



LV. Remarks on the influence of terrestrial radiation in determining the site of malaria

William Addison

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from a small condensation γ . The equation may therefore be thus written, $\frac{di}{d\tau} = k-1$; and as it is true of any number of continuous variations of density or volume, the pressure being constant, it agrees with the equation (a) investigated above. Observing also that $\gamma = \frac{d\varrho}{\varrho}$, and $k-1 = \frac{\alpha}{\beta}$, his two equations (5) and (6) will become,

$$\frac{\alpha d\tau}{1+\alpha\theta} = \frac{d\varrho}{\varrho},$$

$$\frac{\beta di}{1+\alpha\theta} = \frac{d\varrho}{\varrho},$$

θ being the actual temperature of the air. In the first of these equations, $d\varrho$ is derived from $d\tau$; and in the second, $d\varrho$ determines di . The two equations are therefore intimately connected, and no just conclusion can be deduced from the second, if the first be overlooked. Now M. Poisson has integrated the second equation apart, and as if it were in no respect modified by the first. This is the ground of my objection. In reality the integral he obtains satisfies the second equation, but it does not satisfy the first, as it ought to do according to his own calculations. If we reason fairly, and fulfil all the relations of the differential quantities, we shall be necessarily led, even when we follow M. Poisson's train of investigation, to the same theory explained in the present and in former articles of this Journal*.

Oct. 13, 1828.

J. IVORY.

LV. *Remarks on the Influence of Terrestrial Radiation in determining the Site of Malaria.* By WM. ADDISON.

[Concluded from p. 278.]

ONE of the chief arguments in favour of the important influence exerted by terrestrial radiation in the production of that state of the atmosphere favourable to the attacks of disease, and known by the name of malaria, is drawn from the fact that in almost, nay I might say every case, where the violence of the symptoms induced by it will permit us to observe the *first impressions* which it causes, we find that its baneful influence is exerted during the night-season, while in the day-time it is comparatively, if not quite, inert. It would be needless to reiterate here the numerous proofs of this, distributed among the writings of those many accurate observers who have been at the pains of noticing the habitudes of ma-

* See Phil. Mag. and Annals for October 1827, pp. 245, 246, 247.

laria.

laria. I shall content myself, therefore, with quoting only Dr. Ferguson, who observes in his *History of the Marsh Poison*, "that the rarifying heat of the sun dispels the miasms which create fevers and violent diseases, and that it is only during the cooler temperature of the night, that they acquire body, concentration, and power."

Now surely any miasmatic effluvia liberated from exposed vegeto-animal or other matters by the rays of the sun, must exist in the atmosphere as much if not more during the day-season than in the night; for it is more than probable that nothing is *given up by the ground* after sun-set. How is it then, we may ask, that the great potency of malaria at night, and its comparative harmlessness during the day, have so constantly forced themselves upon our notice? Is it not because the air during the former period is cooled by radiation and rendered incapable of retaining those matters which the warmer air of the day-time held in perfect solution? A still atmosphere containing miasmatic matters, therefore, becomes dangerous to health in proportion as it reaches, by a gradual reduction of temperature, such as ensues from radiation, its dew point: for during the period when its temperature is elevated above this point, the malarious matter is without any, or of but little injurious agency; while the nearer it approaches the point at which moisture will be liberated from it, the more those extraneous matters it may contain become developed, as is fully shown by the much greater potency of odours at that period, of which numerous instances might here be mentioned; but it will be sufficient to recall what every one must have observed during the summer months: after a hot day, if the air at night remains still, or is favourable to the process of radiation, it is truly astonishing how far odours will diffuse themselves, and how powerful they generally are: a few hours after sun-set, on evenings favourable to the deposition of dew, many effluvia become very perceptible, and are potent and concentrated in proportion to the stillness of the air and its approach to the *dew point*. Winds, although they very often cause considerable reductions of temperature, are not so prejudicial, or so frequently productive of ill effects upon the human body, as those abstractions of caloric resulting from radiation; and for this reason,—because in the former instance the morbid particles are dispersed, and so diluted by the aerial currents as to be rendered incapable of exercising any injurious influence upon the body, or only upon such as are rendered extremely sensible to the exciting causes of disease; whereas in the latter instance they become often greatly accumulated, and so highly prejudicial, that few escape.

