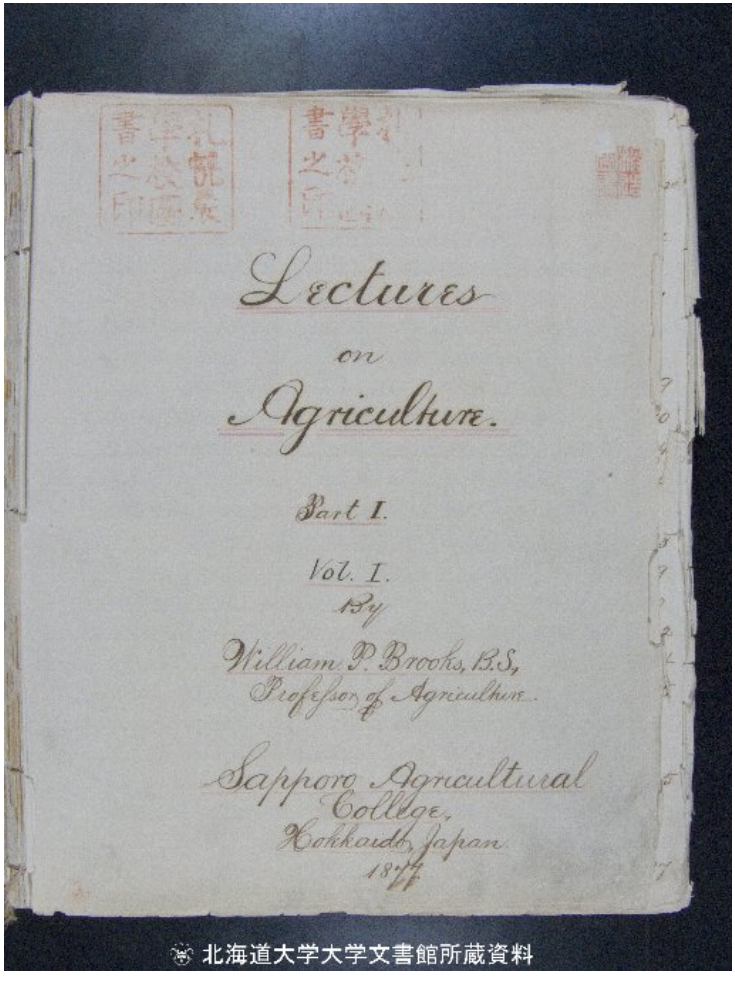

Lectures

on

Agriculture

Part I.

Vol. I.

By

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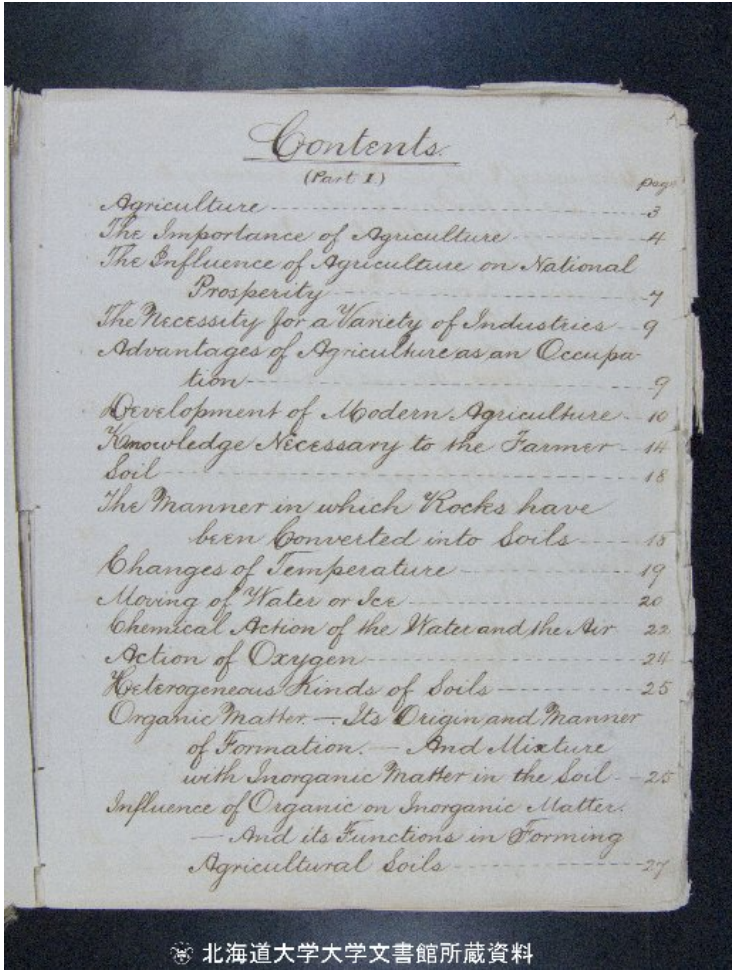
1877.



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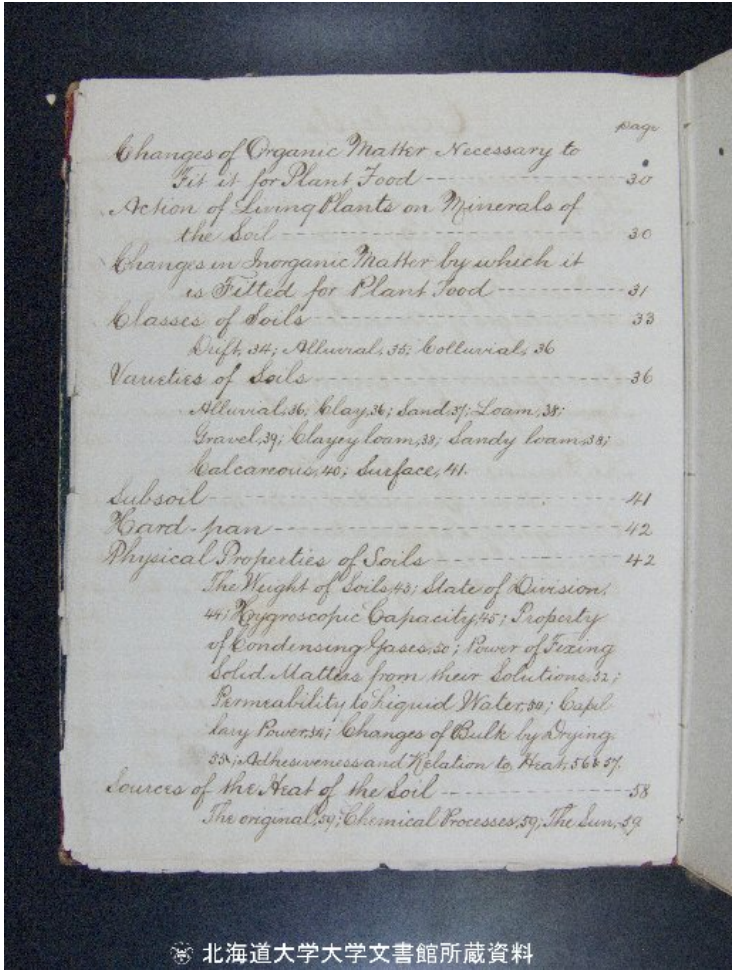
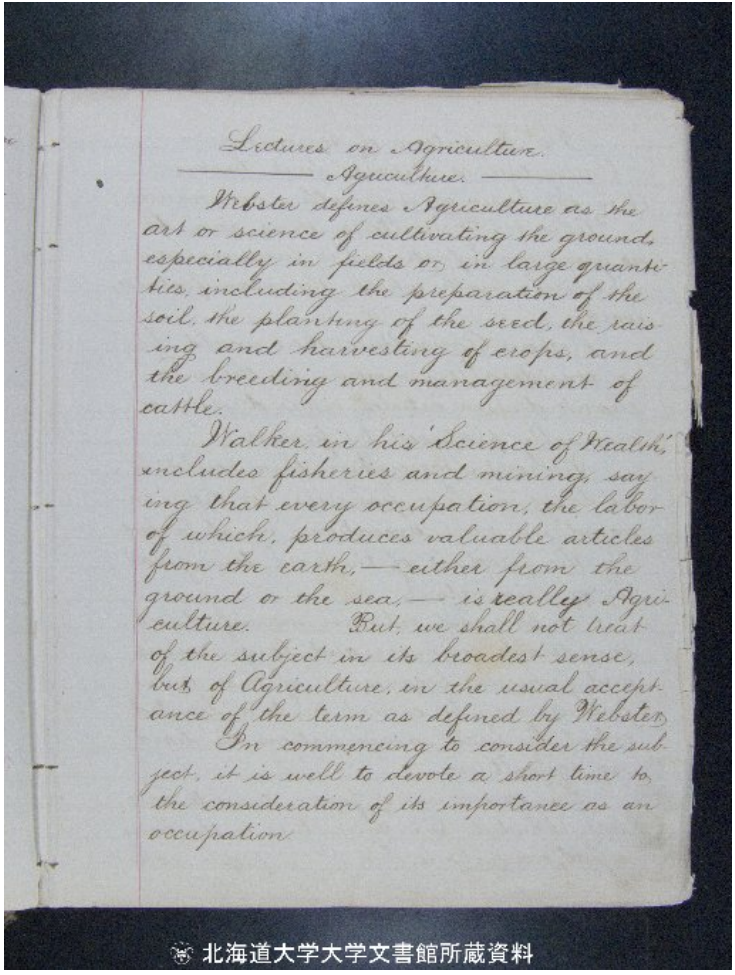
(Part I)





