ART. IV.—*On the Cryptogamous Origin of Malarious and Epidemic Fevers.* By J. K. MITCHELL, A. M., M. D., Professor of Practical Medicine in the Jefferson Medical College of Philadelphia. Philadelphia, 1849. Pp. 137.

THE denomination Fungous Origin, and Fungous Hypothesis of Diseases, to which attention has been recently solicited, is not fortunate. It is, indeed, what ancient writers would call inauspicious, in so far as it gives occasion to those inclined, to think that the hypothesis is as unsubstantial, and as fleeting and temporary in duration, as the vegetable productions from which it derives its appellation. Certain it is, that scarcely anything could be less durable than the hypothesis by which it was attempted to explain the origin of cholera, by ascribing that disease to the presence and operation of fungous growths.

It may or may not be, that in order to obviate this misapplication of the term, that the present author, Dr Mitchell of Philadelphia, has selected the less pliant and flexible name of cryptogamous, in his undertaking to throw some new light upon the origin of miasmatic and epidemic fevers. Though the name is different, the signification is the same. Dr Mitchell thinks that various facts show that, the true causes to which the origin and prevalence of endemic and epidemic fevers have been attributed, are neither the miasmata of marshy grounds, nor the emanations from the soil, but the cryptogamous plants, *fungi*, or mushrooms of various species, which are abundantly produced in situations where, and during seasons when, fevers of this order prevail. On the success of this undertaking, different opinions may be entertained. But it must be conceded, that Dr Mitchell has examined with great learning and judgment, the circumstances in which this order of febrile distempers is liable to be produced, and has adduced a body of evidence which shows, that the hypothesis in his hands is entitled to considerable attention.

Dr Mitchell examines first the usually received theories on the origin of endemic fevers, and considers with candour and impartiality the evidence for their truth. Every one is aware that the theory or hypothesis which ascribes these diseases to what are called marsh miasmata and telluric emanations is open to various objections; and all the progress which impartial inquirers, not decidedly attached to one side, have been able to make, is to infer that the hypothesis, after being modified and restricted by various conditions, possesses a certain degree of probability, and is chiefly adopted, because there is none other which possesses stronger and more manifest claims on the attention of the medical profession. It must be further allowed, that though its reign has been upon

the whole lengthened, yet the experience of every season, and every cycle of seasons, furnishes facts, of which it does not in all instances present an easy explanation. Under these circumstances, it is not difficult to understand that this theory may require to be modified by the restricting power of additional conditions.

In the following passage Dr Mitchell states the difficulties by which this theory is allowed to be embarrassed in the writings of physicians, who have either espoused its defence or admitted its weak points :—

"The commonly received marsh theory is well stated and supported by Macculloch, to whose work on Malaria I refer you for a view of the question. It is in a much more masterly and precise manner, sustained by Dr Craigie of Edinburgh, to whose volumes on the Practice of Medicine you may most profitably resort for a learned, lucid, and, I think, impartial array of the facts bearing on that side of the question. Macculloch involves himself in difficulties without seeming to see them ; whilst Craigie, although inclined to the same conclusions, views with a master's eye the whole of the impediments and objections. The objections presented by the latter are: the low temperature at which these disease-producing changes may take place ; the unaccountable production of them in places in which there is no apparent vegetation and often no marsh ; the exemption of certain places where occur all the seeming elements of decomposition ; the inexplicable effects of rural cultivation ; and the unexplained vicissitudes of health in the same places in different though similar years."—P. 15.

It is well known, accordingly, that the hypothesis of Malaria and telluric emanations has at all times had opponents. Of these Dr Mitchell mentions two, namely, Professor Dunglison and Dr John Bell, who, nevertheless, have been more successful in showing the defects of the old hypothesis, or that which Dr Mitchell names the Vegeto-aerial, than advancing any new one would.

To any one who undertakes to investigate the evidence on which this hypothesis is to be considered as tenable, two questions at the fewest readily suggest themselves for consideration. The first is, Are there regions and districts in the habitable and inhabited globe in which the physical conditions usually specified as associated with the production of endemic fevers are present, yet in which fevers of this description are not observed to prevail ? Are there regions and districts, in which there are marshes, stagnant pools, and ditches, or alluvial flats, with extensive subsoil, moisture and dry surfaces, or argillaceous and gravelly lands, in which endemic fevers are not observed to arise ?

