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Contents.

(Illustrated articles are marked with an asterisk.)

THE GULF STREAM AS A HEAT CARRIER.

The Gulf Stream finds a sturdy champion in the author of "Climate and Time," Mr. Croll, of the Scottish Geological Survey. Dr. Carpenter, who has a theory of his own, goes out of his way to belittle the influence of the Gulf Stream as a modifier of climate, calling the stream a mere rivulet compared with the (theoretically) grand surface drift of tropical water into the North Atlantic: whereupon Mr. Croll resorts to the logic of fact and figures, and demonstrates the enormous influence which the body of warm water, entering the Atlantic through the Straits of Florida, must have in mitigating the climate along its subsequent path. Mr. Croll's argument is presented at great length, proving beyond a doubt that, so far from being currently overestimated, the thermal effect of the Gulf Stream is vastly greater than has ever been suspected hitherto.

The observations of the United States Coast Survey, in re, gard to the breadth, depth, and temperature of the streame were many and careful. Unfortunately, however, no observations were made to determine precisely the velocity of the current at all depths along any particular section; consequently, while the mean temperature of the stream may be determined with considerable precision, it is impossible to make an accurate estimate of the volume of the current. From the limited data afforded by the records of the survey, Maury considered the volume of the stream to be equal to that of a stream 32 miles wide and 1,200 feet deep, flowing at the rate of five knots an hour. That would give a flow of 6,165,700,000,000 cubic feet an hour. In his "Physical Geography," Sir John Herschel estimates it as equal to a stream 30 miles wide and 2,200 feet deep, flowing at the rate of four miles an hour, that is, having a volume of 7,359,900,000,000 cubic feet an hour. More recently Dr. Colding estimated its volume at 5,760,000,000,000 cubic feet an hour. From the same data, Mr. Croll, some years ago, determined its volume to be equal to that of a stream 50 miles wide and 1,000 feet deep, flowing at the rate of four miles an hour, or considerably less than the lowest of the foregoing estimates. To obviate any possible objection on the ground of overestimating the volume of the stream, Mr. Croll calculates its heating capacity on the basis of a velocity of only two miles an hour, according to which the flow would be 2,787,840,000,000 cubic feet an hour, a little over one third of Herschel's estimate.

The average temperature of the surface water in the Florida Channel, for the whole year, is 80°. The bottom temperature, according to Dr. Carpenter, is 60°, which would make the mean temperature about 75°. Mr. Croll thinks this estimate much too high, an error arising from an underestimate of the sectional area of the stream. Believing that the current extends to a depth where the temperature is below 60°, he calculates that the mean temperature of the stream is not over 65°. In its passage to the arctic regions, the water is cooled down to about 30°. Assuming that part of the return current, by the way of the Azores, is fed from the water of the Gulf Stream proper (not entirely from the larger current further east, discovered by the Challenger expedition, and considered by Captain Nares to be an offshoot of the Gulf Stream), a considerable portion of the stream is not cooled below 45°. Altogether, however, Mr. Croll thinks he cannot be overestimating the cooling of the water in fixing the average minimum temperature at 40°, thus allowing for the loss of 25° of heat while the water is making its northern journey. At this rate each cubic foot of the water must transport from the tropics to more northern latitudes upwards of 1,158,000 foot pounds of heat. Consequently the total quantity of heat transferred daily by the entire stream amounts to 77,479,650,000,000,000,000 foot pounds.

The effect which this vast amount of heat must have in mitigating the climate of the regions to which it is carried can best be estimated by comparing it with the amount of heat received from the sun by the same areas.

