five tuberculous and thirty non-tuberculous cases. The tuberculous material (lungs, spleen, peritoneum with miliary tubercles, blood) embraced cases of conglomerated as well as of infiltrated tuberculosis in the different stages of the disease. The non-tuberculous material examined was taken partly from healthy organs, partly from organs affected by various diseases—as, *e. g.*, from pneumonia, emphysema, pulmonary gangrene—and failed to show any of the reactions described above. Carcinomatous, sarcomatous, lupoid, syphilitic, and other non-tuberculous granulations were also examined, with negative results. From his researches, Herr Freund makes the suggestion that in tuberculous growths, and in the blood of tuberculous persons, cellulose forms an intrinsic constituent. We need not refer to the importance and suggestiveness of Freund's discovery for pathological science, making further researches on this subject very desirable.—*Nature*.

THE HOT SPRINGS OF THE YELLOWSTONE REGION.

IN 1806, John Coulter left the Lewis and Clarke expedition to go to the Missouri River to hunt and trap. Escaping from the Blackfeet Indians, he lived for some time with the Bannock Indians, and in 1810, returning to St. Louis, gave an account of wonderful spouting springs and boiling caldrons which he had seen in the Rocky Mountains. By this he acquired a great local notoriety as the chief of modern liars, and the locality which he described was derisively spoken of by hunters as "Coulter's Hell." In 1844 one James Bridger penetrated to the locality described by Coulter, and on his return was no more believed than had been his predecessor. It was not until 1863 that the first credited description of the region now familiar as the Yellowstone Park was given by Captain De Lacy. The more recent history of this wonderful country is now known by all men. We do not propose to inflict upon our readers any description of it at all, but only to say that after having wandered over the greater part of these United States, except the California region, there are, in our opinion, only two places that are worth the trouble of getting at them: one is Niagara Falls, and the other the Yellowstone Park. Possibly the Mammoth Cave might be added to the list. The wonders and beauties of the Yellowstone can scarcely be exaggerated.

The amount of hot water that is going to waste in the Yellowstone region is sufficient to fill the heart of a Chinese laundryman with an agony of sorrow, and to make an American sanitarian look with pity and disgust upon the small springs of Arkansas and upon the rest of the world with profound contempt. There are in the park simply thousands of hot springs of all magnitudes—some mere pellucid pools, some trickling fountains, some spouting masses of water almost sufficient to supply a city. And it can scarcely be otherwise than that in the future some of these springs will be found to possess very valuable medicinal properties.

Generally speaking, most of the springs can be divided into two sets—the calcareous or calcic and the siliceous. The Mammoth Hot Springs are the most important of the calcareous waters. They are really a large collection of springs, which, commingling with one another, have by their conjoint effort deposited a mountain of carbonate of lime. Two of these springs have been analyzed by Dr. Henry Leffmann, of Philadelphia, with the following results. (See U. S. Geological Survey, 1878, part ii., page 389.) The Cleopatra Spring, water strongly alkaline, temperature 154°.

Grains to imperial gallon.

Sodium chloride	13.496
Sodium sulphate	35.504
Calcium sulphate	13.587
Calcium carbonate	24.850
Magnesium carbonate	7.455
Silica	3.500

98.392

Spring No. 17. Temperature, 165°. This may be arranged as follows:

Grains to imperial gallon.

Sodium sulphate	34.370
Sodium chloride	18.900
Calcium carbonate	17.920
Magnesium carbonate	2.170
Silica	3.360

76.720

A greater number of the Yellowstone springs are siliceous, and deposit immense masses, known as geyserite, which contains ninety per cent. of silica. An analysis of one of these, the Opal Spring, a siliceous water in the Gibbon Geyser Basin, by Dr. Leffmann, gives the following result:

Grains to imperial gallon.

Sodium chloride	82.180
Calcium sulphate	3.220
Silica	53.760
Calcium chloride	4.060

143.220

The analysis of the Jug Spring of the Fire Hole Geyser Basin resulted as follows:

Grains to imperial gallon.

Sulphuric acid	1.400
Chlorine	19.180
Silica	14.560
Calcium	traces
Sodium	34.440

69.580

These analyses show that the springs of the Yellowstone are rich in mineral matter. But they do not fairly represent the resources of the region. Many of the waters are certainly strongly alkaline, and the immense masses of sulphur which are to be found in certain portions of the park, as well as the deposits around many of the springs, show that these waters are, some of them, also strongly sulphurous. The so-called Sulphur Mountain is a large butte of small crystalline deposits of sulphur, and with sufficient sulphur emanations coming up through which to make liquid deposits upon the warm ground at the top—

drops of melted sulphur, which might well be spoken of as drops of golden dew.