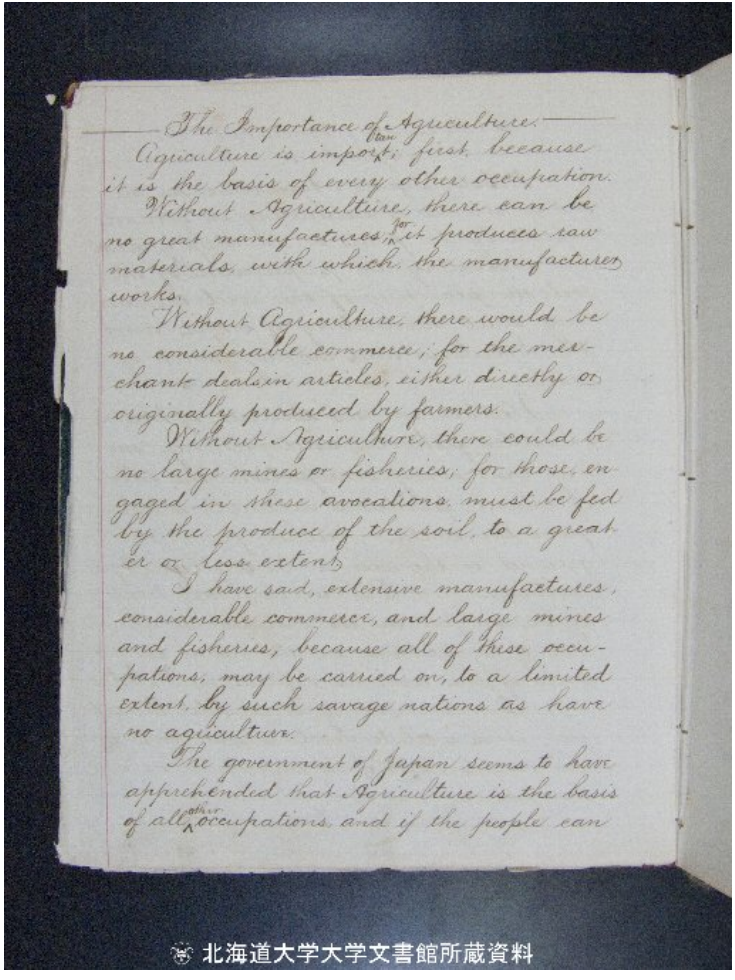
Lectures on Agriculture

——— Agriculture ———

Webster defines Agriculture as the art or science of cultivating the ground, especially in fields or in large quantities, including the preparation of the soil, the planting of the seed, the raising and harvesting of crops, and the breeding and management of cattle.

Walker, in his 'Science of Wealth', includes fisheries and mining, saying that every occupation, the labor of which, produces valuable articles from the earth, ——either from the ground or the sea, —— is really Agriculture. But, we shall not treat of the subject in its broadest sense, but of Agriculture, in the usual acceptance of the term as defined by Webster.

In commencing to consider the subject, it is well to devote a short time to the consideration of its importance as an occupation.



The Importance of Agriculture

Agriculture is important; first, because it is the basis of every other occupation.

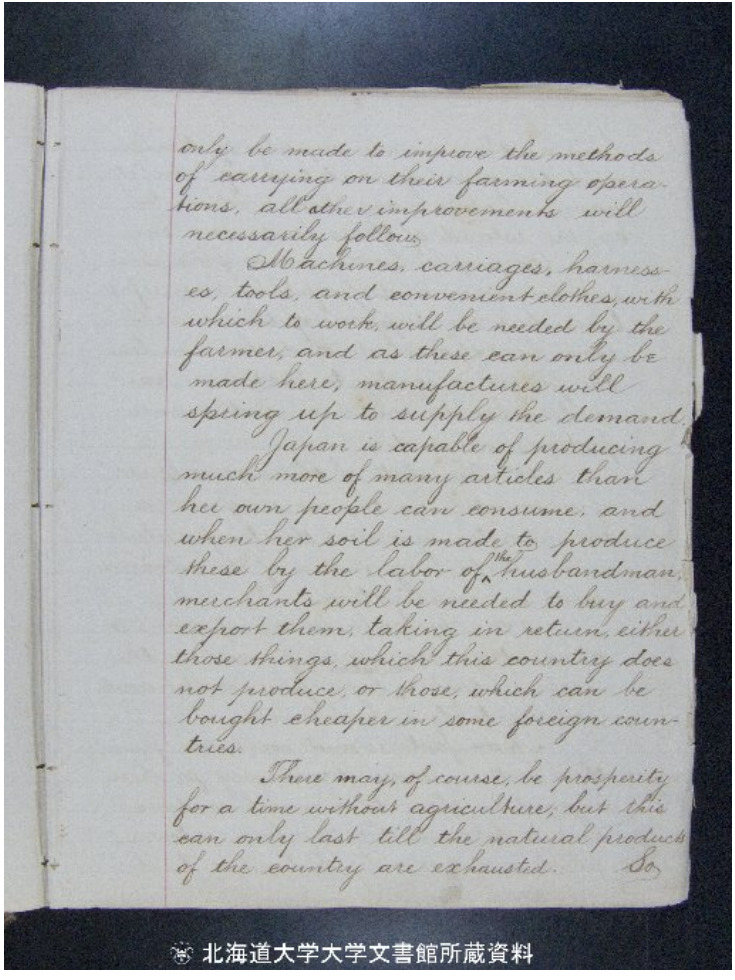
Without Agriculture, there can be no great manufactures; for it produces raw materials, with which, the manufactures works.

