutes she was much relieved. The paroxysms do not now last more than twenty minutes, and she says they have never been so slight before.

"6th. The pain has now resumed its intermittent character. On the 3d, 5th, and 7th, she had a short and slight paroxysm in the evening; each being less severe than that preceding it.

"Quinæ. sulph. gr. v. 6 tis horis.

"9th. The pain returns every other night, but is gradually decreasing in duration and severity.

"There is a man in Luke's Ward, under Dr. Roots, who has a painful affection of the sciatic nerve, for which he used Veratrine ointment for some time without any benefit. He has used the Aconitine for a week, and a very decided mitigation of the pain followed its application.

"Dr. Roots informs me that he has used the same remedy in private practice, in three cases, with similar success."

In conclusion, these are the principal circumstances which occur to me at present, as worthy of mention in regard to this new class of remedies. The facts which have been adduced, appear to bear out the position advanced at the commencement—that there exists a class of active principles in the Ranunculaceæ possessed of similar properties when applied to the surface of the skin, and acting in a similar manner in the same diseases; and if I succeed in calling the attention of the profession to them by what has been stated, my object in making this communication will have been answered.
APPENDIX.

CASES COMMUNICATED TO THE AUTHOR.

Case of Tic-Douloureux cured by Veratria Ointment, communicated by J. Holme, Esq., Surgeon, Linton, Cambridgeshire.

Miss L., a young lady ten years of age, has suffered from tic-douloureux for about four years. In the winter of 1829-30, she first complained of frequent pains in the face, in the situation of the infra-orbital foramen, attended by intermissions, and which at first were considered as probably connected with the teeth. In the winter of 1830-1831, her sufferings became much greater; and on account of the intermittent nature of the pain, she was then treated with quinine; but having experienced no relief from it, she had three teeth extracted, yet without benefit. During the summer of this year (1831), she was not free from suffering, especially when exposed to chilly weather; and if she happened to be out after sunset the pain was brought on.

In the commencement of the next winter I first saw her; at that time she was under active medical treatment, and had taken carbonate of iron, arsenic, morphia, belladonna, quinine largely, purgatives, mercury, and had made use of topical applications, but all without advantage. The paroxysms of pain came on at regular periods, two and three times a-day, for the space of from two to five hours at each accession.

In February 1832, she was taken to London, and put under the care of several eminent practitioners, but derived no benefit, except for three weeks in July, after which the pain returned with increased violence. Baths of various kinds were also tried, but without effect. She returned home, and six weeks since the Veratria ointment was first tried, and in about five days she experienced much relief. Within that time she had no attack of pain during the night, and in three days more, the daily paroxysms nearly ceased. We continued to rub the ointment for about twenty minutes before the expected time of the attack, and in one day, less than a fortnight from beginning to use the frictions, all recurrence of pain had left her, and she now continues quite free from any inconvenience. The only medicine she took during the use of the ointment, was four grains of pil. aloes et myrrhæ, at bed-time.

April 21, 1834.

JANUARY, 1838.—G
Cases in which the *Veratria* Ointment has been employed, communicated by Edward MacGowan, Esq., M.D., Exeter.

**CASE I.**

The first case happened in a farmer, about thirty years of age, who had been many weeks suffering from severe rheumatism in the articulations generally, but especially of the knees and feet. He presented the rheumatic diathesis in a marked degree, and there was a great tendency to leuco-phlegmick anasarea. I gave him the sub-carb. ammon. internally, with guaiacum, and ordered frictions on the joints to be made with the ointment of *Veratria*. In the course of a week, he rode into Exeter, a distance of five miles, and told me he was quite recovered.

To my surprise the swellings and pain in the joints had subsided, and the general health was much restored. He had been almost a cripple previously; and has not had since, to my knowledge, any return of his former complaint.

**CASE II.**

An elderly lady of gouty diathesis, and subject to frequent attacks of gout in the feet, suffered much from a swelled leg and foot, which presented an appearance precisely similar to the Barbadoes leg. There was besides, a chronic inflammation in the toes of the same limb, around the nail of the large toe particularly, which had often been attacked by gout, and which was accompanied with a fungous kind of ulceration. The whole limb was greatly enlarged, and the cellular tissue extremely hard, with now and then an erythematos inflammation over the surface. After poppy-head fomentations, &c., I used the *Veratria* ointment, which reduced the swelling, and abated the pain beyond my hopes. At first it produced a slight irritation, which obliged me occasionally to suspend the frictions, but that was the only inconvenience that resulted from it. The limb is still considerably enlarged but much reduced and less painful than before, which I certainly think is owing to the *Veratria*.

I have some other instances of the advantageous exhibition of *Veratria* externally, which confirm me in the persuasion of its efficacy in rheumatic and gouty swellings, particularly in debilitated constitutions. In such cases, it seems to stimulate the capillary and absorbent systems, and bring back a vigorous and healthy action.

April 12th, 1834.

*Case of Tic-Douloureux cured by Frictions with Veratria Ointment*, communicated by John Spence, Esq., Surgeon, Otley, Yorkshire.

A lady, about twenty-four years of age, has been affected for the last eight or ten years with a most painful neuralgic affliction, situ-
APPENDIX.

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ated in the cheek and temple of the right side. The pain makes its appearance in regular paroxysms, varying in length from a few days to several weeks, and is succeeded by intervals of partial relief. The state of the patient has been very distressing, and during the continuance of the attack her sufferings have been so extreme, as to bring her into a condition almost bordering on distraction.

Before she came under my care, she had been treated by active depleting measures; she had been bled generally and locally, and had applied topical remedies of almost every description, including repeated blistering; but without experiencing any cessation of the pain. For some time I continued a similar course of treatment, along with the internal administration of various medicines, none of which, however, had a good effect, except preparations of iron; these succeeded for a time in diminishing the severity of the affection, but appeared to have no power in removing it. I now ordered the patient to rub the affected part of the face, for twenty minutes, with a portion of ointment made with a scruple of Veratrina to one ounce of lard, when the paroxysm came on. Next time I saw her, she told me that when the pain made its appearance, she applied the ointment as directed, and that the attack was cut short immediately. After this period the paroxysms returned two or three times; but were removed by the same means. I saw her a day or two ago; she was quite well, and is now free from the disease.

June 10th, 1834.

Notices of Cases in which the Veratrina Ointment has been employed, communicated by S. Hood, Esq., M. D., Brighton.

The first case in which I tried Veratrine, was in that of a lady who had laboured some considerable time under tic-douloureux, seated in the second branch of the fifth pair of nerves, on the left side of the face. Many remedies had been previously tried without effect, and it was at last determined upon to attempt the removal of the pain by means of friction over the affected part with the Veratrina ointment of the usual strength. After this treatment had been continued for three days, the disease was apparently cured, but again returned with considerable violence; the ointment was again had recourse to, and the patient is now quite well. It may be proper to state that latterly she had been in the habit of taking three grains of sulphate of quinine a day; I do not think, however, from previous trials of it in this case, that it would have been of the least benefit without the ointment.

In two other cases of tic-douloureux, in the first branch of the fifth pair, the Veratrine was most efficacious: in one, the disease was removed by it in a single night; the other was relieved on the
third day after the first application of the ointment; there was, however, a relapse in about a week afterwards, but the pain was again removed by the friction, and the patient is now quite well.

In addition to these, I have prescribed the Veratrine ointment in three cases of painful affections in the course of the sciatic nerve; they went on gradually improving and are now removed.

About the diuretic effects of the Veratrine there can be no doubt; in every instance in which I have employed it, the application has been followed by an increased discharge of straw-coloured urine. In dropsical cases occurring in old persons, after the diuretics in common use have been carried as far as the stomach can bear them, it will be of great utility while the use of internal remedies is suspended. I have three such cases at present under its influence, and all of them are going on favourably, and likely to terminate well.

April 27th, 1834.

Case illustrative of the effect of Frictions with Veratrina Ointment in Palpitation, communicated by William Porter, Esq., Surgeon, Gower Street.

A lady, about twenty-eight years of age, has suffered from a dropsical affection for about eighteen months, accompanied with a considerable degree of palpitation of the heart and irregularity of the pulse, and these symptoms appeared to be connected with irregular menstruation, from which the patient had suffered for some time. The lower extremities were oedematous, and there was difficulty of respiration and general nervous excitement. In the treatment of the disease various measures were employed without much benefit, until about two months ago, when the oedematous state of the extremities was much relieved by the use of diuretics and drastic purgatives; the palpitation, however, continued the same as before. As this latter symptom was peculiarly annoying to the patient, the attempt was made to remove it by means of an ointment made with twenty grains of Veratrina to one drachm of lard, and a small part of this was ordered to be rubbed over the region of the heart for ten minutes night and morning. After the second or third friction the palpitation disappeared along with the irregularity in the pulse; this took place about eight weeks ago, and although the patient is still unwell, it has not returned.

June 20th, 1835.

THE END.
THE GUMS;

WITH

LATE DISCOVERIES

ON THEIR

STRUCTURE,

GROWTH, CONNECTIONS, DISEASES, AND SYMPATHIES.

BY MR. GEORGE WAITE,
MEMBER OF THE LONDON ROYAL COLLEGE OF SURGEONS.

Quid evenerit postea, nescio:—CICERO, PHILLIP II.

PHILADELPHIA:
HASWELL, BARRINGTON, AND HASWELL.
1838.
I had purposed, two years since, arranging in a new classification the diseases of gums and teeth. My health becoming impaired from an injury on the head, I was prevented the accomplishment of this object. Many new ideas having arisen on the sympathy between the gums and the constitution, and having myself been instrumental to their furtherance, it was suggested to me that the accompanying remarks ought to be given publicity as early as possible.

Comparing the teeth to the vegetable kingdom, I have ventured to give them four seasons, agreeably to the cardinal laws. The construction of the gums from whence these teeth emerge, and beneath which they lie concealed, is like that soil to which the agriculturist and arborist devote their toils and cares. I have described the carotid arteries, and the sympathetic and par vagum nerves, as also the vital properties, for these are essential to understand the diseases and sympathies of the gums.

To those persons who make the teeth their principal study I would recommend an intimate knowledge of the pathology of our frame; this alone will guide them in the diseases of the teeth, and teach them whether such are congenital, inflammatory, or sympathetic with other affections. It will also show them that the works of art cannot compete with those of nature, and, impressing on their minds the reality of this conviction, point out to them that nothing so shows the ignorance of the present dentists as
the manner in which false teeth have gained ground during the latter years.

To the medical world, with all respect to their great exertions and talents, I would submit the teeth as organs most essentially conducive through life to a healthy temperament and digestion; their early development and the irritation often attending them as dangerous in the extreme, as producing fevers, eruptive diseases, hydrocephalus, diseases of the lungs, of the mucous surfaces, and of the glandular system, often bringing on deafness and defective vision, rousing also predispositions which else would have remained dormant in the frame.

To society in general, wherein enlightened ideas are becoming more and more diffused, I would recommend due attention to the condition of the gums; this attention, if properly directed, will quite prevent the occurrence of those decays too often seen in the mouths of our young females, who might else be as the Roman pontifex said of captured youths of ancient Britain, "Non angli sed angeli."

Lastly, I have endeavoured to point out, that till the latest period of our lives, the condition of the teeth depends on that of the gum, and, unless due regard be paid to this point, the most talented operations on them will too frequently be found of little or no avail; the ends for which we intended these operations will become defeated, and the teeth, even if no decay has existed in them, loosening one after the other, will often fall out from the gum.
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The Gums

In

The Different Periods of Life.

In the primary stages of formation the construction of our bodies is separate; but, when the earliest periods of our existence have passed, these separate portions becoming intimately blended together constitute one harmonious whole.

The brain destined to be the primum mobile of our frame, as well as the seat of our understanding, is the first portion of the system to be constructed. It is contained within a series of vascular and important membranes, between the two most external of which the bones of the head are secreted.

The next part is the face, which appears with two small black spots for the eyes; we then gradually see the other parts of the body forming, and, when development of the various parts takes place, they increase in bulk.

When the necessary period of birth arrives, man receives his new existence; the lungs, which were in a state of collapse, now become filled with atmospheric air, and occupy the entire cavity of the chest; the function of respiration then takes place, the thymous gland in the anterior and superior part of the chest now begins to disappear, the jaws lengthen in order to accommodate the formation of teeth, which is destined to commence within them.

The development of the gums, and the offices they perform, are as we go on in life of the greatest possible import to the health. They have attached to them the highest attributes of superior intent and dispensation. If the known phenomena of the heavens, with the various changes of constellations, open to learned eyes a vista into futurity,—or if facts connected with geology call the contemplation to the highest and most unattainable objects,—to the same ends will the design perceptible in the growth and successive changes of the gums lead the scientific mind.

However insignificant these organs may appear, compared to the vast grandeur and magnificence of the considerations with which the mind is overwhelmed when considering the mechanism of the heavens and the wonders of the universe, still the gums can claim
merit as exhibiting phenomena both clear and comprehensive. We may refer to the tender gum, destined by Providence to touch the still more tender nipple, the growth and expansion as the infant gains size, the graceful and semicircular manner in which they throw out the beautiful colour of the teeth, the influence they possess through life over them, and finally, when the teeth no longer exist, the compensative powers with which they are endowed, and the extreme hardness they are often known to assume.

The wisdom of divine economy, evident in all its works, must fill the mind with mingled feelings of awe and admiration. To sing the wisdom of his God, the royal psalmist tuned his harp to the enchanting strains of Hebrew poesy; the pagan, unillumined by the fiery pillar of revelation, and taught only by the voice of nature, was compelled to confess the existence of an all-wise and all-gracious Supreme.

Meditating on the order and offices of various parts of the heavenly bodies, contemplating the rise, the expansion and succession of plants, we may consider the numerous stupendous chemical and mechanical operations perpetually going on in the sphere of our existence, and we cannot fail

"To look from nature up to nature's God."

If then thus admirable and superior to all comprehension be the functions of those objects of the creation destined for the use and happiness of man, we should expect to find all parts of his formation neither less wonderful nor less sublime.

At first man appears in all the impotency of his infantine state, without many of those organs which his future life will demand: these he receives by gradated accession. When the weakness of infancy yields to the succeeding state, and the frame no longer needs the most delicate support, teeth are given him for his new condition; these, in conjunction with other organs, are most strikingly adapted to the exigencies required; they are the coadjutors in one of the noblest characteristics of our distinguished scale in the creation, and the almost indispensable organs of one of the primary objects of animal life.

Nature, or rather the omnipotent Author of nature, is no less sublimely wise in the minor and individual objects of the creation than in those cardinal ones which are common and universal. The regulation and succession of plants is in accordance with the temperature most congenial to them. The due and imperturbable order of the seasons, the rise and decline of the year, are not less wonderful than the dispensation in the condition of the gums. In spring, when, to borrow the words of the author of the "Seasons,"

"Surely winter passes off
Far to the north, and calls his ruffian blasts,"

the welcomed early plants present their tender heads above the surface of the nurturing earth; so, too, in infancy, when the early win-
ter has passed away, the teeth rise from the tender gum. Infancy also has its succeeding state when these organs experience a revolution. When summer has run her course, autumn appears, then botanical nature gives indication of her approaching dissolution; here likewise we have the resemblance of our natures. Well then has Sophocles said,—

"ευκατερίσθαι προφθανέσθαι των θεών και ουράνιων ναυτών την αιχμή της ακρόπολεως και της θρησκείας."  

Winter then appears,—

"Sullen and sad, with all its rising train,  
Vapours and clouds and storms."  

Winter, the universal emblem of advanced old age. In the one, the trees, the herbs fall and decay; and in the other, the gums and teeth, in sympathy with their co-operating organs, fall, and falling rise no more—

"ετησεν, τι δε τυ; τι στοιχεῖα;  
Σχισαε ενα, αιθριότερα."  

Pindar.

Since then four periods of life exist, coeval with the seasons of the year, so each approaching season brings its train of circumstances with it. These periods in the mouth are extremely well defined. Youth and old age have the intervention of summer and autumn, and the interposing secondary and tertian portions have the accompanying changes of life, which take place about the sixteenth year, and again show themselves when spring and summer have passed away.

It is impossible to draw any just conclusion as to the real nature of the gums by looking promiscuously at them. The inferences drawn in such a case would be entirely wrong; for by far the greater proportion of gums are in an unsound and unhealthy state. These diseased appearances differing in themselves, it is only by comparison with different individuals that an exact knowledge of what they should be is imbibed.

We find the diseased appearances ever in conformity with the health and temperament of different individuals. In the healthy state they are much more cartilaginous than fibrous, and possess a reddish appearance, which indicates the existence of a circulating medium, having the papille of numerous little secreting duets opening on their surfaces. In the diseased state they become sensitive, assume a darkened colour, and swell; whereas before they were almost even with the surfaces of the teeth.

It is not to be presumed that a person who is continually in the habit of seeing unhealthy gums is likely to form a just estimate of their aggregate nature. Physiological points give us, however, some conception of their healthy state, and comparative anatomy also draws away a veil which might else obscure what in reality they should be. Without progressively following down the scale of animal existence, we may consider merely the mammalia and

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fierce; we find their gums hard and cartilaginous, rarely swollen, but when too much pampered in the luxuries of man.

Although in refutation of this doctrine it may be urged that the different methods of gaining sustenance which animals possess require their gums to be firm and hard, still in the same method of reasoning the action of mastication in man demands a similar structure of these organs. With this structure they were originally sent forth; but in proportion as luxuries bring on disease, which lays hold of the frame, so the gums put on changes consequent on the various alterations of habit. Hereditary predispositions, following each other in mournful succession, are too often seen desolating the human frame, and the blood changed into impurity shows its real nature by choking up the delicate network of vessels which enter into the structure of these organs.

The manner in which the gums partake of the various changes of habit is well worthy of consideration; but as yet this subject has been much underrated, if not entirely neglected, by our pathologists. Before proceeding further, it will be necessary to explain the various parts in contact with the gums.

THE GUMS.

The Gums covering the superior maxillary bone are reflected over its anterior lateral and inferior parts; they pass between the interstices of the teeth up to the roof of the mouth, cover the tuberous process, and terminate in the soft palate and constrictors of the fauces.

In the inferior maxillary bone they pass in a similar manner, being perforated by the teeth. They proceed backwards as far as the root of the coronoid process, terminating externally in the inner substance of the cheek, and internally in the root of the tongue.

The gums cover the dental processes, and increase in vascularity as they proceed backwards and away from the necks of the teeth. Small vessels pass from the gums into the periosteum and into the bone, and on the surfaces of the gums are the openings of small secreting ducts. On examining the gums at the necks of the teeth, they are found embracing the tooth very firmly, and connected to a membrane of great importance, the periosteum dentium.

In proportion as the bony fabric of the jaws progresses in its usual development, so the substance of the gum also increases in proportion to such development. This consideration has recently called forth doctrines of high importance, which we must hereafter refer to.

PERIOSTEUM DENTIUM

Is the intervening membrane situated between the septa dentium and roots of the teeth. It is found to be very firmly connected to
the gums, and small vessels from them to it penetrate the substance of the root.

The intervention of this membrane serves to retain the teeth firmly in the socket. In pivoting teeth, when the grand object is entirely to destroy life in the root, we see proofs substantiated of the great power which the periosteum possesses over the consolidation of the portion of the root.

Such tenacity to the socket does the periosteum give the root of the tooth that a few mere intervening filaments to its bone serve for years to prevent it dropping out. In cases of loose teeth, numerous are the records which exist of their remaining loose in the mouth, when for years each succeeding day has been apparently their last.

It would be impossible that the conical shape of the root of a tooth could at all influence the manner in which its tenacity to the socket is preserved; the periosteum is a very principal agent in producing this effect; to preserve this membrane in a healthy state becomes an object of paramount importance.

As it derives vessels from the gums it must necessarily be acted on by all causes which produce a diseased state of these organs; when therefore the gums swell, the swelling produces a singular effect on the teeth; they become raised from their original position, and in closing the mouth are the first touched by the opposing row.

After pivoting teeth this becomes a great consideration. It was necessary that the replaced tooth should be so left that no part of it touched the opposing teeth of the bottom row, even in their most rotatory motions. By inflammation, which frequently follows the operation, the root drops, and being much in the way is extremely painful.

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**BLOOD-VESELS**

**CONNECTED**

**WITH THE INTERIOR OF THE MOUTH.**

I.—THE ARTERIES.

In my former work, the Surgeon-Dentist's Manual, I have described the nature and uses of the arteries and veins, as well as those which are intimately connected with the teeth. I shall here go a little further into the subject, and cannot do better than trace the course and branches of the external carotid arteries, which supply the mouth and its adjacent parts with arterial blood.
The external carotid artery is smaller than the cerebral or internal carotid, during the age of infancy; but in adult age they become of equal magnitude. It is continued from the point of its division as high as the cervix of the condyloid process of the inferior maxillary bone, where it terminates by dividing into the temporal and internal maxillary branches. At first it is situated anteriorly, and towards the inner side of the internal carotid or cerebral artery, but soon crosses it, inclining backwards, and subsequently slightly curves as it ascends to the point of its division. For a space of about a quarter of an inch after it arises, it has no other covering that the platisma myoides, fascia, and a portion of common integument: it then passes beneath the digestive and stylo-hyoideus* muscles, near the angle of the lower jaw, as well as the lingual nerve; it then continues its course between the sterno-cleido-mastoideus, the mastoid process of the temporal bone, the ear, and the angles of the lower jaw, where it is covered by the parotid gland, in which it finally becomes imbedded. The stylo-glossus and stylo-pharyngeus, with the laryngeal nerve, run between it and the internal carotid artery, supporting it, or at least partially so, until it reaches the gland. It gives off eight branches.

1. The Ramus Thyroideus Superior arises usually from the commencement of the external carotid artery, occasionally from the common carotid, and sometimes from a trunk common to it and the ramus lingualis. It varies much in size, and runs downwards and inwards in a serpentine direction, to the upper border of the thyroid cartilage. It then descends a little in order to reach the thyroid gland, and divides into two branches. It is at first covered only by the fasciae and plotysmae-myoides, but subsequently by the sterno-cleido-mastoideus, omo-hyoideus, and sterno-thyroideus muscles, inclining inwards towards the superior part of the thyroid gland.

   a. The Ramusculus Thyroideus Superior is the continuation of the trunk, running to the thyroid gland; it inosculates with the same branch from the opposite side, and likewise with the inferior thyroideal branch of the subclavian artery.

   b. The Ramusculus Laryngeus Internus is distributed to the arytaenoid cartilages and epiglottis. It enters the organ of voice, attended by the ramus laryngeus internus nervi vagi, between the cornu of the os hyoïdes and thyroid cartilage: sometimes this branch arises from the external carotid artery.

2. The Ramus Lingualis is somewhat larger than the ramus thyroideus superior; it arises commonly just above the thyroïdal, and sometimes from the trunk of the external maxillary; it passes in a very tortuous manner upwards, inwards, and forwards, to the cornu of the os hyoïdes, where it passes beneath the hyo-glossus, and the middle constrictor muscle of the pharynx; the former muscle parts it from the lingual nerve. Thus far the direction of the vessel is horizontal, but it soon ascends in an almost perpendicular

* Syn. Stylo-Lingualis.—Dewhurst,
direction, being covered by the digastric, mylo-hyoid, and genio-hyoïdal muscles, and ultimately changes its course to run directly forwards beneath the tongue, where it assumes the name of the Ramusculus Raninus. It gives off the following branches:—

a. The Ramusculus Hyoideus takes the direction of the os linguale, and, running towards its superior border, forms an arch by inosculation with the corresponding vessel of the opposite side; it gives off several minute ramifications to the contiguous muscles and integuments.

b. The Ramuscui Dorsales Linguae. These are one or two in number, which take their origin where the artery is deep-seated, and inclining upwards and backwards, covered by the hyo-glossus muscle. They are destined to ramify on the substance of the tongue, as far back as the root.

At the anterior border of the hyo-glossus muscle, the lingual artery may be considered to divide into—

c. The Ramusculus Raninus, which is the proper continuation of the trunk, passing forwards to the tongue, beneath the lingualis muscle, and close to the outside of the genio-glossus, and finally near the tip of the tongue, contiguous to the fraenum; it terminates in an arch, by inosculating with the corresponding artery of the same name on the opposite side.

d. The Ramusculus Sublingualis* passes between the genio-hyoides and the sublingual gland, and, after piercing the mylo-lingualis, reaches the chin, where it gives off several small branches. In its course it supplies the sublingual gland, as well as the muscles passing between the chin and jaw to the tongue; it is sometimes larger than usual, and it will be found to supply the place of the ramusculus submentalis, and is in its turn supplied by that vessel, when deficient.

3. The Ramus Maxillaris Externus† is generally the largest of the three branches, and has its origin a little above the lingual branch. It passes upwards and forwards under the jaw, behind the platysma-myoïdes, the tendon of the digastricus, and the stylo-hyoides, but it rests on the external surface of the jaw-bone, being only covered by the integument and the platysma, and, being close to the margin of the masseter muscle, its pulsation can easily be felt. The artery thence ascends, inclining towards the angle of the mouth, being covered partly by the depressor anguli oris, and the zygomatica. It is very tortuous in its ascent, and then turns down, running in its groove to the superior surface of the sub-maxillary gland, as far as the margin of the jaw, over which it coils in order to reach the sides of the face. Becoming diminished in size, it proceeds to the internal canthus of the eye, by the side of the nose. It gives off the following branches:—

a. The Ramusculus Palatinus Inferior‡ passes to the posterior

part of the mouth, supplying ramifications to the tonsils, styloid muscles, and eustachian tube, the pharynx, the pendulum palati, and adjacent parts. It ultimately inosculates with

b. The Ramusculus Tonsillaris, which ascends by the styloglossus to the side of the pharynx, and terminates by dividing into several small branches, which are distributed to the tonsils and sides of the tongue.

c. The Ramusculi Submaxillares consist of a fasciculus of small ramifications, which pass into the substance of the submaxillary gland, whilst the artery is in contact with it; some of these are prolonged to the side of the tongue.

d. The Ramusculus Submentalis * departs from the artery near its turn round the jaw, runs forwards between the mylo-lingualis and digastric muscles. It is covered by the sub-maxillary gland, and, after giving off some ramifications to the gland and neighbouring parts, it divides at the symphysis of the chin into two smaller branches, one of which, the * R. Superficialis, passes between the depressor labii inferioris and the skin supplying both, whilst the * R. Profundus is situated between that muscle and the bone, sending ramifications to the substance of the lips, and inosculating with the Ramusculus Mentalis of the internal maxillary branch, just as it leaves the canalis mentalis. This and the R. Palatinus inferior are given off previously to the artery passing over the base of the lower jaw.

e. The Ramusculus Labialis Inferior † inclines somewhat inwards, and distributes its ramifications to the muscles of the lower lip, and forms free inosculations at the symphysis of the lower jaw.

f. The Ramusculus Coronarius Labii Inferioris ‡ originates near to the angle of the mouth, runs in a tortuous and transverse course upon the mucous membrane, is concealed by the labial muscles, in the centre of which it inosculates with the corresponding artery of the opposite side. Some of its ramifications pass upwards into the orbicular and depressor muscles of the chin, inosculating with the branches that ramify there.

g. The Ramusculus Coronarius Labii Superioris is larger and more tortuous than the preceding, above which it arises, taking a similar course as it proceeds inwards across the upper lip. It passes beneath the corner of the zygomatic and orbicular muscles, and forming an arch by inosculating with the corresponding one upon the opposite side.

h. The Ramusculi Buccales ramify on and in the substance of the cheeks.

i. The Ramusculus Nasalis Septi ramifies on the septum nasi.

k. The Ramusculus Nasalis Lateralis is distributed on the alae nasi, with those produced by the inosculations of the ramusculus angularis and with the ramusculus frontalis e ramo-ophthalmico arteriæ cerebralis.

* SYN. Arteria Submentalis.  
† SYN. R. Superficialis.  
‡ Arteria Coronaria Labii Inferioris.
l. The Ramusculus Nasalis Anterior is distributed to the anterior part of the nose.

m. The Ramusculus Angularis is the continuation of the trunk; it passes to the inner canthus of the eye, where it inosculates with the anterior nasal twig of the ophthalmic branch of the external carotid, also with the ramusculus transversalis faciei, and ultimately with the frontal twig of the temporal artery.

4. The Ramus Pharyngeus Ascendens Halleri. This is the smallest branch of the carotid. It arises from the commencement of the external carotid, and ascends in the same direction between it and the pharynx; it sends a few branches to the muscles of the pharynx, and then enters the cranium, at the foramen lacerum anticus, terminating on and supplying the dura mater, and then becomes the anterior meningeal artery.

The Ramus Posterior Auris is smaller, and rises higher than the former; it is often a branch of the ramus occipitalis; it passes on the posterior part of the external ear and external carotid, beneath the parotid gland, and inosculates with the temporal branches; it gives off one very small branch, called the ramuscunculus stylo-mastoideus; this goes to supply the parts occupied by the nervus communicans faciei.

The Oral Branches of the Temporal Artery. The ramusculus transversalis faciei is given off as it passes through the parotid gland, runs parallel with and above the stenonian duct, across the masseter muscle, accompanied by a branch of the nervus communicans faciei, and inosculates with a variety of vessels which are contiguous to it.

Oral Branches of the Internal Maxillary Artery.—Ramusculus maxillaris inferior passes down between the pterygoidei muscles, enters the lower jaw at the foramen maxillare posticum, runs along to canalis mentalis, and passes out at the foramen maxillare anticum; it inosculates with the inferior labial and submental arteries.

The Ramusculus Pterygo-Palatinus passes through the canalis pterygo-palatinus, and enters the mouth by the foramen palatinum porticum, and supplies the gums and interior of the teeth; it is distributed to the roof along the alveolar processes, and inosculates with the R. nasalis posterior.

II.—THE VEINS OF THE HEAD, FACE, AND NECK.

The veins of the head are very few in number, and are all of but little moment to the operating surgeon. The veins returning the blood from the head and part of the neck are united into the following trunks, viz.

The Vena Facialis is formed by the frontal vein, and by an intricate plexus of branches upon the face. It winds obliquely outwards and downwards at a distance from the artery; but in
crossing the jaw, goes close by the outside of it, and terminates in the external jugular vein.

The Vena Ophthalmica receives the blood from the orbit, and from the vessels of the eye and eyelids, by the venae vorticosae; it communicates with the vena frontalis, posteriorly with the sinus cavernosus, and with the vena angularis.

The Vena Angularis is situated at the internal canthus of the eye, communicating superiorly with the vena frontalis and the orbits, by means of the vena ophthalmica. The late Joshua Brookes was in the habit of bleeding occasionally from this vein in cases of ophthalmia.

The Vena Maxillaris passes from the inner canthus of the eye, and immediately along the anterior part of the masseter muscle, towards the angle of the lower jaw, where it terminates in the jugular vein.

The Vena Temporalis is formed by superficial and deep-seated branches from the sides and superior parts of the head, and running down upon the temple at some distance from the artery. These branches of the temporal vein form large inosculations, anteriorly with those of the frontal vein, above with their fellows on the opposite side, and posteriorly with the branches of the occipital vein. The trunk ascends at the anterior part of the ear, and along with the artery sinks into the substance of the parotid gland. In its descent before the meatus auditorius externus, it receives branches from the ear, cheek, and parotid gland, corresponding to arteries of the same parts. At the under part of the lower jaw, the facial and temporal veins commonly unite, and form the external jugular vein. Small veins from the pharynx, the internal maxillary veins, and the occipital, empty themselves into the internal jugular.

The Vena Lingualis sometimes terminates in the external jugular: one branch of this, the vena raafina, is seen under the tongue. The vena laryngea superior, and sometimes the vena laryngea inferior, terminate in this vein, but they generally enter the subclavian or top of the cava.

The Internal Jugular also receives branches from the muscles and adjacent parts in the neck, and at length terminates in the vena subclavia.

III.—THE ABSORBENTS.

The lymphatics on the outside of the head accompany the blood-vessels, and pass through glands in their way to the neck. Those accompanying the temporal artery go through small glands connected with the parotid gland, and also through others connected with the root of the zygoma. Those which accompany the occipital blood-vessels penetrate one or two minute glands, placed a little posteriorly to the ear, and over the mastoid process of the temporal bone. The lymphatics proceeding from the different parts of the face accompany
the branches and trunk of the maxillary artery. Some of them pass through glands situated upon the outside of the buccinator, while the principal trunks pass through a number of large glands placed upon the outer and inner part of the lower jaw, at the anterior edge of the masseter, and about the inferior maxillary gland.

The lymphatics from the inner part of the nose principally run in company with the internal maxillary artery, and pass through glands situated behind the angle of the lower jaw, where they are joined by those belonging to the inner parts of the mouth. The lymphatics of the tongue, and likewise those of the muscles, and about the other parts of the os linguale, enter the glands placed behind the angle of the lower jaw. From the superficial and deep-seated parts of the head the lymphatics generally accompany the external and internal jugular veins and the carotid arteries, receiving at the same time branches from the larynx, pharynx, muscles, and other parts of the neck. The principal part of the lymphatics go along with the internal jugular vein and the carotid artery, and in their passage form a remarkable plexus, which goes through the numerous glands seated near the blood-vessels, composing a chain, from which they are termed concatenæ. These are more numerous than any others in the body, excepting the mesenteric. The cervical plexus of lymphatics having passed through these glands, and having received some branches from the interior part of the thorax and axillary glands, unite at the bottom of the neck into a trunk, and sometimes two, which in the left side enters the ductus thoracicus near its termination, and on the right goes into the trunk, forming the general termination on that side. Ultimately this duct enters the left subclavian vein.

IV.—THE MUCOUS MEMBRANE OF THE MOUTH.

On examining the mouth, we perceive the gums to be enveloped by a continuous reflection of the mucous membrane of that cavity, or, as it is generally denominated, the buccal membrane, it being in fact a portion of the alimentary canal, and also the commencement of the mucous membrane of the whole tube. It exhibits great resemblance to the peritoneum in its numerous reflections within the abdominal cavity, although differing very widely from it in its nature; this being a mucous membrane, whilst that forming the peritoneum belongs to the class of serous membranes. It may perhaps not be inappropriate if we detail a brief account of the course and nature of the mucous membrane itself, and the various appearances it assumes throughout the whole of the alimentary canal, whereby the reader will perceive that in consequence of the numerous diseases which the digestive organs are subjected to, the morbid effects upon the gums may be easily accounted for.

As I have already observed, the mucous membrane constitutes a most extensive but continuous tube from the mouth through the intestines, and is united to the external organs and surrounding
tissues by means of delicate cellular substance, but on the interior it presents a moist surface, lubricated by the mucus which it secretes. If, however, we carefully examine it, and investigate its whole extent, we find it exhibiting a considerable resemblance to the peritoneum, both in its appearance and the characteristics it assumes in different parts through which it passes. For example, the epidermis, which we may trace from the lips into the mouth, from the sides of which it is reflected over the gums, tongue, soft palate, &c., may be found continued as far as the connection of the oesophagus with the stomach. However, we find it considerably thicker in the nasal fossae than it is elsewhere, it being soft and pulpy, but very closely adhering to the periosteum. It becomes extremely smooth in the pharynx, and is almost destitute of villi on its surface; it, however, exhibits considerable vascularity, and is of a deep reddish hue. A different arrangement occurs in the oesophagus, where we find it pale, thin, and forming longitudinal folds. In consequence of the contraction of the muscular fibres, it is evidently less vascular than the pharyngeal portion, and has not so many mucous glands. It becomes still paler as it approaches towards the cardiac orifice of the stomach; but, according to the observations of Dr. Yellowley,* it gradually becomes tinged as it becomes prolonged into the stomach into a roseate hue, particularly towards the splenic extremity and the greater curvature. The valvulae conniventes, in the small intestines, are formed by the duplicatures of this membrane, which diminish gradually in their number as they proceed from above downwards, and in the larger intestines they are not visible. In the course of this membrane several valves are to be observed at the interior of several parts of the alimentary canal, which are denominated in accordance with either their situation or the office they perform, among which I may mention the velum pendulum palati, the valvula ileo-colicæ, the pylorus, or gastro-duodenal valve, together with the valvulae conniventes, already noticed. To these may be added the rugæ of the stomach and intestines, which vary in number, and may either be increased or diminished, as the stomach may be full or otherwise. Besides these, there are several minute, delicate processes and fossæ connected with this membrane, which are well deserving of attention.

We find the whole of this mucous surface studded over with a great number of fine villi, of a conical shape; the summit of each exhibits a minute orifice, which leads to an absorbent vessel. Dr. Quain, however, doubts the accuracy of this statement, and believes them to be more of a laminated appearance than of a conical conformation, and states further that they are equally destitute of pores or apertures.† An immense number of papillæ are diffused, bearing some analogy in their structure to those we find on the surface of the tongue, but are of considerably smaller dimensions, and appear

* Medico-Chirurg. Transactions.
† Elements of Anatomy.
to be calculated to increase the extent of the absorbing surfaces. In many parts of its extent we find the mucous membrane elevated by small granules beneath it, the number and dimensions of which greatly vary in accordance to the parts in which they are found. For the most part these are convex and lenticular, possessing a minute pore on their external surface, and which answers the purpose of an excretory duct for the mucus it secretes. These granules are usually comprehended under the general tenour of mucous granules, glands, or follicles, and bear the name of the two anatomists who first described them. At the pyloric orifice of the duodenum these glands, although very numerous, are yet detached from each other at small intervals, hence they have been named glandulae solitariae, and, in honour to their discoverer, glandulae Brunneri: towards the termination of the duodenum they diminish considerably in number. Another set is divided into determinate series or groups, and first make their appearance in the jejunum, and about the inferior portion of the ileum become exceedingly numerous; these are called the glands of Peyer,—a term which, with that of the other set, ought to be abolished, and more appropriate ones substituted.

THE GREAT SYMPATHETIC NERVE.

We must now consider other organs which, in the sympathy existing between constitutional disease and the gums, are of the highest import to be correctly understood. I allude to the great sympathetic nerve and the par vaga. An increased vascularity of the gum being dependent on a disorganized state of the blood, and on increased arterial action, it is easy to conceive that the functions of the nerves supplying the gums become impaired when any thing occurs to interrupt the vital energy. I need scarcely say that through the brain the various nerves receive each their separate functions, the olfactory, the optic, the pathetic, the trigeminum, the ophthalmic, and the auditory, each connected with the brain, and receiving and transmitting its impressions accordingly. It is not our place here to consider how or in what manner such sensations are conveyed from the brain to the various nerves, in order to put in action the separate functions allotted to each; such points are involved in much obscurity.

As to the influence which sudden impressions of the mind have on the digestion, this may be clearly understood. Jaundice has been frequently produced by sudden impressions of grief; numerous are records of other contingencies occurring, the effects of sudden nervous impressions.

In derangement of stomach as well as of mind the gums sympathize greatly through nervous influence.

In constitutions of extreme sensitiveness and sensibility the gums and teeth partake of the general feeling; this is a fact in pains of the teeth well worthy of philosophic consideration. This is the
cause why we may perform an operation on the tooth of one person, when the same operation in another person's tooth is far too sensitive to endure. See the constitution in which nervous sensibility may have been roused writhing with agony, when even a delicate handkerchief may have had contact with a tooth. Let the physiologist watch the muscles of expression when any harsh substance may have rubbed the enamel of a tooth belonging to such a constitution. Let him go further, and even name to a person of extreme sensibility the circumstance of a substance of a harsh nature touching the enamel, and he will perceive on the face an involuntary shiver. On the other hand, we meet with persons living in the open air, and of hardy habits, whose teeth are outwardly unpossessed of sensibility.

"Oh fortunatos nimium, sua si bona norint Agricolas, quibus ipsa, procul discordibus armis, Fundit humo facilem victum justissima tellus!"

All this will lead us to the vast import of the doctrines of neurology, and at the same time deeply into the laws of sensibility, if we wish for a thorough knowledge of the mouth.

In doctrines which have lately been propagated, many curious cases are on record of paralysis of certain nerves being caused by a pressure on others.

There is a celebrated case known in London of pressure of the maxillary nerves causing paralysis of the leg. I saw a case in Paris which was more comprehensible; this was paralysis of the arm. I am indebted to my talented friend, Mr. Hunt, of Lower Brook Street, for two cases where there also existed paralysis by pressure on the maxillary nerves.

After these observations, I hope to be excused for describing the course of the great sympathetic nerve.

The ophthalmic ganglion is placed within the orbit occupying the external side of the optic nerve, and communicating by means of its posterior and inferior angle with the common oculo muscular nerve by means of a small twig, which is in general thick and short. By its posterior and superior angle it communicates with the Surculus Nasalis e Ramo Ophthalmico Willisii, through the means of a long and slender filament. I have never observed the ganglion ophthalmicum communicate with the cavernus plexus, nor the communication which Arnold states as existing between the ganglion meckeli and the one here described. The ciliary nerves take their origin from the ganglion ophthalmicum to the number of fourteen or fifteen; these nerves are extremely flexuous, and are disposed into two distinct parcels around the optic nerve, until they reach the posterior portion of the eye; then traversing the tunica sclerotica, distribute themselves over the ciliary ligament and the iris. During their passage along the optic nerve they often unite, and not unfrequently form one, two, and even three small ganglions.
The ganglion meckeli, or the sphenopalatine, is situated in the summit of the fossa zygomatica; it is generally of a triangular form, but it is very variable in its configuration. Occasionally it is replaced by two or three particular enlargements, according to the number of branches which, issuing from it, communicate with the superior maxillary. The ganglion meckeli sends off and receives from above two or three filaments, which form a means of communication with the superior maxillary. On its inferior side it furnishes three branches, which are denominated the palatine nerves. The principal one enters the posterior palatine canal; the others go to the velum pendulum palati, and also to the tonsils. Very often one or two twigs issue from the anterior part of the ganglion meckeli, in order to unite with a twig which descends from the superior maxillary, and forming with it a small ganglion, the twigs of which pass into the maxillary bone.

