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BY

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TABLE OF CONTENTS

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ORIGINAL COMMUNICATIONS.

ARTICLE I.—*An account of the Vegetable Alkalies, including their Therapeutic action when applied internally, or by the Endermic Method.* By ROBERT PETER, M. D. of Lexington Kentucky.*

AMONG the improvements which the researches of philosophers have, during the last thirty years, introduced into the sciences of chemistry and medicine, few perhaps are of greater importance than the discovery, and the application to the cure of diseases of the new alkaline bodies, called now the Vegetable Alkalies. In the days of our fathers in chemistry very little was known of those principles, or constituents, of vegetable substances, on which their active properties depended. Some of the proximate elements of vegetables must have been known at a very early period; such, for example, as were very obvious, or which were easily separated, as sugar, starch, gum, resin, &c.; but the means of analysis used in those days were but little calculated to throw much light on the subject of vegetable chemistry. Vegetables were introduced into a retort, heat was applied, and the products of the process were condensed in a receiv-

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er. These, of course, were water, empyreumatic oil, and in some cases, ammonia; and in the retort there remained more or less carbon. The gaseous products were not collected, for in those days the idea of coercing or examining *air* had not entered the brain of the philosopher. Thousands of plants were subjected to this ordeal, by some of the industrious eperimenters, with so little difference in the results, that they could not, by this means, distinguish the rank and poisonous Hemlock from the bland and innocuous Cabbage.

Later years have brought with them the knowledge of the art of examining and separating, without destroying, the proximate elements of vegetable substances. To the French chemists we are indebted, more than to any others, for the light thrown on this interesting department of nature, although those of the other nations of Europe, and even of America, have contributed to the mass.

The term alkali has been applied for a great length of time to those bodies which possess the property of uniting with acids, so as to destroy, or neutralize, their acid properties, and of forming compounds with them, called salts: this is the most important distinctive character of an alkali. Another property which they all possess, is that of changing delicate vegetable blue colours, such as that of violets, to green. They all dissolve in water and in alcohol, and this character is sufficient to distinguish them from another set of bodies, called alkaline earths, such as lime, barytes, &c., which, though they neutralize acids, and form salts with them, and change vegetable colours as the alkalies proper do, yet are sparingly soluble in water, or in alcohol.

Until the year 1816, when Sertuerner announced the discovery of morphine, the existence of but three alkalies proper was known, viz. soda, potash and ammonia. The former was denominated mineral alkali, the latter volatile alkali; and potash, because it was obtained only from the ashes of burnt vegetables, was called *vegetable alkali*. The newly discovered alkalies possess no other analogies with the old alkalies proper than those of their solubility in alcohol, their reaction with acids and with vegetable blues, as will presently be seen.

Chemists had been so long accustomed to believe that there was but one vegetable alkali, that when others were presented, even to their senses, the lapse of some years was required to familiarize them to the unexpected discovery. Thus, in 1803 M. Derosne, apothecary of Paris, in the course of some experiments on opium, separated a white crystalline substance, of which he remarks, "*its solution changes the blue colour of syrup of violets to green*," a known property of the alkalies; yet the observation of this reaction did not suggest to him the probability of its real nature, nor did it induce him to extend his researches. He was thus on the very threshold of a most brilliant discovery, the promulgation of which was reserved for another more fortunate enquirer, Sertuerner, who, though he asserts that he made the discovery about the same time,* did not venture to announce the existence of a new vegetable alkali until thirteen years afterwards.

Vauquelin, in 1808, while analyzing several plants of the genus Daphne, (D. thymelea, D. alpina, and D. gnidium,) discovered a substance which he described as follows; "very volatile; *acts on vegetable colours like the alkalies.*" About sixteen years afterwards, when publishing an account of the same substance, as a new vegetable alkali, by the name of Daphnine, he adverted to this circumstance, adding, that as at the time of his previous publication, "the existence of an alkali of a vegetable nature was not known, I did not venture to affirm that it really was a vegetable alkali."

The attention of philosophers was first aroused to this subject by the announcement of the discovery of a new alkali in opium by Sertuerner, in 1816. The discovery was soon confirmed by Robiquet, but so great an apathy existed in the minds of chemists relative to this subject, that but little notice was taken of the matter until two years afterwards, when Pelletier and Caventou, attracted towards it and them

* Seguin also discovered and described it about the same time (1804,) but did not venture to call it an alkali. Ann. de chemie, 92.

selves the general attention of the scientific, by their many interesting discoveries in this department of research.

If we scan over the chemical history of the period from the time of the researches of Derosne to that of the discoveries of Pelletier and Caventou, wə can easily account, in part, for the little attention which was paid to this subject, especially by the British philosophres. We shall see that Wollaston was commanding an engrossing homage by his discovery of platinum and its associate metals; and that his illustrious cotemporary, Davy, was changing the very face of the science of chemistry by the discovery of the metallic bases of the old alkalies and earths, and by his researches into the nature of chlorine, &c. Iodine also, was discovered in this period, with many other important facts and substances.

Sertuerner, pharmaceutist of Eimbeck, Hanover, was the first to announce positively the existence of an organic vegetable alkali; which he obtained from opium, and which he said, was the efficacious part of that drug. His process for obtaining it was to make a solution of opium in distilled water, and to supersaturate the solution with ammonia, which threw down a greyish white precipitate: this collected and washed with water, was the impure alkali, which he purified further by washing in cold aq. ammonia, and subsequent solution in diluted sulphuric acid, precipitation by ammonia, and cold alcohol.

To ascertain the medical properties of this new substance, he tried its effects upon himself and three other persons, young gentlemen of his acquaintance. They each took half a grain dissolved in alcohol and diluted with water. General redness, even in the eyes, covered the whole body, particularly the cheeks; and the animal powers seemed to be raised. Half an hour afterwards, another half grain was taken by each, by which the effects were considerably increased, and a transitory inclination to vomit, and a stunning sensation in the head were felt. A quarter of an hour afterwards another half grain was administered: the young men instantly felt acute pains at the stomach, with a sense of weakness, general stiffness, and faintness. He himself felt similar sensations, and on lying down, fell into a dozing reverie attended with a throbbing in the extremities. Being now somewhat alarmed for the consequences, they each took six or eight ounces of strong vinegar, which caused vomiting and ended the experiment.

The physiological properties of this substance were studied more at length two years afterwards, by Magendie and Orfila, and they and others have since contributed to make them fully known.

No one, according to the strict logic of science, can deny, that Sertuerner was the first who discovered the *alkaline* principle of opium; yet an examination of the account of the experiments of Derosne, published thirteen years before, will leave a conviction that he separated and examined the very same substance, although he was not so fortunate as to prove its alkaline nature, nor to discover that it was the active principle of the drug.

In the paper published by M. M. Derosne and Proust, published in the Annals de Chemie, tom. xlv. 1803, we find the following observations, which plainly show that Derosne had discovered the substance called by Sertuerner morphium, although he (Derosne,) did not distinguish it from another substance discovered at the same time, and known for a long time as "salt of Derosne," now, narcotine. "Caustic and carbonated alkalies produce a copious precipitate in the aqueous solution of opium." M. Proust considered this precipitate a pure resin, but Derosne thought it a compound body. He obtained it as follows; he precipitated it from a solution of opium in six parts of water, by carbonate of potash. Boiling alcohol took up three-fourths of this precipitate, and acquired a dark red colour, and the filtered alcoholic solution yielded, on cooling, a reddish irregular crystallization. This, as I have before intimated, he supposed to be the same as the salt which he had obtained (now known as narcotine) by spontaneous granulation, on evaporating the aqueous solution of opium to the consistence of syrup and diluting it again with water. He remarks, however, "that it showed some difference, arising from the manner of obtaining it. Its taste is a little bitter, (the other was tasteless,) and it does not crystallize so regularly; its *solution changes the blue colour of syrup of violets to green.* It is soluble in alcohol, and its solution is not rendered turbid by the addition of water, but after a short time small crystals appear in the liquid."

It must be evident to every chemist, that in this substance, M. Derosne had actually discovered one of the active principles of opium, morphine. His conclusions from his own experiments were, however, unphilosophical. They were as follows; that opium was a very compound substance, that it contained a *narcotic volatile* principle, extractive matter, mucilage, resin, oily matter resembling wax, a *crystalline substance which is neither saline nor acid*, a substance similar to albumen or gluten, a small quantity of caoutchouc, &c.

In February, 1817, M. M. Pelletier and Magendie, in a paper to the Royal Academy of Sciences, Paris, announced that another vegetable alkali had been discovered, by the former gentleman, in the various kinds of ipecacuanha of the shops, which he called *emetine;* and which, from the experiments of the latter, M. Magendie, an account of which was appended, they asserted to be the active principle of that root.

The next discovery of a vegetable alkali was by Pelletier and Caventou, who separated it from the nux vomica, and from the products of the other plants of the genus strychnos. In their paper, read to the Acad. Nat. Sciences, Aug. 10, 1818, they called the alkali Vaqueline, in honour of that distinguished chemist, who had been their preceptor; but on reflecting that the name which they respected so highly ought not to be connected with a substance of so poisonous a nature as their new discovery was, they changed it to strychnine.

About the same time, M. Boullay announced the discovery of a new alkaline principle of a poisonous nature, in the Cocculus Indicus, (seeds of the menispermum cocculus,) which he called picrotoxine, from the circumstance of those seeds having been used to poison fish. In the same year, M. M. Pelletier and Caventou again appeared before the public with two new alkalies, obtained from peruvian bark, called by them cinchonine and quinine. In their memoir they acknowledge that the former principle had already been detected by M. Gomez of Lisbon, but state that he had neither ascertained its alkaline nature nor studied its combinations with acids; and that in a more recent memoir than that of Gomez, by M. Laubert, it was regarded as a pure crystalline resin; so that little attention had been paid to it by chemists. They justly claimed all the credit of the discovery of quinine.

Peruvian bark, since its introduction into medicine, has been the subject of much chemical research; and the history of the examinations which it has undergone with a view to discover its nature, is interesting on more accounts than one—affording, among other things, another evidence how near a person may approach to the discovery of an important fact without actually making it.

Dr. Maton was the first to point out the fact that an infusion of galls caused a precipitate in the infusion of Bark. M. Seguin, having at a later period discovered that gelatine was precipitated by the tannin of the infusion, affirmed that gelatine was the active principle of the peruvian bark, and instituted a number of experiments to prove that gelatine possessed all the febrifuge properties of that substance. Andrew Duncan, Jr. in Nicholson's Journal, Dec. 1803, attempts to prove that the substance in the bark, which is precipitated by infusion of galls is not gelatine, because it dissolves in alcohol, which gelatine does not; and calls this peculiar principle cinchonine. He found that it was precipitated also by carbonate of potash; and proceeding on the vague idea that every substance which was precipitated by galls and carb. potash, was cinchonine, he stated that that substance exists also in ipecacuanha, columbo, augustura, black and cayenne pepper, and opium. He evidently knew but little of the substance which he named, and did not separate nor obtain it pure. Vauquelin, a few years afterwards, discovered the same substance, but did not obtain it pure; for in his account of it, in the Med. and Surg. Review, xv., 12,—he describes it as being of a " brown colour, bitter taste, less soluble in water than in alcohol, precipitating tart. emetic, but not glue."

Dr. Bernardinus Anthony Gomez, of Lisbon,* seems to have been more successful in his researches, and to have actually obtained cinchonine in a pure state. The process by which he obtained it was as follows, and is very similar, in many respects, to some processes used even at the present day. He made a spirituous extract of bark of the common consistence, which he mixed with distilled water and strained. The aqueous solution was evaporated to the consistence of an extract, and successive portions of a well saturated solution of potash were added until every thing soluble in that menstruum was removed: the residuum was washed in cold water and dried. It was a white powdery substance, easily separated from the filter, bitter, inflammable, very little soluble in water, but soluble " enough, when recently prepared, in sulphuric ether, alcohol, diluted sulphuric, nitric and muriatic acids: in acetic, oxalic, citric, *malic?* but not in tartaric acid?" From these solutions it was precipitated by infusion of galls. This substance was undoubtedly a mixture of cinchonine and quinine; but although Gomez discovered that it *dissolved* in diluted acids, he did not ascertain that it neutralized them. He did not obtain any salt but the sulphate, nor did he guess that it was an alkaline body.† He obtained cinchonine in crystals by dissolving it in alcohol and allowing that substance to evaporate spontaneously. He found some difference in it according to the kind of bark employed; owing, no doubt, to the different proportions in which cinchonine and quinine exist in the several kinds. The inferences which he drew from his ex-

* Edinburgh Med. and Surg. Jour. Oct. 1811, vii. 420 from 3d vol. Memoirs of Royal Acad. Sc. Lisbon.

† The alkaline properties of cinchonine are said to have been first discovered by Labillardiere, nephew to the celebrated navigator.

periments were, that this substance was a pure vegetable principle; that it had some analogy to resin, but differed from it by its crystallization, and its solubility in acids; that by these last properties, it was analogous to camphor, but that it differed in being inodorous, in being precipitated from solution by alkaline salts, in its greater specific gravity, (as it sinks in water,) in giving a precipitate with galls, &c. He inferred that this substance was the febrifuge principle of bark, and hence recommended testing bark with infusion of galls to ascertain its medicinal value.

The experiments of Dr. Van Smissien upon bark, in the laboratory of Pfaff at Kiel, and with his assistance, an account of which was the subject of his inaugural thesis in 1813, threw no new light upon the subject, but rather tended to darken and confuse it.

The members of the medical profession were not long in appreciating the value of the discovery of Pelletier and Caventou. The celebrated Martinet, residing near Pisa, Italy, used the sulphate of quinine as early as the year 1821–2, in doses from three to eighteen grains, with very great success, in the intermittents of that marshy and pestilential country; and several other medical men on the continent had already introduced it into their practice: among them we may mention M. Dupré of Yonne, Dr. F. Ribes; M. Bailly (La Pitié, Paris.) Mr. Miles; Mr. Bushnel, London; John O'Brien, M. D. Dublin, &c.

Dr. Gunther of Cologne, in the Journal der. Pract. Heilkunde, 1826, gives an account of a number of experiments, instituted with a view to ascertain the comparative effects of the alkaline principles of bark and the bark itself. The results of his experiments, which have now stood the test of some years, are as follows:

1. That cinchonine and quinine are preferable to the bark in most cases.
2. That quinine is preferable to cinchonine, and is best in the state of sulphate.

3. That the sulphate of quinine acts more promptly, succeeds oftener, and is less followed by relapses than bark.
4. That it fatigues the digestive organs less; and may be administered in cases where it is necessary to carry the doses very high in a little time.

M. Gunther believed, however, that the bark is preferable when a durable tonic effect is required, to strengthen a weakened constitution, for example, in convalescents.

M. M. Pelletier and Caventou, in a communication to the Academie Royale de Paris, 1826; when a prize was awarded to them for the greatest discovery in medicine, state, that although the sulphate of quinine was at first prepared by themselves solely, it soon began to be prepared in large quantities, in all the other chemical works. That in two manufactories, that of M. Pelletier and that of M. Le Vaillant, during the past year, the quantity of bark used was 1593 quintals; and that taking for an average product, three drachms of sulphate of quinine for a pound of bark, the quantity of 59,000 ounces of sulphate had gone out of these two manufactories alone. They estimated, approximately, the quantity prepared by the other French chemists at 31,000 ounces; giving in all, the immense amount of 90,000 ounces prepared by the French chemists, in one year, seven years after its discovery. This, they stated, had been sent into all parts of Europe, and to America. Italy being then the only country where it was made in proportion to the wants of the population.

These distinguished chemists did not rest from their researches on the discovery of the alkalies of bark: in the succeeding year, 1819 they detected two others; one in the bark of the false angustura, which they called brucine;* and the other in the Veratrum album, the V. sabadilla, and in the colchicum, which they denominated veratrine. In July of the same year, a new alkali was discovered in the seeds of the Delphinium staphisagria, by M. M. Lassaigne and Fen-

*Journal de Pharmacie, Dec. 1819.

culle, which was also discovered about the same time by Brandes of Germany.

Rudolph Brandes, in connection with M. Miessner, was very assiduously engaged, about this period, in the examination of many of the narcotic plants, with a view to discover their active principles. In a paper which he published in 1825, (Jour. der. pract. Hielkunde,) he states that he has been occupied with these researches for six years, and that he had succeeded in the discovery of delphine; of daturine in the Jamestown weed; of hyosciamine in the henbane; atropine in atropa belladonna; conicine in the poisonous hemlock, &c. The examination of these very poisonous principles required very great circumspection; the vapours of some of them were particularly prejudicial to the eyes, and the smallest quantity placed upon the tongue proved dangerous. "The odour of these substances," he adds, "is very repulsive, especially that of conicine; two grains of the etherial solution of which was sufficient to render the air of a room insupportable; and an atom of their etherial solution, or the prolonged action of their emanations, cause a dilation of the pupils of the eyes which lasted several days." His health was so much injured by the action of these bodies, that he was unable at that time to give a full account of his discoveries; of which so little even now is known, that others are appropriating them to themselves.

From the year 1819 until the present time, the progress of the discovery of vegetable alkalies has been onward; but to avoid being tedious, I will not enter any further into chronological details. The number at present known exceeds thirty, and it is highly probable that it will be much increased. For the discovery of those already known, we are indebted principally to the French and Germans, especially the former. American chemists have contributed some two or three, for example, sanguinarine by Dana, cornine by Carpenter, &c. I cannot find that the British chemists have added a single one.

In giving this estimate, I exclude all those principles, which are not of an alkaline nature, as piperine, salacine, &c., which are fully as numerous as the alkalies.

It will not, perhaps, be amiss to subjoin in this place, a catalogue of the alkalies now known, according to the best information I can obtain.

Morphine, } Narcotine, }	from	opium.
Strychnine,	"	nux vomica.
Brucine,	"	false angustura.
Cinchonine, } Quinine, }	"	peruvian bark.
Veratrine,	"	white hellebore, &c.
Emetine,	"	ipecacuanha.
Delphine,	"	seeds of stavesacre, (delphinum staphisagria.)
Solanine,	"	berries of solanum nigrum.
Corydaline,	"	root of fumaria bulbosa.
Nicotine,	"	tobacco, nicotiana tabaca.
Curarine,	"	S. American poison, curara, or woohrara.
Picrotoxine,	"	the coculus indicus.
Violine,	"	roots of some species of violet.
Daphnine?	"	mezereon,
Paralline, } Smilacine, }	"	roots of the sarsaparilla.
Cynapine,	"	æthusa cynapium.
Sanguinarine,	"	roots of sanguinaria canadensis.
Guaranine,	"	fruit of paullinia sorbilis.
Esenbeckine,	"	esenbeckia febrifuga.
Crotonine,	"	seeds of the croton tiglium.
Buxine,	"	wood of buxus sempervirens.
Atropine,	"	atropa belladonna.
Eupatorine,	"	eupatoria cannabina.
Daturine?	"	datura stramonium.
Hyosciamine,	"	hyosciamus niger.
Conicine,	"	conium maculatum.
Cornine?	"	bark of cornus florida.
Illicine?	"	illex aquilifolia.
Digitaline?	"	digitalis purpurea.
Aconitine?	"	aconitum napellum.

According to the strict nomenclature of chemistry the termination of the names of the vegetable alkalies should be in *ia*, as morphia, emetia; but as when this termination is adopted, there is little difference, in many cases, between the name of the alkali and that of the vegetable from which it is obtained, mistakes, dangerous in their consequences, might easily be made, it is thought preferable to retain the termination *ine* first given to these bodies.*

General remarks on their Chemical Characters, and mode of Preparation.—To enter into all the details of the properties and mode of preparation of each of the vegetable alkalies would not only be irksome, but would extend this essay to too great a length. I shall, therefore, only attempt to give some general ideas on this portion of the subject.

These substances are, for the most part, solid; and many are crystalline. Nicotine and conicine, however, are remarkable exceptions; the former being a liquid even at the temperature of 21° Fah., and the latter, according to Geiger,† is a yellowish oil. Most of the vegetable alkalies, when pure, are white; emetine and buxine, however, are brownish; corydaline, greyish; curarine, yellowish; and esenbeckine, of the colour of the dove's neck. Their taste is generally extremely bitter; some, however, owing to their insolubility in the saliva, are tasteless, for example, narcotine and corydaline, but their salts are all strongly sapid. The taste of veratrine, nicotine, daphine and conicine, is strongly acrid and disagreeable.

The intensity of the sapidity of some of these bodies is almost inconceivably great. Thus, one grain of strychnine will communicate a marked bitter taste to 600,000 grains of water; and 10,000 grains of water are rendered acrid by

* During the past summer the writer made an imperfect examination of the *Lobelia inflata*, with a view to ascertain the existence of an active alkaline principle in that very acrid plant. One thousand grains were boiled in water, rendered slightly sour by pure sulphuric acid, and the clear decoction was boiled, with an excess of magnesia, in a retcrt to which a receiver was attached. Nothing but water passed into the receiver, proving that the alkali, if any was present, was not similar to nicotine. The remaining magnesia, separated, washed and dried, afforded to boiling alcohol, (which he had taken pains to render pure,) a principle which readily and decidedly converted the blue of red cabbage to green, and which had the taste of the Lobelia. It was, however, in such a minute quantity that any other of its properties could not be ascertained. He hopes, by operating on larger quantities of the plant, hereafter, to establish fully the existence of *lobeline*.

† The conicine of Brandes is a solid.

the addition of one grain of nicotine, and 1,000 grains, by one of veratrine.

Most of them, though so powerfully sapid, are destitute of any sensible odour. Some few have the characteristic odour of the plant from which they are obtained; that of nicotine is highly pungent and disagreeable, like that of dried tobacco. Conicine has also the peculiar heavy, nauseous, smell of the hemlock; and daphine a pungent odour.

By the application of a sufficient heat, in close vessels, they are all decomposed, giving rise to the same products as all the other vegetable substances which contain nitrogen. In the open air they take fire and burn. Nicotine is particularly combustible. When heated gradually, some of these bodies present some analogies to the resins.

Morphine, on being heated carefully in a glass tube, melts into a yellow liquid, like melted sulphur, which, on cooling, becomes a crystalline solid. Narcotine melts like tallow, and congeals on cooling into a translucent mass. Brucine fuses at about 212°, and becomes like wax on cooling. Veratrine becomes liquid at the temperature of 112°, and congeals into a yellow translucent mass. Quinine also fuses, and cools into a solid and translucent cake, and delphine melts like wax, and cools into a hard transparent cake, which is brittle like rosin.

A few of these alkalies are volatilized before they are decomposed. Cinchonine is so in a slight degree. Delphine volatilizes easily with the vapour of water. Nicotine may be distilled at the temperature of 300°, and daphnine, guaranine, conicine, and perhaps a few others, are more or less volatile. From the circumstance that many of the vegetable substances which contain some of these bodies become inert on being kept for a length of time, it is highly probable that many of them are more volatile in the state of salt than they are when pure.

M. Ferrari states* that a solution of any of the salts of strychnine, rendered slightly acid and exposed to the heat of

* Thompson's Annals of Phil. N. S. 7, p. 470.

212°, so as to become concentrated, becomes volatile. He affirms also, that similar solutions of the salts of quinine, on being heated in a tinned copper vessel, gave out vapours which when breathed were found to be highly bitter. He tried the sulphate, muriate and nitrate. M. Brandes seems to have suffered very severely from the effects of the vapours disengaged from some of these substances. These bodies are generally, nearly insoluble in water, when in the pure state; but when in combination with acids, in the form of salts, they are sufficiently soluble. Solanine, when pure, requires 8000 parts of boiling water for solution; strychnine 2,500 parts of boiling, or 6667 parts of cold water; quinine may be dissolved in 200 parts of boiling water; cinchonine requires 2500 parts, and is almost insoluble in that liquid in the cold.

Nicotine, the alkaline principle of tobacco, and curarine obtained from the curara poison, on the contrary, are so soluble in water that they will unite with it in any proportion.

Digitaline also, is quite soluble, and Picrotoxine requires but 25 parts of boiling, or 75 parts of cold water for complete solution. Emetine dissolves in boiling water, but scarcely at all in cold. It is a general fact that all are rendered more soluble by the application of heat.

Alcohol readily dissolves most of the vegetable alkalies, especially when boiling; it then takes up more than it can retain when the temperature is reduced, so that on cooling, much of the alkali separates in the form of crystals. Narcotine requires 23 parts of boiling alcohol, or 100 parts of the same liquid at 60°, for solution; and strychnine does not dissolve at all in perfectly anhydrous alcohol, and is but sparingly soluble in alcohol of the spec. grav. 83, even when boiling.

Sulphuric ether is by no means so general a solvent of these substances as alcohol is; morphine, strychnine, brucine, cinchonine, veratrine, emetine, delphine, solanine, curarine, violine, cynapine, buxine, atropine, and conicine are not dissolved to any appreciable amount in that fluid. On the contrary, narcotine, quinine, delphine, corydaline, picrotoxine, sanguinarine, and eupatorine, are all soluble; nicotine is so much so that it may easily be separated from its solution in water by agitating it with ether; it then leaves the water and combines with the ether.

Many of the vegetable alkalies dissolve in the fixed and volatile oils: those known to be soluble are morphine, narcotine, strychnine, brucine, quinine, cinchonine, guaranine and veratrine.

Very nearly all of these bodies are rendered soluble in water by the addition of a little acid, as most of their salts are easily dissolved in that liquid. There are but few exceptions to this general remark; all the salts of quinine are but sparingly soluble in water, but they are rendered more so by adding acid in excess; and the gallate of narcotine, brucine, emetine, veratrine, cinchonine* and perhaps of some others, are salts of little solubility in water; as are also the oxalate and tartrate of quinine.

The vegetable alkalies have less affinity for acids than either the common alkalies, or the alkaline earths; so that by the addition of any of these substances, even magnesia, to the solution of the salt of a vegetable alkali, in water, the vegetable alkali is precipitated; even alumine, or the oxide of lead, in some cases, will decompose a salt of a vegetable alkali; most of them, however, cannot be decomposed by the metallic oxides. Narcotine unites with acids by so weak an affinity, that even the evaporation of the solution is sufficient to decompose some of its salts. A portion of narcotine may be separated from opium merely by diffusing that substance in water.

The vegetable alkalies exist, in the vegetable substances from which they are obtained, in the form of salts, usually combined with an excess of acid, and most commonly in combination with a peculiar acid; thus morphine is combined with meconic acid in opium, the alkalies of bark are united with

*Solanine, Guaranine, Esenbeckine?

kinic acid, and strychnine and brucine seem each to exist in combination with acids of a peculiar nature.

A knowledge of these different properties and habitudes of the vegetable alkalies, renders the processes for obtaining them easily understood, some idea of which may be gleaned from the following summary.

1. The most common method pursued, to obtain those which are not readily soluble in water when pure, is to make an infusion or decoction of the vegetable in water, either pure or rendered slightly sour by the addition of sulphuric, muriatic, or acetic acids; this solution is then concentrated by evaporation, and the vegetable alkali is precipitated from it by the addition of potash or ammonia in excess, or by boiling it with a sufficient quantity of caustic lime, or calcined magnesia. When potash or ammonia are used, the alkaline principle is separated in the form of powder, mixed only with the impurities of the vegetable; but when magnesia or lime are made use of, the alkali is mixed with the superabundant portion of those earths. The liquid, in either case, is filtered through paper, and the precipitate, which remains on the filter, is washed with cold water and dried. The alkali is separated from the magnesia or lime, and at the same time, from some of the impurities, by dissolving it out by boiling the precipitate in alcohol. But even then it is usually highly coloured and impure.

Various modes are used, according to the nature of the case, to purify the alkali. In some cases, crystallization from the solution in alcohol several times, will make it sufficiently pure, in others, washing with cold or diluted alcohol, with ether, or boiling with animal carbon, will purify it sufficiently. The most effectual mode is, to dissolve it in a diluted acid, and to boil the solution with animal carbon, then to precipitate the alkali from the purified solution by ammonia or magnesia. Subsequent solution in alcohol, and evaporation, will render it sufficiently pure.

This, in general terms, is the process by which morphine, cinchonine, quinine, emetine, delphine, picrotoxine, atrophine, corydaline, eupatorine, esenbeckine, paralline, &c. are obtained.

2. In some cases, when resinous substances abound in the vegetable, it is advisable to make an alcoholic extract of the plant, then to make an aqueous solution of the extract, filter, and proceed in the manner already directed. This mode of procedure has been recommended for obtaining cinchonine, quinine, picrotoxine, sanguinarine, crotonine, and buxine.

3. In other cases, when the existence of fatty matters interferes with the action of the alcohol, and when the alkali to be obtained is not soluble in ether, the vegetable substances are exposed to the action of boiling ether before the alcoholic extract is made. This method is used to obtain morphine, strychnine, brucine, and emetine.

