SALT AND ITS PHYSIOLOGICAL USES.*

By M. A. DASTRE.

SALT is a universal commodity. It seems to have been used almost without exception in all places, times, and civilizations. To-day it seasons the wretched meal of the Soudan negro and the carefully selected repast of a European table. We find the same predilection for its use as far back in history as we can go. The Jews offered it to Jehovah with the first fruits of the harvest and the fruits of the earth; Homer calls it divine and chronicles its use in the repasts of his heroes; Tacitus tells of furious wars between the Germanic tribes for the possession of salt springs near their territories.

Indeed, men have recoiled before no hardship, no sacrifice, and no danger to procure this precious substance. They have sought to obtain it by war, by fraud, by the fatigue of long journeys. Some very primitive peoples have been remarkably ingenious in methods of procuring it for their own use; for example, the aborigines of the Sunda Islands have invented rude chemical processes for extracting it from the mud about their mangrove trees. Mungo Park saw the inhabitants of the coast of Sierra Leone give all that they possessed, even their wives and children, to obtain it. It is, in fact, an object of so general consumption, so necessary to man, that it affords an assured medium of exchange, and that is what is meant when we say that salt has been used and is still used for money. This is true for the different countries in central Africa. It was the same in ancient times, and, since the Roman soldier received in his ration salt as well as oil, meat, and cheese, his compensation took the name of *salary*, a name extended later to all stipulated wage for material work.

The need, the hunger for salt is not confined to man. Many animals seek this substance with avidity. Buffon wrote: "Nothing pleases the appetite of sheep more than salt." Barrall, Boussingault, and Desaive have informed us that cattle may suffer cruelly from a lack of salt, and that, on the other hand, they thrive when it is added to their ration.†

Reindeer and red and roe deer love to lick the surface of brackish puddles and saline efflorescences. In all climates, in all latitudes, wild ruminants and other hoofed animals resort to salt licks, a circumstance of which hunters take advantage, choosing their shooting covers either where salt naturally effloresces or where they themselves have scattered it.

A predilection so general and an appetite so imperative cannot be considered as mere accidents. They doubtless correspond to a natural need of the system. Modern physiology has attempted to discover the reason for their existence which must be profoundly based in the animal organization. It has asked why, among the mineral substances that form a part of our food, some of which enter much more extensively into the constitution of our tissues, common salt should be the only one that man artificially adds to his natural aliment. The salts of lime and the phosphate of soda, for example, which compose so large a part of the skeleton or of the liquids of our economy, are not used at all in cookery. If we sometimes use them in an isolated state it is merely as medicines. What is the reason for this instinctive and peculiar employment of common salt over and above the quantity naturally contained in foods? This brings up the more general question of the part which salt plays when once introduced into the organism; of the physiological phenomena in which it participates; in a word, of the evolution which it undergoes. . . .

I.

Salt was first used as an aliment at the time of transition from the pastoral and nomadic stage to sedentary and agricultural life. The Indo-European languages have no common word to designate salt, nor have they any for the greater number of the objects that relate to agriculture. But, on the other hand, they have common roots for all words relating to pastoral occupations. We may see in this an indication that the primitive peoples from which our modern races sprang were separated before they abandoned a pastoral life. They did not learn the art of agriculture until later, and with it they learned the use of salt.

There are populations, ethnic groups, and castes that have never adopted it. The Egyptian priests did not salt their food. Plutarch was astonished at this strange disdain. Sallust says that the Numidians did not care for salt: *Neque salem, neque alia irritamenta gulæ quærebant.* And in the same way we see around us, side by side with animals of the farm that are very fond of it, the dog and cat that do not care for it at all.

These exceptions have been for a long time considered as inexplicable. It could not be understood how the need for salt could, in certain cases, be as imperative as true physiological needs, such as hunger and thirst, while in others it seemed entirely foreign to the organism. A learned physiologist, M. Bunge, of Basel, has thrown some light upon this obscure question. After an extensive investigation, ethnographic, historic, and geographic, he has drawn the primary conclusion that the use of salt is connected with the kind of diet. Salt is a necessary complement to a vegetarian regimen. Among animals it is the herbivora that seek it with avidity. Carnivora are indifferent to it or even regard it with disgust. Among men the appetite for this seasoning exists especially in those whose food consists of leguminous vegetables and cereals; that is to say, among agricultural populations or at least among those who live on a mixed diet. On the contrary, those who do not care for it are the pastoral tribes that live upon milk and meat that they derive from their flocks and herds, hunting tribes that subsist upon the products of the chase, and fishing populations who, although they dwell by the sea or at the mouths of rivers, where they can get plenty of salt, yet do not use it. Now, if this is really the case, we may at least consider that the correlation between these two phenomena, the development of agriculture and sedentary life on the one hand and the use of salt with the food on the other, is worthy of investigation.