The internal branches are three in number, but become lost in the nasal fossa and pharynx, one called the naso-palatine enters the fossa through the foramen sphenopalatinum; it traverses the arch of this cavity, and is fixed to the velum pendulum palati. Obliquely descending posteriorly, it passes forwards to the anterior palatine canal, where it is connected with the branch from the opposite side. Prior to their entering this canal, sometimes we perceive a slight ganglionic enlargement at the point of this union. From this enlargement, or rather from the trunk which results from the union of the two nerves, four or five small rami come to their origin, and are distributed over the palatine membrane and also over the delicate tissue of the gums. The slight enlargement which I have just described, Mons. Hyppolyte Cloquet has given the name of naso-palatine ganglion.

From the posterior surface of this ganglion the vidian twig of the pterygoid filament takes its origin. This important branch extends from the anterior to the posterior part of the canalis vidianus ossis sphenoidalis, and when it arrives at the posterior part of this canal it divides into two or three small twigs, but more generally into two; when there are three, two of them enter the canalis caroticus, and connect themselves with the ascending branches of the superior cervical ganglion. In some instances we find that one of them receives the petrous branch, discovered by Dr. Jacobson of Copenhagen. The superior is deemed to be the continuation of the vidian twig; inasmuch as it enters the cranium by means of the foramen lacerum anterius, and passes over the cerebral or internal carotid artery, becomes situated between two laminae of the dura mater, in order to arrive at the anterior surface of the petrous process of the temporal bone. When it arrives at this part it passes along the channel which precedes the hiatus fallopia, and is soon lost upon the nerve in the aqueductus fallopii. Mons. H. Cloquet supposes that this branch of the nerve only unites itself with the facial to separate afterwards, under the name of the chorda tympani; but Mons. Manee states that from numerous dissections he considers
the latter to be a branch of the facial, which differs entirely from
the vidian by its volume, its harder consistence, and its colour never
inclinling to red like the vidian.

The submaxillary ganglion is placed upon the internal face of the
submaxillary gland, a little below the stylo-glossus muscle; it
receives by its superior part two or three filaments, which come
from the lingual branch of the inferior maxillary. From its anterior
part spring many filaments, which go to this nerve, to the sublingual
gland, and to the buccal mucous membrane. The inferior part of
the same ganglion gives off small branches, which are distributed to
the submaxillary gland, and communicate with the branches of the
carotidian plexus, which accompanies the submental artery upon
this gland.

The superior cervical ganglion is situated upon the anterior and
lateral part of the second, third, and fourth cervical vertebrae, from
which it is separated by the great straight anterior muscle; externally
it corresponds with the internal jugular vein; internally with the
cerebral or internal carotid artery; and anteriorly with the hypo-
glossal, pneumo-gastric, and glosso-pharyngeal nerves. This gan-
glion furnishes five orders of branches.

First. The Rami Superiores are two in number, sometimes three
are found; these are situated posteriorly to the internal carotid or
cerebral artery; they mount upwards towards the canalis caroticus,
which they penetrate and pass along it, twining round the artery.
Whenever a single branch springs from the cervical ganglion, it
always divides into two or three filaments at the moment when it
penetrates the canalis caroticus. These filaments, as in the first case,
twine around the artery, and constitute a species of plexus, wherein
is almost constantly found a long ganglion, denominated the carotid
ganglion; when it arrives at the cavernous sinus these nerves form
a plexus, bearing that name; from this organ two twigs separate,
which vary in their dimensions, and communicate with the external
motor oculi; another filament uniformly extends to the first branch
of the trigeminal, and is united with either its trunk or its nasal
ramification. Another filament arises from the same carotid plexus,
and, attaching itself to the inferior part of the sixth pair, occasion-
ally communicates with this nerve, and then, passing through the infe-
rior part of the sphenoidal fissure, slides over the pterygoid processes,
and is lost in the ganglion meckeli. It is probably this twig that
Dr. Boch supposed was furnished by the external motor oculi.
Other branches of the carotid ganglion, and of the cavernous
plexus, accompany the internal carotid artery as far as its first and
second division. I have already mentioned, when describing the new
vidian twig, the filaments which it gives off for the carotidean
canal, likewise the branch discovered by Dr. Jacobson, which goes
thither; so that the plexus cavernosus is formed by the branches
ascending from the superior cervical ganglion, one or two filaments
from the vidian twig, and a very small one from the glosso-pharyn-
geal ganglion.
Secondly. The Ramus Inferior. This is rarely discovered double; it descends upon the great rectus muscle as far as the middle cervical ganglion, or the inferior; when the middle does not exist, several small twigs, the number of which vary, take their origin from its external side, communicating with the cervical nerves; its internal side likewise gives off some filaments, but these are far more slender; the one extending along the carotid, the other uniting with the superior cardiac nerve.

Thirdly. The Rami Externi are exceedingly variable in number: they communicate with the first, the second, and the third cervical pair; that passing the first gives out a small twig, which anastamoses with the hypo-glossal and the nervous branch, and passes over to the transverse process of the atlas, and the others, which are very diminutive, pass to the great and little recti muscles.

Fourthly. The Rami Interni amount to seven or eight in number; they are soft and flexuous; the superior are oblique from above below; the others are almost transverse; they all go to the lateral parts of the pharynx; they anastamose with each other, and with the twigs of the glosso-pharyngeal, of the superior laryngeal, and the pneumo-gastric, to constitute the great pharyngeal plexus. From this plexus arise the branches which go to the constrictor muscles, and others which accompany the external carotid artery and its branches. These may be followed until the third termination of this artery; those which follow the ramus thyroideus superior pass forwards as far as the crico-thyroidal membrane.

Fifthly. The Rami Anteriores are distinguished into the superior and inferior. The first communicates with the facial, the pneumo-gastric, and the hypo-glossal. The inferior forms the roots of the superior cardiac nerves, which are most commonly three or four in number. Here only two are seen arising from the ganglion; they descend behind the pneumo-gastric nerve and the primitive carotid, uniting with a filament coming from the inner side of the superior branch, in order to constitute a single nerve, which unites with a branch of the recurrent; in passing downwards it gives off two or three ramuli, which go towards the primitive carotid. It is to be remembered that this superior branch is but seldom united with the other cardiac nerves.
vian artery, and divides into two branches. The main branch passes behind the root of the lungs, and ascending forms the recurrent nerve; it passes up on the right side behind the carotid artery, and on the left side turning round the arch of the aorta, gives off filaments uniting with the great sympathetic. It continues its course upwards, sending branches to the oesophagus and thyroid glands, and filaments which pierce the cricoid and thyroid cartilages.

Having sent off the recurrent branch, the nerve descends by the side of the trachea, and sends branches forming the anterior pulmonary plexus, and branches behind the root of the lungs, which constitute the posterior pulmonary plexus.

The trunks of the nerve passing upon each side of the oesophagus unite and split, forming a net-work, called the oesophageal plexus. It pierces the diaphragm with the oesophagus, supplies the lesser arch of the stomach, sending branches to the cardiac extremity and other adjacent parts. Sir Charles Bell, on this nerve, says, “Thus we see that the par vagum has a most appropriate name, and that it is nearly as extensive in its connections as the sympathetic itself. It is distributed to the oesophagus, pharynx, and larynx, to the thyroid gland, vessels of the neck and heart, to the lungs, liver, and spleen, stomach, duodenum, and sometimes to the diaphragm. The recollection of this distribution will explain to us many sympathies; for example, the hysterical affection of the throat when the stomach is distended with flatus, the exciting of vomiting by tickling the throat, the effect which vomiting has in diminishing the sense of suffocation, that state of the stomach which is found upon dissection to accompany hydrophobia, whether spontaneous or from the bite of a dog.”

The par trigeminum is also well worthy to be referred to from the circumstance of its supplying the teeth, and from the important connections it has with the sympathetic, cervical, and other nerves.

In the seventh pair of nerves it may be necessary to observe the portio mollis and the portio dura: the former is the acoustic or auditory nerve; the portio dura sends off a branch which crosses the tympanum, and is in communication with the gustatory branch of the inferior maxillary nerve, accounting for the pain in the ear sympathizing with tooth-ache.

The various branches of the portio dura going to the neck and throat are also well worthy of consideration, being connected with the organs of respiration, and from the expression being influenced by them to a great degree, when the parotid glands and buccal membrane are inflamed.

* For an explanation of the branches of the par trigeminum going immediately to the teeth and gums, see “Surgeon-Dentist’s Manual,” page 76.
GENERAL OBSERVATIONS.

I HAVE thought it advisable to describe the various blood-vessels entering the parts in contact with the gums, to elucidate more clearly the influence which increased arterial action has over them. This influence is rendered much more important from the numerous ramifications of arteries which enter their substance.

The colour of the gums ought to partake of the same tint which the healthy colour of the blood assumes. When, however, inflammation prevails, the gums assume tints which are characteristic of this state. If we examine blood when cold, which has been taken from the gums, we find it partaking of the same phenomena as blood from other parts of the frame. Its crassamentum is thick when inflamed, its colour more frequently approaches the colour of venous blood, the serum may be separated easily from the crassamentum, and the appearances as to inflammation are the same as in blood abstracted from any other inflamed part.

The phenomena regarding the heat of blood, in considering the pathology of the mouth, must also be well deserving of notice; for, when inflammation is present, febrile symptoms arise, the saliva becomes hot and frothy, and the gums swelling, frequently elongate and put on a disorganizing action.

With increased arterial action the venous circulation through the gums is retarded, and, from the stasis of the blood thus produced, debility ensues. The following observations by Sir Charles Bell may elucidate in a great measure this point:—"The French Physiologists have departed from the old method of Harvey in explaining the circulation. He wisely took the heart as the centre of the system, and described the vessels going out from it, forming the two circulations, viz. through the body and through the lungs; but they have assumed the lungs as the centre; and the veins of the body, and the arteries of the lungs, they call Système à sang noir, because it contains the dark-coloured blood and the pulmonic veins; and the arterial system of the body they call Système à sang rouge, because it conveys blood of the bright vermilion colour.

It is this stasis of the blood in the veins, added to the greater variety in their distribution than in that of the arteries, which accounts for the appearances of colour in the gums when under the influence of increased action.

The following observations of the highly-gifted individual we have just quoted will also afford some insight as to the circulation through the gums. "The most beautiful phenomenon may be seen, by the aid of the microscope, in the circulation of the blood from the arteries to the veins. When the web between the toes of a frog is submitted to the microscope, the eye at first discovers only a confused motion of particles; but, by a steady continuance of the observation, we are soon able to observe the motion of the red particles of the blood. We distinguish the arteries by the
rapidity of the particles passing through them in single piles, and, pursuing these particles, they are observed to turn suddenly into larger vessels. These vessels, by the number and slower motion and altered direction of the red globules, are recognised to be the veins."

In the pointed apices of the gums, where they dip between the interstices of the teeth, congested blood remains frequently to some extent. From their peculiar shape such an occurrence might be well anticipated; but, pathologically considering the point, it is one of very high yet unexplained import. The gum around becomes insensible, and a morbid exudation then takes place, which is totally incompatible with the proper performance of the functions which nature has assigned to these parts, and which is of high import to the purity of breath.

The remote distribution to other organs, of those nerves which supply the gums has likewise a great influence over their peculiar circulation. The par vagum running on each side of the oesophagus, and the connections with the great sympathetic and par trigeminum, influence not only the gums, but the teeth in a surprising degree: hence arise nervous pains in the teeth and gums unconnected altogether with decay, or any affection whatever of these organs, and hence also the common error, of extracting teeth indiscriminately, which suffer not from any disease which affects themselves, but from the sympathies with which they are bound to the whole economy.

Nervous excitement is in this instance greatly to be considered, and I need not mention doctrines regarding the influence of the brain over the digestion; these are expounded by other writers.

There is no part of pathology which will afford greater opportunities to researches, both novel and important, than the appearances which present themselves in the gums as influenced by the changes of health. As the pulse indicates febrile, debilitated, and other symptoms, so the appearances which the gums assume show the state of derangement of the digestive organs, &c. This is in a great measure by the mucous membrane of the mouth sympathising with the same membrane in the stomach.

There are also other views of this subject well worthy the consideration of the pathologist. A relaxation of the schneiderian membrane of the nose transmits, in an important degree, an influence to the gums; cyananche tonsillaris, both chronic and acute, possesses also its own power over them; by the same rule in pulmonary and other complaints the effect of derangement of the mucous membrane of the alimentary canal is soon perceived in the lungs, trachea, &c.

The same order of effects being reversed, irritation set up in the gums produces great constitutional sympathy, and this is sometimes excessive; indigestion, sore throat, cough, relaxation of the schneiderian membrane of the nose, great depression of spirits, increased and heated saliva, fever, and other concomitants.
In the cold winter of 1823, a young woman was admitted into the Hôtel Dieu of Paris, under the following circumstances:—

Suffering from a violent attack of tooth-ache, she went to a pharmacist’s for something to relieve it. A man in the shop persuaded her to have it touched with a heated iron; on her going into the cold air, an excessive pain continued in the gum, which began to swell; by the evening the pain was most agonizing, the cheeks were swollen, great fever was set up, and delirium supervened; next morning the effects of the incautious operation were dreadful; the cheeks and head were swollen to an enormous size,—the nose and mouth scarcely perceptible; in the evening, the eyes, which were closed by inflammation, were shut, never again to open.

Serious effects are oftentimes produced by these ill-judged operations, such as great dejection of spirits, prostration of strength, swelling of the cheeks, fever, and delirium. We might fill volumes in recording the numerous accidents to the constitution from the effects of pivoting teeth. A very eminent dentist and my late father were dining with a distinguished baronet; the former was seated next to a lady who was very affable. He requested her in the course of the evening to call on him, and said he would render her an essential service. He devoted a considerable time to her teeth, and pivoted four upper teeth and the lower canines. On being offered remuneration, he said, “Do you think I have no honour in me?”—So far his intentions were perfect; he had not, however, calculated on the irritability of the constitution he was dealing with; a sudden and dreadful inflammation supervened, attended by its usual depressing concomitants. The severity of the shock to the nervous system produced miscarriage at about the seventh month, and the patient’s life was with difficulty saved. The ill effects, however, of the operation, long afterwards remained perceptible; the nervous centre was excited to unusual irritability, and blotches came out in the face. The patient did not survive many years, and it was always imagined that the irritability which the operation excited hastened in a great measure the latter event.

I would prefer throwing a veil over many untoward events which the operation has produced to recording them in these humble pages. Many have terminated in death.

It is much to be regretted that, when dentists have arrived at a proper knowledge of their profession, they keep the minutæ of such knowledge so much to themselves. This may have arisen from their usually arriving at conclusions by practice, which theoretically they are incapable of accounting for. It is also to be considered that the operations on the teeth are themselves easily arrived at; and hence those who take a limited view of their acquirements and duties may fear their sinking by their own insignificance did they ever become generally known. This is particularly perceptible in those who make false teeth their principal object. I would repudiate to the utmost of my humble power the charlatanerie and narrow-mindedness of many of these savans, and would guard every one
against impositions with which this town overflows—we must proceed to other considerations.

It is a matter of the highest importance, when the gums assume tints indicative of an irritable habit of body, that previously to teeth being pivoted, the constitution should be well prepared for the operation; that at the time of performing it, all sensibility in the root should be deadened, and the gum corresponding to the extremity of the root freely lanced. This acts with a double effect; it first produces a discharge of blood, and secondly, forms a counter-irritation.

When inflammation is much to be apprehended, the following prescription ought to be had recourse to:

Ext. Col. Comp. gr. viij.
M. Pil. ij. horā somnī sumendāe.
Inf. Senna ⅓ss.
M. To be taken in the morning.

On the following day, continuing spare diet, let a Seidlitz powder be taken, and at night take the following pill:

Ext. Col. Comp. gr. iv.
M. Pil. i.

In the morning let a Seidlitz powder be taken, and the operation may then be performed.

The physiology of the gums cannot be understood without an insight into the absorbent system; for besides the complication of arteries and veins, their substance is made up of minute glands and lymphatic vessels, the whole of which are connected together by cellular tissue.

"The capillary vessels are those extreme branches which are as minute as hairs; but this, though the literal, is not the general meaning of the term. By capillary vessels is rather understood those branches in which the changes are wrought from the blood, and which are either so minute as not to allow the promiscuous flow of the particles of the blood, or possessed of such a degree of irritability and appetency as only to allow certain parts of that fluid to be transmitted.

"It is proved that in the living body there is no exudation; but no sooner is the animal dead than the fluids exude from the vessels, the secretions pass through the coats of those receptacles which formerly contained them, and one part partakes of the colour of another which is contiguous.

"The lymphatics forming a set of absorbents, we might say that they take up all the fluids which have been thrown out upon the various surfaces of the body. Thus they are found on the pores of the skin, on the surfaces of the cavities and viscera which are covered by the pleura and peritoneum, in the cells of the interstitial and adipose membrane, and in all the ducts and cavities of the body."

Absorption is the function assigned to this system of vessels.
It is not our place to enter here into the whole system of absorption. I cannot do better than refer to Sir Charles Bell's work on the Anatomy and Physiology of the Human Body, in the second volume of which it may be found laid down, that the gums with the changes of the body are influenced greatly by the absorbent system. In early life, there may be said to be a continued renovation of parts; and this is peculiarly perceptible in the doctrines of osteology. At middle life, or a little after, the body begins to decrease, the bones get lighter, their prominent edges become rounded, the edges of the sockets of teeth are blunted by the waste going on, and in the general process the gum itself shrinks to a very considerable extent.

I need scarcely mention the number of mouths which are ruined by a residence in India. Independently of the liability to diseases which require the free use of mercurials, the languor and debility which the climate produces have also a wonderful effect on the gums. Persons who are in the continued habit of inspecting various mouths may form an idea of those which have been ruined by a long residence in an oriental country; this is more particularly perceptible in those patients who suffer from diseased livers. In the appearances which these cases present, there has been a strong action of the absorbent system on the gums; and their sensibility is frequently excited to a considerable degree; arterial action has also been roused, while we perceive a debility and inactivity of the veins, and the gum altogether of a deadened and dark purple colour.

We seldom find dyspepsia unattended by a swollen state of the gums. In this, and in all diseases of the stomach, the mucous membrane of the mouth partakes of the general irritability. That irritability, the effects of which are apparent in the furred state of the tongue, &c., is also apparent in a state of the gum. These sympathies would open a vast field for speculation, but it is merely necessary here to allude to them.

We may also consider the constitution of the healthy and robust; their constitution is mostly untainted by hereditary predispositions; their digestion has through life gone on well; the mucous membrane of the alimentary canal, trachea, &c., being healthy, that of the mouth is found in the same state.

Let it not, however, be imagined that I include in this all constitutions apparently healthy; beneath a florid complexion is frequently concealed a predisposition to scorbutic humours and apoplexy, and it is a common occurrence to see a mouth in a most unhealthy state belonging to a person with superabundant health. I do not allude so much to the teeth being decayed as I do to a disease to which the gums are liable, and which we shall hereafter consider. There is, however, a very important caries dentium, to which these constitutions are subject, which is too peculiar to remain unnoticed. In a classification of my own, I bring it in under the head of the nigrosa. Its peculiar characteristic is, that whilst disorganization of one part is going on, another part assumes a compensative action, and almost all sensibility is deadened. This is one of the most peculiar features in the diseases of teeth. It is, however, my opin-
ion, that although a peculiar action is going on in the tooth, the constitution has much to do with the absence of pain.

In considering the phenomena displayed between the gums and the constitution, hereditary predispositions must also be brought before our notice. There is invariably a strong resemblance in the mouth of a child to that which manifests itself in the parents; in the state of the teeth and appearance of the gum this becomes an essential consideration.

We may well regard all the variations which manifest themselves through life in the gums as very complicated; they should, however, be well understood. It is of the greatest importance that a free circulation should be kept up through their substance, to prevent the effects of disorganization; for it is melancholy to see a face which else might boast the greatest beauty, associated with gums of a dark and deadened purple appearance: but the means of promoting a healthy state of the mouth are easy and attainable. It is but necessary, that gums assuming these appearances should be generally distinguished.

If a question were asked as to what most influenced the loss of teeth, it could not be denied that it is the sympathy between the gums and the constitution. If a second question were put as to the immediate influence the gums transmit to the teeth, the answer would be that they send their influence to them in a twofold degree.

1st. The morbid exhalations and exudations from diseased gums decompose the structure of the enamel, and by decaying the teeth exert a primary influence over them.

2dly. Regarding their loss through looseness, the sympathy between the gums and the constitution is greatly concerned; for when the former become inflamed the periosteum is also in the same state. There are also many other considerations of great import to the gums. A properly regulated diet adapted to the exigencies of the constitution, and according to the strength and fatigue the system is capable of enduring. We see the gums of a bon vivant swollen and unhealthy, and when the system is below par we also see them unhealthy and irritable.

From observations I have made in my intercourse with various classes of society, I would give the former gum to luxurious citizens and the latter to the refined branches of our female aristocracy.

In all diseases of the teeth, whether resulting from constitutional disturbance or from the effects of external applications, the gums are in a certain measure affected. If at the onset, when a decay is incipient in a tooth, there should not appear any degree of irritation in the gums, still the moment the nerve is affected, irritation is known to supervene.

On the teeth themselves diseased gums exert a primary influence throughout all the variations of life; the child and the adult, the middle-aged and the old person, each possessing these organs in a bad state if the gums be unsound and impure.
SENSIBILITY.

SENSIBILITY is that faculty of the vital principles which renders us capable of receiving impressions, and which regulates, according to the extent in which we possess it, our feelings and our pain.

In the various secretions necessary to the exigencies of life this faculty is greatly concerned; and this is not the case with man alone: in animals and in vegetable nature "it presides over the phenomena of nutrition."

Sensibility united with contractility is in the earliest stages of our formation directly concerned; for by them certain involuntary actions are performed which perfect the formation of the bone. The flow of bile, and the muscular motions of the heart, are also influenced by this faculty. It will be well, however, to consider the difference between sensibility and contractility: this will be found explained in physiological writers.

The manner in which various parts of our body imbibe sensations is peculiarly worthy of our consideration; the eyes are not acted on by sound nor the ears by light, nor do purgative medicines act equally through their course; each intestine has its separate sensibility attached to it, and each is acted on accordingly.

Richerand makes the following observation on a fact well worthy our consideration:

"After teeth have been shed or extracted, the edges of the alveolar processes and the gums become thin from contraction, and the alveolar cavities disappear. These facts appear to me to prove, better than all the experiments performed on living animals (experiments of which, by the bye, the results ought not to be too confidently applied to the phenomena of man), what one should think of the assertions of Haller and his followers on the insensibility and irritability of the serous membranes, and of the organs of a structure analogous to theirs."

It is by these peculiar laws of nature that we account for the extent and difference of pain connected with the gums and teeth. After mercury has been administered to a considerable extent, we see sensibility roused in the gums and teeth. We also see occasionally the bone of the neck of a tooth so peculiarly sensitive that to touch it produces the greatest agony; we find the gums also in the same way. All these peculiarities admit of easy explanation, when we understand the laws of sensibility.

I have referred in another part of this work to the inosculations between the chorda tympani and the gustatory twig of the inferior maxillary branch of the par trigeminum. It will be well worth while to bring it again under our notice.

It is this inosculations which accounts for the peculiar sensibility of the teeth when a hard grating noise stimulates the acoustic nerve; the intensity of this feeling varies in different persons. In very nervous subjects I have known it excite the most distressing sensa-
tions, accompanied by an increased flow of saliva. But this is not all; for even the description in words of the causes producing such grating sensations, such as rubbing coarse cloth on the teeth, &c., is productive of great distress to many persons.

I knew a lady residing at Clapham, who, on flowers being introduced into the room, fell into a state of syncope. This is from the vidian twig of the par trigeminum forming an inosculation with the great sympathetic, which nerve principally influences the heart.

As, however, it is of the highest importance that the doctrine of sensibility be understood, it may be well to enter a little into it. As it is explained by most physiological writers, sensibility is both percipient and latent, and contractility is voluntary and involuntary.

In the first place, sensibility may be considered as flowing from a source which becomes repaired, drained, and exhausted, and which is sometimes concentrated on certain organs.

2dly. It diminishes with age, and at the period of birth it is said to be very considerable.

3dly. A liveliness and frequency of impressions wear it out very early, but it recovers its delicacy when the sentient organs have been at rest; in like manner contractility is exhausted in those muscles which are fatigued, and by repose they recover their energy.

4thly. Sensibility forsaking one organ becomes concentrated in another. Hippocrates tells us that two parts of the body cannot be in great pain at the same time; tooth-ache is frequently cured by stimulants applied to other parts, also by fear and other nervous impressions. In the same way we may consider the perfection of the senses, for one sense becomes acute when another has lost its energy.

5thly. During sleep, the exercise of the percipient faculty and that of voluntary contractility is entirely suspended.

6thly. Sensibility is more lively and more easily excited in inhabitants of warm climates than in those of the colder regions. Inhabitants of the Northern Pole can have wounds inflicted on the soles of their feet without enduring pain, while the African is thrown into violent convulsions by the most trifling impressions.

7thly. Sensibility is said to be greater with women and children than with men, and the nerves are also larger and softer, speaking proportionately, to other parts of the body. The principles of sensibility diminishing with age appear working towards their complete exhaustion, but it is said that at the approach of dissolution an effort is made either to cling to life or to completely exhaust it.

8thly. Nervous women are usually very thin, and persons of sensibility are seldom overburdened with fat.

It may now be well understood that one person is capable of receiving impressions which another cannot possibly endure; that when the uterus becomes excited, pain may centre itself in different parts along the course of the nerves, sometimes in the back, in the side, in the gum, or in the tooth; this latter circumstance is too frequently the case. Nor is it less remarkable that, in delicate
females, the nerve of a tooth being irritated, the uterus sympathises to so great an extent that miscarriage is frequently produced.

SYMPATHY.

We must now proceed to another faculty, without which our subject would be unexplained. The term sympathy means the relations which the various parts of the body evince towards each other, carrying on a reciprocal intercourse of relations and affections, and a perfect harmony of all actions which take place. When any particular part of the body becomes irritated, it is well known that another, nay, very distant part, may participate in that irritation; that cases of locked-jaw have been produced by injuries to the tendons of the extremities; that pressure on the maxillary nerves has produced paralysis of the muscles of the chin, of the arm, and even of the leg. Although beyond doubt this effect has been produced, nevertheless the more immediate causes producing it remain involved in considerable obscurity.

Richerand makes the following observations on sympathy:—

"Whytt has clearly shown that the nerves cannot be considered as the exclusive instruments of sympathy, since several muscles of a limb which receive filaments from the same nerve do not sympathise together, while there may be a close and manifest relation between two parts of which the nerves have no immediate connection, since each nervous filament having one of its extremities terminating in the brain, the other, in the part to which it is sent, remains distinct from those of the same trunk, and does not communicate with them.

"It is by means of sympathy that all organs concur in the same end, and yield each other mutual assistance. It affords us the means of explaining how an affection, at first local or limited in its extent, spreads and extends to all the systems. It is thus that every morbid process is carried on."

The affections of the stomach are perhaps more directly concerned with our subject than those of any other part of the human frame. Accompanying the nausea, head-ache, and constitutional derangement, we have sympathetic pain extending to the gums and even the teeth.

Those sympathies furnish us with an explanation why, when the stomach is out of order, we have rheumatic affections of the jaws with disturbed nights; why tooth-ache is under such circumstances so liable to occur, and is so terrible; why that gum which before was firm and hard becomes extremely sensitive, swells, and suppurates; why the constitutional languor and dejection are so excessive; why palpitations of the heart on motion, syncope and delirium, are also accompanying characteristics produced by swellings of the gum.

While on this head, we may refer to the great sympathetic chain linking the gums through life to the health and temperament; we

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may go from the restless babe to the decrepit old man; we may see
the separate relations that our organs bear to each other in the dif-
f erent periods of life, each sympathising and extending its sympathy
all around. In the female constitution the periods of pregnancy
produce powerful changes in the gums. Added to the continuity
of membranes, which is a powerful source of sympathy, the whole
system of the sympathetic nerve forms a chain, whose links vibrate
throughout the entire body. We frequently see pain centre itself
in a tooth when the uterus is undergoing changes, and the gums
assume a swollen condition, sympathising with the physiological
state of that organ. Another consideration must be mentioned be-
fore we quit the laws of sympathy. It is a correct knowledge of
sympathies which teaches us how to apply counter-irritation to
relieve pain fixed in any particular organ; and to guide us whole-
somely as to when we should and when we should not interfere with
the operations of nature.

There exist many other points connected with the gums which
might lead us to more extended views of those secret links which
establish consent in the functions of all our organs.

The present observations will, I hope, determine the necessity of
a thorough knowledge of the subject before we can treat the diseases
of the mouth.

THE INFLUENCE OF THE PASSIONS OF THE MIND
ON THE GUMS.

It may be thought singular that I should treat on this subject as
connected with the diseases of the gums; daily experience, however,
tells us that the bodily health and the passions of the mind recipro-
cally depend on each other.

The passions of the mind have been commonly considered of two
kinds in respect to the state of the body, viz. exciting and depressing
the vital powers, producing analogous effects on the functions to
those arising from the operation of stimulant and sedative agents of
a material nature. Among the former may be mentioned anger,
terror, joy, cheerfulness, hope, desire, love, admiration, and the
emotions of refinement. The depressing passions are grief, fear,
shame, and anxiety. It is a matter of daily observation that the
agency of these exciting and depressing emotions in the animal
economy follows the same laws as that of the material stimulants
and sedatives. The moderate enjoyment of the former contributes
to the free and perfect performance of all the functions, and thereby
to the general state of the health; and debility, with all its train of
constitutional effects, equally ensues from an immoderate influence
of the exciting and from the direct operation of the depressing causes.
The operation of the passions and emotions, both as a cause of health
and disease, and also as a remedy in many morbid conditions, is il-
"illustrated by the observations of many physiologists and pathologists,
and by numerous cases which have been recorded by the illustrious Baron Haller.

The exciting passions have been known to produce the following effects on the human frame: cheerfulness and moderate joy are found to give vigour to the circulation, to increase the action of the heart and arteries, consequently to support the vital functions connected with it. They render the perspiration easy and free, increase the heat of the body and the perspirable fluid; they likewise aid the operations of digestion and secretion in the various organs. This state may therefore be considered favourable to the enjoyment and recovery of health, where the body is languishing under general debility. When, however, the excitement of joy has been excessive and sudden, it has sometimes brought on acute fever, syncope, and, in a few persons, sudden death.

Sophocles, as we are informed by the Vit. Annon., died after being proclaimed victor in a dramatic contest.

By the same rules, laughter tends to good intent when moderate, and abscesses in critical situations have been burst by its effects. Hope, which is the most pleasing state the mind can be in, exerting a beneficial influence on the body, and producing serenity of thought, has often tended to lengthen existence. It may be said to be the passion of the mind which is the last to leave us, continuing to linger till almost the extinction of the vital spark.

The ardency of ambition, especially if attended with a prospect of success, produces similar effects. Its excitement has been so powerful in some instances as even to have cured paralytic affections, and roused the body to exertions far beyond those which it appeared capable of sustaining.

But there's a passion whose tempestuous sway
Tears up each virtue planted in the heart,
And shakes to ruin proud philosophy.

Anger rouses the powers of the body and mind, impelling them into action, quickens the pulse, producing redness and heat of the skin. These exertions are often so violent as to exhaust the vigour of the nervous system, as appears by the tremor of the limbs and faltering voice by which they are accompanied. When this passion has been vehement, various diseases have been produced, such as ecchymoses, apoplexies, haemorrhages, great distension and rupture of the heart, ruptured cicatrices of wounds, local inflammations, profuse perspirations, vomiting, and diarrhoea. The increase of the biliary secretion by this passion is very remarkable, and is mentioned both by ancient and modern authors, in so much that with them bile and choler are synonymous with anger. On the other hand, their stimulant effects have under certain circumstances proved beneficial.

Love, which is said to be the strongest of all the passions and the least under the control of our reason, may as well be passed over.
The poets advise—

With caution and reserve
Indulge the sweet destroyer of repose,
Nor court too much the queen of charming cares;
For while the cherished poison in your breast
Ferments and maddens, rich with jealousy,
Abstain distrust, and lessen anxious joy,
The wholesome appetites and powers of life
Dissolve in languor; the coy stomach loathes
The genial board; your cheerful days are gone.
The generous bloom that flushed your cheek is fled,
To sighs devoted and to pensive pains,
Pensive you sit or solitary stray,
And waste your youth in musing.

The love of Antiochus for his step-mother Stratonica is said to have been discovered by his pulse.

The depressing or debilitating passions produce an opposite effect; they rob the body of its vigour; diminish and interrupt the secretions, weaken the digestive powers, and if continued wear out the energies of life. Grief enfeebles the body by its sufferings, the circulation is rendered slower, occasioning obstruction of some of the viscera. The digestive organs no longer perform their functions properly; the nervous system is rendered irritable, the temper becomes peevish, and, the mind being occupied with its own ungrateful feelings, the unhappy individual often falls a prey to melancholy and dies of a broken heart.

Indolence and solitude are ever the supporters and nourishers of grief; society and occupations are the remedies for its alleviation. When grief suddenly supervenes, it causes palpitation of the heart, and renders the pulse irregular.

Blindness, gangrene, and sudden death have followed excessive grief, and reports of its changing the colour of the hair are by some persons believed.

Fear is an analogous passion to the preceding; it weakens the whole of the mental faculties and vital actions. Bashfulness, anxiety, and terror are all different modifications of this passion.

One of the most remarkable passions is nostalgia, or the vehement desire of visiting one’s native country; this is similar to grief, and hope is its cure.

It will be now necessary to state my motives for dwelling on the passions of the mind. I knew a lady who was afflicted with great grief and anxiety; the digestive organs became deranged to a very considerable extent, and great nervous excitement was roused in her constitution; pain became suddenly fixed in the gums corresponding to two front teeth; they dropped and became extremely loose. Her age was forty-four.

An English officer detained prisoner of war at Verdun, and who possessed very strong teeth and healthy gums, laboured under all the symptoms of nostalgia. Although permitted to go out, he took
his imprisonment so much to heart that he never stirred from his room; pain in a similar manner to the case above named centered itself in the gums; the teeth loosened and were extracted. It was an inordinate action of the vessels of the gums, caused in both instances by the mind and body sympathising, which hastened the loss of these teeth.

Debility is also known as a state very favourable to absorption; this is often produced in the gums and sockets of the teeth by the passions at an early period of life, especially in the female constitution; and it is no unfrequent occurrence, when the passions of the mind become greatly excited, and extend their prejudicial influence to the digestion and to the health, to see the teeth generally involved in a mass of ruin and corruption. Thus we may also account for appearances which often present themselves in the gums, which bear sometimes great similarity to those produced by the use of mercury. There is this difference, however, which shows itself when this poison has not laid hold of the frame, the numerous anastomosing branches of arteries and veins, and the dilatations and oscillations of absorbents passing through the glandular structure of the gums, are less affected by retarded circulation.

THE DISEASES OF THE GUMS.

Diseases of the gums may be considered as produced by proximate and remote constitutional causes.

The proximate causes arise from disease of the organs immediately in contact with the gums. The gums and teeth sympathise with each other. Their healthy condition depends reciprocally upon the healthy state of either. Thus, if the gums become swollen, the inflammation extends to the periosteum, loosens the connection which the teeth have with their sockets, awakens in them sensibility to the slightest impression, and renders them incapable of performing the function of mastication: but the mischief does not stop here; the gums become flaccid and spongy, the apices or points between the teeth become congested with blood, and an exudation of a viscid fluid takes place, which, if allowed to remain for any time in contact with the teeth, corrodes the enamel, and they become blackened and unseemly. This effect is particularly observable in the mouths of young females between the ages of eleven and sixteen, at which period, from constitutional change, the circulation is for awhile unsettled. On the other hand, pain in the teeth produces inflammation in the soft parts surrounding them, and, if the vitality of a tooth perish, the adjacent gums refuse the association with dead matter, and the suffering which its presence creates is apparent in the blue or livid condition of the gums, which are exerting themselves slowly to undermine and expel it.

If we were to look for a work which treated, ex professo on the structure, growth, diseases, &c., of the human hair, we should be
much at fault to gratify the object of our inquiry. The gums present a parallel case; much has been allusively and incidentally said of the diseases of the gums, but we should look in vain for a scientific classification of them: indeed such a classification it must be acknowledged is a work of no small difficulty. Dental surgeons are rarely profound physiologists; and profound physiologists, occupied for the most part in other investigations, have but little opportunity of becoming acquainted to the same extent as the dental surgeon with the diseases of these organs. It is impossible that a medical practitioner, who practises every branch of his profession, can have such accurate knowledge of one intrinsic part of the science as the person who devotes himself solely to that peculiar branch. Hence the lithotritist, the accoucheur, the aurist, the oculist, and the dentist, have each struck out a distinct walk in the art of surgery. Between dentists and the medical world the gums have been much overlooked, perhaps from neither party wishing to encroach on what did not seem properly to belong to their respective lines of practice.

The most frequent affections of these organs which come under our observation are abscesses, these being generally produced by the teeth. Abscesses are also often situated at the bottom of the sockets of teeth; matter makes way through and destroys the alveolar processes, and at last points through the corresponding part of the gum. This does not affect the general health, but the tooth soon becomes loose. It is very difficult radically to cure these abscesses without extracting the tooth, it being in a great measure the cause producing them, and the bone of the socket being in a diseased state. They become aggravated according to circumstances, and break out on the slightest cold or derangement of stomach. A sinus is frequently formed, extending along the root of the tooth, and opening between it and the gum. Matter may in this case be pressed out by the finger.

Tumours of the gum occasionally increase in size to a very considerable extent, especially when in the neighbourhood of two or three old stumps which are causing irritation, and they frequently assume a fungoid appearance.

In the same manner abscesses in the gums accompany the exfoliation of a part of the alveolar processes, extending itself to the periosteum, and even sometimes causing exfoliation of the root itself. Abscesses of a more serious nature are frequently produced in the gums from other causes, such as cold striking against the nerve of a decayed tooth, from shocks to the teeth, or from cold penetrating between the gum and the roots of the teeth. This state of things is not unfrequently characterised by severe general symptoms, such as pain first centered in the gum, extending itself to the eye, nose, and ear, head-ache, restlessness, catarrh, cough, occasionally diarrhea and dysentery, dejection and oppression of spirits, fever, unusual irritability, furred tongue, spasms, fits and convulsions in females, high fever, and delirium.
Fulness of blood and sponginess constitute another form of the diseases of the gums. It is frequently caused by decayed teeth, by extraneous accumulations of tartar on the teeth, by congenital tendencies, by the mouth being crowded to too great an extent with teeth, by the determination of blood to the gums during the formation and growth of the secondary teeth, and by the unsettled state of the body at that period. These generally are the diseases of the gums which arise from proximate causes.

The diseases we must next consider are of a more complicated nature, and have a more remote origin. They are produced in consequence of hereditary and constitutional predispositions. To a close observer the gums will be found to represent the various modes and fluctuations between health and disease, or in other words we can, by a proper inspection of the gums, detect the existence of disease in the system, the symptoms of which are more usually sought for, though not with greater certainty, at other sources. The morbid principle known under the name of scurvy may for a long time lie dormant in the gums; it may be detected, however, by a brownish appearance of the gum, by a peculiar discolouration on the enamel of the teeth. The countenance may also lead us to ascertain whether or not it exists in the constitution. When scurvy fully pervades the system, its effects are always perceptible in the gums. They shrink back from the teeth, they assume a peculiar dark-brown colour, bleed on the smallest touch, become fetid, and emit from the secreting surface a disorganizing and carbonized mucus, and the sockets of the teeth are absorbed. The colour and condition of the parts are an indication of the intensity of the affection.

I saw a remarkable case of this kind in a young lady from the country. Her countenance presented all the characteristic appearances of a scorbutic taint; the gums were brown and swollen, emitting a peculiar fæce, contraction and absorption were going on in the gums, the teeth were loose, their roots all exposed and covered with a brownish mucus, which had exuded from the gums and the parietes of the mouth. This was one of the worst cases I ever saw, considering the youth of the person, and the ravages the disease had committed on the teeth. I ascertained shortly afterwards that this young lady died from the effects of fever.

On the first invasion of this disease, a peculiar turgescence and inactivity of the vessels are perceptible in the gums; they appear to fall into a state of insensibility, from whence it is difficult to rouse them, and the blood seems rather to stagnate in, than circulate through, them. In very severe cases of the disease, there exists a purulent discharge from their surfaces, attended by a peculiarly disagreeable odour; the gums assume a most unseemly appearance, their brownish colour has become increased, and they now bleed spontaneously. Not only does matter exude from the gums, but it may be pressed from between the gum and the root of the tooth.