4. Impurities are sometimes partially removed from the infusion of the vegetable, by the addition of sub-acetate of lead, which, it is known to chemists, will precipitate most vegetable colouring matters; the excess of oxide of lead is then removed by passing sulphuretted hydrogen through the liquid. This plan is pursued in some processes for preparing strychnine, veratrine, emetine, atropine, &c.

5. The vegetable is boiled in a weak solution of soda or potash, or with a little lime in water, until every thing soluble in those menstrua is removed. The natural salt of the vegetable alkali is thus decomposed, and that principle, being insoluble in the menstruum used, is left behind, while most of the impurities are dissolved out and removed. Alcohol, or acid water, is afterwards used to dissolve out the vegetable principle, which is purified in the common way. This is an outline of the process which has been used to obtain cinchonine, quinine and guaranine.

6. Solanine and nicotine are obtained from the juice of the plants in which the exist. The former is procured by precipitation by ammonia, the precipitate being dried, dissolved in alcohol, and purified; and the latter by adding lime to the juice, and distilling in a retort; the nicotine passes over and is condensed with the vapour of water which accompa-

nies it, in a receiver, and is afterwards separated from the water by agitating the mixture with ether, which leaves it on evaporation.

Some other little variation is necessary in the processes for obtaining several of these substances: those which are of sufficient importance will be noticed elsewhere.

In the large way, when magnesia is used as a precipitant, it is often economical to use the sulphate of magnesia, and to decompose it, in the vegetable solution, by the addition of a sufficient quantity of potash.

All the vegetable alkalies which have been analyzed, have been found to be composed of carbon, hydrogen, oxygen and nitrogen. The following table exhibits the proportions in which these elements exist in all those which have been examined. The names of the chemists who analized them are attached.

	Carbon.	*Hydrogen.*	*Oxygen.*	*Nitrogen.*		
Morphine,	72,02	7,61	14,84	5,53	Pelletier &	Dumas.
Narcotine,	68,88	5,91	18	7,21	do.	do.
Strynchine,	78,22	6,54	6,38	8,92	do.	do.
Brucine,	70,88	6,66	17,39	5,07	Liebig.	
Quinine,	75,76	7,52	8,61	8,11	do.	
Cinchonine,	77,80	7,37	5,93	8,87	do.	
Veratrine,	66,75	8,54	19,60	5,04	Pelletier &	Dumas.
Emetine,	64,57	7,77	22,95	4,30	do.	do.

It will be seen from this short table, that carbon enters into the composition of most of these bodies in a greater proportion than two thirds; and in some in a greater proportion than three fourths.

The combining atom of most of these substances is very great, so that it requires very little acid to neutralize them: thus, according to Liebig, the sulphate of morphine, dried at the temperature of about 246° is composed of 4,66 parts of water, 73,38 parts of morphine, and but 10,33 parts of sulphuric acid, in the hundred parts.

Application of the Vegetable Alkalies to Medicine.—Interesting as the vegetable alkalies are, in a chemical point of view, they are still more so to the medical profession, when considered therapeutically. There was a time in the history of medicine when every new compound which issued from the laboratory of the chemist was considered of superlative importance, and there was also a time of retributive reaction, when, in the minds of some, the very name of "chemical" was sufficient to condemn any medicine. Although it is evident that some few remains of both "Galenists" and "chemical practitioners" yet exist in the ranks of the profession, it is confidently hoped and believed, that most of the modern seekers after medical truth, will greet her with an equally cordial embrace, whether she be introduced by the Botanist, the Physiologist, or the Chemist.

The advantages afforded to the medical profession by the discovery of these vegetable principles, although they, perhaps, have in some cases been somewhat overrated, as every new discovery is liable to be, are yet numerous, and are beginning to be generally appreciated. They may be summed up in the following statements.

1. These principles contain the active properties of the drugs from which they are obtained, in a very small space. Thus, the active principle of a hundred pounds of peruvian bark may be carried in the coat pocket.

2. Being pure definite compounds, they are not variable in their action, and we can at all times, when they are not adulterated, calculate safely upon a constant relative effect from a given quantity.

3. Being generally destitute of odour, or of any disagreeable appearance, acting in very small doses, they are particularly eligible in many cases wherein the original drugs produced disgust by their appearance, or fatigued the stomach by their quantity.

4. We can in many cases, administer larger doses, by the use of these principles, than could otherwise easily be done.

These advantages certainly render these bodies very useful additions to the apparatus medicaminum; we are, however, very far from believing that because we have morphine, quinine, or emetine, we should discard opium, bark, or ipecacuanha from our shelves: these ever will remain useful in many cases, although they may, in many others, be superceded with great advantage by the new principles.

Believing that an account of the therapeutic effects of such of these substances as have been used in medicine, will not be uninteresting to some, I will endeavour, with such means as are in my power, to give a summary of the experience of those who have examined their action upon the animal frame, in health or in disease. Taking up each of the alkalies in the order given above, I shall, in such as are of sufficient importance, indicate the easiest and best process by which a practitioner, situated at a distance from where these substances can be obtained, and who is desirous of examining their properties, may, with the common amount of chemical knowledge, and simple apparatus, prepare them for himself.

MORPHINE.—This alkali exists in opium combined with meconic acid, and mixed with narcotine, fatty matter, and a number of other substances, which embarrass the process for obtaining it.

The process which would be most likely to succeed in the hand of one who has no command of chemical apparatus is that of Wittstock. One ounce of opium is digested, by heat, with eight ounces of water rendered acid by a quarter of an ounce of muriatic acid, in a glass or earthen-ware vessel, for six hours. It is then allowed to cool, and the clear liquid is poured off and preserved; the dregs are again submitted to the same process twice in succession, with the same quantity of water and acid each time. The liquids obtained by these three processes are mixed, and four ounces of common salt is added to them. This substance has the property of precipitating most of the narcotine. On suffering the mixture to stand, after the salt is dissolved, for some hours, a brown deposite will form, composed of narcotine, colouring matter, &c. To the clear liquid, which has been carefully decanted from this deposite, aqua ammonia is added until the acid is completely neutralized and the ammonia is slightly in excess. The mixture is then boiled a little, and afterwards is allowed to rest for twenty-four hours. Another deposite forms, which is impure morphine. It is separated from the fluid by filtering through paper in the common way; and is then washed with a little cold water, on the filter, and dried with a moderate heat. When dry it is to be boiled in alcohol, which dissolves out all the morphine, which can be obtained by evaporating the alcohol, either in a plate, or, if we have the means, by distilling it off by a retort and receiver.

The alkali thus obtained, which should be in quantity about one drachm, is not absolutely pure; it may be purified by forming a muriate by the addition of a sufficient quantity of muriatic acid, and evaporating until it crystallizes, then pressing the crystalline mass in bibulous paper. On dissolving these crytals again in pure water, filtering, and precipitating by ammonia, we obtain the morphine comparatively pure. If we still suspect the presence of narcotine we may wash it with pure sulphuric ether; taking care, previously, to remove any free acid from the ether by agitating it with a little water.

The morphine may be formed into an acetate by the addition of a sufficient quantity of distilled vinegar; or to a sulphate by carefully adding to the morphine, in a glass vessel, diluted sulphuric acid enough to dissolve it, but not so much as to render the mixture sour.

Blondeau boasts of a process in which the opium, dissolved in water, is caused to ferment by the addition of honey and yeast, and the morphine is subsequently precipitated by ammonia, &c.

M. M. Magendie and Orfila were perhaps the first who experimented upon morphine with a view to ascertain its effects. An abstract from their memoir may be seen in the Eclectic Repository, Vol. 8.*

M. Orfila found that the acetate was more active than

*Philadelphia, 1818.

the pure morphine, on account of the insolubility of the latter. He administered six grains of the acetate to two dogs, severally. In a short time the posterior extremities became paralyzed, the animals seemed to be asleep, but were aroused with the least noise, and as if terrified, made efforts to escape, but falling in the attempt, they appeared instantly to go to sleep again. The pupils were dilated, the pulse slow, and the respiration labouring. At the end of eight hours they uttered a piercing cry. But on the following day the symptoms diminished and the animals gradually recovered.

M. Magendie states, that he administered the salts of morphine, of which he gave the preference to the acetate, with narcotic effects, and without any disagreeable symptoms, in a case where opium was decidedly injurious, by producing extreme agitation, and most intense cephalalgia. M. Bally has also recorded some experiments on the use of Morphine.* He used the acetate; and commenced with doses of one eighth to one fourth of a grain, increasing gradually. When the quantity amounted to six or seven grains, given at twice in the course of twenty-four hours, nausea generally appeared, with occasional pains at the epigastrum. The effects observed by him were diminished force and hardness of the pulse; generally constipation, followed very often by diarrhœa, which ceased on omitting the medicine. Nineteen-twentieths of the males who used it experienced a difficulty in making water, often so great as to require the use of the catheter. No such effect was observed in females, but an uncomfortable pruritis was particularly evident in them. Its principal action was upon the encephalon, determining either serious irritation there, or congestion, or hemorrhage, dimness of sight, vertigo, tinnitus aurium, &c. &c. He convinced himself of the decided vermifuge properties of the acetate; for in several cases in which it was not exhibited with that intention, it caused the discharge of lumbricoid ascarides by vomiting.

*Revue Med. Fev. 1824.

He was of opinion that morphine stimulated the brain, and hence favoured the occurrence of apoplexy and extravasation.

This opinion has since been shown to be incorrect. According to him its effects in producing sleep were variable, being influenced by the season; for this effect he preferred small doses. He found that its use was occasionally attended with cephalalgia, and asserted that the sleep which it produced was disturbed, and that it caused a sort of drunken delirium and lassitude. In this he is contradicted by Dr. Quadri, who attributed M. Bally's want of success, in the use of this article, to too large doses.

Quadri administered it in doses of one eight of a grain, twice in twenty-four hours, increasing gradually to one half and one grain. He records ten cases in which he had used it with decided advantage; viz. one case of inveterate restlessness and watchfulness; two cases of hysteric convulsions; two of colic; one of pectoral complaints followed by colic; one of obstinate vomiting; one of strumous ophthalmia with excessive irritability of the eyes; one of irregular fever after delivery, attended with racking pain of the head and arms; and one of obstinate rheumatic headache.

There is perhaps a great deal of truth in the observations of Prof. Brera, of Padua, who found that spirituous liquors or other diffusable stimulants, taken into the stomach during the action of morphine, caused obstinate headaches; whereas, when the causes of stimulation were avoided, its action was unattended by this disagreeable effect.

The experiments of Dr. Berandi, of Turin, upon himself and some others, students of medicine, tended rather to foster an unfavorable impression against the use of this medicine. His doses were from one eighth to one grain, and were followed by dilated pupils, increased frequency of the pulse, deep coloration of the face, a weighty feeling about the head, painful sensations about the epigastrium, and extending sometimes to the bladder and genitals; nausea; large drops of sweat; drowsiness; and sleep, which was often restless. On waking, there was often acute pain about the frontal sinuses, nausea, abdominal uneasiness, intestinal disturbances, as in diarrhœa, itching, and a papular irruption on the skin. The lassitude which followed was sometimes extreme, and there was occasionally a sense of stricture and pain in the fauces.

The uncertainty relative to this article occasioned by the contradictory statements of those who had tried its effects, left rather an unfavourable impression on the minds of the profession, with a conviction that still further experiments were necessary.

Dr. Bardsley, in his "Hospital facts and observations illustrative of the efficacy of the new medicines strychnine, morphine, &c."* a work of very great interest, has given the result of his experience on the article in question. He had tried it in affections of the stomach, uterine diseases, and in neuralgia, and his opinion of it is favourable. He relates ten cases of dyspepsia in which its application was successful. he used the acetate, in the form of pills, in the quantity of one eighth of a grain at first, afterwards increased to a half or one grain, three or four times a day, sometimes once an hour. In every case there was great abatement of pain, and gradual improvement of the digestive organs, with return of strength and appetite. *Costiveness was not induced in any case*, although some of the patients had been obliged previously to give up the use of opium in consequence of its constipating effects. It was seldom necessary to prolong the treatment beyond a month or six weeks.

He used the acetate in many cases, as an anodyne in schirrus uterus, with invariable success; its use being unattended by constipation; and has recorded a number of selected cases of neuralgia, in all of which it was of material benefit. In six cases, two of the infra-orbitary nerve, two of the inferior dental nerve, one supra-orbitary, and one of the entire side of the face, all of several months standing, and all

*London, 1830.

very severe, the acetate was administered to the amount of one fourth to one grain every other hour; and all were ultimately cured; some in seven or eight days only. In no case were the bowels rendered torpid.

He affirms that the use of morphine has never, in his hands, been attended with the distressing headaches, &c. which too often accompany the use of opium. The production of these effects in the hands of others he attributes to the use of an impure salt of morphine, for he affirms that the brown resinoid body which contaminates it, is the cause of the mischief, and therefore, cautions against the use of any but a pure salt. He is of opinion that the acetate of morphine may be safely used in cases where it is desirable to produce a narcotic effect, and where it is necessary to avoid constipation.

Dr. G. Marolla* has used the acetate in several cases of uterine disease, spasmodic pain, rheumatic affections, and neuralgia, in the quantity of half a grain, mixed with sugar, and divided into two doses to be taken in the twenty-four hours, with decided success.

The favorable impression made by these statements is confirmed by Dr. Wm. Stokes, physician to Neath Hospital, Dublin, who has used it with encouraging success in cases of chronic dyspepsia accompanied with hematamesis and great acidity of the stomach.†

It has been confidently believed and asserted that morphine was the pure anodyne and sedative principle of opium, and that all the stimulating disagreeable effects of that drug were occasioned by another principle contained in it, the narcotine. Hence a process was divised for *denarcotizing* opium, by subjecting it to the action of sulphuric ether, which dissolved out the narcotine.

This opinion, though still prevalent in some degree, seems not to be founded in fact. Some experiments of Prof. Tully, on the action of narcotine, which will be noticed pre-

*Bull des Scien. Med. tom. 13, 275.
†See Western Med. & Phys. Jour. July, 1833.

sently, have done much to remove the unjust odium attached to that substance.

There is one circumstance which will limit the common use of morphine as a substitute for opium; it is that the quantity of that principle obtained from a given amount of opium will not produce more than one fourth the effect which would have been produced by administering the opium in substance. It is probable that much of the activity of the drug is owing to the narcotine which it contains, and it is also highly probable that much morphine remains in the residuum of the process for obtaining it.

Lindberger has attempted to prove that the alkalies of opium produce no other effect on the animal system than a slight nausea, and that the narcotic effects of opium are produced by the *extractive matter* which remains in solution when the alkalies are precipitated. He affirms that an infusion of opium, treated by magnesia, which precipitates the morphine and narcotine, gives, by evaporation, an extract, which produces the same amount of narcotic effect as the opium from which it was obtained.*

Lindberger has evidently been misled by some hidden source of error. We have the experience of too many others to the contrary to believe what he asserts. Be the case as it may, further experiments on the subject are desirable.

Dr. C. A. Lee, of New York, has lately given a new application of the sulphate of morphine. He used it in the form of lotion, in acute ophthalmia attended with conjunctival inflammation, great intolerance of light, and constant pain. He applied the following lotion. ℞. Sulph. Morph. gr. ij, Aq. dist. ℥i. M., tepid, by means of a cloth dipped in it and kept to the eye. It had a direct sedative effect, allayed the pain and irritation, and diminished the intolerance of light.†

The impression left upon our mind by the perusal of what is recorded relative to the use of morphine, is favorable;— that it is a valuable addition to our curative agents from

*Berzelius, Traité de Chemie, tom. 6, 153. †N. Y. Med. & Surg. Jour. 2, 217.

the facilities which it gives us in its use. Valuable, not from any new properties which it possesses, but from the want of certain properties of opium which are sometimes contraindicated in cases where we wish to use that drug.

NARCOTINE, was first prepared by Derosne, in 1803, by making a watery extract of opium, evaporated to the consistence of honey, and then diluting it again with water; on allowing it to stand for some time the narcotine was separated in the impure state, and settled to the bottom of the liquid. It was afterwards purified by repeated solutions in alcohol, and crystallization. This substance was long known as *salt of Derosne*, and was believed, when morphine was discovered, to be a sub-salt of that alkali, until Robiquet accertained that it was a distinct body.

It is obtained in all the processes for preparing morphine, and may be procured from the precipitate, occasioned by the addition of salt, which I have mentioned in the process given for obtaining that alkali. It may be purified by solution in diluted muriatic acid, boiling the solution with animal carbon, and precipitation from the filtered solution by ammonia or potash. It may also be obtained from opium by the action of boiling ether, which dissolves it, and leaves it again, in a very impure state, when evaporated. It may be purified in the manner indicated.

Narcotine has not yet been used in medicine, as far as I can ascertain; but that it is a substance well worthy the attention of physicians seems now pretty well established.

The little attention which has been paid to it is perhaps owing to the unfounded assertion of Magendie, that it was the *exciting* principle of opium, and that it, solely, occasioned the disagreeable after effects of that substance.

M. Bally also contributed to this apathy by asserting, after some experiments, that it produced little or no action on the animal frame. M. Orfila found it to occasion death in dogs in doses from 15 to 18 grains; and he affirmed that its effects were stupifying and deleterious.

Magendie's experiments confirmed those of Orfila as to its deleterious nature, but he called it a powerful *excitant*, and said that it caused death with similar symptoms to those of an over-dose of camphor.

Prof. Tully, of Yale College, has lately examined the effect of this substance on himself and four other persons, young physicians. His highly interesting paper may be found in Silliman's Journal for July 1832. He seems to have given the substance a very fair trial, and his statements may no doubt be taken as a correct account of its action on persons in health. Unfortunately he does not mention whether he used a perfectly pure salt or not.

The results of his observations are as follows:

1st. NARCOTINE is less active than morphine, or even opium, and is less prominent and rapid in its effects than morphine, and more than opium.

2nd. Menstrua nor acids do not alter its activity.*

3rd. Two to five grains is a medium full dose, to be given at once. One grain, a medium small dose, to be repeated at regular and short intervals, say three hours.

4th. It is more or less *nervine*† in its operation, but decidedly less than the sulphate of morphine. *The narcotine does not produce any of that preternatural watchfulness which so often results from the use of morphine or opium!*

5th. Narcotine is considerably diaphoretic; and commonly produces more or less itching of the whole surface.

6th. It is most prominently and decidedly *narcotic.*

He found it entirely destitute of any stimulating power; on the contrary, it invariably reduced the frequency of the pulse. Its antirritant and soporific power was greater than that of opium or morphine; and the sleep which it occasioned was natural and pleasant; no uneasiness succeeded. On

*It is stated by Berzelius (Traité de Chemie, tom, 5. 140) that acetic acid destroys its influence on living beings.

†A *Nervine* action, he states, has four stages. 1st. Moderately antirritant. 2nd. The production of a calm pleasurable sensation. 3rd. The production of a peculiar preternatural watchfulness. 4th. The production of more or less positive exhileration, sometimes amounting to delirium.

the whole, its operation was much more pleasant than that of opium or morphine.

When a person is completely under its influence it causes contraction of the pupils, a sense of dryness and clamminess about the throat, although the fauces appear moist to the eye, and a considerable change and hoarseness of the voice. It produces also, not only a considerable diminution of the secretion by the renes, but also a deficiency of the contractile power, or torpor, of the bladder.

It is hoped that the result of these experiments will lead others to give some attention to this interesting subject.

Strychnine.—I remember being, while a boy, very highly interested in the wonderful story of the Jesuit father about the poisonous Upas tree of Java, whose very emanations were sufficient to render the air deleterious to animal life for miles around it, and which exuded a poison which it was the privilege of condemned criminals to approach and collect, with the risk of the almost certain loss of life in the attempt.

This poison, though now shorn of the diffusive deleterious properties, given to it by the fertile imagination of the Jesuit, is used by the natives of Borneo to poison their arrows, and has been found to owe its poisonous character to the presence of a vegetable alkali, strychnine; which exists also in the nux vomica, which is the fruit of the *strychnos nux vomica;* in the fruit also of the *strych. faba-ignatii*, in which it was first discovered; and in the wood of the *strych. colubrina.*

Strychnine is a substance of an extremely bitter taste, one grain being sufficient to render ten gallons of water sensibly bitter; and, as a rapid destroyer of animal life, it is second only to the concentrated Prussic acid.

Magendie killed a dog by the administration of one eighth of a grain, and another was killed, in the space of two minutes, by the injection of one sixth of a grain into the cavity of the pleura.

It destroys by causing complete tetanus, and consequent immobility of the thorax, and asphyxia.

Like every other poison this substance has been used as a medicine, and the results are such as to be highly interesting to the profession.

Those who wish to examine its properties may obtain it from the nux vomica. The process given by M. Ferrari is the most simple. The nux vomica is to be dried thoroughly in an oven, and pulverised; then boiled, in a glass or earthen ware vessel, in water rendered slightly sour by muriatic or sulphuric acid. To the filtered decoction a small quantity of quicklime is added, more than sufficient to neutralize all the acid; the liquid is set aside, and after two or three days the clear liquor is decanted. The powder which remains at the bottom, washed in a little cold water, is dried, and boiled in alcohol to extract the strychnine, which may be obtained by evaporating the alcohol, sufficiently pure for all medicinal purposes.

The alcoholic extract of nux vomica, which owes its efficacy to the presence of strychnine, has been used by M. Fauquier.* (la Charitié, Paris) and others, in the cure of palsy, administered in pills of two grains each, to the amount of two a day at first, gradually increased to ten or twelve.

"The constant effect of this substance is to produce, at first in the paralyzed parts, and afterwards in the rest of the system, shocks, or contractions, similar to those caused by galvanism. These continue for a greater or less time after each dose, and give place to a state of calm; they have in many cases recalled the power of motion."—"M. Fauquier thinks that the doses should be so divided that this action of the medicine be repeated several times in the twenty-four hours, and be restricted to the paralyzed members." He accompanies this medicine with laxatives, and watches carefully for any sign of congestion of the brain.

M. Fauquier, in 1816, published a full account of a series of cases illustrative of the effects of this extract in chronic palsy.

*Formulaire des hopitauxde Paris, par Ratier.

Dr. Bardsley* reports thirty-five cases of palsy in which he administered the pure strychnine with very great success, as most of them recovered, and all, with the exception of two, were materially relieved. The first appearance of amendment, he states, is immediately preceded by twitching of the muscles, sometimes of the palsied, and sometimes of the healthy limbs; and if the dose was increased, after the appearance of this symptom, they partook more and more of the tetanic character. Great caution was necessary in increasing the doses; for on the one hand, no benefit is felt unless the physiological effects of the medicine are developed, and on the other, any increase of that action beyond the simplest manifestation of its existence is attended with serious, and possibly dangerous symptoms. He, therefore, cautions to watch closely the effects of every dose when the quantity is nearly that at which action may be looked for.

His common dose was one sixth of a grain, twice or thrice a day, and he, by gradually increasing it, seldom reached half a grain, twice or thrice a day, without spasmodic symptoms exhibiting themselves. He found that the system does not become accustomed to its effects by long continued use.

In cases of recent palsy, when there is a determination to the head, he first subdued this determination by depletion, by bleeding, &c. before he used the strychine; and he states, that it should never be used in acute cases of palsy accompanied by inflammation. It is in such cases of palsy which seem to arise from diminished nervous excitement, that strychnine is indicated.

In cases of chronic diarrhœa, without pain, causing exhaustion by the constant thin discharge, owing to torpidity of the bowels, he found that small doses of strychnine slowly restored their healthy action, after the other usual remedies in such cases, sedatives and astringents had failed.

He also used the strychine with good effects in several obstinate cases of amenorrhœa.

*Hospital facts and observations, &c.

In a paper published in the American Journal of Medical Science, Feb. 1831, to which we refer the reader as a paper of considerable interest, Dr. E. Geddings of Charleston, S. C. records four cases of paralysis, caused most probably by the ingestion of lead, which he successfully treated with strychnine.

The first was a case of hemiplegia, in an intemperate subject; the second, one of general paralysis, and utter helplessness; and the others, paralysis of the fore-arm and hand. His dose was usually the one sixth of a grain, night and morning, gradually increased. Speedy relief was attained in every case, and was preceded by spasmodic twitchings of the palsied muscles.

Morphine has been recommended as an antidote to the dangerous effects of too large doses of strychnine.

As yet, strychnine has been but little used in medicine. A considerable quantity of it is annually manufactured in France to supply the demand in India, where a great deal is consumed for the destruction of wild beasts.

Brucine was obtained by M. M. Pelletier and Caventou, from the false Angustura bark, which was at first supposed to be the bark of the *Brucea antidysenteria*, but is now known to be that of the strychnos nux vomica of the shops. It remains in solution in the alcohol, (in the process given for obtaining strychnine,) after the strychnine has crystallized. It resembles strychnine so much in its properties and action that very little need be said of it.

It has been used in palsies, the dose being six times greater than that of strychnine, but with nearly similar effects. Dr. Bardsley found it less efficacious than that article.

Quinine and Cinchonine are both found in Peruvian bark, and the different varieties of bark contain variable proportions of these alkalies.

According to Pelletier and Caventou, the red bark contains more than any other variety, the cinchonine being rather predominant in quantity. Carpenter, of Philadelphia, asserts that the kind called Calisaya bark contains the most, and that it is principally quinine; Pelletier and Canventou have lately found that this alkali of the calisaya bark is a new and distinct one, and they state that its sulphate possesses this peculiar property, viz. that its boiling saturated aqueous solution becomes, on cooling, a trembling jelly, which, on drying, assumes the appearance of horn. Nitric acid decomposes this base, and the mixture takes an intensely green colour.*

The loxa bark is inferior only to the red, and contains, according to Carpenter, rather more cinchonine than quinine. The common bark of the shops, in the West especially, is a very inferior kind, which will scarcely sell at all in the Eastern market, called Carthagena bark. It contains very little alkali of any kind. Gruner asserts that a peculiar alkali is found in it, resembling quinine, which is said to be destitute of febrifuge properties.†

The sulphate of quinine is now so generally known, and so extensively diffused, that nothing need be said here of its mode of preparation, and scarcely any thing of its use in medicine.

The quinine, in the pure state, has been little used. Dr. Elliottson, of St. Thomas Hospital, London, however, records ten cases of intermittent fever cured by the use of the uncombined alkali.‡ The sulphate is undoubtedly to be preferred, as by a little additional sulphuric acid it is rendered readily soluble in water.

The sulphate of quinine has been extensively used in the treatment of intermittents; but rather more in Europe, and in the Eastern States, than in the Western parts of the United States, where it is only considered an adjuvant to a more efficient course, venesection, calomel, and other evacuants.

It has been often remarked, that persons cured of intermittents by the use of quinine alone, were subject to relapses. M. D. Gola asserts, that, by combining it with tartar emetic, the danger of relapse is, in a great measure, remov-

*Berzelius, Traitè de Chemie, 5, 186. †Ibid.
‡Med. Chir. Trans. Vol. 12, p. 2.

ed. His formula is as follows—℞. Tart. Emet. grs. iii, Sulph. Quin. grs. x, mixed, divided into six doses, one to be taken every two hours during apyrexia. He tried this mixture on four persons who had relapsed several times after the use of quinine alone. Its effect was sometimes to produce vomiting of bitter matter, sometimes alvine discharges; but in other cases it occasioned no sensible evacuation. The fever, in every case, was subdued, and no relapse followed.

The sulphate of quinine has been used in typhus. Dr. Elliottson has given one case.* John O'Brien, M. D. of Dublin Fever Hospital, treated six cases of the very worst grade, with the sulphate of quinine, the disease being characterized by large petechia of a dark bluish color, and affections of the brain and nervous system. Two recovered as rapidly as from intermittent fever; three recovered more slowly; there was no relapse in either case. One died, but the Doctor asserts that it was a very severe case. Few physicians have followed, or probably will follow, Dr. O'Brien in his treatment of this disease.

Henry Perrine, M. D. of Natchez, Miss.† thought he derived great advantage from the use of sulphate of quinine in very large doses, in fever. He gave from 8 to 60 grains, after venesection, followed, when the quinine had produced its pro-effect upon the skin, by copious evacuations from the bowels. He alleges that it did not increase the frequency of the pulse, but rendered it full, and produced free perspiration, and secretion from the kidneys.

A singular observation was made by Dr. Harty, of Dublin,‡ which, if true, is of some importance; it is, that sulphate of quinine has the effect of accelerating mercurial action upon the system. Some female convicts in Richmond Bridewell, to whom the sulphate of quinine had been administered, were attacked suddenly, and violently, with ptyalism, after taking a few pills of calomel and scammony. In some male prisoners in Newgate, the use of quinine re-excit-

*Med. Chir. Trans. Vol. 12, p. 2. †Philad. Med. Journ. 13, 36.
‡Edinb. Med. & Surg. Jour. Oct. 1829.

ed ptyalism after it had subsided; and a medical friend of his who had been taking bark and quinine for an ague, was salivated in less than six hours after taking five grains of Plummer's pills, which contained only one grain of calomel.