All the nomadic tribes of the north of Russia and Siberia abstain from salting their food. They can readily obtain salt; for deposits, efflorescences, and salt lakes abound in those regions; still these peoples, who live by the chase and by fishing, have a decided aversion for this condiment. An explorer who lived a long time with the Kamchadales and Tunguses, the well-known mineralogist, C. von Ditmar, amused himself by inducing them to taste the salted food which he himself used and by noting the expressions and grimaces of dislike which this simple seasoning caused. This was not, however, because these people had an excessive delicacy of taste. They habitually fed upon an unnamable mixture made of fish massed in enormous silos where they putrefied at leisure awaiting the time when they should be eaten. The Russian government desired to change these too disgusting and unhealthy food habits. It taught these people the art of salting fish so as to preserve them from putrefaction, establishing for this purpose curing stations near their encampments and furnishing them with salt at nominal price. Vain efforts! These docile peoples obeyed. They salted the fish, but they ate them not.

Similar examples of indifference or antipathy to this apparently necessary seasoning are found in other latitudes. The Kirghizes of Turkestan, who live upon milk and meat in their salt steppes, do not use salt at all. The Bedouins of Arabia, according to Werde, find the use of salt ridiculous, and the Numidians, whom Sallust describes as disdaining the use of salt, fed, according to his testimony, upon milk and meat—*lacte et carne ferina.*

Africa furnishes still other examples quite as demonstrative. The Scotchman, Mungo Park, who a century ago explored the region now called the great bend of the Niger, was struck with the eagerness for salt shown by the negro agricultural populations. This was brought to them with difficulty and sold at a very high price by caravans that obtained it from Mauritania, from the sebkha of Ijil, halfway between Senegal and Morocco, or from the deposits of Taudeni north of Timbuktu. "In the interior countries," he says, "the greatest of all luxuries is salt. It would appear strange to a European to see a child suck a piece of rock-salt as if it were sugar. This, however, I have frequently seen, although, in the inland parts, the poorer class of inhabitants are so very rarely indulged with this precious article, that to say a man eats salt with his victuals, is the same as saying he is a rich man. I have myself suffered great inconvenience from the scarcity of this article. The long use of vegetable food creates so painful a longing for salt, that no words can sufficiently describe it." This is an important statement. We may compare it with an observation of an opposite character also recorded by Bunge, which completes and serves to confirm it. It relates to the astronomer, L. Schwarz, who, after living some three months with the Tunguses of Siberia on an exclusive diet of reindeer meat and game, lost the desire and the habit of adding salt to his food.

In America similar observations have been made. At the time of its discovery the greater number of the tribes of North America lived by the chase and by fishing. They used no salt, although it was very common in their prairies. A small number only were at that time sedentary and agricultural. These were fond of salt and undertook frequent wars for the possession of saline springs. Farther south, in Mexico, a sedentary people of more cultured character used salt regularly, while in the Pampas, covered with salt lakes and efflorescences, the Gauchos scorned a vegetable diet and the salt which seasoned it as food fit only for their beasts.

The examination of what has occurred in the people of the Indian archipelago and Australia supports anew the law of Bunge. Everywhere it is the populations devoted to agriculture that use salt. Everywhere, also, peoples addicted to the chase, to fishing, or to a pastoral life either disdain it or refuse to use it. Some European explorers who have, like Schwarz, adopted an animal diet have become accustomed to do without salt, while others, like Mungo Park, reduced to vegetable food only, have endured an almost painful hunger for this substance.

II.

There is, then, a well-established relation between a vegetable diet and the need for salt and reciprocally between an animal diet and the exclusion of this article from food. We must now push the matter further and ask the reason for these remarkable relations. This is the problem formulated by G. Bunge, who, as a chemist, has advanced a very ingenious theory for its solution.