This is not the place to enter into the question whether a tendency to scurvy is always directly hereditary, or whether it is brought on
by a particular train of circumstances, oftentimes unavoidable. It is, however, certain that scurbutic tendencies are transmitted from parents to their offspring. Many of the effects of such tendency when manifested in the gums are utterly uncontrollable by art, and they not unfrequently involve the total loss of teeth, and this sometimes at a very early period of life. But here we are speaking of extreme cases; on the other hand, art may enable us not only to mitigate symptoms, but to completely arrest their progress. It is impossible, however, to cope with any malady, unless we fully understand the source from whence it springs, and the physiological construction and sympathies of the part it attacks. From this consideration I entertain hope that once having ascertained the real nature of these causes, and the extent of their effects, the subject will be disentangled from the obscurity which surrounds it, and equally under the control of the dental surgeon as other diseases to which these organs are subject.

Tracing the alteration which takes place in the system from the first point at which a change is observed, we find that in scurvy the digestive function suffers, and all the organs connected with that function become more or less impaired. The elimination of the secretions and the assimilation of the food become less and less perfect, until not only the fluids but the solids present an atonic character, and show that the powers of life are enfeebled. The alteration in the blood consists in the redundancy of carbon and the deficiency of fibrin. It is consequently of a dark colour, and less coagulable than it should be. Its plastic properties are not only diminished, but sometimes entirely lost, and it exhibits a great tendency to putrescence. There can be little or no reparative, or healthy power, in such a circulating mass. Thus the formative process is impeded, and parts in which the organization is not vigorous are the first to manifest a disposition to give way; wounds will not heal, and newly formed matter is destroyed. This state of things produces those alterations in the gums characterizing the appearance of scurvy; but there exist other points marking out the hold which the disease takes of these parts.

The capillaries are in the same diminished state of vitality as the rest of the solids. Their coats are morbidly attenuated; they have lost their tenacity, consequently their propulsive power. The increase of their diameter necessarily induces an influx of more blood to them than is consistent with the health of the gum; and, as from their debilitated state they cannot get rid of it, a stasis of that fluid takes place, constituting itself a powerful local aggravation of the original constitutional derangement; for the detention of the blood (admitting even that it were healthy) would, by reason of its assuming a venous character, destroy the tone of the part in which it was involved. Having noticed some of the effects of scurvy on the gums, let us now place in contrast with them those of scrofula on the same parts. The appearances which scrofula produces on the gums did not escape the observation of John Hunter:
—it is much to be regretted that he gives the subject such brief mention; he speaks of them in these words:—"But as this seems to be the principal way in which the gums are affected, I suspect that the same symptoms may arise from different causes, as I have often seen the same appearances in children evidently of a scrofulous habit, and have also suspected them in grown people." The indication, however, which the gums furnish of scrofula lurking in the system differs materially from that denoting the existence of scurvy, for their colour approaches more to a greenish blue; they appear flasecid and irritable; hang looser than other gums round the necks of the teeth: grow as it were luxuriantly in the interstices between them, and there is a general languor and debility of the vessels.

In drawing a comparison between the effects of scurvy and scrofula in the gums, we must notice the following very highly important facts. Scurvy is principally caused by an undue action of those vessels which build up and renovate the system; while, on the other hand, scrofula is caused by a morbid condition of those vessels destined to eliminate the excrementitious part of the body, or in other words to remove matter which may be left behind while the circulation is performing its offices and running its usual course. Matter also is taken up which ought to give place to a healthy deposit; it attacks the glandular parts, and diseasing them transmits its baneful influence to the whole system; so follows consumption and other diseases.

Arrived at this part of my subject, great complication must exist in giving a specific character in each disease to the appearances of the gums; for the first physiologists of the day look on scrofula, cancer, fungous hematodes, and scirrhus, as so closely allied to the same diathesis of constitution that it is very difficult to define the peculiarities, and give to the circulatory system in each disease its specific tendency. I shall therefore leave scrofula and scurvy by themselves, and go to the appearances which the gums present in inflammatory cases.

Besides the symptoms which common or healthy inflammation produces in the gums, and which yield to the general treatment of inflammation, we have also the effects of other constitutional peculiarities perceptible in the appearances of these organs. In inflammatory fevers, with the furred tongue, parched mouth, and thirst, we have a swollen and vascular appearance in the condition of the gum accompanying other symptoms of fever. In cases of intermittent fever, with the languor and general constitutional debility, we have the same languor of the gum, with the usual appearances of increased vascularity and retarded venous circulation. A celebrated German writer on intermittent fever considers that during the intensity of the symptoms of this disease the gum swells, and continues in that state as long as the febrile condition remains. He states that during this period a tonic regimen ought to be persisted in. It is evident that, by the same rule as the gum first falls into a state of
apathy, it is also long in recovering its usual tone and circulation, and before such is the case a complete restoration to health must take place. Under these circumstances, when fever has once been allayed, the gums may be restored quickly to a healthy state; but we must now consider those constitutions subject to general irritation, in which inflammation brings on sometimes cancerous and fungoid diseases, and the appearances which in such cases the gums present it is impossible to eradicate from them.

Numerous opportunities are open to every one of examining the cancer patients at the various hospitals of this metropolis. In most of these cases an experienced eye will detect a peculiarity of countenance and constitution. Although cancer and scirrhous may be produced by local injuries, yet it is generally acknowledged that an undue action depending on some remote cause may be roused in the constitution, and that scirrhous may come on at certain periods of life, aggravated by circumstances connected with constitutional tendencies. Sir Astley Cooper, in his lectures on this point, says, "The formation of scirrhous matter is not confined to the breast, but it is the index of a disordered constitution." It is from this circumstance that gums assume those alterations which I consider to have the character of disease. In cancer, as in scirrhous affections and fungous haematodes, there are strong indications of disease in the gums, differing according to the extent the constitutional symptoms may have run. At the commencement the gum appears red, irritable, and vascular; granulations, with an increased action around them, are occasionally interspersed over their surfaces; high up under the lip the veins are unusually swollen, their apices between the teeth are all overcharged with congested blood, and underneath the mucous membrane covering them their substance is of a fluid more than of a solid tendency.

In persons somewhat advanced in years most of the teeth are gone, while those remaining are loose and much better away. In young persons reduced by haemorrhages from these diseases, the effects on the gums are in accordance with what we might anticipate. The blanched cancerous countenance, the pale but irritable-looking gum, and the pale conjunctiva of the eye as in consumptive cases, are invariably the companions of each other. There is this essential difference between the diagnosis of cancer and scrofula, which may not prove unworthy of notice: cancer attacks those glands destined for formative functions in the animal economy, while scrofula centres itself in those glands destined for the offices, as we have before observed, connected immediately with the absorbents and capillaries. While on this head, we may mention tumours and diseases of the antrum highmorianum, as produced by a peculiar diathesis of constitution, also cases of lupus and noli me tangere. The following case was furnished me by my brother; it occurred while he was house-surgeon at the Middlesex hospital;—A small spot first appeared on the nose of a female aged forty-seven, and increased, baffling all medical skill; the eyes, lips, and gums were attacked in
a most horrible manner; the gums sloughed, with the sockets of most of the teeth; there was also a dreadful slough of the nose, and of the integuments of the eyes; they presented a most ghastly appearance; vision was almost gone, the septum nasi and nose all eaten away, and, through the orifice remaining, one could distinctly look down the throat. The lips were quite destroyed, and the chin and gums were even with each other. Three teeth only were left, and these added to the horrors of the face. In this state the progress of the disease was arrested.

Connected also with the constitution are other changes which the gums frequently assume; they are subject to callous thickenings, and these sometimes grow to a very considerable size both on the outer and inner edges of the gums; they seldom however cause inconvenience, and are rarely found but in the mouths of persons of strong constitutions. It must be clear that the different conditions of the gums in diseases produced by certain diatheses of body form alone a set of diseases of the highest importance to the pathologist and to the dental surgeon. The transmission of venereal virus from the parent to the offspring may also be brought in with a sympathising condition of the gum. In secondary symptoms when exfoliations of the jaws are frequent, there is always disease of the gums and great looseness of the teeth; but nature having separated the diseased from the healthy portion of the bone, a reparative process commences, and the gums heal over the new bone that is formed.

There are also other important alterations to which the gums are subject; these may form another separate class of diseases. Under this head I would arrange those changes produced by debility, by the use of mercurials, by climate, by indigestion, by sedentary habits, by the passions of the mind, &c.

The causes producing debility in the gums are various; but whenever a debilitated state of the system ensues, no matter from what source or disease, the effects of such debility are soon transmitted to them; hence in early life the septa-dentium become absorbed, and a recession of the gum which then takes places show the state of atrophy and debility which has existed.

This condition of the gum may be brought on by the effects of fever, by the use of mercurials, by affections of the nervous system, by bad living, by parturition, by haemorrhages, and by chronic disease. When the system has been subjected to waste or absorption, the sockets of the teeth and gums frequently recede for a considerable time; but if a period arrives when the body recovers from this state, and assumes a stronger tendency, the absorbent process discontinues its rapid course. Agreeably, however, to the destinies of nature, after the fortieth year, decay of constitution proceeds in the same order as growth did up to that period; we then take our course to the grave with diseases more frequently producing debility; there is a gradual waste of parts, the fluids become more disposed to putrescence, and in the general process of life the gums, with their teeth and the sockets, exhibit phenomena of vast interest and importance.
All this might even form another separate class of diseases in the gums.

The diseased appearances induced by the passage of mercury through the capillary vessels of the gums deserve also much attention. It is curious to see the influence which only a small portion of this mineral sends to these organs. It first produces an alteration with somewhat a bluish appearance, but this in some constitutions is much more marked than in others; if its use be continued for any length of time, the gums become swollen, their extremities are congested with blood, and they then take a very decided blue appearance. This, however, differs in the diatheses of different constitutions. I look on those gums which evince signs of latent constitutional irritation as more easily affected by the use of mercury than the gums of those persons free from such conditions. Where indeed decided signs of constitutional irritation exist, the exhibition of mercury will rouse up disease in the gums, and not unfrequently involve the whole of the teeth in a loosened state, from which in these constitutions they seldom or never recover. I look on the gums of persons of a pure diathesis of constitution as affected by mercury but with the greatest difficulty, and when under its influence these organs assume a very blue appearance.

On the contrary, those gums in other constitutions not so fortunate are acted on in different ways, according to the tendencies they evince to disease. Hence, when mercury has been given to persons of a scrofulous habit, the use of mercury ought not to be resorted to without due consideration; the sudden effects it produces on the gums are caused by their incapability of bearing the subtile action of this mineral, for the capillaries and absorbents throughout the system are already in a state of atony and disease.

A change of residence to a damp climate will often rouse up in the gums a great degree of vascularity. In the damp places of England and Ireland, the appearances which the gums present are of a turgid and vascular nature. In the damp countries of France these conditions of the gums run a much greater length from the circumstance of the difference in the constitutions of the two nations. In the damps of Germany and Switzerland persons also lose their teeth early in life, the climate engenders malaria and low fever, enfeebles the powers of digestion, and brings on rheumatic affections with languor and general constitutional debility.

A morbid vascularity of the gums is oftentimes produced by cerebral affections, by close scholastic application, by a state of fear and anxiety in which youths are kept, added to the manner in which they are often made to pore over books by parents who themselves are untaught in the real doctrines of nature.

We have already enlarged on the sympathy between the stomach and the gums, an altered appearance of the one coinciding with the same phenomena which may be distinctly traced to the other; hence
dissipation and vice in young persons produce derangement of the stomach, transmitting its characteristics to the gum. The young female, emerging from the nursery to the nocturnal scenes of London revelry, is also subjected to disease of these organs, the gums as well as the stomach sympathising with the state of excitement she is then kept in. Here we may also bring in the man of literature and close application; the tradesman, exposed to hot rooms, and capable of enjoying but little air and exercise; the statesman, borne down by the trammels of office, with its anxieties and perplexities; the unhappy hypochondriac; and, lastly, the maniac himself.

The period of pregnancy often produces a diseased alteration in the gums, which occasionally loosens and destroys the teeth; this comes on from the unsettled state of the circulation during that important period.

Thus far I have endeavoured to explain some leading facts connected with the diseased appearances of the gums. There remains still another important pathological sympathy which must not be passed over. I allude to a morbid state of sensibility in which they are frequently found; this state is roused in the gums to a considerable extent by the effects of scarlet and other fevers when severe, by the after effects of mercury when given in an oriental country, as also by all circumstances which tend to disease the general state of the nervous system.

I lately witnessed a remarkable case:—A young gentleman had just returned from India, where he had taken mercury to a very considerable extent. He had fallen into a regular state of hypochondriasis; he had sensations every now and then over him of momentary dissolution occurring, and of these he evinced the greatest horror; he dreaded the appearance of a razor, of a knife, or of any instrument which could inflict a wound; his gums had receded from the teeth; their edges were thickened, but of a firm consistency; these were very painful to the touch, as also were the necks of all the teeth where the bony part was exposed. I used my utmost endeavours to persuade him that he would soon be well, and under medical guidance he went into the country. In cases of tic-douloureux, especially in elderly females, the gums frequently possess extreme sensibility. I recollect a lady who was dreadfully afflicted with tic-douloureux: her gums were soft, and it appeared as if most of the capillary vessels in them had sloughed, and that a lymph of a light brown pellucid colour, coinciding with the state she was in, was underneath their surfaces.

Sensibility is also often roused in the gums to a great extent by heat of stomach and cold: it also succeeds the vascular condition, roused by the many circumstances we have considered, which bring on an inordinate circulation through them.
SYNOPSIS OF THE DISEASES AND MORBID ALTERATIONS OF THE GUMS.

Diseases produced by proximate causes.
Infantine and puerile diseases of the gums.
Abscesses, tumours, swellings, inflammations, morbid affections.

Diseases produced by remote constitutional causes are, First, those from the effects of scurvy or from scrofula. Secondly, from constitutional irritation, when neither scurvy nor scrofula has developed itself. Thirdly, from fevers, from indigestion, from catarrh, from inflammations. Fourthly, from mercurials. Fifthly, from constitutional debility, however induced, including nervous excitement and the passions of the mind.

1st. Diseases produced by scurvy are,
A turgescence of the gums, with a brownish appearance of their structure.
An inordinate detention of highly carbonized blood in their vessels, and occasional haemorrhage.
Diminished vitality of the capillary vessels.
Suppuration, with purulent discharge from the mucous surfaces of the gums.

2dly. Diseased appearances produced by scrofula.
An alteration of the glandular structure of the gum, with disease of the capillary vessels.
Detention of blood in the apices of the gums.
Morbid exudations from the surfaces.
An atonic state of their general circulation.
These diseased appearances being devoid of the brown colour perceptible in scurvy.

3dly. Diseased alterations from constitutional irritation, when neither scrofula nor scurvy has developed itself, are General heat, irritation, and redness, fungous excrescences, and hardened ridges.

4thly. Diseased alterations from mercurials produce
Increased glandular action and vascularity.
Foulness, languor. A slough of the capillary vessels.
Morbid sensibility. Haemorrhage.

5thly. Constitutional debility, however induced, including the various passions of the mind.
Atrophy and atony of the gum.
Absorption of the socket and recession of the gum.
Languor, and the same morbid sensibility as results from the use of mercurials.

REMARKS ON THE DISEASES OF THE GUMS.

It may be asked, What phenomena do the diseases of the gums open to our view?
The diseases of the gums, caused by proximate causes, elucidate many abstruse points in pathology: they show the laws of nature, connecting the wholesome state of the teeth to that of the gums; they open to our view many essential considerations between the principles of living and dead parts, and teach us that, in the production of disease, there is always an irritating cause, exciting the changes which come on; for of this there exists no circumstance more clearly illustrating the point than the fact of obstinate abscesses in the cheek, which will yield to no medicinal aid, being cured by the extraction of an unsound tooth, which, although remotely situated, was the principal cause of the irritation. These circumstances, although of great import and merit, sink into insignificance when we consider the vast field of research the diseases of the gums produced by the more remote causes open to us.

It is a well known and established fact, that although we may consider ourselves well in health, and in the enjoyment of all our faculties with their blessings, still there exists in every one a diathesis of a peculiar nature; each varied disposition has its different tendencies; in one we have a disposition to one condition, which may be connected with the venous and arterial system; and, in another constitution, we have that connected with a diseased state of the nervous, glandular, and absorbent system.

There is not recognised by pathologists any invariable indication of each diathesis; nor are we oftentimes at all aware of it, until we see the development of disease fully set up in the constitution.

If the tongue, which is a fleshy body, covered merely by a reflection of the mucous membrane of the mouth with corrugations and rugæ, give us a correct view into the state of the health, how much more may we look forward to in the state and condition of the gum? We have not here a dense mass of muscles, but we have one of the most delicate net-works of arteries, veins, and absorbents, that we can meet with in the whole construction of the body. We have nerves of sense with small glandular bodies, and opening mouths of capillary vessels divested of thick skin, which renders their exact nature imperceptible to us, while the gum is covered merely by a thin expansion of the mucous membrane of the mouth. We may not then wonder why deviations in the general mass of circulation alter the appearance of these parts, or why, in fact, the circulating mass, changed into an impure state, produces also a diseased alteration of the gum.

In inferring, therefore, à priori, that if the nature of the gums be properly known and scrutinized, it will manifest greater changes, indicative of the alterations in the body’s condition, than any other part of the frame, I trust that I am borne out by true physiological facts. Amongst other important considerations, I must allude to the correctness with which, if we have a real practical knowledge of the gum, we may judge of the extent of irritation lying dormant in the constitution. I must state, from observations which I have made with considerable care for the last thirteen years, that there is no person
in whose constitution disease is lurking who has his gums in a wholesome and pure state; and that previously to the development of disease, let it show itself how it will, the gum becomes so perceptibly involved in the changes as to afford premonitory forebodings of illness. In the diseased alterations from scurvy, scrofula, and other diseases, this theory is directly applicable; as also in changes of high importance to the health which occur at middle age.

By the physician, I hope to see these facts appreciated according to the importance they actually possess. To the surgeon, the gums may prove a guide as to the derangement of system he may expect his operations to set up; they may direct him as to previous treatment, and prepare him for after consequences arising, which are oftentimes both mysterious and uncontrollable.

The theories regarding the alterations which take place in the breath remain involved in very considerable mystery. The changes which it is subjected to from alterations in the habit of body never occur without an altered appearance in the condition of the gum; and this is an actual fact, which, to elucidate any theory on the point, is of more avail than volumes of the finest composition. It must be admitted that no one can form so correct an estimate of the condition of the breath, as connected with that of the constitution, as the surgeon, who, laying aside all other professional occupations, is compelled to be in close contact with the mouth and teeth.

It has always been observed that a mercurial breath has its peculiar taint, and that those suffering from scurvy have the same peculiarity; but the variations of breath appear to me so diversified that each may be easily detected by any person subjected as I have been to be in close contact with various mouths. The foetor arising from false teeth, and that from decayed teeth, can each be easily distinguished.

By a wholesome and pure gum it may be known that let mercury be given even to a great extent, let the most noisome drugs and eatables be continually swallowed, let, lastly, high fever arise, the breath will be affected but with difficulty, and on the discontinuance of medicines will retain all its pristine sweetness, going down through life pure as the constitution of the person whose lot may be the happiness of possessing it.

On the contrary there is an irritable appearance of the gums which indicates an impurity of breath; for a short time indeed it may prove wholesome, but, should any thing occur to cause the least excitement, it assumes an unpleasant foetor, and this is occasionally quite insupportable.

From all these circumstances it may be clearly seen that the gums open to us an extended view of many tendencies which the constitution evinces to disease, and also that there is no other part of the frame whose outward appearances will unfold to us the real character of each diathesis of body with equal certainty.

However unconnected the pathologist may have considered the appearances of the gums with disease in general, and more particu-
larly with derangement of the digestion, the day will most probably arrive when they will not only direct him in the treatment of disease, but give him such insight into the tendencies to it as to guide him greatly in both averting and subduing its effects. Hitherto there has existed no certain means of detecting the existence of disease till its regular symptoms have been fully set up and developed; but the phenomena of diseased alteration in the structure of these organs may tend one day to throw the most important light on this interesting subject.

PART II.

ON THE GUMS IN THEIR EARLY STATE.

In noticing the varied appearances of the gums in the different ages of life in which I continually see them, I have observed many other phenomena besides those mentioned, which may form novel and important theories, but I must renew the observations I have already made, that the gums have been underrated, if not neglected by our pathologists. It was a matter of much surprise to me that this point did not strike the attention of a very highly-gifted physician who has given out some recent theories on dentition. To those theories, however, I must give my humble but most ardent praise, congratulating society in general on the fact of their elucidating many points which, before his work was published, were somewhat unexplained.

I have given his observations some unusual consideration, for I had previously notes of cases corroborating many which are mentioned. Convulsions, however, occasioned by cutting the last wisdom tooth, are not very common. I have heard of very few cases decidedly occurring within the last three months; one was communicated to me by my highly-talented friend Mr. Costello. In according great constitutional disturbance to pressure on the dental twigs of the maxillary nerves, we follow the natural laws of doctrines of pressure on nerves. The considerations of anormal development of the teeth, which are introduced to the medical profession, are worthy of merited praise.

I wish it, however, to be clearly understood that, without underrating in the smallest degree the phenomena occasionally accompanying pressure on these nerves, I attribute causes producing constitutional effects more immediately, and more frequently, to the irritability of the gum during the important changes which take
place when the process of teething is going on. I would not, however, wish my observations to end with the completion of the teeth; I would extend them from the earliest periods of life to the prolonged days of our existence.

As at the very onset of our life many arguments have existed, whether the capsule investing the pulp or whether the gum itself was the seat of constitutional disturbance during teething, I wish to give each of these organs some pathological consideration, as regards the state they are in at that important period of our life.

That each organ has its separate destinies allotted to it is a matter not involved in the slightest doubt.

The capsule is a delicate membrane, situated over the rudiments of each future tooth lying under the gum, and attached at its extremities to the bone, from which I have frequently detached it. It is divisible into two laminae, which may be separated from each other. I have always considered it, at that period, as the periosteum to the bone, with an internal coat studded with the minute mouths of secreting ducts to deposit the liquor inspissens of Morgagni hardening afterwards to the enamel. It is therefore the matrix to that portion of the tooth. The future state of the enamel is directly under its influence. To effect its own destinies it is furnished with blood-vessels to some extent: these obey the phenomena of secretion, which is always influenced in its nature, by the powers of the constitution, to exert its functions in a proper and wholesome way.

I look upon all causes tending to the vitiation of secretions generally, at an early period of life, as tending to the detriment of the enamel. I would more especially call my reader’s attention to the inordinate action of all important organs when an adjacent part is in a state of inflammation; hence arise spasmodic cramps, vomiting, and other severe symptoms of adjacent organs. If this then, as regards the offices of the capsule, may be thought somewhat novel, I hope to give it also some degree of interest. When during teething the gums are labouring under great irritation, sore and tender to the slightest touch, the constitution, sympathizing also to a great extent, is borne down by the depressing influence of diarrhoea, spasms, cramps, fevers, and convulsions. Mark, then, the curious phenomena perceptible in the deposition of the liquor inspissens. The powers which the capsule possessed to deposit this fluid become suspended, and the bone of the tooth progressing in growth on the pulp becomes frequently developed, when the deposition of the enamel is retarded. At this early time of life the secondary teeth are gradually growing; arrived at the period when they are destined to come forth, the effects of infantile disease are perceptible in them. The part of the enamel to be formed about the period of illness is wanting, while the other part which developed itself afterwards has its natural covering.

In the same way, any sudden shock to the constitution exerts the same influence on the depositing surface of the capsule. It was thought necessary to wean an infant at the age of three months, but
he grew up remarkably strong and healthy. I kept sight of him as a case subservient to this theory. All his family had particularly healthy teeth; but at the period when the primary teeth were gone the secondary ones came forward devoid of enamel. Numerous cases, bearing a similar analogy, come continually under notice, these frequently extending themselves through a whole family. Such are the purposes for which nature destined the capsule. The following are the observations of Sir C. Bell, whom I consider to have a greater knowledge of the growth of teeth than any other physiologist with whom I have conversed: "The enamel is formed after the body of the teeth has advanced towards its perfect form. It is formed by a secretion from the capsule or membrane which invests the teeth, and which is originally continuous with the lower part of the pulp. The enamel is thicker at the point and on the body of the tooth than at its neck. Mr. Hunter supposed that the capsule always secreting, and the upper part of the tooth being formed first, it would follow of course that the point and body of the tooth would be covered with a thicker deposition; but it rather appears that that part of the sac opposite to the upper part and body of the tooth has a greater power of secreting, being in truth more vascular and spongy; for the whole body of the bony part of the tooth is formed before the enamel invests the tooth. We are indebted to Herissant for much of the explanation of the manner in which the enamel is formed. He describes the sac, its attachment to the pulp and to the neck of the teeth. As the tooth changes to its natural form the sac also changes: at first it is delicate and thin, but it thickens apace, and he asserts that if after this process is begun you examine the inner surface with a glass, you will perceive it to be composed of little vesicles in regular order, and which sometimes have a limpid fluid contained in them: this liquid, exuded from the surface of the tooth, he supposes to be the enamel. He explains how this sac, originally investing the body and neck of the tooth, being pierced by the edge of the tooth, and the tooth rising through it is inverted; and, by still keeping its connection with the circle of the crown of the tooth, rises up in connection with the gum, and in some degree forms the new gum surrounding the tooth."

We must now consider the gum at this period of life: its appearance is not as cartilaginous as at a later period of life; it constitutes, in fact, a membranous covering to the jaw. Added to the continuity of membranes which we have already considered as a very powerful source of sympathy, we must bear in mind that the gums possess sensitiveness as other parts, and this is acute when roused into action. In whatever light the physiologist may see them, they equally deserve his attention. Let him view them as they exist in the early periods of dentition; then the speechless babe is easily brought into debility by trifling circumstances; add to this debility the continued irritation kept up by the excessive tenderness of the gum, and the nervous communication with these organs: the sympathetic affections may be clearly comprehended as arising from the
gum, and the excessive dejection and prostration of strength accompanying inflammation which may be centered in them afford other proofs of this fact.

The following case occurred to a young gentleman who was cutting a wisdom tooth. Pain was centered at the back of the mouth, with stiffness of the jaw, headache, and very unusual constitutional disturbance; the gum over the part was so tender that the slightest touch was agonizing. The tooth presented itself to the gum in a slanting direction, so that its anterior points alone caused the mischief. On the gum being freely lanced, a portion of the tooth protruded, and, the position of the tooth being changed, the posterior portions began to come forward. The respite was therefore of short duration; the same symptoms supervened, with the same exquisite tenderness of the gum. This case may be considered as particularly referable to our subject, from the positive absence of the capsule, from the constitutional disturbance accompanying the progress of the tooth throughout the case, and from the great pain produced by touching the surface of the gum. I look on the pain seated in the capsule as trifling compared to that centered in the gum. The growth of the tooth below is gradual; arrived at the gum, it exerts, as it were, an attempt to pass rapidly through it. All these circumstances induce me to be somewhat doubtful as to the constitutional disturbance during dentition being in any way influenced by the capsule.

Long before the period of birth the gums performed an office deserving our peculiar notice. In the construction of the different capsules, both of the primary and secondary sets of teeth, these organs contributed to preserve their arched arrangement: the position they assume is guided by an attachment of each capsule to the gum, the primary set by a small fold to it, and the secondary set by a direct suspension. The changes of position which the teeth at this period take, to accommodate themselves regularly to their destined situation, is well worthy of scientific researches.

Other circumstances connected also with conformation and disease take their origin at this early period of life. That the shape of the jaws, the appearance of the gums, the size of the teeth, with their decays and diseases, are influenced by congenital predispositions, is a matter which I have long settled in my own mind. We find in some families a peculiarly-shaped jaw, in others a deficiency of teeth, sometimes the milky teeth large, and remaining till a late period of life in the gum; at other times, the secondary teeth small and large, but always bearing a strong analogy to those of one of the parents. We find decay of teeth running through whole families; we find, where constitutions of parents differ, some of the children taking the maternal tendencies and others the paternal. In my humble opinion, the order of the sexes is in these cases often reversed, the girls taking after their father, the boys after their mother. I do not give these rules as certain, but in this order I have most frequently perceived them.
The gums in their early state.

The jaws, and the membranous expansion covering them which forms the gum, increase in development with each other. Hitherto no teeth have existed in the infant's mouth: these would have irritated the tender nipple from which sustenance was to be drawn. The primary teeth below the gum, having acquired their proper shape, evince a determination to assume their destined position in the mouth. At this period of life an epoch may be said to commence full of danger to the infant. It has been computed by statistical writers that half the number of children die during the first few years of their existence. Professor Camper informs us that, out of 5989 infants admitted into the foundling hospitals in Paris in one year, no less than 4095 died during the first month, 673 in the remaining eleven months, and at the expiration of five years only 884 were found alive. The mortality, however, in London is very far below this computation.

The fatality of teething may be computed in very difficult cases at about one in six or seven; this process, however, is calculated to rouse up many diseases which else might have remained quiescent. Dentition, when difficult, is preceded by various symptoms; heat in the gums, thirst, fever, restlessness, an inclination to insert the finger in the mouth, and an increased action of the salivary glands. I leave considerations going deeper into the subject to the writings of medical men.

I was favoured by my friend Mr. Rice, of the Royal Metropolitain Infirmary for Diseases of Children, with an unparalleled opportunity of permission to examine 20,899 physician's cases which have come under his immediate notice. I subjoin an average of the diseases which occurred in each hundred cases, drawing them from different seasons and years in which they occurred.

<table>
<thead>
<tr>
<th>Affections of the head</th>
<th>3</th>
<th>Gastritis (inflammation of the stomach)</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Affections of the bowels</td>
<td>3</td>
<td>Herpes (itch)</td>
<td>10</td>
</tr>
<tr>
<td>Affections of the lungs</td>
<td>1</td>
<td>Hydrocephalus</td>
<td>1</td>
</tr>
<tr>
<td>Catarrh post rubroa</td>
<td>1</td>
<td>Itarus (jaundice)</td>
<td>1</td>
</tr>
<tr>
<td>Cephalitis (inflammation of the brain)</td>
<td>8</td>
<td>Marasmus (wasting)</td>
<td>1</td>
</tr>
<tr>
<td>Cholera</td>
<td>2</td>
<td>Mesenteritis chronica</td>
<td>1</td>
</tr>
<tr>
<td>Cynanche (sore throat)</td>
<td>1</td>
<td>Meningitis (inflammation of the meninges of the brain)</td>
<td>2</td>
</tr>
<tr>
<td>Croup</td>
<td>1</td>
<td>Pulmonitis</td>
<td>2</td>
</tr>
<tr>
<td>Dentitio</td>
<td>5</td>
<td>Pneumonae</td>
<td>8</td>
</tr>
<tr>
<td>Dyspepsia</td>
<td>3</td>
<td>Pertussis (hooping cough)</td>
<td>3</td>
</tr>
<tr>
<td>Febris</td>
<td>1</td>
<td>Phthisis incipient</td>
<td>2</td>
</tr>
<tr>
<td>Febris catarrhalis</td>
<td>2</td>
<td>Paralysma abdominalis</td>
<td>1</td>
</tr>
<tr>
<td>Febris bileo remittens</td>
<td>1</td>
<td>Swelled face</td>
<td>3</td>
</tr>
<tr>
<td>Febris gastrica</td>
<td>1</td>
<td>Serofula</td>
<td>8</td>
</tr>
<tr>
<td>Febris dentitionalis</td>
<td>6</td>
<td>Tinia capitis</td>
<td>10</td>
</tr>
<tr>
<td>Febris cum eruptione</td>
<td>2</td>
<td>Ulcers and abscess</td>
<td>2</td>
</tr>
<tr>
<td>Febris verminosa</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Febris mesenterica</td>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
I would give it as my humble opinion, and this may receive strength from Mr. Rice’s high authority, that more than two-thirds of physicians’ cases which occur between the fifth and thirtieth month of an infant’s life are connected more or less with dentition. In the registers of this dispensary it does not appear that children are generally brought with actual convulsions. The name of the diseases with which they are actually suffering being specified on the day of admission. It is however known, that most of those diseases more immediately the effects of dentition, in the above abstract, are attended more generally with convulsions. Affections of the head, of the bowels, of the lungs, with sore throat, dyspepsia, dysentery, and fever, may be attributed generally to the constitutional disturbance which the state of the gum at this period of life produces.

We have also chronic eruptive diseases; and according to the tendency which the constitution has to scurvy or scrofula so the irritation of teething tends to the more early development of these diseases.

100 Surgeons’ Cases.

<table>
<thead>
<tr>
<th>Abscesses of the ear</th>
<th>2</th>
<th>Rachitis</th>
<th>2</th>
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</thead>
<tbody>
<tr>
<td>Exomphalos</td>
<td>1</td>
<td>Swelled face</td>
<td>2</td>
</tr>
<tr>
<td>Enlarged tonsils</td>
<td>1</td>
<td>Sora and seabies</td>
<td>11</td>
</tr>
<tr>
<td>Erysipelas</td>
<td>2</td>
<td>Scrofula</td>
<td>6</td>
</tr>
<tr>
<td>Eruptio infantilis</td>
<td>2</td>
<td>Tinia capitis</td>
<td>14</td>
</tr>
<tr>
<td>Dentition</td>
<td>9</td>
<td>Tumours</td>
<td>2</td>
</tr>
<tr>
<td>Leucorrhœa</td>
<td>2</td>
<td>Tumours in the axilla</td>
<td>2</td>
</tr>
<tr>
<td>Herpes</td>
<td>13</td>
<td>Ulcers</td>
<td>2</td>
</tr>
<tr>
<td>Ophthalmia</td>
<td>7</td>
<td>Psoas abscesses</td>
<td>2</td>
</tr>
<tr>
<td>Purulent ophthalmia</td>
<td>1</td>
<td>Wounded head</td>
<td>2</td>
</tr>
<tr>
<td>Phymosis</td>
<td>1</td>
<td>Ulcerated cornea</td>
<td>1</td>
</tr>
<tr>
<td>Porridge</td>
<td>9</td>
<td>Accidents</td>
<td>4</td>
</tr>
</tbody>
</table>

These I have averaged from 5907 surgical cases, which occurred also under the scientific care of Mr. Ribe at the Broad Street Infirmary for Diseases of Children.

It will be seen that the surgical cases brought on from the effects of teething are not so numerous as those which come under the care of the physician. Many are congenital, and others oftentimes the results of accidents; the great constitutional sympathy which the gum when irritated produces, is frequently witnessed by the surgeon in various ways; it often produces effects which baffle all the skill and science he can bestow on it. He sees latent scrofula roused up, and abscesses arise, leaving marks which go down through life to the grave. This is oftentimes accompanied by other symptoms, more especially in the female constitution, most strikingly illustrative of all the laws of sympathy. The mortality which occurred among the patients at this institution has become greatly diminished from the great attention which is paid to the symptoms which teething produces on the nervous system, and by the use in many
instances, where danger exists, of cooling and frigerative applications to the head.

The teeth continue to pierce the gums for nearly two years after their first appearance, the train of circumstances connected with this process being regulated by the constitution and health of the child. The gums ought now to remain in a quiescent state for about three years and a half; this calculation I conceive to be tolerably correct. Unpleasant circumstances frequently interrupt this respite; the primary teeth are often found in a state of decay, abscesses are produced in the gums, and a continual state of irritability is kept up in the mouth.

In this instance I would advise practitioners and parents to adopt great firmness and decision. This is rendered doubly essential from the easy manner in which debility is produced at this early period of life. The tooth-ache is accompanied by fever and restlessness, with loss of sleep, abscesses, and swellings of the gum. The submaxillary and parotid glands frequently enlarge, and many constitutional tendencies come forward. All these circumstances render the extraction of the primary teeth when decayed and irritable as most essentially requisite.

I hope to be thought neither unfeeling nor presuming, but I cannot conclude these remarks without strongly urging their propriety. I will defy any child to gain proper health who is continually worn down by pain in the jaw; it must impair the energy of the constitution, and frequently be a focus to kindle symptoms which may be long regretted as unextinguishable.

We must now view the infant as having passed the most critical periods of his life, capable of walking erect, and beginning to exercise the powers of speech; to the perfection of this faculty the regular shape of the jaws and teeth is most essentially requisite. In considering the process that has been going on, there are many points well worthy of notice to the physiologist, the theologian, and to those seeking for general information. It is well worth consideration how the growth of teeth from the gums is adapted to the shape of the jaws, and how they progress in growth with the exigencies which nature requires to support the strength of the constitution. In the first instance, when sustenance is to be drawn from the nipple, the gums are tender and extremely delicate; as they increase in strength the nipple gets gradually harder—teeth also come forward, showing that an alteration in constitution is taking place, which requires a change of diet; the teeth are at first only calculated to bite a soft and delicate substance, preparing it for suction. Afterwards come teeth for tearing the more solid morsel; then we have others for bruising it; this being in unison with the strength the child has gained, and with the changes of nutriment the constitution demands to support the growth which it continues to acquire.

When five years and a half of a child’s life have been completed, other changes take place in the gum; their vascularity is perceptibly increasing; swellings appear corresponding to the roots of the teeth,
and if we touch the two lower incisors they are found to be loose in the gum. All this is to usher in a period when another process of the animal economy commences of the greatest import to the health and beauty of the child. It was necessary early in life, when the jaws and gums were small and delicate, that those organs which nature furnished for mastication should be also of a corresponding construction; now, however, the case is very different. During the interval of rest which the gums have had, they have increased in growth along with the jaw beneath them; the teeth are evidently too small for the mouth; they begin to stand separate, and a change is required to keep pace with the strength the child is daily acquiring. We may pause to consider the consequences had these teeth been given us in the first instance; their immense size would have produced irritation in the mouth beyond what the child was capable of enduring; the incisor teeth would most probably have presented themselves sideways or in a slanting direction; there would have been no room for the immense molar teeth, and in the chaotic mass the canine teeth would have either projected into the nose, or perhaps touched the orbit of the eye; these effects nature has happily averted. It is ordained that when the primary teeth should be no longer subservient to the exigencies required, a secondary permanent set of teeth should come forward from the gums in gradation with the strength the jaws have acquired, and subservient to the purposes of mastication; for the child now requires solid food to keep him in full vigour and growth.

The period when this process commences differs in most children; it may, however, with great correctness, be computed to take place from the period the child is five years and a half old, to when he arrives at the seventh year; this however is very late, but I have seen instances of teeth being cut at this period.

The first indication of a change taking place is behind the last primary teeth; there is then a direct pressure forwards. This I consider to be an impulse to the growth of the secondary teeth; for they now begin to loosen the primary set, whose bodies have long since been formed and hid in the jaws.

I conceive that absorption of the roots of the primary teeth only commences when the secondary set begin to grow, and the following is the manner in which I consider the process begins:—

When the development of the jaws progresses, the primary set of teeth become involuntarily pressed into a different position, and the growth is alone concentrated in the future set beneath them. The first large molar tooth begins to push forwards, and the whole pressure falls directly on the front of the mouth, the centre of which may be considered as the point of an angle. There is an apparent increase in the vascularity of the gum; numerous absorbent vessels which exist in it, and those going from it are set in action, and this is extended to the periosteum of the root. It is not my place to enter here into a discussion as to the existence of circulation in the bony part of these teeth; but I give it as my opinion that the roots
of all teeth possess a degree of life which may be easily roused into action. Many absurdities have been stated as to the manner in which absorption of the roots of these teeth takes place, and these have been given out by writers of acknowledged reputation.

Shedding the teeth is a process accompanied in general with little or no danger. I have seen a few cases in which similar symptoms presented themselves to those which accompany early dentition. I attribute these circumstances more to the tardy development of the first permanent molar tooth than to the circumstance of any irritation which shedding the teeth is likely to produce. In the last case which I witnessed, the central incisors in the upper jaw were making their way through the gum nearly at the same time as the under teeth were falling out: these were coming out behind the primary teeth, which were in their usual position; there was considerable tumefaction of the adjacent part, and the gums generally were tender and irritable. This case was accompanied by fever, irritation, restlessness, increased flow of saliva, starting in sleep, and other symptoms which usually accompany difficult dentition.

I subjoin the following tables of the order in which both sets of teeth grow, and I conceive them to be as correct as the normal and anormal considerations will admit of. Any table of my own would be of no avail.

**Sir Richard Croft's table of the eruption of the first dentition.**

<table>
<thead>
<tr>
<th>Molars</th>
<th>Can.</th>
<th>Incisors</th>
<th>Can.</th>
<th>Molars</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>5</td>
<td>7</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>10</td>
<td>6</td>
<td>8</td>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>

**Dr. Ashburner's table of the eruption of the second dentition.**

<table>
<thead>
<tr>
<th>Periods</th>
<th>Teeth.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Six years</td>
<td>First four permanent molares appear.</td>
</tr>
<tr>
<td>Seven years to eight years</td>
<td>Two central incisors of the lower jaw fall out, and are replaced by two permanent central incisors.</td>
</tr>
<tr>
<td>Eight years to nine years</td>
<td>Two central incisors of the upper jaw fall out, and are succeeded by the large permanent incisors.</td>
</tr>
<tr>
<td>Nine years to ten years</td>
<td>Shedding of the lower lateral, then of the upper lateral incisors, and their replacement by permanent teeth.</td>
</tr>
<tr>
<td></td>
<td>Shedding of the first deciduous molar teeth of the lower jaw, their replacement by the first bicuspied, then of the first deciduous molar teeth of the upper jaw, and their replacement by the first bicuspied teeth.</td>
</tr>
</tbody>
</table>

*January, 1838.*—*N*
Periods.  
Nine years and a half to twelve years.  
Cutting of the four second permanent molares.