The sulphate of quinine has been highly lauded as a curative agent in neuralgia. As early as April, 1822, M. Piedagnel published an account of a case of violent periodical supra-orbital neuralgia, which he entirely cured by the administration of ten grains of the sulphate during one of the daily intermissions, and the repetition of the dose in the following twelve hours.

P. L. Dupré, (officier de Santé, at Cerisier, Yonne,) in August, 1822,* with one case of typhus gravior and two cases of intermittents, which were cured by the use of this remedy, relates two also of neuralgia. The one was a tertian, complicated with sub-orbitar neuralgia, in a person sixty four years of age. Three grains of the sulphate of quinine were given every four hours, before the paroxysm, and the patient was cured after two portions of twelve grains each were taken in this way. The other case was one of femuro-popliteal neuralgia, the patient æt 33, of a sanguine temperament. Bleeding, local and general baths, issues, frictions with ether, opium, &c., had been tried without success. He was cured by the use of nine grains of sulphate of quinine daily, in eight days. Many other cases might be quoted, but these, perhaps, are sufficient.

One of the formulæ used by Dupré was the following:

℞ Sulph. Quinine, gr. 8.
Syr. Rhæi, }
Aq. flor. Aurant, } āā ℥iiss.
Ether Sulph.—gutt. x. mix.

Three doses were given per day. The quantity of quinine being increased each consecutive day.

The high price of the sulphate of quinine has induced persons to sophisticate it. It is of course a matter of import-

*Magendie's Journ. de Physiol.

ance that the article used should be pure. The impure may be detected as follows:

1. If it does not dissolve entirely in alcohol.

2. If it is not entirely consumed when thrown on a red hot iron; or, 3d. If it does not dissolve entirely in water rendered sour by the addition of sulphuric acid; it is sophisticated. These three tests must be used in conjunction.

Cinchonine has many properties in common with quinine; it differs from that substance, however, in being insoluble in ether, which may, consequently, be used to separate these two alkalies when they are mixed together.

It was at one time believed that this alkali was destitute of the febrifuge properties of quinine. As there is such a large proportion of cinchonine in most of the varieties of bark, it is gratifying to learn that this belief is unfounded.

M. Bailly (La Pitié, Paris,) has used it with advantage in the form of sulphate, in doses of from twelve to sixteen grains: and Dr. Bardsley, from a number of experiments, is satisfied that it is hardly inferior to the quinine. He records nine cases of intermittents which were cured by its use.

Veratrine is found in the seeds of the *Veratrum sabadilla*, in the root of the *Veratrum album*, (white hellebore,) and in that of the *Colchicum autumnale*. It has no odour, but its smell proves powerfully sternutatory. It is an acrid, drastic purgative; and, according to Dr. Bardsley, is not more useful than croton oil and other similar agents.

It is the active principle of the celebrated *Eau medicinale* d'Husson; and Magendie gives a formula to replace that nostrum in the cure of gout, as follows:

℞ Sulph. veratrine, gr. 1.
Aqua dist. ℥i.—mix.

The dose of the veratrine is about 1–6th of a grain. Taken into the mouth it excites salivation; and in large doses it produces tetanus and death.

Emetine may be prepared from ipecacuanha by boiling it in water mixed with a little sulphuric acid, concentrating the clear decoction to the thickness of thin syrup, then boiling it with magnesia, and proceeding as directed under the head of Strychnine.

The only superiority which emetine possesses over ipecacuanha, in substance, is the certainty of its uniform strength, and the facility with which it may be administered. It may readily be dissolved in water by the addition of a little of any common acid, or may be made into syrrup or pastils for administration to children, and in these forms cannot be easily detected by taste or appearance.

"*It has a special action upon the lungs and the mucous membrane of the intestinal canal; and also a marked narcotic quality." In over doses it proves fatal, causing a violent inflammation of the lungs and intestinal canal.

Dr. Bardsley found it a good expectorant in frequent doses of one fourth of a grain, united with opium; a mild diaphoretic in double that quantity; and a good emetic in doses of five grains, dissolved in rose water. The doctor most probably used the common unpurified emetine, for one grain of the pure emetine is sufficient to produce emesis.

The reader is referred to Magendie's Formulary for many preparations of the vegetable alkalies.

Delphine has not yet been used in medicine. Orfila found it fatal to dogs in doses of six grains.

Solanine acts as an emetic and narcotic.

Corydaline and *Nicotine* have not been employed in medicine. The latter must be an extremely powerful substance, being the active principle of a very active plant, tobacco. There is but little doubt that valuable therapeutic effects will some day be derived from it. Its mode of preparation may be gathered from the general remarks on that subject.

Curarine is a violent poison, being derived from the poison called Curara, which is used by the S. American Indians to poison the points of their arrows.

Picrotoxine is a virulent poison; ten grains caused death,

*Magendie.

with convulsions, in a middle sized dog, in forty-five minutes. It has not been used in medicine.

The remaining alkalies will not require a long comment. Very few of them have been examined accurately, and still fewer used in medicine.

Atropine seems to be a very powerful substance. Brandes, in publishing his account of its discovery, adds, "*I have been obliged to discontinue my researches on the properties of this alkali. The violent headaches, the pains in the back, and giddiness, with frequent nausea, which the vapour of atropine occasioned while I was working on it, had such a bad effect on my weak health that I entirely abstained from any further experiment. I once tasted a small quantity of the sulphate of atropine; the taste was not very bitter, but merely saline, but there soon followed violent headache, shaking in the limbs, alternate sensation of heat and cold, oppression of the chest, difficulty of breathing, and diminished circulation of the blood." Even the vapour of the salts of atropine produced giddiness and dilation of the pupil, which was also a very manifest effect of tasting them; the dilation lasting twelve hours.

Atropine has been recommended to be applied topically to the rectum, so relax the sphincter, in the operation for fistula in ano; this, however, seems to us to be a useless refinement. It has also been applied to the neck of the uterus, to assist in the dilation in parturition.

Hyosciamine, when prepared from the seeds of the henbane, is said, by Dr. Reisinger, to produce great dilation of the pupil, which lasted for seven days, (a solution of one grain in an ounce of water being used,) without producing any of the irritation of the eye which was invariably occasioned when the extract was used.† The action of atropine he found similar, but its effects were not so prolonged.

*Thompson's Ann. Philos. N. S. 1, 270. It is now believed that Brandes had not succeeded in obtaining the pure alkali.

†Bulletin des Scien. Med. 5, 261.

Conicine, in a dose of one half a grain, killed a rabbit, with tetanic symptoms. It is certainly a more elegant preparation than the extract conii.

Illicine and cornine are said to be efficient in intermittents.

Digitaline, in the dose of one grain, was fatal to a rabbit; half a grain injected into the veins of a cat destroyed it, and a dog similarly treated with one and a half grains, was also killed by it. It has the same sedative action as the digitalis from which it is obtained, but it has not yet been introduced into medicine.

On the Endermic application of the Vegetable Alkalies.—It would not be doing justice to the subject of this paper to pass over in silence a new mode of administering therapeutic agents, which promises to extend the limits of medical efficiency to many cases hitherto considered almost hopeless; a method to which the vegetable alkalies are particularly adapted.

The method of applying medicines to the skin, previously denuded of its cuticle, seems to have been first brought into notice by Antoine Lembert, Hospital assistant, Paris, whose "*Essai sur la methode Endermique, &c.*" was read before the Acad. Roy. des Sciences, Sept. 1826. M. Lesieur and M. Dubrary, however, have both put in claims to the discovery.

It sometimes happens, in the treatment of diseases, that the internal administration of medicines becomes impossible or inefficient. Medicines, owing to the disgust which their taste or smell occasion, or to gastric irritation, cannot be swallowed or retained upon the stomach. Or, in some diseased conditions of the alimentary canal, they may either pass without producing any effect upon the system, or may prove a source of local irritation, and thus be productive of disagreeable effects. They may, also, in some cases, when of a vegetable nature, be so acted upon by the digestive agencies of the stomach, that their effects may be materially modified.

In such cases the endermic mode of applying medicines becomes a valuable resource.

We may reckon among the advantages of this mode,

1st. That the system is sooner brought under the action of the medicine than by the internal mode of application.

2d. That the doses may be graduated at pleasure, for if an over-dose is at any time applied, we can easily remove it again.

3d. That we can in this way use medicines without the knowledge of the patient; which renders it a valuable resource in the treatment of children and insane persons.

4th. It is admirably calculated to produce either sudden effects upon the system, or for producing the least possible effect.

The plan pursued in the endermic application of medicines is, first to raise a small blister upon the epigastrium, the arm, or any part of the front of the body: the back has not been found so suitable, as the absorbing power of that surface does not appear to be so great. If the disease is local, the blister must be placed as near as possible to the seat of the affection.

The common blister of flies is used for this purpose, and M. Lembert asserts, that pain is in a great measure prevented by surrounding the blister, when applied, with a large poultice. It has also been advised to produce vesication by a mixture of equal parts of the strongest Aq. Ammon. and simple cerate, which is said to produce the effect in an hour. Boiling water, and hot iron have been used, but have been found improper from their deadening effect on the cutis vera.

When the blister is raised, the serum is to be discharged by a moderate opening, and after a short time, the medicine is to be applied under the cuticle, either in the form of fine powder, cerate, or solution. At each subsequent dressing, the surface is to be completely cleaned, by careful washing with warm water, before a new application is made.

All medicines are not equally proper for endermic application; they should be such as operate in minute doses, and which do not produce too great irritation on the tender surface. The acrid purgatives, and mineral bodies generally, with the exception of calomel, are unsuitable. A little inflammatory action is favorable, while too much prevents absorption, the local action in that case overpowering the general one. The vegetable alkalies, as before intimated, are generally very suitable to this mode of application.

When too great constitutional action follows the use of any agent in this way, the remains of it may be washed off, and the effects counteracted by the applicatian of some other medicine, by pressure, or by dry cupping. The alarming contractions of the muscles, or tetanus, produced sometimes by an over dose of strychnine, are completely subdued by the application of morphine, which, according to Lembert, is a complete antidote. He introduced six grains of the acetate of morphine under the skin of a dog, on one side of the spine, and three grains of strychnine on the other, and no visible effects followed, although either, separately applied, would have caused death.

Acetate of morphine, in doses from one sixteenth to between one half and two grains, he found to produce a slight itching or prickling of the surface, succeeded by a state of calm. It produced its usual anodyne effect on the system in a very few minutes after its application, bringing on reverie, sleep or coma, swimming in the head, &c. M. Lembert found it useful in a number of cases. He records a case of severe trismus, caused by an ulcer on the external malleolus, in a female of twenty-eight, at the Salt Petriére, inwhich bleeding, warm baths, mercurial frictions on the neck and legs, blisters, and sudorific draughts, had been used without effect. One fourth of a grain of acetate of morphine, with a minute portion of cerate, was applied to the vesicated surface on the morning of the second day of the disease. The trismus completely ceased, but some rigidity of the neck remaining, the dose of acetate was doubled in the evening. At 11 o'clock, p. m. the patient was perfectly restored. At the same hospital a case of idiopathic tetanus, brought on by fright and syncope, was cured in the same manner, in an equally short space of time. He gives also several other cases. The account of one of chronic bronchitis in a female will perhaps not be devoid of interest. The usual anodynes and pectorals, and blisters to the arm, had been tried with no effect. In order to relieve a constipation of eight days duration, he sprinkled five grains of powdered aloes on the blistered surface. Ten hours afterwards this gave rise to several alvine discharges, with colic pains. Encouraged by this, Dr. L. (14th March, 1824) applied half a grain of acetate of morphine in powder to the same surface. This produced a slight prickling in the sore, and a quarter of an hour afterwards, the tracheal tickling, the cough, and oppression of the breast were sensibly moderated. On the 17th the application of one grain of the acetate was followed, in an hour, by a feeling of general ease and comfort, and the patient was enabled, for the first time for a long while, to taste the luxury of sleep. The medicine was continued until the 22d, the dose having been increased to two grains. The amendment was then decided, the cough having disappeared. With a view to ascertain whether the subsidence of the catarrhal symptoms was owing to the use of the morphine, its use was discontinued on the 23d, when all the former evils returned, with the addition of cold sweats, chills, and faintings. The use of the medicine was resumed on the 24th, in doses of three grains; it was finally raised to four grains, and the patient was discharged, towards the end of May, perfectly restored. During the treatment, the use of the remedy was suspended at various times, with invariably the same effects, which the imagination of the patient had no agency in producing, as it was always done without her knowledge.

Some cases of acute rheumatism, and sciatica, successfully treated in this way, are also recorded by Dr. L. with many others, showing the calmative power of morphine, when externally applied, over parts affected with neuralgia, or convulsive and spasmodic disorders. M. Bally* affirms, that he has used the morphine successfully, in this way, in three cases of tetanus; one traumatic, the other caused by the use of

*Mem. de l' Aoad. Roy. de med. tom.

strychnine, and the third by fright; and states that it produced "marvellous effects in rheumatism, lumbago, and sciatica."

Dr. Gaspard Cerioli, of Cremona,* gives also satisfactory results from the external application of acetate of morphine. He records a case of infra-maxillary neuralgia, and one of tetanus, which were cured in this way, after the common remedies had failed.

In the United States, judging from what has been written upon the subject, but little attention has been paid to endermic medication. A very interesting paper upon that subject appeared in the N. A. Med. and Surg. Journ. Vol. 9 and 10, by D. W. W. Gerhard, in which are recorded the results of his favourable experience in a great number of cases, and to which the reader is referred.

He found the salts of morphine very suitable agents to be employed in this manner, and preferred the sulphate, which he used in powder, or mixed with cerate, in doses varying from a half to three or four grains. One case of chronic bronchitis, which had not been subdued by the common remedies, or even morphine taken internally, was cured by the application of a cerate composed of sulph. morphine five grains, cerate simp. ℥. ℥; M. one third of which was applied three times a day.

In a case of phthisis, much relief was derived from the endermic use of morphine; and two severe cases of delirium tremens were completely cured. One of violent neuralgia in the course of the ramifications of the frontal nerve, was cured in less than half an hour by the application of five grains of sulph. morphine, on a blistered surface, over the orbit; and one of severe rheumatic pain in the muscles of one side of the neck, and another of gonorrhœa, with great irritation of the urethra and glans penis, and constant inclination to pass his urine, were both speedily relieved by the same means. In the one case the blister being applied to the perineum, and in the other, to the seat of the pain.

Strychnine, endermically applied, causes, according to Dr.

*Ann. Univ. de Med.--May and July, 1829.

Lembert, less topical irritation, but more suppuration, than morphine. Its constitutional action seldom begins in less than two hours, and it continues from five to twelve hours.

The effects were the same as those produced by its internal application. Dr. Lembert used it with success in several cases of paralysis; in which application of this medicine his experience is confirmed by that of M. Bally and others.

Strychnine has been lately used with flattering success in cases of amaurosis; that variety which depends on paralysis of the optic nerve and retina, or a congested and inactive state of the capillaries of the neurilema, producing pressure on the nerve, In cases of structural derangement, it, of course, could not be expected to produce any good effect.

Dr. Thomas Shortt, of Edinburgh, claims the merit of having first applied strychnine, by the endermic method, in amaurosis. His paper* is well worthy a perusal. A number of cases are given, and the results are encouraging. Some of them were entirely cured, and in all there was evident improvement.

In one or two cases the stimulating effects of the strychnine caused an absorption of opacities of the cornea.

He applied the blisters to the temples, and sprinkled the strychnine in doses, increasing from one eighth or one fourth of a grain, to two and half and three grains. In some, the action of the strychnine was greatly assisted by the previous use of mercury, internally; and in one case it failed altogether until mercury was resorted to.

More lately, these favourable reports have been confirmed by Mr. Middlemore, Assistant Surgeon in the Birmingham Eye Infirmary. Several cases of amaurosis from an atonic state of the nerve and retina, which had baffled all the common modes of treatment, were cured by the endermic application of strychnine. A narrow blister was placed over each eye-brow; when it had risen sufficiently the cuticle was cut away, and a piece of linen was applied for half an hour to absorb the serum. The strychnine was dusted on, in fine

*Edinb. Med. and Surg. Journ.—Oct. 1830.

powder, chiefly in the direction of the supra-orbitary nerve. Twenty-four hours afterwards, at the second dressing, the blistered surface was covered with a piece of linen spread over with ung. cetacei. The quantity of strychnine was gradually increased, from one twelfth of a grain until the vision was improved, or disagreeable effects were produced.—When the medicine caused pain, he mixed it with flour or opium, or suspended its use, until he had relieved the chylopoietic organs by appropriate medicines.*

There are undoubtedly many cases of amaurosis in which no benefit could be possibly hoped from the application of strychnine, yet in many others, especially when they are of recent origin, this remedy seems to afford us another "loop to hang a hope upon."

The SULPHATE OF QUININE proves more irritating to the denuded cutis vera than either morphine or strychnine. In the state of powder it is, consequently, ineligible; exciting, when used in that form, livid redness, inflammation, the formation of a gelatinous pseudo-membrane; and often destroying, here and there, the vitality of the surface, so as to occasion small sloughs. When mixed with a little cerate no such disagreeable effects are produced.

The observation of these irritating effects of the sulphate of quinine has induced M. Pointé, (Hotel Dieu, Lyons,) to apply the remedy in cases where its internal use was impracticable, by friction on the gums and internal parts of the lips, in which way he found it fully efficacious; the only inconvenience being the extreme bitterness of the drug. He details nine cases of intermittents which were cured in this way, by the application of from four to eight grains, morning and evening.†

M. D. Martin‡ employed the sulphate in the form of fine powder mixed with cerate, according to the common endermic mode, in intermittents, and stated that it never failed to

*Amer. Journ. Med. &c.—9, 231.
†Memoir to the Royal Acad. Paris, 1826.
‡Revue Medicale—Sept. 1827.

check the fever at once. He applied four to eight grains daily. The experience of M. Lembert accorded with that of M. D. Martin. He asserts, that ten or fifteen minutes after the application of the remedy to the arm, a sensation of warmth diffused itself along the limb towards the trunk, and thence slowly throughout the whole body; the capillary system became injected, and the pulse stronger but not more frequent, nay, sometimes even slower; the sensation of warmth is often accompanied by a prickling, of the skin; the muscular power is increased; and this state of excitement, or increased action, lasts for several hours.

Without fatiguing the reader with any more cases by the European practitioners, we will merely give an abstract of Dr. Gerhard's experience in the use of this article by the endermic method.

He treated twenty cases of intermittents, in this way, with the most perfect success; and asserts that it cures more speedily than when given internally. The blister and the quinine were always applied during apyrexia; and bleeding in the hot stage, with the use of mild cathartics, was not neglected. The average quantity of quinine exhibited before the paroxysms were stopped, was twenty grains. Leaving the question of the modus operandi of medicines applied in this way, for the discussion of those who are so inclined,* the writer is convinced that the endermic method is a valuable addition to the arts of practice; and believing that a knowledge of what has been writen of it will plead most successfully in its favour, he has done little else that present to the reader a condensed view of the experience of others, leaving him to form his own theories and his own opinions.

Let him, however, when making up his conclusons on the merits of this mode of practice, give proper weight to some of its disadvantages; which are as follows:—

This practice is attended with the disagreeable necessity of raising a blister; and the blistered surface becomes in

*All the writers on the subject affirm, that the medicine applied in this way is absorbed, so that often, at the subsequent dressings, none, or scarcely any is found upon the surface of the skin.

some cases, a painful, even a suppurating, and sometimes a sloughing sore; producing, by its irritation, disagreeable effects upon the constitution.

These, however, are extreme cases; and the endermic method is not likely to be resorted to when medicines applied internally will produce the desired effect.

Art. II.—*Observations on Sanguineous Tumors of the Vagina.* By Hugh H. Toland, M. D. of Newbury Village S. Carolina.

IN consequence of the frequent appearance of many diseases, and the number of publications that exist respecting them, every member of the profession is enabled to acquire tolerably correct views, both of their pathology and therapeutics. Therefore, any article of this description, that may appear, which does not contain new and useful facts, no matter how well it may be executed, must be injurious to the cause of science, on account of the unprofitable labour it imposes upon her votaries. There are, however, others equally violent, and as frequently fatal, although of more rare occurrence, that require attention, and none call for it more loudly than the disease under consideration.

Yet it must be acknowledged that this subject has not been entirely neglected; for about six dissertations appeared, and nearly sixty cases were recorded, from the year 1734 to 1830; at which time Deneux, a distinguished French physician, collected all the facts that were then known upon the subject, and published a treatise that is much more perfect than any that preceeded it, and which must be considered as worthy of its author, and highly useful to the profession of which he is so respectable a member. Among the names of the individuals who have contributed to the elucidation of this subject by the publication of cases, may be enumerated those of Hunter, Ledran, Baudeloque, Dewees, Macbride, Mad. Lachapelle, Chaupier, ect. And Kronauer, Boer, Audi-

Art. IX.—*On the mode of Collecting and Preserving objects of Natural History, with a view to the formation of a Cabinet, or to their transportation.* Read before the Medical Society of Lexington, by Robert Peter, M. D.—and published at its request.

IN selecting this subject for the basis of a few remarks, I was prompted by the evident interest expressed by your late resolutions in the cause of natural science; and by a desire to contribute my mite, however small, to aid in the laudable enterprise in which you have embarked; viz. the formation of a Museum of Natural History.

Interesting and attractive as the works of nature always are, to the man of observation in any part of the world, those of our own beloved West, for variety, number and beauty, are not perhaps to be surpassed in any quarter, while they possess this still further incentive to their study, that they have, as yet, been comparatively little examined by naturalists. Fascinating as this study is of itself, it cannot but be doubly interesting and instructive to medical men. We accordingly find, that among them nature has always found her warmest and most enthusiastic admirers. The study of medicine is in fact the study of nature; and the insight into her many works, necessarily given in that amount of knowledge which is requisite to constitute a practitioner, often elicits a desire for still further investigation.

The formation of a museum is one of the best modes of facilitating this study. Objects from all the kingdoms of nature placed side by side, can be examined and compared, and all their points of peculiarity as well as all those reesmblances which connect them together into one great chain, extending from the green patch of lichen upon the rock, up to man himself, can with peculiar advantage be traced out.

Of all this, however, you are fully convinced, and I shall, consequently, proceed immediately to the subject proposed.

Much of the beauty of zoological specimens depends on the care taken in their procurement and preservation. The gun affords one of the best means of obtaining objects for the zoological cabinet. In shooting for this purpose we must employ the smallest size of shot which can be efficient, and always shoot from such a distance as not materially to injure the skin or plumage of the quadruped or bird we shoot at. We should be provided with cotton-wool, wrapping paper, writing paper, and a pencil. As soon as the animal falls we should immediately run up and secure it, to prevent it, if a bird, from injuring its plumage by its struggles, and in order to search out the shot holes and plug them with cotton, that the blood may not escape upon its feathers; an accident always to be avoided, the blood having the effect of matting them together in a very unseemly manner, and being so difficult to wash out, that it is scarcely ever attempted except in very rare and valuable specimens, in which case it is done by careful sponging with tepid water. The plumage, however, never looks so well after this ablution as it did in its natural state. In most quadrupeds, except those with very fine and light coloured fur, the process of washing succeeds much better, and we are not, consequently, under the necessity of taking so much pains to avoid the spotting of their coats with blood.

If the bird should only be badly wounded, but not killed, the best mode of putting an end to its sufferings is, to squeeze its chest for a few moments with the finger and thumb applied on each side, immediately under the wings; this compresses its lungs, and soon suffocates it. A little cotton is now to be stuffed into its throat and nostrils, to prevent the escape of any fluid which would soil its plumage, and in some birds it will also be necessary to insert a small quantity into the vent, for a similar purpose. If the crop is much distended it had better be previously emptied by holding the bird up by the legs and pressing the contents out through the mouth. Having arranged its plumage, the bird may be placed head foremost into a paper cone, formed as the grocers usually make them to contain tea, &c. and after inserting also a small note of the observations made upon the bird, the end of the cone may be closed up, and it may be placed in the game-bag, or what is still better, in a tin vasculum, similar to that used in herborising.

It will be found of very great advantage in stuffing and setting up a bird, or other animal, in a cabinet, in a natural position, to make as accurate an observation of its habit and manners as possible. For example, if a bird, observe whether he perches, whether in perching his body is held horizontally or obliquely, whether his wings droop, or are crossed over the tail, the position of the latter, the degree of extension of his legs, the carriage of the head &c. &c. The colour of the iris of the eye and the legs should also be observed, as they often change in death. A note of all these observations should be made with the pencil on a small piece of paper, and should be placed in the cone with the bird.

On a warm day, and in southern climates, decomposition commences its ravages so soon after the death of the animal, that if no precautions be taken, the lapse of a few hours will be sufficient to render a delicate bird unfit for preservation; the cuticle will begin to separate, especially on the abdomen, and the feathers will be rendered loose. The best mode of preventing this rapid decomposition, in the field, is to fill the box, or bag, in which the specimens are carried, with fresh juicy green vegetables, as mint &c. which will keep down the temperature by the evaporation constantly taking place from them until they are wilted and dry, when they are to be changed for fresh plants.

After permitting the animal to remain long enough to cool, and for its blood to coagulate, or to be absorbed from its vessels, so that it may not flow from our incisions, and thus embarrass the process, we proceed next to skin it, preparatory to stuffing. We shall first give the manner of proceeding with this end in a *quadruped*.

The animal is to be laid on its back on the table, with its head to the left hand, and an incision is to be made the whole length of the abdomen. The skin is to be separated by means of the fingers and the knife until the upper ends of the extremities are exposed; these are now to be divided at the second joint from the foot, and the tail is also to be separated from the body at its root. The body may now be suspended by means of a hook, or a piece of cord, and the skin is to be separated from the back, and the skinning continued over the neck and head until it remains attached only at the jaws around the outside of the mouth. In skinning the head, we must be careful to cut off the ears deep down into the skull, and must avoid cutting the eyelids. The body may now be separated from the head, between the latter and the first vertebra of the neck, and laid aside to serve as a model for the artificial body which is to be substituted. The head is to be perfectly cleared of all its soft parts—the tongue, and eyes removed and the brain scooped out through the foramen magnum. Each of the extremities is now to be drawn out of the skin as far as the toes, and all the muscles and soft parts removed, the bones being left to give support to the body, and a natural appearance to the limbs. The tail may also be drawn out. This is sometimes difficult, but may easily be done in most cases by means of a split stick, with which the integuments are pressed back, while the tail is pulled out of them. All fat or other soft matter must now be removed from the skin, and if it is a large one, it has been recommended to immerse it for a day or two in a moderately strong cold solution of alum and salt, in order more fully to preserve it. This however, will be found in most cases unnecessary. The whole of the inside of the skin, all the bones &c. are now to be covered by means of a brush, with a coat of arsenical soap, made into the consistence of cream with water.

This soap, originally proposed by Becœur, has now stood the test of experience, and is the best preservative which is at present known. It may be formed by taking of

White soap,	32	parts,
Salt of tartar, or carbonate of potash,	12	do.
Quick-lime—slacked,	4	do.
White arsenic (arsenous acid,)	32	do.
Camphor,	5	do.

The camphor is to be pulverised in a mortar, previously adding a few drops of alcohol; the soap may then be added and worked into a soft paste with a little water, the other ingredients may then be well rubbed up with it, adding as much water as will make the whole of the consistence of butter. It may be kept in a wide mouthed bottle, or a covered jar, and will retain its virtues any length of time, merely requiring to be mixed with a sufficient quantity of water when it is to be used.

A more quick and effectual process, perhaps, is to mix all the ingredients, except the camphor, together over the fire, in a sufficient quantity of water; the camphor, pulverized, being added after the mixture has cooled.

Care must be taken during the whole of the process of skinning, to prevent the soiling of the skin by blood and other matters. And to prevent the embarrassment which the damp clammy nature of the freshly exposed surface of the flesh would cause in skinning small animals, causing the fur to stick and become soiled; it is better to be provided with some carb. magnesia, or ground plaster of paris, with which to rub the flesh in order to destroy its adhesiveness.

Having given the skin and bones a good coat of the preservative soap, if it is intended to send the skin away without stuffing, it is to be drawn back over the head, having previously stuffed the orbits of the eyes and the cranium and the spaces occupied by the temporal muscles, with cotton, tow, hemp, or the long tree moss of the south. The leg bones are next to be wound with tow, as nearly as possible of the shape which they had when covered by their muscles, and the skin is to be returned over them. The skin of the tail is to be stuffed out to its natural size, by means of a piece of wire wound with tow, covered with the soap, and inserted into it; and the body is to be loosely stuffed out with any light vegetable matters, such as cotton, tow, spanish moss, or hay. The dimensions of the body, the colour of the eyes, and other necessary particulars, may then be noted on a piece of paper, which is also to be inserted into the body with the stuffing. In this state, after the skins are sufficiently dry, they may be transported to any distance, after being securely packed in a tight box.