The answer might be very easy. If, for example, the difference between the two diets was that of a difference in the amount of salt which they respectively contained; if the food of vegetable origin was poor in common salt and that of animal origin rich in that substance, the solution would be clear; the law empirically established by Bunge would have a very evident explanation.

But the matter is not so simple. The two kinds of diet are not distinguished from each other by the quantity of salt which they contribute to the organism. In fact, both kinds are very poor in salt.

If we examine food as it comes from plants or animals we find that the greater part of it is tasteless and insipid, insufficiently salted for our taste. The albuminoids of meat, the fats, the starch of cereals and leguminous plants, do not, by themselves alone, exercise any action upon our gustative sense. The flavor of our food comes from secondary products, from aromatics and odors that are added in some way; to be exact, from foreign substances existing in very minute quantities, ethers, acids, and essential oils that culinary preparation and cooking only develop to a greater degree. In general, natural food is but slightly saline.

Since the small quantity of common salt contained in natural aliments suffices for our needs when the diet is confined to animal food, it ought to answer for them in the case of a vegetable diet. Why is it otherwise? Whence comes it that one of these methods of alimentation requires the artificial addition of salt? Chemists have ascribed the cause of this peculiarity to the different composition of the two kinds of food. Although both contain equally small quantities of chloride of sodium, they are distinguished from each other by another mineral product which they possess in an unequal though considerable degree. This is potash. In marked contrast with common salt, this substance, always abundant, varies greatly in its relative quantity in different kinds of food. There are foods that contain a great deal of it, and these are precisely those that are taken from the vegetable kingdom. Plants are generally distinguished by their richness in potassic salts. They accumulate enormous quantities of them, drawing them from the poorest soils. Indeed, before the discovery of the mines of Stassfurt, the incineration of green plants was the only source of industrial potash. Inversely, there are other aliments derived from animals that are generally relatively poor in these compounds. In fine, the capital difference—we do not say the only one—that distinguishes in the eyes of the chemist the two modes of diet, is the abundance of potash in the vegetarian ration and its deficiency in the meat ration.

If we make a list of foods arranged according to the increasing quantity of potash which they contain, it will be seen that animal substances (blood, milk, meat) stand at the head, while lowest are vegetables (beans, strawberries, potatoes, clover). Still, there are some remarkable exceptions. Rice, for example, is very poor in potash, a kilogramme of rice in a dry state furnishing only a gramme. It is true that it furnishes still less soda (33 times less). In this respect a rice diet approaches an animal diet; and, in fact, provokes but a slight appetite for salt. On the contrary, a kilogramme of potatoes contains 24 grammes of potash and 60 times less of soda. This food approaches, from this point of view, the vegetarian type in its perfection.

The information given us by chemical analysis may then be succinctly stated as follows: The vegetable kingdom furnishes the economy with much potash and very little soda—about 25 to 150 times more potash than soda. On the other hand, the animal kingdom reduces the supply of potash without reducing in the same degree the supply of soda. It introduces into the economy no more than 2 to 5 times as much potash as soda.

All this is perfectly true and interesting in itself, but it may be asked what it has to do with the question we are considering, and what hidden relation there is between the proportion of potash that distinguishes the two diets and the inequality in the need for salt which they produce. M. Bunge believes that he has discovered this relation. His hypothesis is that potash is responsible for our like or dislike of salt in cookery. This he justifies by a series of closely connected inductions. The need for salt is the consequence of the loss of salt from the organism, as thirst is the consequence of the loss of water due to hemorrhage, transpiration, or other causes. The need for salt implies a previous loss of salt. Secondly, the loss of salt should be a phenomenon of a chemical nature resulting from reactions of disintegration. Thirdly, this chemical phenomenon having, as is proved by experiment, a relation to the different kinds of diet, should be caused by their chemical characteristics—that is to say, by the difference in their proportions of potash. That is his doctrine. Theory having led him to this point, the rest is a simple matter for the clever chemist of Basel; he has no difficulty in discovering the mechanism by which the vibrations of the potash introduced into the system control the proportion of salt that is eliminated.

When a theorist declares that something *should* be, he usually suspects that it *may* be otherwise; this occurs twice in the reasoning which we have just cited. Hence, there are two weak links in the chain of argument. Therefore the principle of this theory is uncertain and may be contested. Indeed, it has been.