Without Agriculture, there would be no considerable commerce; for the merchant deals in articles, either directly or originally produced by farmers.

Without Agriculture, there could be no large mines or fisheries; for those, engaged in these avocations, must be fed by the produce of the soil, to a greater or less extent.

I have said, extensive manufactures, considerable commerce, and large mines and fisheries; because all of these occupations, may be carried on, to a limited extent, by such savage nations as have no agriculture.

The government of Japan seems to have apprehended that Agriculture is the basis of all other occupations, and if the people can

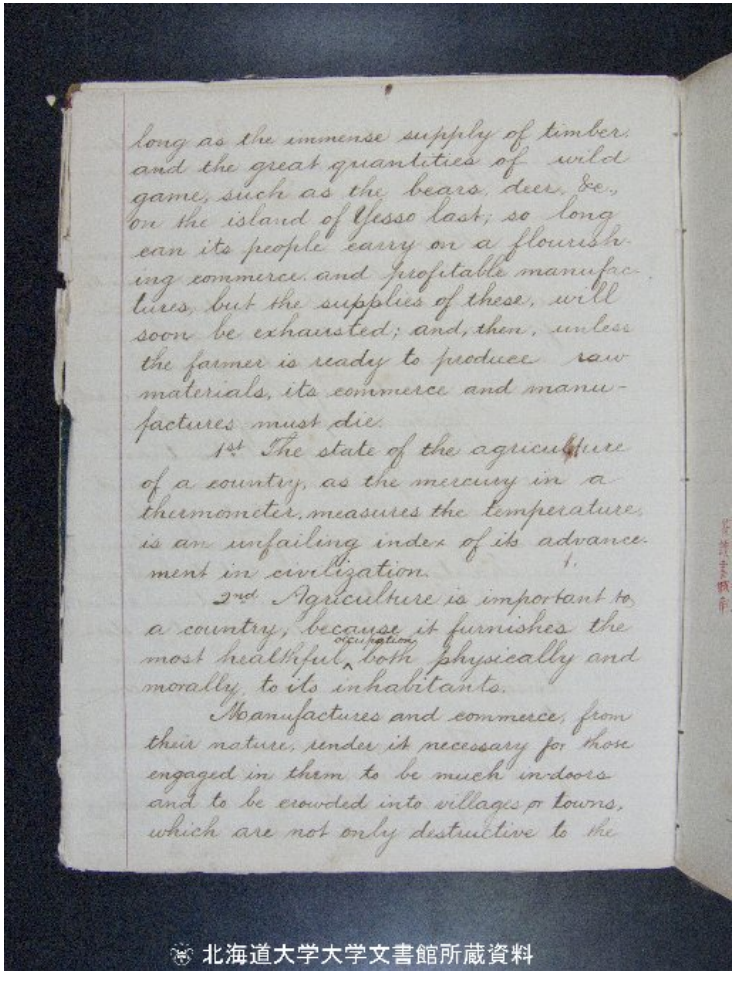


only be made to improve the methods of carrying on their farming operations, all other improvements will necessarily follow.

Machines, carriages, harnesses, tools, and convenient clothes, with which to work, will be needed by the farmer, and as these can only be made here, manufactures will spring up to supply the demand.

Japan is capable of producing much more of many articles than her own people can consume, and when her soil is made to produce these by the labor of the husbandman, merchants will be needed to buy and export them, taking in return, either those things, which this country does not produce, or those, which can be bought cheaper in some foreign countries.

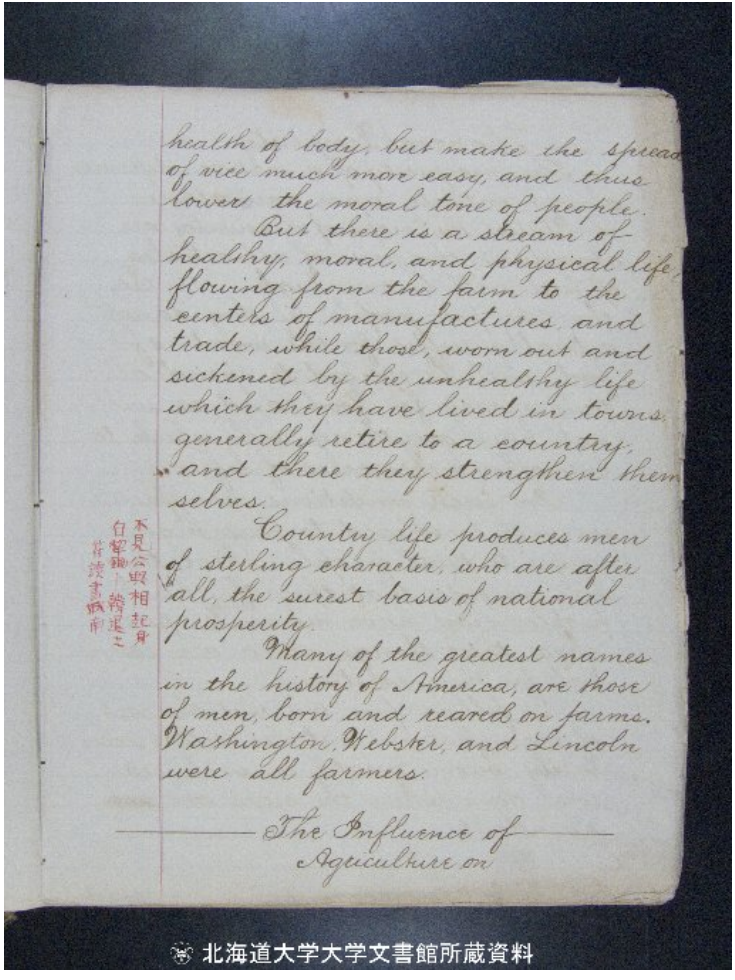
There may, of course, be prosperity for a time without agriculture; but this can only last till the natural products of the country are exhausted. So


long as the immense supply of timber and the great quantities of wild game, such as the bears, deer, &c., on the island of Yesso last; so long can its people carry on a flourishing commerce and profitable manufactures, but the supplies of these, will soon be exhausted; and, then, unless the farmer is ready to produce raw materials, its commerce and manufactures must die.

1st The state of the agriculture of a country, as the mercury in a thermometer, measures the temperature is an unfailing index of its advancement in civilization.

2nd Agriculture is important to a country, because it furnishes the most healthful occupation both physically and morally to its inhabitants.