But if it is intended to set up the specimen in a natural position, and to make a finished preparation, the mode of procedure must be somewhat different. After having skinned it and coated it with the preservative, as before stated, it will be necessary to form an artificial body, and to introduce wires into the limbs, in order to support it. Five pieces of iron wire must be taken, of a size proportionate to the weight of the body they are intended to support; they must be previously made red hot in the fire, in order to destroy their elasticity. These must be each filed to a sharp point at one end. Four of these are to be introduced into the legs, and must be of such a length that after being introduced into the leg, and fastened into the artificial body, they will project several inches beyond the foot. The fifth wire is to be several inches longer than the body of the animal, including the neck and head. Upon this fifth wire we wind a quantity of tow, or other light vegetable material, as nearly as possible of the shape and size of the real body and neck of the animal, taking the denuded carcass as the model; commencing our winding close to that end of the wire which is not sharpened. Having formed the body to our satisfaction, and having given all the inside of the skin and the bones a coat of the preservative, and returned the head as before directed, we pass the pointed end of the wire up the neck, into the foramen magnum of the head, and through the skull and skin just between the eyes; leaving it projecting there until the animal is dry, when it may be cut off close to the skin. In some cases, when the skull is very hard, it will be necessary to pierce it previously with an awl for the passage of the wire.

The end of the wire which was introduced into the tail is now to be stuck into the body, and fastened there by bending; and a wire is to be introduced into each foot and run up each leg, by the side of the bones, and after a sufficient quantity of tow has been wound on the bones of the leg to give it the natural size and shape, the wires are to be stuck into the body and strongly fastened there by bending and twisting.

The skin may now be sewed up; the needle being passed from within outwards, so as to avoid including the hair, passing it successively from one side to the other, until the whole of the incision is sewed up, taking care as the sewing progresses to add cotton, tow, &c. in any places where the stuffing is deficient. The hair may now be brushed down over the suture, which will completely hide it. It now only remains to place the animal in its proper position to dry, and subsequently to introduce artificial eyes made of glass.

In order to set the animal on its feet we must make a small platform of wood, by merely nailing two strips under a flat piece of board, to support it a short distance from the ground. In this board we make four holes for the passage of the wires which project from the feet of the animal, and the wires being passed through these holes and then bent backwards will hold the animal in an erect posture. We can afterwards, by bending the wires of the legs and body, give the animal any desired attitude. The nature and shape of the support on which we place the animal must of course vary according to the posture which we may wish to give it.

Having introduced small rolls of paper into the nostrils, to keep them distended, and placed each of the ears between two pieces of paste-board to prevent them from curling up, we put the animal in an airy place to dry. In some cases, it will be necessary to keep the lips together by means of a few stitches, and to support the head by fastening the wire which projects from it into an upright stick fixed into the platform.

The preparation of *birds*, although much care is requisite in keeping the plumage unruffled and free from the soil of blood or other matters, is, upon the whole, a more easy task than that of quadrupeds; as in the former the plumage, by judicious management, may be made to cover many defects, whereas in the latter every little imperfection is easily visible.

The general character of the process is the same in birds as in quadrupeds, with some slight modifications. We place the bird in the same position, and pushing aside the feathers, make an incision through the skin from the top of the breast to the vent. The skin is then to be removed until the extremities are visible; the legs are to be separated at the second joint from the foot; the wings divided close to the body; and the tail cut through close to the insertion of the tail feathers, leaving a small piece of the rump attached to the skin. In the whole of the process, we must be very careful not to stretch the skin, as it would destroy the smoothness of the plumage, and we must employ a sufficiency of magnesia or powdered plaster of paris on the denuded flesh to prevent the feathers from sticking to it. Before skinning the neck it will be necessary to put cotton in the throat and nostrils, to prevent the escape of any liquid to soil the plumage, and to pass a string or wire through the nostrils, leaving the ends so long as to serve to lay hold of, when the skin of the neck is inverted over the head like the finger of a glove turned inside out, by which to draw it out again when the cleaning of the head is completed. The skinning is to be conducted as already advised, and the head to be separated from the first vertebra; the brain and tongue are also to be taken out, and the eyes withdrawn from within, by breaking through the bony palate. Then, having given the bones and skin a good coat of the arsenical soap, and stuffed the orbits, and the spaces before occupied by the muscles, with cotton, the skin is to be drawn back over the head. The thighs are now to be drawn out of the skin, and the muscles removed, and the whole inside of the skin and the surface of the bones covered with the preservative. In large birds it is necessary also to skin the wings as far as possible, to remove the soft parts, but in small ones this may be omitted. As a general rule, however, every soft part is as far as possible to be removed.

In the formation of the artificial body, we proceed very much as already indicated for quadrupeds, except that the wire on which we form it should be pointed at both ends, one end to be passed into the remains of the rump to support the tail, while the other end is passed up the neck, and through the skull at the front part of the head. We must of course make our artificial body and neck as nearly as possible of the size and shape of the real one. A wire sharpened at one end is now to be passed up each leg, beginning at the bottom of the foot, and a sufficient quantity of tow is to be wrapped around the wire and bone of the thigh to replace the flesh which was removed. The sharp end of the wire is to be firmly fixed, by twisting, into the body at the place where the legs are naturally attached, a sufficient length of wire being left projecting from the feet to fasten the bird to the stand on which it is to be placed to dry. The skin is now to be sewed up in the manner already indicated, taking care to avoid including any of the feathers. After bringing back the feathers in a natural manner over the suture, the bird may be placed and fastened on its stand by introducing the wires of its feet into suitable holes made for the purpose. The nature of the stand must vary according to the habits of the bird. If it perches, it may be formed by nailing a round stick horizontally on the top of a vertical one, which is fastened to a suitable foot to prevent it from upsetting. Two holes are bored in the horizontal stick to receive the wires of the feet, which, after being passed through the holes, are twisted around the stick to make them firm.

The bird is now to be placed in a natural attitude by bending the legs, neck, and body. The wings which hang loosely and in an unseemly manner, are to be pinned to the body by two wires passed through them; the plumage is to be smoothed and arranged, and it and the wings are to be kept in their proper places by thread wrapped loosely several times all around the body. The tail may be kept straight by means of a small piece of split cane, or small splints of wood tied above and below at its root; the beak tied shut, and the head supported by tying it up, by means of the same thread which is used in closing the bill, to the wire that projects from the top of the head, which is to be bent down in a proper position for the purpose. The artificial eyes may now be introduced, and the eyelids carefully arranged over them, and the bird may be set aside to dry. When dry, the pins of the wings may be removed, the thread, &c. taken off, and the wire projecting from the forehead cut off close to the skin, and it may be placed in the cabinet.

When our object is merely to preserve the skin, with a view to stuff it at some future day, or to transport it to another part of the country, it will not be necessary to use the wires nor to form an artificial body, but after we have well cleaned the skin and the bones which are left, and covered the whole on the inside with the soap, we loosely stuff the neck, body and thighs, with cotton, and merely draw the cut edges of the skin together without sewing, placing in the skin the note of observations made on the bird while living, having added to it a note of the dimensions of the body which we have removed. Skins dried in this manner, wrapped in paper and packed in some soft material may be transported a great distance without injury, and may afterwards be stuffed and set up by softening the skin again by moisture, and giving it a fresh coat of preservative.

I have now endeavoured to give a general outline of the process of preserving quadrupeds and birds, but it must be evident to every one conversant with the great diversity of nature, that it would be impossible, in the short space to which I am restricted, to give all the varieties of the process to which this diversity gives rise. I consequently leave much to be added by the ingenuity of the beginner, who in engaging in this pleasing occupation, will find much in which to consult his judgment, and much wherein his taste must direct him. Some few more particulars, however, seem to be necessary.

When large holes are made in the skin by shot, or otherwise, an attempt may be made to stitch them up on the inside. When the head is so large, and the neck so small, that the skin of the neck cannot be passed over the head without stretching it, which in birds must always be avoided, a longitudinal slit may be made in the skin of the neck, which is to be sewed up again when the head is returned.

In large birds with fleshy feet, it will be necessary to make incisions in the bottom of the toes, to remove some of the soft parts, and to introduce some of the preservative. And in web-footed or palmated birds, the webs must be prevented from curling or shrinking in drying by pinning them out on the board on which the bird is placed to dry. Wires must be introduced into the wings of very large birds, and fastened into the body, in the same manner as the wires of the legs. In the whole of the process of preparation, it should be the aim of the preparer to give the animals as much the appearance of life as possible. The attitudes which he gives them should be graceful, natural, and varied, and should be founded on observations made on them in the living state. In this consists the perfection of the art, which peoples our cabinets with the timid songsters of the grove, and which by its magic almost makes us forget that they are mute.

Some observations are necessary on the preservation of other classes of animals, but they will not detain us long.

The different species of *Lacertæ*, from the Alligator to the small scaly lizard of the woods and fences, called commonly "*scorpion*," may be prepared on the same general principles as the quadrupeds and birds. A great variety of these exists in the western country, which are highly interesting to the naturalist. In skinning these animals, it will be remarked that the integuments are so firmly fixed to the front of the skull that no attempts need be made to remove them. The small species may be obtained by means of a long switch with which they may be struck on the back, or by means of a hook baited with a fly. The soft-skinned species which live under damp logs, and under stones, and those which inhabit the water, called newts, "ground pups," or "water dogs," had better be preserved in whiskey, which, upon the whole, is the most easy mode of preserving the small species of the scaley kinds also.

The various kinds of *Tortoise*, whether of the land or of the water, which possess a hard shell, may be stuffed with advantage. The soft shelled kinds make but bad dried preparations, and are generally preserved in whiskey.

In order to prepare a tortoise, we saw the connection between the upper and the lower plate of its shell, at the under part of the body at the side, and then cut the lower plate entirely out by separating the integuments close to this plate all around. All the soft parts are now to be removed from the shell and skin, the skull, and the bones of the legs being left, the brain, &c. well cleaned out. The inside is then to be covered with the preservative, and the neck, legs, tail and shell, filled out to their natural size by judicious stuffing with tow or other suitable materials. The skin is now to be stretched over the stuffing, by means of thread passing in all directions across from opposite points, being passed through it by means of a needle, so that when the lower plate is laid in its place none of the stuffing can be seen. The lower plate is to be fastened in its place by two pieces of wire, which fix it to the upper plate by means of holes, which perforate the two shells where the section was made with the saw. The head, body &c. being supported in a natural position, and the feet pinned out upon a board, the preparation is set aside to dry. And when dry, it may receive a coat of varnish, which, if we have taken the precaution, previous to stuffing it, of washing the shell well with a hard brush, will make its natural colours show to advantage.

The small kinds of *Snakes*, and other reptiles, may be preserved in clear whiskey, or a mixture of one part of alcohol and two of water; but the large kinds may be skinned. The best mode of procedure, in some cases, is to open the mouth and cut through the vertebra of the neck through the mouth, cutting the muscles all around, and taking care not to cut the skin, the whole body may thus be skinned and drawn out through the mouth. In some cases, however, it will be necessary to open the animal by an incision made down the side of the belly avoiding the abdominal plates. After it is skinned and has received a coat of the arsenical paste, fine dry sand may be poured into the mouth until the skin is completely and equally filled. It may now be arranged in a natural position, and set aside to dry, after which the sand may again be poured out and the skin varnished, after having supplied by means of water-colours any tints which may have faded from the skin. In pursuing this plan it will be necessary to avoid stretching the skin. This process may be used for snakes, frogs, toads, &c. &c., with the same general precautions which have already been given in reference to quadrupeds and birds. This mode may also be used with advantage in the preparation of some kinds of scaleless fishes.

The *Fish* of our waters are objects of considerable interest to naturalists both at home and abroad, but it is to be regretted that they are extremely difficult to preserve in all their beauty, most of their colours being so extremely evanescent, that whether we preserve them in spirits, or skin and stuff them, they are sure to fade; and the glossy appearance given them by their natural covering of mucus, is but imperfectly replaced by varnish.

The best process for stuffing these animals is that given by William Bullock, F. L. S. former proprietor of the London Museum, whether original with him, I know not. I will give it in his own words.

"Procure the fish, particularly if it be one of which the scales are large and loosely attached to the skin, as fresh as possible, lay it on its side, and cut out the gills with a pair of scissors, then introduce a little tow into the place to prevent the blood or moisture from flowing out. Then with a damp sponge carefully wipe the sides of the fish, raise the fins, and carefully extend them; cut two pieces of paper the shape of each fin but a little larger, rub a little mucilage of gum arabic on one of the pieces, and extend the fin on it, press the corresponding piece of paper on the other side, when it will adhere, and drying in a few minutes, will keep the part extended, and preserve it from injury in handling or transportation. When this is completed, take a piece of thin silk paper, and neatly cover over one side of the fish; the natural gluten of the fish will cause it to adhere firmly to the scales, and it will presently dry and form a strong case over them, and admirably preserve them in their places whilst you take the skin off. After the first coat of paper is dry, it may be still further strengthened by applying another or two of paper slightly gummed; this when dry will not only keep the scales on, but will assist afterwards in retaining the fish in its proper form, by preventing distention. When these papers are thoroughly dry, turn the fish on a soft cloth, with the uncovered side upwards, and open it with sharp scissors, from the tail to near the nose, along the lateral line, which is observable in most fishes, cutting open the cheek to enable you afterwards to clear the flesh from that on the opposite side under the bone, for unless this be done, and that part filled with cotton, it will inevitably shrink, and have a bad effect. Care and a little practice will now be required in detaching the skin from the flesh: begin at the head and work downwards, using a sharp knife in separating the skin from the flesh, and cutting off the fin-bones on the inside with scissors. When this is completely done, by taking away as much animal matter as possible, for in this consists the perfection of preserving all skins, wipe the inside dry, and apply the arsenical soap, and then, using great caution not to distend unnaturally, or in one part more than another, fill the skin to its proper form with cut tow or cotton, and sew up the incision. It may then be dried in the shade, and in a few days the papers may be taken off, by dampening them with a sponge, the glass eyes may be introduced, and the skin covered with two or three coats of varnish."

The *Insect* tribe is so numerous and so diversified that volumes have been written on it alone, and the life of one man would scarcely be sufficient for its complete study. Yet it is, when fully examined, so replete with interest and wonder that persons exist who have devoted themselves almost exclusively to this branch of nature. While so much that is more striking remains to be studied, in our country, it is not to be supposed that many will give much attention to this apparently endless pursuit, but there are, notwithstanding, many prominent objects in it which will attract the attention of the most careless observer of nature. It is therefore proper that we should give a few moments to the subject of the preservation of these animals, although time will not permit us to go into details.

Many of the nimble insects may be caught by means of a gauze net, made like the scoop-net of the angler, and fixed on the end of a cane. Many of them may be found under stones, or the bark of rotten logs, on decaying animal and vegetable matter, on trees and on plants, &c. The hard shelled kinds may be taken in the hand with impunity, only avoiding their pincers; none of them are venomous. The best mode of carrying them, and of sending them to a distance, is to provide a wide mouthed bottle filled with whiskey, in which a small quantity of corrosive sublimate has been dissolved, say one drachm to the pint. The insects are thrown into this liquid as soon as caught, and their vitality is almost immediately destroyed, and when the liquid is filled with them, the bottle may be filled up, a tight cork dipped in a mixture of tallow and wax inserted, and the mouth tied over with a piece of linen imbued with the same mixture. In this state they may be sent to any distance. To place them in the cabinet, they are to be removed from the liquid, a pin is to be passed through the upper part of the right wing, going through the body, by means of which they are stuck in shallow boxes the bottoms of which are lined with cork. Our limits will not permit us to enter into the details relative to the butterflies and other kinds of insects. Suffice it to say, that they are to be killed by heat, or by squeezing the thorax, and then stuck, by means of a pin, into suitable boxes.

The *Shells* of our rivers, ponds, and creeks, as well as those commonly called snails, which frequent the land, have attracted much attention, being so numerous, and so peculiar and interesting, that perhaps no present would be more acceptable in the way of exchange, to a European naturalist, than a complete collection of them. The best water shells are found in the softest mud of our rivers and creeks. Those which have least erosion on their surface, and which contain the living animal, are to be selected; the dead sun-bleached shells of the shores being comparatively valueless. The animals may be removed from all kinds of shells by previously placing them in boiling water, and then picking them out. If any have an *operculum*, or covering for the mouth, this is also to be preserved. The Bivalve shells are to be tied round with a piece of thread to keep them shut until they are dry, and the whole may be packed in sawdust, paper, cotton or other soft materials.

Minerals require no other preparation than merely wraping them in paper, with a note stating their locality. And it would be well enough to remark here, that as many particulars as possible relative to locality, habits, &c. should be enclosed with any specimen of natural history when sent away.

Petrifactions should be broken carefully off, with a small piece of the rock in which they are found attached, and as much information relative to the adjoining strata, as possible, should be given.

Preservation in spirits has been several times mentioned. It is admirably adapted for every variety of animal bodies which are too delicate, or too soft, for the process of stuffing. Whiskey, or any cheap low proof spirit, will answer the purpose, and the best mode of economising it, is to wrap the object, for example a fish, in a piece of muslin with a small piece of lead attached, bearing a number which refers to a catalogue sent. The specimens are then packed with tow in the bottle or keg in which they are to be sent, and when it is filled, and headed up tight, (if a keg,) the liquor is to be poured in until the vessel is full. The cork or bung should of course be made tight. Peron recommends, that corks should be soaked in a mixture of three parts of wax and one of tallow melted together, and then sealed over by a mixture of four parts of pitch, one of sulphur, and one and a half of tallow, applied hot, and tied over with a piece of muslin while yet hot, some of the cement being subsequently poured over the muslin.

Artificial eyes, which have often been mentioned, are made of coloured enamel and glass, by means of a blow-pipe, or of small semi-spheres of glass painted suitably on the inside. They may be procured in the Eastern cities, or fabricated by those who understand the use of the enameller's lamp.

In conclusion, Gentlemen, let me entreat you to persevere in your highly laudable undertaking, until the Lexington Medical Society shall be as remarkable for her extensive cabinet of Natural History, as she now is for the energy of her members, and their zeal in the cause of science.

The time is fast approaching when many of you will leave these halls, loaded with your honours, never again perhaps to revisit it—these benches will again be filled by equally numerous classes, but like the momentary pictures of the kaleidoscope, new elements will enter into their composition, and those kind faces which now surround me, will perhaps gradually fade in the tablet of memory, until but scarce a misty image will remain of the present striking reality. But there are some things which will leave an impression too deeply imprinted to be effaced, and actions which have transpired in this society will consecrate the names of their performers. Your present zeal will leave the impression, that though the duties of your profession will have the first claim upon your time and attention, yet you will occasionally steal a calm moment from its toils, and from the blandishments of the domestic circle, to cull a flower from the rich parterre of nature, and mindful of the many pleasant and interesting hours you have spent in these halls, will transmit us many a remembrancer, in the shape of a preparation of some natural object.

TRANSACTIONS

OF

THE LEXINGTON MEDICAL SOCIETY.

ART. I.—*Thoughts on some of the Applications of Chemistry to Medicine.* By ROBERT PETER, M. D. Read before the Society, November 14th, 1834.

IT cannot but be gratifying to every true friend of the medical profession that, while in every town in the west some ignorant and presumptuous quack with unblushing front pushes his way into the graces of the people, often to the exclusion of the regular bred physician;—while the notorious Thompson vends at the low price of ten dollars, his wonderful book which contains the whole art of healing, and which transforms at once the idle dunce, too stupid to be a blacksmith or too lazy to labor, into a *doctor* competent to the exalted task of relieving the diseases of the human frame, the most intricate and perfect piece of workmanship in the whole creation: it is gratifying, I repeat, that while charlatanry, in a sister state, has received the sanction of legislative enactment, and crowds of pretenders are annually sent forth by this legalized institution for the promulgation of quackery, with the title of Doctor of Medicine most falsely attached to their names, to prey on a too credulous public;—that while the mass of the people are still so much inclined to be gulled by the pretensions of *steamers* and other empirics, and to give faith to the pretended virtues of *Catholicons*, *Panaceas* and *Hygeian pills*,—so many persons have assembled together to pursue the study of medicine in a regular, scientific manner.

It is an evidence that truth, though often hidden, will finally prevail,—a cheering sign that the medical profession is not destined to be brought to the level of the mountebank and the conjurer,—a pledge that this most noble of all arts will not be borne down and trodden under foot by a savage horde of Goths and Vandals.

The belief in the curative powers of the seventh son of a seventh son, in the virtues of charms, amulets, and incantations, in short, in all the superstitious relics of past and darker ages, has, as far as I am able to judge, found but little favour among our enquiring population; but there is a belief fully as preposterous, and as destructive of human life, that has much too wide an influence among us. It is the belief that medicine is a mystery soon learnt and easily communicated,—so easily, in fact, that a knowledge of it may be acquired in an afternoon's study, or even by intuition only. A belief which fills our country with designing empirics, and which has caused a greater destruction of human life than all the victories of Napoleon.

The science of medicine is, on the contrary, one of the most extensive in the circle of the sciences; and there is no pursuit which requires a greater amount of knowledge, more judgment and discernment, than the practice of medicine. Had the science arrived at the rank of an exact one, a routine practice, founded on its fixed principles, requiring but little learning and less judgment, would be all that would be necessary; but it is by no means as yet, an exact science, much yet remains unknown of the human body, and of the causes of disease, and nothing certain is known of the vital principle. A great deal, therefore, is left to the judgment of the practitioner; and in order that he may exercise that judgment properly, it is necessary that he should be enlightened by all the knowledge pertaining to the subject. The practice of medicine, were it an exact science, would be like travelling through a country on a magnificent road, on which the skill of the engineer, and the lights of science had been employed in spanning the vallies and the rivers, and circumventing the hills; but at present it is like travelling through a country in which only the land-marks are known, where the knowledge and ingenuity of the traveller are constantly put to the test, where observations and calculations are to be made at every step, and many obstacles are to be encountered and overcome. To be an able scientific practitioner of medicine is one of the most arduous undertakings ever commenced; requiring a life-time of laborious study; but it is possible in the course of a very few years to acquire that amount of knowledge which is requisite to constitute a mere routine practitioner. The routinist studies his profession as a carpenter, a brick-layer, and a printer learn their several arts. He learns to distinguish diseases, and to know the most useful articles of the materia medica; and he applies the latter to the removal of the former according to the most approved authority. His head and his common-place book are filled with recipes and cures for all known maladies, and he applies them *secundem artem*, without caring or knowing how they act, or how the diseases are removed. Some of his patients recover under this treatment, and the cure serves to rivet his faith in his nostrums, and increase his reputation; but others die, perhaps from the force of the disease, perhaps because that disease was not fully understood, or perhaps, because the medicine which he used was not entirely adapted to remove it. Be it as it may, the doctor is unable to tell why they died,—and who is there that is wiser than the doctor?

On the other hand, the conscientious and high-minded student of medicine, unwilling to follow blindly the beaten path, studies his profession, not with a view solely to the making of money, although with a rational hope of an honorable support; but he studies it as a liberal art, the end of which is the alleviation of the miseries of human nature, and the practice of which, in a proper manner, requires profound judgment and most extensive acquirements. The human body is a complicated machine; years of study are requisite in order to understand it; but the generous student feels that he would not be competent to the relief of every exigency of disease or injury, to which the body is subject, without a full knowledge of its structure. He is sensible also that he could not understand the various functions of the organs of the body, discover the lurking disease, or trace the actions of remedial agents, and of the common supporters of life, without an acquaintance with Physiology, Pathology and Therapeutics. Nor is he satisfied until by the study of Chemistry, he is enabled to understand the nature of the compounds used in medicine, and the laws of their composition and decomposition. He is also convinced that Botany will be of great advantage to him, in making him acquainted with the vegetable treasures of his own country; and that the study of Zoology and Comparative Anatomy throws a new light on the structure and functions of the human body.

Were it possible, the physician should be imbued with every species of knowledge, for there is scarcely a department in the whole wide field that has not more or less connexion with his profession; but the capacity of the human mind is too small, man's life too short to take in so extensive a range. He must, consequently, select those branches of study which are comparatively of the greatest importance. What those branches are is a point on which there has been some difference of opinion; some for example, assert that an application of ten or more years to the study of languages, is a necessary preliminary even to that of Anatomy and Chemistry, while others would lead us to believe that even Anatomy and Chemistry might be excluded from the list of necessary studies.

One thing is certain; a physician cannot know too much, nor study too much; but there are few, however well disposed, who can find time and means to master all the collateral branches of medicine, and it is therefore of consequence that they make from them a judicious selection of studies to which to devote their attention. This selection has already been made by experienced teachers, and upon it has been based the course of instruction which is pursued in most schools of medicine. But surprising as it may appear, even this selection of studies is too extensive for some persons. The practice of medicine, they have the hardihood to say, may be successfully pursued with but a limited knowledge of Anatomy;—Chemistry may be neglected altogether, and the Institutes of Medicine may be doomed to share the same fate; so that *medicine* is contracted down into a limited knowledge of remedies and their mode of application, and some slight insight into the functions and diseases of the human body. This is, indeed, to narrow down the science to the meanest capacity, but it is to make medicine a profession to which no high-minded person would stoop. Bringing it below the level of a mere mechanical pursuit, and taking from it all the honour and dignity among men, which, when properly pursued, it is so well calculated to produce.

No one, I am confident, who is present, would be content to follow a profession of this degraded character. Your ambition aims at something higher. Honour, respect and wealth are the objects which tempt you in the long perspective, and for these you are prepared and willing to toil through years of laborious application and research.

To you, whose ambition it is to be respected as the possessors of extensive information, and to be esteemed as men as well as physicians, I need enter into no arguments to induce you to give to Anatomy and the Institutes all the attention which their undoubted importance demands; nor does the study of Chemistry need my weak assistance to establish it among those which are indispensable, not only to the well educated physician, but to the well educated man in any walk of life. But as this latter science has received much injury in the minds of many, from its injudicious friends, I propose in the course of a few remarks to exhibit some of the rocks on which these too sanguine persons have been cast away, and to show a few of its many important applications to the science and practice of medicine.

Not very long ago Chemistry deserved all that its worst enemies ever said against it. It was made up of speculation, and based upon credulity; and while some of its deluded votaries believed that by means of it, they might be enabled to turn all the baser metals into gold, to prolong human life to infinity, or even to form a living being out of inorganic materials; others, more wise but more knavish, filled their purses with the precious metal from the stores of those who were foolish enough to be the dupes of their designing pretensions. But now, having been pruned of its extravagant theories, and having settled down into an exact science, and extended its researches into all the departments of nature, it stands forth at once extensive, interesting, and highly important. Teaching us the intimate nature of every compound on the earth, and exhibiting to us the laws which govern bodies in their combinations, it is now, to an enlightened physician, an indispensable acquirement. In the study of Materia Medica, particularly, it is of immense importance, by exhibiting to us the nature of remedial agents, their incompatibilities, and the principles in which their active properties reside. Had chemistry done nothing more for medicine than merely to present it with the active principle of peruvian bark, (the quinine,) or of the other vegetable articles of the materia medica, it would still be a study worthy the attention of the medical philosopher. But it has done much more, for without it, pharmacy, or the art of preparing medicines, could have no existence. It claims, moreover, the still higher office of throwing much light on the structure and functions of the human body, and thus of being of great assistance to physiology.

Here, however, the enthusiastic friends of the science have materially injured its progress, by claiming for it more than it could sustain. Enthusiasm, the inseparable companion of genius, is ever apt to lead it beyond the pale of reason. Because they could, by means of chemistry, analyze organic matter, and explain some of the changes which take place in the body, they believed that all functions of the body were *chemical*, and that, in fact, they should finally be able in their laboratories to form organic matter, and even, like Prometheus, to endow it with vitality. But this was the day-dream of madmen, a hallucination which has long since been dissipated by the steady march of knowledge. Chemistry now pretends to no such creative power, and nothing could be a stronger evidence of insanity in a modern chemist than a belief in the possession of it. But let us also avoid running into the opposite extreme, and, because we cannot make a man by chemistry, disregard the great light which this science sheds, not only on processes in which inorganic bodies are concerned, but also on the changes which take place in the animal economy.

To set this in a proper point of view, let us take for example the process of respiration. Here, chemistry does not pretend to explain the whole of the process; without it we might have discovered that the dark blood of the veins, which is unfit to support life, becomes, by passing through the lungs and gaining contact with the air, bright arterial blood, fitted for the wants of the system; but without chemistry we should never know that oxygen was consumed in the lungs, from the air which is breathed, and that carbon and hydrogen are given out, in combination with the oxygen, in the forms of carbonic acid and water.