The second question is, Are there regions and districts in which fevers are endemic and occasionally epidemic, yet in which

neither marshes nor ditches are evident, nor alluvial flats with extensive subsoil moisture, nor argillaceous bottoms, nor gravelly banks, nor dry rocky ravines, are observed to exist?

Of such places as the dry sandy plains of Brabant, in which it is well known remittent and intermittent fevers are endemic, and in certain seasons epidemic, various authors have spoken as furnishing arguments against the miasmatic hypothesis; and we observe that Dr Mitchell adds his name to the number. Plains of the kind now specified, however, furnish no arguments of the kind stated. These plains, however dry they appear at the surface, are perfectly moist and watery, much like a sponge; and, in point of fact, when carefully examined, they furnish substantial arguments in favour of the hypothesis. Such plains are common in Belgium and Holland, and in certain parts of Spain; and in all instances, if perforations are dug, to a moderate depth, the cavities are speedily filled with water, which percolates, indeed, through the entire subsoil, to the depth of no one can tell how many feet. In Belgium, especially where the surface is flat and much intersected by slowly moving rivers, the subsoil moisture is most abundant. Now it is exactly this condition of subsoil that favours the production of the poisonous cause of the endemic fever, whatever that may be. As soon as the surface is exposed to considerable solar heat, on the approach of warm weather, that is, after the vernal equinox, a process of desiccation advances all over it for about one inch or so down. But along with this process, water is constantly ascending to the surface through the loose porous soil; and as that which ascends is evaporated by the heat, a constant process of exactly the same nature as that which takes place on the margins of the marsh, must be advancing at the points at which the subsoil moisture is in contact with the drying surface of mould. Soils and districts of the kind now specified are, to all intents and purposes, miasmatic. We do not pretend to say what the poisonous element is; but we think every accurate observer of these soils must allow that they possess all the conditions necessary to produce a poison, the same as that which is exhaled from the surface of the soil in districts confessedly miasmatic; for instance, the banks of the Scheldt in Holland; the mouths of the Rhone in France; the delta of the Mississippi, in America; and the delta of the Niger in Africa.

It is our opinion, therefore, that this case cannot be received.

The example of New South Wales furnishes a greatly stronger argument. That country, extending from 10°. 5′ to 38° S. latitude, embraces a region similarly situate to that of America, from the West Indies to Chesapeake Bay. It is subject to a rainy season; it has streams, estuaries, and extensive swamps. Around

some of its towns lies a deep black highly productive vegetable mould. It is liable to extraordinary inundations, which lay the country, as far as the eye can reach, under a sheet of muddy water. The temperature is as high as that of any other like latitutude. The coast is covered by mangroves. Its animal and vegetable products are those of the equinoxial regions. But notwithstanding all these conditions, which usually denote a febriferous region, New Holland is remarkable for its salubrity. Pulmonary diseases, and in the wet season dysenteric attacks, are observed; but the fevers incident to warm climates elsewhere are of rare occurrence in this part of the globe.

Mr Titian Peale, who accompanied Captain Wilkes in the exploring expedition to the Pacific Ocean, states, that he never saw a case of ague, either in natives or strangers in the Polynesian Islands, though the officers and men employed lived and slept in the midst of marsh exhalations and mosquitoes, when the days were hot, and the huts were open and exposed.

The experience derived from the Island of Tongataboo is of the same nature. This is what is called an organic island, formed by coral; flat, rich, and luxuriant, with a temperature rising to 98° F., and offering a mean temperature during the period of the sojourn of the expedition of 79°, 25′. Much rain fell, and when the atmosphere was clear, there were heavy dews. The people of the expedition, though on shore at night, suffered no attack of illness.

Ovolau (Fegee) is a volcanic island, the mean temperature of which, for six weeks, was 77°, 81′; maximum, 96°; minimum, 62°. Vegetation was vigorous and rapid. Fevers are unknown.