It is possible, contrary to the reasoning of Bunge, to increase the relative and absolute quantity of potash taken into the system without increasing the appetite for salt; indeed, we may even decrease the desire for it.

An example of this sort is found among the negro tribes of Africa who use "*ash salt.*" The use of this mineral condiment extends throughout a large part of Central Africa in the basins of the Ogove and Sanga north of the Congo and in the provinces of the Free State to the south on the opposite side of the river. The lack of sea salt or rock salt causes these populations to replace this substance by another saline material which they prepare on the spot by their own means.

But this is not ordinary salt—chloride of sodium; it is not even a soda salt. They obtain this spurious salt from the ashes of plants. Not the first that come to hand, for it is not immaterial what plants are chosen for this purpose. On the contrary, they are carefully selected species. They use particularly two plants from the river. The favorite one is a floating aroid common on the Ogove and determined by M. Lecomte as the *Pistia stratiotes.* It is said that at certain places this plant is cultivated solely for the purpose of extracting its salt. The second is a sort of high bamboo that grows in clumps upon inundated banks.

What peculiarity have these plants that causes them to be chosen to the exclusion of others? We do not know. M. L. Lapicque, from whom we have derived a part of this information, supposes that it is the slight proportion of carbonates that they furnish when incinerated, or as the effect of subsequent treatment. In a product destined for food, the lack of alkaline carbonates is a decided advantage, for their nauseous odor and alkaline taste is repulsive to all.

After being harvested the plants are dried and then burned; the ashes are collected and leached. At Berberati, on the Upper Sanga, Dr. Herr witnessed this process. The aborigines use for this purpose a rude filter made of a conical basket, in which the ashes are placed. Through this water is passed and repassed several times to dissolve out all the soluble salts. The

* Translated and condensed in Smithsonian Report for 1901, from the Revue des Deux Mondes for 1901, Vol. I, pp. 197-227.

† In practical agriculture it is generally admitted that there should be given to each sheep about 2 to 5 grammes of salt per day, 30 to 50 grammes to a horse, 60 to 100 grammes to an ox. In England and in Germany stock raisers much exceed these amounts.

solution thus obtained is then evaporated by heat. The fixed residue forms the "*ash salt.*"

The composition of this salt, at least as to its general features, is well known. M. Dybowski, in 1893, communicated to the Academy of Sciences some analyses of it. Its composition varies little from that furnished by most plants similarly treated. Normally, as has been already said, potash is greatly in excess of soda in all vegetables. The proportion varies from 30 to 150 parts of potash to 1 of soda. That is what we find in this case; the quantity of soda is very minute. The characteristic features of the chemical composition of these plants would then be an abundance of chloride of potassium and a scarcity of carbonates.

This spurious salt tastes much like common salt, but leaves the sharp after-taste of potassic salts. It is not, on the whole, decidedly disagreeable to a European palate; the aborigines prefer it to common salt.

The strong appetite which these sedentary, agricultural negroes have for this mineral condiment quite justifies the rule established by Bunge, according to which the need for salt is connected with agricultural habits and vegetable diet. And if this appetite is manifested here not only for true common salt but for a sort of spurious salt, the law is still better exemplified. Bunge goes so far as to say that in this case observance of the law is carried even to aberration, but, on the other hand, it will be readily seen that the theory devised by the chemist of Basle to explain his rule is undermined by this very example, for this need for salt being due, according to him, to the waste of chloride of sodium from the organism, which, in its turn, is indirectly caused by an excess of potash in the food, should only be remedied by restoring the lost chloride. But in this case the ash salt that appeases and satisfies the need is a salt of potash, and so ought, theoretically, to exasperate it.

The explanation of Bunge is therefore not tenable. All that experience teaches is that an exclusive vegetable diet causes a need, a particular appetite, which can be satisfied by substances having the taste of cooking salt and containing either chloride of sodium or chloride of potassium. In brief, from a chemical point of view, it is a need for chlorides; from a physiological point, a need for salty savor; that is to say, for a particular kind of gustative sensation.

III.

One of the effects of the progress of civilization has been to substitute a mixed diet for that of primitive people, this latter being sometimes exclusively animal, at others exclusively vegetable. At the same time the use of salt has become general and is now a universal habit, but we have just seen that its use was originally limited to vegetarian peoples and had its origin in a need either for a material constituent of the body or for a sensation.