In like manner, the explanation of the process of calorification is as much beyond the power of chemistry, as it is beyond that of every other science. We might, indeed, learn without chemistry that respiration, arterial blood, and nervous action were necessary to this process, in animals, but chemistry alone could teach us that arterial blood has a greater capacity for caloric than venous blood, *i.e.* that it holds more caloric in combination at the same temperature than venous blood does, and that in passing from the state of arterial to venous blood, this superabundance of caloric must always be given out:—nor should we know that when arterial blood is exposed to galvanic action heat is always eliminated, which does not take place with venous blood, nor with the arterial blood more than once. That these facts are not sufficient to explain this process, by which the heat of the animal body is kept up, we are free to admit, but that they tend to exhibit the great utility of chemistry in investigations of this kind, no one we think can deny.

Without chemistry, we might know that articles of food taken into the stomach are there acted on by a fluid, the gastric juice, which, even out of the body, if kept at a proper temperature, reduces them to a uniform pulpy mass, which when formed in the stomach is called chyme; but without this science we should never know that the gastric juice, which so powerfully aids in the process of digestion, is essentially composed of muriatic, acetic, and butyric acids, and that an artificial mixture of these acids in a proper state of dilution, and at a proper temperature, is almost as powerful a solvent of articles of food as the natural gastric fluid itself. For a knowledge of all these things we are indebted to chemistry. Much more, however, remains yet to be explained in this interesting process, and while it would be highly improper to assert that digestion is entirely a *chemical* process, or even that by the aid of this science we had fully succeeded in our endeavors to understand it, it would be quite as preposterous to deny to chemistry the credit of having shed much light upon the subject.

No series of functions of the animal economy is more calculated to excite our admiration, and none has baffled more completely all attempts at explanation, than that by which the wants of the growth and the natural wear and tear of the organs of the body are supplied. Articles most dissimilar in their nature are taken into the stomach, and being there reduced into *chyme*, supply, when depurated in the upper intestines from the parts which are not fitted to the wants of the system, the nutritious *chyle*, which, poured into the veins and submitted to the process of respiration, is sent throughout the frame;—here depositing bone and muscle, there, the albuminous matter of the brain; in one part laying down stores of adipose matter, and in others furnishing the materials for the formation of bile, urine, saliva, and all the various secretions of the animal economy. The attempts of philosophers to comprehend this wonderful process of assimilation have been almost entirely futile. What it is that gives life to the dead matter of the food, and reorganizes that which was reduced to an almost inorganic pulp in the stomach, or that determines the arrangement of one set of particles into cerebral matter, another into muscular fibre, and the third into bone, will, perhaps, ever remain hidden from man. But even in this everlasting darkness, chemistry sheds some light, which, though but feeble and far from being sufficient to exhibit all the secrets of the place, yet enables us to comprehend where the mystery of mysteries resides.

What does chemistry teach us respecting these recondite processes? We learn from her that all organic bodies are in their ultimate nature exceedingly simple;—only three essential elements enter into vegetable substances, viz; carbon, hydrogen and oxygen; and but four into animal matter,—nitrogen, being superadded to the three former. The principal difference between the various forms of organic matter, in a chemical sense, is either a slight variation in the *proportion* of these constituents, or only a difference in the *manner in which their particles are arranged.* For example, (to render this latter proposition more clear,) what three substances in the vegetable kingdom are more dissimilar in their properties than starch, gum, and sugar? Yet these three bodies are each composed of precisely the same number of atoms of carbon, hydrogen and oxygen;—the only difference in them being in the different manner in which these atoms are arranged. Hence it is easy, under certain circumstances, to convert sugar, or starch into gum, or starch into sugar, without changing the proportion or the nature of their elements.

Further, we are taught by chemical research, that many of the articles which are used as food are composed of carbon, hydrogen and oxygen, in such proportions as that we may suppose them to be compounds of carbon and water, and that many of them differ only in the relative amount of water which enters into their composition. Thus sugar differs from vinegar only in containing a little less water, and in the acetous fermentation, in which sugar is converted into vinegar, oxygen, absorbed from the air, unites with some of the carbon of the sugar and passes off with it in the form of carbonic acid, leaving the remaining carbon and the water in such proportions as to form the acetic acid. Common woody fibre differs from starch, gum and sugar, only in containing a little less water, and it is possible to convert this substance into both gum and sugar. Thus it appears that a slight change in the quantity of the water which enters into the composition of an organic compound may convert it into another of quite different properties, although the chemical nature of the substance may be very little altered. The common white of egg, albumen, for example, when uncoagulated, is readily soluble in water, but when coagulated it can no longer be dissolved in that fluid, and presents upon the whole. quite a new appearance; yet the only change which has taken place is, that a little water, which before was *chemically combined* with it, is, in the process of coagulation, thrust out of combination and becomes merely *mixed* with it. As much water remains after coagulation as was in it before, but in the latter case it is *combined* with the albumen, while in the former it is merely *mixed*. If this coagulated albumen be taken into the stomach it is speedily reconverted into its former fluid soluble state, having by the action of that organ been caused to combine with a sufficiency of water for the purpose. In this state it is carried into the blood, and serves to supply the consumption of some of the organs of the body. Let us suppose that its destination is to become muscular fibre,—chemists inform us that muscular fibre is, in fact, essentially, a form of coagulated albumen; and the probability immediately strikes us that the only action of the vital principle, in producing the change from soluble albumen to insoluble muscular fibre, is, besides endowing it with vitality, to cause it to part with a few atoms of water; which is subsequently expelled by the lungs in the form of vapour. But on the other hand, let us suppose that the destination of the albumen is to serve the purpose of regenerating the skin, which is principally composed of gelatine. Here another change is necessary, for gelatine contains four or five per cent less carbon than albumen does; but this change, by the power of the vital principle, seems to be effected through the agency of the oxygen obtained through the medium of respiration, which by combining with the superabundant carbon, carries it off through the same medium, in the form of carbonic acid gas.

The facts thus presented by chemistry relative to these intricate processes, in the higher orders of animals, who feed on organized matters, are; that, in the first place, their articles of food probably contain nearly all the elementary materials, which are necessary to the construction or reparation of any part of their bodies;—that the stomach has the power, by the aid of the gastric juice, or otherwise, of so reducing and arranging these elements, and causing them to combine with more or less water, that the food, of whatever nature, is changed into a semi-fluid mass of very nearly the same composition;—that some of the elements of the food which are superabundant or extraneous, are separated in the first intestines, by the action of the bile, the pancreatic liquor, and the lacteals, and that others are thrown out in the round of the circulation, at the lungs, which throw off water, carbon, hydrogen, and some volatile substances,—at the liver, which secretes a highly carbonaceous matter;—at the kidneys, which often throw off much nitrogen in combination; in short, at all the different excretory glands of the body;—that respiration supplies oxygen, and perhaps nitrogen, for the wants of the system; and that the vital principle, whatever it is, has the power of entirely suspending the action of chemical affinity, and of arranging elementary particles so as to form organized compounds, which can only exist under its immediate action,—compounds which cannot be imitated by the chemist, but which, on the contrary, when left by the removal of the vital principle, to the sole action of chemical affinity, are speedily destroyed and converted into inorganic substances. This much does chemistry teach us relative to these beautiful and intricate processes, and the steady onward march of the science justifies the hope that much may yet be discovered. The dark veil which now hides from our view many of the secrets of creation, may by perseverance in research be finally removed; and what now is obscure may at last be enlightened, until all the mysteries of nature are exposed, and the creation presents to exalted man, one splendid whole of beautiful and wonderful design.

But here let us pause, lest, in the enthusiasm of our aspirations for the future, we suffer ourselves to run, as too many have done, into present error. The study of chemistry, it is true, tends to elucidate many of the vital functions, by giving us to understand the nature of some of the changes which take place in the animal economy, but it does not, cannot, teach us any thing of the power or causes which effect these changes. Here all is mystery; and no error can be greater than to suppose, as some enthusiasts have done, "that it is by chemistry that we live, move, and have our being." This is as great a mistake as to believe that the glass which exhibits to us a beautiful landscape, is the sole cause and origin of the prospect; or that the astronomer who points out to us

> "——— the range
> Of planets, suns and adamantine spheres,
> Wheeling unshaken through the void immense;"

who calculated and exemplified the forces and laws which govern their everlasting motions, or who studied out their forms, their seasons, and their magnitudes, was the projector and artificer of the magnificent scheme. Astronomy never did arrange a universe, and chemistry never will be able to construct a man.

Chemistry when applied to physiology is like the rude clown, who inspects the complicated machinery of a cotton factory; who hears the puffing of the steam, and the buzz of the machinery, who sees the entrance of the raw material, the turning of wheels, the discharge of the refuse parts, and then the appearance of the perfect fabric, but who knows nothing of the motive force, or of the ingenious applications of machinery which produce the wonderful effect. She can exhibit some few of the secondary means employed by the vital principle in its processes; can analize the materials used, and explain some of the changes and combinations which they undergo in the formation of organic bodies; but the power which presides, and the manner in which that power acts to produce these changes, are utterly beyond her comprehension.

As if to confound the weak reason of man, the Deity implanted in us a vital principle, whose ways are inscrutable, and whose nature mocks our closest investigations. A principle without which all organized matter would soon cease to have existence, and whose forces are exerted in direct opposition to those attractions which govern inorganic matter. Without this principle there might still be rivers, seas and winds, the gentle dew of the evening, the melting rain, or rattling hail storm;—lightning might still flash in the heavens, in the tempest, and the majestic bow might still span the evening sky;—but the dew of heaven, and the falling shower would refresh no springing plants,—no seeds would be wafted on the wings of the barren winds, and no fish sport in the rivers or in the seas; while the lashings of the storm, or the appearance of the rain-bow would not terrify or console the heart of man. Cheerless, indeed, but grand, would be the spectacle of a world submitted to the government of chemical laws, without the presence of the mysterious vital principle to call into existence the grass of the field, the green herb, the creeping thing, and proud man the image of the Deity.

Descending in our investigations to the lower orders of beings, chemistry renders us more important assistance; and in the vegetable kingdom, we first detect the vital principle, labouring in the construction of initial organic matter for the food of animals. Few, if any, of the animal tribes are endowed with the faculty of subsisting on chemical or inorganic substances:—the force of chemical affinity among the elements must be somewhat overcome by vitality, before they can serve for the food of these more perfect beings; but plants have the power of working up inorganic matter, water, and carbonic acid, into the organic compounds, starch, sugar, gum, gluten, woody fibre, and all the various well known vegetable products; and of selecting, from the wide field of rude nature, the elements which are essential to the nutrition and growth of animals, and of arranging them in such proportions, and in such forms, as are at once most pleasant, and best fitted to the purposes for which they are designed. Next, the herbivorous animals elaborate, by their powerful and extensive digestive apparatus, these products into more perfect forms of organic matter, fitted to the nutrition of carnivorous animals, who, having but little to do in the selection or arrangement of elements, are provided with digestive organs of the greatest simplicity. Thus the eye of philosophy, aided by physiological and chemical research, can trace, in the wonderful economy of nature, the never ceasing revolutions of unchangeable elements, through the various forms of inorganic and organic matter; can see them in the plant first fitted to be the recipients of life, then arranged into the most perfect state of animal matter, and then, the master spirit being removed, reduced by the common process of decay, into a few solids, liquids, and gases, ready to be again elaborated into new forms of existence.

But it is in the inorganic kingdom of nature that chemistry is most instructive. To confine her to the explanation of vital processes, would be to restrict her to a too narrow and a most disadvantageous field. Within the pale of vitality her laws and forces are trampled on and contemned; compounds are formed which she cannot imitate, and powers and means exerted which she is unable to understand or explain; and she is compelled to stand aside, and be content with the analyses of results and the knowledge of ultimate facts; but in inanimate nature, her sphere is wide and extensive—nothing is done which she cannot imitate, and no change occurs which she cannot explain. Here there is no uncertainty, but she proceeds, with the accuracy of mathematical demonstration, to the erection of a fabric of truth, which will be as immutable as its eternal author. Taking up every form of matter on the earth, she has submitted them to analysis, and exhibited the simple substances of which they are composed, and shows us that by the combination of these simple bodies, not much more than fifty in number, all this immense variety of substances is constructed. The powers and actions of affinity, electricity and magnetism also come within the sphere of her investigations; and no natural phenomenon, dependent on the motions of the particles of bodies can be understood without her assistance. The importance of chemistry, therefore, to a medical man cannot but be very evident. Is it important that he should have an extensive and profound knowledge of the nature and habetudes of bodies, in order that he may be fully prepared to use them with the greatest advantage in the prevention and cure of diseases? Chemistry alone can give him the requisite kind of information. Is it desirable that he should be fully acquainted with all the modifying actions of caloric on inanimate nature, exemplified in the rushing tornado, or the ventilation of a hospital;—in the furious rain, or the gently distilling dew, as well as in the mists of the valley, or the clouds of the upper air;—in the currents of the ocean as in the heating of a liquid? It is to chemistry that he must resort for the knowledge of all these things. Ought he to know the nature of the electric fluid, as seen in the dreadful flash in the storm, or in the playful corruscations of the aurora borealis, now lending buoyancy to the clouds, and then precipitating the sudden hail storm? Chemistry alone can give him the desired instruction. By her he will be taught that this universal fluid, always tending to an equilibrium, but never at rest, is set in motion by the most trivial causes; not only by the friction of glass in our common machines, and the action of acids on dissimilar metals in the galvanic battery, but also by the evaportion or freezing of water, the burning of combustibles, the friction of wind upon solid bodies, or the pressure together of two pieces of orange peel;—that, in fact, scarcely any two bodies can be placed in contact, and no two substances can combine together, without some disturbance in the electrical atmosphere;—that a galvanic battery may be constructed by piling up slices of beet-root or by alternate layers of brain and muscle; and that electricity is developed whenever any substance is partially heated. When we see its powerful command over chemical attraction, as exemplified by the galvanic battery, whose decomposing action no known compound can withstand; and learn the powerful action of electricity on the animal economy, and its probable connexion with a healthy or epidemic condition of the atmosphere, we cannot but be convinced of the importance of the study of this part of chemical science.

But to you whose presence at this medical school, is an evidence that you are determined to keep up the dignity of the profession, by making yourselves enlightened and scientific physicians, enough has been said on this subject. Let me conclude, therefore, by entreating you to fulfil to the utmost of your abilities, the pledge which you have thus publicly given. To your protective care will its honour be committed: let not its brightness be sullied in your custody. Physicians of the present and of past ages, have been the philosophers, the benefactors and the guardians of society; respected for their learning, they have filled the highest seats in the circle of science; and venerated for their philanthrophy, they have erected monuments more durable than brass. The practice of medicine has been, and ought to be, ranked among the most honorable of all professions. Will you permit it to sink in your hands? Shall the title of *Doctor* become an object of scorn, and the practice of medicine a mere scramble for money, in which the *steam-quack* and the self-styled *regular* physician, regardless of shame, deaf to honour, and blind to the wants of their patients, join in unhallowed contest! Heaven forbid that it should suffer such pollution!

Conscious that moral worth and extensive learning can alone command a proper degree of respect in the profession; that assiduity and perseverance can alone bring learning; you will, I trust, by constant application and untiring zeal in the acquisition of knowledge, endeavour to rise above the level of the mere routinist, and by meriting a place among *medical philosophers*, be at once benefactors to your race, and illustrious supporters of the dignity of the profession.

Notice of the Crab Orchard Mineral Springs. By ROBERT PETER, M. D.

Having been much gratified, a short time since, by a hasty visit to the vicinity of Crab orchard, Lincoln county, in this State, I was struck with the circumstance that, although a number of interesting mineral springs existed in that neighbourhood, no notice had been taken of this locality, either by Dr. Drake, or by Dr. Yandell, in their useful papers on the mineral waters of Kentucky. To endeavour to supply this deficiency, I made such an examination of the waters, during my short stay, as a few reagents, which I had carried with me for the purpose, enabled me to make; and now offer the results, not by any means as those of a correct analysis, but as merely calculated to give a general idea, correct as far as it goes, of the nature of the springs which are found in that place.

The village of Crab orchard is situated near the eastern border of Lincoln county, on the Cumberland gap road, and near the head waters of Dick's river, a small stream which, passing on and forming the boundary between Mercer and Garrard counties, soon enters into the Kentucky river, near the Upper Shaker ferry. In the vicinity of Crab orchard, Dick's river is a tame and uninteresting stream, but as it approaches the Kentucky river, its banks become more steep and picturesque, until it finally passes between mural cliffs of grey limestone, which are represented to be fully as high and as romantic, as those which bound the river into which it empties, reminding one forcibly of Scott's graphic description, in his Rokeby, of the course of the Tees, which,

————"Full many a fathom low
Wears with his rage no common foe;
For pebbly bank, nor sand-bed here,
Nor clay-mound, checks his fierce career,
Condemned to mine a channeled way
O'er solid sheets of marble grey.
*   *   *   *   *   *   *   *
It seemed some mountain, rent and riven,

A channel for the stream had given,
So high the cliffs of limestone grey
Hung beetling o'er the torrent's way,
Yielding, along their rugged base
A flinty footpath's niggard space,
Where he who winds 'twixt rock and wave,
May hear the headlong torrent rave,
And like a steed in frantic fit,
That flings the froth from curb and bit,
May view him chafe his waves to spray,
O'er every rock that bars his way."

The village and the springs of Crab orchard, are on an extensive elevated plain, where there formerly existed, a considerable forest of Crab apple trees, which gave the name to the spot, and which was celebrated as a central gathering place, for those adventurous travellers, who wished to pass into the then uninhabited and almost trackless South and West, and who went in parties for mutual assistance and protection. Within a few miles, rise several hills, which give an agreeable relief to the eye in the distance, and which would afford healthful and delightful exercise to the invalid who is strong enough to ascend their sides;—or should he prefer the exhiliration of a deer hunt, the woods, in the immediate vicinity of the town, would afford him ample gratification.

The strata are principally coarse, arenaceous limestone, alternating with a black bituminous shaley slate, and beds of clay, indicating a near approach to the extensive coal formation of the state. I observed no organic remains in any of the strata of the neighbourhood. Embedded in the clay, and in some cases also in the slate, are found a great number of silicious geodes—round hollow balls of flinty stone, lined, in many cases, with crystals of quartz, or botryoidal crusts of *hyalite*. The soil is not remarkably fertile, and with the nature of the vegetation, is strikingly different from the rich country of the Elkhorn, affording to that rare character, the Botanist, a rich and various treat, in the extensive flat, and on the sides and the summits of the surrounding hills. Among other vegetable productions, the *Andromeda arborea*, or sour wood, a small tree, is conspicuous, at this season of the year,* by its beautiful compound racemes of white flowers; and, in the fields, and the wet places of the plain, the *Cassia chamæcristi*, very abundant, and conspicuous from its yellow flower and finely pinnate leaves, and the richly purple flowered *Rhexia virginica*, are evident even to the common observer. In many places the ground is carpeted with the *Sarothra hypericoides*, interspersed with the various-hued flowers of several *Polygalas*. On the hills, the pine is often met with, and whortle-berry bushes of various species, almost entirely usurp the tops of the ridges.

The springs, seven or eight in number, are scattered over the plain at various distances from the establishment of Mrs. Davenport, the proprietress of the principal of them, and afford, perhaps, a greater variety in kinds and strength than is to be found at any other watering place in the state; there being three *Chalybeate* springs, two *Saline* springs, and two or three *Sulphur* springs; one of them, which I did not see, is said to yield a saline sulphur water.

The *Chalybeate* springs are nearest the establishment of Mrs. Davenport, who is now engaged in fitting up a number of cottages for the reception of company. The water from each of them gave very nearly a similar reaction, with the tests which I used; for example, with the

Muriate of Barytes, it afforded a copious white precipitate.

2. *Infusion of Galls*, immediately struck a deep purple colour.
3. *Ferro-cyanate of Potash*, caused a blue precipitate.
4. *Oxalic Acid and Oxalate of Ammonia*, each caused a slight white precipitate.
5. *Carbonate of Ammonia and Phosphate of Soda*, threw down a slight white precipitate.
6. *Lime water* gave a white precipitate, soluble in nitric acid; and,
7. *Nitrate of Silver*, caused a scarcely manifest turbidity of the water.

*Beginning of August.

Acetate of Lead gave no indication of the presence of sulphuretted hydrogen.

The water, upon standing a short time, deposites a dirty, orange coloured ochre of iron, and a thin, iridescent film is formed upon the surface, owing to the escape of carbonic acid which held some of the oxide of iron in solution, and to the decomposition of the sulphate of the protoxide of iron, contained in the water, by the oxygen of the atmosphere, which by *peroxidating* the iron, causes it to be precipitated.

The substances, then, detected in these waters, by this rude examination are *Sulphuric acid*, indicated by expt. No. 1., *Oxide of iron*, indicated by 2. and 3., *Lime*, shown by 4, *Magnesia*, detected in expt. 5., *Carbonic acid*, by No. 6, and a trace of *Muriatic acid*, shown by No. 7; and we may suppose these various substances to be united together, in the water, into the following compounds, which are, most probably, the saline ingredients contained in it, viz;

Sulphate of Iron,
Sulphate of Lime,
Sulphate of Magnesia,
Carbonates of Iron and Lime,
and a trace of a Muriate.

The three *chalybeate springs* are at various distances from the house, and are of somewhat different strengths. The nearest one is only about one or two hundred yards distant, the next, called the "Field Spring," is but a short distance further, in an opposite direction, and the third, called the "Brown Spring," from the colour of its deposite, flows out of the side of a gentle slope about a quarter of a mile distant. This latter spring is decidedly the strongest of the three, while that nearest the house is the weakest. Each of these springs, as far as could be judged from the position of the rocks in the neighbourhood, flows out from the sandy limestone.

The only *Saline spring*, (called the "Epsom spring,") the water of which I tested, is situated about a mile from Mrs. Davenport's, and about a quarter of a mile from the Stanford road; but, when it was too late to enter into an examination, the water of another spring in the neighbourhood was brought in, which to the taste, seemed much stronger in saline ingredients, than this, although apparently of very nearly a similar character.

Reagents, indicated the presence of the following substances; viz:

Sulphate of Magnesia,
Sulphate of Lime,
and the Carbonates of Magnesia and Lime.

No iron could be detected, and only a trace of a Muriate.

The two "*Sulphur springs*" are at a greater distance than any of the others from the establishment.

The "*Black Sulphur*" spring flows out from the black shaley slate, at the edge of a small creek, about two miles from the village, on the Somerset road. It is but weakly impregnated with sulphuretted hydrogen, which, however, is sufficiently evident in the water at the spring, both by its peculiar taste and smell, although a bottleful of the water carried from the spring and kept a few hours, in a common glass-stoppered decanter, had lost all traces of its presence. The black sediment which it deposites, and to which it is indebted for its name, is doubtless sulphuret of iron, the result of the precipitation of the iron, from a small quantity of the sulphate or carbonate, by the sulphuretted hydrogen. The amount of iron, however, present in the water, is so small, that it could not be detected by galls or the ferro-cyanate of potash. This water was found to contain

Sulphuretted hydrogen,
Sulphate of Lime,
Sulphate of Magnesia, in exceedingly small quantity,
and a trace of Muriate of Soda.

The "*White Sulphur*" spring rises in a small ravine, that crosses the Cumberland gap road, about four miles from Crab orchard. It is rather weaker than the last; makes no deposite; contains no iron; and holds in solution, besides the saline ingredients contained in the other, a minute quantity of muriate of soda, rather larger in amount than that of the Black Sulphur spring.

It must be evident that these springs, so various in their kinds, situated on a high and salubrious flat, and so placed as to render exercise on foot, on horseback, or in a carriage, almost a necessary attendant upon the drinking of the waters, offer many inducements to those who visit watering places really for the benefit of their health.

It is not my intention to enter into a long disquisition on the mode of using the water of these springs, nor on the cases in which its use might be appropriate, for it would be only repeating what has already been so ably said by Dr. Drake, in the 2d. Vol. of the Western Medical Journal, by Dr. Yandell, in the 5th Vol. of this Journal, and by Dr. Bell, in his valuable work on "Baths and Mineral Waters." What is said by those gentlemen relative to the *Chalybeate*, *Saline*, or *Sulphur* waters which they have examined, or of which they write, will apply equally well to these. To these writings, therefore, I refer the reader who may be interested in the subject. One precaution, however, it may not be improper to give, viz: that in the use of the chalybeate or sulphur waters, they should always be drank at the spring, as they both lose a great portion of their virtue by transportation, or by remaining exposed to the air. The iron is soon deposited from the chalybeate water, and the sulphuretted hydrogen soon escapes from the sulphur water.

Various as may be the opinions relative to the efficacy of mineral waters, in the cure of diseases, every one is obliged to admit that many cures, especially of chronic cases of disease, have been effected by their judicious employment. All the benefit which results in these cases, is not to be attributed to the water, nor to the medicinal ingredients contained in it, although pure water, drank in the quantities in which mineral water is usually taken, is no doubt a most valuable remedial agent, and small doses of the saline substances, or of sulphuretted hydrogen, continued throughout a length of time, produce an alterative effect upon the system, while the compounds of iron are among the best of the tonics. Yet it is universally admitted, that almost as much of the benefit which is derived from visiting watering places, in most instances, is to be attributed to the change of scene which the patient enjoys, the pleasant occupation of the mind by the presence of agreeable company, or by the examination of an interesting country, and the exercise which is taken in the open air. In selecting a watering place, therefore, for the restoration of health, the valetudinarian should, in most cases' pay as much attention to these adventitious circumstances, as to the nature or composition of the mineral water which he drinks.

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Presented by
Robt Peter

REMARKS

ON THE

FUNCTIONS OF RESPIRATION IN ANIMALS, AND ON VENTILATION.

BY ROBERT PETER, M. D.

If the interest of any subject of observation or discussion be commensurate with its importance to the health, and even existence of man, none can have greater claims upon our attention than that of Respiration:—for, from the almost invisible *monad*, which is a mere animated speck, visible only by the aid of the microscope, found in vegetable and animal infusions, up to the complicated and wonderfully constructed "lord of the creation," no animal being exists which is not immediately dependent on this function for daily and hourly existence. The celebrated Spallanzani has contributed by his numerous experiments to establish the universality of this fact. He exposed some of these minute infusory animals to the influence of an imperfect vacuum, and found that in the course of time they invariably gave indications of uneasiness; their movements became languid, and a general relaxation and death followed. But in a complete vacuum, he observed that animal and vegetable infusions, which when air is not excluded, soon swarm with millions of these minute beings, never exhibited a single animalcule; although, they soon made their appearance in great numbers, if the smallest quantity of air was admitted into the receiver. Yet these microscopic beings are so tenacious of life, that some of them may be dried up into dust, by the action of the Sun's rays, and remain in that state for a great length of time, and yet will resume their activity on the application of moisture.

Respiration is that process by which the blood, or vital fluid of the animal system, is exposed to the action of the air of our atmosphere.

To attain this purpose, so necessary to animated beings, nature has adopted a great variety of contrivances, in the various orders of animals, suited to their habits and structure, and the medium which they inhabit. For example, in the most simple animals, as the infusory animalculæ, and the polypi, there is no distinct apparatus appropriated to respiration, but the whole surface of the body, and of the open cavities, exposed to the action of the air, which is contained in the water in which they exist, perform for them the office of the lungs of more perfect animals.

In the numerous tribe of insects, whose hard, horny envelope is unfit to expose their fluids to the action of the atmosphere, air is brought to the fluids by a number of tubes or *tracheæ*, which open on the sides of the body, and ramify throughout the whole system; so that the whole body of an insect presents many analogies with the lungs of higher orders of beings; and hence insects are immediately suffocated on being covered with oil, which stops up the mouths of their air tubes.

In the extensive class of molluscous animals, we meet with great variety in the apparatus for respiration. Some which live in the water, as the oyster and the common river muscle, have a kind of *branchiæ* or gills; organs, having a great extent of surface, in which the fluids of the body are exposed to the action of the air in the water, which the animal, by various means, causes to circulate constantly by them: others of this tribe, as the land snail, and some of the fresh water univalves, receive air into certain cavities of their bodies, on the parieties of which the blood passes through minutely ramified vessels. The whole surface of the body which is exposed, in most of these animals, contributes also, no doubt, to the perfection of the process of respiration.

Respiration in fishes is almost wholly performed by the medium of branchiæ or gills, among the branches of which water is caused constantly to pass, so that the air dissolved in it, which contains more oxygen than the same quantity of air in the atmosphere, may act on the blood, which is sent to the gills by the contractions of a single heart, to pass through the minute ramifications of the pulmonary artery in these organs, and, after having been re-collected into a main vessel or aorta, to pass throughout the whole body before returning again to the heart. The amount of surface on which the blood is exposed in the gills, to the action of the air contained in the water, is very great: so great that although fully sufficient, aided by the surface of the body, for respiration, when their minute ramifications are separated by being suspended in water, although exposed only to the small quantity of air which is found in that liquid, the animal dies of asphyxia, when, on being taken out of the water, the fine subdivisions of the gills become agglutinated together by their natural mucus, leaving the exterior surface of the mass only, exposed to the influence of the atmosphere.