The island of Singapore in the East Indies, is on the main low and level. In the interior rises one hill to the height of about 500 feet, and in this granite rocks make their appearance. Scattered here and there are low round sand-hills, the level ground between which is formed of a ferruginous clay upon a sandy substratum. The greater part of the island is covered with jungle. In many places are found lofty trees, and a most luxuriant vegetation. The island is well watered by streams, which descend from the hills to the sea. The tides have produced and continued a chain of marshes nearly all round the coast. In some places fresh stagnant water covers extensively the low grounds.

The city, which lies in latitude 1°. 17′, that is, almost, under the equator, contains a mixed population of Chinese, Malays, Indians, and Europeans, amounting to about 20,000 souls. It is nearly surrounded by marshes, the jungles of which are almost impenetrable, and are infested by tigers and other ferocious animals. In some spots the Chinese have cleared and cultivated

the ground, and near the city are some sugar and nutmeg plantations.

Vegetation is rapid and profuse; decay is not less rapid. The mean annual temperature is, in the morning and evening, 79°.45; at noon, 84°.

Notwithstanding this combination of physical circumstances, fevers, especially among the natives, are rare. Remittent fevers take place occasionally; agues more rarely. Foreigners are the parties most readily attacked; and attacks, though few, are attributable chiefly to exposure to the sun, or much fatigue. The island has the character of being very healthy.

We have only to observe, that, with regard to the physical characters of the soil of Singapore, wherever there is ferruginous, that is, iron-clay, endemic disease is almost unknown. With the ferruginous impregnation, the production of endemic or telluric disease seems to be incompatible.

The author next refers to Brazil, the physical and hygienic characters of which being generally known, it is unnecessary to repeat.

The hypothesis proposed by Mr Daniel regarding the influence of sulphuretted hydrogen, he regards as quite inadmissible, in so far as in situations where are sulphur-works and manufactories for gunpowder and sulphuric acid, endemic fevers prevail so little, that he states that ague, with vegetation, has entirely disappeared. Nor does Dr Mitchell assign greater importance to other gaseous bodies, to which different speculators have attributed the origin of remittent fever.

After disposing of the miasmatic hypothesis, as modified by Dr Fergusson and Dr Jackson, he directs passing attention to what has been called the animalcular hypothesis, or that which ascribes endemic and epidemic disorders to the presence of multitudes of minute animals. Against the truth of this hypothesis, he urges the following objections:—1. It has never been shown that animalcules are in any way poisonous. 2. None of the difficulties of the inquiry are thus removed. 3. The assumption is hypothetical at first, and does not, in the progress of examination, become more demonstratively probable or logically admissible. And, 4*th*, To the vegetable branch of the organic hypothesis belongs a higher degree of probability, and, by adopting it, much of the obscurity of the subject may, in the estimation of the author, be dissipated.

Upon the exposition of this hypothesis, therefore, namely, that by the germs of cryptogamous plants, Dr Mitchell enters. The idea of this hypothesis appears to have been suggested to his mind by accident; though, after its first suggestion, he appears to have diligently collected proofs in favour of its probability.

Standing, Dr Mitchell informs us, at St George's, in Delaware, more than twenty years ago, upon the bottom of what had been a short time before a mill-dam, he found around, the undecayed stumps of several trees, which had been for 117 years submerged in fresh water. Two or three years afterwards, when he again visited this spot, he observed that these stumps, no longer thoroughly covered by water, but damp, had been entirely disintegrated by the dry-rot, and that they crumbled to pieces in handling. In the handful of dust which he picked up he found innumerable spores of what he supposed to be POLYPORUS DESTRUCTOR, and MERULIUS VASTATOR, cryptogamous plants, whose active existence had been bought, he adds, at the expense of the old stumps. Dr Mitchell immediately drew the inference, that probably the miasm, so much dreaded in that place, might be directly or indirectly the product of these concomitants of rapid decomposition. He has since that time collected many facts which he thinks tend to give the hypothesis a degree of probability. At the same time he candidly acknowledges, that though he has much confidence in the force of his subject, he has no desire, that the hypothesis be established at the expense of truth and reason.