A member of the United States Geological Survey told us that one of the springs is very rich in boric acid, and that a number of them contain a notable percentage of arsenic. Near the Mammoth Hot Spring is a lake of warm water in which the invalid might well disport himself for hours, suiting the temperature to his needs by shifting his position toward or away from the thermal springs which feed the waters.

The only place that we know of in the Northwest which is at present prepared for the treatment of disease by the use of water and bathing is that which is known as Hunter's Springs. This is situated a few hours' of railroad riding this side of Livingston, near the Yellowstone River, whose rapid waters would afford to the invalid much amusement in the taking of large trout. There are three or four distant springs which furnish a very abundant supply of water, both for drinking and bathing purposes. The hotel, which is just finished, is primitive but sufficient. There is a large bathing pool, which reminded us forcibly of that at the famous baths of Luck, in Switzerland, besides numerous bath tubs, and all necessary arrangements for private bathing. The heat of the main spring is 168° F., and it has a specific gravity of 1.03 at 60° F. No analysis of it has ever been published, but we are enabled to give an original analysis made by Prof. Lehen, of St. Paul:

Grains to imperial gallon.

Solid contents	21.76
Magnesium carbonate	3.35
Ferrous carbonate	0.16
Calcium carbonate	1.65
Potassium chloride	2.10
Sodium chloride	0.15
Potassium sulphate	1.68
Sodium sulphate	1.38
Magnesium sulphate	7.07
Calcium sulphate	2.01
Alumina and silica	2.21

21.76

The amount of solid matter in the Hunter's Spring water is not very great, but there are more salts than are contained in the Hot Springs of Arkansas, and it is probable that syphilitic, rheumatic, and skin affections could be very successfully treated by it. The spring already enjoys a considerable repute in the Territory of Montana, and at the time of our visit there were some eighteen or twenty people undergoing treatment.

Before the thermal springs of the Northwest can attract invalids from distant places, much greater development must certainly take place, and we strongly urge upon the Northern Pacific Railroad authorities the policy of furthering such development. It would certainly pay the railroad, then, to have a thorough exploration of the springs of the park made at their own expense. The United States government, however, as owner of this property, ought to develop it.

Attached to the present United States Geological Survey there should certainly be a chemist, who should have a sufficiently well furnished laboratory in the park to make careful studies on the spot of a large number of these innumerable hot springs. At present there are no facilities in the park for the reception or care of health seekers, although there are large general and well managed hotels, and to them sanitariums could readily be attached.—*Therapeutic Gazette*.

A NEW THEORY OF COAL FORMATION.

THE *Bulletin de la Ceramique* has lately dealt with a theory regarding coal formation which it rightly or wrongly considers of sufficient originality to merit treatment of a detailed character, while the facts are said to reconcile features of the more ancient theories with results obtained by modern experimental science. Ideas of a more or less novel kind have from time to time been put forward by French writers with regard to this subject. M. Gennete asserted that coal is produced from a certain sandy earth which he names agas, while M. De Gonsanne regards it as clay mixed with sufficient bitumen and sulphur to render it combustible. In further illustration of his theory, he quotes the fact that none of the ligneous products with which we are acquainted can, strictly speaking, be called coal; referring specially to lignites, etc. Buffon has indicated the fact that coal deposits are situated in places which were at one time covered with water. Following out this idea, M. De Grand' Eury argues that the water of such seas or lakes was heated by the earth's caloric properties and by the sun. The atmosphere being charged with carbonic acid, there was in these waters an enormous production of inferior vegetation, which absorbed the carbonic acid of the air and became decomposed by the want of either water or oxygen. A sort of vegetable jelly will thus have been formed, which, gradually losing its humidity, transformed its carbon into ulmic hydro-carbureted substances; to become successively transformed into asphalt, petroleum, naphtha, earth pitch, bitumen, and finally coal.