The respiratory process in the reptiles is a little more complicated and various. Some possess both lungs and gills; some respire by gills when young, as in the tadpole, and by lungs when in the mature state. In these animals the heart generally has two auricles and but one ventricle, and the pulmonary artery is only a branch of the aorta, so that only a part of the blood is sent to the lungs, in each round of circulation; this organ is generally in the form of a bag, that will contain air to continue the pulmonary respiration for a short time after the animal is under water. Not being possessed of the more perfect contrivances of the higher animals for inhaling air, the reptiles fill their lungs by swallowing that fluid, received through their nostrils; which they can only do when the mouth is shut; so that a frog or toad is suffocated when obliged to keep his mouth open. The process of asphyxiation would be, however, a slow one, as the whole surface of the body is an important agent in these animals, in the aeration of the blood. Dr. Edwards found that these reptiles can live for many days by the aeration of the blood, which is effected through the skin only; and proved satisfactorily the existence of this *cutaneous respiration* by the quantity of carbonic acid which was exhaled from the skin, and the oxygen which was absorbed;

indeed he found that tree-frogs were unable to subsist by the influence of pulmonary respiration alone, unaided by the cutaneous respiration.* When under the surface of the water, the pulmonary respiration is almost nothing, but life is supported for a long time by the action of the air which is contained in the water, upon the blood at the surface of the body. Dr. Edwards, by daily renewing the water in a glass vessel, at the bottom of which a male frog was secured, was enabled to keep it alive for more than two months and a half.

The mammaliæ have all a double heart, with two ventricles and two auricles, which, by the contraction of one of its ventricles drives the blood through their very perfect lungs, where it is fully exposed to the action of the air, the returning blood from this organ being forced by the contraction of the other ventricle throughout the body: so that all the blood of the body, in each round of circulation, passes through the lungs.

Birds have a yet more perfect respiratory apparatus; they not only possess a double heart, lungs, and a complete double circulation, but air is introduced through the lungs, into all the cavities of their bodies, even into their hollow bones.

Man belongs to the class mammalia, and is endowed with a complete double circulation. The heart, which is essentially a hollow muscle, receiving the blood through the *veins*, propels it out again by its contractions, through other vessels called *arteries*, has valves, artificially arranged, at the mouths of these several vessels, analogous to the valves of a forcing pump, which prevent the regurgitation of the blood, in both the veins and the arteries. The human heart seems like two single hearts joined intimately together, one of which, the right side, receives the blood through the great veins, from all parts of the body, and forces it, by its contractions into the lungs, through a large pulmonary artery, which subdivides and ramifies, in all parts of the structure of the lungs, until the branches become too minute to be followed by the naked eye; these, passing along, gradually coalesce again, until all the blood sent into the lungs from the right heart, leaves them in

*Edwards on the Influence of Physical agents on Life, &c.

four large pulmonary veins, which pour it into the left heart, to be driven, by its contractions, through the arteries, throughout the whole body.

It is in the lungs, aided doubtless, by the surface of the body, that the blood is exposed to the action of the air. The lungs being so constructed that the air, which passes into and out of them, on the expansion and contraction of the cavity of the chest, is carried through the trachea, into the minutest part of its structure, by means of tubes, the subdivisions of the trachea, and little cells, of which this organ is made up. It has been calculated, that if the whole of the surface of the lungs to which air thus gains access were spread out, it would cover 20,000 square inches of surface; on the whole of this vast surface is the blood exposed to the action of the air, being merely separated from it by an exceedingly thin membrane, easily permeated by gases.

That a thin membrane affords but little resistance to the passages of gases is now fully established. Dr. Priestly, as early as 1790, in his Essays on Air, published an account of an experiment which threw some light on this subject. He filled a bladder with blood, and on exposing it to the atmosphere, found that that fluid was rapidly reddened wherever it was in contact with the bladder, and that the coat thus reddened was as thick as it would have been had the bladder not been interposed between it and the atmosphere. Dr. Faust of South Carolina, more lately,* has performed the experiment more accurately, and proved that, under these circumstances, carbonic acid is evolved from the blood; but it is principally to Dr. J. K. Mitchell, of Philadelphia, that we are indebted for a knowledge of the force and rapidity with which gases permeate membranes.†

It is not our intention in this place, to give a full synopsis of the important and highly interesting experiments of Dr. Mitchell; for a knowledge of them we must refer to his original paper;—it is sufficient for our present purpose to state a

*See American Journal of the Medical Sciences, Vol. vii, p. 31.
†Ibid, page 36.

few of his results, as follows:—lime water, baryta water, and solution of acetate of lead, were placed severally on one side of a thin membrane of gum elastic, and the other side of the membrane was placed in contact with carbonic acid, in the first two instances, and sulphuretted hydrogen in the case of acetate of lead; the lime and baryta were rapidly precipitated by combination with the carbonic acid, which permeated the membrane, and the sulphuretted hydrogen almost instantly precipitated the lead of the acetate, placed in solution on the opposite side of the membrane. Oxygen gas, he found to penetrate membranes less rapidly than the above gases, and nitrogen much more slowly than oxygen; but in attempting to measure the *force* with which the penetration took place, he found that no pressure, that could be supported by his membranes, would prevent the passage of the gases, although he employed the pressure of a column of mercury sixty-three inches in height—equivalent to about thirty-three pounds to the square inch. Animal membranes were penetrated in the same manner, and the more *recent* the membrane, the more rapid and extensive the effect produced; and in *living animals*, the transmission was very rapid, as he proved by experiments. These facts assist us in comprehending the manner in which the fluid in the lungs, and the air, act upon each other, although a thin membrane is interposed.

The whole amount of blood in an average sized body is estimated to be about thirty-seven pounds, and about three ounces of blood is propelled at every contraction of the heart; and, as it contracts about seventy-three times in a minute, all the blood in the body passes through the lungs in a little more than two minutes and a half, or about twenty-four times in an hour. From this we can form an idea of the perfection of the circulation in man, and of the constant exposure of the blood to the action of the air in the lungs.

The blood thus exposed to the influence of the atmosphere, becomes, as is well known, remarkably changed in its colour and other properties. When sent to the lungs it is blackish-red, *venous*, blood, but when it returns from the lungs it is bright scarlet, *arterial*, blood. The blood sent to the lungs, dark venous blood, returned from all parts of the body, having once contributed to the nourishment of the system in its round of circulation, is now unfit to supply the wants and uses of the body: but on being exposed to the action of the atmosphere in the lungs, it acquires new vitality, as it were, and is fitted again to support the life and action of all the organs.

This change in the blood is essential to the support of the life and health of the system; bright arterial blood being its only fit stimulant and nourishment; and if any cause prevents the change from venous to arterial blood, by the action of the air, disease is the immediate consequence, and death soon follows if the cause is continued. This fact is daily exemplified; for example, when death occurs by drowning, it is not occasioned by the introduction of water into the lungs, but by the exclusion of air; the blood, consequently, does not become changed from the venous to the arterial state, and the action of the heart itself, as well as of all the other organs, is soon stopped, for want of its natural stimulus. In death by hanging, when the spine is not dislocated the same cause operates. This is also exemplified by holding the breath: some persons can hold their breath so long as to bring on apparent death: and this is, most probably, the mode by which those persons who possess the faculty, throw themselves into a state resembling death; the heart finally stopping its beatings, on account of the absence of its proper stimulant to action, arterial blood.

It is highly probable, that sedentary and studious persons owe some of their ill-health and pallor of countenance to the want of proper attention to this function. It has been observed, that when a person is deeply engaged in study, or in the perusal of an absorbing narrative, respiration is not so perfectly carried on as when the mind is not so engaged; the breath is often held, until a sense of weight at the chest calls for a long inspiration. On the other hand, when a person is engaged in moderate exercise of the muscles of the body, the action of the heart and of the organs of breathing is involuntarily increased; he acquires the bloom of health, and new vigour and life by the additional aeration of the blood thus brought about, while the sallow skin and soft muscles of the student show the effects of the want of respiratory action, as well as of muscular exercise. It is, hence, of importance that sedentary persons should pay particular attention to their respiration, and while they avoid every posture or thing that will tend to cramp or compress the chest, should even, sometimes, by the exertion of their voluntary powers, keep up constant and vigorous breathing.

This is of the more importance to students, because, that one of the first symptoms of this want of aeration is a sense of dullness, a want of power to command the attention, an obtundity of intellect: an evidence that the brain performs its functions imperfectly, because of the want of its natural stimulus, bright, aerated, arterial blood.

Air, therefore, is essentially necessary to the support of the life of animals. The same portion of air, however, will not support life for an indefinite length of time: breathed for a time, proportionate to its quantity, it becomes unfit for respiration. Thus a small animal shut up in a bottle soon dies, and persons who descend in diving-bells, beneath the surface of water, find it necessary to keep up a constant supply of fresh air. The necessity for this constant renewal of the air, was never more horribly exemplified than it was at Calcutta, in 1776, in the fate of the English soldiers who were shut up in the celebrated "Black-hole." One hundred and forty-six, men and officers, were thrust into a place eighteen feet square, having only two very small grated windows, which were both on one side, so that ventilation was utterly impossible. The door had scarcely been shut when their sufferings commenced, and in a short time, a delirious and mortal struggle ensued to get near the windows. In four hours, all who survived were in the silence of apoplectic stupor; at the end of six hours, ninety-six had died, and in the morning when the door was opened, twenty-three only, of the one hundred and forty six were alive, and many of these were subsequently cut off by putrid fever. Dr. Combe, also, in his "Principles of Physiology applied to the preservation of health"—an in-valuable work—quotes several instances of persons who were destroyed in consequence of shutting themselves up closely at night, in the cabins of vessels, where the ventilation was not sufficient to support life during the night.

To convey some idea of the quantity of air thus rendered unfit for respiration, by an adult individual, in twenty-four hours, we will take the results of the experiments of some celebrated philosophers who have examined the subject. It appears that most persons fill their lungs about eighteen or twenty times in a minute, and that about fifteen cubic inches of air is renewed at every respiration, in ordinary breathing; that more than a gallon of air is rendered unfit for perfect respiration in a minute, and about thirty-nine hogsheads of air is thus deteriorated in twenty-four hours.

The air that has been thus deteriorated by respiration, is not materially changed in quantity; some change must, therefore, have been effected in it composition, which renders it unfit for the support of life: the nature of this change is now pretty well understood. Atmospheric air, as is well known, is composed essentially of two gases, oxygen and nitrogen, united in the proportion of about four of the latter to one of the former;—united as we may suppose a mixture of alcohol and water to be. It is also well known that the former gas, oxygen, is the main supporter of life, and also of combustion, in the atmosphere; the nitrogen, although undoubtedly sometimes absorbed by animals in breathing, being apparently intended principally to dilute the oxygen; the existence of pure oxygen being incompatible with the existence of animated beings as they are at present constituted; being too stimulating to the organs, and causing death by inflammation and fever. Combustibles, too, would be consumed so rapidly in an atmosphere of pure oxygen, that a fire once lighted could not be extinguished; even iron itself would burn like tinder; as is daily shown in the laboratory of the chemist.

The change which the air undergoes in respiration is mainly this, that a portion of the oxygen disappears, being communicated to the blood in the lungs; and that, instead of the oxygen, there is thrown out about an equal quantity of another gas, the carbonic acid; a heavy gas evolved from the lungs and breathing surfaces of all animals; a gas which not only will not support life or combustion, but which is positively poisonous and destructive to both; for a candle will not burn in a mixture of one part of this gas to ten parts of pure air, neither can an animal exist, even for a short time, in such a mixture; it would act upon it as a powerful narcotic poison, as has often been painfully exemplified in old wells, sinks, and wine-cellars, in which this gas is sometimes found, and in which many persons have been destroyed by its influence.

There is always some of this poisonous gas present in the atmosphere, but it does not generally exist in a greater proportion than from 1–2000th to 1–200th. Animals may breathe the mixture when the carbonic acid does not amount to one-tenth, but in that proportion it is certainly fatal; and when in smaller quantities it exerts an injurious effect upon the health, by preventing the due arterialization of the blood; for it has been established, by the experiments of Dr. Mitchell and others, that the rapidity with which the carbonic acid of the blood will penetrate the membrane of the lungs, to escape into the atmosphere, will be in inverse proportion to the quantity of carbonic acid in the air which is inspired, and that when as large a proportion of this gas exists in the atmosphere, as is found in the gases dissolved in the blood, no penetration of carbonic acid outwards will take place. The blood, therefore, would continue of its dark venous color, even after having been passed through the lungs: the heart not being sufficiently stimulated by black blood, would become feeble in its action, and the animal would speedily be thrown into a state of stupor and disease, by the circulation of black blood, unfit for the uses of the system.

The quantity of this poisonous gas, which is thus discharged from the lungs of an adult individual, in the course of twenty-four hours, is about forty or fifty thousand cubic inches, or about one hundred and forty, or one hundred and fifty gallons; an amount which cannot fail to startle those who reflect on it, and which tends to exemplify the necessity which exists for a constant renewal of the air which we breathe. About the same quantity of oxygen is also removed from the air in the same process.

This great deterioration of the atmosphere in the process, of respiration—by the removal of its vital air, and by replacing it with the poisonous carbonic acid gas, is, without doubt, a most prolific source of disease; and is the more dangerous because it is almost unheeded or overlooked. A number of persons will crowd into a small close room, and seem to have no other care than to prevent the free circulation of the air. Sleeping apartments are shut up, as though an enemy were to enter at the first open window, and the air, if the rooms are small and tight, breathed and re-breathed, unfit for the healthy arterialization of the blood, is the hidden source of head-aches, fevers, and, in short, of disease in all its varieties, and even death. Hospitals, also, are too often constructed with no regard to the constant supply of the most necessary of all elements, pure air; and patients are crowded into them, keeping the air constantly in a state unfit for complete respiration, so that disease, in the form of low typhus, or putrid fever, or hospital gangrene, causing whole limbs to slough off, appears in frightful violence; and is to be checked, or prevented, only by the removal of the sufferers to fresh air, or by bringing fresh air to the patients.

An anecdote from Humboldt's personal narrative is just in point, illustrative of the beneficial effects in the cure of disease, of a removal from an impure to a pure atmosphere. "A sailor, who was near expiring, recovered his health from a circumstance which is worthy of being mentioned:—his hammock was so slung that there was not ten inches between his face and the deck. It was impossible to administer the sacrament in this situation; for, agreeable to the custom on board of Spanish vessels, the *viaticum* ought to be carried by the light of tapers, and followed by the whole crew. The patient was removed into an airy place, near the hatchway, where a small square birth had been formed with sail-cloth; here he was to remain until he died, which was an event expected every moment; but passing from an air extremely heated, stagnant, and filled with miasm, into fresher and purer air, which was renewed every instant, he gradually recovered from his lethargic state, and his recovery dated from the day of his quitting the middle deck."

Dr. Ure of Glasgow, Scotland, in his late work "On the philosophy of manufactures," &c., gives an equally interesting circumstance, relative to the importance of pure air to the support of health, which occurred at Anderson, near Glasgow, in a long building erected many years ago by Mr. H. Houldsworth, for a dwelling house for the people of his cotton factory. "A corridor runs the whole length of the building; on one side of which the entrance doors to the lodgings are placed. The people crowded to the number of five hundred, into these barracks, and are so careless of cleanliness and ventilation, in spite of every remonstrance of the proprietor, that they were frequently visited by typhus fevers of the most malignant and fatal type. At length science has enabled him to effect a reform. He led along the ceiling of the corridor a large iron pipe, shut towards the door of the passage, and connected by a valve, at its other open extremity with the great chimney of the mill. From the side of this horizontal pipe, opposite to each house, a tin tube, one and a half inches in diameter, branches off at right angles, and enters through the wall, so as to present its open end immediately over the bedstead of each apartment. Whenever the steam engine is stopped, either at meals or at night, the mechanism which shuts the fire-damper, is so constructed as to open, at the same instant, the inner end of the corridor pipe; whereupon a brisk current of air is established in each tin tube, and a stream of air rushes into it from every apartment. Since the introduction of this self acting and most powerful system of ventilation, the factory barracks have been not only completely delivered from every appearance of pestilential fever, but have become, in fact, a remarkably healthy habitation."

A constant supply of pure air being a desideratum of such magnitude, it cannot but be of importance to understand how it may be attained; so that in dwelling houses, churches, hospitals, and other buildings where human beings are collected together, a sufficient amount of this pabulum of life may be secured, and a proper outlet, for the escape of the poisonous gas from the lungs, may be arranged. These necessary purposes, by a wise provision of Providence, are fortunately most easily accomplished. Air is the most motile of all fluids, and motion is caused in it by the slightest variation of temperature: if any portion of it is rendered a little warmer than that by which it is surrounded, the warmer air is immediately pressed upwards by the colder air around, because it has been rendered specifically lighter by the expansive power of the heat.

It is the action of this law, which, on a large scale, causes those motions in the atmosphere called winds—which, on a smaller scale, causes the draught up our chimnies,—and which, when understood and employed, will be efficient in the ventilation of our apartments. A fire, or even a candle, cannot be lighted in a room, the sun cannot shine into it, nor can a person enter it, without causing an upward current, to the ceiling, of the warmer air, heated by either of these causes. The air which comes from the lungs, partly deteriorated, being warmer than the surrounding air, immediately rises, the cold, pure air of the room forcing it up and taking its place. Any one who has entered the gallery of a court-house or church, in which there was an assembly of people, must have observed a striking exemplification of this fact, in the great difference, in temperature and in purity, between the air there, and that in the lower part of the building.

This heated impure air, as buildings are generally constructed, not finding an outlet at the highest part of the house, continues to rise until all the upper part of the room, above the level of the open doors or windows, is filled, when it flows out at the top of the door or window, while cool, fresh air pours in below in a counter current. A fact which any one can observe for himself, by placing two lighted candles in the open door of a heated room; one near the upper part, and the other on the floor: the flame of the upper candle will be blown outwards, and that of the lower one will be inclined inward, by the lower current of air rushing into the room.

The best mode of ventilation then, must be obvious:—it is only necessary to construct openings, either in the form of windows, or in any other convenient or agreeable shape, in the highest part of the room, to allow the heated, deteriorated, air to pass out; and to make other openings, in the lower part of the apartment, for the entrance of cold fresh air; which should be so arranged, however, as not to allow a current of cold air to blow in at any one spot. With such an arrangement, not the slightest heating cause, nor a person, could be admitted into the room without causing a circulation of the air, to a greater or less extent, according to the intensity of the heating cause, or the number of persons.

It will not often be necessary to construct any other openings, for the admittance of the cold air, than those generally made for the convenience or beauty of the building. Doors and windows generally fit loosely enough to admit a sufficiency of air, if openings be constructed above to allow the heated air to escape, or a few open doors and windows would be amply sufficient for most rooms, however crowded. In hospitals, however, where pure air is of the greatest importance, air holes should be purposely made, to be opened or shut at pleasure.

In dwelling houses, no other openings are required than judiciously constructed windows: while in the winter season, when so great a difference exists, in temperature and specific gravity, between the air within and that without, few rooms are so tight, as not to admit of sufficient circulation of air, with even the windows and doors closed. It is of great advantage, in the warmer months, to have the windows so constructed as to open both at the top and bottom, and to cause them to be opened in this manner as often as is convenient. This is more particularly true of the windows of sleeping apartments, of which all the windows and doors should be thrown open as early as possible in the morning, if the weather will permit, and the bedding should be spread out and exposed to the free action of the air for a sufficient length of time to allow of the complete dissipation of the invisible emanations from the body, with which the clothing is saturated.

Few causes are more injurious to health than a want of attention to these particulars;—than keeping these apartments closed during the whole of the day, thus retaining in them the air which has been rendered impure by respiration during the night;—than making up beds as soon as they are left in the morning, thus effectually preventing their proper ventilation, and the removal of the carbonic acid, and other emanations from the skin, is in a measure prevented.

I have thus briefly attempted to describe the phenomena of the functions of respiration, and to point out some of the principal laws and circumstances which affect this important process. To produce any thing absolutely new on the subject, at this time, is not my object, were it even in my power. I shall be satisfied if I have succeeded in arranging and pointing out some of the knowledge which the labor of years has been accumulating. Knowledge which *ought to be* familiar to every one from the great influence which it exerts on our health and happiness, but which, unfortunately, may yet be new to a great majoriry of mankind. Knowledge which *will be* familiar to every one when education shall lose the austere, mysterious, and pompous character which she acquired in the ages of the cloister—when she shall cease from her preposterous endeavours to force the minds of youth to the one Procrustes' bed, of classics, mathematics and metaphysics, and shall be content with storing them with that kind of attainment which will be the most *useful* to themselves in after life, and most subservient to the purposes of improving the moral and physical condition of man. Not that I wish to be understood as asserting that classics, mathematics, and metaphysics are not of high importance in their places, and to minds adapted to their pursuit, but that I wish to protest against the too common practice of making them the essential parts of the education of every one; while the study of nature, which should be the basis of every system of education, is almost wholly neglected.

ON THE APPLICATION

OF

GALVANIC ELECTRICITY TO MEDICINE.

Read to the Lexington Medical Society, December 2d, 1836.

BY ROBERT PETER, M. D.

When, in the year 1790, Galvani, whose name is immortalized by its connection with the branch of science to which his observations gave rise, noticed that when a spark from an electrical machine was taken by a person standing near another engaged in dissecting a frog, who had his scalpel in contact with a nerve, that the limbs of the frog were immediately convulsed;—and when this philosopher subsequently discovered that if a nerve and a muscle of a frog be brought into connection by means of a clean metal, convulsions were equally produced in the muscles of the dead animal,—he believed that for him had been reserved the discovery of the nature of that mysterious agent in vital contraction, the nervous fluid.

Volta, however, soon established the fact that the cause of the contractions, in the cases observed by Galvani, was not the animal nervous, or electrical fluid, but a current of electricity, analagous to that of the common machine, which was produced by the contact of dissimilar metals, or by the action of dissimilar fluids on a single metal. The discovery of the fact that the contact, and action upon each other, of bodies of a dissimilar nature, always caused the formation of currents of electrical fluid, brought the physiological experiments of Galvani within the pale of what had already been long known, and disappointed the expectations of those who believed that the nature of the nervous fluid, and perhaps of vitality itself, was about to be unveiled to the understanding of man. Since that period, muscles in all parts of the dead body have been made to contract by the agency of the galvanic fluid;—even the heart itself, in a recently dead subject, has been caused to beat;—the peristaltic motion of the intestines has been renewed; the function of digestion has been restored, after the nerve going to the stomach has been cut; and in a living body, diseased and paralized nerves have had their healthy action reestablished, by a galvanic current;—even a fibrous subtance, analagous to muscular fibre, has been generated, by M. M. Prevost and Dumas, in yolk of egg, under the influence of the pile;—yet we are but little nearer, perhaps, to the solution of the mystery of life and nervous action than we were in the day of the discovery of Galvani.

The progress of discovery, in this interesting branch of science has not, however, been entirely stayed. Many analogies between the actions of an electrical current and nervous actions have been made out, as well as many new and successful applications of the former agent, the electrical current, to the removal of disease. On the analogies existing between the actions of electricity and of the nervous influence, and on the applications of the former to medicine, I propose to base the present paper. It is not my intention to go into the minutiæ of the subject, as the time allotted would not permit, could I even hope to carry your attention with me, but merely to give some of the most prominent and obvious of the facts which have been established.

To commence with some of the analogies between the actions of electricity and the nervous power, we will examine, first, the production of muscular contractions by means of electricity. It has long been known that a current of electricity causes contraction in animal muscles, and every one who has experienced a shock from a Leyden jar, has had an evidence of the fact in his own person. Contraction in this case is sudden and violent, so much so, that when, in 1746, Cuneus and Muschenbroek, who discovered this piece of apparatus, first experienced its effects, they were so much terrified that one declared that he would not submit to another shock for the whole kingdom of France, and the other dieted himself for a week, and took cooling medicines to correct fever. Similar contractions are produced in recently dead bodies. The Leyden jar causes a sudden and instantaneous current of electricity, but the Galvanic battery produces a current of longer continuance, and hence its effects are more striking. Galvani, in the severed head of an ox that had recently been killed, caused the eyes to open, the ears to shake, the tongue to move, and the nostrils to expand, by the action of a Galvanic pile of one hundred pairs of silver and zinc plates, one pole of which was placed in connection with the nose, the other being placed in the ear. M. De Humboldt took a Linnet, on the point of expiring, its eyes were closed and it could no longer support itself on its legs. He placed a small plate of zinc in the beak, and another of silver in the rectum, joining them together, out of the body, by an iron wire; at the moment of contact the bird opened its eyes, raised itself on its feet, flapping its wings. It respired for six or eight minutes, and then tranquilly expired.

By a similar arrangement, viz., a piece of silver on the tongue and a piece of zinc in the rectum, joined by a wire, Achard, of Berlin, caused an increase of the peristaltic motion of the bowels, in his own person, and a dejection of fœcal matters. This arrangement is now, in fact, in fashion, in some parts of our country, for the same purpose, and it has been found to cause alvine discharges when other means have failed. Some interesting facts relative to this piece of apparatus may be found in the present volume of this journal, in the paper of T. L. Caldwell, M. D. In persons recently dead, contractions of most of the muscles have been produced by the galvanic fluid:—for a striking account of one case, that of a hung malefactor, who was galvanized by Dr. Ure, I beg to refer to Ure's Chemical Dictionary, Art. Galvanism.

Another analogy exists in the production of Tetanus by Galvanic electricity. In certain disorders of the nerves involuntary contraction of the muscles, called tetanus, occurs; a similar contraction may be produced or removed by galvanism. M. Nobili, in exposing frogs, prepared for electrical experiments, to the action of a galvanic current, found that some of the vigorous individuals had their limbs stiffened so that they could with difficulty be bent. Sometimes the animal extended and stiffened its limbs as though they suffered a tetanic convulsion, which continued for some time. He rendered the contractions permanent by alternately interrupting and re-establishing the galvanic circuit; and he, moreover, found that while the current was continued in one direction the tetanic contraction continued, and that when the direction of the current was changed the spasm of the muscles was removed.

Another analogy.—By continued exercise of the nervous system, whether by motion, sensation, or intellection, fatigue or lassitude is the result. Electricity is capable of producing the same result, as is evident in the following case, recorded by M. Rozet, in his "Travels in the regency of Algiers," in which the effect was produced by a disturbance in the electrical equilibrium of the atmosphere, and of the surface of the earth. "On the 8th of May, 1831, after the setting of the sun, all the atmosphere was on fire and announced a violent storm. On the ends of the flag-staffs at Algiers, there could be seen a white light in the form of an *aigrette* or brush, which persisted for half an hour: some officers who were walking on a terrace, were much astonished to feel their hairs become erect, and to see a little *aigrette* of light on each of those of their comrades. On elevating their hands *aigrettes* formed also at the ends of their fingers. All the persons who were exposed to the action of the atmospherical electricity, suffered nervous contractions in their limbs, and a general lassitude, particlarly in the legs." Every one knows that life, even to the last vestige of irritability, may be instantly destroyed by the influence of a large charge of electricity.

The production of animal heat affords us another analogy. The action of the nerves upon the blood, it is believed, is the main *immediate* agent in the production of animal heat. Paralize the nerves of a limb and you affect its temperature-preserving power. Paralytic limbs are generally below the natural temperature. Dr. James H. Miller, in 1833,* on establishing a galvanic current in the paralyzed limbs of a patient in the Baltimore Alms House, caused the temperature to rise, in a few minutes, from 62° to 89.° And Sir Wilson Philip, by exposing arterial blood to the action of the galvanic battery, observed that its temperature became elevated some degrees; an effect which could not be produced, in the same circumstances, in venous blood, and which he could cause only once in the same portion of arterial blood.

The most striking analogies between nervous actions and those of the electrical fluid, are presented to us in certain animals which possess the power of giving, at will, an electrical shock. A power which seems to have been given to them to protect them from their enemies and to procure them food. The most remarkable of these animals are the electrical Ray or Torpedo, (*Torpedo electricus*, and other species,) of the Mediterranean;—the electrical Eel, (*Gymnotus electricus*,) of South America, and the *Silurus electricus*. All these fishes can at pleasure give an electrical shock to animals that are in connection with them by means of conductors. In the gymnotus this power is so energetic that horses and mules are stunned by them. Each of these remarkable animals possesses an apparatus of the same general character,—which is, a series of six-sided, aponeurotic tubes, aggregated like the cells of a honey-comb, into a mass, which, in the Torpedo is placed on each side of the head; in the Gymnotus, under the tail, and in the Silurus, around the body. Each of the cells is divided by a great number of membraneous diaphragms, placed at short distances from each other throughout the tube. In the Torpedo, John Hunter counted 1182 of these tubes in one half of the apparatus. The spaces between the membraneous di-

*American Jour. Med. & Surg. vol. 14.

visions in these tubes is filled with mucus, and fibrils of nerves, entering the tubes at the angles, pervade every part of the apparatus; the main nerve supplying the electrical organs being unusually large compared with the other nerves of the animal.