Twelve years to thirteen years and a half.  
Cutting of the four third permanent molares or wise teeth.

Seventeen years to twenty-one years.  
Shedding of the posterior molares of the lower jaw, or of the canine teeth, and their replacement; then those of the upper jaw, the molares being replaced by bicuspid teeth.

It will be observed that nature ordains our being furnished with teeth for mastication at the same time that a provision is made for the front of the mouth. The canine tooth is generally the last to come forward. The position which this tooth takes depends principally on the normal growth of the jaw. At this period of life, especially in the female constitution, the growth of the jaws is often retarded, while development of another organ is going on, preparing it for offices it is hereafter destined to perform. We have, in this instance, a sympathetic tardiness of growth in the jaws, which is but little known to the dentists of this metropolis. It is no uncommon occurrence to find teeth extracted to make room for an eyeteeth which may appear coming out from the gum in an irregular position. At this period nature may be directing the powers of the constitution to the proper formation of the uterus, and then all growth in the jaws is frequently retarded. Dr. Ashburner is the only person who has hitherto satisfactorily explained that the growth of the jaws and the uterus depend reciprocally on each other, but here we have a most powerful insight into this fact: a tooth may have been extracted; nature, having perfected the formation of the uterus, directs its attention to the jaws; they increase in growth, the gums expand along with them, and the teeth get much less crowded; that correct arrangement which nature herself would have managed is now disturbed by the ignorance of the dentist: the teeth are found to stand separated from each other; the consolidation of their architectural strength is disturbed; they are less capable of resistance to mastication than they would have been, and stand much less firm in the gum through life than nature originally intended. It cannot, however, be denied, that the extraction of a tooth from a crowded jaw, if resorted to at a proper period, is often the means of preserving many teeth which would otherwise have been ruined by decays. Before the permanent canine tooth is itself visible, its shape may be ascertained by a rise in the gum which indicates its future position; if the corner of the mouth be raised, this may be distinctly seen; here we have a guide as to the future arrangement of the teeth which the dentist should always refer to. Before, however, he can decide as to the extraction of a small bicuspid tooth, should the
mouth be crowded, he must bear in mind the retarded growth which we have just considered, the concentration of the powers of the constitution to complete other formations, and the circumstance of the gums and jaws being subject to an increase of their capacity when other processes have assumed a healthy growth.

We have rather digressed into circumstances connected more with the teeth than with the gums: we left them at a period when the process of shedding the teeth had commenced; this period, at a fair calculation, may be averaged at about six years before its completion. We must now consider the state these organs are in during this period.

At about the sixth year the vascular action of the gums increases; the determination of blood to them being part of the process which is going on, the primary teeth become loose, they are subjected to motions whenever any resistance is offered them; and this also increases the vascularity of the gums. The gums do not take part in the formation of the new set, but their absorbent vessels are decidedly active in the removal of the roots of the primary set; and they exert themselves gradually to expel the sequestra which the remaining portions of these teeth now become. The gums gradually accommodate themselves to the shape of the secondary teeth as soon as the primary ones are shed. While the body of the tooth is passing through the gum there can be no possible adhesion; the substance of the enamel renders this quite impossible: the case differs very widely when the neck of the tooth comes in contact with the gum; the periosteum covering the root is firmly attached to it at its neck, and it is there, if we examine the parts, that the gum has a very firm attachment also to it. The manner in which this attachment takes place may be found worthy of future researches.

We now see the gums attaching themselves to a new set of teeth, and performing for them the same offices as they before did to the set that has been shed. A great change has taken place in their appearance; they formerly surrounded the necks of the primary teeth, which were small and delicate; they now cover teeth with large roots projecting upwards and backwards in the jaws; the gum takes the shape of the root around which it extends, and there is a great increase of vascularity produced by the tension that existed while the secondary teeth forced their way forwards.

At this early period of life, we frequently see ill effects arising from the condition of the gums and mouth sympathising with that of the stomach and the general health. It is no unfrequent occurrence to find the first permanent grinder decayed as soon as it has appeared above the gum; this is more particularly observable in children of a very fair complexion who may have overgrown their strength.

We also frequently, about this age, observe spiculae of the roots of the primary teeth remaining in the gum and keeping up a continued state of irritation. It is of the highest importance to the
healthy state of the gum that these spiculae should be removed; and this can always be effected with little inconvenience at this period of life.

It is often found that there exudes from gums, when languor of circulation exists in them, an exudation which produces a brown stain on the enamel of the front teeth: this appearance is wholly peculiar to an early period of life. If a healthier condition of the gum come on, that part of the tooth which grows down from it will assume also a more cleanly appearance.

During this period nature has been occupied in perfecting the various parts of the frame by a continued and general renovation, preparing each part for the duties it has hereafter to perform; with the general growth therefore of the body, the jaws, the gums, and the teeth also have increased. We still trace this growth adapting itself to the powers and exigencies of the constitution; and the gradual manner in which the whole has been conducted may be considered a grand feature in the mechanism of our frame.

Between the thirteenth and fourteenth year we find that twenty-eight teeth are formed in the mouth. There remains, however, a wisdom tooth on each side to come forward; the growth of the jaws is still very far from being completed. We frequently find, where their development has been retarded, and where the teeth are large, that they are far too crowded for their size. The condition of the gum now indicates considerable derangement; the face is subject to flushes, head-aches come on, nervousness, and a general atonic state of the whole system. Here is often disease established, the true cause of which is not known. I must award to Dr. Ashburner much praise for recommending to the notice of the medical world considerations which must tend to elucidate this important point.

I know several cases of actual paralysis being cured by the extraction of a tooth. One of the most remarkable occurred to the daughter of a nobleman, residing in Arlington Street. Paralysis of the leg had come on after symptoms indicative of nervous derangement had shown themselves. The jaw was formed abnormally, and the teeth were crowded to a very considerable extent. Mr. Dumergue suggested that the paralysis was caused by the crowded state of the jaw, and recommended the extraction of a tooth. The result of this operation was singular; for the use of the leg was restored. This case is well worthy of notice from its showing that, if nervous irritation be once conveyed to the sensorium, there is no knowing where the effects of the irritation may fall.

A case came under my immediate eye, through the kindness of my friend Mr. Hunt, of Lower Brook Street. Here was paralysis of the muscles at the back of the neck relieved by extraction of a tooth.

Similar cases to these are well known on the Continent. I had them mentioned to me as frequently occurring by the celebrated M. Pernet of Paris.
These cases all admit of a physiological explanation in the following manner:—Lesion of a branch of the maxillary nerve, if not of the nerve itself, takes place, the consequent irritation is transmitted upwards to the sensorium, and a change of parts is so established in that organ that paralysis of some part of the body ensues.

We find cases analogous to these often occurring in dentition; and, although not attended with paralysis, they are involved in the same theories. Irritation is sent up by the fifth pair of nerves to the pons varolii; a turgescence of the neighbouring vessels takes place, and this in its turn becomes a source of injury. The eighth pair of nerves, arising from the medulla oblongata, behind the pons varolii, becomes soon involved in the same turgescence, and then those parts to which the eighth pair of nerves sends branches partake of the general irritation; hence symptoms similar to those of croup are often known, when in fact nothing exists but irritation consequent on dentition, being established by means of the laryngeal nerve; and hence also may arise many other symptoms, producing many disagreeable circumstances. I saw also a case in the winter which deserves considerable attention. The wisdom tooth was so impacted in the back of the jaw as to press against the maxillary nerve, just before its entering the canal; the consequence of the lesion was, as we might expect, loss of sensation of those muscles which are supplied by this nerve as it emerges from the foramen mentale. The case serves to substantiate the splendid discoveries made by our great physiologist, Sir Charles Bell, on the nervous system; for here, although sensation was gone, motion still existed. On the extraction of the irritating tooth, the parts supplied by this nerve recovered their usual sensation. I would draw a very essential difference between the symptoms which pressure on nerves produces and those which accompany an inflamed state of the gum. In the one we have cases of paralysis, and in the other we have convulsions.

While awarding to nature the full extent of all her beauties, we must not forget that preternatural growths of various parts of the frame are often seen, and that these occasionally may be benefited by surgical skill. It would appear that these circumstances depend on a peculiar diathesis of constitution; for we find them hereditary and rarely existing in the mouth but with diseased alteration in the structure of the gums; and it is no less remarkable that decays of teeth are mostly concomitant with these alterations. I do not, however, pretend to assert, that where teeth are crowded they must for a certainty decay: this would be an actual error. I have known instances, where many of the primary teeth have not been shed, where the mouth was so crowded as to constitute what is commonly called a double row, and yet these teeth have gone on without decaying till a very lengthened period of life. This I attribute to the health and temperament generally; for it is well worthy of remark, that most of these instances occurred to persons of very strong constitutions. We must here consider that the jaws may fre-
quently be crowded from various causes; the teeth may come forward very large, while, as far as relates to the normal growth of the jaw, there is nothing found to complain of. All these instances differ very materially from cases attended by anormal growth; for here we invariably find diseased alteration in the structure of the gum. As, however, numerous cases exist where looseness of teeth comes on without any decay being present, and as in these cases it is necessary to preserve the support which one tooth derives from another, the grand criterion then to be our guide as to the extraction of teeth to give room in the mouth must be the shape of the jaws, and at the same time the condition of the gum.

If we watch narrowly the phenomena of diseased alteration in any part of the frame, it is seldom that we are at a loss to detect its origin. It is a very common remark that the side teeth are the first to decay, and I have often heard much doubt expressed as to the reason why this so frequently occurs. I consider it firstly influenced by the great pressure of the canine tooth at the period of its irruption; indeed, if we examine these teeth when such pressure occurs, we find the striated texture of their sides altered from its original appearance by the force of pressure which has existed, and, as the gum at this period is here subject to detention of blood, so the exudation which takes place from it lodges on the weakened part, while the process of decomposition is assisted by the pressure which is still going on. This I consider the reason why the side teeth are so frequently the first to decay. But we come to another consideration which is of much higher importance: I allude to decays which frequently commence at this early period of life, and blacken and destroy the front teeth.

I can readily join in the deepest feelings of regret which all parents must experience at the occurrence of this melancholy circumstance. This is often in addition rendered more unfortunate from the circumstance of the decay being undiscovered, even when it has made rapid progress in the teeth. It is well worthy of remark, that subjected to this peculiar decay we frequently see females of the most extraordinary beauty. The large dark eye and brow, with fair hair, added to a skin of delicacy betraying every blue vein beneath it, may at this age be looked on with suspicion. By the same rule, the teeth of the tall and very fair young female of fifteen, who may have outgrown her strength, are also subject to the same occurrence. Minute observation, strengthened by a due regard tophysiology, places it beyond doubt that all persons subject to that peculiar diathesis of constitution, where there exist laxity of fibre and delicacy of structure, are more especially subjected to this caries of the front teeth. But although some of the most beautiful persons I have seen, I may safely say, of this age, have been afflicted by this distressing occurrence, I wish to make it understood that, when debilitating symptoms are seen, it is reckless of beauty and of form. It does not follow but that, accompanying extraordinary beauty, we have a full and perfect mouth of teeth. I could here instance two
ladies of very high rank; for I have the honour of occasionally looking at their mouth; their teeth and gums deserve equal merit with their beauty, and this has long been a theme of conversation. I have also observed that in most cases where puberty is attained either too early or too late, or where the constitution has more duties to perform than its strength is adequate to, where organic disease and exciting causes exist, we have too often the distressing occurrence of these decays. In selecting from the male constitution those afflicted in a similar manner, we find the same circumstances are conducive to it, but of course we must draw a distinction between the difference of the two habits of body.

If I take to myself any credit for a general success in operations on the front teeth, I wish it to be clearly understood that this success depends principally on the attention which in these instances I always pay to the health and condition of the gum. I have satisfactorily discovered that the gum, influenced by disease, is the principal agent in producing these decays; but, previously to entering into any explanation on the point, we must consider some facts connected with the decay itself.

Much complication has existed as to whether decays of teeth commence externally or internally. Daily experience, however, shows that all substances or fluids coming in contact with the enamel, which have in their component parts any of the different acids, possess, according to the greater portion of the acid they contain, an adequate power of decomposing the texture of the enamel. Decays almost always commence by the enamel losing its striated texture, and this is frequently first produced by the sides of the front teeth being subjected to attrition, by the pressure which in cases of crowded teeth invariably falls on them.

At this early period of life the bone of the front teeth has not acquired its proper solidity; their internal cavities and the pulpy substances contained in them being large, the whole tooth soon becomes involved in a mass of corruption. Here, then, we have the principal cause why teeth which decay early in life so soon blacken; for the increase of the bone in thickness is not at all calculated to keep pace with the decomposition which is going on. This process of decomposition once commenced acts on itself in a two-fold ratio; since it also becomes a contaminating cause to the rest of the teeth, even if the causes which first created the mischief have ceased to exist.

It is impossible often to witness mouths disfigured by black and decayed front teeth without considering the serious attention which the importance of the subject merits. It must be allowed that in many instances the contaction of various solids and fluids with the teeth bring on in them a state of decomposition and decay, but I attribute these circumstances more to the manner in which their component parts were originally formed than to any thing else; for it is a circumstance well worthy of notice, though dangerous to experiments repeated too often, that where at the period of
teething the health has been good, and where circumstances during the
time of growth have tended to give the enamel its compatibility
and hardness, it is capable of resistance to all food and drink which
we commonly make use of. In later years than the epoch of life,
the peculiarities of which are now to be considered, great difference
can be distinguished between decays caused by constitutional effects,
and those produced by the contaction of deleterious particles in the
food with them; for in these instances we see teeth corroding while
their adjacent gum is in a healthy state: I therefore look on these
decays as somewhat slow in their progress, while those we meet
with occurring between the twelfth and fifteenth year are of a
different character, and each of these is peculiar to different diatheses
of constitution. Never having seen the decays I am now treating
of but in teeth whose necks were surrounded by gums in a condition
almost bordering on a state of decomposition, I must necessarily
consider the decay as influenced in a great degree by the mucus
exuded from the unhealthy gum. I am strengthened in these con-
clusions from conversations which I have had with some of the
eminent experimental chemists of the day. It is taught by chemical
professors, that decomposition cannot go on in the living subject;
but we have the decided existence of life in the bone of a tooth.
This, however, prevails only in a low degree, and when detention
of blood takes place in the apices of the gums, between the teeth, it
becomes carbonized; and then I consider the exudation covering
them as partaking of disorganization.

As great difficulty exists in collecting a sufficient quantity of the
mucus which we find exuded from the gums and collected on
them when the muscles of the lip and the tongue are in a quiescent
state, I cannot be expected to give its precise analysis; I can only
state those products which arise from decomposition of animal
matter. Putrefaction of dead animal matter comes on by its expo-
sure to air, moisture, and a moderate temperature, and during the
process its original texture disappears, and products of an offensive
nature are generated. The products arising from the decomposi-
tion are water, ammonia, carbonic acid, and sulphuretted, phospha-
retted, and carburetted hydrogen gases. It would appear that this
effect produced on the teeth is by the sulphuretted hydrogen. This
might receive confirmation from the same factor attending the
mucus exuded from these parts and lodging between the teeth, as is
frequently found in the breath; and as the factor, thus arising, is sul-
phuretted hydrogen. From experiments, however, which I have
made, I attribute the decay to the presence of carbonic acid.

To keep the teeth in a healthy condition while their structure is
yet in its early days, it is necessary to attend minutely to the con-
dition of the gums, to empty their vessels when turgid and swollen,
to promote a general tone and healthy circulation through them,
and to resort to those remedies which their debilitated or heated
state each separately requires; but, while the dental surgeon exerts
his skill to check the diseased alterations presenting themselves,
he must not omit calling in assistance from the physician, who, by duly regulating the constitution, can provide remedies best calculated to prevent general disease of the teeth.

We come to another process which produces many serious effects in the mouth, and which influences also all parts sympathising with the gums: I allude to the irruption of the wisdom tooth. Much has already been published on the irruption of this tooth, but the views which have been generally taken on the subject have, till lately, been very limited. Science, however, having made rapid strides in every department, we might have expected that those persons whose occupations were devoted to the teeth and mouth would have given out some doctrines explanatory of the constitutional disturbance which so frequently occurs with the appearance of this tooth. The subject has lately increased in interest. I have heard it stated that a much higher colouring had been given to many cases which Dr. Ashburner relates than they actually merited. As, however, convulsions and other effects on the constitution have been removed by free incisions into the gum, at the part where this tooth by its pressure is causing irritation, this alone may form a fact which may open to our eyes other effects likely to be produced on the nervous system. That this system is liable to changes excited in the first instance by this tooth is a point respecting which there exists no doubt. From this derangement there comes on too many conditions of health, the true origin of which is often unsuspected; and if I place foremost among these, diseases of the brain, lungs, and stomach, I need only refer to the anatomy of the base of the brain, and this fact will be clearly established.

Dr. Ashburner quotes the following passage from Alp. Toirac, Docteur en Medicine, published in 1828: "M. Esquirol, à qui j’ai communiqué cette observation, m’a rapporté qu’une dame atteinte de folie avait été amenée à sa maison de santé, et qu’il l’avait rendue à la raison en favorisant par une incision cruciale la sortie d’une dent de sagesse." I can readily conceive that when there exists in the diathesis of a constitution a predisposition to diseases of the mind a difficult irruption of this tooth is alone capable of producing the most serious effects.

I lately saw a case of a young West-Indian lady which deserves considerable attention. Her age was sixteen; three large wisdom teeth had come forward, and had produced frequent convulsions: she still suffered from the fourth, which was beneath the gum. I made a longitudinal incision over the centre of the tooth from its posterior to its anterior part; on either side of this I made a circular figure, defined by the extremes of the longitudinal incision; the gum over the tooth was then separated into two portions.

I have since received intelligence that this tooth is giving very little trouble. I cannot too strongly recommend this operation to the notice of the medical world in all cases where the irruption of the wisdom tooth is attended with constitutional disturbance. It may with safety be performed when the tooth shows its first signs
of appearance; the surface of the gum is then flat, condronous, and somewhat insensible. It is shortly after this period that the worst constitutional effects are produced; for just as the tooth is through the gum the inconvenience is concentrated more in the spot itself; there are tenderness and increased vascularity around it: convulsions have by this time generally ceased.

Amongst other severe symptoms which we often witness at this period, we must not forget tetanus, neuralgic symptoms, and in females, leucorrhœa is no unfrequent occurrence. If I do not penetrate more deeply into the subject, and contemplate cases of hydrocephalus and of other diseases terminating frequently in death, which cases have occurred from difficult and impeded dentition, it is solely because the subject concerns the medical practitioner, and is not in the province of that part of surgery which alone I profess. That, however, these occur, I can bear ample testimony, from the results of post mortem examinations.

The case which was brought before the Westminster Medical Society last winter was as follows:—The underjaw of a gentleman aged thirty-nine was short; his teeth were very large, so much so, that there was no room in the mouth for the tooth which is denominated the second molaris. He was subject to continued swellings of his face, which always burst internally. In these swellings there was a peculiar feature: sometimes they appeared corresponding to the parotid gland, and sometimes near the submaxillary glands a sinus was formed, connecting one abscess to another. There was pressure of the maxillary nerve, for loss of sensation was established corresponding to the chin. As no wisdom tooth existed in the mouth, it was thought probable that one was hid in the parts, and that the swellings which came on were the effects of the efforts which nature was making to extricate it from its curious position. In probing the abscesses, the tooth was felt about an inch behind the flap extending from the upper to the lower jaw. I first made a free incision, connecting the two abscesses together, and imagined that they would not again occur; the pus which came away was very considerable, and the swelling for a time went down. This, however, soon re-appeared, to my great annoyance. I proposed the extraction of the tooth; for the immense mass of matter which had long pressed on the bone would soon have caused an extensive exfoliation. The operation was considered highly dangerous, but was decided on. Mr. Hunt, of Lower Brook Street, who first sent the patient to me, was present at the time, and assisted in the operation. He made an incision in the flap, to render the tooth more easily got at. As, however, it lay imbedded a great depth in the soft parts, its real position could not be detected, and the incision was not sufficiently large to admit of the forceps passing down. I forced a strong straight instrument underneath the tooth, and with all my strength disengaged it from its socket. This was not effected without great laceration. As, however, the aperture was not yet large enough to admit of the forceps,
ON THE SECONDARY AGE OF THE GUMS.

much difficulty existed as to the means of removing the tooth from the soft parts it was forced into, and at this period I was advised to desist from further attempts. In examining the tooth with a strong and curved instrument, I thought I had a firm hold at the posterior part; and, taking advantage of the moment, forced it through the aperture which was made. The hæmorrhage was, throughout the operation, considerable, but not alarming.

Here is a case illustrative of several points worthy of peculiar notice. It is no unimportant feature in the case that the root of the tooth was very curved, and its points particularly sharp. Let it, in addition, be remarked, that all teeth in the construction of which I have observed the foregoing anomaly, and which I have ventured to call loxostreptic, and aemated (a λξ^{2}στ, obliquus, et στριβατις, verto; αρμα, punctum) teeth, more frequently produce serious effects than those of a normal construction. We must not omit observing that this tooth, before its appearance, frequently produces a heated state of the gums: at this period we often find the breath tainted, the head hot, the countenance blanched, accompanied by general languor and debility. The pathologist ought to bear in mind that this general illness may terminate in the most fatal results; and that no effect is ever produced without a cause. In the female constitution it too frequently occurs, even when no pain exists corresponding with the wisdom tooth, that derangement of health is produced by lesion of some dental twig, and this is established by changes in the position of the wisdom tooth; these changes of position more frequently occur when the wisdom tooth is pushing forwards to take its position in the mouth, if development of the jaw is abnormal.

At about the nineteenth or twentieth year terminate, in my opinion, the peculiarities of the primary age. More extended and enlightened views might be taken of the general effect which the difficult irruption of teeth, and the abnormal development of the jaws, produce on the nervous system. I am fully persuaded, that at some period, and that not far distant, the mazy labyrinth of puerile diseases, and all the arcana of what humanity* suffers during the early periods of life, will be much more clearly revealed to the medical world when the important features which dentition presents from its earliest to its latest stages are fully investigated.

ON THE SECONDARY AGE OF THE GUMS.

We terminated the primary age with the period when the formation and development of the teeth are usually completed. It may however happen that the wisdom tooth does not appear till a very late period of life. To the primary age, which is synonymous with youth, succeeds another age corresponding with manhood. Then all increase of the body in height is at an end; and all the organs

* Quod si mihi quidquam humaniter eveniret.—Cicero Epist. ad Fam.
acquire hardness, solidity, and consistency. Fauchard says, "Les dents s'embellissent jusqu'au l'age de vingt ans;" but I have observed that the age of nineteen is generally the period of their highest beauty.

The gums and teeth may, at this period, be considered as the plants and trees in the summer season, arrayed in their garb of beauty, and arrived at the highest point of strength and vigour; the constitution has emerged from the debilitating operation of growth, and the powers of the frame are concentrated in it, to preserve the bulk it has at length attained.

Amongst other changes perceptible in the frame which the evolution of nineteen or twenty years has produced, we see in the gums a relationship and pathological affinity to other parts of the body which have been formed. Those gums which about the tenth year presented diseased alterations, and were turgid and swollen, coinciding with the unsettled state of the constitution, have now with improved health assumed a healthier state. But, as we have before explained that each diathesis of body takes its own peculiarities, so this is the period when each gum has taken its own characterising features. We might take advantage of this period to enter again into the exact differences in different gums; but, perhaps, enough has already been said. We must not, however, neglect to observe the hard cartilaginous gum accompanying the healthy habit of body, and indicating absence of latent disease; and that wherever this appears, we have an exact equipoise in the lymphatic and the energy of the sanguineous system.

It is not at this period of life that the gums are subject to any peculiar diseases, save those conceived in the previous age, and handed down to this succeeding one. As to those effects produced by the follies and intemperances of youth, the original purposes of the gums are not to be found fault with. When the action of mercurials has been resorted to in order to eradicate disease contracted in youth, when the moral government was weak, and had fallen under the empire of appetite, we have recession of the gum and of the sockets of the teeth—we find schism of the one from the other, and the roots of the teeth left exposed by the natural covering of the gum. The bone thus exposed is extremely sensitive, for it is devoid of the protection which nature planted around it. This constitutes the most peculiar feature of disease which we witness in the gums at about the twenty-first year; but, although it is produced in its severest forms by the action of mercurials, we see modifications of it as we pass on in life from other causes. It is often met with in the gums of females of a delicate and nervous temperament, and may be attributed to causes connected with the sanguineous system, in which an undue excess of action has fallen into an acquired habit; and an early waste of constitution has been induced by debilitating causes. We see it also produced by the state of debility which follows acute and intermittent fevers; and that which continued fever also induces. In many instances where it
occurs it may be considered as somewhat unaccountable, especially if we do not thoroughly understand the processes of absorption, nutrition, the secretions, sensation, and the whole functions of assimilation.

But while I seek in the intricate labyrinths of the animal economy for illustrations from the remotest sources, I must not forget that this diseased appearance is produced by other causes, which although ostensibly simple, are nevertheless entitled to our serious attention. Accumulations of tartar frequently lodge on the necks of the teeth, and become in time firmly impacted under the gum: this, increasing by constant accession of matter, separates the gum from the root; and, being hard, swells out the gum, and produces a recession of it from the tooth.

Amongst other qualifications which the present enlightened age considers essential in the person of the female of a superior sphere of life, of the well-bred and thoroughly gentlemanly character, and the man accustomed to move in genteel society, the attribute of cleanliness holds, perhaps, the highest consideration, and this not unworthily, for it is of real benefit to the maintenance of health. To the mouth itself it is of the highest importance, whether we consider our own comfort or the nicer feelings of those around us. I must particularly mention that the various particles of food which after meals might lodge between the teeth should be washed away, that at night they should be well brushed to ensure this object, and that in the morning the same process should be resorted to in order to remove the mucus which, during the hours of repose, has exuded from the gums and collected on the teeth. Where ordinary means fail in the attainment of this desirable object, a good rough powder may be used. I recommend hard friction to the gums and teeth early in life; it serves to keep the one in a healthy, the other in a cleanly state. In later years, when the teeth stand loose, and when the bone of the tooth is exposed, the case becomes necessarily different. Sponginess of the gums, which is often at this age produced by accumulations of tartar round the teeth, may be prevented by these salutary means.

Passing on in this age, and considering many phenomena which occur, especially in a female constitution, connected with the various temperaments and idiosyncrasies, where the passions of the mind are strong, and where their influence prevails over the habits of the body, we are not at a loss to conceive why the gums from a healthy condition frequently fall in a few years into a state of atony and languor; why then the teeth, participating as they do in the general idiosyncrasies, fall also by the indomitable impetus producing diseases of the gum; why, by vitiated secretions, by heat of the stomach and breath, their bony part becomes decomposed; and why, losing their affinity for lime, they become, as it were, a soft and yielding substance. With an undue excess of the exciting passions, with disease of the liver, and hypochondriasis, we have often general disease of the gums and teeth, and the condition in which I have
often seen them influenced by these diseases deserves the most serious attention; the teeth mouluding by decay, and falling into crumbling atoms, their necks exposed, and exquisitely tender to the touch; the gums greenish, the openings of the capillaries appearing obliterated, and their whole structure altogether diseased. If it happen that most of the teeth have broken away, then, in the place of them, we have diseased gum; it elongates over the root, bleeds by the contacto of food, keeps up great heat of the mouth, and involves, even at this early age, the fifth pair of nerves in general irritability. We occasionally meet with abscesses, ulcers, tumours, and morbid growths in the gums at this period of life, but they are not natural to the gum; they all depend on accidents, on teeth deprived of life, on diseased bone, or constitutional irritability.

If we look to the gums at the thirtieth year, we see in them those changes which the wear and tear of the constitution might naturally induce us to expect. Ten years passed in London differ from the same period passed in rustic enjoyments; to the close applications of life, its fatigues, its sedentary moments dragged on without the enjoyment of fine air to purify the constitution, the country gentleman is an entire stranger. The peacefulness of a retired village, and the busy bustling scenes of London, produce on the nervous system opposite tendencies; and so also in the mouth we see a decided difference produced. In the resident of London we find heat of the mouth, increase of saliva, continued fever, and frequency of decay in the teeth; and in the mouth of the countryman, where the constitution is sound, we only see disease in the form of accidents, or caused by inconsistencies of living, love of table enjoyments, or other sensual delights.

It is during the past ten years that many habits have been acquired which must prejudice or benefit the future state of the constitution; and, as its powers have been cherished or diminished, so we see the gums more or less affected by debility.

Repeated child-bearing and miscarriages often produce this effect, which, however, may be traced back to the change of general circulation taking place previously to such occurrences: we then often see an inordinate circulation roused in the gums, and the foundation laid for disease, which at about the forty-fifth year subjects the teeth to looseness. It is of the highest importance that at this period of life this effect produced should be especially considered, and that all inflammatory symptoms which show themselves should be reduced by topical bleeding.

By the thirty-fifth year we find, where decided tendencies to disease of the gums at the commencement of this age existed, that these tendencies have mostly increased. It is exceedingly difficult to define the peculiarities of the gums at this age; for it is rarely that we find them in two persons bearing an exact similarity to each other. In some persons, premature old age has come on, while in others the strength of youth is still in all its vigour. We must, however, take into consideration all the vicissitudes of life. Many gums may about the middle of this age have evinced dispositions to
disease from the constitution having been subjected to development of such disease; but in the ensuing period, the causes tending to the development of such tendencies being removed, the gums have, with the constitution, had time to become settled and healthy.

It is about this age that accidents which occurred some years back to the teeth become seriously annoying. If any of the teeth have received blows early in life, they now often become loose and troublesome. If their vitality has been destroyed, they become black and unseemly, and the gums all around them fall into a state of irritability. In those habits of body where excess of arterial action exists there is great turgescence of the vessels; and, in many instances, we see small white papillae interspersed over the surfaces of the gum. It is thus in many instances that looseness of teeth occurring at this age may be traced back to a blow, or violence which early in life they may have received.

As we increase gradually in years we find that those gums which were of an unhealthy nature are the first to be deprived of their teeth; and by the fortieth year the mouth seems to be preparing for changes brought on by the critical period of life towards which we are gradually progressing. The back teeth are in many instances gone, and all the pressure of the under-jaw falls directly on the front of the mouth. Some of the teeth are often found loose, or falling apart towards the place where others formerly stood. By absorption of the socket the teeth become placed as pressure of the opposing jaw directs, and the gum conforms itself to the position they take. Sometimes when no pressure falls on them they change position by the increase of diameter in the gums, which increased vascularity induces. We occasionally see teeth which stood prominently forwards in the mouth assuming a most unseemly appearance, and the lips are disfigured by it.

Drawing a comparison between the gums of different individuals, it is evident that new changes are now taking place, preparing for a different train of circumstances to those which have hitherto been considered: with the commencement of these changes we may finish our secondary age.

ON THE TERTIAN CHANGE OR AGE OF THE GUMS.

"Now black, now deep, the night begins to fall,
A shade immense."

This age differs very widely from those we have just considered. It too often comes on with very unfavourable prognostics. The ill-spent hours of youth begin to tell up on the human frame: we are at the predisposing period to anasarca, cancer, scirrhus, gout, rheumatic affections, and other diseases of a most serious character.

A great proportion of gums are by this period devoid of many teeth; this has been occasioned by decays, by looseness, and by accidents; those teeth, however, which have withstood the action of various detrimental causes until this age are more than likely destined to go through life unimpaired by decay.
It is a remarkable coincidence in the pathology of the gums, that teeth which have gone on till this period of life without causing inconvenience should suddenly become the seat of extreme pain. The patient of course imagines, under such circumstances, that they are decayed. On consulting a dentist, he is informed that some of them are loose, and that others are getting into a similar condition; the gums are perhaps lanced, and an astringent tincture recommended. This, however, is not calculated to arrest the progress of the disease; it spreads round other teeth, and another dentist is then probably applied to; the patient hears that he has a disease in the sockets of the teeth, and that nothing can be done for him. Some of his teeth soon drop out, and his friends hear that he loses them "by their coming out whole."

Looseness of teeth is a subject but little understood in London; I believe Mr. Bell is the only author who has any real knowledge of the subject. It may be produced from various causes, but the disease I now mention is of such a specific character that we must consider it separately.

If we examine teeth which have been affected by it, we find on their roots various symptoms of disease, such as tumours, abscesses, thickenings of the periosteum, and necrosis of the root itself. On inquiring from patients their various habits, tendencies, and modes of living, we find in general some peculiarities which serve as a datum to the commencement of the disorder. We come, however, to other lights on the subject, of vast interest and importance. We learn that the disease is hereditary, that it was imbibed from one or both parents whose teeth "dropped out whole also."

In many male cases where it exists we find the bilious and melancholic temperament prevailing. In females, where, connected with the temperament we have exquisiteness of feeling, and acute perception, the disease occurs often with symptoms of hypochondriasis and nervousness; and as connected with this, and not remotely, we have hysteria, chorea, epilepsy, and mania; we might soon get on to the intricacies of mental as well as corporeal derangement. It ill, however, becomes me to dwell on these affections, with the peculiarities of looseness of teeth, and to dip into the almost unfathomable depths of diseased and unsound intellect. I may, however, be forgiven for observing, that in most cases of diseased mind, and of hysterical and epileptic tendencies, if we have not the disease I am now mentioning we have loss of teeth from a peculiar decay, against which it is most difficult to contend. Its existence, however, in unison with other diseases which baffle the science of the first pathologists of the day, may prove some excuse, if its theories have not yet been expounded.

Tracing the alterations in the gums where this disease exists, from its earliest rise, we find that vascular action is roused in them from some exciting or predisposing cause; we find that those teeth whose bodies are long and large are more immediately subject to it than others; the patient's face is flushed or florid, the gums are of a deep colour, and if we elevate the upper lip we see that the
vessels going from the gum to its mucous lining are deeply in-
jected; we suspect an undue equipoise in the circulation through
them: passing on some few years we find the disease more fully
established, several teeth are quite loose in the gum. Increased
vascularity comes on by the motion which occurs during mastication,
and by this the periosteum of the root is often brought into a
diseased condition.

In the early stages of the disease, constitutional remedies may
tend to check its progress, but this requires considerable nicety;
and, while an equilibrium is necessarily to be preserved between
the constitution and the quantity of food taken, hot suppers must be
strictly forbidden; or, in fact, any food likely to produce restless-
ness in sleep, for this is often accompanied by a jarring and grating
of the teeth. As with this disease the physician may too frequently
see the health declining, change of scene, of diet, and every thing
conducive to the general health should be most strictly enforced.

It is the province of the dental surgeon to detect this disease in
its infancy, to adopt every means to prevent the gums becoming
turgid and swollen, and to exert his utmost to secure tone and cir-
culation through them. It may with accuracy be stated that when
it occurs before the fortieth year, if the constitution be pretty good,
and the affected teeth sacrificed, it discontinues altogether its pro-
gress. I met with more cases occurring in many parts of the contin-
nent than are to be seen in England; and from the results of
many thousands which I have seen, under treatment, I consider
this the most advisable remedy that can be adopted.

When, however, he is consulted in the later stages of the disease,
it is very difficult for him to suggest relief; by the extraction of
an affected tooth, by repeated, bleeding the gum and the use of as-
tringent tinctures, the progress of the disease may be considerably
retarded, but in the end several teeth become exceedingly loose.
In all these cases I wish it to be understood that nothing will so
tend to relieve the teeth generally as the extraction of those which
are diseased. I consider them to be a certain cause of contaminata-
tion to those remaining sound; and, as by this operation a great
quantity of blood will be drawn from the parts immediately affected,
it cannot fail to prove most beneficial.

We may consider whether the gums and sockets of the teeth,
which long ago had wasted and absorbed, have by this time, if the
constitution has gained strength, effected, the process of reproduction.
This might at first sight appear probable, for up to this age there
has been a successive absorption and reproduction of all parts of the
frame, and the jaws and alveoli are more immediately furnished
with the means of producing these changes.

Minute observation teaches us that when the alveoli and gums
once absorb there can be renovation of them. Sometimes the gums
may elongate by a morbid action which they put on, and this is
mistaken for a growth instead of a disease. Teeth are most gener-
ally deprived of the sockets and gums when absorption of the
frame preponderates over nutrition, and when this is the case the tooth looses a great portion of its strength.

We always detect a slight motion which nature establishes in the sockets of the teeth to avert the jarring that would else occur during the necessary process of mastication. This motion becomes increased by the waste going on, and, as whenever we have motion so we have friction, an irritation is established, which, although trifling in itself, prevents the renovating process from taking place. If, till change of life, an equilibrium be kept up between absorption and renovation, the sockets of the teeth and the gums will retain their pristine strength. This period past, and waste exceeding deposit, we pass on to our destined end slower or faster, according to our strength and powers. All this must be acknowledged as indicating with exactness many points connected with the pathology of our frame.

Common looseness of teeth comes on from a variety of causes. Undue pressure falling on any tooth will, by the force of the muscles employed in mastication, fatigue it beyond what its powers can endure; it then becomes loose in its socket. The force and pressure which dentists resort to when the teeth of young people take an irregular position, tend also to lay the foundation for disease, which at this period is roused, and which terminates in looseness of the teeth.

It also appears that this is a period when all injuries which have occurred to the gums and teeth show themselves with the worst effects they have then the power of producing. Teeth which years previously received blows, and which in the last age were becoming weak, in this one loosen and come away; the gums at last appear to lose all tenacity to them. Amongst the complication of causes tending to produce looseness of teeth, we find that roots deprived of vitality and remaining in the gum are oftentimes very prejudicial. The following is the manner in which this circumstance may be explained: the edges of the alveolar processes are thin, vessels pass directly through them, and the periosteum is reflected on each side of the alveolar cavities: thus inflammation extends from one to the other.

When, also, as is often the case, exfoliations of the socket by pressure of the alveolar abscesses take place, an entrance is made to the adjoining socket; this, in its turn, becomes diseased, and, partaking of the same characteristics, transmits disease to its neighbouring tooth; so it continues its course, from one tooth to another, through the whole range of the jaw.

We have noticed in the commencement of the secondary age, that tartar, which accumulates behind the front teeth, destroys often a portion of the gum. In this age, however, it produces effects of a much more serious character: it has remained encrusted during life behind the front teeth, and has gradually undermined them; it has been a local cause of considerable mischief, and the gums are in that state as now to commence bleeding on the slightest touch. It becomes highly necessary to remove this accumulation; for the heated state
in which the mouth is often kept produces relaxation of the schneiderian membrane of the nose, and of the mucous membrane of the trachea and oesophagus; it excites colds, sore throat, and other diseases.

A gentleman residing in Dover Street was sent to me with pains in his face similar to those of hemicrania. He described himself as dreadfully afflicted with tic-douloureux; he told me that the paroxysms came on in bed, but said that they lasted during the whole of the night; his face appeared as if he were recovering from an attack of erysipelas inflamation. On examining his mouth the gums were in a sad scoriatic state, emitting the characteristic factor of this disorder, and they bled on the slightest touch. The quantity of tartar collected round the teeth was immense. The treatment I adopted was to remove the tartar; and to empty the distended vessels of the gum. I ordered an astringent tincture to be continuously used. The rheumatic pains yielded to alterative medicines, and to the carbonate of iron given in small doses. It was somewhat ridiculous that the patient always gave me credit for curing him of a confirmed attack of tic-douloureux: I could never convince him to the contrary.

Fungous tumours also loosen those teeth which during their development are in contact with them. It is not my province to enter into a description of the numerous and various tumours which occur to these as well as to other parts of the frame. Many beautiful specimens of morbid growths of tumours from the jaws are to be seen in the various museums of the metropolis. Those which come under the treatment of the dental surgeon are mostly the effects of decayed teeth or roots, and will always yield by the removal of the cause exciting them, oftentimes to a weak solution of nitrate of silver. We frequently find them circumscribed at their base, and about the size of a pea; they are mostly seated in the cellular tissue of the gum, which appears to puff out and subside as irritation may or may not exist; they are not wholly peculiar to the age we are now considering.

Teeth which, by the ignorance of operators, were extracted by mistake, and replaced, now become a source of irritation to the gum; the tenacity which existed between them now begins to go, and they fall out. This may lead us into some explanation regarding an operation called "transplanting teeth," which was often, years since, performed on the continent: it has now justly fallen into disuse. A tooth being removed from the gum of one person was inserted into the socket of another tooth, removed from another person from its being defective; both operations being performed at the same time, and the parts being fresh, adhesion, as in the experiments made by John Hunter, took place.