According to the observations of Sir John Herschel and M. Pouillet, the sun pours down upon every square foot of the earth's surfaces at right angles to its rays about 83 foot pounds of heat a second: this allowing for no absorption of heat by the atmosphere. M. Pouillet estimated the loss of heat by atmospheric absorption to be 24 per cent of the amount received from the sun. Mr. Meech (*Smithsonian Contributions*, Vol. IX) estimates the loss at 22 per cent. At the latter rate of absorption there would remain 64·75 foot pounds of heat a second to fall on each square foot of the earth's surface when the sun is directly overhead. On the equator at the time of the equinoxes, the sun shines daily for twelve hours. Were it to remain at the zenith all this time, its heating effect per square foot would be 2,796,768 foot pounds. Not so remaining, its effect is less in the ratio of 1 to 1·5708; so that each square foot of the earth's surface at the equator, under the most favorable conditions, receives 1,780,474 foot pounds of heat during the twelve hours from sunrise to sunset. A square mile receives 49,636,750,000,000 foot pounds. As we have seen, the Gulf Stream carries from the tropics daily 77,479,650,000,000,000,000 foot pounds, or as much as falls upon 1,560,936 square miles at the equator.

Mr. Meech estimates the quantity of heat received from the sun annually, by each square mile of the frigid zone, taking the mean of the whole zone, at 0·454 of that received at the equator: consequently the heat conveyed by the Gulf Stream is equal to that which falls on an average of 3,436,900 square miles of the frigid zone, or nearly $\frac{2}{5}$ of its entire area: this, assuming that the percentage of heat absorbed by the atmosphere in polar regions is no greater than at the equator. If the obliquity of the sun's rays is allowed for, it appears that the Gulf Stream conveys not far from half as much heat as the sun furnishes to the entire area within the arctic circle.

The mean annual quantity of heat received from the sun in temperate regions, per unit of surface, is to that received by the equator as 9·08 to 12. Consequently the Gulf Stream furnishes as much heat as the sun gives to an area of 2,062,960 square miles in temperate regions. Since the area of the Atlantic from the latitude of the Straits of Florida to the arctic circle is only about 8,500,000 square miles, it follows that the quantity of heat conveyed to that region by the Gulf Stream is to that received from the sun by the same area, as 1 to 4·12: in other words, very nearly one fifth of all the heat possessed by the water of the Atlantic within those limits, even supposing that every sun ray is absorbed thereby, comes from the Gulf Stream.

To assert that this enormous reinforcement of the normal heat supply of the North Atlantic is without sensible effect upon its climate is simply absurd. To Mr. Findlay's assertions that the inability of the Gulf Stream to affect the climate of England is self-evident and needs no calculations, Mr. Croll retorts with calculations from Mr. Findlay's own data, most effectually disproving his rash assertions. Mr. Findlay says, for instance, that all the water passing through the Florida channel will not make a layer of water more than six inches thick a day over the space which the stream is supposed to cover off the coast of England. Mr. Croll replies that a layer of water six inches thick, cooling 25°, will give out 579,000 foot pounds of heat per square foot. The amount of heat received from the sun in the mean latitude of Great Britain, 55°, taking the mean of the sun's heat for the entire year, is 1,047,730 foot pounds per square foot a day. Consequently Mr. Findlay's layer of water must give out an amount of heat equal to more than one half of all that is received from the sun. But assuming that the stream should leave the half of its heat on the American shores, and carry to the shores of Britain only 12½° of heat, there would still remain a heating power of 289,500 foot pounds per square foot, or more than a fourth as much as the sun supplies in that latitude.

THE PATENT DRIVE WELL.

This consists of a small tube driven into the ground by means of a hammer, until water is reached. A pump is then applied to the tube, and the well is complete. It is the invention of Colonel Nelson W. Green, of Courtlandt, N. Y., patented by him May 9, 1871, but discovered and put into use by him in 1861 while he was serving in the United States army. It has been brought into use all over the world, and is one of the most valuable of inventions. Nearly all the dwellings at the famous watering place of Oak Bluffs, Martha's Vineyard, are supplied by this means with water, including the Sea View Hotel. At the latter establishment a six inch pipe is driven down 22 feet into the ground; and such is the abundance of the supply that a steam pump of equal bore, running constantly for eighteen hours out of twenty-four, never lacks water, which is pure and excellent. There appears to be a fresh water lake or stratum under the whole island, at about the above depth. When the drive well tube is sunk to 27 feet, it strikes salt water. If the well tube is sunk in the salt-water-covered bottom, a few rods out from the shore, the result is the same; fresh water is found at about 22 feet, and salt water at about 27 feet. The drive well patent has been a subject of litigation for several years. The owners are at present conducting an important litigation against W. & B. Douglas, of Middletown, Conn., who are alleged to be infringers. Nearly a year has been occupied in taking testimony, which reaches three thousand pages of foolscap, while the costs so far are estimated at upwards of a hundred thousand dollars. The case is before the United States Circuit Court, Brooklyn, Judge Benedict presiding.