It seems pretty evident that the electricity, which these animals can accumulate, is derived, in some way, from the nervous system, and that the use of the arrangement of the divided tubes and mucus, is to collect the fluid and to increase its tension, or power of penetrating bodies. This opinion, is strengthened by the fact, that the exercise of this apparatus, by the animal in giving shocks, speedily exhausts its vital powers. Thus Humboldt and Bonplandt were only enabled, with safety, to obtain the electrical eels on which they experimented, by causing them to exhaust themselves by giving their shocks, and they assert that a long rest and abundance of food is necessary to the recuperation of their electrical powers. By the advice of the Indians, a drove of horses was driven into pool where these fishes abounded, and after the eels had spent the fury of their strength upon the horses, causing the death of one or two by drowning, they were so much exhausted that, approaching the edge of the pool, they were easily secured by harpoons. Mr. Todd, (Philosophical Transactions of Roy. Soc.) found that if the Torpedo be irritated, and caused to give a number of shocks in a short time, it soon died of the consequent exhaustion; but that if the nerve going to the electrical apparatus be cut, the animal loses the power of giving a shock, and may then be teased and irritated at pleasure without inducing exhaustion; an animal having these nerves cut, living much longer under these circumstances than one which had not been deprived of its power of giving the shock. Mr. John Davy, in his experiments on the same animal, also found that if the fish be often excited to give its shock that its digestion appeared to be completely arrested. In one of his experiments he found in the stomach of the animal, after its death, a little fish, which it had swallowed, but which it had not digested.

Another interesting fact is, that, according to the anatomical examination of M. Geoffrey Saint Hillaire, of those fishes, no particular nerve is especially appropriated to the function of developing electricity; for in the Torpedo it is the fifth pair of nerves which supplies the electrical apparatus; in the Gymnotus the nerves of this organ are cerebral in their origin; and in the Silurus those of the eighth pair supply this function. These interesting facts render probable the prophecy of M. Becquerel,* to whom I am indebted for many of the facts of this paper, "that if we one day discover that the electrical fluid enters into the phenomena of life, it will be through the study of the singular property possessed by these fishes."

An electrical shock has been obtained from a common animal. In 1686, Cotugno announced, that a student of medicine, while dissecting a living mouse, was much surprised to experience in the hand, an electrical shock, on touching one of the nerves of the animal with his scalpel. (Jour. Encyclop. de Bologne No. 8.) Analogous observations have been made by those who have employed acupuncturation in the removal of diseases. Acupuncturation consists in the introduction, into the body, of slender metallic needles, which are first driven through the skin by smart strokes with a small hammer, and then, by twirling them in the fingers, carried to any required depth. The most important vital organs have been transfixed in this way, without accident, and the operation is said to relieve many neuralgic affections, rheumatism, &c. It has been supposed by some that these needles acted by conducting electricity out of the system, and the following case seems to favour the supposition. M. Jules Cloquet† inserted a needle into the thigh of a patient to the depth of one inch; about six minutes afterwards, on touching the body of the needle with a wet finger, he perceived a slight shock, similar to that produced by the pole of a weak galvanic pile. At every new touch the patient complained of severe prickings and darting pains, proceeding from the

*Traite Exper. de Elect. et du Magn. T. 3. p. 255.

†Morand on Acupuncturation, Translated by F. Bache, 1828, p. 31.

point of the needle. Professor Recamier repeated the same experiment with the same result, and the presence of electricity, in the needle was further demonstrated by the attraction of light bodies and the electrometer. In these experiments the point of the needle becomes speedily corroded; and some are disposed to attribute the electrical phenomena to the corrosion of the needle,—but no such corrosion is produced in a dead subject, and it seems more probable that the action on the point of the needle was caused by its positively electrical state, according to known laws, than that the corrosion induced that electrical state in the needle.

Many other points of analogy might be given, did time permit, but I will be content with but one or two more.

One effect of a galvanic current is to counteract and modify the action of chemical affinity. Under the action of such a current the elements of all known chemical compounds may be separated, one class of these bodies being carried to one pole of the galvanic arrangement, the other to the other pole. Thus, when we decompose a salt, the acid is carried to the positive pole, and the alkali or base to the negative pole. Something analogous to this takes place in the animal body: for example; digestion could not commence unless the stomach secreted an acid, the muriatic principally, to dissolve the articles of food; and chylifaction could not be perfected without the aid of the alkaline secretion of the liver. The existence of Muriatic acid in the gastric juice, and of soda in the bile, would still continue, although we might never have swallowed either muriatic acid or soda, but we are constantly taking muriate of soda, which is always present also in the blood, and it is highly probable that the nervous influence is exerted in separating the elements of this compound at these two organs, in a manner analogous to that in which a galvanic pile would separate the acid and the alkali at its several poles.

Such analogies, in the body, are so striking as to have been evident to a common observer, although an uncommon man, the Emperor Napoleon. We are told by Becquerel, who got the anecdote from Chaptal, an eye witness, that when the Emperor saw repeated before him the phenomena of decomposition by the galvanic pile,* "he was struck with astonishment at seeing the transportation of the elements of the salts to their respective poles. After an instant of silence, turning to Corvisart, his physician, he addressed him in these remarkable words; "Doctor, behold the image of life!—the vertebral column is the pile, the liver the negative pole, and the bladder the positive pole." Words, which although they do not evince much of physical or physiological accuracy, are yet remarkable as coming from one who had devoted his life to far other pursuits than the study of galvanism.

No two substances, in opposite chemical states, such as an alkali and an acid, can be brought into contact, out of the body, by means of imperfect conductors, without causing currents of electricity;—analogy makes it probable that similar currents are caused in the animal body by arrangements of this kind that are known to exist in it. Thus, the saliva is alkaline, the gastric juice is acid; perspirable matter is slightly acidified by acetic acid, the serous and sinovial fluids are alkaline; the urine is acid, the bile alkaline, and all these dissimilar bodies are in connection by imperfect conductors. Such arrangements among inorganic bodies, would give rise to electrical currents, and M. Donné has lately proven that they cause such currents in the animal body. He placed a plate of platinum, connected with one end of the wire of a galvanic multiplier, on the tongue, which is alkaline in its reaction, and put another platinum plate, connected with the other end of the wire, on the skin which is acid; the magnetic needle of the instrument was deflected fifteen, twenty, and sometimes thirty degrees. On placing the two ends of the wire of the multiplier, one in connection with the coat of the stomach, and the other in the gall-bladder, a very strong current of electricity was indicated. These experiments, however, only prove the existence of electrical currents in the body, the results of the action, on each other, of the dissimilar substances, which exist in the sys-

*Tome I, p. 108.

tem; but they by no means prove that the nature of these secretions is dependent on the electrical state of the organs, or on the currents of electricity which pass among them. M. Matteucci supposed that he had thrown some light on the subject when he proved that the electrical currents ceased in an animal as soon as it was killed, or as soon as the nervous influence was cut off, although the acidity of the stomach, and the alkalinity of the liver still continued, and that the currents existed in the living animal even when the acid of the stomach and the alkali of the liver were severally neutralized, artificially, by proper reagents. He, therefore, believed that the different electrical states of these organs was due to nervous action, and that the secretions were modified by these electrical conditions. His experiments, however, have not as yet been verified: yet Orioli has ventured the supposition that the derangement of the secretions, in diseased states of the system, is a result of the derangement of the electrical conditions of the organs; and he proposes to study the natural electrical states of the organs in order that we may be able to restore them to the healthy electrical condition, when deranged, by contrivances adapted to that end.

In this connection it is well to notice another experiment of Sir Wilson Philip. This gentleman cut the eighth pair of nerves, on each side, in some rabbits, and found that parsley, which they had eaten, remained undigested in their stomachs; but that on causing a current of galvanism to pass along the course of the cut nerves, the gastric juice was again secreted, and digestion proceeded. The force of this experiment, however, is weakened by the fact, that similar effects were produced by subjecting these nerves to mechanical irritation, and it is hence objected that the galvanic fluid, in this instance, acted only as a mechanical irritant.

The action of the galvanic fluid on the nerves is capable, not only of causing contractions of the muscles, but also of causing sensations. Marianini, on subjecting a frog, which was prepared so that its posterior extremities were attached to the spine by the crural nerve only, to the galvanic current, observed that when the current went from the trunk to the extremities of the nerves, it only produced contractions, unaccompanied by any signs of pain; while, when the current passed in the opposite direction, namely, from the extremities to the trunk, the contractions were less violent than in the former instance, but the animal gave undoubted evidence of great pain. This accords with the observation of Dr. James H. Miller, whose name I have already m ntioned, who, in treating a case of paraplegia, in the Baltimore Alms House, by the current of galvanism evolved from a plate of silver on the nape of the neck and a plate of zinc on the inside of the knee, connected by a wire; one day, for experiment, reversed the position of the plates without the knowledge of his patient. The man immediately began to respire with great anxiety;—complained of the inversion of all his bowels threatening suffocation, and of a great deal of a new kind of pain; asserting that if the plates were not immediatly removed they would kill him: as soon as the Doctor changed the plates again to their original positions he asserted that all was right again.

"According to Ritter, the electricity of the positive pole augments the vital forces, while that of the negative pole diminishes them; the first tumefies the parts, the second depresses them. The pulse of the hand held in contact with the positive pole is strengthened, while it is weakened if it is in contact with the negative pole. In the first case, according to this ingenious philosopher, we feel a sensation of heat, in the second one of cold. Objects appear larger, more brilliant and red, to an eye positively electrified, than to an eye negatively electrified, which sees them smaller, less distinct, and bluish."

Humboldt placed two blisters, of the size of a five franq piece, on his shoulders. When the blisters were opened the serum flowed out, as usual, colourless. He covered the sore of the right shoulder with a plate of silver. A conductor of zinc was no sooner brought near it, than a new flow of humour was provoked, accompanied by a very painful burning sensation. This humour was not, like the first, white and of a mild character. It acquired, in a few seconds, a lively red tint, and wherever it ran over the skin it left a mark of a reddish blue colour. The most malignant ulcer does not furnish an humour as acrid, nor as prompt in its action.

Not to multiply examples of the analogy between some of the actions of galvanism, and those of the nervous fluid,—for time reminds me that I have said enough, and it must already be evident that there are some striking points of resemblance between them,—we will pass on to the second division of my subject, the therapeutical application of galvanism. Before proceeding, however, I beg that I may not be misunderstood. While I make the assertion that there are striking analogies between the action of electricity, and nervous action, on the body, I am far from asserting that they are the same; it would be wholly unphilosophical to say so. Analogical reasoning can never be fully relied on, and should only serve to lead to new observations and experiments on Nature. At the same time, analogy is not to be entirely neglected, as it often serves to connect one discovery with another, and to lead to new ones; and although in the end it may be discovered to be erroneous, yet, while it stimulates to exertion and research, it cannot be denied that it may sometimes be highly useful.

It must have been long known that electricity exerts a powerful influence on the animal system. We have accounts that the shock of the Torpedo was used by the ancients in the cure of diseases, and to the present day it is still, probably, employed in intermittent fever; and the effects of the Gymnotus were formerly used, in Guiana, in the cure of paralysis. Among the earliest accounts that we have of the effects of lightning, we have those of persons, who were previously paralytic, having been restored by a partial shock of that agent; and when the identity of common electricity and lightning was established, and the electrical machine brought to a state of comparative perfection, the common electrical fluid was employed in a variety of modes, and with various degrees of success, in the cure of diseases.

One of the most remarkable instances of the remedial effects of the electrical fluid on record is that given by Mr. W. Scoresby, which I obtain from Becquerel. "The packet, New York, left America on the 16th of April, and on the 18th was near the western limit of the gulph stream, in 30° N. latitude. Here she encountered a tremendous storm. At half past five o'clock, on the morning of the 19th, the lightning, with a great crash, struck the ship and filled all the births with thick clouds of a sulphureous smoke. All the elements were in a most violent commotion. In a second discharge on the vessel, which took place along a metallic chain which the captain had caused to be fastened by one end to one of the masts, while the other plunged in the sea, having at its upper end a pointed rod of iron, the vessel appeared all on fire by the effect of the discharge, the chain of communication was melted by degrees. Concentrated by the conductor into a strong current, the electrical fire dispersed as soon as it penetrated into the sea, but a luminous vapour seems to rise from the water even to the clouds, while the re-action which operated on the vessel was so violent that several individuals fell prostrate on the deck. The vessel appeared to be on fire a second time; all the parts of the ship were filled, as before, with sulphureous vapours, which were so thick, that it was impossible to distinguish any thing at two paces distance. One of the passengers experienced a singular effect from the two discharges. A man of advanced age, infirm, and of a remarkable corpulency, was sleeping in his bed; he was so little in a state to take exercise, that, for three years, he had not walked over a space of half a mile, and he had not even appeared on deck since the commencement of the voyage. But after the discharges, this same person left his bed, mounted on deck, and went from one side to another with much ease and without manifesting the least pain, but in a state of mental aberration. Fortunately, the derangement of his intellectual faculties was only momentary, and the benificial influence of the electricity on his infirmities more durable; for he not only preserved the use of his legs during the rest of the trip, but he was even able, when he landed, to go on foot a considerable distance to his hotel."

The application of common electricity to the cure of diseases may be said to have had its day. For a time when the subject was new, this agent was applied to almost every disease, and numerous were the cases, particularly of nervous disorders, which were cured or relieved by it, but as the novelty of the thing wore off, and consequently the faith of both the physician and the patient in the efficacy of this fluid, it got gradually into disrepute, and now scarcely any, but an old practitioner, has an electrical machine among the furniture of his office. Thus has it always been in medicine; a new remedy is first inordinately praised, and, after a time, when experience fails to justify the extravagant assertions and expectations which were at first made and raised, the remedy is just as inordinately decried.

When galvanic electricity was first discovered, among its earliest applications were those to medicine. Galvani himself employed it in this way; and up to the present day it has been occasionally used, with more or less propriety and intelligence; and with such success, when judiciously applied, as to justify the prophecy that before the conclusion of the present century it will be ranked among the most efficient of the therapeutical agents. The application of this powerful agent cannot, however, be successfully made except by those who are fully familiar with its laws and actions, and of the contrivances and arrangements by which a current of this fluid may be induced. Without this preliminary knowledge, one who attempted to employ it would be groping in the dark, and be as liable to produce injury as benefit to his patient. In proportion to the power and efficiency of any agent is the danger to be apprehended in its malapplication.

The galvanic current may be caused to act in various ways upon the system. Dr. Palaprat employed it for the purpose of cauterizing internal parts. A platinum wire being introduced into the part, placed in connection with one pole of a sufficiently powerful battery; the other pole of the battery being placed in connection with some other part of the body; the end of the platinum wire was immediately made white hot by the galvanic current, and a tubular eschar, which separated in a few days, was the result. The same physician used the pile for introducing into the system certain medicinal agents, in the manner indicated in the following experiment. Having dried, as much as possible, the two arms of a female, he placed on one a little compress moistened with a solution of iodide of potassium, and on the other another compress moistened with a solution of starch; he covered each compress with a plate of platinum, and put them in connection with the poles of a pile of thirty pairs of plates, the starch being in connection with the negative pole. In a few moments the starch became blue, indicating the presence of iodine, resulting from the decomposition of the iodide of potassuim, and which had been conveyed through the body, to the negative pole, by the galvanic current. In this manner, by using needles for the poles, introduced as in simple acupuncturation, the Doctor succeeded in conveying iodine, and other substances, to different parts of the body; and he asserts that in this way he was successful in removing engorgements that had resisted all the medications that had been previously employed.

Those who have studied the chemical action of the galvanic battery know, that when any salt, or other compound substance, is exposed to the action of its current, the acids of the compounds are soon transferred to the positive pole, and the alkalies or bases to the negative pole. Let any one repeat an experiment of Sir H. Davy's, and he will be convinced that such actions of the pile may take place, to a certain extent, through the animal body. Let him wash his two thumbs completely in distilled water, and then place them into two glasses, filled with distilled water, that are in connection with the two poles of a battery. After holding them in that position for a sufficient length of time, the galvanic current traversing his body, he will find, on examination of the water in the glasses, acids,—muriatic, phosphoric and sulphuric, in the positive glass, and fixed alkali in the negative glass, derived from the decomposition of the salts of the fluids of the body, by the agency of the galvanic current. It is evident, therefore, that in addition to the stimulant or irritating action of a current of galvanism on the nerves, other effects may be produced by the acids, or the bases, of the compounds in the fluids of the body, the elements of which, separated by the electrical agency, are carried to the positive and negative poles respectively.

Davy exposed a piece of clean muscular flesh to the action of a galvanic pile of 150 pairs, for five days, the flesh being in connexion with water at each pole; and on burning the flesh, at the end of the experiment, none of the salts usually found in the ashes of flesh, were obtained; but in the water of the positive glass there were sulphuric, nitric, muriatic, and phosphoric acids, and in the negative glass, potash, soda, lime and ammonia; proving that the salts of the flesh had been decomposed, and their constituents carried out of the flesh to the several poles of the battery. On this principle it has been proposed to decompose, and destroy, urinary and other calculi in the body, and the method promises to be of utility, in the hands of persons who know how to apply it.

In the application of galvanism to the cure of diseases much, no doubt, depends on the direction of the current. A current passing from the trunks to the branches of the nerves, it has been seen, stimulates the muscles to contraction, without painfully exciting the nerves, while a current passed in the opposite direction, namely, from the ramifications to the trunks of the nerves, although it excites contractions, causes on the other hand, painful irritation. Some regard must be had to this cirstance, as well as to the power, continuance, and duration of the current, in its application to the animal economy.

Various modes of applying the galvanic fluid to the human body have been employed. Sir Wilson Philip used the small battery of Cruikshank; and it will be seen, by reference to his work "on the Vital Functions" that it was instrumental, in his hands, in relieving a number of persons of spasmodic asthma—one pole of the battery, the positive, being put in connection with a silver plate laid on a moistened spot on the nape of the neck, and the other, in the same manner, on the pit of the stomach. The same form of the instrument was used by Dr. Munsell, who gives the history of six interesting cases, relieved by galvanism, in the 6th volume of this journal. In one of these cases, case 5th, that of a lady of 70 years of age, on whom the galvanic current was applied to the head,—one pole to the nape of the neck the other to the temple,—for the removal of a neuralgic affection, vulgarly called a sun-pain, a very remarkable effect resulted. The pain instantly ceased on the contact of the wires, and for a short time after the application of the galvanic fluid, her vision was rendered as clear and distinct as it ever had been during her life, so that she could read very small print without her spectacles.

Dr. Mansford, in his work on epilepsy, gives an account of another mode of applying a galvanic current. Two plates were taken, one of silver the other of zinc, and were fastened, by strips of adhesive plaster, the one on the nape of the neck and the other on the inside of the knee, on spots from which the cuticle had previously been removed by small blisters. The plates were connected together by a wire, soldered to each, which passed down the back. To moderate the irritating effects of the metals on the raw surfaces, a piece of moistened sponge was placed under each plate, and, under the zinc plate there was put, in addition, a piece of fresh muscle free from fat. Thus the patient was enabled to move about, without inconvenience, carrying his galvanic apparatus on his person, and subjected to the influence of a constant weak current of galvanism. The positive pole being near the brain, the negative on the extremity. It was necessary to remove and clean this apparatus every 12 or 24 hours, in order to renew the muscle, and scrape off from the zinc plate the crust of oxide which forms on it. In this way Dr. Mansford succeeded in relieving a number of cases.

This same apparatus was employed by Dr. James H. Miller, in the Baltimore Alms House, with decided success, in two cases of paralysis; and by Dr. Harris, of the United States Navy, one of the physicians of the Pennsylvania Hospital, in several cases of neuralgia. An account of the cases of both of these gentlemen is recorded in the Amer. Journ. of Medical Science, vol. 14.

M. Sarlandiere applied the galvanic current to internal parts, by means of the introduction of needles of steel or platinum, as in acupuncturation, passing the current through them. In this way M. Majendie succeeded in curing some cases of amaurosis, which had resisted the action of the most violent means that surgery could employ, such as blisters, moxas, etc. The first experiment was made on a young man, attacked with amaurosis, with immobility of the pupil, on whom he first tried simple acupuncturation, transfixing the nerves with his needles, without any beneficial result. The needles were subsequently placed, the one in the frontal nerve, and the other in the superior maxillary nerve, and put in connection with the two poles of a pile composed of twelve pair of plates, six inches square. At the moment of contact the patient experienced a painful shock in the course of the nerve,—the light affected him visibly, and the pupil contracted. After a treatment of fifteen days the disease was sensibly ameliorated, and the pupil regained its ordinary dimensions. In several other cases of incomplete amaurosis he obtained successful results. In a case of paralysis of the third pair of nerves, with deviation of the eye downward and outward, and depression of the upper eyelid, that had resisted the common modes of treatment, a single application of the current of electricity through needles inserted into the supra-orbitary and sub-orbitary nerves, caused a complete cure. Similar happy effects resulted from this mode of treatment in another case, that of paralysis of the sixth pair of nerves, with deviation of the eye inward and downward.

In other cases of paralysis it has been employed with success by a number of persons;—as well by Marianini, who treated his patients by a succession of shocks of electricity caused by the continual interruption of the current, as by Dr. Miller, who used the constant weak current of the plates of Mansford. It seems evident, in fact, that it is principally to nervous disorders that the galvanic current is applicable.

I have now given some of the analogies between nervous action and the action of the electrical fluid, on the animal body, and a few of the applications of this powerful agent to medicine. Were I to attempt to give the whole of them, a book would be the result, not a paper; and were all the speculations and theories, to which these analogies and actions have given rise, to be recorded in one work, it would be swelled into numerous tomes of ponderous size. That the study of the galvanic fluid has given rise to ardent aspirations and fanciful theories, cannot be denied; so have the magnificent discoveries of the astronomer; but the imaginings of the poets, or the conceptions of the theorists of science, have not affected the truth of the discoveries either in the one case or in the other; and the philosophical mind, while it may be delighted for a time with the beauties of the poetry of science, finds no difficulty in separating from it the unimaginative but instructive prose.

Presented by the Author

Art. V.—*On the influence of Caloric on the living Animal Body.* By Robert Peter, M. D., Professor of Chemistry and Pharmacy in Transylvania University, &c. Lexington, Kentucky.

As far as our limited knowledge of nature will permit us to judge, certain principles or powers pervade the universe and act in an important manner on all created existences, animate or inanimate. These principles or powers, are *attraction, electricity, caloric and light.* What they are in their intimate nature, or whether they are not all mere modifications of one kind of matter or influence, has never been ascertained by philosophers. Many of their laws, actions, analogies and properties have been ascertained, especially of late years, but we are as ignorant of their real nature, as were the barbarians who worshipped a deity in the sun or saw the anger of offended Jove in the electric flash.

We know enough of these agents to be convinced that a constant and most powerful influence is exerted by them on all nature, inanimate as well as animate, and that without their instrumentality all created beings would be resolved into primeval chaos.

Among these principles none surpass in importance caloric. Acting by its repulsive power among the particles of inorganic matter in opposion to cohesion, it modifies its form, from solid, to liquid or gaseous; and being a stimulant to latent vitality, without its presence, in a certain degree, vegetable seeds would cease to germinate and animals to have existence.—Were we to attempt to sketch out all its actions on inorganic and organic matter, the space allotted to this paper would not be sufficient for the purpose. We shall confine our remarks, therefore, to some of its relations to living animals; a subject of the highest importance to medical philosophy, and which is too little studied or understood by physicians.

We have every reason to believe that animal life could neither be manifested nor sustained without the presence of caloric. A certain degree of warmth is as necessary to the germination of the seed of the most simple vegetable as for the continuance of the life of the most perfect animal. The degree of heat which is most salutary, varies according to the nature of the being, and all require its presence in some degree; but all vegetable and animal bodies are so constituted as to be able to support, without material injury, certain variations of temperature to which the surface of the globe, for which they are destined, is subjected in the natural rotation of the seasons.

In addition to a certain power of *endurance* of external changes of temperature, most animated beings are endowed with the faculty, to a greater or less extent, of controlling in some measure the temperature of their own bodies, by generating caloric within their systems, in greater or less amount according to circumstances, or by neutralising the influence of external heat, by certain means not perhaps fully understood.

All animals who respire, which we presume includes all the subjects of the animal kingdom, generate a certain amount of caloric, which, it is believed, bears a relation to the activity and extent of the respiratory process. Those which are denominated cold-blooded animals possess this faculty in a low degree, so that they are unable to preserve a peculiar internal temperature much differing from the general external one. The animals denominated warm-blooded, on the other hand, enjoying a more perfect respiratory action, are able to preserve the heat of their bodies, under all external variations, at nearly a constant state; although it is necessary to this end, that at some times a much greater quantity should be produced by the animal body than at others, and that at all times, under ordinary circumstances, a large amount of caloric should be evolved by the action of the animal powers. How these apparently difficult desiderata are supplied by the animal economy is not as we have stated, clearly comprehended.

The subject of animal temperature has always been a puzzling one to physiologists, and, like every other difficult question, has given rise to numerous ingenious theories. A number of facts have indeed been ascertained by experiment, in relation to the production of animal heat, but not enough as yet to form a perfect system or prevent the clashing of conflicting dogmas. The principal facts bearing on this subject, are; 1. That complete aeration of the blood is necessary to the perfect performance of this animal function;—the quantity of caloric evolved, bearing a relation to the amount of oxygen consumed in a given time. 2. Perfect circulation of the arterialized blood is also necessary; and thirdly; a change of this blood, by the action of the nerves, from arterial to venous, in the round of circulation, is also necessary to the evolution of the proper quantity of caloric. Any cause that may obstruct or prevent either of these actions will always diminish or destroy the production of animal heat, and the complete performance of them all is necessary to the perfect function.

These facts, however, may be compared to distant landmarks in a newly discovered country, and much labour in investigation and discovery may be necessary to connect them. Meanwhile theories take the place of ascertained truths. The most rational of these is that which we owe to the researches of Crawford, Brodie, Wilson Philip, Edwards and others, which is, that the oxygen of the inspired atmospheric air, passing into the blood through the delicate membrane of the lungs, combines, in the round of circulation and during the process of assimilation, under the action of the nervous influence, with a sufficient amount of carbon to form carbonic acid, and that the act of combination is attended by the evolution of caloric, as it would be out of the body, and is the principal source of animal heat.

This theory is, however, imperfect, for it has been ascertained that the amount of caloric given out by a vigorous animal is greater than that which would have been evolved by the formation of the carbonic acid it exhales: the production of some of the animal heat, therefore, must be attributed to the independent action of the mysterious nervous influence.

There is one circumstance, attending the changes which take place in respiration and assimilation, that has not yet received sufficient attention from physiologists. Chemists have long since been satisfied that no decomposition or combination can take place among bodies without great disturbance in their electrical atmospheres. The decomposition of water in the cells of the galvanic battery is the cause of the current of electric fluid that passes through its poles, and Mr. Farraday has established the fact, that as much electricity is evolved when a single grain of water is decomposed as is contained in a powerful flash of lightning. The changes which attend respiration and assimilation, which are a series of combinations and decompositions, must be accompanied by the evolution of electricity, which would form circuits, of greater or less extent, through the best conductors in the body, the nerves. The passage of an electric current through imperfect conductors is always attended by the evolution of caloric, greater in amount, within certain limits, in proportion to the imperfection of the conductor. If then the current passes through one series of nerves to the great nervous centres of the body, to be returned through another series, and in its passage, according to its known laws, evolves caloric, we are enabled satisfactorily to account for the production of that part of the animal heat attributable to nervous action alone, as well as for the production of the nervous fluid itself, which many facts seem to prove is analogous to or identical with the electric fluid. For this hypothesis, the boldness of which is justified by the numerous important connexions which late researches have ascertained to exist between electricity and attraction, caloric, light and even vitality, we are indebted to Mr. Leithead, in his late work on "Electricity, &c."