I have had repeated conversations with dentists on the continent, who in their early days were celebrated for this operation. It was mostly young people who were operated on; the operation often lasted till about the forty-fifth or fiftieth year, after which period it was never thought advisable to attempt it.
The most horrible effects have been produced by this operation that can be recorded. In many cases actual disease was introduced from one constitution to the other; in others it appeared as if this had been the case, but the contrary could clearly be proved; a disease arose which was quite uncontrollable; ulceration first took place in the parts near to the operation; blotches came out on the face and all over the body; a sanious discharge took place from the gums, accompanied with dreadful exfoliations; fever and nocturnal pains arose, with an aggravation of all the above-named symptoms. It was found that the disease would not yield to mercury, but it was similar to that contagion imbibed from wounds while dissecting horses which had died of the glanders, the glands of the axilla, the submaxillary, and inguinal glands becoming dreadfully swollen: it was the fatal termination of these cases which brought the operation into disuse.

By the fifty-fifth year we see the appearance of the gums most materially altered; some teeth have elongated, and others stand wide apart, retiring always towards those spaces whence others have been extracted. In other mouths, at this age, we have the necks of most of the teeth uncovered by the gum, and these are often subject to rheumatic pains and inflammations. Operations, which some time since could be performed on the teeth, are now often impracticable; there is a general tendency about many mouths to irritation. Decays of teeth arise which are peculiar also to this age; we would gladly preserve many of these teeth by stopping or filling them with gold, but we often find that this is impracticable; it appears that the pressure which we make is greater than the strength of the socket can bear, or that a peculiar irritability in the vascular or nervous system in or around the teeth is excited by the presence of the extraneous body. It is no uncommon occurrence to find, when teeth are stopped at this age, even though the nerve be unexposed, that pain and irritation are roused by the stopping, which before the operation the patient was altogether a stranger to.

Another condition in which we must consider the gums is that into which they are often brought by the unrelenting work of the tooth-maker. A tooth may early in life have been pivoted, and perhaps have gone on twenty years with tolerable comfort. This is often so when the root on which the tooth is pivoted is sound and good. The case, however, now alters: the root becomes either loose in the socket or worn by the pressure of the pivot, and it is necessary to fix it in another manner. This is effected by means of a plate of gold stamped exactly to the shape of the vacant gum and adjoining teeth, round which clasps are worked. The best contrivances of this nature which we meet with are those worked for many of the eminent toothmakers of London by Mr. C. Ash, of Broad-street. Those persons who profess peculiar methods of fixing false teeth, and pretend that inventions belong solely to themselves, are generally the adventurers of the town. The great secret of false teeth consists in employing scientific manufacturers.

In considering the influence which false teeth have on the gum,
I must observe that there never can be a plan known by which they can be kept firm without injuring the adjoining ones.

I admit that in cases where they can be kept up by atmospheric pressure or suction, that the loosening process is slow; but this method of fixing teeth is not always practicable, and the bone employed is soft and easily discoloured. The grand object then in these cases is, that the plate of gold be so stamped to the gum and teeth as to require little pressure on them. If due regard were always paid to this point, false teeth would not so soon loosen their adjoining ones. The state into which some gums are brought by false teeth is exceedingly distressing: the clasps which often press round on them produce inflammation, which brings them into a discoloured and distended condition. The gums are furnished with the means of expelling teeth and roots of teeth, which at this period become deprived of life, and in such instances, where false teeth are supported by one or two loosened teeth, it always appears that the gum is using double exertions to expel the burden which is hanging from it. When mouths are once in this condition, and where patients find it necessary to wear false teeth, I particularly advise that all the loose and irritating teeth be removed; for then they may be resorted to with comfort.

The public generally are not aware what an extended field false teeth present for imposition; for the circumstances relating to them are always kept secret. As, however, I have been informed that means will be adopted to check the numerous abuses which have too long been undisturbed, I shall here say no more on the subject.

At the sixtieth year the gums and teeth often are a great source of irritation to each other. It appears that in the fall of teeth, as in their growth, there is a painful ordeal we must undergo. By the gum receding from the roots of teeth we see externally a division of their fangs, and internally the entire socket gone; but the gum here, although denuded entirely from each root, is found still elongated between them. This, however, does not prevent the cold penetrating to the more sensitive parts, and producing distressing pain and inflammation. In this condition we find suppuration to some extent; it oozes out between the roots and the remaining portion of the gum. The constant pressure against the teeth tends to keep up the irritation, and the matter increases in its formation.

At about the sixty-third year would then appear the time when senile tendencies come on, and, considering every constitution, it must be generally confessed that at this period we are actually beginning to grow old.

ON THE SENILE AGE OF THE GUMS.

Old age, which in the annals of humanity is what winter is in the seasons of the year, comes on bearing ample testimony that man was not made for immortality here below, and advances with manifold indications of approaching dissolution.

The gums may be considered as tending more to establish the
existence of old age than any other organs of the human frame. They have been exerting their powers to expel from them many teeth which were loose and irritable, and this has been effected in a singular manner. At the same time as absorption of the alveoli of teeth has been going on, the internal and external gum have, by a contractile power peculiar to themselves, approached each other and undermined the root of the tooth. This has lost its tenacity to the gum; for it hangs only on one side by a few slender filaments: on its falling off there is no haemorrhage; a sulcus only is left in the gum, which in a very short time disappears. The expulsion of teeth in this manner from the gum is particularly worthy of notice; the socket fills up at the bottom, and then the gums close above the root. When looseness of teeth comes on by the gradual march of old age, many years pass away before they drop out; when, however, by the sudden supervision of illness, from blows, or from the effects of mercurials, the teeth become loosened at this age, their loss is effected in a much shorter period.

It will be well to consider some few facts connected with the process of life, which is now fast drawing to a close. Decay advances, the cellular tissues shrivel, the sensibility of all organs gets blunted, active impressions cease, the hair turns grey, the fluids are disposed to putrescence, the cartilages ossify, the bones become heavy, the teeth and sockets fall, and the face is considerably shortened. Then comes the digestion which now requires more than ever the use of teeth for mastication; this is weak, and at the same time nutrition is imperfect. There is a languor of secretions, and absorption is difficult from an alteration which has taken place in the glandular system. A want of tone comes on, and the temperature of old people is much lowered. The diseases which the gums are subject to at this age are those which we may look for from their sympathy with other organs: heat and redness, apthous affections, and occasional abscesses, are amongst the affections they are most liable to.

No doubt can be entertained but that those persons who in old age retain their teeth subservient to the process of mastication live to a more advanced age than others who are subjected to their loss.

In the manufacturing districts, where little time is allowed for meals, and where food is swallowed in an unmasticated state, numerous diseases are prevalent, and roused by this exciting cause, which else would always have remained dormant in the constitution. If, when the constitution be in its hale days, there be this liability to disease, to how much greater extent must we expect to find its prevalence when old age has crept on, accompanied by the general constitutional debility!

While following down the condition of the gum to a late period of life, we must necessarily observe that so long as the powers of the frame continue in full vigour, so long will the gum possess tenacity to the teeth; and there is no criterion affording more certain characteristics of a general breaking up of the constitution, than a sudden loosening of the teeth from natural causes. When the exhibition of mercurials is resorted to about the seventieth year,
and the capillaries and absorbents are already in an atonic state, it
seems to act as a focus by which a morbid condition of the gum is
brought on which soon terminates by an expulsion of the teeth.
Indeed there is no cause which at an advanced period of life will
sooner destroy the tenacity of the teeth to the gum than the use of
mercurials. Fortunately for those who value their teeth, the use of
this medicine is now resorted to with discretion and care.

It must be observed that, with the physical diminution of sensi-
bility, the teeth are almost incapable of receiving impressions, and
have but little power of transmitting them. Hence decayed teeth,
which early in life would have been the seat of extreme pain, are
now almost insensible.

Notwithstanding that the physical diminution of all faculties, and
waste instead of growth is going on, I know two instances of the eye-
teeth growing from the gum at this late period of life. One of these
cases was singular, for the health was much debilitated. I mention
these facts, for they may be useful to dental surgeons in guiding
them against too hastily extracting the primary side teeth; for if
there be a retarded development, as is often the case in the canine
tooth, then they will be accused of having taken away that one
which is often late in coming forward; and I must also observe,
that we frequently find the first primary double teeth remaining in
the gum till a late period of our life.

It is worthy of notice, that females who have passed the sixtieth
year, and who have still many teeth remaining in the gum, will in all
probability preserve these to a very late day of their life. If, not-
withstanding the trials the constitution has endured, they are still
firm and good, the vital energy must be strong, and the powers of
life but little diminished. To such a person, then, I would predict
a patriarchal age before she be summoned by the "King of terrors."
This theory, however, is applicable to the male constitution in a
different manner—he has been unexposed to the severe trials of the
female; and we find about the sixty-eighth year that his teeth fre-
quently fall away from, or decay in the gum.

We come to the seventieth year. Many gums are by this period
returned to the condition in which we first considered them. Man
also, who has arrived at the scriptural age of "threescore years and
ten," is also returning to his original state.

This may not be an inappropriate place to mention, that longevity
is much on the increase; comforts of all kinds, many of which are
most essentially conducive to health, are more attainable to the pre-
sent than to the past generation. It is no longer an accomplishment
to finish several bottles of wine after dinner, to lie elegantly under
the table in a drunken condition: diet is by all classes of society
made a most essential consideration; the digestion is generally under-
stood, and medical science is arriving at a high degree of perfection.

I could, however, instance many remarkable persons who at this
age have their teeth in great strength and vigour. I could select
others who, years ago, were in ill health, but who have recovered
from such a condition. It is true that many may be indelentulous,
but nature has perhaps called into action the compensative powers of the gums, and they are capable of performing mastication. Such persons live to an advanced old age. We get to the eightieth year. Now we are at the period of decrepitude; looking at the roof of the mouth we now find that it is flat and shallow; the under jaw, also, has changed its shape, and the gum has conformed itself to it. It is a remarkable fact that, where at this age teeth are found in the gums, the gums are invariably those which I have described as unpredisposed to disease, and uninjured by the intemperancies of life; those of a different character are, alas, by this time consigned to the silent tomb. On inquiring from the old man who may still possess the blessings of those organs we have considered subservient to the primary process of animal existence, we learn that the following has been the tenour of his life:—He has adopted general means to secure health, avoiding excess of exciting potions; he has so acted under the norma of prudence as to ensure peace and serenity of mind. Such a man, enjoying in old age the retributive blessings of temperance and self-command in youth, may recollect the different career of many now mouldering to their kindred dust.

While I would give religion and virtue their due meed of commendation, even in the temporal end of preserving health, I do not wish by any means to imply that a puritanic abstinence from manly sports, an enthusiastic disrelish of all social comforts, are necessary to the attainment of old age; facts, were I to maintain such a doctrine, would prove me in error; the mental and corporeal faculties require each a due exercise and cultivation. I would repudiate the shallow-mindedness of those persons, more zealous than rational, who, undertaking to turn a man from the errors of his way, preclude every healthy exercise and enjoyment, burden the weak and unrelaxed mind with the terrors of futurity, and see their own ends defeated by the exchange of moral depravity, for physical madness.

Let, then, the rich man, to secure the blessings of old age, instead of indulging in indolence, which is ever the support of anxiety, resort to the sports of the field, or adopt other means of relaxation in those hours not otherwise engaged. Let the occupant of a humbler threshold, a thatched roof, spend his hours not allotted to labour, at quoits, at the vaulting-green, or at some other rational and innocent amusement. Such a line of conduct produces energy of the nervous and muscular system, a wholesome condition of the secretions generally, a serene and tranquil state of mind, and is calculated to open the heart to all those nobler virtues that should dignify mankind.

But, to return from our digression, the winter has fast set in, the vegetative existence to which man was reduced is frozen, the shades of darkness begin to compass us around, and the body, as says the eloquent De Buffon, dies slowly and by degrees.

THE END.
AN ESSAY

ON

DE W,

AND

SEVERAL APPEARANCES CONNECTED WITH IT.

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ESSAY ON DEW.

INTRODUCTION.

I was led, in the autumn of 1784, by the event of a rude experiment, to think it probable, that the formation of dew is attended with the production of cold. In 1788, a paper on hoarfrost, by Mr. Patrick Wilson of Glasgow, was published in the first volume of the Transactions of the Royal Society of Edinburgh, by which it appeared, that this opinion had been entertained by that gentleman before it had occurred to myself. In the course of the same year, Mr. Six of Canterbury mentioned, in a paper communicated to the Royal Society, that, on clear and dewy nights, he always found the mercury lower in a thermometer laid upon the ground, in a meadow in his neighbourhood, than it was in a similar thermometer suspended in the air, six feet above the former; and that, upon one night, the difference amounted to 5° of Fahrenheit's scale. Mr. Six, however, did not suppose, agreeably to the opinion of Mr. Wilson and myself, that the cold was occasioned by the formation of dew; but imagined, that it proceeded partly from the low temperature of the air, through which the dew, already formed in the atmosphere, had descended, and partly from the evaporation of moisture from the ground, on which his thermometer had been placed. The conjecture of Mr. Wilson, and the observations of Mr. Six, together with many facts, which I afterwards learned in the course of reading, strengthened my opinion; but I made no attempt, before the autumn of 1811, to ascertain by experiment if it were just, though it had, in the mean time, almost daily occurred to my thoughts. Happening, in that season, to be in the country on a clear and calm night, I laid a thermometer on grass wet with dew, and suspended a second, in the air, two feet above the other. An hour afterwards, the thermometer on the grass was found to be 8° lower, by Fahrenheit's division, than the one in the air. Similar results having been obtained from several similar experiments, made during the same autumn, I determined in the next spring to prosecute the subject with some degree of steadiness, and with this view went frequently to the house of one of my friends, who lives in Surrey. At the end of two months, I fancied that I had collected information worthy of being published but fortunately, while preparing an account of it, I met by accident with a small posthumous work of Mr. Six, printed at Canterbury in 1794, in which are related differences observed on dewy nights, Oct. 1838.—Q 2
between thermometers placed on grass and others in the air, that are much greater than those mentioned in the paper presented by him to the Royal Society in 1788. In this work, too, the cold of the grass is attributed, in agreement with the opinion of Mr. Wilson altogether to the dew deposited upon it. The value of my own observations appearing to me now much diminished, though they embraced many points left untouched by Mr. Six, I gave up my intention of making them known. Shortly after, however, upon considering the subject more closely, I began to suspect, that Mr. Wilson, Mr. Six, and myself, had all committed an error, in regarding the cold, which accompanies dew, as an effect of the formation of that fluid. I, therefore, resumed my experiments, and having, by means of them, I think, not only established the justness of my suspicion, but ascertained the real cause both of dew, and of several other natural appearances, which have hitherto received no sufficient explanation, I venture now to submit, to the consideration of the learned, an account of some of my labours, without regard to the order of time in which they were performed, and of various conclusions which may be drawn from them, mixed with facts and opinions already published by others.

PART I.
OF THE PHENOMENA OF DEW.

SECTION I.
OF CIRCUMSTANCES WHICH INFLUENCE THE PRODUCTION OF DEW.

Aristotle* and many other writers have remarked, that dew appears only on calm and serene nights. The justness of this observation, however, has not been universally admitted. For Musschenbroek† says, that dew forms in Holland, while the surface of the country is covered with a low mist; but, as he mentions at the same time that it is deposited upon all bodies indiscriminately, the moisture, of which he speaks, cannot properly be called dew, as will be more distinctly seen hereafter. Other writers of considerable reputation have also regarded clearness of the atmosphere, as not being requisite for the production of dew, misled, I believe, partly by theory, and partly by observing on misty mornings copious dews, which had been produced during preceding clear nights. Respecting this point I can aver, after much experience, that I never knew dew to be abundant, except in serene weather. In regard to the

† Nat. Phil. T. ii. De Rore.
necessity of the air being still, I know of no person who rejects it, except M. Prieur,* a late French author of little consideration, and he affirms, in opposition to the most common observation, that a fresh wind is requisite for the production of dew.

The remark of Aristotle, however, is not to be received in its strictest sense, as I have frequently found a small quantity of dew on grass, both on windy nights, if the sky was clear, or nearly so, and on cloudy nights, if there was no wind. If, indeed, the clouds were high, and the weather calm, I have sometimes seen on grass, though the sky was entirely hidden, no very inconsiderable quantity of dew. Again; according to my observation, entire stillness of the atmosphere is so far from being necessary for the formation of this fluid, that its quantity has seemed to me to be increased, by a very gentle motion in the air. Dew, however, has never been seen by me, on nights both cloudy and windy.

If, in the course of the night, the weather, from being calm and serene, should become windy and cloudy, not only will dew cease to form, but that which has formed will either disappear or diminish considerably.

In calm weather, if the sky be partially covered with clouds, more dew will appear than if it were entirely covered, but less than if it were entirely clear.

Dew probably begins, in this country, to appear upon grass, in places shaded from the sun, during clear and calm weather, soon after the heat of the atmosphere has declined. My opportunities, however, for making such observations have not been numerous, since, while pursuing this subject, I seldom went into the country till late in the afternoon; but I have frequently felt grass moist, in dry weather, several hours before sunset. On the other hand, I have scarcely ever known dew to be present in such quantity upon grass, as to exhibit visible drops before the sun was very near the horizon, or to be very copious till some time after sunset. It also continues to form, in shaded places, after sunrise; but the interval between sunrise, and its ceasing to form, is, according to my observation, which, upon this point, has not been extensive, considerably shorter than that between its first appearance in the afternoon and sunset. Contrary, however, to what happens at sunset, if the weather be favourable, more dew forms a little before, and, in shaded places, a little after sunrise, than at any other time. Musschenbroek, therefore, errs greatly when he says, that dew does not form after the sun has risen. The preceding observations, on the early appearance of dew in the afternoon, are to be restricted to what happens to grass, or other substances highly attractive of dew placed on the ground; for it occurs much later on similar substances which are elevated a few feet above the ground, though upon these it continues to form as long after the rising of the sun as upon the others, if they be equally sheltered from the rays of that body.

* Journal de l'Ecole Polytechnique, Tom. ii. 409.
The formation of dew, after it has once commenced, continues during the whole night, if the weather remain still and serene. M. Prieur, indeed, of whom I have already spoken, asserts, that dew forms only in the evening and morning, and that any which occurs in the former season always disappears in the course of the night. I can affirm, however, from long experience, that grass, after having been dewed in the evening, is never found dry until after sunrise, unless the weather has, in the mean time, changed. Upon one serene and still night, I placed fresh parcels of wool upon grass every hour, and by weighing each of them, after exposure for an hour, found that they had all attracted dew.

When dew forms upon a smooth dense body as glass, and it is only by means of such a body that the process can be accurately observed, the appearances are altogether similar to those which occur on a like body when exposed to the steam of water a little warmer than itself. The exposed surface has first its lustre diminished by a slight damp uniformly spread over it. As the moisture increases, it gathers into irregularly shaped flat drops, which are, at first, very small, but afterwards enlarge and run into one another, forming streamlets, by means of which a great part escapes from the body which had received it.

During nights that are equally clear and calm, dew often appears in very unequal quantities, even after allowance has been made for any difference in their lengths. One great source of these differences is very obvious. For, it being manifest, whatever theory be adopted concerning the immediate cause of dew, that the more replete the atmosphere is with moisture previously to the operation of that cause, the more copious will the precipitation of water be after this operation has commenced, all the circumstances which tend to increase the quantity of moisture in the atmosphere, must likewise tend to increase the production of dew. Thus dew, in equally calm and clear nights, is more abundant shortly after rain, than during a long tract of dry weather. It is more abundant, also, throughout Europe, with perhaps a few exceptions, and in some parts of Asia and Africa, during southerly and westerly winds, than during those which blow from the north and the east. Aristotle* says, that Pontus is the only country in which dew is more copious during a northerly than during a southerly wind. But a similar fact occurs in Egypt; for dew is scarcely ever observed there, except while the Etesian winds prevail. Both cases, however, though contrary to the letter, are consonant with the spirit of the rule; since the north wind in one country proceeds from the Euxine sea, and in the other from the Mediterranean. Another circumstance, of the same kind with the blowing of wind from the south and the west, as showing that the air contains much moisture, is the lessening of the weight of the atmosphere. My experience on this point has not, indeed, been great, as the falling of the mercury in the

* Meteor. Lib. i. c. x.
THE PHENOMENA OF DEW.

barometer is very commonly attended with wind or clouds, both unfavourable to the production of dew; but still the greatest dew, I have ever witnessed, occurred while the barometer was sinking. A corresponding observation is made by M. de Luc, who says, that rain may be foretold, when dew is uncommonly abundant in relation to the climate and season.*

To the greater or less quantity of moisture in the atmosphere, at the time of the action of the immediate cause of dew, are likewise to be referred several other facts respecting its copiousness, the explanation of which is, perhaps, not so apparent as in the preceding examples.

In the first place; dew is commonly more plentiful in spring and autumn than in summer; the reason is, that a greater difference is generally found between the temperatures of the day and the night, in the former seasons of the year than in the latter. In spring this circumstance is prevented often from having a considerable effect, by the opposite influence of northerly and easterly winds; but, during still and serene nights in autumn, dew is almost always highly abundant.

In the second place; dew is always very copious on those clear and calm nights which are followed by misty or foggy mornings; the turbidity of the air in the morning showing, that it must have contained, during the preceding night, a considerable quantity of moisture.

Thirdly; I have observed dew to be unusually plentiful on a clear morning which had succeeded a cloudy night. For the air, having in the course of the night lost little or no moisture, was in in the morning more charged with watery vapour, than it would have been if the night had also been clear.

Fourthly; heat of the atmosphere, if other circumstances are favourable, which according to my experience they seldom are in this country, occasions a great formation of dew. For, as the power of the air to retain watery vapour in a pellucid state increases considerably faster while its temperature is rising, than in proportion to the heat acquired, a decrease of its heat, in any small given quantity during the night, must bring it, if the temperature be high, much nearer to the point of repletion, before it be acted upon by the immediate cause of dew, than if the temperature were low. We read, accordingly, in the writings of those who have travelled into hot climates, of a copiousness of dew frequently observed by them there, which very much exceeds what occurs any time in this country. But even here, dew, though for the most part scanty in our hottest season, is sometimes very abundant during it, an example of which occurred to me on the night common to the 29th and 30th of July 1813; for on that night, notwithstanding its shortness, more dew appeared than has ever been observed by me on any other.

In the last place; I always found, when the clearness and still-

* Rech. sur les Mod. de l'Atm. § 725.
ness of the atmosphere were the same, that more dew was formed between midnight and sunrise, than between sunset and midnight, though the positive quantity of moisture in the air must have been less in the former than in the latter time, in consequence of a previous precipitation of part of it. The reason, no doubt, is the cold of the atmosphere being greater in the latter, than in the prior part of the night.

But there are many circumstances influencing the quantity of dew which, though much more open to accurate observation than those hitherto mentioned, are yet much less easy to be understood.

In my first attempts to compare the quantities of dew formed during different times, or in different situations, I attended only to the appearance which it made on bodies having smooth surfaces. But quickly seeing this method to be very imperfect, I next employed wool to collect dew from the atmosphere, and found it well adapted for my purpose, as it readily admits amongst its fibres the moisture which forms on its outer parts, and retains what it receives so firmly, that I never but once had occasion to suspect that it suffered any portion of what it had thus acquired to pass entirely through it. The wool which I used was white, moderately fine, and already imbued with a little moisture, from having been long exposed to the air of a room in which no fire was kept. I divided it into parcels of 10 grains each, and, immediately before exposure, pulled the fibres of every parcel somewhat asunder, so as to give it the form of a flattened sphere, the greatest diameter of which was about 2 inches. As in doing this I went by the judgment of my sight alone, some inequality, in point of size, must have existed among different parcels, but none, I think, sufficient to affect the accuracy of my conclusions from the experiments in which they were employed, more especially as my conclusions scarcely ever rested upon single trials.

Previously to mentioning the results of any of my experiments with these parcels of wool, I think it right to describe the place where by far the greater part of my observations on dew were made. This was a garden in Surrey, distant, by the public road, about three miles from the bridge over the Thames at Blackfriars, but not more than a mile and a quarter from a densely built part of the suburbs on the south side of that river. The form of the garden was oblong, its extent nearly half an acre, and its surface level. At one end was a dwelling-house of moderate size, at the other a range of low buildings; on one side a row of high trees, on the other a low fence, dividing it from another garden. If this fence had been absent, the garden would have been on the latter side entirely open. Within it were some fruit trees, but, as it had not been long made, their size was small. Towards one end there was a grassplat, in length 62 feet, and nearly 16 broad, the herbage of which was kept short by frequent mowing. The rest of the garden was employed for the production of culinary vegetables. All of these circumstances, however trifling they may appear, had influence on my experiments, and most of them, as will hereafter be
seen, must have rendered the results less remarkable than they would have been if they had occurred on a wide open plain, considerably distant from a large city.

I now proceed to relate the influence which several differences in the situation, mechanical state, and real nature of bodies, have upon the production of dew.

I. One general fact relative to situation is, that whatever diminishes the view of the sky, as seen from the exposed body, occasions the quantity of dew, which is formed upon it, to be less than would have occurred if the exposure to the sky had been complete.

I placed on several clear and still nights, 10 grains of wool upon the middle of a painted board, 4 1/2 feet long, 2 feet wide, and 1 inch thick, elevated 4 feet above the grassplat, by means of 4 slender wooden props of equal height; and, at the same time, attached, loosely, 10 grains of wool to the middle of its underside. The two parcels were consequently only an inch asunder, and were equally exposed to the action of the air. Upon one night, however, I found that the upper parcel had gained 14 grains in weight, but the lower only 4. On a second night, the quantities of moisture, acquired by like parcels of wool, in the same situations as in the first experiment, were 19 and 6 grains; on a third, 11 and 2; on a fourth, 20 and 4; the smaller quantity being always that which was gained by the wool attached to the lower side of the board.

I bent a sheet of pasteboard into the shape of a house-roof, making the angle of flexure 90 degrees, and leaving both ends open. This was placed one evening, with its ridge uppermost, upon the same grassplat, in the direction of the wind, as well as this could be ascertained. I then laid 10 grains of wool on the middle of that part of the grass which was sheltered by the roof, and the same quantity on another part of the grassplat fully exposed to the sky. In the morning, the sheltered wool was found to have increased in weight only 2 grains, but that which had been exposed to the sky 16 grains.

In these experiments, the view of the sky was almost entirely cut off from the situations in which little dew was formed. In others, where it was less so, the quantity gained was greater. Thus, 10 grains of wool, placed upon the spot of the grassplat, which was directly under the middle of the raised board, and which enjoyed, therefore, a considerable oblique view of the sky, acquired during one night 7, during a second 9, and during a third 12 grains of moisture, while the quantities gained, during the same times, by equal parcels of wool, laid upon another part of the grassplat which was entirely exposed to the heavens, were 10, 16, and 20 grains.

As no moisture, falling like rain from the atmosphere, could on a calm night have reached the wool in any of the situations where little dew was formed, it may be thought that the substances under which the wool was placed, prevented, mechanically, the access of that fluid. But on this supposition it cannot be explained, why some dew was always found in the most sheltered places, and why a considerable quantity occurred upon the grass under the middle
of the raised board. A still stronger proof of the want of justness in this supposition is afforded by the following experiment. I placed, upright, on the grassplat a hollow cylinder of baked clay, the height of which was $2\frac{1}{2}$ feet, and diameter 1 foot. On the grass, surrounded by the cylinder, were laid 10 grains of wool, which, in this situation, as there was not the least wind, would have received as much rain as a like quantity of wool fully exposed to the sky. But the quantity of moisture obtained by the wool surrounded by the cylinder was only a little more than 2 grains, while that acquired by 10 grains of fully exposed wool was 16. This occurred on the night during which the wool under the bent pasteboard gained only 2 grains of moisture.

Dew, however, will, in consequence of other varieties of situation, form in very different quantities upon substances of the same kind, although these should be similarly exposed to the sky.

In the first place; it is requisite, for the most abundant formation of dew, that the substance attracting it should rest on a stable horizontal body of some extent. Thus, upon one night, while 10 grains of wool, laid upon the raised board, increased 20 grains in weight, an equal quantity, suspended in the open air, 5½ feet above the ground, increased only 11 grains, notwithstanding that it presented a greater surface to the air than the other parcel. On another night, 10 grains of wool gained on the raised board 19 grains, but the same quantity suspended in the air, on a level with the board, only 13; and on a third, 10 grains of wool acquired on the same board 2½ grains of weight, during the time in which other 10 grains, hung in the air at the same height, acquired only $\frac{1}{2}$ a grain.

In the second place; the quantities of dew attracted by equal masses of wool, similarly exposed to the sky, and resting on equally stable and extended bodies, oftentimes vary considerably, in consequence of some difference in the other circumstances of these bodies. 10 grains of wool, for instance, having been placed upon the grassplat, on a dewy evening, 10 grains upon a gravel walk which bounded the grassplat, and 10 grains upon a bed of bare garden mould, immediately adjoining the gravel walk; in the morning, the wool on the grass was found to have increased 16 grains in weight, but that on the gravel walk only 9, and that on the garden mould only 8. On another night, during the time that 10 grains of wool, laid upon grass, acquired 2½ grains of moisture, the same quantity gained only $\frac{1}{2}$ a grain upon the bed of garden mould, and a like quantity, placed upon the gravel walk, received no accession of weight whatever.

Two objections will probably be made against the accuracy of these, as well as my other experiments with wool. One is, that wool placed on grass may, by a kind of capillary attraction, receive dew previously formed on the grass, in addition to its own. To this I answer, that wool in a china saucer, placed on the grass, acquired very nearly as much weight as an equal parcel immediately touching the grass. The second objection is, that a part of the increased weight in the wool might arise from its imbibing moisture, as a
hygroscopic substance. I do not deny, that some weight was given to the wool in this way; but it may be safely affirmed, that this quantity must have been very small. For, on very cloudy nights, apparently the best fitted to increase the weight of hygroscopic substances, wool upon the raised board would, in the course of many hours, acquire little or no weight; and in London I have never found 10 grains of wool, exposed to the air on the outside of one of my chamber windows, to increase, during a whole night, more than \( \frac{1}{2} \) a grain in weight. When this weight was gained, the weather was clear and still; if the weather was cloudy and windy, the wool received either less or no weight. This window is so situated, as to be, in great measure, deprived of the aspect of the sky.

It being shown that wool, though highly attractive of dew, was prevented, by the mere vicinity of a gravel walk, or a bed of garden mould, for only a small part of it actually touched those bodies, from acquire nearly as much dew as an equal parcel laid upon grass, it may be readily inferred that little was formed upon themselves. In confirmation of this conclusion, I shall mention, that I never saw dew upon either of them. Another fact of the same kind is, that, while returning to London from the scene of my experiments about sunrise, I never observed, if the atmosphere was clear, the public road, or any stone pavement on the side of it, to be moistened with dew, though grass within a few feet of it, and painted doors and windows of houses not far from it, were frequently very wet. If, indeed, there was a foggy morning, after a clear and calm night, even the streets of London would sometimes be moist, though they had been dry the day before, and no rain had in the meanwhile fallen. This entire, or almost entire, freedom of certain situations from dew depends, however, much more upon extraneous circumstances, than upon the nature of the substances found there; for river sand, though of the same nature with gravel, when placed upon the raised board, or upon grass, attracted dew copiously.

A third difference from situation, in the quantity of dew collected by similar bodies, similarly exposed to the sky, depends upon their position with respect to the ground. Thus, a substance placed several feet above the ground, though in this situation later dewed than if it touched the earth, would, notwithstanding, if it lay upon a stable body of some extent, such as the raised board lately mentioned, acquire more dew during a very still night, than a similar substance lying on grass.

A fourth difference of this kind occurred among bodies placed on different parts of the raised board. For one that was placed at the leeward end of it, generally acquired more dew than a similar body at the windward extremity.

II. Difference in the mechanical state of bodies, though all other circumstances be similar, has likewise an effect on the quantity of dew which they attract. Thus, more dew is formed upon fine shavings of wood, than upon a thick piece of the same substance. It is
chiefly for a similar reason, I believe, that fine raw silk, fine unwrought cotton and flax, were found by me to attract somewhat more dew than the wool I employed, the fibres of which were thicker than those of the other substances just mentioned.

III. Bright metals, in consequence of some circumstance in their constitution, attract dew much less powerfully than other bodies, all of which, after allowance has been made for any difference which may exist in their mechanical states, seem to attract dew in quantities not very unequal, if they be similarly situated.

Musschenbroek was the first who distinctly remarked this peculiarity of metals; but Dufay,* I believe, published it before him, referring, at the same time, the discovery to its proper author. Both Musschenbroek and Dufay, however, made too large an inference from their experiments; for they asserted, that dew never appears on the upper surface of bright metals, whereas the contrary has since been observed by many persons, and I have myself known dew to form on gold, silver, copper, tin, platina, iron, steel, zinc, and lead. Dew, however, when it does form upon metals, commonly sullies on the lustre of their surface; and even when it is sufficiently abundant to gather into drops, these are almost always small and distinct. Two other facts of the same kind are; *first, that the dew, which has formed upon a metal, will often disappear, while other substances in their neighbourhood remain wet; and *secondly, that a metal, which has been purposely moistened, will often become dry, though similarly exposed with bodies which are attracting dew. This inaptitude to attract dew in metals is communicated to bodies of a very different nature which touch or are near to them. For I have found, that wool laid upon a metal will acquire much less dew than an equal quantity laid upon grass in the immediate vicinity.

A large metallic plate, lying on grass, resists the formation of dew more powerfully than a very small one similarly situated. I conclude from various collateral facts, that a considerable difference in the thickness of two pieces of metal, exposing equal surfaces to the sky, will be attended with a similar consequence wherever they be placed, though I have no observation which proves this directly. If, however, a large and a very small plate be suspended horizontally at the same height in the air, the small plate will resist the formation of dew more powerfully than the large.

If a metal be closely attached to a substance of some thickness which attracts dew powerfully, the attraction of the metal itself for dew, instead of being increased from this circumstance becomes diminished, provided the metal cover the whole of the upper surface of the other body. If only a part of this body be covered, the production of dew on the metal is forwarded by the conjunction, and this somewhat in proportion to the quantity of surface in the lower body left uncovered. The justness of the first of these observations

* Mem. de l'Acad. Fran. 1736.
is proved by the following experiment. I joined, in the form of a cross, two pieces of very light wood, each 4 inches long, a third of an inch in breadth, and 1 line in thickness. To one side of this cross I fastened, by means of mucilage, a square piece of gilt paper, and then exposed the instrument to the sky, with its metallic side uppermost, on a dewy night, by suspending it, in a horizontal position, about 6 inches above the ground. A few hours after, the unattached parts of the metallized paper were found covered with minute drops of dew, while those which adhered to the cross were dry.

A large metallic plate, laid upon grass, was dewed with more difficulty on its upper surface, than a similar plate elevated a few inches above the grass by means of slender props, which allowed the air to pass freely under the metal. But the case with respect to small pieces was the reverse; for I have often seen covered with dew the metallic sheath of a small thermometer lying upon grass, while the similar sheath of another thermometer suspended in the air remained dry.

Removing a metal several times in the course of the night from one part of the grassplat to another facilitated its being dewed. The same effect was produced on gilt and silvered paper, by first exposing them to the sky, for some time, with the bare side uppermost, and then turning them.

If a piece of glass, covered on one side with a metal, be placed upon the ground, with this side downwards, the upper surface will attract dew precisely as if no metal were attached to the lower surface.

The upper surfaces of metals are most readily, and most copiously dewed on those nights, and in those parts of the night, during which other substances are the most readily and the most copiously dewed.

If a metallic plate had been laid upon grass before dew began to form anywhere, its lower side, notwithstanding, always became moist in the course of the night; and the same effect was almost always observed, if the plate had been placed horizontally in the air a few inches above the grass. While the undersides were thus moist, the upper surfaces were very often dry. If, however, the plate was elevated several feet in the air, the condition of both sides was always the same, whether this was dry or moist.

The remarks hitherto made on the relation of metals to dew, apply to the class generally; but it is now to be mentioned, that they do not all resist the formation of that fluid with the same force.

I saw, for example, platina one night distinctly dewed, while gold, silver, copper, and tin, though similarly situated, were entirely dry; and I have also several times seen these four metals free from dew, while iron, steel, zinc, and lead were covered with it.

I once supposed, in consequence of the difficulty with which metals are dewed, that they might in all circumstances resist, in a greater degree than other bodies, the condensation of watery vapour upon their surface; and I afterwards found, that Le Roi* asserts this

* Mem. de l'Acad. Fran. 1751.
to be the case. But having exposed at the same time, to the steam of warm water, pieces of glass and of metal, I did not see that moisture formed in the least more readily upon the former than upon the latter. I have since learned, that Saussure* once entertained a similar suspicion, which was also proved by an experiment to be groundless.

All my experiments, hitherto spoken of, were made in the country. But Le Roi having said, that dew is never deposited by the air of cities, I determined to ascertain if his assertion was just. With this view, I frequently exposed, at night, 10 grains of wool upon a slight wooden frame, placed in such a manner, between two ridges of the top of my house, which is situated in one of the most crowded districts of London, as to be 3 feet distant from the nearest part of the roof. The event was, that, upon clear and calm nights, dew was always acquired by the wool, though never in any considerable quantity; probably, however, more from the wooden frame being nearly surrounded by buildings much more elevated than itself, than from any particular condition of the air in cities. The formation of dew, in this situation, proceeded much less regularly than in the country. For, upon one evening ten grains of wool gained in it 3 grains of moisture in 1 hour and 18 minutes, though I scarcely ever knew a greater quantity to be collected by a similar parcel of wool, in the same place, during a whole night. These experiments will no doubt seem to many superfluous, since dew may be observed every fine evening upon grass in London. But as dew upon grass is said by Le Roi to proceed from the ground, and not from the atmosphere, the argument derived from its appearance there, in cities, against his assertion is thus eluded by him.

The last subject, which I shall here touch upon, is that of hoarfrost.

This substance has, I believe, from the time of Aristotle,† been uniformly, and according to my observations justly, considered as frozen dew. I shall, therefore, frequently refer hereafter to the experiments of the late Mr. Patrick Wilson of Glasgow respecting it, as if they had been actually made upon that fluid. Indeed, several of my experiments upon dew were only imitations of some which had been previously made upon hoarfrost by that ingenious and most worthy man.

SECTION II.

OF THE COLD CONNECTED WITH THE FORMATION OF DEW.

Dew is often spoken of as being cold by popular writers. Thus Cicero and Virgil apply to it the epithet of "gelidus," Milton that

of "chill," and Collins that of "cold." Of the same import is a passage in Herodotus, in which it is said, that in Egypt the crocodile passes a great part of the day on dry land, but the whole of the night in the Nile, this being warmer than the atmosphere, and the dew. Among philosophers, however, Mr. Wilson was the first, I believe, who ever suspected the existence of such a conjunction.

In my experiments on the temperature of bodies moistened with dew, small thermometers were employed, (the largest being only 8 inches long) having globular bulbs, which, in most of them, were not more than from 2 to 2 ½ lines in diameter. Their scales, which were marked in the manner of Fahrenheit, were of ivory or wood, and were furnished, almost all of them, with hinges. They were always employed naked, except I wished to know the effect of covering them with any particular substance.

By means of these instruments I have very many times, during serene and still nights, examined the temperature of dewed grass, and have constantly observed it to be less than that of the air, anywhere between 1 inch and 9 feet above the ground, the latter being the greatest height at which I ever marked the heat of the atmosphere in these experiments. I generally, however, compared the temperature of dewed grass with that of the air 4 feet above the ground; and on nights that were calm and clear, very frequently found the grass, at the ordinary place of my observations, 7, 8, or 9 degrees colder than the air at that height. Several times it was 10° and 11° colder than the air, and once 12°. These differences are not so great as those related in Mr. Six's posthumous work. But in his experiments the temperature of grass was compared with that of the air 7 feet above the ground, which, in clear and calm nights, may be regarded as ¾ a degree warmer than the air at the height of 4 feet. Besides; the most considerable differences, mentioned by Mr. Six, occurred in winter, when he says a greater degree of cold is occasioned by dew, than at any other time; whereas very few of my experiments on the temperature of grass were instituted in that season. In the last place; my experiments were almost always made on very short grass, while Mr. Six's thermometers were laid upon long grass bent, by strong pressure, towards the earth; in which state they marked a temperature 1, 2, and 3 degrees lower, than that shown by similar thermometers placed upon grass less than an inch in height. Had it not been for these circumstances, and the unfitness, in various respects, besides the shortness of the grass for the production of a great cold, of the common scene of my operations, I believe that, in consequence of my thermometers being much better adapted to mark a superficial, or transitory cold, than those of Mr. Six, I should at some time have seen a difference several degrees greater than the greatest ever seen by that gentleman, which was one of 13½°. In confirmation of this opinion, I shall mention, that having, during a short visit to a more distant part of the country, exposed in the evening a thermometer upon the surface of an open grass field, I found it soon after, although Oct. 1838.—R
the grass was short, and the weather warm, $14^\circ$ lower than a similar thermometer, suspended in the air, 4 feet above the grass. If to this quantity be added $\frac{1}{2}$ a degree, on account of the difference in elevation between our suspended thermometers, the cold, connected with dew, observed by me this night on grass, will exceed the greatest ever observed by Mr. Six by 1 degree.

