CHAPTER V

FOUR PROBLEMS OF FOOD

THEY say the chameleon feeds on air. Well, so do we. And this calls to mind a true story.

Once there lived on the good ship *Earth* —and still lives for aught I know—an Englishman named North—Colonel North, "The Nitrate King". Of all the earth-beings who have gained dominion over their fellow passengers on this great globular *Zeppelin,* Colonel North once seemed to have the greatest dominion—greater than that of Rockefeller; or Cecil Rhodes, of South Africa; or Clive, the conqueror of Hindustan; or the "Gentlemen Adventurers" of the Hudson's Company. Greater than the dominion of Genghis Khan, of Tartary, Attila the Hun, Alaric the Goth, or Genseric the Vandal. For it seemed at one time as if Colonel North, the nitrate king,

and his descendants would be able through their ownership of the nitrate beds of Chili to make all their fellow passengers buy nitrates of them, until the beds should be exhausted; and then all the passengers of the good ship *Earth*—after moving about from one nitrogen-exhausted place to another, and warring and wasting and ravaging as peoples always do when they move—were to starve together, —for lack of nitrates!

What greater deed could a monopolist hope to achieve than to get hold of something which God made for all of us—who are all in the same boat remember,—sell it to us at starvation prices and lord it over the rest of us; even though at the last we should use up the supply, and all starve? Truly, a gigantic and characteristically nineteenth-century conception!

The thing the colonel had cornered was nitrogen for the growth of crops. Nitrogen is one of the ten elements of plant food that must be found by the roots of the plants or they die. And all animal life is based on plant life—and

we passengers are animals. So there you are! Of these ten elements, only three or four, as we have seen, are often scarce in the soil—nitrogen, phosphorus, potassium and probably sulphur; and the colonel had the nitrogen—or so he thought. For though seventy-five per cent. of the air in which every plant grows is nitrogen, the crops can not use it. It is "free" nitrogen, and the crops can't eat it unless it is "fixed"—that is, tied up with some other chemical element. There are 75,000,000 pounds of nitrogen in the air which rests on every acre of land; and the crop dies for want of it unless it is "fixed" or tied up with something else in chemical bonds! A soil is in good condition for crops if it possesses two tons of this 75,000,000 pounds per acre—but how to get it?

Science was in despair. But Colonel North, I suppose, was in high feather. For in Chili nitrogen has accumulated in the form of nitrates in the soil until that dry region is the great storehouse of the fixed nitrogen of this great air-ship *Earth* in which we are all passengers, going we know not where. Sir Will-

iam Crookes put on his black cap and gave out the sentence of science. This was the verdict:

A good soil possesses only from 2,500 to 10,000 pounds of nitrogen per acre. A good crop takes from this store from 75 to 400 pounds per acre, depending on the crop. Call it 75 so as to scare ourselves as little as possible, and give every acre 10,000 pounds, which is twice what we can count on, and where are we? Why, we can see our way to 134 crops, and a part of another. But there's Colonel North with his paper title to the nitrate parts of the decks of the ship which clearly belong in common to all of us—how about Colonel North and his nitrate beds? Well, said science, at the present rate of shipments, they will last only a few decades, at most—some said thirty years, some three hundred—because nobody knows just how much Colonel North had. And then? Why, then, with that illimitable sea of nitrogen about our heads, we shall all gradually die out of starvation! There was no way out of it—human life is based on plant life, and plant life on nitrogen,

and the fixed nitrogen supply is approaching exhaustion. So said science through Sir William Crookes.

But the good farmers of the world always felt that Sir William was a bit off. They knew that when they planted clover, beans, vetch, peanuts, or any other leguminous—that is pod-bearing—crop, and plowed it under, the soil seemed richer in something afterward. Science said that that couldn't be. "For," said science, "all the nitrogen the legume gets, it gets from the soil, and you can't get any more by plowing back what you've just taken out." Moreover the scientists "proved" by experiment that the pod-bearers don't secrete nitrogen from the air.

"But," said the good farmer, scratching his head, "it *is* richer, for all that!"

"Nonsense!" said science.