After the general statement of the hypothesis, Dr Mitchell adduces those facts and arguments which he thinks tend to show its probability, if not to prove its validity. It is unnecessary that we follow the author in this survey. We shall merely advert to some of the leading topics in the train of reasoning.

Among cryptogamous plants the FUNGI are the most remarkable. Occupying an intermediate position between the LICHENS, which thrive in dry soils, and the ALGÆ, which live in water, salt or fresh, they evince a preference for damp, unsound, and loaded atmospheres, and feed on organized matter, the vitality of which is gone or going.

To this condition it appears to us that the fungi constituting fairy rings form an exception. The air there is neither damp nor unsound. It is of the dry, pure, and to all appearance, most salubrious.

In all the FUNGI the element is a minute cell, not often distinguishable when isolated from the elementary cells of even animal organisms. Of all vegetable substances they are, chemically, most highly animalized. Like animals, they evolve carbonic acid and imbibe a quantity of oxygen; from some, hydrogen, and from some, nitrogen, is extricated. They yield the vegetable products resin, sugar, gum, fungic acid, and saline compounds; and they afford adipocire, albumen, and osmazome, as animal elements. Their basis is fungin, a substance white, soft, and doughy, which yields nitrogen, hydrocyanic acid, oxalic and some other acids, and wax, tallow, and, in some instances, oil. According to the author,

they are chemically constituted plants, some with animal motions and volitions, and others with animal composition and the structure and habitudes of vegetables.

It is unnecessary to follow Dr Mitchell in the enumeration of the various beings, animal and vegetable, which are liable to be attacked by fungi of various sorts and in different parts. All this has been so fully done in previous numbers, that it would only lead to useless repetition. It is sufficient to observe that, in the decomposition of all dead animal and vegetable matter, and their aqueous solutions, that is to say, wherever water or moisture comes in contact with animal or vegetable matter, fungi are formed. Thus clothes, leather, timber, in damp situations, become covered by fungi of various sorts. Dr Mitchell shows that the insalubrity of any given region or district has the most constant relation to the habits of the living vegetation. Whatever may be the temperature or humidity, the most unhealthy period of the year is in any given locality that, when the phanerogamous vegetation has completed its annual task of growth, flowering, and fruitage, and feeling the weakness of an exhausting effort, it is liable to be overcome, as it were, by the cryptogamous plants which now begin upon the phanerogamous division their operations of plunder and destruction.

The fungi are chiefly active in the end of summer and autumn; and a wet autumn is generally found to be prolific in these plants. Even when forced to prematurity in May and June under the influence of heavy rains and unseasonable heat, they are never so perfect or vigorous, as they are when produced in what may be regarded as their proper season. Of one hundred and five species of fungi enumerated by M. Roques, only one grows at all seasons; four in spring; one in spring and autumn; three at the very end of summer; eight exclusively in summer; twenty-eight in summer and autumn; and sixty-two exclusively in autumn. Of the total number, therefore, of one hundred and five, ninety-two are active in autumn, and thirty-six in summer.

This survey leads to the inference, that the growth of *fungi* and the formation of Malarial Fevers is in general, in the order directly of,—autumn, summer, spring, winter.

Dr Mitchell next directs attention to great frequency of attacks of endemic fever during the night. Taking this fact as admitted, and as showing the superior liability of the frame to receive the poison of these diseases, and the greater power of these diseases to attack, during the cold dark hours of night than during the day, he maintains, that all the explanations hitherto suggested of night air, low temperature, exhalations being more energetic after nightfall, than during the continuance of daylight,—are quite inadequate to account for the facts. On the other hand, when we advert to the tendency which fungous plants have to be de-

veloped and spring up during the night, and to show their general energy, we must allow that an important analogy between the prevalence and energy of malaria, and the growth and activity of fungi is thus established.

It may here be proposed as a question, whether the exhalations from these plants are not more active or derive greater energy from the moist air of night, loaded as it is with dew and humid vapour, than from the dry warm air of day.