According to a few observations made by me, the greater coldness of grass than that of the air begins to appear, in clear and calm weather, in places sheltered in the afternoon from the sun, but still open to a considerable portion of the sky, soon after the heat of the atmosphere has declined. A similar coldness continues upon grass in still and serene mornings for some time after the rising of the sun, in places shaded from its direct light, but otherwise open to the sky. My experiments on this point have also not been many, and none of them were made in winter; which I presume are the reasons that I never observed a cold, from this cause, later in the morning than an hour after sunrise. The surface of snow, however, was once in the depth of winter observed by Mr. Wilson of Glasgow to be considerably colder than the air, till a little after mid-day.*

In cloudy nights, particularly if there was wind, the grass was never much colder than the air. On such nights the temperatures of both were sometimes the same; at other times that of the grass was the higher of the two, even when the grass was wet from preceding rain, and when, consequently, it must have been in some measure cooled by evaporation. On one such night the grass was found to be $4^\circ$ colder than the earth an inch beneath the surface of the plat, which afforded a sufficient reason for the grass itself being warmer than the air. In windy weather, however, if the sky was clear, some degree of cold, in addition to that of the air, was always observed upon the grass; and in calm weather, very high clouds, though sufficiently extensive and dense to conceal the sky completely, would yet frequently allow of the grass being several degrees colder than the air. I once observed, upon a night of this kind, a difference of $5^\circ$ between the temperature of those bodies.

If the night became cloudy, after having been very clear, though there might be no change with respect to calmness, a considerable alteration in the temperature of the grass always ensued; and this sometimes very suddenly. Upon one such night the grass, after having been $12^\circ$ colder than the air, became only $2^\circ$ colder than it, the temperature of the air being the same at both observations. On a second night, grass became $9^\circ$ warmer in the space of an hour and a half. On a third night, in less than 45 minutes, for the whole change occurred while I was absent 45 minutes, the temperature of the grass rose $15^\circ$, while that of the neighbouring air increased $34^\circ$. During a fourth night, the temperature of the grass at half past 9 o'clock was $32^\circ$. In 20 minutes afterwards it was found to

* Paper in Phil. Trans. 1781.
be 39°, the sky having in the mean time become cloudy. At the end of 20 minutes more, the sky being clear, the temperature of the grass was again 32°. These were the most remarkable of my observations on this subject; but I may add to them, that I have frequently seen, during nights that were generally clear, a thermometer lying on the grassplat rise several degrees, upon the zenith being occupied only a few minutes by a cloud. On the other hand, upon two nights I observed a very great degree of cold to occur on the ground, in addition to that of the atmosphere, during short intervals of clearness of sky, between very cloudy states of it.

I did not speak in the preceding section of another obscure state of the atmosphere, that occasioned by fog, or mist, as the moisture deposited in it attaches to all bodies indiscriminately; on which account I was unable to determine whether or not dew forms during its continuance. But, with respect to the connexion of this condition of the atmosphere with cold, I have to remark, that I have several times on its appearance betwixt day break and sunrise, found the difference between thermometers on grass and in the air, which had been considerable during the night, to diminish greatly. I never indeed observed it to vanish, but this I used to impute to the air being not very much obscured. I have now, however, reason to doubt the justness of this conclusion; for on the evening of the first of January in the present year, 1814, I found, during a dense fog, while the weather was very calm, a thermometer lying on grass, thickly covered with hoarfrost, 9° lower than another suspended in the air, 4 feet above the former. On the following evening, when the air was equally calm, but the fog sufficiently attenuated to allow me to see that the sky was almost entirely covered with clouds, the difference between two thermometers, similarly placed with the former, was only 1°. On comparing the observations of these two evenings, I conclude, that on the first few or no clouds existed above the fog, and consequently that fog, if there be no clouds above it, may, in a very calm air, admit of the appearance of a considerable degree of cold at night upon the surface of the earth, in addition to that of the atmosphere. Mr. Six, indeed, says, while speaking of the cold connected with dew, in his paper in the Philosophical Transactions for 1788, "fogs did not, as far as I could perceive, at all impede, but rather increase, the refrigeration." But this was a mistake; which in all probability arose from his ascribing the effect of a clear night to an ensuing foggy morning, as he examined his thermometers only in the daytime. He afterwards discovered his error; for, in his posthumous work, thick fogs are ranked among the circumstances which always impede, and sometimes prevent altogether, the appearance of a cold upon the surface of the earth greater than that of the atmosphere. During a very dense fog, Mr. Wilson found no difference, at night, between a thermometer laid upon snow, and another suspended in the air.*

* Edin. Phil. Trans. I. 170.
When, during a clear and still night, different thermometers were examined, at the same time, which had been placed in different situations, those which were situated where most dew was formed were always found to be the lowest. Thus, upon one such night, I found a thermometer placed upon a little wool, lying upon the middle of the upper side of the raised board, to be 9° lower than another thermometer, in contact with an equal quantity of wool attached to the middle of the underside of the board. On two other nights the difference between two thermometers in the same situations was 8°. I found also, on two other serene and calm nights, a spot of grass covered by the pasteboard roof, and another spot surrounded by the earthen cylinder, to be both 10° warmer than neighbouring grass fully exposed to the sky. Thinking it possible that the cylinder, which had been exposed to the sun the preceding day, might still possess some of the heat which it had then imbibed, I placed near to it, on another night, a cylinder made of very thin pasteboard; but this was equally efficacious with the earthen one in preventing cold from occurring on grass. When the exposure was greater than in the preceding examples, and more dew was in consequence formed, the cold was also greater, but still less than where the exposure was complete. For instance, upon the night during which 10 grains of wool placed upon the middle of the grass, which was sheltered by the raised board, had gained 7 grains, and the same quantity on grass fully exposed to the sky had gained 10 grains, the difference between the temperatures of the two portions of grass was only 2¾°.

The same correspondence was observed, when the differences in the quantity of dew did not depend, as in the preceding instances, upon any diversity of exposure to the sky. Thus, the mercury in a thermometer placed upon wool, lying on the raised board, was found to be at the 44th degree, while that in another, pendent in the air, at the same height from the ground, and wrapped in wool, was at the 48th. Wool, also, on the raised board,* was commonly a little colder than the same substance on grass, when the night was very still; and the leeward end of that board was generally colder than the windward extremity.

But the most remarkable examples of this kind were exhibited by the gravel walk and the bare garden mould. In still and serene nights the surfaces of these bodies were always warmer than the neighbouring grass, and frequently warmer than the air. On one night of this description, I observed 2¼ hours after sunset, the surface of the gravel walk to be 16½°, and that of the garden mould to be 12½°, warmer than grass very near to them, and similarly exposed

* The greater cold of the raised board in my experiments, most probably depended on the grass being very short; since Mr. Wilson found, that snow on the ground was colder than the same body on a raised board. If 1, 2, or 3 degrees were added to the cold of the grass at my place of observation, agreeably to the difference found by Mr. Six, between the temperatures of long and short grass in dewy nights, the cold on my raised board would, upon such nights, have been always less than that of the grassplat.
to the heavens. As the night proceeded, clouds formed and accumulated; in consequence of which the difference at sunrise, between the temperatures of the grass and the gravel walk, was only 6°, and between those of the grass and the mould only 4°, the temperature of the grass having in the mean time increased considerably, while that of the other bodies had decreased a little. At another time, shortly before sunrise, a very clear morning having succeeded a cloudy night, I found the gravel walk to be 10° and the garden bed to be 9° warmer than neighbouring grass, which was 8° colder than the air. Both of these examples occurred in summer, and I believe that such considerable differences will occur in that season only. It was on the first of these two nights, that 10 grains of wool gained only 1/4 a grain of moisture on the mould, and that the same quantity gained no weight on the gravel walk. That the unfitness of the gravel walk, however, to become cold, like its unfitness to attract dew, arose from its situation, and not from the nature of the substance of which it was made, is proved by this circumstance, that river sand, placed on the raised board, was on four different nights, none of them highly favourable for the production of cold 7, 7, 8 and 8½ degrees colder than the air at the same height.

It may be added here, that I have always found, on dewy nights, the temperature of the earth, ½ an inch or an inch beneath its surface, much warmer than the grass upon it. On five such nights the differences were from 12 to 16 degrees. The earth, at the above mentioned depth, was also almost constantly warmer on dewy nights than the air; sometimes it was considerably so, for I once observed it to be 10° warmer, at another time 9°, and at a third 7½°. An exception will no doubt occur if very mild weather should follow a long frost; but of this I have had no experience.

In the experiments upon my housetop in London, I always found, during clear and calm nights, wool lying on the wooden frame to be colder than the air, at the same height; but the difference was seldom more than 3°. On the evening, however, during which dew formed there more copiously than usual, the difference was 5°. That the smallness of these differences was not wholly occasioned by any thing special in the air of cities was afterwards proved, by my finding others much greater, in a garden nearly in the middle of London, from which almost the whole of the sky was visible.

Metals, likewise, furnish proofs of the connexion of dew with a cold in the substance on which it forms, superior to that of the neighbouring atmosphere. My observations, however, on the temperature of metals, when exposed to the sky on dewy nights were less numerous than those on several other subjects treated in this Essay, by reason of the less frequent opportunity I enjoyed of making them; and many of those which I did make were afterwards found by me to have been improperly conducted. I thought, for instance, for some time, that the temperature of a metal, on a dewy night, might easily be learned in the way in which I had been accustomed to ascertain the temperature of dewed grass. But
observing dew one night on the glass tube of a thermometer, which was lying on a metal placed upon grass, while the metal itself was free from moisture, I conceived it probable, that the cold then indicated by the thermometer was not the real temperature of the body to which it was applied. To determine the point, I placed on the same metal a second thermometer, covered with gilt paper, upon which this was found at three observations to be 64°, 7°, and 7° higher than the other. In this experiment, the bulb of the naked thermometer from being very small did not project as far as the outer surface of the scale, and, consequently, did not come in contact with the metal. But even when the ball of a thermometer was applied directly to a metal, on a clear and calm night, a temperature was marked by it, commonly 2 and 3, and sometimes more degrees less than that marked by a similar thermometer, inclosed in gilt paper, and similarly placed. I found it likewise necessary, in this inquiry, to correct the temperature of the air as given by a naked thermometer. For, on still and serene nights, a thermometer inclosed in a case of gilt or silvered paper, and suspended in the air 4 feet above the grassplat, was usually observed to be 1½° or 2° higher than a bare thermometer of the same construction suspended near to it. The difference of two such thermometers, thus placed, was once observed by me to be 2½°, and once 3½°. It may be thought, perhaps, that these differences were caused by the metalled case obstructing the transmission of the temperature of the air to the inclosed instrument. But that this was not the reason is shown by my observing, that on cloudy nights there existed no difference between the two thermometers; that even on clear nights, a thermometer contained in a case of white paper somewhat thicker than the metalled was always nearly of the same temperature with a naked one which was suspended close to it; and that when a difference did exist between the two latter, the thermometer in the white paper case was commonly lower than the other.

The estimation of the heat, both of air and of metals, on a dewy night, is liable to errors from other causes. As these, however, are trifling, I shall not mention them, but proceed to state the results of my observations, upon the temperature of metals exposed to the sky at night, though unable to vouch for their entire accuracy.

Thin bright metallic plates, the least having a surface of 25 square inches, and some of them a surface of more that 100 such inches, were several times observed, while lying on grass which was attracting dew, to be 1 and 2, and once 3 degrees warmer than the air 4 feet above them. At other times their temperature was the same with that of the air. In both of these cases their upper surfaces were always free from dew. Metals thus situated were, consequently, often much warmer than the grass which surrounded them. I made no experiments on this point, during the nights on which occurred the greatest instances of cold on grass, relatively to the temperature of the air; but I found, notwithstanding, during one night, a metal on grass to be 10° warmer than the
exposed grass near to it. On two other nights the differences were 9° and 8°. The superiority of the heat of metals on grass over that of the air, when it did exist, was evidently connected with the temperature of the grass which they covered, and this again with that of the earth under the same portion of grass; for this portion was always a little warmer than the metal, but not so warm as the earth.

On the other hand, metals, on which dew was forming while they lay upon grass, were always colder than the air. In like manner, if one metal upon the grassplat were dewed, while another similarly situated remained dry, the former was always colder than the latter. When a metal lying on the grassplat became dewed, the grass under it was always colder than that under another metal, which was undewed.

A metal, while receiving dew in consequence of being elevated in the air, was always colder than a similar metal which remained undewed on the grass.

The greatest instances of cold observed by me on metals, occurred at times when other bodies near to them had become considerably colder than the atmosphere.

The cold, however, contracted by metals from exposure to the sky in a clear and still night, was always less than that of other bodies similarly situated; the greatest excess of cold ever observed by me, in the larger metallic plates, from this cause, over that of the air, being not more than 3 or 4 degrees. If much smaller pieces were placed upon grass, the result was different. For I have found a small thermometer placed in this situation, while inclosed in a sheath of gilt paper, to be only 3° less cold than the surrounding grass, during a night favourable to the production of cold on the surface of the earth.

I collected only a few facts respecting the comparative temperatures of different metals, when they were exposed together to the sky on dewy nights; but such as I did collect tend to prove, that the most readily dewed metals become colder than the air, sooner than those which receive dew with greater difficulty.

Many of the experiments which have been mentioned in this section show, that when bodies which had been equally exposed to the night air were examined at the same time, those which were most dewed were also the coldest. No such correspondence, however, was found in the experiments of different nights, or even of different parts of the same night. Thus, during two nights, on which grass was 12° and 14° colder than the air, there was little dew; while on the night which afforded the most copious dew ever observed by me, the cold possessed by the grass, beyond that of the air, was for the most part only 3° and 4°; and I have always seen less dew about sunset than about sunrise, when the weather has been calm and clear at both times, though there is commonly, in this country at least, a greater difference between the temperature of grass and of air in the evening than in the morning. I had early
observed, also, bodies exposed to the sky, on a cloudy but calm night, to be sometimes 2° or 3° colder than the air, without having any appearance of dew; and when two metals possessing different relations to dew were exposed together, I have seen the one, which was the fitter to attract that fluid, colder than the other, though both were dry.

I shall conclude this part of my Essay, with relating the results of some experiments which were made for the purpose of ascertaining the tendencies of various bodies to become cold upon exposure to the sky at night. Unfortunately the weather was not always favourable to my views; but what occurred appears to me, notwithstanding, worthy of being related.

In the observations hitherto given by me on the cold connected with dew, the temperature of grass has been chiefly considered, partly because my first experiments had been made upon it, and partly from a wish, which arose afterwards, to compare my own experiments with those of Mr. Six, which had been confined to that substance. I found it, however, very unfit to furnish the means of comparing the degrees of cold produced at night on the surface of the earth at different times and places; as its state on different nights, on the same parts of the plat I commonly made use of, and in different parts of the plat on the same nights, was often very unequal, in point of height, thickness and fineness, all of which circumstances influenced the degree of cold produced by it. I observed, in consequence, a much greater uniformity in the results of experiments made with various other bodies, whose condition when first exposed to the air was always the same. Of these, the most productive of cold were the filamentous and downy, as wool of moderate fineness, very fine raw silk, very fine unspun cotton, fine flax, and swandown, all of which were not only more steadily cold, upon clear and calm nights, than grass, but also gave rise to a greater degree of cold than was almost at any time observed upon it, even in its best state. Among the bodies of this class, wool produced the least cold, and I formerly mentioned that it attracted less dew than silk, cotton, and flax. The last mentioned substances, and swandown, were found equal, or nearly so, in their tendency to become cold. Swandown, however, exhibited the greatest cold rather more frequently than any of the rest; on which account, and from its being more easily managed, as it was used while adhering to the skin of the bird, I at length scarcely ever employed any other body of the same class. On the night during which grass was observed to be 14° colder than the air, swandown, lying upon a neighbouring piece of grass, was still one degree lower. The difference of 15°, between the temperature at night of a body on the surface of the earth, and that of the air a few feet above the earth is the greatest which I have hitherto seen.

Fresh, unbroken straw, and shreds of white paper, though not properly to be ranked among filamentous substances, were also found to be a little more productive of cold than the wool which I used.
The next class consisted of bodies in the state of a powder, more or less fine. These were clean river sand, glass, chalk, charcoal, lampblack, and a brown calx of iron. Chalk produced the least, and the three last substances the greatest cold. They were all, however, inferior in this respect to bodies of the first class.

Solid bodies, having a surface exposed to the sky of at least 25 inches square, formed a third class on which such experiments were made. The particular substances of this description subjected to trial, were glass, brick, cork, oak-wood, and wax; all of which were, likewise, found inferior to the filamentous substances. From these last experiments it follows, that when a glass bulb of a thermometer is applied at night to a body exposed to a clear sky, the temperature exhibited by the instrument will not be accurately that of the body in question, except the disposition of the latter to become cold in such a situation, be the same as that of glass. An example of this fact has been given in this Essay.*

My principal experiments, however, of this kind were made with snow.

On the 25th of January, 1813, the ground being then covered with snow about an inch deep, I went to my usual place of experiment in the country; but, during 8 hours that I attended to my thermometers, the whole sky was constantly overcast with clouds. The atmosphere was, for the greater part of that time, very still, and a thermometer on the snow was generally about 2° lower than another in the air. That this difference was not owing to evaporation was proved by the thermometer on the snow always rising from a half to a whole degree whenever the air was a little moved, and falling the same quantity as soon as a great stillness again took place.

I had no opportunity of renewing my observations upon snow before the beginning of the present year, 1814. The state of my health rendering it improper that I should incur much fatigue, or be long exposed to night air, I restricted myself to the making a few experiments in the large garden in Lincoln’s-Inn Fields. I went thither, for the first time, on the evening of the 4th of January, immediately after a considerable snowfall had ceased, wishing to begin my observations before any cold should arise on the snow’s surface from exposure to the sky. This was desirable on another account; for Mr. Kirwan, in direct opposition to indisputable facts most clearly stated by Mr. Wilson, has said, that the great cold, observed by that gentleman on snow, was occasioned by this substance having retained the temperature of the high region from which it had fallen.† The result of my inquiry was, that the surface of the snow and the air 4 feet above it had precisely the same heat. The depth of the snow was 4 inches.

My next experiment took place on the evening of the 6th, the intervening day having been snowy. The sky was clear, but the air had a considerable motion. The heat of the atmosphere, at the

ESSAY ON DEW.

height of 4 feet, was at $\frac{9}{4}$h. 26°; while that of the surface of the snow, and of swandown lying upon it, was 22°. The depth of the snow was now about 5 inches.

On the 7th, a little after sunset the heat of the air in the garden was 23°, that of the surface of snow 19, but that of swandown lying upon the snow only 15°. There was then a gentle breeze; some parts of the sky were covered with clouds, and the lower atmosphere was a little obscure. While the exposed surface of the snow was 19°, a part of its surface, which had been covered, about 20 minutes with a piece of pasteboard, was 22°. Grass at the bottom of the snow was 31°, and the earth an inch beneath the grass 32°.

After this there was no fit time for observation until the 13th. The thermometers were exposed at 8h. On the evening of that day, the sky being then without clouds; but the stars were not bright, and there was a perceptible motion in the air. At $\frac{8}{4}$h. the temperature of the air was 223°, that of the surface of the snow 13°, and that of swandown lying on the snow 8°. At 9h. the air was 231°, snow 17°, and swandown 15°. The sky being now, in great measure, covered with high thin clouds, my experiments ceased. At 101$\frac{1}{2}$h. the sky was very bright, and the atmosphere very calm; but it was not then convenient to me to renew my observations. Had I repeated them at that time I should probably have found a difference, between the temperature of the swandown and air, several degrees more considerable than the one of 141°, which had already occurred on this evening, and consequently greater than the greatest observed by Mr. Wilson, between the temperatures of snow and of the atmosphere, which was one of 16°.

The next favourable evening was that of the 21st. Much snow having in the meanwhile fallen, its depth was now more than a foot. The thermometers were observed 5 times between 4h. 15m. and 4h. 55m. At 4 of those times the swandown was 13°, and at one of them 133°, colder than the air, the heat of which at the 4 first observations was 26°, and at the last 253°. The temperature of the surface of the snow, during the whole period of observation, was 17°, and consequently 4 times it was 4°, and once 5°, less cold than that of the swandown. The atmosphere was altogether free from clouds, and nearly quite calm, but a good deal hazy.

Before another proper evening arrived, my health became so infirm that I was obliged to relinquish this pursuit. I conclude therefore my account of it with two remarks. 1. If Mr. Wilson had been accustomed to examine the temperature of swandown, or any similar substance placed upon snow, he would probably have observed a cold on the surface of the earth exceeding that of the atmosphere by 20° or more, on the night of his actually observing an excess of 16°. 2. Since upon one evening when the atmosphere was neither very clear nor very still, a difference of 141° was found by me between the temperatures of air and of swandown, which is only $\frac{1}{2}$ a degree less than the greatest difference I have ever observed between the same substances on the stillest and clearest nights in
summer, a corroboration is hence derived of a conclusion, made by Mr. Six from his experiments, that the greatest differences at night, in point of temperature, between bodies on the surface of the earth and the atmosphere near to it, are those which take place in very cold weather.

PART II.

OF THE THEORY OF DEW.

Dew, according to Aristotle,* is a species of rain, formed in the lower atmosphere, in consequence of its moisture being condensed by the cold of the night into minute drops. Opinions of this kind, respecting the cause of dew, are still entertained by many persons, among whom is the very ingenious Mr. Leslie, of Edinburgh.† A fact, however, first taken notice of by Gersten, who published his treatise on dew, in 1733, proves them to be erroneous; for he found that bodies a little elevated in the air often become moist with dew, while similar bodies lying on the ground remain dry, though, necessarily from their position, as liable to be wetted by whatever falls from the heavens as the former.

Shortly after the appearance of Gersten’s treatise, Musschenbroek made the remark, already mentioned in this Essay, that metals will be free from dew while other bodies attract it copiously. This philosopher contented himself with publishing his discovery; but his friend Dufay concluded from it, that dew is an electric phenomenon, since it leaves untouched the bodies which conduct electricity, while it appears upon those which cannot transmit that influence. If dew, however, were to form on the latter only, its quantity would never be sufficiently great to admit its being distinctly seen; for the nonconductors, as soon as they became in the least moist, would be changed into conductors. Charcoal, too, is now known, though the best solid conductor of electricity after the metals, attracts dew very powerfully; and in the last place, contrary to the assertion of Dufay, dew frequently forms upon metals themselves.

Other authors have ascribed the production of dew to electricity, for reasons different from that of Dufay. But there are several considerations, which seem to me to prove that no such opinion can be just. 1. When dew is produced in a clear atmosphere, the portion of air by which it is deposited must necessarily be unable, at that moment to retain in a state of pellucid vapour, all the moisture which it had immediately before held in that form. But I know of no experiment, which shows that air, by becoming posi-

* Meteor. Lib. 1. c. x. et De Mundo. c. iii.
† Relations of Heat and Moisture, p. 37, and 132.
tively electrical, which is said to be its condition on the evenings during which dew is most abundant, is rendered less able than it had previously been to contain watery vapour in a state of transparency. 2. Bodies in similar circumstances, as far as electricity is concerned, acquire very different quantities of dew. Wool placed on the raised board, for example, attracted very much more dew than wool attached to the lower side of the same board, and even considerably more than the same substance freely suspend-
ed in the air, and entirely exposed to the sky. 3. Dew forms in different parts of the night, in quantities no way proportioned to the degrees of electricity found in the atmosphere at the same times. Thus it is commonly more copious in the morning than in the evening, notwithstanding that the air is observed to be in the latter season more highly electrical than in the former. 4. I have several nights held a glass bottle upon which dew was forming close to the top of a Bennett's electrometer, which had been previously kept in a dry place; but I never saw the slips of gold leaf to move in con-
sequence. It is very probable, however, that more refined experi-
ments will show that electrical appearances attend the production of dew. These, perhaps, accompany every change in the chemical form of bodies. But the facts which have been stated, seem suffi-
cient to establish that any such appearances which may be hereafter remarked during the formation of dew, must be considered as effects, and not as the cause, of the conversion of the watery vapour of a clear atmosphere into a fluid.

A remaining argument applies equally to all the theories, which have hitherto been made public on the cause of dew. This is, that none of them include the important fact, that its production is attended with cold; since no explanation of a natural appearance can be well founded, which has been built without the knowledge of one of its principal circumstances. It may seem strange to many, that neither Mr. Wilson nor Mr. Six applied this fact to the improvement of the theory of dew. But according to their view of the subject no such use could have been made of it by them, as they held the formation of that fluid to be the cause of the cold observed with it. I had many years, as was formerly mentioned, held the same opinion; but I began to see reason, not long after my regular course of experiments commenced, to doubt its truth, as I found that bodies would sometimes become colder than the air without being dewed; and that, when dew was formed, if different times were compared, its quantity, and the degree of cold which appeared with it, were very far from being always in the same proportion to each other. The frequent recurrence of such observa-
ations, at length converted the doubt of the justness of my ancient opinion into a conviction of its error, and at the same time occa-
sioned me to conclude, that dew is the production of a preceding cold in the substances upon which it appears. Wishing, however, to obtain proofs, more striking in degree, of the validity of these inferences, than such as had been afforded to me by casual observa-
tion while attending to other parts of my subject, I instituted the experiments which will be next related.

I had frequently remarked, early in the evening, a considerable degree of cold on substances exposed in calm weather to a clear sky, and I had also sometimes seen, early in the evening, the raised board altogether dry, while the grass was much moistened. I therefore determined to make the experiments in view on the raised board, and to commence them as soon as the sun should cease to shine upon it. The first day I went to the country for this purpose, the 19th of August, 1813, almost every circumstance was favourable to its completion. There had been no rain for three weeks; the wind was northerly; and the barometer was rising; all which indicated, that the atmosphere contained little moisture. The air too was extremely still. The only appearance in the least unfavourable was, that the sky was not entirely free from clouds; but these were few, of small extent, thin, and high.

At 6h. 25m. immediately after the sun had ceased to shine upon the spot, where my experiments were to be carried on, though the time of its setting was still 47 minutes distant, I placed upon the raised board 10 grains of wool, and a small bag, made of the skin of a swan's breast with the down adhering, and stuffed with wool, the whole weighing nearly 5 drachms. On each of these substances the naked bulb of a small and delicate thermometer was laid. A similar thermometer, with its bulb also naked, was suspended in the air over the grassplat, at the same height with the board. Two thermometers were placed in other situations, as will be seen in the annexed table. After an exposure of 20 minutes, the wool was 7° colder than the air, but the swandown bag only 6°, no doubt in consequence of its comparatively great quantity of matter. Neither, however, had gained the least weight, according to the scales employed by me, which were sensibly moved by the 16th of a grain. These observations were repeated several times during the following hour, as will be seen by the table, at none of which, except the last, was either the wool or swandown found in the least heavier, than when first placed on the board. At this last observation, the wool, though 9½° colder than the air, was still without any increase in weight; but the swandown which was 1° colder than the wool, had gained ½ a grain. My experiments now properly ceased; but having suffered the thermometers, which had been placed on the wool and swandown, and in the air, to remain in those situations, I examined them again at 8h. 45m., that is, 2h. 20m. after they had been first exposed. The wool, which was still 9½° colder than the air, had gained somewhat less than ½ a grain; and the swandown, which was now 11½° colder than the air, had gained 2 grains, including the ½ grain already mentioned. When these last observations were made, the sky was entirely cloudless, and the atmosphere very calm.

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ESSAY ON DEW.

TABULAR VIEW OF OBSERVATIONS ON THE EVENING OF AUGUST 19, 1813.

<table>
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<tr>
<th></th>
<th>6th 45m.</th>
<th>7th</th>
<th>7th 30m.</th>
<th>7th 40m.</th>
<th>7th 45m.</th>
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<tbody>
<tr>
<td>Heat of air 4 feet above the grass,</td>
<td>60° 30'</td>
<td>60° 30'</td>
<td>59°</td>
<td>58°</td>
<td>54°</td>
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<tr>
<td>wool on the raised board,</td>
<td>53 1/2</td>
<td>54 1/2</td>
<td>51 1/2</td>
<td>48 1/2</td>
<td>44 1/2</td>
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<tr>
<td>swandown on the same,</td>
<td>54 1/2</td>
<td>53</td>
<td>51</td>
<td>47 1/2</td>
<td>42 1/2</td>
</tr>
<tr>
<td>surface of the raised board,</td>
<td>58</td>
<td>57</td>
<td>55 1/2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>grassplat,*</td>
<td>-</td>
<td>-</td>
<td>49 1/2</td>
<td>49</td>
<td>42</td>
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Similar experiments made at the same place, on the evenings of the 25th of August and 17th of September, in the same year, had results, which were also similar but less in degree; the greatest difference between the temperature of wool or swandown, while they were without any increase of weight, and the temperature of the air having been, on the first of those evenings, only 4°, and on the second only 5°. The reasons were, in great measure, if not wholly, that a considerable part of the sky was covered with clouds, and that the air was commonly in that state of motion which is denominated a gentle breeze.

On the evening of my first experiments, I had omitted to measure the heat of the raised board, before the thermometers were placed upon it. This was attended to on the two latter evenings, on the first of which its upper surface was found, at the commencement of the experiments, 4° warmer than the air; on the second, both it and the air were of the same temperature. Again; on the first of the latter evenings, 10 grains of wool, to which three grains of water had been added, having been laid on the raised board, near the thermometers; at the end of 45 minutes the parcel was found to have lost 2 1/2 grains of moisture by evaporation during the time that dry wool had become several degrees colder than the air.

A fourth experiment of this kind was made by me on the 7th of January, 1814, in the garden of Lincoln's-Inn-Fields, by placing 10 grains of wool on a sheet of pasteboard, which lay upon the snow. At the end of 35 minutes the wool was 5° colder than the air, without possessing any additional weight.

I took advantage of being in the country, at the distance of a few miles from London, on the 21st of the present month, the last day but one of an unusually long tract of dry weather, to expose to the sky, 28 minutes before sunset, weighed parcels of wool and swandown, upon a smooth, unpainted, and perfectly dry fir-table, 5 feet long, 3 broad, and nearly 3 in height, which had been placed an hour before in the sunshine, in a large level grass-field. At this time, and throughout my experiments, the air was very still, and the sky very serene.

*In these experiments, contrary to what usually happens, the grass was almost constantly colder than the filamentous substances, although they were placed upon the raised board.
The atmosphere, too, in all probability, contained but little moisture in consequence of the long absence of rain; and the surface of the ground apparently contained none. The wool, 12 minutes after sunset, was found to be 14° colder than the air, the temperature of the latter being measured by a naked thermometer suspended 4 feet above the ground, and to have acquired no weight. The swandown, the quantity of which was much greater than that of the wool, was at the same time 13° colder than the air, and was also without any additional weight. In 20 minutes more, the swandown was 14½° colder than the neighbouring air, and was still without any increase of its weight. My experiments now ceased from a failure of daylight.

In my former experiments of this kind, the greatest cold observed by me from radiation, without the appearance of dew, was only 9½°.

While making the experiments on wool and swandown, I attended frequently to the temperature of the grass, and found it at one time 15° colder than that of the air 4 feet above the ground. This difference is 1° greater than any I had ever before seen between the temperatures of the same substances, and is equal to the greatest which I had ever known to occur, between those of the atmosphere and of swandown lying upon grass. I had this evening placed no swandown upon grass.

Having thus shown the justness of my former conclusion, that the cold observed with dew is the previous occurrence, and consequently, that the formation of this fluid has precisely the same immediate cause, as the presence of moisture upon the outside of a glass or metallic vessel, when a liquid considerably colder than the air has been poured into it shortly before; I shall next apply this fact to the explanation of several atmospheric appearances.

I. The variety in the quantities of dew, which were found by me upon bodies of the same kind, exposed to the air during the same time of the night, but in different situations, is now seen to have been occasioned by the diversity of temperature which existed among them.

II. Agreeably to the opinion of Mr. Wilson and Mr. Six, the cold connected with dew ought always to be proportional to the quantity of that fluid; but this is contradicted by experience. On the other hand if it be granted, that dew is water precipitated from the atmosphere, by the cold of the body on which it appears, the same degree of cold, in the precipitating body, may be attended with much, with little, or with no dew, according to the existing state of the air in regard to moisture; all of which circumstances are found actually to take place.

III. The formation of dew, indeed, not only does not produce cold, but like every other precipitation of water from the atmosphere produces heat. I infer this, partly because very little dew appeared upon the two nights of the greatest cold I have ever observed on the surface of the earth, relatively to the temperature of the air, both of them having occurred after a long tract of dry weather; and partly from the most dewy night, which I have ever seen, having
been attended during the greater part of it with no considerable degree of cold. On this night the difference between the temperatures of grass and of air was at first $7\frac{1}{4}$, the dew being then not very abundant. But after the dew had become very abundant, the difference of those temperatures never exceeded $4^\circ$, and was frequently only $3^\circ$.

With the view of obtaining, though indirectly, some knowledge of the quantity of cold, which had been prevented, by the formation of dew, from appearing on the surface of the earth in the night just spoken of, I made the following experiment. To 10 grains of wool having the same form and extension as the parcels employed for the collection of that fluid, were added 21 grains of water, this being the quantity of moisture, which had been attracted by 10 grains of wool, lying on the grassplat, in the space of 8 hours on that night. The wet wool having been then placed in a china saucer, laid on a feather-bed in the room, the door and windows of which were shut, its heat during the following 8 hours was, frequently found to be about $4^\circ$ less than that of a dry china saucer on the same bed; the temperature of the air in the room not having altered more than $\frac{1}{2}$ a degree in the course of the experiment. At the end of the 8 hours, the wool still retained $2\frac{1}{4}$ grains of moisture. If this quantity had also evaporated the cold uniformly produced during 8 hours would, in all probability, have been about $4\frac{1}{4}^\circ$. From this experiment, therefore, I think it may be inferred, that the mean quantity of cold, which was prevented, by the formation of dew, from appearing on the ground, during the night which has been mentioned, was also about $4\frac{1}{2}^\circ$. But as the production of dew, during some parts of the night, was at a greater rate than that of 21 grains for eight hours, 1 or 2 degrees may be added for those times, which will raise the effect of the dew in diminishing the appearance of cold during them to about $6^\circ$, on the supposition, which cannot be far from the truth, that dew had been attracted as copiously by the grass, as by wool which lay upon it.

The less difference commonly observed between the temperatures of grass and of air in the morning than what occurs in the evening, is likewise to be, in part, attributed to a greater quantity of dew appearing in the former than in the latter season.

A more remarkable fact, deriving an explanation from the same source, is the greater difference which takes place in very cold weather, if it be calm and clear, between the temperatures of the air and of bodies on the earth, at night, than in equally clear and calm weather in summer; since, in very cold weather, any diminution of the temperature of a portion of air, in contact with a cold body, will be attended, in consequence of the well known relations of the atmosphere to moisture, with a much less formation of water than an equal diminution would be in summer, supposing the air, before it touches the cold body, to be at both times equally near to its point of repletion with moisture.
IV. In very calm nights, a portion of air which comes in contact with cold grass, will not, when the surface is level, immediately quit it, more especially as this air has become specifically heavier than the higher, from a diminution of its heat, but will proceed horizontally, and be applied successively to different parts of the same surface. The air, therefore, which makes this progress, must at length have no moisture to be precipitated, unless the cold of the grass which it touches should increase. Hence in great measure is to be explained, why on such nights as have been just mentioned, more dew was acquired by substances placed on the raised board, than by others of the same kind on the grass, though it began to form much sooner in the latter than in the former situation, those on the raised board having received air, which had previously deposited less of its moisture.

A reason is now also afforded, why a slight agitation of the atmosphere, when very pregnant with moisture, should increase the quantity of dew; since fresh parcels of air will hence be more frequently brought into contact with the cold surface of the earth than if the atmosphere were entirely calm.

V. Dew, in agreement with the immediate cause which has been assigned by me for its production, can never be formed, in temperate climates, upon the naked parts of a living and healthy human body during the night; since their heat is never less in this season, in such climates, than that of the atmosphere. I have, in fact, never perceived dew on any naked part of my own body at night, though my attention was much occupied, for three years, with every thing relative to this fluid, and though I had been during that period, much exposed to the night air. On the other hand, in very hot countries the uncovered parts of a human body may sometimes, from being considerably colder than the air, condense the watery vapour of the atmosphere, and hence be covered with a real dew, even in the day-time.

VI. Hygrometers formed of animal or vegetable substances, when exposed to a clear sky at night, will become colder than the atmosphere; and hence by attracting dew, or according to an observation of Saussure,* by merely cooling the air contiguous to them, mark a degree of moisture beyond what the atmosphere actually contains. This serves to explain an observation made by Mr. De Luc,† that in serene and calm weather, the humidity of the air, as determined by an hygrometer, increases about, and after sunset with a greater rapidity, than can be attributed to a diminution of the general heat of the atmosphere.

These examples are sufficient to show the value of the fact, that bodies become colder than the neighbouring air, before they are dewed, in explaining many atmospheric appearances. To this point, the investigation of the cause of dew might have been carried at any time since the invention of thermometers; but its complete

* Hygronometrie, p. 25. † Introduction à la Physique Terrestre, II. 491.
theory could not possibly, in my opinion, have been attained before the discoveries on heat were made, which are contained in the works of Mr. Leslie and Count Rumford.

The experience of most persons, respecting the communication of heat among bodies in the open air, is confined to what happens during the day; at which time, those that are situated near to one another are always found to possess the same temperature, unless some very evident reason for the contrary should exist. To many, therefore, it may appear incredible that a perfectly dry body, placed in contact on all sides, with other bodies of the same temperature with itself, shall afterwards without undergoing any chemical change, become much colder than they are, and shall remain so for many hours; yet these circumstances are found to occur in substances attractive of dew, when laid on the surface of the earth, in a still and serene night, and are in perfect agreement with the doctrine of heat, now universally admitted to be just.

To render this more easy of apprehension, let a small body which radiates heat freely, and possesses a temperature in common with the atmosphere, higher than 32°, be placed while the air is clear and still, on a slow conductor of heat lying on the surface of a large open plain, and let a firmament of ice be supposed to exist at any height in the atmosphere; the consequence must be, that the small body will from its situation quickly become colder than the neighbouring air. For, while it radiates its own heat upwards, it cannot receive a sufficient quantity from the ice to compensate this loss; little also can be conveyed to it from the earth, as a bad conductor is interposed between them; and there is no solid, or fluid except the air, to communicate it laterally either by radiation or conduction. This small body, therefore, unless it shall receive from the air nearly as much heat as it has emitted, which, considering the little that can be communicated from one part of the atmosphere to another in its present calm state, must be regarded as impossible, will become colder than the air, and condense the watery vapour of the contiguous parts of it, if they should contain a sufficient quantity to admit of this effect. But events similar to these occur when dew appears in an open and level grass field during a still and serene night. The upper parts of the grass radiate their heat into regions of empty space, which consequently send back no heat in return; its lower parts from the smallness of their conducting power, transmit little of the earth's heat to the upper parts, which at the same time receiving only a small quantity from the atmosphere, and none from any other lateral body, must remain colder than the air, and condense into dew its watery vapour, if this be sufficiently abundant, in respect to the decreased temperature of the grass. *

* I have adopted in this explanation the hypothesis of Mr. Prevost of Geneva, on the constant radiation of heat by bodies in contact with the atmosphere, even at the time that they are exposed to the influence of bodies warmer than themselves; as it appears to agree perfectly with all the phenomena of the communication of heat, which do not depend upon conduction. I shall hereafter make frequent use of this hypothesis.
THE THEORY OF DEW.

This subject may be further illustrated by a reference to what happens in the experiment, which has been used to prove the reflection of cold.

In the simplest form of this experiment, a small body, the bulb of a thermometer, possessing the temperature of the atmosphere, is placed before a larger cold body, rendered equal in effect to one still larger, by means of a concave metallic mirror. In this situation, the small body radiates heat to the larger, without receiving an equivalent from it, and, in consequence, becomes colder than the air through which its heat is sent, notwithstanding that it is continually gaining some heat, both from the air which surrounds it, and from the walls and contents of the apartment in which the experiment is made. Dew, therefore, would as readily form upon the thermometer in this experiment, as it would upon one suspended in the open air at night, under a clear sky, provided that the two instruments were equally colder than the atmosphere, and that this was in both cases equally near to being replete with moisture.*

Regarding now as established, that bodies situated on or near to the surface of the earth become, under certain circumstances, colder than the neighbouring air, by radiating more heat to the heavens than they receive in every way,† I shall in the first place offer a few remarks on the extent and use of this occurrence, and shall afterwards apply the knowledge of it to the explanation of several more of the appearances described in the former part of this Essay, and of some others which have not hitherto been mentioned by me.

Radiation of heat by the earth to the heavens must exist at all times; but, if the sun be at some height above the horizon, the degree of which is hitherto undetermined, and probably varies according to season, and several other circumstances, the heat emitted by it to the earth will overbalance, even in places shaded from

* The invention of this experiment having been ascribed a few years ago to Mr. Pictet of Geneva, various English writers have shown, that it occurs in several much older foreign authors. But I have not seen any mention made of its having been also long since known in this country. That it was so appears from the following extract of a letter, written by Mr. Oldenburgh to Mr. Boyle in 1665. "I met the other day in the Astrological Discourse of Sir Christopher Heydon, with an experiment, which he affirms to have tried himself, importing, that cold accompanies reflected light, by employing burning spherical concaves, or parabolical sections, which, he saith, will as sensibly reflect the actual cold of snow or ice, as they will the heat of the sun."—Boyle's Works, folio, vol. v. p. 345.