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In this country the pernicious nature of the morning and evening mists formed over low grounds has been observed, and in hotter climates I need scarcely say that their influence in generating fever is as notorious as any of the best established facts on this subject; and the progress of the sun upwards being a remedy for the morning mists, and the day altogether for those of the night, seems to confirm the opinion, that a watery and moist atmosphere is the active conductor or repository of malaria; and that when the former is dissipated, the latter is checked in its progress; when the one is entirely dispersed, the other may be destroyed: so that the matter of malaria seems to be defined as to its place and extent by vapour and mist*.

That the diseases arising from miasmata in the air do sometimes cease in a definite and sudden line, and terminate also at particular altitudes, has often been observed and recorded; and these remarkable instances cannot be satisfactorily explained upon any other supposition than that afforded by the *radiation of caloric*. To explain their cessation in the former instance, we may remark, that that depression of temperature which ensues at night over a good radiating surface, may be sufficient to render active the miasms existing in the air; while over others, less powerful in the dissipation of caloric, the depression of temperature may not be sufficient; and it is probable that in many cases an atmosphere rendered prejudicial by the one, is again made innoxious by passing over the other. With respect to altitude, I have before shown that slight elevations are frequently a protection against the heavy miasmatic air which subsides to the lowest situations.

But to place this important subject in the clearest possible light, let me endeavour (by an appeal to some well-known chemical facts) to set forth the nature of the connection existing between free caloric and the matter of malaria. Let us suppose that the former exerts over the latter an influence analogous to that exercised by an *acid* over an *alkali* (neutralizing its qualities and destroying its effects), and we shall immediately perceive that the mere presence of malarious matters in the air may not be sufficient to excite in the human body a state of disorder or disease: carry the reasoning a little further, and then we can fully understand the way in which *radiation* proves injurious. Are we not warranted in concluding, from those facts which observation and experience have discovered to us, that similar phenomena are exhibited in the relations subsisting between the matter of heat and miasmatic

* *Vide* Macculloch's Essay, pp. 259 and 274.

effluvia, as we witness among the various combinations of the chemical world? Withdraw one of the elements of a binary compound, and the other becomes immediately apparent, and is developed with all those potent qualities which had been destroyed or neutralized whilst in union. So miasmatic matters are inert while fixed to the ground, from which they can arise only in conjunction with caloric; and as long as they continue together no ill effects ensue: but diminish the temperature, or, in other words, take away the caloric, and the injurious qualities of the miasms immediately become apparent. It may be objected, that if the injurious agency of miasmata in the air results from the mere abstraction of heat, no reduction of temperature could ensue without the production of malaria.—But this is not true; for we may justly suppose that in a great majority of cases there is not sufficient noxious matter on the ground to saturate—if I may be allowed the term—the caloric existing in the air, and therefore that in these instances great reductions of temperature may take place without any appearance of malaria, in the same manner as (to carry on the analogy drawn from chemical combinations) we can detach a portion of the acid from a supersaturated salt, without developing the existence or qualities of the alkali. On the other hand, the miasmatic source may sometimes afford a supply amply sufficient to satisfy even a very high temperature; and then any trifling escape of caloric will be accompanied with an injurious precipitation: and if the cooling process continues, a highly noxious malaria will result.

It has been observed, that very often the diseases arising from malaria ensue upon the temperature of a place reaching a certain point; that they increase in frequency and violence as the heat increases, but diminish as the mean temperature falls. These facts are not at all irreconcilable with the phenomena of *radiation*; for in these cases we may justly suppose, that at the higher temperatures malarious matter is liberated from the soil, the quantity of which is greater in proportion to the thermometric rise, while the lower temperatures are not sufficient to liberate any quantity of the noxious effluvium and diffuse it through the air: in the former case the radiation of caloric will be attended with disease, in the latter it will not.

I might here relate many facts tending to show the intimate connection which subsists between caloric and miasmatic effluvia, but I conceive that what has been here stated will be ample to establish this point, as well as the fact that the latter become virulent in proportion to the abstraction of the former by the process of radiation.