Which of these two alternatives is the true one? Must we admit, with Bunge, that we have a true chemical need, an appeal, an attraction of the organism for a substance necessary for its constitution and, at the time, deficient? Is it not, rather, merely a need of the senses, a sort of protest of sense against the habitual tastelessness of vegetable foods which has to be remedied by a condiment otherwise inoffensive?

This is the conclusion of the greater number of physiologists. It is that of M. Lapicque, who sees, in the appetite for salt, a particular case of a very general taste for condiments common to all populations that live on vegetables: To the Abyssinians, who counteract with *berberi*, a sauce spiced with pimento, the insipidity of their durrha or Indian millet; to the Hindoos and Malays, who mask with curry the tastelessness of rice, the basis of their diet. This is also the opinion, of far greater antiquity, of Sallust, who, speaking of the salt disdained by the Numidians, ranks it among the *alia irritamenta gulæ*.

In reality, one may reconcile these opinions and bring Bunge into agreement with Sallust and M. Lapicque. The sole function of condiments is not that of rendering agreeable the enforced task of eating and of transferring into a pleasure the necessity for food. The gustatory sensation is not wholly for the pleasure it gives; it is charged with an important function relating to the operations of the digestive apparatus. As Prof. Pawlow and his pupils have recently shown, it starts into action the vital energy of the stomach and induces the secretion of an efficient gastric juice, rich both in acid and in ferment (pepsin). Even the contact of the food with the mucous membrane of the stomach, which physiologists have until recently supposed to be the only means of arousing the secretion of that organ, does not have as much effect as the sensory excitation due to sapid substances. The gustatory impression is more efficacious. It causes a more abundant secretion of gastric juice, which is more energetic in its action and therefore of greater value.

Condiments and seasonings are therefore found to have a justification that is to some degree of a physiological character. They insure the proper action of the stomach.

Salt does more. At the same time that it puts in motion the secretion of the stomach it furnishes it with materials, at least with some of them. Hydrochloric acid, which is characteristic of the gastric juice and insures its digestive efficacy, is derived from salt, from the chloride of sodium of the blood. The same origin should be ascribed to the chlorine compounds found in the juices of the stomach, fixed chlorides and organic chlorine. In other terms the material for the chlorine compounds of the gastric juice comes primitively from the salt of our food.

This is not the place to discuss how, in order to produce this result, the salt of the blood is decomposed within the gastric glands. This is a problem that has greatly occupied modern physiological chemists, and upon which they as yet do not fully agree. Maly has supposed one kind of mechanism for this reaction, Laudwehr another. The method matters little. That which should be noted is the fact that salt is destroyed by gastric digestion, and that the equilibrium of the organism demands that it be replaced. If, then, the loss of salt is not, as Bunge supposes, the primary cause for the need of salt so general among all peoples, it is at least its consequence and its physiological justification.

Any other chloride than that of sodium susceptible of introduction into the blood may there participate in similar reactions and play the same part.

The ash salt, rich in chloride of potassium, is a good substitute for cooking salt. Recent experiments have led MM. Dastre and Frouin to conclude that chloride of magnesium may be used for the same purpose with still more striking results. The secretion of gastric juice, which increases in quality by the introduction of common salt into the blood, is still more increased by the introduction of the magnesium salt.

The same result would be obtained by the introduction of the spurious ash salt prepared by the negroes of the Ogove and the Sanga as by the use of common salt; still better results by the magnesium salts if other reasons did not exclude their employment. In the absence of salts belonging to the same group as common salt we may even substitute, as has been shown by the well-known chemist, E. Külz, others farther removed, such as the alkaline iodides and bromides. These give rise to a gastric juice acidified by hydriodic and hydrobromic acid instead of by hydrochloric acid as is normal gastric juice. Still, if such a substitution in no way affected the functions of the stomach, it might not be the same in relation to other organs.

IV.

Ordinary salt, the chloride of sodium, is one of the constituent elements of animal organisms, existing everywhere in them. The blood has a saline taste more or less marked; all the secretions are salty; the tears themselves are more salty than bitter, whatever good people may say about them. Salt water, in fact, bathes all living particles and leaches continually from the organic structure, escaping from all its tissues, carrying with it the waste matters which should be rejected from the body.