This principle is opposed to the idea that large trees and shrubs produced coal, and in further support of this theory it is stated that the carboniferous flora consisted of plants deficient in substances necessary for producing coal, the investigation of M. Gaston de Saporta on this point indicating that this vegetation consisted of a relatively thin circle of wood and of a large quantity of a softer substance. Brogniart and Elie de Beaumont attribute the formation of coal to the transformation of the close herbaceous vegetation which surrounded the larger forest trees and plains. Similar opinions have been expressed by M. Ponchet and other *savants*, so that M. Grand' Eury has more or less eminent authorities for his statement that a calculation of the accumulation of trees, etc., necessary for the conversion into even a thin coal bed of a forest suddenly buried under water, or gradually letting its residue gather on the ground, leads to an evidently erroneous result, so greatly is it necessary to exaggerate either the mass of vegetable matter or the duration of the process of coal formation.

Even admitting for a moment that coal is produced by the decomposition of trees, M. Grand' Eury asked how it can be maintained that wood in losing its moisture has become liquid. Wood is known to contain a

good deal of water, and coal has only traces of it. While he regards it as certain that coal was at one time liquid, and gradually assumed a solid shape, he considers that coal beds were formerly beds of naphtha and bituminous petroleum produced by the decomposition of inferior aquatic vegetation under the influence of heat and dampness. As a proof of this assertion, he quotes the fact that the porous minerals found at the bottom of coal pits are impregnated in their pores with naphtha and petroleum. This is immediately detected by their odor (particularly with the porous minerals of lithoidal carbonate of iron), and it is therefore argued that this naphtha could only have been absorbed during the first state of coal formation. It is further remarked that this theory serves to explain the formation of petroleum, asphalt, and other bituminous springs, which are found at various depths, and even at the bottom of some lakes. A porous soil would allow of filtration, and hence M. Fongas has remarked that in calcareous districts the coal found is usually of poor quality.

In further defense of the hypothesis that coal was once in a liquid state, it is urged that cannel coal lights in the same way as resin, and can be used like a torch or flambeau. Another proof is the fact that the lighter substances (turfs, lignites, etc.) are on the top. Various proofs are furnished by the absence of similarity between the ashes of wood and coal that the two substances are not so closely connected as has been thought to be the case. The presence of fossil imprints or plants is explained by the fact that these imprints are in the earthy and schistous portions of the mines, and not in the coal itself. The trunks of trees which are sometimes found are not coal, properly so called, and retain certain properties of wood. The waters in which there grew the vegetable substances, to which reference has been made, contained (like such waters at the present time) carbonate of lime, carbonate of iron, and alum. Hence the presence of these salts in certain kinds of coal is explained. These interesting facts quoted by Mr. Paul Noel are possibly not altogether new, but in any case deserve attention.

COAL.*

By FRANK CALVERT.

Is coal, as presented in nature, formed exclusively of the remains of primeval forests, or are the vestiges of vegetation in coal the exception, as not constituting the bulk of the general mass of carbonaceous matter? This question forms the subject of the present essay.

The arguments in favor of a vegetable origin have been so generally accepted, that the advance of an opposite opinion may be received, at first sight, as emanating in a spirit of contradiction or of presumption. For many years the vegetative theory was held by the writer as a fundamental belief. Certain facts that present themselves, and the ideas they suggest, have led to the modification of this view, to substitute the hydrocarbons, or bituminous family, as the basis of coal, and to relegate the vegetable remains found therein as incidental matter.