† Count Rumford offered the following conjecture, in a paper printed in the Philosophical Transactions for 1804. "The excessive cold which is known to reign, in all seasons on the tops of very high mountains, and in the higher regions of the atmosphere, and the frosts at night, which so frequently take place on the surface of the plains below, in very clear and still weather, in spring and autumn, seem to indicate, that frigorific rays arrive continually at the surface of the earth, from every part of the heavens." But he gave no experiments to prove, that such a communication actually exists between the heavens and the earth at night. Neither does it appear from any of his writings which I have seen, that he ever supposed, that the surface of the earth is more cooled by these frigorific rays, than the air through which they pass, or that some solid bodies are more cooled by them than others.
its direct beams, that which the earth radiates upwards. I sus-
pended at midday, on the 24th of July, 1813, in the open air over
a grassplat, while the sky was wholly covered with very dense
clouds, and the weather calm, two delicate thermometers, one of
which was naked, but the other cased in gold paper. At two ob-
servations, having an interval of 10 minutes between them, the ther-
nometer in the gilt case was 2° lower than that which was naked.
A white paper case was then drawn over the gilt one, upon which,
after 5 minutes, the covered instrument was observed to be at the
same height with the naked. The outer white case having, in the
next place, been taken from the covered thermometer, but that which
was gilt suffered to remain, the two instruments were in a few mi-
nutes found again to differ 2°. A thermometer on the grassplat was,
during these experiments, higher than the naked instrument in the
air by 2°, and than that in the gilt case by 4°. It is evident, therefore,
that heat radiated by the sun must, on this day, have been transmit-
ted in considerably quantity through the thickest clouds; since not
only was the earth’s surface warmer than the air, but a small body,
covered with a substance not readily admitting the entrance of
radiant heat was colder than a similar body which was uncovered.
In like manner, I observed at noon, on the 2d of January, 1814,
during the prevalence of a dense fog; a thermometer placed upon
swandown, which was lying upon grass thickly incrusted with
hoarfrost, to be 2° warmer than the air, and 1° warmer than the
grass.*

In a calm and serene night, however, when consequently little
impediment exists to the escape, by radiation, of the earth’s heat to
the heavens, and when no heat can be radiated by the sun to the
place of observation, an immense degree of cold would occur on the
ground, if the following circumstances did not combine to lessen it.
1. The incapacity of all bodies to prevent, entirely, the passing of
heat, by conduction, from the earth to substances placed upon them.
2. The heat radiated to these substances by lateral objects. 3. The
heat communicated to the same substances by the air. 4. The heat
which is evolved, during the condensation of the watery vapour of
the atmosphere into dew.

The extent of the effect of all these checks upon the production
of cold, by the nightly radiation of heat from bodies on the surface
of the earth, cannot, in the present state of our knowledge, be pro-
perly estimated; but facts show that, notwithstanding their operation,
the cold originating in this source must be often very considerable.

1. Mr. Wilson once observed a difference of 16°, from this cause,
between the temperatures of snow and of air. In taking the latter
temperature, however, he employed a naked thermometer, on which
account, in consequence of what has already been mentioned by me,

* Another fact of the same kind, which occurred at the same time, is that,
although the temperature of the air was 30°, the hoarfrost on trees rapidly de-
creased, the solid matter of the trees intercepting radiant heat, which had pen-
etrated through the fog from the sun, and converting it into heat of temperature.
about 2° are to be added to the 16° noted by him, in order to obtain the real difference between the heat of the snow and the air at that time.*

2. If Mr. Wilson, as was formerly said, had laid a thermometer on any downy substance in contact with the snow, he would, in all probability, have found a cold indicated by it at least 20° greater than that of the air, as marked by a naked instrument, and consequently at least 22° greater than the real cold of the surrounding atmosphere.

3. Mr. Wilson's place of observation was not very favourable to the occurrence of a great cold, from radiation of heat at night, it being near to a large smoky city, in the immediate vicinity also, as appears to me from what he says of it, of one or more considerable buildings, and in a climate abounding in moisture.

4. None of Mr. Wilson's experiments, in which a very great degree of cold occurred, were made within an hour or two after sunset, during which time, according to my observation, the most considerable differences between the temperatures of the air, and of bodies on the surface of the earth, commonly happen.

If, then, such experiments should be made in an atmosphere still colder than that in which Mr. Wilson made his, on a large plain remote from any city, and free from objects of every kind that are elevated above the ground, and in a country remarkable for the dryness of its air, all which circumstances may be found in Russia during the winter; a difference of at least 30° would probably appear, on some still and serene night, between a small thermometer placed with its bulb naked,† on the middle, or leeward side of a stratum of a downy substance, occupying a space upon a grass field, or bed of snow, one or two square yards in extent, and a similar thermometer inclosed in a case of gilt paper, and suspended in the air a few feet above the other. Two thermometers, thus placed, would, I think, be sometimes found even in this country to differ not much less than 30°. I have myself never made any such experiments with a downy substance, which had a surface of more than a few square inches, or in a very cold night, when the atmosphere was clear and calm, and the scene of observation remote from large masses of building.

But even a cold of 30° appears not to be the greatest that can be thought to occur from the radiation of heat to the heavens, at night, by substances on the surface of the earth. For experiments by Mr. Pictet,‡ Mr. Six,§ and I may add by myself, establish that, in ex-

* As bright metals, when suspended in the air, and exposed to a clear sky on a calm night, become colder than the surrounding atmosphere, a thermometer covered with metalled paper, and placed in the circumstances which have been just mentioned, will mark a temperature less than that of the air near to it. But, as the difference must be small, and as I know of no way to estimate it accurately, I have hitherto always neglected to consider it.

† The effect would, perhaps, be a little increased, by covering the bulb with a very thin layer of lamp-black.

‡ Essai sur le Feu, c. x.

§ Phil. Trans. 1784, and 1788.
exception to the common rule, the heat of the atmosphere in clear and calm nights increases with the distance from the earth. Agreeably to Mr. Six's experiments, the atmosphere at the height of 220 feet is often, upon such nights, 10° warmer than what it is 7 feet above the ground. If, therefore, I am able to show, as I expect I shall be in the course of a few pages, that the air at the smaller height becomes colder than that of the greater, from its vicinity to the surface of the earth, previously rendered cold by radiating its heat to the heavens, it will follow, that these 10° must be added to the quantity of cold already mentioned; and, consequently, that a body on the ground may become at night, at least 40° colder than the air two or three hundred feet above it, by the radiation of its heat to a clear sky.

I shall add, with the greatest diffidence, a few words upon a final cause of the radiation of heat from the earth, at night, and upon some of the circumstances which modify its action, though fully conscious of the danger of error which is always incurred in the attempt to appreciate the works of our Creator.

The heat which is radiated by the sun to the earth, if suffered to accumulate, would quickly destroy the present constitution of our globe.* This evil is prevented by the radiation of heat by the earth to the heavens, during the night, when it receives from them little or no heat in return. But through the wise economy of means, which is witnessed in all the operations of nature, the prevention of this evil is made the source of great positive good. For the surface of the earth, having thus become colder than the neighbouring air, condenses a part of the watery vapour of the atmosphere into dew, the utility of which is too manifest to require my speaking of it. I may remark, however, that this fluid appears chiefly where it is most wanted, on herbage and low plants, avoiding, in great measure, rocks, bare earth, and considerable masses of water.† Its production, too, by another wise arrangement, tends to prevent the injury that might arise from its own cause; since the precipitation of water upon the tender parts of plants, must lessen the cold in them which occasions it. I shall observe in the last

* Count Rumford says; "May it not be by the action of these (frigorige) rays, that our planet is cooled continually, and enabled to preserve the same mean temperature for ages, notwithstanding the immense quantities of heat that are generated at its surface, by the continual action of the solar rays?" Phil. Trans. 1804, p. 151.

† I have no direct observations for the foundation of this assertion concerning considerable masses of water. But, I hold it, notwithstanding, to be just; because, as soon as the surface of the water is in the least cooled by radiation, the particles composing it must fall downwards, from their increased gravity, and be replaced by others that are warmer. The whole mass, therefore, can never, in the course of a single night, be sufficiently cool to condense into dew any great quantity of the watery vapour of the atmosphere. Besides; I have found, that even a small mass of water, as will be more particularly mentioned in the last part of this essay, sometimes acquires no weight from the reception of dew, in the space of a whole night favourable to the formation of that fluid.
place, that the appearance of dew is not confined to any one part of the night, but occurs during its whole course, from means the most simple and efficacious. For after one part of the air has deposited its moisture on the colder surface of the earth, it is removed, in consequence of that agitation in the atmosphere which exists during its stillest states, and gives place to another having its quantity of water undiminished; and again, as the night proceeds, a portion of air which had before deposited all the moisture, which circumstanc- es at that time permitted, is rendered fit, by the general increase of the cold of the atmosphere, to give out a fresh parcel, when it comes anew into contact with the ground.

I. The first fact which I shall here attempt to explain, is the prevention, either wholly or in part, of cold from radiation, in substances on the ground, by the interposition of any solid body between them and the sky. This evidently appears to arise in the following manner. The lower body radiates its heat upwards, as if no other intervened between it and the sky; but the loss, which it hence suffers, is more or less compensated by what is radiated to it from the body above, the under surface of which possesses always the same, or very nearly the same temperature as the air. In this way, therefore, is to be accounted for the warmth of the substances, which were sheltered from the sky by the raised board, the pasteboard roof, and the hollow cylinders of earth and pasteboard. In these examples, the interposed substances cannot be supposed to have remitted more heat than they received. But in situations where large masses of bare solid matter exist, which are warmer than the atmosphere, from the heat of the preceding day or other causes, a greater heat will be received by the exposed body than what is radiated by itself. For example, it seems certain to me, that the houses surrounding Lincoln's-Inn Fields had an influence upon my thermometers, during my experiment there at night, beyond what arose from their merely returning a quantity of heat, equivalent to that which they received from the surface of the garden. It is not, however, absolutely requisite that a body should be itself exposed to the sky on a clear and calm night, in order to become colder than the atmosphere; exposure to the influence of another body, so situated, is sufficient for the production of a slight degree of this effect. Thus I have always found wool attached to the underside of my raised board, on such a night, to be a little colder than the air; and it has appeared to me a sufficient reason for the fact, that the wool in this situation was in some degree exposed to the influence of grass, which had become considerably colder than the atmosphere by radiating its heat to the sky.

II. No direct experiments can be made to ascertain the manner in which clouds prevent, or occasion to be small, the appearance of a cold at night, upon the surface of the earth, greater than that of the atmosphere; but it may, I think, be firmly concluded, from what has been said in the preceding article, that they produce this effect, almost entirely, by radiating heat to the earth, in return for that
which they intercept in its progress from the earth towards the heavens. For although, upon the sky becoming suddenly cloudy during a calm night, a naked thermometer, suspended in the air, commonly rises 2 or 3 degrees, little of this rise is to be attributed to the heat evolved by the condensation of watery vapour in the atmosphere, as was supposed by Mr. Wilson;* since, in consequence of the ceasing of that part of the cold indicated by the thermometer, which was owing to its own radiation to a clear sky, the temperature of the atmosphere may seem to increase 2°, or more, notwithstanding that it has received no real addition. Besides; the heat which is extricated by the condensation of vapour, during the formation of a cloud, must soon be dissipated; whereas the effect of greatly lessening, or preventing altogether, the appearance of a superior cold on the earth to that of the air, will be produced by a cloudy sky, during the whole of a long night.

Dense clouds, near the earth, must possess the same heat as the lower atmosphere, and will therefore send to the earth, as much, or nearly as much heat as they receive from it by radiation. But similarly dense clouds, if very high, though they equally intercept the communication of the earth with the sky, yet being, from their elevated situation, colder than the earth, will radiate to it less heat than they receive from it, and may, consequently, admit of bodies on its surface becoming several degrees colder than the air. In the first part of this Essay, an example was given of a body on the ground becoming at night 5° colder than the air, though the whole sky was thickly covered with high clouds.†

Islands, and parts of continents close to the sea, being, by their situation, subject to a cloudy sky, will, from the smaller quantity of heat lost by them through radiation to the heavens at night, in addition to the reasons commonly assigned, be less cold in winter than countries considerably distant from any ocean.

III. Fogs, like clouds, will arrest heat, which is radiated upwards

† Mr. Prevost of Geneva, in his work on Radiant Heat, p. 382, has already in this way, conjecturally accounted for the effect of clouds, in diminishing at night the cold of the atmosphere, and of the surface of the earth; but he seems not to have known, that their effect on the temperature of the latter is much greater than that which they produce upon the air. My explanation of this influence of clouds, on the temperature of the surface of the earth, during the night, is a direct consequence from the facts, which I had observed respecting the prevention of cold on the ground from radiation, by the interposition of solid bodies between it and the heavens, and occurred to me in 1812. Mr. Prevost's work, indeed, was published in 1809; but I did not see it before the summer of 1813; when it was lent to me by his relation Dr. Marecot of London, who at the same time said, that he believed there was no other copy of it in Great Britain, except one, which had been sent by himself to Edinburgh.

Note to second edition.] I did not know, until after the first edition of this Essay was printed, that Mr. Prevost had published his opinion on the effect of clouds in preventing the occurrence of cold at night in the atmosphere, and upon the surface of the earth, as early as 1792, in a work entitled 'Recherches sur la Chaleur.'
by the earth, and, if they be very dense, and of considerable perpendicular extent, may remit to it as much as they receive. Accordingly, Mr. Wilson found no difference at night, in very foggy weather, between the temperature of the surface of snow, and that of the air. Several observations by myself tend to confirm that of Mr. Wilson. An instance, however, as was formerly said, occurred to me of a difference at night of 9° between the temperatures of grass crusted over with hoarfrost, and of air, during a very dense fog. A fact, remarked by Mr. Leslie, respecting fogs, serves to explain this apparent anomaly. For it was found by that philosopher,* from experiments made with his photometer, that in mists and low fogs the diminution of the sun’s heat is small, when compared with what occurs when the sky is obscured by a dense body of clouds; and it will, I presume, be readily granted, that the same state of the atmosphere, which allows the heat of the sun to pass copiously, will also give a ready transit to heat radiated by the earth. Now there are several reasons for believing, that the fog during which grass was 9° colder than the air, did not ascend far above the ground. 1. The barometer had been falling for some days before, and it is a matter of common observation, that great fogs seldom occur, except it be high. 2. On the day preceding the observation, the air, after having been extremely foggy for nearly a week, had become clear enough to allow the sun’s being distinctly seen during the whole of the afternoon, though there was still a sufficient obscurity in the lowermost parts of the atmosphere, to obstruct considerably the view of objects on the ground and very near to it. 3. On the day following the observation, the fog was again much less; on the next it disappeared, and was succeeded by snow. It is to be mentioned likewise, that on the evening in question the state of the grass, which was the subject of experiment, was unusually favourable to the production of cold; since, contrary to general experience, it was as cold as swandown. If, then, the latter substance, from the much greater regularity of the appearances exhibited by it, be taken as the standard, by which the occurrences of different nights are to be compared together, it will follow that the fog of which I am speaking, though it did not prevent, must have lessened the production of cold from radiation. For, on the preceding evening, when there was little fog, the atmosphere being equally still on both, the difference between swandown and the air was 12°; and on another, a fortnight after, the difference at the same place of observation between thermometers in the same situations, was 141°, the air being now free from fog. If the atmosphere had been as still on this as on the former evenings, a greater difference would doubtless have been seen. I conclude, therefore, that fogs do not in any instance furnish a real exception to the general rule, that whatever exists in the atmosphere, capable of stopping or impeding the passage of radiant heat, will prevent or lessen the appearance at night.

* On Heat and Moisture, p 57.

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of a cold on the surface of the earth greater than that of the neighbouring air.

It follows also, from what has been said in this article, that the water deposited upon the earth, during a fog at night, may sometimes be derived from two different sources, one of which is a precipitation of moisture from a considerable part of the atmosphere, in consequence of its general cold; the other, a real formation of dew from the condensation, by means of the superficial cold of the ground, of the moisture of that portion of the air, which comes in contact with it. In such a state of things, all bodies will become moist, but those especially which most readily attract dew in clear weather.† I have had no opportunity, however, of trying this conclusion by the test of observation since it occurred to me.

IV. When bodies become cold from radiation, the degree of effect observed must depend not only on their radiating power, but in part also on the greater or less ease with which they can derive heat, by conduction, from warmer substances in contact with them. Thus grass on a clear and still night was constantly colder, sometimes very much colder than the gravel walk, though a small quantity of sand placed upon grass was always nearly as cold as this substance. In this case, the difference in temperature between the gravel walk and sand, evidently depended on the different quantities of heat which they received from the parts beneath. A like reason is to be given for dew appearing in greater quantity on shavings of wood than on the same substance in a more dense and compact form; and for filamentous and downy substances becoming colder than all others, even than lampblack, which is placed by Mr. Leslie, at the head of the best solid radiators of heat. For the lampblack exposed by me being about 2 lines in depth, possessed, in consequence, a fund of internal heat, which would more readily pass to its cold surface, than the heat of the lower parts of the downy substances would to their upper surface.

This subject is illustrated by the following experiment. On a dewy evening I depressed into a soft garden mould a drinking glass having a thick flat bottom, until its brim was upon a level with the surrounding earth, and at the same time placed a similar vessel with its cavity also towards the sky, on the surface of the mould. In the morning the inside of the depressed glass was entirely dry, while that of the other was dewed. I then applied the bulb of a small thermometer to the inside of the bottom of each vessel, on which I found the heat of that part of the depressed one to be 56°, but of the same part of that which stood on the mould only 49½°. At this time the temperature of the air was 53°. The cause, therefore, was evident, both of the witness of the first vessel and of the dryness of the second.

From this source also is to be derived the reason, why the promi-

† The moisture observed at night by Musschenbroek in Holland, and called by him dew, appears to me to have been of this kind. See this Essay, p. 6.
nent parts of various bodies were observed by Mr. Wilson to be crusted with hoarfrost, while their more retired and massy parts were free from it.*

V. Bodies exposed in a clear night to the sky, must radiate as much heat to it during the prevalence of wind as they do if the air were altogether still. But in the former case little or no cold will be observed upon them above that of the atmosphere, as the frequent application of warm air must quickly return a heat equal, or nearly so, to that which they had lost by radiation. A slight agitation of the air is sufficient to produce some effect of this kind; though, as has already been said, such an agitation when the air is very pregnant with moisture, will render greater the quantity of dew; one requisite for a considerable production of this fluid being more increased by it, than another is diminished.

VI. A small body, as a thermometer, suspended in the air, will even in the calmest night exhibit but little cold from radiation, since it is continually exposed to the application of fresh parcels of warmer air, both from the progressive motion of this fluid and from the downward motion produced in it by the superior gravity of such portions as have been cooled by contact with the suspended body. On the other hand, a thermometer upon a board, raised above the earth and possessing a surface of several square yards, will have its cold from radiation much less diminished than the former, as it is exposed to no loss from a downward motion of the air, and as the air which approaches it horizontally must almost always have had its temperature previously lowered by passing over another part of the board. The reason then of the lee side of the raised board being often colder than the windward is obvious.

VII. There is a remark by Theophrastus,† which has been confirmed by other writers, that the hurtful effects of cold occur chiefly in hollow places. If this be restricted to what happens on serene and calm nights, and it does not, I believe, hold true in any other circumstances, two reasons from different sources are to be assigned for it. The first is, that the air being stiller in such a situation than in any other, the cold from radiation in the bodies which it contains will be less diminished by renewed applications of warmer air; the second, that from the longer continuance of the same air in contact with the ground, in depressed places than in others, less dew will be deposited, and therefore less heat extricated during its formation. It will be seen in the last part of this Essay, that in the East Indies depressions in the earth are artificially made, for the purpose of increasing the cold, which appears in serene nights. On this subject, however, it is to be observed, that if the depressed or hollow places be deep, in proportion to their horizontal extent, a contrary effect must follow; as a case will occur more or less similar to that which existed in some experiments formerly related by me, in which a small portion of grass was surrounded by a hollow cylinder.

* Paper in Phil. Trans. 1780.
† Lib. v. c. xvi.
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VIII. An observation closely connected with the preceding, namely, that in clear and still nights frosts are less severe upon hills than in neighbouring plains,* has excited more attention, chiefly from its contradicting what is commonly regarded an established fact, that the cold of the atmosphere always increases with the distance from the earth. This inferior cold of hills is evidently a circumstance of the same kind with that ascertained by Mr. Pietet and Mr. Six respecting the increasing warmth, in clear and calm nights at all seasons of the year, of the different strata of the atmosphere, in proportion as these are more elevated above the earth. As the greater cold of the lower air is the less complicated fact, I shall attempt to explain it in the first place. Mr. Pietet, indeed, furnishes an explanation himself, by ascribing it to the evaporation of moisture from the ground. But to show that this is not just, it need only be mentioned, that the appearance never occurs in any considerable degree, except upon such nights as are attended with some dew, and that its great degrees are commonly attended with a copious formation of that fluid; since it cannot be thought that the same stratum of air will deposit moisture on the ground, from an insufficiency of heat, at the very time it is receiving moisture from the ground, in the state of pellucid vapour, as this presupposes that it is not yet replete with water.

Our atmosphere has been very generally regarded, as incapable of being heated directly by the rays of the sun, principally because these give no heat to any particular portion of it, in which they are brought to a focus. I do not know, whether this experiment was ever made with all the accuracy of which it is susceptible; but granting that it has been thus made, my opinion is, notwithstanding, that no reliance can be placed in it. For as air, if heated at all by concentrated sunbeams, must be heated by them in a very slight degree during the time that their focus may be looked upon as stationary, otherwise the present question would not have arisen, it is necessary for conducting the experiment properly, that during the whole of it, the same individual small portion of air shall constantly receive that focus; but this, for various manifest reasons, cannot possibly happen. Viewing therefore the argument founded upon this experiment as without force, I shall now offer several considerations, which seem to prove, that air is actually heated by the sunbeams which enter it.

1. Air both reflects and refracts light, and all other bodies, as far as I know, acquire heat, while they act thus on the light of the sun.
2. Air suffocates or absorbs the sun's light, which it cannot be supposed to do without increasing in temperature.
3. If air, considered as an uniform fluid, were even incapable of gaining heat directly from the sun's rays, heat would be communicated by them to it, through the intervention of the innumerable

* Theophrastus also remarks, that it freezes less on hills than on plains, but without mentioning, that this happens only on calm and serene nights. Lib. v. c. xx.
particles of solid matter, which the trivial experiment of receiving a sunbeam into a darkened room shows to be present in the atmosphere. Should it be said, that this appearance may occur only in the neighbourhood of the earth, from the accidental admixture of solid matter raised from its surface by winds, or in any other way, the answer is that, as my inquiry is concerning the existence of a certain condition of the atmosphere, it matters not how this originates. Nothing more can be demanded than that it should always be found, which I believe to be the case; since, if I can trust my memory with respect to what took place many years ago, I should say that such particles are to be seen, by means of the sun's light in the air, over the middle of the Atlantic ocean. These particles then, must receive heat from the sunbeams, which impinge upon them, and this they will communicate to the contiguous pelucid air.

4. Unless it be admitted, that the atmosphere is capable of intercepting part of the heat which is radiated into it by the sun, and of converting this into heat of temperature, I deem it impossible to find a sufficient reason for the great warmth which exists after a long calm, in air incumbent upon the Atlantic and Pacific oceans, at the distance of a thousand miles or more from any considerable body of land. It cannot be derived from the neighbouring water, since this is colder than the lower atmosphere; and no one will suppose it to be the same heat which the air had acquired from the last continent it had passed over many days before. But if even this were supposed, another difficulty would remain to be removed, which is, that during the whole of the calm the air is cooled every night, and again becomes warm in the day.*

Should what has been said be thought sufficient to establish, that the air arrests part of the sun's heat, which is radiated into it bound up with light, two consequences must also be allowed. The first is, that air will exert a greater power of the same kind upon heat radiated into it without light, since the sun's heat passes instantaneously through many bodies, which refuse a similar way to heat radiated by terrestrial substances; the other, that air must be as capable of becoming cold by radiating its own heat,† as of becoming warm from heat radiated into it, as these two properties are uniformly observed to exist together, and to be proportional to each other. The truth of the latter conclusion may also be inferred from this fact, that in still and calm weather the heat of the air, a few feet above the earth, will sometimes decrease, even in this country, 18 or 30 degrees between sunset and sunrise, though no change of wind has in the meantime occurred; for the inconsiderable conducting power, which air is now known to possess, will per-

* One reason is hence apparent for the great coldness of the high regions of the atmosphere; since the air in them must be less fit than that of the lower strata to arrest heat which is radiated into it.

5*
mit only a small part of this diminution to arise from heat passing, by means of that power, from the atmosphere to the colder earth. Mr. Leslie,* indeed, ascribes this effect to the descent of cold air from the higher regions of the atmosphere; but if this were just, a less cold ought to be found, on a clear and still night, in the lower than in the higher strata, which is contrary to the uniform results of numerous experiments by Mr. Pietet and Mr. Six. Winds, too, which produce such a mixture, always lessen the nocturnal decrease of temperature in the lowermost part of the atmosphere.

Having thus shown, that air is capable, both of absorbing heat which is radiated into it, and of radiating heat which had before formed a part of its temperature, I proceed to apply the knowledge of these facts, to the explanation of the phenomenon observed by Mr. Pietet and Mr. Six.

This phenomenon occurs on those nights only, which permit bodies, on the surface of the earth, to become cold by radiating their heat to the heavens. On other nights, when bodies, thus situated, were not colder than the air, I have observed the atmosphere, within the limits of 9 feet from the ground, the boundary of my own experiments, to decrease a little in temperature as the distance from the earth increased. Mr. Six likewise found, that, on cloudy nights, the air was sometimes colder 220 feet above the ground than at the distance of 9 feet from it. When, therefore, the earth has become colder, from radiation, than the neighbouring air, in consequence of the latter having, by reason of its small radiating power, emitted a less proportion of its heat to the heavens, the warmer air must radiate a part of its heat to the earth without receiving a full compensation, and will therefore become colder than it otherwise would have been. In proportion too as the air is nearer to the earth must the cold of the former from this cause be the greater. My own conception of this matter is facilitated,† by contemplating the occurrence of an opposite effect, when the earth is warmer than the air. Let it be supposed then, that while the earth, in this state, radiates upwards a quantity of heat, a foot in depth of the incumbent air is capable of stopping a 1000th of what it hence receives, and of converting it into heat of temperature. The consequence must be that the next foot, from receiving only 999 parts of what has been emitted by the earth, will not be so much heated as the first foot, though it should absorb the same proportional quantity of what enters it. In this way, every successive foot will acquire a less quantity of heat than the preceding, and a state of the atmosphere be produced, like to that which is actually observed in a calm and sunny day. In the day, however, the phenomena, from the heating of air by rays from the earth, are somewhat confused by the warmed portions rising upwards, and mixing with what is colder; whereas, at night, the air, which has been cooled by radiating heat to the

* On Heat and Moisture, p. 11, and 132.
† The same facility is afforded by considering cold as a body.
earth, is rendered, by an increase of gravity, the more fit to retain its low position. I have here, for the sake of simplifying the argument, taken no notice of the cooling of any considerable mass of the air, in consequence of the actual contact of its lowermost stratum with the earth, or by the conduction of the temperature of one portion of it to another. But, in a calm state of the atmosphere these effects must be inconsiderable, though it appears to me impossible, in the present state of our knowledge to determine them with any precision.

According to the view which has been given by me of this subject, the heat of the air, in a clear and calm night, ought to increase, within the limits of the phenomenon, in some decreasing geometrical ratio, as the atmosphere ascends; and this conclusion is so far confirmed by the observations of Mr. Pictet and Mr. Six taken together, that the increase of temperature is found to be greater in a given space very near to the earth than in an equal space more remote from it.

To return to the immediate object of this article, the fact is certain, whatever may be thought of my explanation of it, that in every clear and still night the air near to the earth is colder than that which is more distant from it, to the height at least of 220 feet, this being the greatest to which Mr. Six's experiments relate. If then a hill be supposed to rise from a plain, to the height of 220 feet, having upon its summit a small flat surface covered with grass; and if the atmosphere, during a calm and serene night, be admitted to be 10° warmer there than it is near the surface of the low ground, which is a less difference, according to the observations of Mr. Six, than what sometimes occurs in such circumstances, it is manifest that, should both the grass upon the hill and that upon the plain acquire a cold of 10° degrees by radiation, the former will, notwithstanding, be 10° warmer than the latter.

But the equality here supposed to be in the cold acquired by grass, in two such situations, can seldom exist. For according to an observation made by Aristotle, and since frequently repeated, the air of high places is much more agitated than that upon low ground. The frequent renewal, therefore, from this cause, of the air in contact with the grass on the hill, will prevent it from ever becoming much colder than the general mass of the atmosphere at the same height. Consequently, any diminution in this way of the 10° of cold formerly supposed to occur there from radiation, must be added to the difference of temperature in the grass in the two situations.

What has hitherto been said refers only to the occurrences on the very summit of the hill. With respect to its sides, these can be only a little colder than the atmosphere upon a level with them, even in its calmest state. For, in the first place, they do not enjoy the full aspect of the sky; and, in the second, the air which is

* Meteor. lib. 1. c. x.
cooled by contact with them, will, from its increased gravity, slide down their declivity, and thus make room for the application of new and warm parcels to the same surface. The motion, too, thus excited in the air, near to the sides of the hill, must occasion a motion in that upon the summit, which may, in some measure, account for the last mentioned observation of Aristotle, as far as relates to what happens in a clear night.

The height of the hill in this example has been supposed to be small, to make it accord with that of the stations whose temperatures were compared by Mr. Six with the heat of the air near the ground. But observations of the same kind will apply to hills of much greater elevation. For granting, first, that the air at the height of 220 feet is never more than 10° colder than that near to the earth, which is not probable, and is indeed contradicted by some of Mr. Six's observations; and again, that the increase of the air's heat in a calm and serene night, ceases precisely at the greatest height to which Mr. Six carried his observations, which is also improbable; still a reduction to the extent of 10° in the temperature of the air near to the earth, will render the cold of this low portion of the atmosphere greater than that of any other portion, which is not more than 2500 or 3000 feet above the former; if the estimate be just, which makes a declension in the heat of the atmosphere of 1° for every 250 or 300 feet of its height, when no counteracting cause exists.

The remarks, however, which have been offered on the greater warmth of hills at night, in a certain state of weather, are strictly applicable to those only which are insulated, and of inconsiderable lateral extent; and it is upon such chiefly, if not solely, that this phenomenon has been observed. The superiority of the cold of a low plain, from radiation, over that of a wide expanse of hilly ground, will, for obvious reasons, be less; and no superiority of this kind will probably exist in the former situation, when the high ground is not only extensive but flat on the top, forming what is called a table land; unless, indeed, which seems to be actually the case, the air of such an elevated country should be commonly more agitated than that of lower places equally level.

An explanation may be now easily given of an observation by Mr. Jefferson of Virginia,* which, however, had also been made by Aristotle,† and Plutarch,‡ that dew is much less copious on hills than it is upon plains. For allowing, at first, the surface of the ground to be in both situations equally colder than the air which is near to it; still, as the production of dew must be in proportion to the whole depression of the temperature of the air which furnishes it, below what its heat had been in the preceding day, and as one part of this depression, the general cooling of the atmosphere, is much more considerable on the plain than on the hill, moisture must necessarily be deposited more copiously in the former than in

* Notes on Virginia, p. 133. † Meteor. Lib. I. c. x. ‡ De Primo Frigido.
the latter place. If the greater agitation of the atmosphere, and
the less quantity of moisture during clear weather, in its higher
region than in the lower, be added, it may readily be inferred that
dew shall sometimes be altogether wanting on a hill, though abundant
on a plain at its foot, agreeably to what has been actually observed by
Mr. Jefferson.

IX. The leaves of trees often remain dry throughout the night,
while those of grass are covered with dew. As this is a similar
fact to the smallness of dew on hills, I shall in accounting for it do
little more than enumerate the circumstances on which it depends.

1. The atmosphere is several degrees warmer near the upper parts
of trees on dewy nights than close to the ground. 2. The air in
the higher situation is more agitated than that in the lower.
3. The air at a little distance from the ground, from being nearer to
one of its sources of moisture, will on a calm evening contain more
of it than that which surrounds the leaves of elevated trees.
4. Only the leaves of the very tops of trees are fully exposed to the
sky. 5. The declension of the leaves from a horizontal position
will occasion the air, which has been cooled by them, to slide
quickly away, and be succeeded be warmer parcels. 6. The length
of the branches of the trees, the tenderness of their twigs, and the
pliancy of the footstalks of their leaves, will cause in the leaves an
almost perpetual motion, even in states of air that may be denomi-
nated calm. I have hence frequently heard, during the stillness of
night, a rustling noise in the trees, which formed one of the bounda-
ries of the ordinary place of my observations, while the air below
seemed without motion.

Nearly in the same manner is to be explained why shrubs and
bushes also receive dew more readily than lofty trees.

X. Bright metals, exposed to a clear sky in a calm night, will be
less dewed on their upper surface than other solid bodies; since of
all bodies they will, in such a situation, lose the smallest quantity
of heat by radiation to the heavens, at the same time that they are
capable of receiving, by conduction, at least as much heat as any
others from the atmosphere, and more than any others from the
warmer solid substances which they happen to touch.

If the exposed pieces of metal be not very small, another reason
will contribute somewhat to their being later and less dewed than
other solid substances. For in consequence of their great con-
ducting power, dew cannot form upon them, unless their whole
mass be sufficiently cold to condense the watery vapour of the
atmosphere; while the same fluid will appear on a bad conductor of
heat, though the parts a very little beneath the surface are warmer
than the air.*

* I hence think it probable, that dew will sometimes form on the bulb of a
thermometer, before the mercury in it is cooled below the temperature of the air.
It seems certain to me, also, that dew may appear upon substances, which, from
the thinness of the layer of matter their cold is confined to, will produce little or
no sensible effect upon a thermometer that is applied to them.
From the same ready passage of heat from one part of a metal to another, a metallic plate suspended, horizontally, in the air several feet above the ground, will be found dewed on its lower side, if the upper has become so; while the lower surface of other bodies, more attractive of dew, but worse conductors of heat, are without dew in a similar situation.

A metal placed at night in the air, near to the ground, is, for the most part, sufficiently cold to condense, on its underside, the vapour which arises from the warmer earth; though its upper surface may be dry, from possessing the same, or almost the same temperature, as the atmosphere near to it.

As the temperature of metals is never much below that of the neighbouring air, a slight diminution of their cold from radiation will often occasion them to evaporate the dew, which they had previously acquired, though other substances, which had been more cooled by radiation, are still attracting dew. For a like reason, a metal, which has been purposely wetted, will often become dry at night, while other substances are becoming moist.

A substance highly attractive of dew, such as wool, if laid upon a metal, will derive heat from it, and will therefore acquire less dew than an equal portion of the same substance laid upon grass.

A large metallic plate will be less readily dewed while lying on grass, than if it were placed in the air, though only a few inches above the grass; because, in the former situation, it receives freely, by means of its great conducting power, heat from the earth; whereas, when placed in the air, it powerfully resists by another property, possessed in a great degree by bright metals, the entrance of heat radiated towards it by the grass beneath. Besides; the grass under the metal possesses now less heat than when this substance was in contact with it, partly from having a small oblique aspect of the sky, and partly from receiving air, which has been cooled by passing over other grass fully exposed to the heavens.

When a piece of metal, having closely applied to its under surface a substance of some thickness, which attracts dew powerfully, and therefore imbibes readily heat that is radiated to it, is exposed to the sky at night, the heat supplied by the attached substance, both from its own original store, and from what it has acquired through the radiation of the ground to it during the exposure, will enable this piece to resist longer than a bare piece the formation of dew, or even than another piece which has only a thin coat of matter considerably attractive of dew attached to its underside. The experiment with the wooden cross, covered with gilt paper, affords an example of the latter fact.

A very small metallic plate, suspended in the air, is less readily dewed than a large one similarly situated, as it receives, in proportion to its size, more heat from the atmosphere. On the other hand, a very small plate laid upon grass, rendered cold by radiation, will be sooner dewed than a larger one in the same situation, from presenting a greater proportional circumference to the surrounding
grass, and therefore losing more quickly its heat by conduction. It will be also sooner dewed than another very small plate suspended in the air; since the latter, like other small bodies similarly placed, must be continually acquiring more heat than the former, in the manner described above in this Essay.*

A piece of metal, applied to different portions of cold grass in succession, will sooner become cold itself, than another piece which is suffered to remain constantly upon one portion of the same grass, and will in consequence be sooner dewed.

If the bare side of a piece of metallized paper be exposed to a clear and calm sky at night, it will become cold, by radiation, and receive, by conduction, the heat of the inferior metallic surface; whence, if this surface be afterwards made the upper one, it will sooner acquire dew than a similar metallic surface which has been exposed to the sky during the whole of the experiment.

When a metal covers, in part only, the upper surface of a piece of glass, the uncovered portion of the glass quickly becomes cold by radiation, on exposure to a serene sky in a still night, and then, by deriving to itself a part of the heat of the metal, occasions this body to be more readily dewed than if the whole of the exposed surface had been metallic. In this experiment, the outer edge of the metallic surface, from being nearest to the colder glass, will be the first and the most dewed, while the parts of the uncovered glass, which are contiguous to the warmer metal, will be the last and the least dewed, of their respective substances.

A piece of glass, covered on one side with a metal, being placed on grass, with this side down, its upper surface attracts dew as readily as if no metal were attached to it; since the metal in this situation has no power to lessen the radiation of heat from the upper surface of the glass. I conclude, however, from general principles, for I have not made the trial, that if the same piece of glass, having its metallic side still undermost, were raised in the air a little above the grass, it would be more readily dewed on its upper surface than if it had been without a metallic coating on the lower, as this coating must resist the introduction of heat radiated by the warmer grass, and thus preserve nearly undiminished the cold acquired from radiation of heat to the sky, by the bare upper surface.

The preceding remarks apply to the whole class of metals; but the discoveries of Mr. Leslie, respecting the difference in the capacities of these bodies to radiate heat, furnish an explanation of a diversity among themselves, in regard to attraction for dew, which was noted in the foregoing part of this Essay. Gold, silver, copper, and tin, are there said to resist the formation of dew more strongly than other substances of the same class; but these metals according to Mr. Leslie radiate heat the most sparingly. On the other hand, lead, iron, and steel, which according to the same author radiate heat more copiously than the former metals, were found by me to acquire

*Page 43.
dew more readily. I do not know if the radiating power of platina has been ascertained by direct experiments; but as its conducting power is small its radiation must be great, since these qualities exist always in opposite degrees in the same substance; and I have accordingly observed it to be dewed, while the four first-mentioned metals were dry. I am ignorant both of the radiating and the conducting power of zinc, as determined by ordinary experiments; but I infer from its being more easily dewed than gold or silver, that it radiates heat more copiously than they do; unless indeed, the pieces which I used, from having had their surfaces roughened by friction with sand, which was employed to brighten them, had acquired a radiating power greater than that possessed by polished pieces, agreeably to the results of some of Mr. Leslie's experiments.*

XI. Thinking it probable, that black bodies might radiate more heat to the sky at night than white, I placed upon grass, on five different evenings, equal parcels of black and white wool. On four of the succeeding mornings the black wool was found to have acquired a little more dew than the white; whence I inferred that it had, in consequence of its colour, radiated a little more heat. But I afterwards remarked that the white wool was somewhat coarser than the black; which circumstance alone was sufficient to occasion a difference in their quantities of moisture. Another night I laid on the raised board a piece of pasteboard covered with white paper, and close to this a second piece similar to the former in every respect, except that it was covered with paper blackened with ink. At daylight I saw hoarfrost upon both pieces; but the black seemed to have a greater quantity than the white. A doubt, however, afterwards arose upon the accuracy of this experiment likewise; for as the light was faint when I viewed the two surfaces, the quantity of hoarfrost, though equal on both, might have appeared greater on the black than on the white, from the contrast of its colour with that of the former surface. But trials of this kind, as Mr. Leslie† has observed, never afford firm conclusions; since a black body must always differ from a white in one or more chemical properties, and

* I once intended to subjoin here an explanation of some very curious observations by Mr. Benedict Prevost on dew, which were published, first in the 44th volume of the French Annals of Chemistry, and afterwards by Mr. Peter Prevost of Geneva, in his Essay on Radiant Heat; but fearing to be very tedious, I have since given up the design. I will say, however, that if to what is now generally known on the different modes, in which heat is communicated from one body to another, be added the two following circumstances; that substances become colder by radiation than the air, before they attract dew; and that bright metals when exposed to a clear sky at night, become colder than the air much less readily than other bodies; the whole of the appearances observed by Mr. Prevost may be easily accounted for.

† On Heat, p. 95.
this difference may of itself be competent to produce a diversity in their powers to radiate heat.

With the view to render the subject less complicated, I have hitherto treated of dew as if it were altogether derived from watery vapour previously diffused through the atmosphere; this appearing to me to be by far its most considerable source, and none of my conclusions of any importance being liable to be affected, even by the establishment of a contrary opinion. Other writers, however, have regarded dew as being entirely the product of vapour emitted during the night, by the earth and plants upon it. According to this theory dew is said to rise.