And then the most wonderful discovery of agricultural science convinced the wise men that the farmer was right. Science found that on the roots of these leguminous plants, are little knobs like tiny potatoes, and in the knobs,

millions upon millions of little plants called bacteria, so small as to be invisible to the naked eye. We used to think they were disease-galls! Suddenly through the patient researches of science, the mistakes of science were corrected; and we were informed that these bacteria, unlike the big plants, have the power to take free nitrogen out of the air in the ground, and fix it so the other plants can get it!

Science threw up its hat. We needn't starve for lack of nitrogen! Colonel North's descendants can't look forward to the time when the other passengers on the good ship *Earth* will come crawling on their bellies, begging nitrates, supplicating for the privilege of living on board a while longer. We can get our nitrogen out of the air.

When God started to build a world, he started from the bottom. When the first plants were evolved, they had to be plants which could get nitrogen from the air, because except for a small amount deposited through the action of lightning, there was none in the rocks. The first plants were one-celled plants

which could do this. When the clover began business the bacteria came around and asked the privilege of building houses in which to live on the clover roots. "Certainly," said the clover, "but you've got to pay rent." "All right," said the bacteria, "we'll furnish the nitrogen, if you'll look out for the other table board, and the matter of lodging. Is it a go?" "It's a go!" said the legume; and they have been partners ever since, each living on the other, and all taking nitrogen out of the air for themselves and other plants.

In the crust of the earth there is only a trace of nitrogen, and all there is, as far as I know, is in the soil. I suppose that all of it which is in the soil has been taken from the air by the bacteria and fungi—Colonel North's and all the rest. If these tiny, tiny passengers had not come aboard millions of years before us, we could never have come into being. Despise not the day of small things. The basis of all life is too small to be seen by the microscope.

I often wonder what we should have done about North's monopoly, if Crookes had not

been mistaken. Would the other passengers have recognized his paper title to the power to starve them? I wonder! The courts, of course, would have stood up for Colonel North.

It is, therefore, the clover-plant and its brethren, the peas, beans, alfalfas and the like, that will save the passengers on the good ship *Earth* from being obliged to go crusading in search of soils provided with nitrogen.

I am trying to look at some of the larger problems of the world as concretely as possible. We are passengers on a huge ship driving through space as one of Zeppelin's airships drives through air, save that we know not what guides us, and that we spin like a curved baseball, and whirl round and round the sun from which, by wireless transmissions over the ninety-five millions of miles of space which separate us from our planetary "control", we get our light, heat and power.

We are all in the same boat. We did not make the boat—we ourselves are made from the dust on the planking of her decks. We are

divided up into nations, clans, tribes, classes and races; but we are all tenants of the decks of the ship *Earth.* Looked at as an original question, what are our rights and what our duties to our fellow passengers, and the great property—for the ship is really our property —which our children must be made of, and live upon?

We have learned that as animals we must live either on plants, or on other animals which have been made of plants—plants which break out in a green rash all over the decks of the old boat. And that there are ten things which must be found in soil or air before a field can nourish plants—every one of the ten: carbon, hydrogen, oxygen, phosphorus, potassium, nitrogen, sulphur, calcium, iron and magnesium. Of these there are only three or four that need give us any uneasiness—nitrogen, phosphorus and potassium—and probably sulphur. Not that these are any more necessary than the other six or seven, but that they are soil elements that are scarce, and the using

up of which would put an end to the human race by putting an end to vegetation.

We have seen that there was once a scare for fear that the nitrogen would soon be exhausted; and that we discovered that certain plants of the clover tribe are taking it from the air all the time when given a chance, and storing it in the soil. So that scare ended.

Let us now look into the hold of the ship and see how we are supplied with potassium.

But first, what is potassium? It is the element which gives its name to potash—which any one may make from the lye of wood ashes. It is found in the ashes of any field crop, when the plant is burned. It is plain, then, if it is a part of every one of these plants, that it must exist where the plant can reach it, or no crop can grow. Potassium is not found in the air as is nitrogen—so it must be obtained from the soil.

In the grain of a hundred-bushel crop of corn, there are nineteen pounds of potassium. An average soil contains enough at this rate to

make 2,500 crops. No need to worry then? Well, is it any less serious for the race to end for lack of food in 2,500 years, than in one hundred? Or be sent crusading and slaying after new lands in the year A. D. 10,000 rather than A. D. 2,000? If we are wasting what the passengers must some day need, does it make any real difference that we shall not be present to witness their sufferings? It does not seem so to me. I think we should be as alive to suffering in Europe or Asia to-day, as if it were in the next room; and as solicitous for the happinesss of the world's passengers a thousand years hence, as next week. Especially as our acts make for or against that happiness.