Two theories are held on the vegetable formation of coal—the growth of forests *in situ* and the amassing of drift. The general concave nature of the beds in a coal field, with a depression of a hundred feet or more in its center, evidence forcibly against the theory of the local paludal growth of coal as a rule. If water were present, it would be in the form of a lake. Bogs, moreover, in their growth, assume, generally, a convex shape, that is, higher in the center. Suppose, then, an aquatic vegetation—take a bed of coal, say ten feet (at Wolverhampton thirty) deep, representing an uncompressed bulk of at least double that thickness. The vitality and longevity of stigmata and other plants, whose roots, embedded in the soil at the bottom of the water, would then be such as to survive an accumulation of twenty feet of vegetable matter. That such extraordinary growth did not exist is proved by the unbroken beds of foreign matter that completely separate the mass in horizontal sections; therefore, the theory of local growth does not meet the case. Again, the hypothesis of an arrested state of subsidence of land, repeated, say fifty times, in the formation of a coal field at long intervals, each interval representing an age, conveniently suspended to allow of a vegetable growth, makes too great a claim on credulity. Submerged forests, with stumps of trees still remaining in the place of growth, are certainly found in the earth's strata, but there is no continuity in the relation of their growth to the bed of coal to establish the fact that they originated the general mass. The dividing nature of the thin beds of foreign matter in the seam of coal already mentioned proves the deposit to have been effected in tranquil waters under conditions in which vegetation, admitting it existed then and there, had not the power to penetrate from below the unbroken plane or its roots to traverse from above. To establish a fresh start of vegetation based on clay or sand a fraction of an inch thick is an inadmissible argument. The older theory of drift vegetation has more claim to attention than the newer idea of local growth. Drift vegetation has contributed certainly to the formation of coal, but this to a limited extent, to what relative degree will be shown farther on. The motive that led to the examination of the subject of the present essay was accidental. Some years since, an eruption of petroleum occurred in the sea off the island of Samothrace, near the Dardanelles. A portion of the mineral entered the straits. As the pieces of bituminous matter neared the shore they grounded and spread on the bottom of the sea in patches, incorporating remains of marine and terrestrial vegetation. The density was nearly equal to that of the water of the sea. The oily portion of the ejected petroleum coming in contact with the water was eliminated to a greater or less degree, while the gravity of the more solid part increased until it sunk and spread on the bed of the sea. These facts suggested the following ideas: Suppose this deposit, in the course of ages, buried under a mass of strata, to have undergone enormous pressure, would not the bituminous substances appear as a seam of glittering coal? Suppose a piece of this coal be cut into very thin slices and submitted to the microscope (as experimented by Hutton), a vegetable texture would be apparent, and a *prima facie* proof of a vegetable origin adduced.

* Recently read before the Greek Literary Syllagos of Constantinople.

The sharpness of outline of vegetation sometimes seen in coal is due to the prophylactic property of the bitumen in which the remains have settled, as the delicate insect is preserved in amber. The process through which the vegetable remains in question have passed may be instanced in a fragment of wood or branch of a plant that has been left to sink in bitumen or in tar. The pores are gradually imbued with the viscid matter, and the minutest fibers or leaf preserved from decay.

The manner of deposition suggested by the eruption of petroleum near Samothrace would be not only more natural than that of local forest growth or drift, but it would explain the formation of the thinner seams of coal. A portion of the petroleum from Samothrace, in my possession for some years past, still retains its viscid consistence, showing the absorption or setting of vegetable matter in a mass of the substance, such as a bed of coal in its nascent state would present, may extend over a considerable period. The form of stigmata, sigillaria, and other aquatic and terrestrial plants which sink, when saturated with moisture, into the yielding mass, has thus been frequently preserved in coal.

Corroborative evidence is furnished by Nicholas Nugent (Polehampton Gallery, vol. v.), who visited in 1807 the pitch lake in the island of Trinidad. He mentions "pieces of recent wood," and "even large branches of trees enveloped in the bituminous substance." "Some parts of the asphaltum," he informs us, "had a splintery, conchoidal fracture, resembling particular kinds of coal; in others it bubbled up in a perfectly fluid state, so that you may take it up in a cup." Here is presented in a comprehensive view the substance of original matter, the inspissation of the asphaltum, and the presence of vegetation in the first stages of the formation of coal.

The bituminous springs of Albania furnish conclusively a proof of the deposition of bitumen in stratified form. Flowing from the springs, the bitumen leads to the small lake, where it accumulates on its bed. The bitumen is found over an area of several square miles, round the springs, in the form of numerous strata, the deposits of past ages. These strata vary in thickness and in purity, and are interstratified into beds of clay. Convolutions of the earth's surface have displaced in part the prior horizontal position of the beds, some of which dip at a high angle and afford an instructive section of this interesting formation.

The varied nature, the degree of purity of the carbonaceous matter, the diverse conditions it has encountered, has originated the many descriptions of coal, from anthracite to the highly bituminized Newcastle. It is to be observed that both marine mollusca and vertebrata are found in coal fields, though the proportion to terrestrial is smaller. The accumulation of coal, physically, is more natural in fresh water basins than in the sea, where currents, more or less prevalent, would spread the bitumen into thinner seams.

The general appearance, in some kinds of coal, shows the successive accumulation of portions of semi-fluid bitumen. The form of these pieces approaches the lenticular, such as bituminous matter assumes in setting in water. On the cross section to the general bedding of the coal, these portions appear as elongated patches of varied degrees of brilliancy—an arrangement which is not natural to a vegetable deposit.

