ART. XVIII. ON THE EFFECT OF CLEARING AND CULTIVATION ON CLIMATE, AND ON THE SITUATIONS MOST FAVORABLE TO THE DEPOSITION OF HOAR FROST AND DEW; BY WM. KELLY, M. D.

[Read 20th February, 1836.]

Ever since the first settlement of North America, the opinion appears to have obtained amongst the inhabitants themselves, as well as amongst scientific men, that the climate was gradually ameliorated, or rendered more temperate, in consequence of the clearing away of the woods, and the progress of cultivation.—For a long time it was supposed, that the climate of the American colonies would become as mild and equable as that of Europe, when the country should be cultivated to the same extent; and although such a change is now no longer expected by philosophers, since the causes of the difference of climate in the northern parts of the two hemispheres are better understood, nevertheless, much importance is still generally attached to the effects of clearing, and great hopes entertained of the amount of amelioration which will result when the country is fully cultivated. If, however, we compare the present climate of Canada with that which obtained two hundred years since, as far as it can be made out from the writings of the earliest settlers, we find no perceptible difference. The length and severity of the winter, the amount of snow that fell, and the time when plants first appeared in spring, were the same then as now.

It is easy to understand how philosophers may be occasionally led astray by pursuing a favorite theory, or philanthropists by the hope of a favorable change in any thing which influences the comfort or prosperity of mankind; but we do not so readily see why, in this case, the opinion of a gradual improvement in the climate should be held by the colonists themselves, contrary to what, from a general view, would appear to be the real state of the matter. My attention was directed to this subject some years ago, when preparing a paper on the climate of Canada; and as some facts which came to my knowledge since that time appear to me to cast considerable light on the subject, and would, if confirmed by the observations of others, probably afford a satisfactory solution of the difficulty, I venture to submit them for the consideration of the society.

Having noticed in some newly cleared spots in the vicinity of Gaspé basin, that the potatoe tops were destroyed by frost in the latter part of September, whilst the potatoe fields in the open ground about the harbour remained uninjured,—I made enquiries concerning the circumstance, and was informed by elderly persons of considerable intelligence, that, when they first came to Gaspé, their fields were very liable to injury from hoar frosts, both in the spring and fall; but that, as the country was gradually cleared about them, they suffered less from this cause; though the new settlers, particularly if surrounded by the forest, continued to be much affected by it.—The same persons asserted, that the climate where they lived was greatly improved within their own memory, in consequence of the clearing, and that such, no doubt, would be the case with the spot I mentioned, (about three miles distant), when the clearing and cultivation should extend so far. I found this account corroborated on further enquiry;—I was informed that the clear spots which are surrounded by woods, are particularly liable to hoar frosts in the spring and autumn; and that frosts occurred in such places, and in the vicinity of water courses, when the comparatively open country was free from them.—When any of our parties pitched their tents near the exits of rivers, they found the nights colder, and observed hoar frosts to occur more frequently, than those whose encampments were differently situated.

If such is generally the fact, it gives a ready solution of the difficulty above alluded to. An untimely hoar frost which nips the early shoots of spring, or the unripe fruits of autumn, would impress the mind of the settler with the idea of a severe climate, more than a great intensity of cold at seasons when his crops were not in a situation to suffer from it; and a less frequent occurrence of these frosts would be, for all his practical purposes, a great improvement in the climate, even though the mean temperature of the year remained unchanged. Indeed, it is not easy to imagine any material difference in the mean temperature of two places, at equal elevations, and within the circuit of a few miles; and it is probable, that the same causes that tend to produce cold at night in this case, would favor the production of a compensating increase of heat by day.

The principal cause of hoar frost in these situations appears to be the shelter afforded by the surrounding forest. The cleared spot is beneath the general level, and is consequently little acted on by light winds: hence on clear nights, the effects of radiation become more intense. There is in fact a calm in such spots

while the more open space has the benefit of currents of air. The cleared spot resembles those shallow pits that are made in India, for the purpose of obtaining ice, when the cold on the surface generally does not descend to the freezing point. The same shelter causes an accumulation of heat in these spots during the day. The vegetable productions, thus alternately exposed to severe cold at night, and heat by day, are rendered torpid by the one, and overstimulated by the other, hence they perish prematurely.

According to the generally-received theory of dew and hoar frost, this shelter is the only evident circumstance, in this particular case, that can influence their production. But the fact of frosts occurring at the same time, in the vicinity of streams and rivers, even where no clearance had been made, would lead us to infer that moisture also was in some way concerned in producing the cold. In every country, frosts are known to occur in sheltered valleys, particularly when the surface is wet, although the dry exposed upland escapes. Yet the higher lands can radiate more freely on all sides than the low. The usual mode of accounting for a fact, so opposed to the received theory of dew, and hoar frost, by attributing it to masses of air cooled on the hills, becoming thus specifically heavier, and falling, or rolling down into the valleys, is more ingenious than satisfactory. The cleared spots within the forest are probably moister than the open country : as from their comparatively small size, they must in some degree participate in the state of the surrounding woods. That the forests are wetter than the cleared lands is inferred by the greater amount of drainage from them : for whatever may be the effect of clearing on the mean temperature of a country, we find here that it is followed by a diminution of the quantity of water in the rivers that flow through it: small streams becoming nearly dry, and large ones, that were just navigable, when the forest was untouched, ceasing to be so, as cultivation is generally extended over the country.

Perhaps there is no doctrine in Meteorology so well established as Dr. Wells' theory of dew and hoar frost. His experiments seem to have demonstrated, beyond doubt, that the cold of the surfaces, which causes the deposition, is produced solely by radiation, and is quite independent of evaporation. Yet the observer of natural phenomena will often find it extremely difficult to account by radiation alone for all the circumstances that, in many instances attend, and seem to influence the deposition of dew and hoar frost. Dew is deposited at sea often under circumstances that usually prevent it from appearing on land.

Thus I have seen heavy dew, on board ship, on clear nights, though the wind was fresh and constant: I have also seen it under similar circumstances, on small islands, and near the shores of the main. I think its deposition has been less affected by passing clouds, even though they occupied a considerable part of the sky, than I expected from theory. And I have seen, on shipboard, a copious dew formed, nearly two hours before sunset, when the air was highly charged with vapour.

I do not cite those instances as subversive of the theory which makes radiation the sole cause of dew, for they may be reconciled to it without much difficulty. Perhaps they merely shew that when the air is charged with moisture, the slight cooling of the surface, that occurs notwithstanding winds or passing clouds, is often sufficient to cause its deposition, though it would not have had such effect under the same circumstances of wind and sky, combined with a drier state of the air.

The deposition of dew or hoar frost however may be promoted in some degree by evaporation, in as far, as it alone, in the absence of the sun, would reduce a warm wet surface to the temperature of the dew point of the air. If of two portions of the same surface, equally heated during the day, one is dry, and the other wet, it is evident that, when the sun sets, the wet one, in consequence of the evaporation from it will have its temperature reduced more quickly than the dry. The reduction of temperature from this cause cannot proceed lower than the dew point of the air, and may not even reach so far; still concurring with that from radiation, the combined effect may in many cases, be sufficient to cause deposition from the air, when it would not be effected by the cold resulting from radiation alone.