CEREALS AND THEIR CHEMICAL VALUE.

Wheat, oats, rye, barley, and Indian corn are cereals which yield to men all the principles which build up the human frame. Some other plants make fat-forming matter; some merely afford acids, which assist the digestion of food. Among the latter are the various fruits, particularly the grape, so much recommended to the invalid, the acid of the grape being the active agent. But in wheat and its companions of the field, namely, oats, barley, and rye, we meet with every substance necessary for the staff of human life. We will first glance briefly at the constituents of the cereals, and ascertain something of their properties.

If we take a grain of wheat or other cereal, and burn it in a gas flame, we find that only a portion of it is consumable. The unconsumable portion that remains is termed the ash, which is the mineral or inorganic portion. The consumable portion is the organic or combustible compound of vegetable matter, the proportion being 94 per cent of principally vegetable matter, and from 1 to 6 per cent of mineral matter. The organic constituents of wheat, oats, etc., are: The woody fiber, next comes the starch, then the sugar, gum, and oil, and after these the two nitrogenous substances, the albumen and the gluten, which contain large quantities of nitrogen, these latter being the flesh-forming substances in wheat; the others are the fat-forming substances; and the mineral ash contains the constituents which are necessary for building up the structure of man. Let us examine these bodies in their proper order.

If we take a piece of paper or wood, or almost any organic substance, we find that it contains a very large quantity of woody fiber. Hemp and flax also contain large quantities of this fiber, which is the back bone of the plant. Starch is a white, glistening substance which will not dissolve in water, although it will mix with it in small quantities. Potatoes, wheat flour, and oatmeal are chiefly composed of starch. Sago and tapioca are pure starch. To detect the presence of starch, put a little iodine into the substance to be tested; if it turns blue, chemistry will at once tell you that starch is present. To detect the presence of iodine, you have only to get a similar reaction, by applying starch; and although there are many different forms of starch, which may be distinguished by the microscope, it may always be detected by iodine. Gum and sugar are also present, as we have already stated, but the quantities are so small as to call for no special remark. Albumen exists not only in the vegetable, but also in the animal kingdom. The white of an egg, for instance, is entirely pure albumen. It is met with in flesh, and is the commencement of the formation of muscle. One of the chief characteristics of albumen is its coagulation by heat. The coagulation may be easily effected by chemicals. For instance, nitric acid will do it; and although albumen and gluten are both nitrogenous substances, gluten cannot thus be coagulated. Both are found in wheat. Gluten is of a very tenacious character, and makes good birdlime. Oil is chiefly found in many seeds of plants, generally in the outer portion of them. In making wheat flour, we ordinarily throw away that which we ought to retain, that which is the source of the development of the bony structure, namely, the woody fiber, and keep the starch.

Of the mineral or inorganic matter of cereals, water is 14 per cent, while the principal constituent of wheat, phosphoric acid, is present to the extent of 40·91 per cent, potash being 31·30, and silica only 9·71. The silica of wheat is identical with the widely diffused silica of sand and flints, and is combined in cereal products with alkali, in which it is soluble. Silica, taken alone into the system, would pass right through; and to secure its assimilation to the human body, it must be connected with potash or soda. But it can be recovered from its solutions by putting nitric acid in the mixture; it at once separates in the form of solid flint. The ash of wheat contains nearly 10 per cent of this substance. It may be seen in the glaze on straw, and some plants are