Manufactures and commerce, from their nature, render it necessary for those engaged in them, to be much indoors and to be crowded into villages or towns, which are not only destructive to the



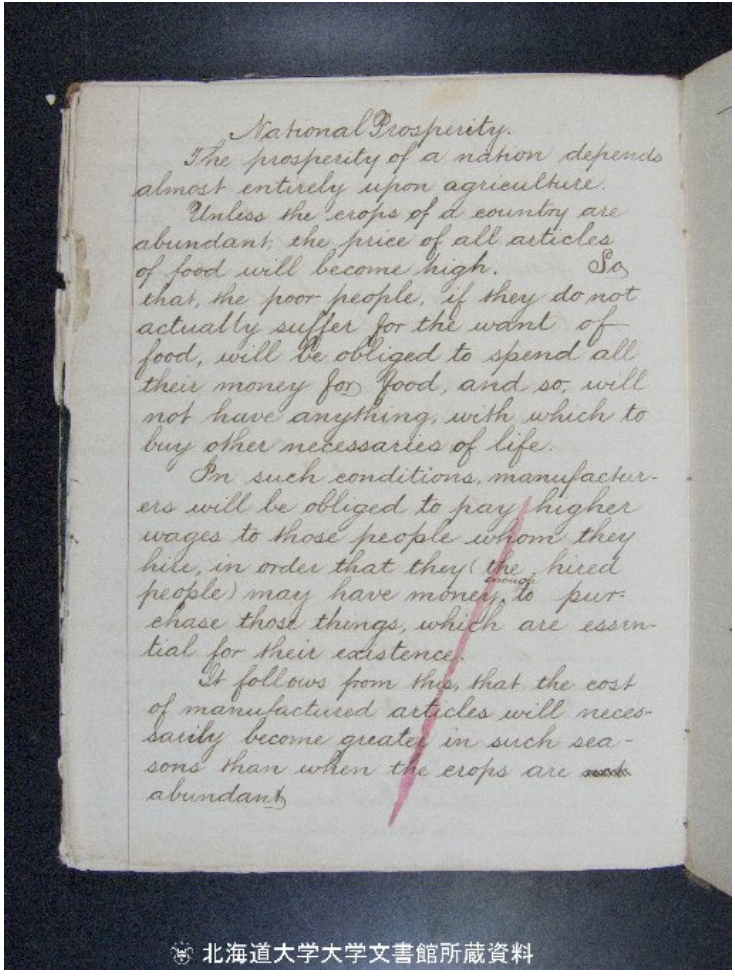
health of body, but make the spread of vice much more easy, and thus lower the moral tone of people.

But there is a stream of healthy, moral, and physical life, flowing from the farm to the centers of manufactures and trade, while those, worn out and sickened by the unhealthy life which they have lived in towns generally retire to a country, and there they strengthen themselves.

Country life produces men of sterling character, who are after all, the surest basis of national prosperity.

Many of the greatest names in the history of America, are those of men, born and reared on farms. Washington, Webster, and Lincoln were all farmers.

——— The Influence of ———
Agriculture on


National Prosperity.
The prosperity of a nation depends almost entirely upon agriculture.
Unless the crops of a country are abundant, the price of all articles of food will become high. So that, the poor people, if they do not actually suffer for the want of food, will be obliged to spend all their money for food, and so, will not have anything, with which to buy other necessaries of life.
In such conditions, manufacturers will be obliged to pay higher wages to those people whom they hire, in order that they (the hired people) may have money enough to purchase those things, which are essential for their existence.
It follows from this, that the cost of manufactured articles will necessarily become greater in such seasons than when the crops are abundant.

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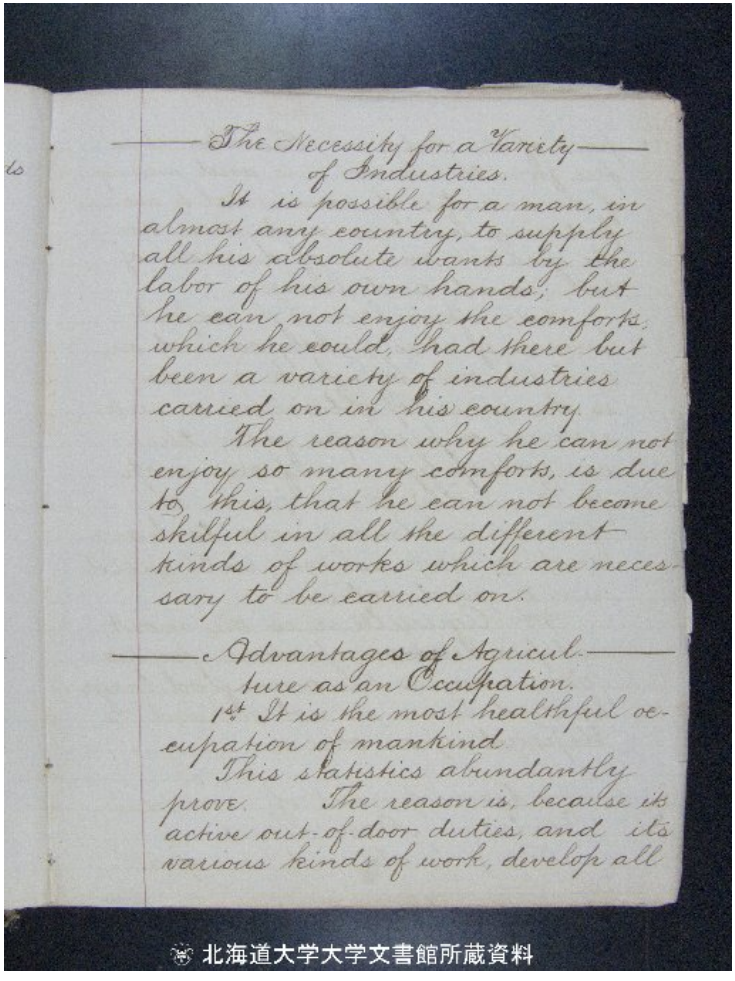


The Necessity for a Variety of Industries

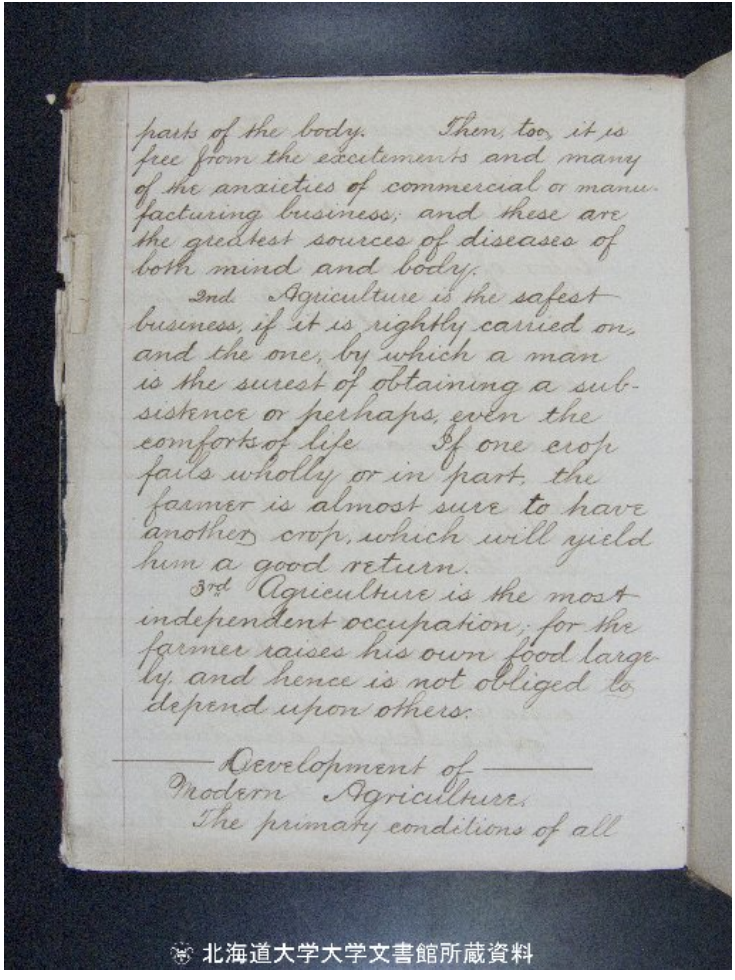
It is possible for a man, in almost any country, to supply all his absolute wants by the labor of his own hands, but he can not enjoy the comforts, which he could, had there but been a variety of industries carried on in his country.