Although a certain moderate temperature is salutary and even necessary to animal existence, too much heat is productive of injurious consequences. Animals of the higher orders, therefore, are enabled by several means to neutralize, to some extent, the action of a high external temperature. Under ordinary circumstances, in atmospheric air, animals exposed to a great heat are aided in the maintainance of their proper temperature by the evaporation of moisture from the surface of their bodies. It has been found by Edwards and others that the perspiration increases with the external temperature; and the great cooling influence of the evaporation of moisture from the surface was exemplified in an experiment of Delaroche and Berger; who placed, in a stove, the heat of which varied from 126°5, to 142,°25 Fahr., during the experiment, one of those porous earthen vessels, "called by the Spaniards alcarazaz, which are susceptible of evaporation from the whole of their surface," two moistened sponges and a frog; and observed that they maintained a temperature, for nearly two hours, from 27.° to 28.°7 Fah. below that of the surrounding medium. The process of evaporation, in which caloric is rendered *latent* in the vapor which arises from the body,—a certain amount of heat being necessary to produce the change of form which the water undergoes from liquid to vapour,—relieves it, most probably, of most of its extraneous heat, and is the main agent in keeping down its temperature when it is exposed to a high heat in atmospheric air. The great evaporation from the body, under these circumstances acts also in another way to reduce the animal temperature. It is a process that weakens and exhausts the nervous energies. Blagden, who, as every one knows, made some interesting experiments on his own person on the effects of the very hot atmosphere of a stove-room, found that it soon caused his hands to shake very much; produced noise and giddiness in his head, and was followed by considerable languor and debility. Reduction of the nervous energy must be attended by a corresponding decrease in the temperature-producing power, and it is, most probably, in this manner that the external application of heat to the body, lessens its power of evolving caloric. Dr. Crawford, as early as 1781,* ascertained this fact, on placing a dog in hot water or hot air, the former

*Philosophical Transactions of the Royal Society.

heated to 112° and the latter to 134,° and observing that although the respiratory motions were much increased, the blood was so little changed in its round of circulation, that the venous blood was almost as bright as the arterial. Believing that the evolution of animal heat attended this natural change in the blood, he inferred, that the prevention of the change prevented also the usual developement of caloric. Much languor, in the animal, succeeded the experiment.

If we were permitted to theorise on the manner in which great evaporation of perspirable matter from the body tends to exhaust the nervous energy, we would state our belief that it is, most probably, in part by robbing it of a great amount of electricity. It is a fact well known to chemists and meteorologists that whenever water evaporates, especially from a saline solution, like the water of the ocean, or the fluid of perspiration, the vapour carries off with it a large amount of positive electricity, leaving the surface from which it arose, in a negative electrical state; and it has been proven by the experments of Ritter and others, that while positive electricity exhalts the nervous energies, the negative depresses them.

One manifest effect of the decreased amount of oxygen consumed in respiration, under the influence of external heat, is the great increase of the biliary secretion, and the liability to hepatic derangement, in inhabitants of hot countries. It is well known that the liver and skin aid the lungs in throwing off superfluous carbon from the blood. In the lungs it is thrown off in the form of carbonic acid, having combined with oxygen in the processes of respiration and assimilation; it is thrown off in a similar state from the skin; but the liver separates it from the venous blood in the form of bile, which abounds in carbon. When, therefore, this depurative action is lessened at the lungs by the action of a hot climate, the liver, in its vicarious action, has an increased labour to perform, and often secretes a bile that is black from the great amount of carbon in it.

The effects of external variations of temperature on the animal economy are of more importance than is generally believed, and are worthy of much more attention than is usually given to them by medical men.

There is a certain mean temperature most favorable to the healthy action of the animal economy, differing in animals of different orders and in different individuals of the same species; but to all of them an excessively high temperature, or a very low one, is injurious or deleterious, according to the degree. A temperature that would be considered rather a low one, by our feelings, seems most conducive to vigorous vital action. This fact has been observed by every one who has felt the bracing effect of a frosty morning and the lassitude, languor and debility, mental and bodily, produced by excessively hot weather. The debilitating effect of excessive heat is still further proved by the number of deaths that occur in all our cities during the prevalence of hot weather, by *coup-de-soleil,* and on drinking cold water. Sun-stroke is generally believed to be similar to apoplexy, but Surgeon Russel, who examined the bodies of several soldiers destroyed by *coup-de-soleil* at Madras, found the brain invariably in a natural state; but the great congestion in the lungs, which were black with blood, and the accumulation of blood in the right side of the heart and the vessels which lead to it, indicated exhaustion of the general nervous energy and that of the heart, which depended on it. Those who die on drinking cold water, are doubtless similarly affected, for it is generally believed the ingestion of cold fluids is not likely to injure a vigorous body strongly heated, but one that has been *exhausted* by great exertion or the debilitating effects of external heat. Under such circumstances the sudden application of cold is often productive of fatal consequences; not only in man but also in the lower animals. Vaillant, when travelling in Africa, found that when his dogs were much heated and exhausted by the chase, if they plunged into cold water, they were liable to be injured by its sudden influence, before he could rescue them from the deceitful element.

The debilitating influence of high temperature on the mind is equally evident. Its actions are rendered weak, laborious and painful, and, with the rest, even the *moral* faculties lose much of their force, and the individual becomes slothful, peevish and irritable. We are told that the Italians were so well convinced of this fact, that according to a former law, the punishment for crime, committed while the hot sirocco was blowing, was less than at other times, because the people were supposed to be in part divested of their reason during the prevalence of the hot wind. Montesquieu, in his *Esprit des Lois*, is supposed to attribute too much influence to hot climate in debilitating the bodies and the minds of men, but his observations seem to be strongly supported by the facts in the case; although a comparison instituted, in this particular, between the several *races* of men that inhabit the different portions of the globe, is not a fair one.

Much has been said by physiologists of the great power, possessed by man and the warm-blooded animals generally, of resisting the effects of a very high temperature. The celebrated experiments of Fordyce, Blagden and others in 1775, who supported a temperature, in air, of from 240° to 263° Fahr. for eight minutes,—high enough to cook eggs and beef-stakes;—that of the oven-girl in France, who astonished Messrs. Duhamel and Tillet, in 1760, by remaining twelve minutes in an oven heated to 264.° Fahr.; as well as the common feats our *soi-disant* Fire-kings, are, however, all to a certain extent deceptive. Atmospheric air is such an imperfect conductor that, although it might be intensely heated, it would part with its caloric very slowly to bodies immersed in it;—a good conductor, at a much lower temperature than that above mentioned, would not only speedily kill, but disorganize the body of an animal exposed to its influence. Moreover, the great evaporation which takes place in hot dry air, lends its aid to keep down the temperature of the body. Air saturated with vapour is a better conductor of heat than dry air, and permits less evaporation, consequently animals are not able to support so high a temperature in it as in the former.

M. Delaroche could not support, above ten minutes and a half, a vapour bath, which, at first, at 99,°5 Fahr. rose, in eight minutes, to 124,°25 Fahr. and afterwards fell one degree.

"M. Berger was obliged in twelve minutes and a half to come out of a vapor bath, of which the temperature had risen from 106,°25 Fahr. to 128,75. He was weak, and tottered on his legs, and was affected with vertigo. The weakness and thirst lasted the remainder of the day. These gentlemen however, supported for a considerably longer time, without much inconvenience, a higher temperature in dry air."

In water, which is a better conductor than dry air or vapor, the temperature which is supportable is still lower. *"Lemonnier, being at Baréges, plunged into the hottest spring, which was about 113° Fahr. He could not remain in it above eight minutes. Violent agitation and giddiness forced him out."

Moreover, in all the experiments made on the effect of intensely heated air, the individuals exposed to it remained under its influence but a short time; not long enough, if the imperfect conducting power of the air be considered, to experience its full effects. Yet even these individuals were more or less affected. The temperature of their bodies was raised some degrees and the circulation accelerated. "A young man, in Dobson's experiments, remained for twenty minutes, without great inconvenience, in a stove, the air of which was at 210° Fahr., but his pulse, which commonly was 75 per minute, beat 164 in this hot air." Had he been kept in this heated atmosphere for a greater length of time, serious consequences would no doubt have resulted. According to the numerous experiments of Delaroche and Berger, man and the warm-blooded animals generally cannot support, under the influence of hot dry air, a greater elevation of their own temperature than from 12° to 14° Fahr. In these experiments, animals of various kinds, exposed to an atmosphere of the temperature from 122° to 200.°, all died, sooner or later, having all acquired nearly the same increase of temperature, viz: from 11,°25, to 12,92. Fahr.

*Edwards on the influence of Physical Agents on Life.

The direct influence of high temperature, in weakening or exhausting the nervous action, is better exemplified by experiments in the comparatively good conductor, water, than in the very imperfect conductor of caloric, air. Dr. Edwards found, by his experiments on animals immersed in water, that in cold-blooded animals drowned in water of a temperature from 32° to 107.°6 Fahr, *the duration of their life was inversely proportional to the elevation of the temperature;* and that in water at the latter temperature, 107.6, these animals died almost instantly. Even at 104.° Fahr., fish, frogs, lizards, snakes, &c., are almost immediately killed. Warm-blooded animals are capable of supporting a greater heat in water. By drowning small animals of this class in this fluid at various degrees of heat, he ascertained that the temperature at which they lived longest was about 68° Fahr., above or below that degree the duration of their lives was proportionately lessened; but more rapidly, when it rose above than when it descended below that temperature.

It must be evident, therefore, that temperature, by acting directly on the nervous system, exerts an important influence on the animal economy, and that it is in the power of the physician, who is well acquainted with its effects, to employ it, often with great advantage, in the practice of his profession. He does, in fact, employ it, and in some cases, unwittingly. Warm or hot baths owe their principal effects to the agency of the caloric, which they impart to the system. The effect of the water itself, besides that of cleaning and softening the skin, is perhaps very little. Writers on baths have recorded many instances of the effects of the hot bath, which are similar to those produced by application of caloric, through the medium of air. We refer the reader particularly to Dr. Jno. Bell's compendious work "On Baths and mineral waters." A *hot* bath is one of a temperature exceeding 98° Fahr. Under its influence the circulation becomes excited and the perspiration increased, the respiratory action is also quickened, although the amount of oxygen consumed seems really to be lessened; for the blood is not as much changed in its round of circulation, when the body is exposed to the high temperatnre, as under ordinary circumstances.—The skin becomes hot, swelled and red, and if the bath be excessively prolonged, or usually hot, oppression, vertigo, hemorrhage, universal weakness, syncope, apoplexy or paralysis, may be the result. The hot bath is said to be stimulating or irritating to the nervous system, but whether stimulating or not in its primary action, its secondary effect, when prolonged in its action, is to weaken or exhaust the nervous powers. This is well known to the enligh ened physician, who employs it accordingly in his practice.

To high temperature, long continued in its action, is weakening and destructive to the animal powers;—too low a degree of heat, or rather too great, long continued, or rapid abstraction of caloric from the body is also injurious, although not to the same degree or precisely in the same manner. A certain degree of cold seems bracing and salutary; it increases the muscular and mental powers, and in fact the vital actions generally; but in excess it contracts the surface, driving the blood to the internal organs; rendering the skin hard and insensible and the mental powers dull and inactive. The inhabitants of countries who are exposed to *moderate* cold are among the best developed and active of our race. Those who inhabit *very* cold regions are curtailed in their developement; their extremities are small and their bodies large; their skin hard and their mental and other vital faculties, inactive.

Exposure to moderate cold induces an increased production of animal heat, and to produce this effect a greater amount of oxygen is consumed in a given time, and the blood is more thoroughly changed in its round of circulation. The increased oxygenation of the blood and the accelerated assimilatory processes, are attended by a general augmentation of the vital powers. The individual feels light and active, and is more fitted and able to sustain prolonged mental or bodily exertion, than when, under the influence of external heat, the amount of oxygen consumed is smaller and the blood is less changed in its round of circulation. But when the external cold is greatly increased the temperature-preserving power is too strongly taxed to sustain the internal temperature, and the general nervous power seems to become exhausted in the effort. Under its influence the surface becomes shrunk and contracted, and the blood is driven to the internal organs.—The result of this disturbed equilibrium is that the process of assimilation, and consequently, the evolution of animal heat in the extremities and on the surfaces, are lessened, and the internal organs become oppressed by a load of the vital fluid; weakness, stupor, a strong inclination to sleep, torpor, apoplexy and death, are known to be the final effects. Larrey, who had a very good opportunity, during the disastrous retreat of the French army from Moscow, of observing these effects of long continued low temperature, records that the "organs of visions and muscular power were so much debilitated, that it was difficult for the individual to pursue his way and preserve his equilibrium." The individuals seemed to suffer general torpor and paralysis, and loss of the senses, unattended by much pain. They staggered forward, like drunken men, supported by their companions, and if they once wandered from the moving mass of the retreating column, to sit down on the road-side, or fall into the ditch which bounded it, they never rose again, but perished in a very short time. Captain Parry, observed analogous facts, in those of his crew who had been exposed to intense cold. There was paralysis of the mental and corporeal faculties; the individual had a vacant stare, spoke thick, and it would be difficult to persuade those unacquainted with these effects, that they were not in a state of stupid intoxication from drinking ardent spirit.

A very low temperature, then, is injurious to the powers of life. There are many other facts that corroborate this opinion. For example, Larrey observed on his own person, as well as on that of others, that exposure to great cold was followed, on attaining a more moderate temperature, by a species of catarrhal typhus of the malignant kind, similar to hospital fever; and he states that when persons, torpid with cold, approached a fire, gangrene commenced in the frozen or torpid extremities, and progressed so rapidly that its course was visible to the eye. Or else the sufferer was suffocated by great turgescence of the lungs and brain and perished, as in asphyxia. John Hunter observed that a long continued frost was productive of the worst kind of putrid fevers. These effects are most visible in persons whose powers of life are weak, such as old persons and infants. Dr. Heberden* states that the "tide of mortality" of persons above sixty, "follows the influence of cold in winter. So that a person used to such inquiries. may form no contemptible judgment of the severity of any of our winter months merely by attending to this circumstance." The injurious effects of cold on infants, are strikingly exemplied in the following extract from the Appendix to Dr. Edwards' work on the Physical Agents, &c. "It is the custom in France to convey infants, within an hour of their birth, to the office of the Mayor of the quarter in which the nativity took place, in order that the birth may be registered, and the child become possessed of its civil rights. A careful comparison of the register of births, and the register of deaths, furnished statistical observations on so large a scale, that there can be no room to doubt the correctness of the results. It appeared that the proportion of deaths, within a very limited period after birth, compared with the total births, was much greater in winter than in summer, and that this difference of proportion, was much greater in the northern and colder departments, than in the southern and warmer." These observations were made by Dr. Milne Edwards and Dr. Villermé, who subsequently continued their investigations and found thus their results confirmed. "In order to ascertain in a more positive manner than before, whether the mortality of new-born children is increased by their being carried to the *maire* immediately after birth, we obtained from the minister of the interior, necessary orders to have the tables of mortality of infants made in a certain number of parishes, where the inhabitants are scattered over a larger surface of ground;

*Philos. Trans. Roy. Soc., 1796.

and in others, where they are, on the contrary, agglomerated around the *maire*. It appeared evident to us, that if our opinion was correct, the increase of mortality during winters, must be much greater in the former parishes than in the latter; and such is, indeed, the result actually afforded us by our tables."

Moreover, it is well known to physiologists, that certain fish, which possess the power of giving an electrical shock, derive that power from the nervous system. A certain elevation of temperature is found necessary to its complete developement. The great electrical eel only exists in the warm basins of the great rivers of the tropical part of the globe;--cold weakens its powers; and it was stated as early as 1775, by Dr. Jno. Ingenhouse, that the Torpedo of the Mediterranean has but little electrical force in the winter season.

By the foregoing facts the physician may judge of the importance of preserving a proper medium temperature, neither too high nor too low, in all persons whose powers of life are feeble. The temperature most salutary seems to be what would be determined by our feelings *cool or temperate*, say from 68.° to 75.° Fahr.—at all events, it is higher than the freezing point of water, 32,° which would be denominated *cold*, and lower than the mean animal temperature, 96.° or 98,° which would be called *hot*. A valuable application of a knowledge of these facts, may be made, in the case of young children and aged persons, persons debilitated by general disease. or individuals, who in consequence of disease or partial disorganization of the lungs, or disease of the heart, have the respiratory powers, and consequently their temperature-preserving power, materially lessened, as is manifested by their chilliness, and great sensibility to changes of temperature. Many other facts of high practical importance might be added had we space; for many of them we refer the reader to Dr. Edwards' work "*On the influence of the Physical Agents on Life;*"—a work that should be *studied* by every physician.*

*We perceive with pleasure that Dr. Jno. Bell has republished this important work in his valuable "Medical Library."

Extremes, both of heat and cold, are injurious to the nervous energies;—they act however in a different manner.—Extreme heat destroys the nervous power, even to that the most remote from the great centres, viz: *irritability* or *contractility;* while extreme cold seems rather to excite or preserve the irritability of the system. Many experiments, by Dr. Edwards and others, confirm this statement. Sir A. Carlisle, in his Croonian Lecture on muscular motion,* in 1804, gives the following experiments. "The hinder legs of a frog, attached to the pelvis, being stripped of skin, one of them was immersed in water at 115.° Fahr. during two minutes, when it ceased to be irritable:"—while similar muscles, kept in a frozen state for twelve hours, were yet irritable on being thawed. He drowned a hedge-hog, in water at 48.° Fahr.; the animal struggled much and finally rolled itself up into a ball, evidently in a state of muscular contraction; after thirty minutes from the time of its immersion it was taken out, and it yet recovered minutes. But one of these animals, immersed in water at 94.° Fahr. died in ten minutes, remaining stretched out, its muscular system completely relaxed, after the cessation of the vital functions. It is well known also, that cadaveric contraction of the muscles, which is the last effort of the lowest animal function, irritability, takes place to a greater extent, and lasts longer, in winter than in summer.

The process of *crimping fish* illustrates this proposition. Fish are taken, and by a blow on the head sufficient suddenly to kill, they are prevented from exhausting the last powers of life by prolonged struggles; before cadaveric contraction takes place, their muscles are divided, by transverse sections with a knife, on both sides of the body, and they are immedidiately immersed in cold spring or well water. In this state they are cooked. The effect is, that the remaining *contractility* of the muscular fibre acts so powerfully, as to make the fish so hard as even to crackle under the teeth. A similar prepar-

*Phil. Trans. Roy. Soc. 1805.

tion of common animal muscle, such as beef, would make it too tough to be eaten; and hence the epicure always waits until the cadaveric contraction has subsided, aud the irritability of the muscular fibre of his meat is completely exhausted before he permits it to be brought to his table. This, it is well known, occurs much sooner in summer than in winter.

The preservative, or even perhaps exciting effects of cold on animal irritability or contractility, may explain the action of the cold dash, in restoring suspended animation from fainting or other causes. No more efficient agent can, perhaps, be employed to recover individuals, who are suffering under the effects of narcotic poisons. Dr. Oppenheim, in his account of his travels in Turkey, records the fact that, if a person happens to fall asleep near a poppy field, and the wind from it blows over him, he gradually becomes narcotised and would die if not relieved. The country people, on discovering any one in this situation, immediately bring cold water from the next well or spring and pour it over his face and body until he is recovered. The doctor experienced in his own person the beneficial effects of this practice. It is well known that an intoxicated person may be soon relieved by pouring cold water on his head, and no more efficient means can be employed, than the cold dash, to relieve persons who have been stunned by a stroke of electricity, or asphyxiated by breathing any deleterious gas. Dr. Herbst, of Gottingen, has even shown, that in cases of poisoning with the powerful prussic or hydro-cyanic acid, no remedy is so much to be relied on as the cold dash. In short, in all cases in which the nervous powers have been suddenly oppressed, as in narcotism or aspyhxia from any cause, the forcible application of cold water—which seems to act only by reducing the heat of the the body—is the most efficient remedy; while the application of hot water, or any other means of heating the body, is the most effectual mode of destroying the latent spark of vitality that may remain in the body. An experiment of Legallois illustrates this proposition. On cutting the eight pair of nerves in animals, he found that the glottis became partly closed and they soon died from the consequent imperfection of the respiratory process. A puppy that was warm and vigorous died in half an hour, after the section of this nerve, but another, that was torpid with cold, lived a whole day.

These facts throw some light on the rationale of the exceedingly injurious effects of the sudden application of heat, to parts of the body that are frozen, or much benumbed with cold; and they lead us reasonably to doubt, whether the general want of success in the efforts made to recover the animation of persons asphyxiated by drowning, may not be as much owing to the sudden and too great application of heat, in accordance with the popular prejudices, as to any other cause. And they may remind the accoucheur, that suspended animation in the new-born infant, while it may be destroyed by the application of hot water, might be most probably recovered by that of cold.

The effects of the *momentary* application of heat or cold, are somewhat different from those of their continued application. Long continued application of heat, we have seen, by retarding the process of assimilation, lessens the temperature-producing power in animals; but the *momentary* application of heat, by exciting the surface of the body, rendering it hot and red with the blood thus invited to it, increases for a time the power of endurance of cold. Thus, a person who has just warmed himself at the fire can bear great cold, for a short time, much better than one who has been for sometime exposed to a low temperature; and the Russians and inhabitants of Finland, after remaining for a short time in their hot vapour baths, are able to plunge into rivers, filled with floating ice, or roll themselves in the snow, without any unpleasant feeling: in fact, the cold, by reducing the too great excitement of the skin, counteracts the weakening effects of the previous hot bath and gives even an agreeable sensation. On the other hand, the *momentary* application of cold, instead of increasing the power of generating animal heat, as the long continued application of a moderately low temperature is known to do, actually, by causing spasm of the surface and sending the blood to the interior—thus disturbing somewhat the circulation, decreases, until reaction takes place, the power of producing heat or enduring cold.

This obvious effect of heat and cold, in exciting or depressing the circulation and action of the skin, aid us in explaining, what is apparently an anomaly; the fact, that the inhabitants of hot climates, and persons of a sanguine temperament, are better able to support, for a time, the rigours of severe cold, than the inhabitants of cold countries or persons of a phlegmatic temperament. This fact was observed by Larrey. He states that the Russians, and the inhabitants of the cold and northern countries of Europe, suffered more in the disastrous campaign in Russia, than the French, or those who were from the hot and southern parts. As an example, he states, that of the third regiment of Holland Grenadiers, composed of seventeen hundred and eighty-seven men, who went to Russia, only forty-one were alive two years after. On the same principle, the inhabitants of cold countries, whose surface is rendered hard and inactive by the long continued action of cold, are less seriously affected by intense heat, for a time after their removal to a hot climate, than the inhabitants of those countries themselves.

The continued application of heat, we have seen, has the effect of weakening the nervous energies, and particularly the irritability or contractility of the system. It may, therefore, be employed as an important agent in the hands of the physician and surgeon. It has indeed been thus employed, but not generally nor extensively. Dr. Crawford, in 1781, inferred from his experiments that the application of the "warm-bath cools the system, and removes the tendency to inflammation." Professor Graves of Dublin,* states, "that in 1833 a violent influenza, accompanied by most distressing headache, attacked thousands in Dublin; this intense pain in the head was relieved by nothing so effectually as by diligent steeping the temples, forehead, occiput, and nape of the neck, *with water as*

*Clinical Lectures, p. 37, Bell's Select Med. Library.

hot as could be borne." This fact, he states, was first discovered by Mr. Smith, in 1833, who was unexpectedly relieved of violent head-ache by bathing his head in hot water, and he asserts that it was also discovered by Dr. Oppenheim. We believe, however, that the Professor is in error in relation to the date and author of the discovery of the beneficial effects of hot water, topically applied, in cases of irritation or inflammation, for it is notorious in our region of country, that with Professor Dudley, of Transylvania University, this has been a favorite and most successful remedy for a great many years. We will give one case, illustrative of its efficacy, kindly communicated by Dr. Pawling, who experienced the remedial effects of hot water in his own person.

"In the month of November, 1835, I had a violent attack of fever, attended with derangement of the digestive organs, great determination of blood to the brain, extreme watchfulness, and partial delirium: so intense was the cerebral excitement, that I was unable to sleep for four days and nights. In the meantime, I was freely vomited with tartar emetic and ipecacuanha, and purged with calomel. These remedies, while they lessened the febrile excitement, produced no alleviation of the pain and fulness of my head. At the suggestion of Dr. Bush, hot water was poured upon my head. This application produced the most soothing and delightful sensations; my head was entirely relieved and the nervous system quieted, which was followed by a pleasant sleep.

"Although I continued very ill for ten or twelve days, after the first application of the hot water, a repetition of it never failed to relieve the head.

"I have been in the habit, for many years, of sponging the body freely with warm water in almost every form of fever, with the most decided benefit, yet I never used it by pouring it on the head until after it was applied in my own case; since that time, I have used it in every case of fever, that has come under my care, where there was much pain and fulness of the head; and the result of my observation, is, that it never fails to alleviate the pain in the head and quiet the nervous system; *in truth, it is the best anodyne known in such cases;* it also produces an abatement of the fever and promotes the operation of calomel or other purgative medicine."

To prevent or allay irritation, as we have stated, bathing with hot water, as hot as can be borne, for a sufficient length of time, has been long a favorite remedy in the practice of Dr. Dudley, more particularly in his surgical practice; and he is able to detail a great number of cases in which this means has been almost wonderfully successful. This part of our subject we expect will be taken up and treated more extensively, by other hands more competent to do it full justice; we will merely, in this place, give a concise history of two cases, which lately occurred in the surgical practice of Dr. Bush, (Adjunct Professor of Anatomy and Surgery in Transylvania University,) illustrative of the efficacy of this agent in allaying or preventing inflammation.

CASE I.—Early in the present month, Aug. 1838, a young man of this city, received a lacerated wound in his right hand from a rail-road car. The injury was about five inches in extent, passing obliquely across the wrist and hand; lacerating all the soft parts, including fascia, tendons, nerves, and most of the blood-vessels, quite down to the carpal bones. This wound was dressed by drawing its edges together with adhesive strips and passing a roller bandage over the whole, fingers, hand and arm. The case was then submitted to the action of warm water, which was applied every hour for thirty-six, as hot as could be borne; hot enough indeed speedily to separate the cuticle. Under this treatment the wound healed by the first intention, and in three days after the accident the wound was cured, except a small part of the carpal arch, which was suppurating finely.

CASE II.—March, 1838. A boy, aged sixteen, was wounded in the right hand by the discharge of a pistol. The wad entered at the lower part of the wrist and passing longitudinally through the palm of the hand, came out between the little finger and the ring finger; laying the parts open, in its progress, down to the inter-osseous muscles. The wound was cleansed from the powder and the remains of the wad, dressed in the same manner as the last case, and similarly submitted to the influence of hot water. It united in about seventy hours; the upper extremity of the wound, only, suppurating for a few days after.

These effects, we think, we may very properly attribute, mainly to the agency of caloric:—the water aided in keeping the parts soft and clean, but the beneficial results were most probably the result of the influence of the heat, in keeping down irritation and inflammation within healthy limits. Indeed late experiments on animals, which we cannot precisely quote at present, have proven, that wounds are more rapidly healed in hot *air* than in cold, an effect which could only be attributed to the agency of the caloric.

High temperature, *momentarily applied*, has been used with great success, in some cases, as an *excitant* or derivative remedy. Hot water, as a rubefacient or vesicatory, is very quick in its action and may sometimes be advantageously employed. In croup particularly, it has been latterly very highly recommended. Professor Graves, some time ago, in the Dublin medical journal, directed to bathe the throat and chest with very hot water, in this formidable disease.

The long continued application of cold, while it reduces the temperature of the body, preserves, or increases its irritability, and renders it more sensitive to the impressions of heat. An inflamed part bathed in cold water, reacts powerfully when the bathing is intermitted, and a part that is frozen or rendered torpid by intense cold, is unable to bear without injury the action of the *sudden* application of heat. Hence those persons who are partial to the use of cold water or ice, in the treatment of fever or inflammation, are careful not to intermit the use of the cold application until their object is effected; for the reaction, which would result, would more than counterbalance the beneficial agency of the cold. It will be seen that the application of either heat or cold, above or below a certain medium temperature, (about 68 or 70°,) tends to reduce nervous action. There is this important difference, however, in their mode of action on the animal economy, viz: that the application of heat reduces the irritability of the system, while cold applications, while they may reduce the general nervous energies, seem to preserve, or even augment irritability; rendering the system more sensitive to the application of caloric and less able to support its effects, and hence inducing, in some cases, a reaction, after their use, which more than counterbalances their good effects.

To understand these subjects fully we conceive to be a matter of great importance to the medical man, as it it evident that caloric is a most powerful agent, for good or evil, in health or disease. It is an agent the remedial use of which in a judicious manner, must be of great value in a number of cases of disease; the action of which affects, more or less, the results of most cases. Reflecting on these facts, it is a matter of some surprise that caloric has been so much neglected by writers on the materia medica and therapeutics. It undoubtedly deserves a prominent place among remedial agents; and a more general and thorough study of its effects on the animal economy, would prevent much of the too common abuse of the heroic medicines.