There are many lands even now which need potassium. We import millions of dollars of it annually. As "kainite" and in other forms it is a very important article of commerce.

The lands which need it most, are not yet under cultivation to anything like the extent which the future will require. As the passengers on the good ship *Earth* multiply and need land, instead of swarming out against

other peoples, they will, let us hope, draw off the water from the lands that are only just submerged and reclaim them. In other words, we shall drain swamps.

By doing this, we may dry up additional deck room in the United States so as to add to our habitable heritage an area as big as the three states of Ohio, Indiana and Illinois—about 76,000,000 acres.

We often say of a swamp: "Drain it and it will be the richest land in the world." This is always said, and usually it is true. The land of swamps usually is rich in nitrogen, in phosphorus and most other plant foods. But watch a corn-field in a drained swamp, and you will often see the corn turn yellow in July, and you will note a failure of yield. This spot is not helping to feed the passengers. The swamp was a peat-bed, and lacks potassium. So, as we drain our swamps, and as we exhaust the potash from other lands, we shall need to put on the fields untold tons of it. And we do now buy it by the millions of pounds.

Whence comes it? Nitrogen, we recall,

comes mostly from Chili, and the nitrate beds with which Colonel North, the nitrate king, dreamed of ruling the world in that dreadful day when the world should crawl to him on its belly for nitrogen—that great and awful day of the Lord.

Is there a potash king, then? Yes, and no. If there is one, he is Kaiser Wilhelm, of Germany. The great potassium beds of the world are in his realm. It lies there, in beds 5,000 feet deep—enough for the world for thousands of years, if there were no other place from which to get it. There are no such beds known elsewhere.

But the kaiser dreams no such dream as that of Colonel North; for he knows that we can get potash elsewhere. Not so cheaply, nor in such accessible masses, but we can get it. There are plenty of rocks that contain from six to eight per cent. of potassium—we may be able to grind them and extract their potassium and put it on the land.

And did you ever run over from the California coast to Santa Catalina Island for an

outing? If so, did you notice the great fields of a water plant called "kelp" that grows in huge beds all along that coast? Well, the department of agriculture has discovered that we have in this weed a possible source of potash, to the value of $40,000,000 a year, if we choose to extract it. And out of the weed, too, would come by-products like iodine, glue, shellac and paper. Probably these things will in part or in whole pay for the work, and the potash may be clear gain. Isn't it fine to discover so much food of which we were unaware in the sea? For potassium is food, remember —when the crops have worked it up for us. The geological survey, too, have recently found small deposits of potash in the government domain—enough for thirty years.

The German potash princes and the German government have been a little stingy about their potash, lately. We have had a fuss with them about it. And I don't blame them for looking closely after so important a matter. But I'd like to see our government develop our potash industry by opening up our mines,

and setting up works to make potash out of kelp—for the benefit of the human race, whose very flesh must be made of the planking of the decks of the good ship *Earth*. I'd like to see shiploads of potash come from the kelp of California to the hungry lands of the east, through the Panama Canal, from those government works.

There are pastures in Australia, of a kind of herbage called "kangaroo grass". Live stock fed on this grass for too long a time suffer from a fatal disease of the skeleton, called by the farmers "bone disease". The cause of it has been a mystery until lately.

Scientists have known that the soil is deficient in phosphorus—but they did not know that the plants growing out of it were also poor in this element. Recently it has been discovered that these plants have adjusted themselves to the lack of phosphorus so that they have only one-tenth of the phosphoric acid in their make-up that crops must have on which animals with bony skeletons can live.

The bone disease is thus accounted for. Phosphorus is an essential part of bone, as well as of blood and of flesh. Any race which possesses "bone and sinew", or "good red blood" must feed on plants receiving phosphorus from the soil, or on animals which have done so—so dependent are we who are made in the image of God, on the very dust beneath our feet, for our moral as well as physical existence. If the soil on which a nation lives loses its phosphorus, that nation must die—or go out killing and ravaging, seeking other lands.