Common salt is more suitable than any other for this purpose. In a dose of 9 grammes per 1,000 it forms a solution innocuous to the anatomical elements, that can circulate around the most delicate of them without causing the least damage. This close association with salt has become habitual to them from immemorial usage; they have adapted themselves to it, and it would lead to some inconvenience if another mineral constituent should be too abruptly substituted for it. In certain animals that have been bled to exhaustion, life may be kept up for some time if the blood is replaced by a saline solution, named, because of its properties, the physiological solution. A turtle or a frog in whose veins this fluid circulates continues to live for a considerable time. Certainly this is not a generous liquor; the living alimentary particles find in it nothing by which they can be nourished and sustained, and they can live in it only as long as their own reserves may last, but at least it does them no harm.*

We may now begin to comprehend what becomes of the salt we consume in obedience to the curious need of which we have spoken. It is easy to predict its destiny. The greater part of it will remain in simple solution; the remainder will enter into combination, more or less intimate, with living matters. The former will penetrate into the circulating liquids, lymph and blood, and will with them pass through all the systems of the body without taking any direct part in the vital changes, but, on the contrary, act merely as a filling, neutralizing by the number of its molecules the danger which the cellular community would incur if the medium in which it lives were too much diluted, and it will finally pass out by the natural emunctories, invariable, unchanged, but having performed the service of removing from the economy the effete products of cell life. This eliminated salt must be replaced. Its loss, reacting upon the organism, is the primary cause of the need for salt.

The second and smaller portion of the salt taken into the body will penetrate into the elements themselves, will make an integral part of them, will participate in their chemical changes, not only those which give rise to the gastric juice, but also others, finally becoming destroyed and lost to the organism. The void left by this continual elimination has doubtless some weight in the sensation of need for salt, which the animal feels. It is a second element of it.

V.

The necessity for common salt in the food results from this series of changes. The organism could not be maintained, or, in other words, health would be impaired if that which was lost were not restored. Mineral aliments are therefore a necessity. It is necessary that we should have salt. There are some physiological functions in which common salt may be replaced by another, as we have seen in the case of the gastric secretion, but there are others for which such substitution is, probably, impossible. A modicum of chloride of sodium is indispensable to life.

In truth neither men nor animals have to occupy themselves in finding this modicum. It is exceeded by the quantities normally existing in natural foods. The difficulty, then, is not in obtaining the nutritive substances which contain this modicum; it would rather be in devising a food sufficient in other respects, that is to say, as regards nitrogenous, fatty, and starchy matters, in which this modicum did not exist.

Nevertheless a physiologist, Forster, in 1864, was able to do this. He utilized the waste from meat powder derived from the manufacture of Liebig's extract, treating it several times with boiling water, so as to wash away almost all the soluble salts. With this leached meat, together with starch and fat, he formed a ration in which there was wanting nothing but the mineral salts.†

Animals nourished with this ration in reality suffered from mineral inanition. The experiment of Forster, carried out at Munich under the direction of Voit, is, in fact, a typical one of this kind and perhaps the only one performed until latterly, when Bunge and other physiologists took up the matter again.

The necessity for mineral alimentation was affirmed as a general principle as early as 1861 by Liebig in his Letters on Chemistry. It is true that Chossat and Boussingault had called attention to the necessity for lime and that Becquerel and Rodier had spoken of the need for iron; but these were only special studies. Liebig stated the general principle; animals require for their proper maintenance albumenoids, fats, either starches or sugars, and mineral aliments; but it was not Liebig who demonstrated this, it was Forster.