From coal proper of bituminous origin are to be separated woody lignite and brown coal (such as may have originated in bogs) and jet. The circumstance of amber being inclosed in jet indicates its origin in the resinous portion of coniferæ which has been preserved, as in the pine forests of the present, while the softer or more resinous part decays. Isolated pieces of coal have had their origin also in the carbonized remains of forest fires, caused by volcanic agency, lightning, friction, or spontaneous combustion. Many pieces of carbonized wood washed down by floods in the Tertiary ages are still preserved, with the characteristic cross fissured appearance wood takes by contraction, when charred.

Bitumen, in disseminated form, has played an important part in the preservation of vegetable matter. Non-resinous plants, for instance reeds, frequently found in a carbonized state embedded in a stratum of rock, would apparently show that coal may be formed independently of bitumen. Opposed to this feature, the next stratum may show identical plants, of which the cast or impression of the leaf or stem remains, while the carbon, or vegetable matter, has been replaced by stone or clay. In these two strata, the plants have been embedded under similar conditions, that is, in an undecayed state. Why is the plant in the one case preserved, and not in the other? The cause may be due to the prophylactic property of the embodying sediment in the first instance, to the absence of the preservative in the second. A shaft made in the boraciferous basin of the Sultan Chair, near the Simaov River (ancient Macestus), in Asia Minor, confirms this hypothesis in a clear manner. While in the bituminous clay and sand the carbonized remains are preserved, the form alone of vegetation remains in the non-bituminous strata. The bituminous clays and boraciferous gypsum of the Miocene basin of Sultan Chair are of volcanic origin. Close to the basin, in the older rocks, are the springs of Lidgia, of a high temperature. At Omerkiol, in the newer rocks, near the edge of the basin, are other sources of a more moderate degree of heat. These springs are charged with carbonic acid.

Bitumen, in attenuated quantity in rocks, from the coal shales to lessening gradations, is common, and sufficient to act as a preservative. Bitumen in different forms is not uncommon in mineral waters. A certain portion of vegetable matter has been undoubtedly converted into coal, still, as has already been remarked, it is far from forming the general constituent bulk of the same.

In the valley of the Dent, in England, a bed of coal a fraction of an inch in thickness is continuous through an area of several miles in diameter. Thinner beds forming attenuated sheets are frequent in coal fields. It is physically impossible the continuous seam of coal, as fine as a sheet of paper, shining with brilliant purity, has had its origin in a deposit of leaves; that time has eliminated the earthy portion of vegetable matter and purified the carbon. The quantity of ash in some kinds of coal is so small as to form but one five-hundredth part of the weight, yet we have the significant fact the component materials of this small quantity of ash differ essentially with that of wood. Taking in gene-

ral the insoluble portion of ash, lime leads with an average of forty-five per cent. in wood ash as to five, while silica, three per cent., is increased to forty-three in coal. Alumina, the next predominant mineral in coal ash, which furnishes forty-one per cent., is remarkably by its scarcity in the vegetable kingdom. It is interesting to compare the foreign matter in the inspissated asphaltum at Trinidad. In a hundred parts of this matter, there were, according to Nicholas Nugent, sixty of silica, ten of alumina, ten of iron, but not a trace of lime. Silica and alumina are the minerals most frequently held in mechanical suspension in lakes and seas. To the deposition of this sedimentary matter its presence in coal is due, in varying quantity, from a small percentage to rising gradations, through the many varieties of coal to the shales, when carbon takes a secondary position. The purity of coal, devoid of the constituent minerals of wood ash, with but a trace of sedimentary matter, further sustains the hypothesis of a bituminous origin, some varieties of which substance burn without residue.

Assuming the bituminous origin of coal, the question presents itself, from what source the bitumen of which it is composed be derived. The rearrangement of mineral matter in accumulated individual form in sedimentary rocks, as compared to the general homogeneous character of the earth beneath the superficial crust, has originated: First, the great variety of igneous rocks (through which a link of affinity exists), by intense heat acting on, fusing, and destroying the form of the sedimentary rocks. Secondly, the transformation of the constituent minerals in their separated or concentrated form of rock, by the action of comparatively moderate heat, without displacement of the stratified position. To the latter section is to be placed the conversion of carbon, stored in such vast quantities in limestone, under combinations of heat and moisture, to the generation of the hydrocarbon and bituminous group.