The reason why he can not enjoy so many comforts, is due to this, that he can not become skilful in all the different kinds of works which are necessary to be carried on.

Advantages of Agriculture as an Occupation

1st It is the most healthful occupation of mankind.

This statistics abundantly prove. The reason is, because its active out-of-door duties, and its various kinds of work, develop all



parts of the body. Then, too, it is free from the excitements and many of the anxieties of commercial or manufacturing business, and these are the greatest sources of diseases of both mind and body.

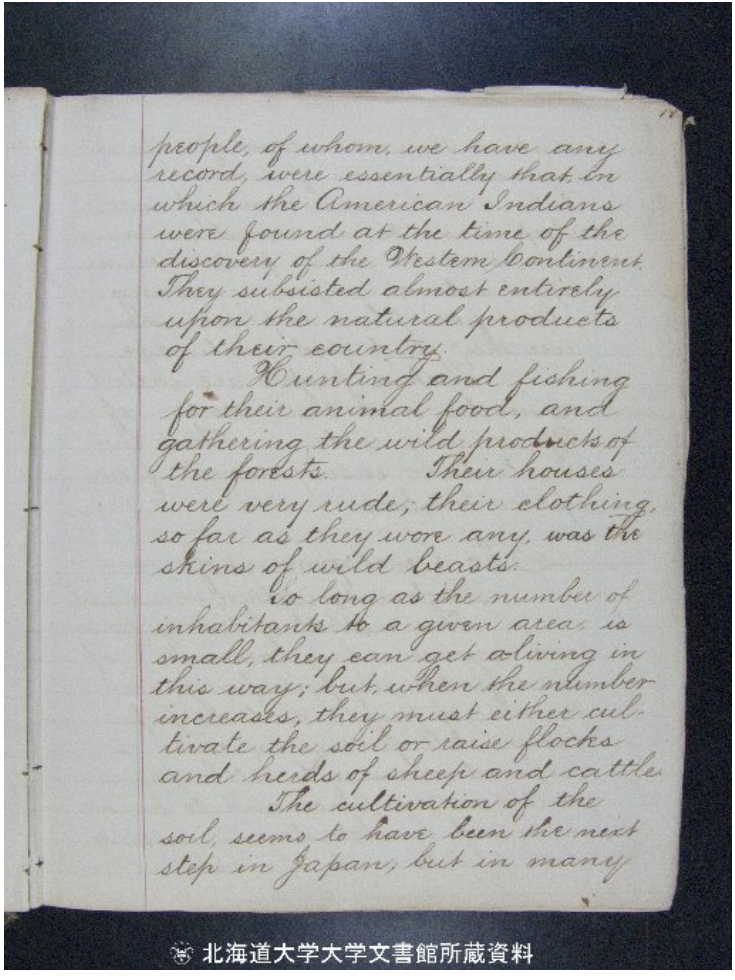
2nd Agriculture is the safest business, if it is rightly carried on, and the one, by which a man is the surest of obtaining a subsistence or perhaps, even the comforts of life. If one crop fails wholly or in part, the farmer is almost sure to have another crop, which will yield him a good return.

3rd Agriculture is the most independent occupation, for the farmer raises his own food largely, and hence is not obliged to depend upon others.

——— Development of ———

Modern Agriculture

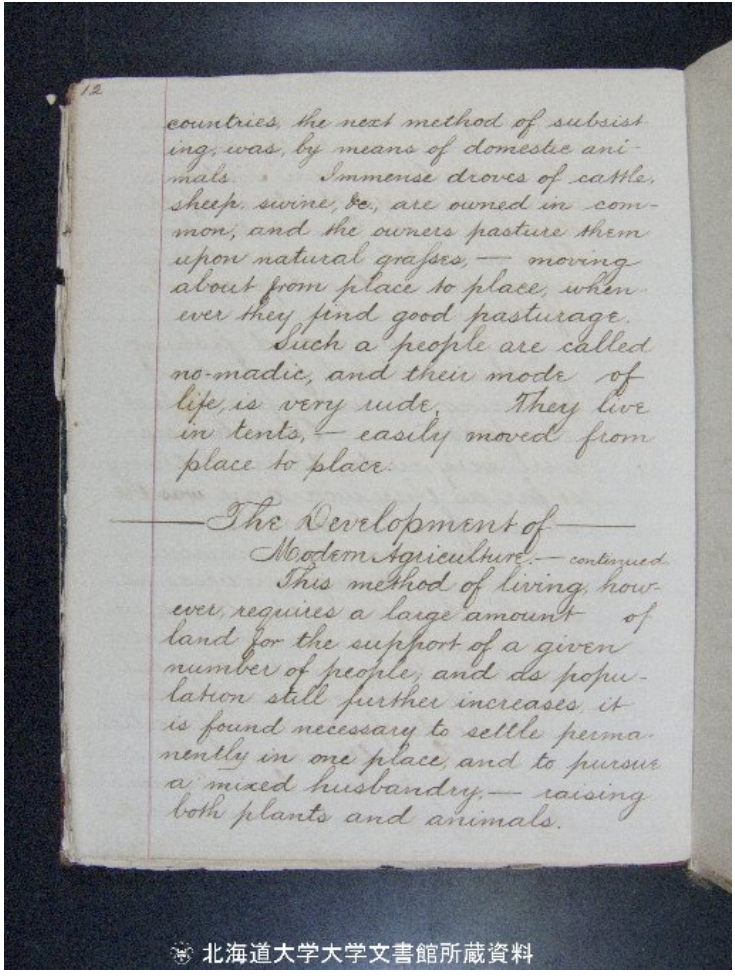
The primary conditions of all


people, of whom, we have any record, were essentially that, in which the American Indians were found at the time of the discovery of the Western Continent. They subsisted almost entirely upon the natural products of their country.

Hunting and fishing for their animal food, and gathering the wild products of the forests. Their houses were very rude; their clothing, so far as they wore any, was the skins of wild beasts.

So long as the number of inhabitants to a given area, is small, they can get a-living in this way; but, when the number increases, they must either cultivate the soil or raise flocks and herds of sheep and cattle.

The cultivation of the soil, seems to have been the next step in Japan, but in many



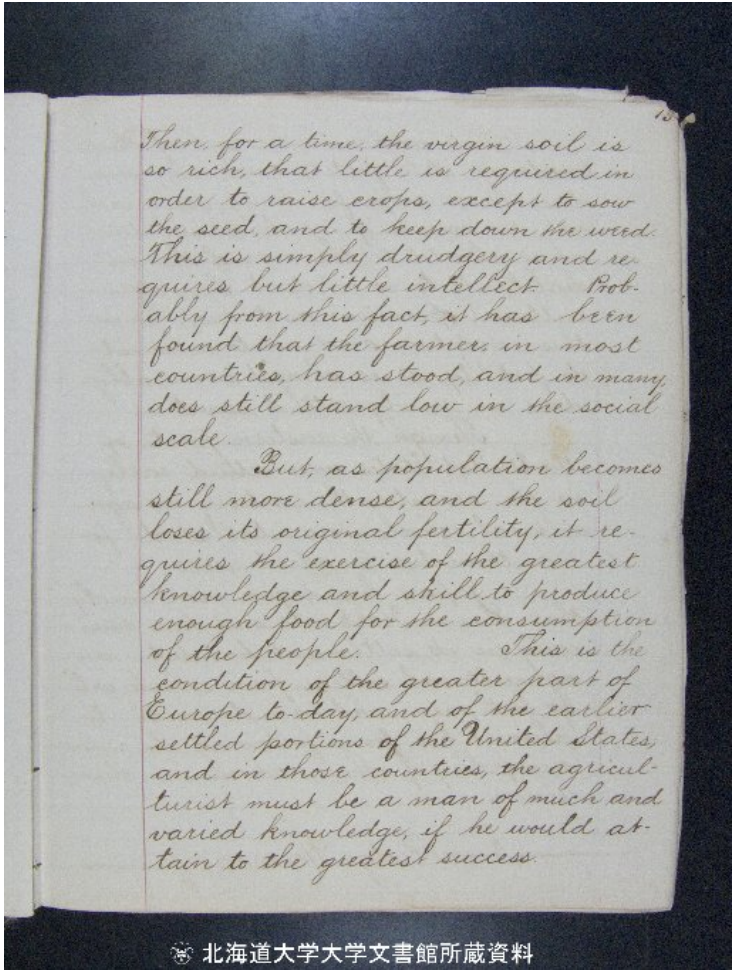
countries, the next method of subsisting, was, by means of domestic animals. Immense droves of cattle, sheep, swine, &c., are owned in common, and the owners pasture them upon natural grasses, —— moving about from place to place, whenever they find good pasturage.