Animals have been fed, as an experiment, on foods deficient in phosphorus. For a while they seemed to do well. Then they collapsed. It takes only three months of a ration without phosphorus to wreck an animal. Individual creatures were killed after a month of this diet, and it was found that the flesh was taking the phosphate—for the phosphorus exists in the body in that form—from the bones to supply its need. In other words, the body was eating its own bones! When this process had

robbed the bones to the limit, the collapse came, and the animal could never recover.

Now as passengers on the good ship *Earth,* it will be worth our while to look into the hold of the ship and see how much phosphorus the cosmic forces put into the bunkers when they flung us spinning out into space, under wireless control, to whirl we know not where. Shall we find enough? Are we as a race doomed after many famines and pestilences, and wars and rumors of wars to die—perhaps of starvation, perhaps of bone disease—and to leave the ship lifeless, or to plants like those of Australia which have learned to do with little phosphorus, or to boneless animals, fitted for a similar phosphateless life?

This is the indispensable element in which we find the soils of the world poorest. In the original rocks there are only eleven hundredths of one per cent. of it on the average. Good virgin soils are even poorer than this. It is a good soil indeed which has 2,000 pounds of phosphorus per acre in the top seven inches of soil. So we see that in the

process of making soil, a large part of the original stock is lost.

Where we have worked over the soil—the dust on the planks of the good ship *Earth*—until it is said to be "exhausted" we find that it is usually the phosphorus which is gone—or nearly so. Old soils from the level coastal plain of Virginia, said to be too poor to work, test as low as 340 pounds of phosphorus in the upper 2,000,000 pounds of soil. The worn-out fields of Asia are very poor in phosphorus. Some depleted soils in India have been found to show only what the chemists call a "trace" of it—too little to measure.

In the youth of the race, these old fields made men—but they are now deserts.

"They say the Lion and the Lizard keep
The Courts where Jamshyd gloried and drank deep:
And Bahrám, that great Hunter—the Wild Ass
Stamps o'er his Head, but can not break his Sleep!"

And the lion and the lizard will return to

keep the courts where we reign and glory and drink deep—when the phosphorus of the soil goes. And then the lion and the lizard will themselves go the same road. And then the good ship *Earth* will sail the illimitable fields of space without passengers! Is this what the fates have in store for us?

A fair crop of wheat takes from each acre of the deck room devoted to its culture, 12.5 pounds of phosphoric oxide; barley, 15 pounds; oats, 12; corn, 18, and other crops accordingly. So even our rich lands possess only enough in the upper eight inches to mature from 160 to 250 crops. There is phosphorus deeper than that, and there are richer soils. But where fields like those of Japan, China, Korea and Manchuria have been farmed for forty centuries, we find the farmers now obliged to put back every year as much of this element as they have taken away, or more. A single year's failure to do this on their part, and these nations would begin to starve.

This depletion of the soil makes a full and enlightened life to be derived from it almost

out of the question. The peoples who are forced by necessity to return to the soil all they take from it are bowed down in servitude to the crops. They carry ordure in buckets and make soup of it for the rice. They seek for dung on the highways as for a treasure, and look upon a latrine as an Iowa farmer looks upon a bank. They climb mountains to pluck herbage which they thrust down into the mud of the fields with their feet. They carefully lift the mud from the bottoms of streams and canals and carry it to the fields for the little fertility it holds. They reap the aquatic plants from waterways as we reap harvest fields, and compost them for the crops. They carry the very earth of the fields to their houses, and mix ashes, night-soil and other fertilizers with it, carrying it back in the proper season to feed the crops. All this is wonderful and admirable as agriculture—but where the books of the fields are so strictly balanced as to fertility the amount of human life expended on the up-keep of the land is almost incredibly near to the volume of vitality which the prod-

uce of the field will sustain. This is the expression in terms of fertility of the economic pressure on the oldest farms in the world. It tells in terms of human life what happens when the deposits in the bank of the soil have been all checked out by farming.

Yet we, the "civilized", the "progressive" nation, waste our precious store like drunken sailors. The limiting element in even our rich Mississippi Valley soils is already phosphorus. Fifty years of our awful robbery of the storerooms of the race, takes out a third of the phosphorus—a short fifty years! After crediting the farms of Wisconsin with the return of everything the farmers put back, the net loss per year in phosphorus to that state is 15,000,000 pounds, worth at five cents a pound, $750,000. Our great "balance of trade" of which we so much boast, and with so little reason, would look much smaller if we deducted from it the phosphorus sent away—the actual land—in the grains and meats and fruits.