Nature gives the faculty to vertebrata and to plants to decompose matter and to form new combinations in the production of fat, oil, and resin. The synthesis of matter on a grander scale, in the mighty laboratory of the earth, is therefore an admissible hypothesis, hence the present source of petroleum and the rest of the bituminous family. Forced through the fissures of the earth, from the locality of generation in the past, the bituminous issue has formed the coal beds of former ages. The process of transformation of the carbon in limestone under required conditions may be continuous, that is, has been and is still in operation in the earlier and succeeding sedimentary rocks, to be continued hereafter in beds in actual course of deposition at the present day.

THE EARTHQUAKE AT CHARLESTON.

To the Editor of the Scientific American:

Referring to my letter of Sept. 18, suggesting a line of inquiry as to causes influencing the recent earthquakes, and the answer of P. M. F. thereto in your issue of Oct. 9, I beg to suggest that the reasons assigned by him in antagonism to the theory are by no means sufficient to divest it of scientific interest, for the reason that they ignore one fundamental fact. He says:

"1. Almost, if not all, of the theories accounting for the presence of gas and petroleum accept the fact that these substances were formed subsequent to the final comparative quiescence of the earth's crust after ages of upheaval and disturbance. This being so, there must have been cavities for the reception of gas and petroleum before they were formed; and if the overlying strata kept their position then, when the cavities were empty, why should they now be disturbed by the withdrawal of the contents of the cavities?"

Accepting all of this as true, he ignores the generally admitted and—in this connection—important fact that the earth is *still gradually cooling and contracting*; and even if the cavities did exist before they were filled with oil and gas, it is perfectly apparent to reason that a contraction of the earth's crust would gradually produce an increased pressure upon the confined cushions of oil and gas until the gravity of the superincumbent mass was balanced, or nearly so, by the degree of compression or elastic resistance of said bodies of oil and gas. Now, after this condition of things has been reached, a ventage of these bodies of oil and gas would leave the crust free to collapse from gravity, and might involve the result predicted in my former letter. That the earth is contracting is generally admitted, and the fact has been, I believe, particularly observable along the Atlantic slope in the gradual encroachment of the sea upon the land, which has been frequently the subject of remark in recent years. This encroachment of the sea upon the land may be fairly taken as *one* evidence of the contraction of the earth, for, as the solid crust contracts, it becomes of smaller diameter, and the body of water on the surface consequently overlaps a larger portion of its circumference.

P. M. F. also, in accounting for the increased presence of the gas by the continued accumulation of oil and gas from its source of generation, says that such pressure would not hinder the chemical combination of materials of which they are formed. Now the transformation or evolution of gas from the heavier hydrocarbons is mainly a question of volatilization, and this is *directly* retarded in proportion to pressure. P. M. F. also, I think, attributes too insignificant an agency to the pressure exerted by this oil or gas. Although the pressure at which it issues at the surface may only reach a few hundred pounds, this does not signify that the pressure which it exerts within is as insignificant, any more than the pressure at the exhaust pipe of a steam engine correctly indicates the pressure within the boiler. It is a fact that the frictional resistance which a fluid meets in passing through a long line of pipe so reduces its pressure at the discharge end as to constitute one of the serious obstacles to the transportation of natural gas; for, although it may enter a pipe line at a high pressure of several hundred pounds, this pressure falls at no great distance to an insignificant figure.

Now, the gas, in passing through the cellular crevices and rough channels of its passageways to the surface of the earth, undoubtedly meets with such great frictional retardation as to cause the few hundred pounds pressure at the surface to represent an original pressure of many thousand pounds in the storage cavities

within the earth; and this is no insignificant factor, and may, when depleted by long continued ventage, be sufficient to disturb the balance between gravitation and centrifugal action.

If, however, P. M. F. speaks as one having an intimate acquaintance with the oil and gas regions at the time of the earthquake, his reply is of the very kind that my letter was intended to evoke, and the inquiry must be held to have been fairly answered by his assertion that there was no such disturbance of flow or pressure at that time. While demurring to his philosophy, I am bound to accept his "fact."

EDWARD W. BYRN.

Washington, D. C., Oct. 9, 1886.

THE REARING OF TURKEYS.

By HENRY STEWART.