Such a people are called no-madic, and their mode of life, is very rude. They live in tents, —— easily moved from place to place.

———— The Development of ————

Modern Agriculture. —— continued.

This method of living, however, requires a large amount of land for the support of a given number of people, and as population still further increases, it is found necessary to settle permanently in one place, and to pursue a mixed husbandry, —— raising both plants and animals.


Then, for a time, the virgin soil is so rich, that little is required in order to raise crops, except to sow the seed, and to keep down the weed. This is simply drudgery and requires but little intellect. Probably from this fact, it has been found that the farmer, in most countries, has stood, and in many, does still stand low in the social scale.

But, as population becomes still more dense, and the soil loses its original fertility, it requires the exercise of the greatest knowledge and skill to produce enough food for the consumption of the people. This is the condition of the greater part of Europe to-day, and of the earlier settled portions of the United States, and in those countries, the agriculturist must be a man of much and varied knowledge, if he would attain to the greatest success.

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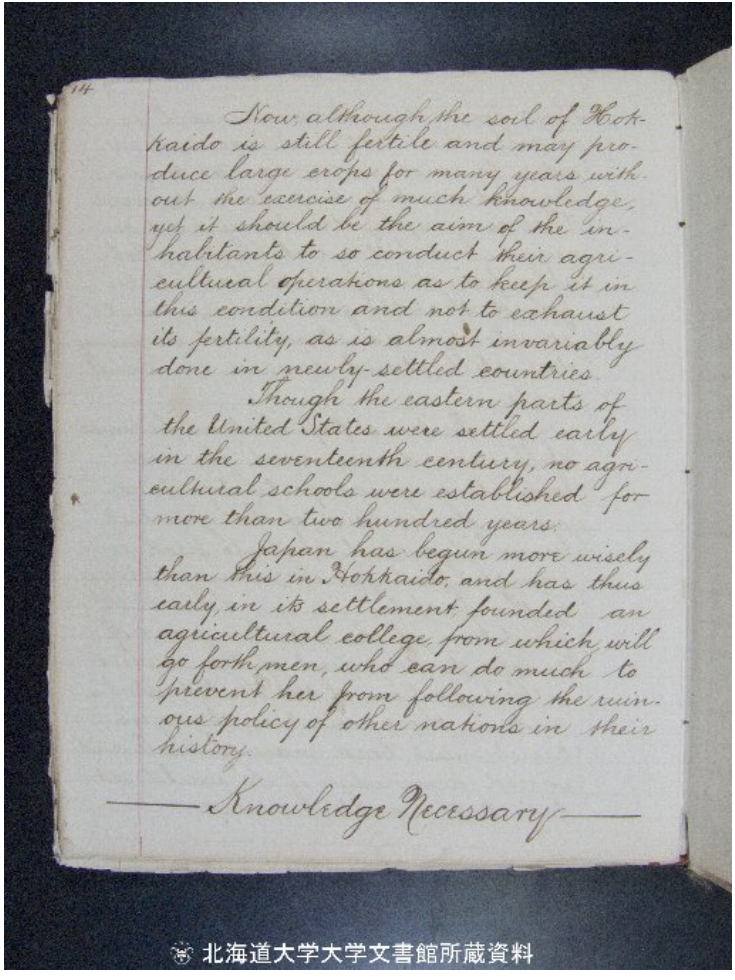
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Now although the soil of Hokkaido is still fertile and may produce large crops for many years without the exercise of much knowledge, yet it should be the aim of the inhabitants to so conduct their agricultural operations as to keep it in this condition and not to exhaust its fertility, as is almost invariably done in newly-settled countries.

Though the eastern parts of the United States were settled early in the seventeenth century, no agricultural schools were established for more than two hundred years.

Japan has begun more wisely than this in Hokkaido, and has thus early, in its settlement founded an agricultural college, from which will go forth men, who can do much to prevent her from following the ruinous policy of other nations in their history.

——— Knowledge Necessary ———

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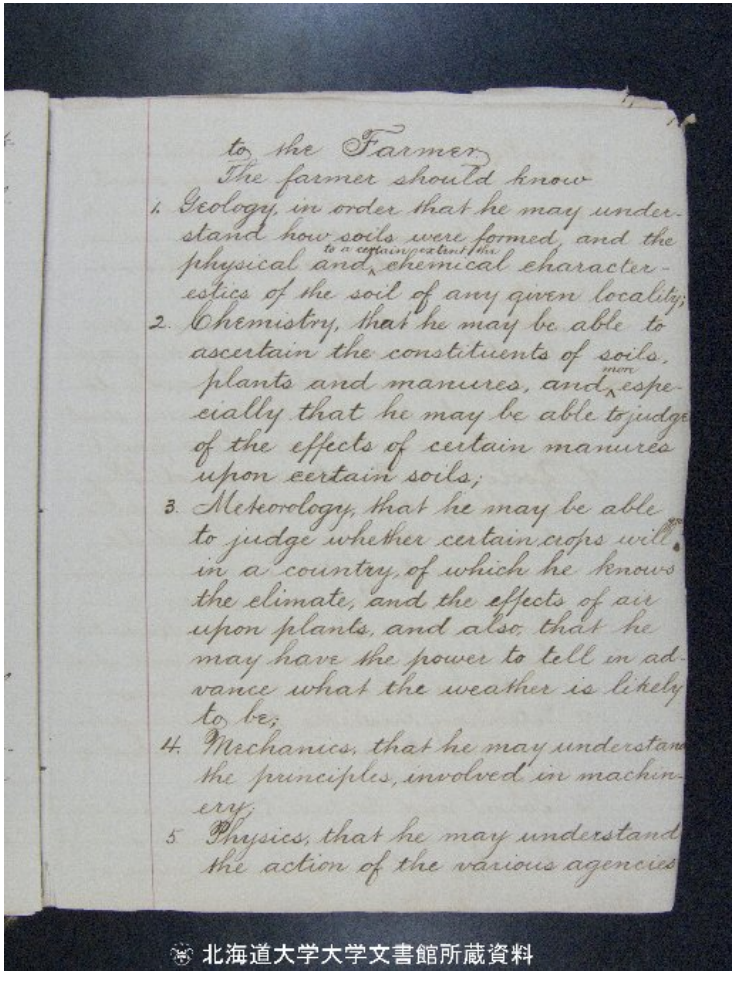