In conclusion, I shall briefly point out the importance of
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the foregoing observations, if they shall be found correct, towards the attainment of that desirable end, *the protection of mankind against the injurious impregnations of the air.*

As regards the prevention of the rise of miasms from the ground, I fear we have too little controul over the powerful agency of the rays of the sun to adopt successfully any plan with reference to this head. The solar influence is too great and too general to enable us to obstruct the emanation of various effluvia from the soil: nevertheless, much may be done by removing as far as possible from the surface of the ground any thing likely to afford them; and although our endeavours on this point must be very inefficient, they may be more successful and beneficial if directed to obviate those conditions which, as we have seen, have such a considerable effect in rendering active the noxious properties of malaria; viz. 1st, by preventing the dissipation of caloric through a still atmosphere; and, 2ndly, by promoting those aërial currents which tend so much to dilute and carry off any deposition which may ensue from that process.

In order to accomplish the former of these indications, we must use every means in our power to diminish the radiation of heat from the ground after sun-set, or to remove as far as possible from the circle of its operation, by attaining during the night-season some moderate elevation, interspersed here and there with lofty trees, and hedges or inclosures, and placed to windward of the more rapidly radiating surfaces which may be near: for although we speak of a calm and still atmosphere as being highly favourable to the development of malaria, still it must be understood that in almost every instance there are gentle, although perhaps imperceptible currents in the air, fully sufficient to waft to a considerable distance the miasms liberated by the dissipation of caloric; and any increase of temperature which such currents may acquire in their passage over less perfect radiators, will not always be enough to disarm them of their injurious influence. In situations therefore more particularly, where we are likely to be subjected to miasmatic products, and where the air at night is generally still, or where the gentle breezes are found to sweep over tracts favourable to radiation, it behoves us to endeavour,—by exciting artificially aërial currents, and by raising or keeping up the temperature of the air of the place where we may be by circumstances constrained to remain,—to prevent the deposition and development of malaria. This may be accomplished by lighting *large fires* to windward of the place of our nightly sojourn.—This is not a new idea: fires have already been observed to be beneficial in warding off the nocent power of malaria, though

though the principle upon which they act has not been properly understood, and consequently they have never been employed to the best advantage for this purpose. Dr. Macculloch relates a very important case, where a superintendant engaged in directing the cutting of wood in Africa, erected thirty earthen furnaces on the spot where his men were employed, lighting them every day. Before this, he had always from forty to forty-eight of his workmen sick; when in a short time they were reduced to twelve, then to four, and finally to one. Napoleon adopted the same expedient very largely, and with success, when his armies were occupied in the very worst district of Italy*. Knowing the principle of their operation, I should recommend them to be lighted at sun-set, and to be allowed to burn until sun-rise, having a regard to their position as pointed out in the foregoing remarks. Where large numbers of human beings are congregated together, as in armies, camps, &c., and where their situation at night is too often determined by other circumstances than salubrity, the value of these observations, with the knowledge of the principles which should direct their application, cannot but be very apparent.

It will be easily seen, from what has already been said, that fires as defences against malaria will be much more necessary during the nocturnal period than at any other; and even at this season, when the wind is blowing strongly and the night is overcast, they will not be so much required as when the air is clear and still.—It is not my intention to speak here of those various extraneous circumstances which render the body more susceptible of injurious influences at night than during the day,—such as bodily and mental exhaustion, sleep and diminished temperature; nevertheless they are well worthy of our serious regard, as cooperating powerfully with noxious miasmata in producing a state of disease.

Malvern, July 1, 1828.

WILLIAM ADDISON.

LVI. *An Account of the Formation of Alcoates, Definite Compounds of Salts and Alcohol analogous to the Hydrates.* By THOMAS GRAHAM, Esq. M.A. F.R.S.E.

[Concluded from page 272.]

II. *Alcoate of Nitrate of Magnesia.*

IT is difficult to expel the whole of the water with which nitrate of magnesia is combined, without driving off a portion of the acid, and decomposing the salt. For this salt may

* Macculloch's Essay, p. 286.