THE turkey is supposed to be a delicate bird, not easily reared. It would be strange if it were so, considering that the best kind of birds are reared in a state of nature in the forests of the South and Southwest, and grow to a size and vigor quite equal to the domesticated varieties, and yet the wild birds have none of the advantages of the feeding and care which can be given to those reared upon farms. The fact is that the domestication of the turkey has not improved its natural hardiness and vigor, nor has it increased its weight, for wild birds are occasionally seen which are equal to the finest of the domesticated. But yet the domesticated bird is by no means wanting in the natural hardiness of the race, for it is the mistakes of the owners which cause such a very large mortality among the young birds, just as it is the case in the rearing of chickens, of which the larger part are lost by disease in the earlier period of their lives; and the great difficulties which lie in the way of success, and which disappoint the hopes of the farm housewife, are precisely those which interfere with success in rearing chickens, viz., a want of the proper arrangements for controlling the hens during incubation, exposure of the young broods to damp and filth, and overfeeding. From my experience during a good many years, I have found turkeys to be more easily reared than chickens, and no more subject to the fanciful dangers of youthful periods than any other young animals. The greatest danger of all is simply overfeeding—cramming the young things with food which they cannot digest, and of course vitiating all the vital functions, when there is not strength enough to withstand or counteract the injury.

In the care of all sorts of animals whose instincts are peculiar and strong, it is necessary to consider these, and conform the methods of management to them. Thus the hen turkey must be provided with a secluded place for her nest, and this should be on the ground, and in a dry, sheltered place. Some low trained bushes and evergreens are excellent to afford these desirable conveniences for the hens. When the nest is made, and the hen retires, her natural shyness is to be accommodated by leaving her alone, simply putting food (corn is the best) and water somewhere near the nest, where the hen may come quietly and unobserved. At the end of four weeks, the food should be changed to coarsely cracked wheat, rye, and corn, so that the chicks may be fed. When they are a week old, the hen will lead them out to forage, and the coop in which the nest has been made may be brought out into the yard, where the active little creatures can find a good range. As these birds are quite ornamental, and do no damage, the lawn may be given up to them for a range until they are 12 weeks old, when the coops will no longer be wanted, and a hundred acres will hardly suffice to contain a brood. The coops should be placed among the shrubbery, and on dry ground, and be moved every two days to a clean place. The coops are much the same in every way as those for chickens, but larger—4 feet long, 2½ feet wide at the bottom, and roof-shaped, leaving the peak 2½ feet high. This gives ample room for the young birds when confined during stormy, cold days, or in sudden heavy rains. It is necessary to keep a watch for these storms, and during the first 8 or 10 weeks of their life to drive the young ones up to the coops for shelter, when rain is seen to be approaching.

The feed need consist only of corn, rye, and buckwheat coarsely ground together, and should be given in small quantities frequently. Half a pint of food is sufficient for the hen and 10 or 12 young ones at once, and this may be given four times a day. Any more than will be eaten up clean should not be given, and the right quantity may soon be found after a few trials. As the young turkeys grow, the food may be increased gradually, although as they run abroad they will pick up a good many insects and some grass, and will not need much more than the quantity above mentioned. A good deal is written about the food for turkeys, and boiled mush, chopped eggs, and a lot of other prepared food, which will give a great deal of trouble, is recommended. This is all unnecessary and even injurious, because it is wholly contrary to the natural needs of these birds, whose proper food consists of insects, seeds, and green vegetable matter. For years past I have never given any other food than the ground mixed grain or wheat crushed in a common coffee mill of a cheap kind, which is very useful to have about any poultry establishment.

When the young turkeys get their full plumage, they may be turned out of the coops and permitted to go as they please. The old hens will prefer to roost in a tree, and will do very well in that way; but a comfortable house with lofty perches, kept specially for the turkeys, and having a suitable yard attached to it, will be found the best. Labor and annoyance is always avoided, in the care of all kinds of poultry, by having easy means of controlling them when it is desired, and leaving them no chance but to do as the keeper desires. When the marketing time comes, the birds are rapidly fattened in coops, being then fed upon corn meal boiled in milk, and made quite thick, so that it is easily eaten. It is not necessary to cram the food down the throats, as is often recommended; this rather retards fattening than helps it, and I have found birds crammed in this way to be several pounds less in weight than others fed, *ad libitum*, in the natural manner. A spring turkey can be made to weigh 16 or 20 pounds by Thanksgiving day or Christmas, and a brood of 10 young ones will thus bring in about \$20 at the low price of 10 or 12 cents a pound. The profit of a