to the Farmer

The farmer should know

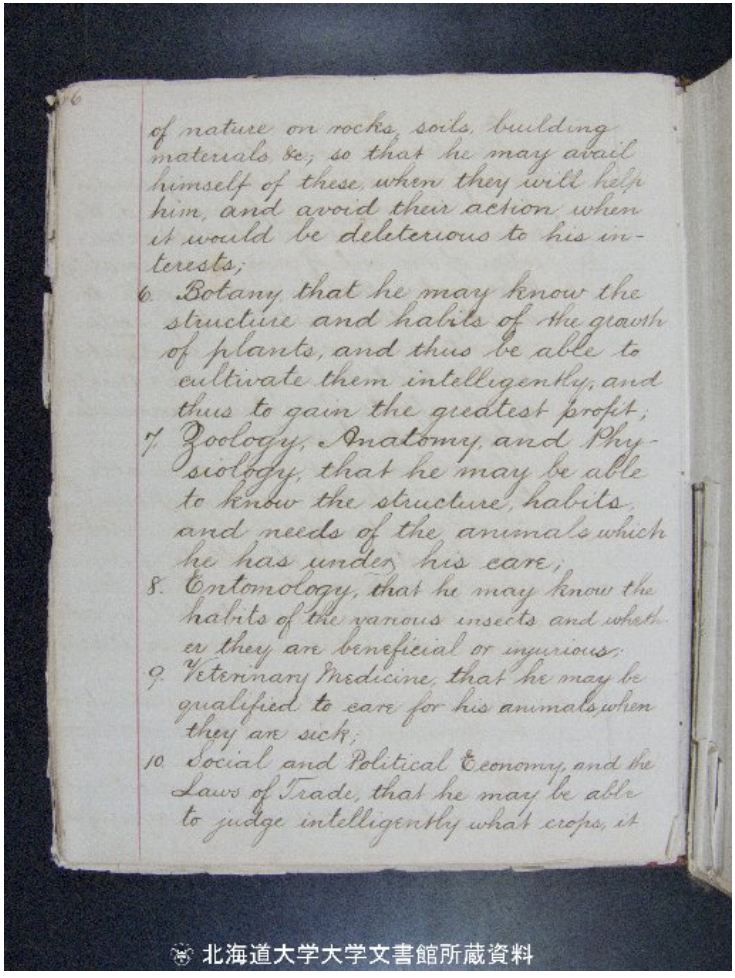
1. Geology, in order that he may understand how soils were formed, and the physical and to a certain extent the chemical characterestics of the soil of any given locality;

2. Chemistry, that he may be able to ascertain the constituents of soils, plants and manures, and more especially that he may be able to judge of the effects of certain manures upon certain soils;

3. Meteorology, that he may be able to judge whether certain crops will grow in a country, of which he knows the climate, and the effects of air upon plants, and also, that he may have the power to tell in advance what the weather is likely to be;

4. Mechanics, that he may understand the principles, involved in machinery;

5. Physics, that he may understand the action of the various agencies



of nature on rocks, soils, building materials, &c; so that he may avail himself of these, when they will help him, and avoid their action when it would be deleterious to his interests;

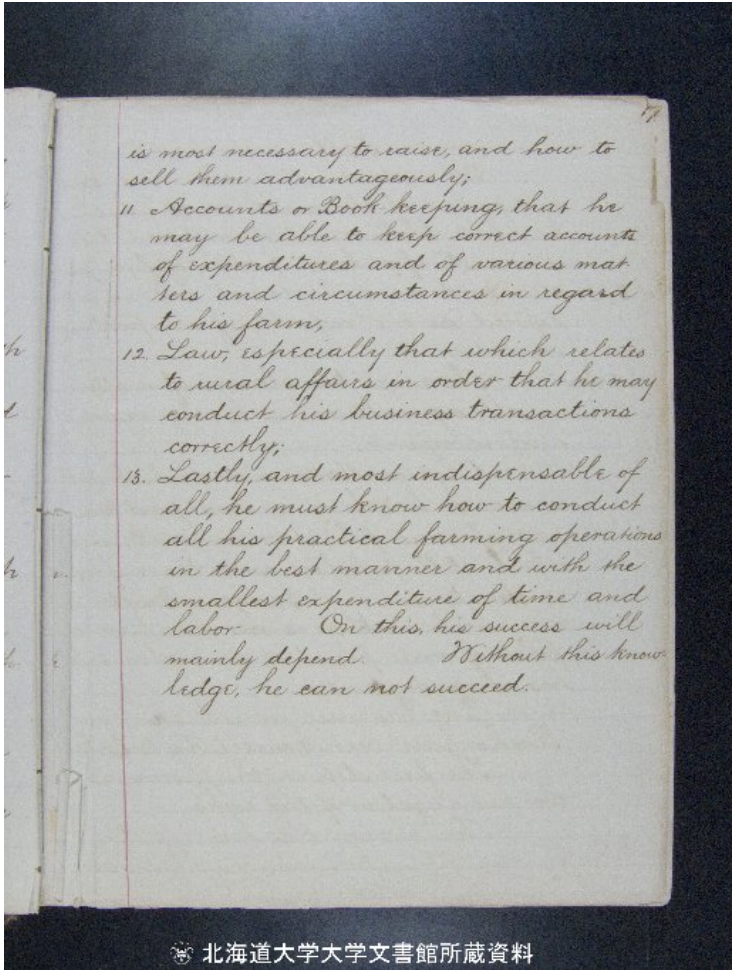
6. Botany, that he may know the structure and habits of the growth of plants, and thus be able to cultivate them intelligently, and thus to gain the greatest profit;

7. Zoology, Anatomy, and Physiology, that he may be able to know the structure, habits and needs of the animals which he has under his care;

8. Entomology, that he may know the habits of the various insects and whether they are beneficial or injurious;

9. Veterinary Medicine, that he may be qualified to care for his animals when they are sick;

10. Social and political Economy, and the Laws of Trade, that he may be able to judge intelligently what crops, it

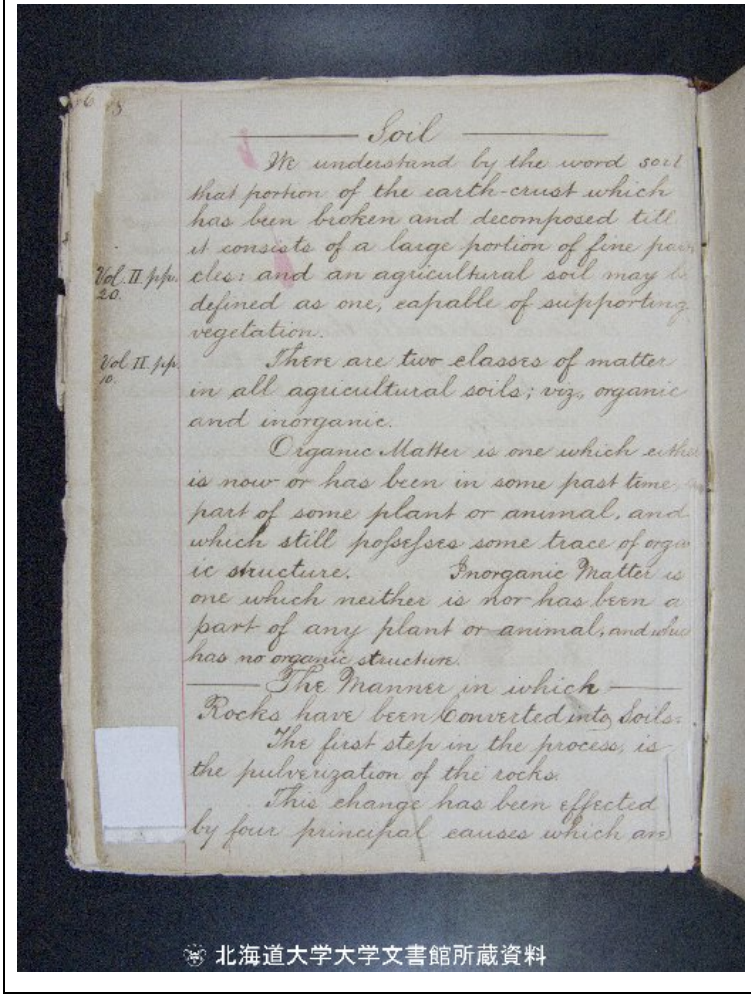


is most necessary to raise, and how to sell them advantageously;