Dr Mitchell adduces next various instances of epidemic diseases, during the prevalence of which *fungi* in various forms, as rust, smut, mould, mildew, bloody rains, and similar unusual phenomena, were abundantly produced.

The milk-sickness, trembles, tires, slows, stiff-joints, and puking fever, are different names for a peculiar distemper incident to the cattle of the western regions of the United States. This distemper prevails mostly in the end of summer and in autumn, chiefly in September and in October. It acts only at night, or until the dew has been evaporated from the grass in the morning. It prevails in rich alluvial pastures, on high barren ridges, on open plains, and in the deepest woods. Dr Mitchell infers from many concurring circumstances that the disease is owing to the presence and operation of *fungi* in the places frequented by the cattle. These *fungi*, he thinks, must be swallowed with the food, and in this manner give rise to the disease.

Dr Mitchell next adduces various facts to show that fungi, either when eaten or when introduced with food into the system, or when inhaled in the form of vapour, give rise in the human body to the symptoms of intermittent and remittent fever, of plague, or gangrenous fever, and other disorders usually ascribed to the influence of miasmatic poison. He next adverts to the fungous growths in the bodies of men and animals in connection with the cutaneous and mucous diseases, which have of late years attracted attention.

Fungi may also produce diseases quite similar to yellow fever. The fungi from which this disease arises, may be preserved in their sporules for months, or over several seasons, he thinks, and then, in favourable seasons, induce the disease. The same may be said of cholera, the propagation of which, he thinks, is most easily explained by this hypothesis.

Again, countries most remarkable for the prevalence of endemic fever, are also remarkable for the production of fungi. Thus, in Africa, whether in the interior, on the banks of rivers, or on the coast at their outlets, fungi are most easily produced. Every thing animal and vegetable is speedily covered with mould, especially during the rains. In Italy, the Maremma which is most febriferous is also most productive of mushrooms. The volcanic

tufa round Naples, and that round Rome, are most remarkable for the abundnce of mushrooms they produce; and the same places, it is known, are most productive of fevers.

As a final argument to prove analogy and alliance between the production of fungi and the appearance of endemic and epidemic fevers, Dr Mitchell remarks, that these distempers are observed to possess periods of repose. After remittent fever has prevailed, one, or it may be two seasons most extensively in a district, it ceases for years. In the same manner, he observes, the growth of fungi is liable to undergo periods of inactivity. The volcanic tufa, if actively employed, loses, in about three or four years, the power of producing mushrooms. After the fungi have been for several seasons abundantly produced, they evince the property of destroying themselves. In other words, they exhaust the soil first, and then they die out; while a vigorous crop of grass, and healthy phanerogamous plants follows, as in the instance of fairy rings.

The foregoing is rather a hasty sketch of the contents of this volume. But it may serve to convey to the reader some idea of the manner in which the author treats his subject, and of the nature of the facts and arguments which he adduces in defence of his hypothesis. It is not to be expected that he will convince all. But he has the merit of directing attention to an important concomitant of febriferous seasons; and if he does not supplant the hypothesis of marsh miasmata and telluric exhalations, he at least shows cause why it ought to be modified.

It must also be allowed, that the cryptogamous hypothesis, as here stated, does not exclude the operation of marsh miasmata. It may be that the miasmata are the cryptogamous products. In other respects, the hypothesis makes a near approach to that of the ligneous hypothesis, so ingeniously explained in 1827 by Dr John Wilson.*

Finally, if there be merit in this hypothesis, it is due to Dr Mitchell to say, that he preceded Dr Cowdell in bringing forward this doctrine. The six lectures of which this work consists, were delivered at the Jefferson Medical College of Philadelphia, in the course of 1846.

Art. V.—*An Appeal to the Public on behalf of Sick Children.* London, 1850. Post 8vo, pp. 16.

It is a fact well known to those who study the comparative mortality of the human race at different periods of life, that a large amount of sickness and death takes place during the first nine or

* Memoirs of West India Fever, &c., by John Wilson, M. D., London, 1827; and Edinburgh Medical and Surgical Journal, vol. xxix., p. 189. Edin. 1828.