The first trace, which I have found of the opinion that dew rises from the earth at night, occurs in the History of the Academy of Sciences for 1697. It is mentioned there briefly and obscurely, and was, probably, shortly forgotten; for Gersten, who advanced it anew in 1733, held himself to be its author. Musschenbroek and Dufay embraced it immediately after Gersten; but the former soon admitted, that dew sometimes falls. As far as I have learned, no writer upon dew has since ascribed its total production to vapour, emitted by the earth at night, except Mr. Webster of New England. But this opinion is frequently advanced in conversation by persons not much accustomed to philosophical pursuits, chiefly, I think, because it contradicts a popular belief.

The only argument used by the French academicians, in support of their opinion, is, if I understand it rightly, that as much dew is observed under an inverted glass-bell as in any other situation. But admitting, for a moment, this to be true, they would not thus prove that the ground is the only source of that fluid. Gersten was led to think that dew rises from the earth, by often finding grass, and low shrubs, moistened with it, while trees were dry. Respecting this fact, I shall add nothing to what I have lately said upon it. But his chief argument is derived from another fact related in the first part of this Essay, which is, that a plate of metal, laid upon bare earth on a dewy night, will remain dry on its upper surface, while it becomes moist on the lower. This also is easily explicable by what has already been mentioned by me. For the lower side of the metal, in consequence of the upper being in contact with the air and being exposed to a clear sky, is colder than the earth a little below the surface, and therefore condenses the vapour, which strikes against its bottom; while the upper side, from being frequently warmer, and never more than a little colder than the air, is for the most part unable to condense the watery vapour of the atmosphere. Gersten, moreover, describes several appearances

* Mem. of American Acad. vol. iii.
† I have, in like manner, observed, on a cloudy night, a piece of glass, laid over an earthen pan containing water and placed upon the ground, to be wet on its lower side, while the upper was dry; the glass being, in this situation, sufficiently cold to condense the vapour of water heated by the earth, but not enough so to condense the watery vapour of the atmosphere.
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himself, which refute his opinion. He mentions, for example, that the higher parts of shrubs are more dewed than the lower; that metallic plates, placed horizontally in the air, are as much dewed on their superior as on their inferior surfaces; and that convex and cylindrical bodies, suspended in the air, the latter having a position parallel to the horizon, are dewed only on their upper parts.

The principal reason given by Dufay for the rising of dew is, that it appears more early on bodies near to the earth than on those which are at a greater height. But this fact readily admits of an explanation on other grounds that have already been mentioned. 1. The lower air, on a clear and calm evening, is colder than the upper, and will, therefore, be sooner in a condition to deposit a part of its moisture. 2. It is less liable to agitation than the upper. 3. It contains more moisture than the upper, from receiving the last which has risen from the earth, in addition to what it had previously possessed, in common with other parts of the atmosphere. Dufay attempted to strengthen his argument, by exposing, on three dewy nights, similar substances at different heights from the ground, expecting that the lower would always acquire more moisture than the upper; but, upon all the nights, some one of the lower substances acquired less moisture than some one of the higher.

Mr. Webster has advanced no new fact in favour of the opinion of which I am speaking.

Enough having been said to prove, that dew is not entirely the product of vapour rising from the earth at night, I shall next show, that it often occurs when this cause can have little or no operation.

1. It appears from Hasselquist and Bruce, that in Egypt, shortly before the rising of the Nile, and consequently when the ground there is in its dryest state, dew becomes exceedingly plentiful, though little or none had formed before, while the earth was somewhat less dry. The cause evidently is, as was formerly mentioned, the moist air brought from the Mediterranean by the north wind, which then prevails.

2. Mr. Webster, speaking of hoar-frost, which he properly regards as frozen dew, candidly says, though it overthrows his opinion: "This frost appears when the surface of the earth is sealed with frost, and of course the vapour of which it is formed, cannot at the time, perspire from the earth."

3. I have myself, at all seasons of the year, frequently observed wool, upon the middle of the raised board, and therefore out of the way of vapour rising from the ground, to acquire more dew than wool laid upon the grassplat.

4. The bodies that condense the rising vapour must necessarily be colder than it; but, as they are likewise, according to the opinion under view, of the same temperature with the air surrounding them, this also should condense the rising vapour. Dew, therefore, should never appear in any considerable quantity, without being accompanied with fog or mist. Now I can assert, after much attention to this point, that the formation of the most abundant dew is consistent
with a pellucid state of the atmosphere. Hasselquist makes a similar observation with regard to Egypt; where, during the season remarkable for the most profuse dews, "the nights," he says, "are as resplendent with stars, in the midst of summer, as the lightest and clearest winter nights in the north."

But, although these facts prove that copious dews may occur with little or no contribution by vapour immediately rising from the earth, it must yet be admitted, that some of the moisture, which forms during clear and still weather, on bodies situated upon or near its surface, is in most cases to be attributed to this source; since, in my experiments, substances on the raised board became much later moist than others on the ground, though equally cold with them. The quantity from this cause, however, can never be great. For in the first place, until the air be cooled by the substance attractive of dew, with which it comes in contact, below its point of repletion with moisture, it will be always in a condition to take up that which has been deposited upon grass, or other low bodies, by warm vapour emitted by the earth; just as the moisture formed upon a mirror by our breath is, in temperate weather, almost immediately carried away by the surrounding air. Accordingly; I have sometimes, in serene and still weather, observed dew to appear sparingly upon grass in the shade, several hours before sunset, and to continue in nearly the same quantity till about sunset, when it would increase considerably, at the time that the same fluid began to show itself on the raised board. In the second place; though bodies situated on the ground, after they have been made sufficiently cold, by radiation, to condense the vapour of the atmosphere, will be able to retain the moisture which they acquire by condensing the vapour of the earth; yet, before this happens, the rising vapour must have been greatly diminished, by the surface of the ground having become much colder. These considerations, added to the fact, that substances on the raised board attracted rather more dew, throughout the night, than similar substances lying on the grass, warrant me to conclude, that on nights favourable to the production of dew, only a very small part of what occurs is owing to vapour rising from the earth; though I am acquainted with no means of determining the proportion of this part to the whole. On the other hand, however, in a cloudy night, all the dew that appears upon grass may sometimes be attributed to a condensation of the earth's vapour; since I have several times, in such nights, remarked the raised board to be dry, while the grass was moist. These nights were calm, and evaporation from the grass consequently not copious. When evaporation on cloudy nights was assisted by wind, dew has never, as was mentioned in the first part of this Essay, been any where observed by me.*

* The interval between the first appearance of dew in the afternoon on grass in shaded places, and sunset, was formerly said by me, on the authority, however, of only a few observations, to be considerably greater than that between sunrise and the ceasing of the formation of dew upon grass in the morning. These ob-
Agreeably to another opinion, the dew found upon growing vegetables is the condensed vapour of the very plants on which it appears. But this also seems to me erroneous for several reasons. 1. Dew forms as copiously upon dead as upon living vegetable substances. 2. The transpired humour of plants will be carried away by the air which passes over them when they are not sufficiently cold to condense the watery vapour contained in it; unless, which is almost never the case if mist does not already exist, the general mass of the atmosphere be incapable of receiving moisture in a pellucid form. Accordingly, on cloudy nights, when the air, consequently, can never be cooled more than a little below the point of repletion with moisture, by bodies in contact with it, dew is never observed upon any plants that are elevated a few feet above the ground. 3. If a plant has become, by radiating its heat to the heavens, so cold, as to be enabled to bring the air in contact with it below the point of repletion with moisture, that which forms upon it, from its own transpiration, will not then indeed evaporate. But other moisture will, at the same time, be communicated to it by the atmosphere; and when the difference in the copiousness of these two sources is considered, it may, I think, be safely concluded, that almost the whole of the dew which will afterwards form on the plant must be derived from the air; more especially when the coldness of a clear night, and the general inactivity of plants in the absence of light, both lessening their transpiration, are taken into account.

An experiment however has been appealed to in proof, that the dew of plants actually does originate from fluid transpired by them; that, namely, in which a plant shut up in an air-tight case becomes covered with moisture. But this experiment, if attentively examined, will be found to have little weight. First; the inclosed plant being exempt from the cold which its own radiation would have produced in its natural situation, on a dewy night, will transpire a greater quantity of fluid than a similar plant exposed at the same time to the open air. Again; the small quantity of air contained in the case must soon be replete with moisture, after which, the whole of what is further emitted by the plant will necessarily assume the form of a fluid, whatever may be the condition of the external atmosphere; whereas, during even the clearest night, only a part of the smaller quantity of moisture, emitted by the exposed plant, will be condensed on its surface. In the last place; notwithstanding observations were made on spots exposed during the greater part of the day to the sun. In such places, the heat acquired, from the sun, by the uppermost layer of earth, will be longer retained than that acquired by the grass, which will, therefore, be sufficiently cool, soon after the heat of the day has declined, to condense a part of the vapour then copiously rising from the earth; whereas in the morning, both less vapour will rise, the surface of the earth having now lost a great part of its heat, and a less proportion of that which does rise will be condensed by the grass as the temperature of this body now more nearly approaches that of the ground, from first receiving the heat of the sun reflected from the atmosphere and other substances.
standing the circumstances which favour the appearance of moisture upon inclosed plants from their own transpiration, still the quantity observed on them is said to be, for I have made no experiment myself respecting this matter, much less considerable than what is seen upon plants of the same kind, exposed to the air for the same time, during a calm and serene night.

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PART III.

OF SEVERAL APPEARANCES CONNECTED WITH DEW.

There are various occurrences in nature which seem to me strictly allied to dew, though their relation to it be not always at first sight perceivable. The statement and explanation of several of these will form the concluding part of the present Essay.

I. I observed one morning in winter, that the insides of the panes of glass in the windows of my bedchamber were all of them moist, but that those, which had been covered by an inside shutter during the night, were much more so than others which had been uncovered. Supposing that this diversity of appearance depended upon a difference of temperature, I applied the naked bulbs of two delicate thermometers to a covered and uncovered pane; on which I found, that the former was $3^\circ$ colder than the latter. The air of the chamber, though no fire was kept in it, was at this time $11\frac{1}{2}^\circ$ warmer than that without. Similar experiments were made on many other mornings, the results of which were; that when the warmth of the internal air exceeded that of the external, from $8^\circ$ to $18^\circ$, the temperature of the covered panes would be from $1^\circ$ to $5^\circ$ less than that of the uncovered; that the covered were sometimes dewed, while the uncovered were dry; that at other times both were free from moisture; that the outsides of the covered and uncovered panes had similar differences with respect to heat, though not so great as those of the inner surfaces; and that no variation in the quantity of these differences was occasioned by the weather's being cloudy or fair, provided the heat of the internal air exceeded that of the external equally in both of those states of the atmosphere.

The remote reason of these differences did not immediately present itself. I soon, however, saw, that the closed shutter shielded the glass which it covered from the heat that was radiated to the windows by the walls and furniture of the room, and thus kept it nearer to the temperature of the external air, than those parts could be, which from being uncovered received the heat emitted to them by the bodies just mentioned.

In making these experiments I seldom observed the inside of any pane to be more than a little damped, though it might be from $8^\circ$ to $12^\circ$ colder than the general mass of the air in the room; while
in the open air I had often found a great dew to form on substances only 3° or 4° colder than the atmosphere. This at first surprised me: but the cause now seems plain. The air of the chamber had once been a portion of the external atmosphere, and had afterwards been heated, when it could receive little accession to its original moisture. It consequently required being cooled considerably, before it was even brought back to its former nearness to repletion with water; whereas the whole external air is commonly, at night, nearly replete with moisture, and therefore readily precipitates dew on bodies only a little colder than itself.

When the air of a room is warmer than the external atmosphere, the effect of an outside shutter, on the temperature of the glass of the window, will be directly opposite to what has been just stated; since it must prevent the radiation into the atmosphere of the heat of the chamber transmitted through the glass.

II. Count Rumford* appears to have rightly conjectured, that the inhabitants of certain hot countries, who sleep at nights on the tops of their houses, are cold during this exposure, by the radiation of their heat to the sky; or, according to his manner of expression, by receiving frigorific rays from the heavens. Another fact of this kind seems to be the greater chill, which we often experience upon passing, at night, from the cover of a house into the open air, than might have been expected from the cold of the external atmosphere. The cause, indeed, is said to be the quickness of transition from one situation to another. But, if this were the whole reason, an equal chill would be felt in the day, when the difference, in point of heat, between the internal and external air was the same as at night, which is not the case. Besides; if I can trust my own observation, the feeling of cold from this cause is more remarkable in a clear than in a cloudy night, and in the country than in towns. The following appears to be the manner in which these things are chiefly to be explained.

During the day, our bodies while in the open air, although not immediately exposed to the sun’s rays, are yet constantly deriving heat from them, by means of the reflection of the atmosphere. This heat, though it produces little change on the temperature of the air which it traverses, affords us some compensation for what we radiate to the heavens. At night also, if the sky be overcast, some compensation will be made to us, both in towns and in the country, though in a less degree than during the day, as the clouds will remit towards the earth no inconsiderable quantity of heat. But on a clear night, in an open part of the country, nothing almost can be returned to us from above, in place of the heat which we radiate upwards. In towns, however, some compensation will be afforded, even on the clearest nights, for the heat which we lose in the open air, by that which is radiated to us by the surrounding buildings.

To our loss of heat by radiation at times that we derive little

*Phil. Trans. 1804. p. 182.
compensation from the radiation of other bodies, is probably to be attributed a great part of the hurtful effects of the night air. Descartes* says that these are not owing to dew, as was the common opinion of his contemporaries, but to the descent of certain noxious vapours, which having been exhaled from the earth during the heat of the day, are afterwards condensed by the cold of a serene night. The effects in question certainly cannot be occasioned by dew, since that fluid does not form upon a healthy human body, in temperate climates; but they may, notwithstanding, arise from the same cause that produces dew on those substances, which do not, like the human body, possess the power of generating heat for the supply of what they lose by radiation or any other means.

III. I had often, in the pride of half knowledge, smiled at the means frequently employed by gardeners, to protect tender plants from cold, as it appeared to me impossible that a thin mat, or any such flimsy substance, could prevent them from attaining the temperature of the atmosphere, by which alone I thought them liable to be injured. But, when I had learned that bodies on the surface of the earth become, during a still and serene night, colder than the atmosphere, by radiating their heat to the heavens, I perceived immediately a just reason for the practice which I had before deemed useless. Being desirous, however, of acquiring some precise information on this subject, I fixed perpendicularly in the earth of a grass-plat, 4 small sticks, and over their upper extremities, which were 6 inches above the grass, and formed the corners of a square, the sides of which were 2 feet long, drew tightly a very thin cambric handkerchief. In this disposition of things, therefore, nothing existed to prevent the free passage of air from the exposed grass, to that which was sheltered, except the 4 small sticks, and there was no substance to radiate heat downwards to the latter grass, except the cambric handkerchief. The temperature of the grass, which was thus shielded from the sky, was upon many nights afterwards examined by me, and was always found higher than that of neighbouring grass which was uncovered, if this was colder than the air. When the difference in temperature, between the air several feet above the ground and the unsheltered grass, did not exceed 5°, the sheltered grass was about as warm as the air. If that difference, however, exceeded 5°, the air was found to be somewhat warmer than the sheltered grass. Thus, upon one night, when fully exposed grass was 11° colder than the air, the latter was 3° warmer than the sheltered grass; and the same difference existed on another night, when the air was 14° warmer than the exposed grass. One reason for this difference, no doubt, was that the air, which passed from the exposed grass, by which it had been very much cooled, to that under the handkerchief, had deprived the latter of part of its heat; another, that the handkerchief, from being made colder than the atmosphere by the radiation of its upper surface to the heavens, would remit

Meteorolog. c. vi.
somewhat less heat to the grass beneath than what it received from that substance. But still, as the sheltered grass, notwithstanding these drawbacks, was upon one night, as may be collected from the preceding relation, 8°, and upon another 11°, warmer than grass fully exposed to the sky, a sufficient reason was now obtained for the utility of a very slight shelter to plants, in averting or lessening injury from cold, on a still and serene night.

In the next place; in order to learn whether any difference would arise from placing the sheltering substance at a much greater distance from the ground, I had 4 slender posts driven perpendicularly into the soil of a grass field, and had them so disposed in other respects that their upper ends were 6 feet above the surface, and formed the angular points of a square having sides 8 feet in length. Lastly; over the tops of the posts was thrown an old ship flag of a very loose texture. Concerning the experiments made by means of this arrangement of things, I shall only say, that they led to the conclusion, as far as the events of different nights could rightly be compared, that the higher shelter had the same efficacy with the lower, in preventing the occurrence of a cold upon the ground, in a clear night, greater than that of the atmosphere, provided the oblique aspect of the sky was equally excluded from the spots on which my thermometers were laid.

On the other hand; a difference in temperature, of some magnitude, was always observed on still and serene nights, between bodies sheltered from the sky by substances touching them, and similar bodies, which were sheltered by a substance a little above them. I found, for example, upon one night, that the warmth of grass, sheltered by a cambric handkerchief raised a few inches in the air, was 3° greater than that of a neighbouring piece of grass, which was sheltered by a similar handkerchief actually in contact with it. On another night, the difference between the temperatures of two portions of grass, shielded in the same manner as the two above-mentioned from the influence of the sky, was 4°. Possibly, experience has long ago taught gardeners the superior advantage of defending tender vegetables, from the cold of clear and calm nights, by means of substances not directly touching them; though I do not recollect ever having seen any contrivance for keeping mats, or such like bodies, at a distance from the plants which they were meant to protect.

Walls, I believe, as far as warmth is concerned, are regarded as useful during a cold night, to the plants which touch them, or are near to them, only in two ways; first, by the mechanical shelter which they afford against cold winds, and secondly, by giving out the heat which they had acquired during the day. It appearing to me, however, that, on clear and calm nights, those on which plants frequently receive much injury from cold, walls must be beneficial in a third way, namely, by preventing, in part, the loss of heat, which they would sustain from radiation, if they were fully exposed
to the sky, the following experiment was made for the purpose of determining the justness of this opinion.

A cambric handkerchief having been placed, by means of two upright sticks, perpendicularly to a grassplat, and at right angles to the course of the air, a thermometer was laid upon the grass close to the lower edge of the handkerchief, on its windward side. The thermometer thus situated was several nights compared with another lying on the same grassplat, but on a part of it fully exposed to the sky. On two of these nights, the air being clear and calm, the grass close to the handkerchief was found to be 4° warmer than the fully exposed grass. On a third, the difference was 6°. An analogous fact is mentioned by Gersten, who says, that a horizontal surface is more abundantly dewed than one which is perpendicular to the ground.

IV. The covering of snow, which countries in high latitudes enjoy during the winter, has been very commonly thought to be beneficial to vegetable substances on the surface of the earth, as far as their temperature is concerned, solely by protecting them from the cold of the atmosphere. But were this supposition just, the advantage of the covering would be greatly circumscribed; since the upper parts of trees and of tall shrubs are still exposed to the influence of the air. Another reason, however, is furnished for its usefulness, by what has been said in this Essay; which is, that it prevents the occurrence of the cold which bodies on the earth acquire, in addition to that of the atmosphere, by the radiation of their heat to the heavens during still and clear nights. The cause, indeed, of this additional cold, does not constantly operate: but its presence, during only a few hours, might effectually destroy plants which now pass unhurt through the winter. Again; as things are, while low vegetable productions are prevented, by their covering of snow, from becoming colder than the atmosphere in consequence of their own radiation, the parts of trees and tall shrubs, which rise above the snow, are little affected by cold from this cause. For their outermost twigs, now that they are destitute of leaves, are much smaller than the thermometers suspended by me in the air, which in this situation very seldom became more than 2° colder than the atmosphere. The larger branches too, which, if fully exposed to the sky, would become colder than the extreme parts, are, in a great degree, sheltered by them; and, in the last place, the trunks are sheltered both by the smaller and the larger parts, not to mention that the trunks must derive heat, by conduction through the roots, from the earth kept warm by the snow.*

In a similar way is partly to be explained the manner in which

* It may be remarked here, however, that a thick covering of snow, while it renders the surface of the earth warmer than it would otherwise be, must occasion the lower atmosphere to be colder, by preventing the passage of the heat of the ground to the air, either by radiation or conduction.
a layer of earth or straw preserves vegetable matters in our own
fields from the injurious effects of cold in winter.

V. The bare mention of the subject of this article will be apt to
excite ridicule, it being an attempt to show in what way the expo-
sure of animal substances to the moon’s light promotes their putre-
faction. I have no certain knowledge that such an opinion pre-
vails any where, at present, except in the West Indies; but I con-
clude, from various circumstances, that it exists also in Africa, and
that it was carried thence by negro slaves to America. It was en-
tertained, however, by persons of considerable rank and intelligence
among the ancients; for Pliny* affirms it to be true, and Plutarch,
after making it a subject of discussion in one of his Symposia,†
admits it to be well founded.

As moonbeams communicate no sensible heat to the bodies on
which they fall, it seems impossible that they can directly promote
putrefaction. But still a reason for ascribing such a power to them,
may be derived from their being received by animal substances, at
the very time that a real, but generally unnoticed cause of putrefac-
tion in warm climates, (and it is in these alone the opinion I am
treating of has ever prevailed) is taking place, which ceases to act
as soon as the moon’s light is excluded.

The nights on which a steady moonshine occurs must necessarily
be clear; and nights which are clear are almost always calm.‡ A
moonshiny night, therefore, is one on which dew forms plentifully;
hence the expressions “rosaedia” and “rorifera luna” employed by
Virgil and Statius; and hence also an opinion held, as appears from
Plutarch, even by philosophers among the ancients, that the moon
communicates moisture to the bodies which are exposed to its light.§

Animal substances are among those which acquire dew in the
greatest quantity. To do this, indeed, they must previously become
colder than the atmosphere; but having acquired the moisture of
dew in addition to their own, they will on the following day be in
that condition which is known by experience to favour putrefac-
tion most powerfully in hot climates.

The immediate cause assigned here for the quick putrefaction of
animal substances, which have been exposed to the moon’s rays in a
hot country, is the same as that given by Pliny and Plutarch; but
they attributed the origin of this immediate cause, the additional
moisture, to the peculiar humefying quality which they supposed
that luminary to possess. This false theory has probably contri-

* Lib. ii. § civ.
† Lib. iii. Prob. x.
‡ Mr. De Luc has remarked, that clouds frequently disappear soon after sunset.
Idées sur la Meteorologie, i. 98. I have often observed this myself, and at the
same time another fact of which he takes no notice; namely, that the atmosphere
is then calmer than it had been before sunset. This calmness of the air very
commonly, if not always, precedes the dissipation of the clouds.
§ A kin to this opinion of the ancients respecting the humefying quality of the
moon, is one, which has been held by modern writers as well as ancients, upon
that planet’s being a cause of cold to the bodies which receive its rays; though
I know of no author who has taken notice of this affinity.
but did not discredit, with the moderns, the circumstance which it was employed to explain.

VI. The last fact of which I shall treat in this Essay, is the formation of ice, during the night in Bengal, while the temperature of the air is above 32°.

I have seen only two original descriptions of this process, both of which are contained in the Philosophical Transactions; the first by Sir Robert Barker, in the 65th volume; the other in the 83d, by Mr. Williams.

According to the method followed by Sir R. Barker’s ice-maker, square excavations 2 feet deep, and 30 wide, having been formed in a large open plain, their bottoms are covered with sugar-cane, or stems of Indian corn, dried to the thickness of 8 inches or 1 foot. On this layer, are afterwards placed in rows, near to each other, small unglazed earthen pans, \( \frac{3}{4} \) of an inch thick, and 1 inch and \( \frac{3}{4} \) deep, filled with boiled soft water. The pans are sufficiently porous to allow their outer surface to appear moist after water has been poured into them. Sir R. Barker adds; that the nights the most favourable for the production of ice, are those which are the calmest and most serene, and on which very little dew appears after midnight; that clouds and frequent changes of wind are certain preventives of its formation; and that, although ice is thus very readily procured by art in Bengal, during the winter, it scarcely ever occurs there naturally.

The process described by Mr. Williams must, from its extent, 300 persons being employed in it, have been carried on for profit, and would, consequently be conducted in the most economical manner. A piece of ground nearly level, containing about 4 acres, was divided into square plats, from 4 to 5 feet wide, which were surrounded by little mounds of earth 4 inches high. In these inclosures, previously filled with dry straw, or sugar-cane haum, were placed as many broad, shallow, unglazed earthen pans, containing unboiled pump water, as they could hold. The air was generally very still when much ice was formed; wind prevented its formation altogether. In the morning, between 5 and 6th., at which time alone Mr. Williams made his observations, a thermometer, with its bulb naked, placed on the straw, amidst the freezing vessels, was never found by him lower than 35°; and he has observed ice, when a thermometer so placed was 42°. Another thermometer, suspended 5½ feet above the ground, was commonly 4° higher than that among the pans. It is possible, therefore, that Mr. Williams may have seen ice a little before sunrise, when the temperature of the air was 46°. But granting this were the fact, it would not hence follow, that the ice was formed while the air possessed that heat. For although the air is generally held to be in all countries colder about sunrise than at any other time, I know from my own observations, that this is not always the case in England; and similar exceptions may occur in Bengal. Sir H. Davy has said, in his Elements of Chemistry, that ice will form in Bengal when the temperature of
the air is not below 50°; but he has given no authority for this assertion.

The formation of ice, in the circumstances which have been just mentioned, was attributed by Sir R. Barker altogether, and by Mr. Williams in great measure, to cold produced by evaporation. Sir R. Barker’s opinion has since been adopted by some of our most distinguished writers on Natural Philosophy, as Watson, Thompson, Young, Davy, and Leslie, apparently, however, without their having fully considered it, as I shall now attempt to show.

1. It is necessary for the complete success of the process, that the air should be very still; wind, which so greatly promotes evaporation, prevents the freezing altogether. Sir R. Barker admits, that the excavations in the earth are made to increase the stillness of the air in contact with the water in the pans; but, with the view to explain the utility of this stillness he supposes, in opposition to all experience, that water kept very quiet freezes more readily, when other circumstances are the same, than if it were a little agitated.

2. No proof is given, that evaporation from the pans actually does occur at the times which are the most favourable for the appearance of ice. At any rate it cannot be considerable; since agreeably to what is mentioned by Sir R. Barker, dew forms in a greater or less degree during the whole of the nights the most productive of ice; and it is not to be thought, as was said upon a former occasion, that one portion of air will be depositing moisture, from possessing a superabundance of it, while another in the immediate vicinity is receiving moisture in great quantity, in the state of pellucid vapour; as the latter fact can exist only when the air is far removed from a state of repletion with water.

3. If evaporation produced the cold under consideration, the wetting of the straw or other matter, upon which the pans are placed would tend to increase it; and, accordingly, Sir H. Davy affirms this to be the case. But Mr. Williams, who must here be regarded as the better authority says, that it is necessary to the success of the process that the straw be dry; in proof of which he mentions, that when the straw becomes wet by accident, it is replaced; and that when he purposely wetted it in some of the inclosures, the formation of ice there was always prevented. The reasons are clear. The water, by softening the straw, renders it easily compressible by the weight of the pans, and at the same time fills up what would otherwise be vacant spaces among its parts. The straw, therefore, in this condensed state, must afford a ready passage to heat from the earth to the pans, the hindrance of which is allowed by every person to be the use of it in this process when dry. Again; the moisture which passes through the straw to the earth it covers, will rise afterwards in the form of vapour, having the same temperature with the warm ground, and will communicate heat to the pans. In the last place; a part of this vapour will be condensed into water by the pans, in consequence of which heat must be extricated.
4. It is mentioned both by Sir. R. Barker and Mr. Williams, in support of their opinions, that the pans, when new, are so porous, that they readily permit water to transude them; and that old pans, which permit this in a less degree are less fit for the making of ice. But the argument, which is hence derived by them, is completely refuted by a fact related by Mr. Williams himself; for he says that the pans are greased before they are used, to prevent the adhesion of the ice to their sides; since, if this purpose be answered, the water can never be in contact with the pans, and therefore can never pass through them.

The real reason of the less fitness of old pans for the making of ice is perhaps the following. The production of the cold, which occurs in this process must take place in the water; since neither the straw upon which the pans are placed, nor the air above them, was ever found by Mr. Williams of so low a temperature as 32°. Whatever, therefore, obstructs the passage of heat from the straw to the water, must favour the freezing of the latter. But this will be less effectually done by an old than by a new pan, as the density of the former is greater, from the grease forced into it by rubbing, and from the slime and sand that will enter with the water into its pores, when these are not entirely closed by the grease which must often happen as the smearing is performed only once in three our four days. The difference, however, in effect betwixt old and new pans must be very small; as it does not appear that the old are ever laid aside on account of their unfitness.

In a like way may be explained, without the aid of cold produced by the evaporation of moisture from the outsides of the pans, another fact mentioned by Mr. Williams, that ice was often found by him in those vessels, while water contained in a china plate, surrounded by them had none; since the thin and dense substance of the plate must have transmitted more readily, than the thick and rare substance of the pans, the heat of the straw to the water.

5. In accounting for the making of ice in Bengal, it is requisite to show, not only how the first film is produced, but also in what way the thickness of this film is afterwards increased. If evaporation be the cause of this increase, it follows that a plate of ice in the night-time, and in the stillest air, both unfavourable to that process, must yet emit as much moisture, as is necessary for the production of a cold, according to Mr. Williams, of at least 14°, and according to Sir H. Davy of at least 18°; a conclusion, as it appears to me, of itself sufficient to destroy the credit of the theory from which it is drawn.

While attending to this subject, I became desirous of acquiring some knowledge of the degree of cold, which might be produced by evaporation from water contained in a shallow vessel. With this view I placed on a feather bed, situated between the door and window of a room in my house in London, two china plates, into one of which as much water was poured as covered its bottom to the depth of ¼ of an inch. The other plate was kept dry. The Oct. 1838.—X
bulb of a small thermometer being then applied to the inside of the bottom of each plate, I observed upon many days in various seasons of the year, the difference between these instruments while the door and window were open. I found in consequence, that when the temperature of the air in the room was 75°, the highest at which any experiment was made, the thermometer in the plate, containing water, was between 6 and 7 degrees lower than the one in the dry plate; that the difference between these thermometers diminished gradually as the air became colder; and that when the temperature of the air was 40°, the lowest for which I have any observation, the difference was only 14°. At 32°, therefore it would have been very small, and at a few degrees below 32 it would probably have vanished. This supposition agrees with an observation made by Mr. Wilson of Glasgow, who found that no cold was produced by evaporation from snow possessing a temperature of 27°, though the air in the immediate neighbourhood was purposely much agitated by him.

The conclusions here given by me, respecting the cold produced by the evaporation of water, were drawn from experiments made in the day, while the sky was clear, the air very calm, and the temperature of the atmosphere stationary. At night and during a cloudy day, the differences were less. On the other hand, if there was any perceptible motion in the air, they were greater. They were also greater if the heat of the atmosphere was increasing; but less if this was decreasing.

Having thus, I think, placed beyond doubt, that the formation of ice in Bengal is not occasioned by evaporation, I shall now state several reasons, which have induced me to believe, that it depends upon the radiation of heat to the heavens.

1. This cause not only exists, but exists in a degree sufficient for the production of the effect which I attribute to it. For Mr. Wilson found the surface of snow, during a clear and calm night, to be 16° colder than air 2 feet above it, the temperature of the latter being taken by a naked thermometer; whereas the greatest heat of the atmosphere ever observed by Mr. Williams, at the distance of 5½ feet from the ground, during the time that he supposed ice to be forming, was only 14° higher than the freezing point of water. I need say nothing of the difference of 18° related by Sir H. Davy, as he does not speak from his own observation, and as he gives no authority for what he advances; though even this difference is considerably less than what I have attempted to show must sometimes occur from the radiation of heat at night, between the temperature of air a few feet above the earth and that of bodies placed on its surface.

It is to be mentioned here also, that, according to Mr. Leslie,* the power of water to radiate heat exceeds, perhaps, that of all other substances.

2. Ice is chiefly formed in Bengal during the clearest and calmest

* On Heat, p. 80.
nights: and it is on such nights that the greatest cold, from radiation, is observed on the surface of the earth. In Sir R. Barker's more refined mode of conducting the process, an unusual stillness of the air, in contact with the water to be frozen is procured, by placing the pans containing it a little below the level of the ground, in which situation, it was formerly shown, bodies must grow colder from radiation to the heavens at night than in any other.

3. The cold, by means of which ice is produced in Bengal, appears, as I think may be inferred from what is said by Sir R. Barker, in its greatest degree, like cold from radiation in other substances, on those still and serene nights, during which little dew is deposited by the atmosphere.

4. Clouds and wind prevent the formation of ice in Bengal; and the same states of the atmosphere either prevent, or considerably diminish the occurrence of cold from the radiation of heat at night by bodies on the ground.

I shall close this subject, by giving some account of a few attempts to procure the freezing of water at night in this country, by exposing it to air of a temperature higher than that of 32°. These were made by me in 1812, at my usual place of experiment, which was formerly stated to be not well adapted for the appearance of a great cold from radiation, and on nights not among the most favourable to such an undertaking, even of those which occur in this country. It is proper also to mention, that I was then less able to conduct such experiments, and to make use of them, than I afterwards became from a longer attention to similar objects.

EXPERIMENT I.

With a view to imitate the method of making ice described by Sir R. Barker, I had a pit dug, on the evening of the 3d of May, in the middle of the garden so often spoken of, 4½ feet long, 3 wide, and 2 deep. It consequently had the same depth as the excavations mentioned by that gentleman, but was considerably less in its other dimensions. Clean dry straw was then strewn, to the height of a foot, over the bottom of the pit. On the straw were next laid a number of small shallow earthen pans, a part of which were glazed, and a part unglazed. In the last place; all the pans were filled with soft water, which had been boiled on the same evening. Contrary to my expectation, the unglazed pans remained as dry on the outside, after water had been poured into them, as those which were glazed. I conclude, therefore, that the former were more dense in their substance, than the unglazed pans used in India; and that their density was probably the reason, why ice did not afterwards form in them sooner than in the glazed pans which were employed by me.

Two pans, containing boiled water, were set upon the grassplat,
at a little distance from the pit. A watch-glass filled with boiled water was also placed upon the grassplat, and another was laid upon the raised board, which had been thinly covered with sand. All these arrangements were not completed before 10 h. at night.

At 1 h. in the morning, ice appeared in the watch-glasses on the grassplat and raised board; the heat of the air, as measured by a naked thermometer, being then, at 4 feet above the ground, 394°, and at 7 feet, 403°. At 2 h. ice was observed in the pans in the pit, while a thermometer in the air, 2½ feet above the ground, was 364°. Shortly afterwards, ice began also to form in the pans upon the grassplat. The temperature of grass fully exposed to the sky, was at the same time 30°, while that of the earth an inch below the bottom of the grass was 45°. During the time of these observations, dew formed copiously.

EXPERIMENT II.

My next attempt was in the manner mentioned by Mr. Williams. On the evening of the 22d of May, I encompassed a square piece of level ground, the sides of which were 3 feet long, with a border of earth 4 inches high, and filled the area with dry straw. On this were placed several of the earthen pans, which had been formerly used, and a few smaller vessels, all containing unboiled water. After an exposure of little more than an hour, water in a watch-glass upon the straw was found frozen, the temperature of the air, 2 feet above the straw, being then 37°. In half an hour more, ice began to appear in the earthen pans, while a thermometer 5½ feet above them, this being the height at which Mr. Williams used to suspend his instrument, was 36°. The air soon after became colder; but its temperature was never less than 33°, though taken by a naked thermometer, which, as was before said, upon a clear and calm night, occasions the air to seem about 2° colder than it really is.

It might be inferred, from what is mentioned by Mr. Williams, that the temperature of the straw beds, on which the ice-pans were set at Benares, was always found by him above the freezing point, for this reason, that the straw, from containing no moisture, could not, like the water, grow cold by evaporation. I had, therefore, been surprised, during the first experiment, for I had then but little acquaintance with the phenomena of cold observed with dew, that a thermometer, laid upon an exposed part of the straw, was always below the freezing point, after ice had begun to form in the pans. On reading, however, his account of the process a second time, with increased attention, my wonder ceased. For, as the pans he speaks of were large, and touched one another, and as all the pans employed in India, for the making of ice, widen as they rise from the bottom, like our milk-pans, the thermometer placed by him on the straw must have been secluded from all view of the
sky, and would therefore mark a temperature much higher than if it had been laid, as in my experiment, upon straw fully exposed to the heavens. On this, the second night, therefore, I placed a thermometer under the edge of one of the pans lying on the straw bed, and found it some time afterwards 6° higher than a similar instrument upon a part of the straw bed which was uncovered. Generally, however, the difference was not so great. If my pans had been large, like those of Mr. Williams, I should, no doubt, have observed more considerable differences; for, in consequence of their smallness, I could not lay a thermometer on the straw bed, so as to be fully screened from the sky by the edge of any of them, without its being almost in contact with the vessel, every part of which was always colder than the sheltered straw.

Much dew formed in the course of this night. The greatest difference marked by me, during it, between the temperatures of grass and of air, was 6°; and between those of air and a fully exposed part of the straw bed 9°.

EXPERIMENT III.

This was begun on the evening of the 16th of October, and was likewise made agreeably to the method related by Mr. Williams.

Ice appeared in the pans, when the temperature of the air, at the height of 5½ feet, was, according to the naked thermometer, 37°.

On this night, I placed upon the straw bed a dry earthen pan, among those which contained water, and found the inside of its bottom to be as much colder than the air as the water was in the other pans, before ice appeared in them. After the water had begun to freeze, no proper comparison could be made between its temperature and that of the empty pan. This pan, in the course of the night, attracted moisture, which was afterwards converted into a film of ice.

But the chief fact established by the present experiment was, that water may freeze at night, in air of a temperature higher than 32°, not only without any loss of weight from evaporation, but with a gain of weight from an opposite process. I had observed that water, exposed early in the evening in the open air to the sky, lost a little weight, in the course of a clear night. This I imputed to evaporation taking place before the water had been cooled enough to condense the vapor of the atmosphere, and to the weight gained afterwards being insufficient to compensate the previous loss. I exposed, therefore, on this night, water to the influence of the sky, until it was cooled to 34°. Of this I put 2 ounces into each of two china saucers, which had also been exposed to the air, and then placed the saucers upon the straw bed. In the morning a thin cake of ice was found in both saucers, one of which had gained 2½, and the other 3 grains, in weight. Dew was also
copious on this night. At one time, grass was 94°, and the exposed part of the straw bed 12°, colder than the air.*

It must be evident to every person, that the formation of ice, in the three preceding experiments, was the effect of a natural operation, similar to that by which the same substance is produced in Bengal. These two facts must, therefore, have a common cause, and this has been shown, by the last experiment, independently of what was said before in this Essay, not to be evaporation. It is also clear, that the cold induced on the water in those experiments, had a common cause with that observed at the same time upon the grass and the straw; which latter cold must, in consequence of proofs formerly given, be admitted to have arisen from the radiation of the heat of those substances to the heavens. A necessary inference, therefore appears to be, that the formation of ice, in Bengal, in the circumstances described by Sir R. Barker and Mr. Williams, must likewise be attributed in far the greater measure, if not altogether to a loss of heat, which the water suffers by its own radiation, while situated in such a manner, that it can receive little heat from other bodies, either by radiation or conduction.†

CONCLUSION.

The experiments which were made by me on dew, and other subjects treated of in the preceding Essay were unavoidably attended with many inconveniences, which were the more felt, as my health had long been feeble, and as my professional duties obliged me often to return to London in the morning, without having previously taken rest, after the whole of a night having been spent in attending to the objects of my pursuit. The inconveniences here

* The greater cold, observed in this and the preceding experiment, upon straw than upon grass, is to be referred to the shortness of the latter, by reason of which heat was readily communicated to its upper parts by the earth.
† On the evenings preceding the nights during which ice is produced in Bengal, the temperature of the water exposed in the pans is, probably, often 60° or more. But water of the heat of 60°, if exposed in a shallow earthen vessel to air of the same temperature, during the day, while the weather is calm and clear, will lose about 3° of heat by evaporation. A cold from this cause may, therefore, concur with that from radiation, and, consequently, may, in Bengal, accelerate somewhat the formation of ice. The influence, however, of evaporation there, in this respect, should the state of the air with regard to moisture still permit it, which must often not be the case while dew is forming, will, as the night proceeds, gradually diminish, and at length almost disappear, before the freezing of the water commences; since I have lately shown, that evaporation from water of 32° produces very little cold, even in the day-time. Indeed, it seems to me much more probable, that on a clear and calm night, though in a dry winter of Bengal, water, at the temperature of 32° will acquire warmth from the formation of dew upon it, than that it will become cold from evaporation.
alluded to were indeed so great, that I was twice or thrice obliged to intermit my labours for several months together, and at length found it necessary to cease from them entirely, before I had nearly completed the plan which I had formed. I take the liberty of mentioning these things, to excuse in part the imperfections which will be observed in what I have written, as some of them would, no doubt, have been removed by a further interrogation of Nature.

THE END.
[Philadelphia, November, 1841.]

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