Phosphorus does not exist in the air, and being an element, it can not be artificially pro-

duced. We must find it if we get it. We find it in fossil guano and in the phosphate rocks. There are in South Carolina 3,000,000 tons of good phosphate rock, which will pay to grind; in Florida 166,000,000 tons; in Tennessee, 160,000,000 tons. We are mining this and exporting it to restore the depleted soils of Europe —for profit. It has been estimated that all this store in our Southern phosphate fields will be gone by 1932—probably it will vanish before. We can grind poorer rock, but there is a limit to the lowness of grade which will return as much food as we shall expend in grinding it.

Perhaps there is a region where nature has placed her store of phosphorus, as she did in Chili in the case of nitrogen, and in Germany for potash? There are many rocks still unexplored, and there may be much more phosphate than we know of; but aside from 60,000,000 tons of high-grade in three South Sea Islands, we know of no great deposits save what Uncle Sam possesses in Idaho, Wyoming and Utah—the deposits the conservationists have fought to keep them out of private hands.

Uncle Sam is the Colonel North and the Kaiser Wilhelm of phosphorus—with 9,500,000,000 tons of good rock in his bunkers.

But no matter how rich the rocks may be, within any reasonable probability, the supply will give out unless it is rigidly conserved—and the race will die. Once there were millions of tons of it—called guano—in the droppings of sea-birds on Pacific islands. The sea-birds catch fish—which have much nitrogen and phosphorus in their bodies. These fish pass through the digestive organs of the birds, the unassimilated parts being dropped on the islands where the nests are made. The old Peruvians protected the sea-birds from destruction; for they knew that these winged benefactors were retrieving from the ocean the lost fertility of the globe.

But we are civilized, and kill the birds. The last men on earth may be grouped about the spots whose phosphorus has not been lost from the soil—spots like the phosphatic soils of the bluegrass region of Kentucky, and similar portions of France, and some other countries; and

in regions kept populated by the fertility retrieved from the sea by billions of sea-birds bred for the purpose. But before that time comes, as unless we change our ways it will, the world will tremble with the tread of armed hosts leaving lands depleted of this phosphorus, and hunting new lands.

For many years we have believed that there are only three elements of mineral plant food which are likely to give us trouble by their scarcity—phosphorus, nitrogen and potash. To these, however, we must now reluctantly add sulphur. The analyses of plants on which chemists relied as showing their needs in sulphur have been shown to be unreliable, because of the fact that this element escaped in the fumes thrown off in the chemical laboratory, and was to some extent lost. We underestimated the amount of sulphur taken out of the soil by the crops.

We were lulled into security, also, by the fact that sulphur falls from the skies in rain and snow. At Madison, Wisconsin, where the latest determinations have been made by Hart

and Stevenson, the annual precipitation of sulphur in rain and snow is from fifteen to twenty pounds per acre. This is enough for the crops if it were all available; but much of it falls outside the growing season, and a good deal is lost in the run-off of water and carried away by drainage.

That the supply is not sufficient for the requirements of farming is shown by two facts. The first fact is that soils cropped for from fifty to sixty years have lost forty per cent. of their original supply of sulphur. The second is that when sulphur is applied to the soil the crops are improved, which would not be the case if this element were not getting scarce.

Most authorities disagree with this statement as to the scarcity of sulphur. It is a new idea, and is not yet generally accepted. It may be an error. But, if it does turn out to be scarce, fortunately, there is no lack of sulphur in the earth's crust. A ton of gypsum contains about 900 pounds of sulphur; and gypsum is found in enormous beds in most parts of the world. Phosphorus is ordinarily

applied either in the form of ground phosphate rock, or in superphosphate, which is phosphate rock treated with sulphuric acid. This latter fertilizer carries from 200 to 300 pounds of sulphur to the ton, in addition to its phosphorus.

Our ancestors used to apply "land plaster" (which is ground gypsum) to their farms seventy-five years ago, with good results. There is every reason to believe that we shall be obliged to return to a modification of this practise. The sulphur problem is not an insoluble one, but it calls for study, and the restoration of sulphur to the depleted soil is one of the tasks which confront the mariners who navigate the good ship *Earth*.