In fact, the experiment of Forster relates to the entire sum of mineral matters, not specially to the chloride of sodium. It is an example of complete *mineral* inanition, not of *saline* inanition. It furnishes, however, some information as to the consequences which may follow from the suppression of salt in alimentation. As soon as the regimen was established, the animal showed a considerable diminution in the quantity of salt rejected by the emunctories, though the urea and the organic waste products maintained their usual proportion. The organism, then, retained its mineral matters; the mutations of chloride of sodium engaged in organic combinations were slight. After twenty-six days of this method of alimentation the animal had lost but 7 grammes of this chloride of sodium in combination. Its health, however, was much impaired. It grew more feeble day by day. Nervous troubles appeared, consisting at first of habitual inertia, paralysis of the limbs, and later of convulsive seizures and attacks of madness. The gastric secretion diminished at once. Toward the last it no longer contained hydrochloric acid. Grave digestive disturbances finally intervened. The animal, however, lost but little in flesh; its pining away, its corporeal and physical failure, was but the result of the suppression of mineral salts. The lack of common salt was, doubtless, but a single factor in the production of these phenomena. The absence of other salts, particularly of the phosphates, had also something to do with it. Nevertheless, it is striking to see what violent disturbances may result from slight variations. In fact, the animal succumbed more quickly from the deprivation of mineral elements alone than it would have done from total inanition, that is to say, from the suppression of all aliments except water.

The necessity for a modicum of common salt is shown by these experiments. Chloride of sodium is then a plastic aliment. It is placed by Munk and Ewald in the category of nutritive salts together with the alkaline and earthy phosphates and the salts of iron. According to statistical data the daily consumption of salt in Europe is on the average 17 grammes per capita. Of these about 2 grammes are necessary to cover the loss by disassimilation. These two grammes represent *nutritive* salts. The remaining 15 grammes would then represent on the one hand 8 to 10 grammes carried away by excretions and necessary for restoring the constitution of the circulating liquids, and a surplus; but, considering the influence of salt upon the secretions, it would not be prudent to say that this surplus is a sacrifice made to the pleasures of appetite.

We have just seen the ill effects of a deprivation of salt. We should perhaps say a word about those which result from its excessive use. It is known that if taken in amounts beyond the average it causes thirst, and an increase in the renal excretion. It has been shown that this increase remains about the same whether or not the subject drinks. The water excreted is then taken from the tissues.

If the absorption is pushed beyond moderate quantities, vomitings and intestinal disturbances ensue. This kind of excess has rarely been observed unless we regard as authentic the story of those midshipmen who are said to have been compelled by Peter the Great to drink sea water for the purpose of inuring them to a sailor's life and who died as a consequence.

VI.

Besides taking an active part in certain of the vital phenomena, common salt fulfills better than any other substance the conditions of a medium that is indifferent and yet suitable for the physiological necessities of living matter. In animals as well as in plants, in the mobile corpuscles of the blood as well as in the fixed elements of the tissues, living protoplasm is always rich in potassic salts. The interior medium which bathes it abounds, however, in sodic salts, particularly the chloride of sodium, resembling in this respect sea water, which might, if properly diluted, circulate in the veins and replace for a time the plasma of the blood, as we have seen may be done with the physiological solution. Some naturalists, recalling the circumstances under which life appeared on the globe, and the manner in which it was for a long time maintained in the saline waters of the Palæozoic seas, have thought they perceived in this fact the survival of an ancestral condition.

From this point of view chloride of sodium would be an element handed down from remote times, belonging to a medium suitable to animal life, to the blood and to the organic humors; and salted food, by introducing it about the anatomical elements of the body, would recall the marine origin of animal life, would connect, as one may say, the physiology of the present with that of the past. . . .

CROSSING THE STREET.

"I NEVER cross the street in front of any approaching vehicle except an omnibus; it is the only vehicle I can trust to pull up and not go over my body if I should fall." This is the remark quoted by a writer in the Lancet, who overheard it in the crowded Strand of London. It may be true of London. It certainly is not true of New York. At all events the Lancet's comments on the matter are not without interest. Why are not all vehicles supplied with powerful brakes as all omnibuses are, it asks? We have seen a horse and cart coming full tilt out of a side street, the driver being quite unable to pull the horse up and avoid a collision "amidships" with another vehicle, simply because his vehicle was without a brake. It is surprising what a number of vans pass through London streets

* A solution of this character, having the proportions of about 6 parts of chemically pure sodium chloride to 1,000 parts of distilled water, rendered aseptic and warmed to 100 deg. F., is in common use in surgery and medicine, being known as the "normal salt solution." Readers will doubtless recall that it was used in the lamentable case of President McKinley, both for the cleansing of the abdominal cavity during the surgical operation and later as a hypodermatic injection. It was also used some months before with good effect in the treatment of Mrs. McKinley, who was suffering from a disorder that had drained the blood of its fluid.—Translator.

† There remained but eight-tenths per cent of the dry weight.