11. Accounts or Book-keeping, that he may be able to keep correct accounts of expenditures and of various matters and circumstances in regard to his farm;

12. Law, especially that which relates to rural affairs in order that he may conduct his business transactions correctly;

13. Lastly, and most indispensable of all, he must know to conduct all his practical farming operations in the best manner and with the smallest expenditure of time and labor. On this, his success will mainly depend. Without this knowledge, he can not succeed.



Soil

We understand by the word soil that portion of the earth-crust which has been broken and decomposed till it consists of a large portion of fine particles; and an agricultural soil may be defined as one, capable of supporting vegetation.

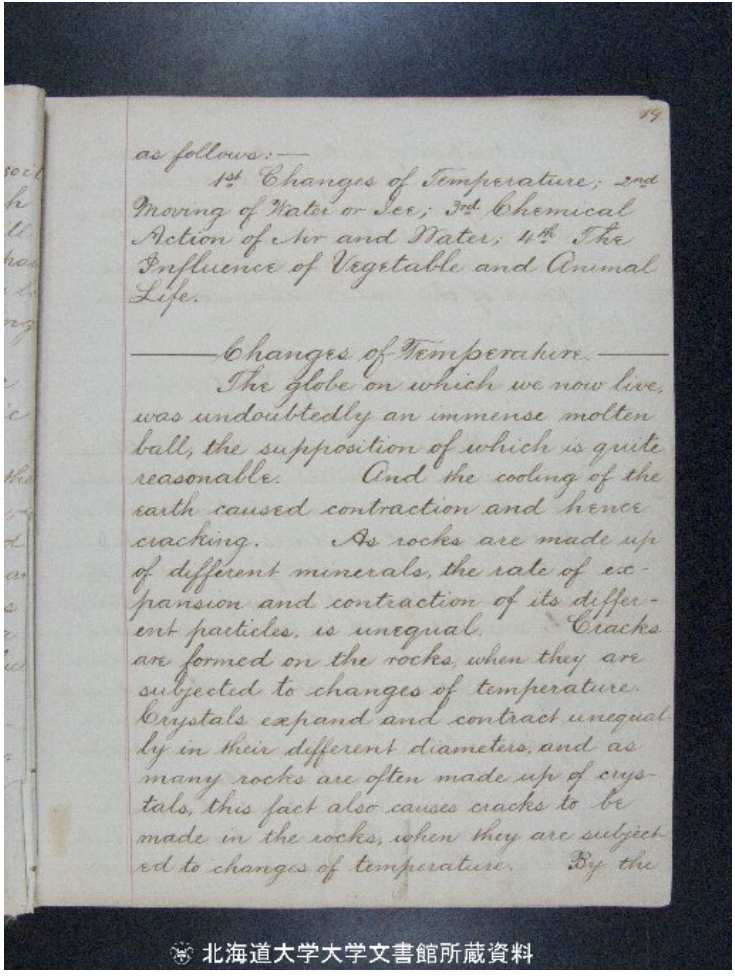
There are two classes of matter in all agricultural soils; viz., organic and inorganic.

Organic Matter is one which either is now or has been in some past time, a part of some plant or animal, and which still possesses some trace of organic structure. Inorganic Matter is one which neither is nor has been a part of any plant or animal, and which has no organic structure.

The Manner in which Rocks have been Converted into Soils.

The first step in the process, is the pulverization of the rocks.

This change has been effected by four principal causes which are

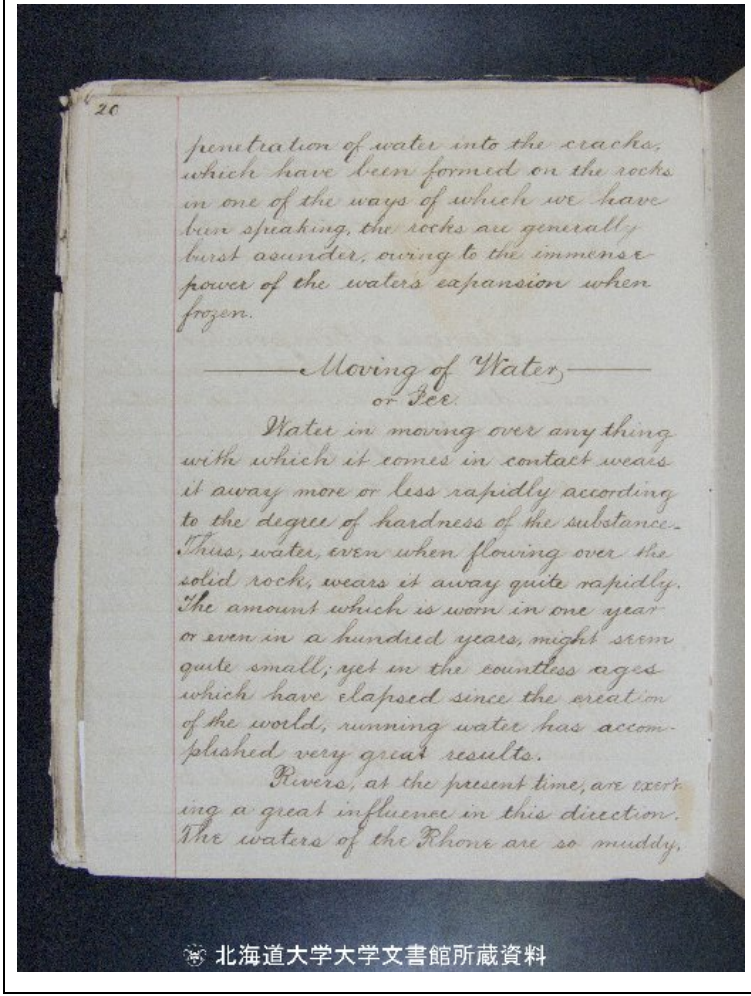


as follows: —

1st Changes of Temperature; 2nd Moving of Water or Ice; 3rd Chemical Action of Air and Water; 4th The Influence of Vegetable and Animal Life.

————Changes of Temperature ————

The globe on which we now live, was undoubtedly an immense molten ball, the supposition of which is quite reasonable. And the cooling of the earth caused contraction and hence cracking. As rocks are made up of different minerals, the rate of expansion and contraction of its different particles, is unequal. Cracks are formed on the rocks, when they are subjected to changes of temperature. Crystals expand and contract unequally in their different diameters, and as many rocks are often made up of crystals, this fact also causes cracks to be made in the rocks, when they are subjected to changes of temperature. By the

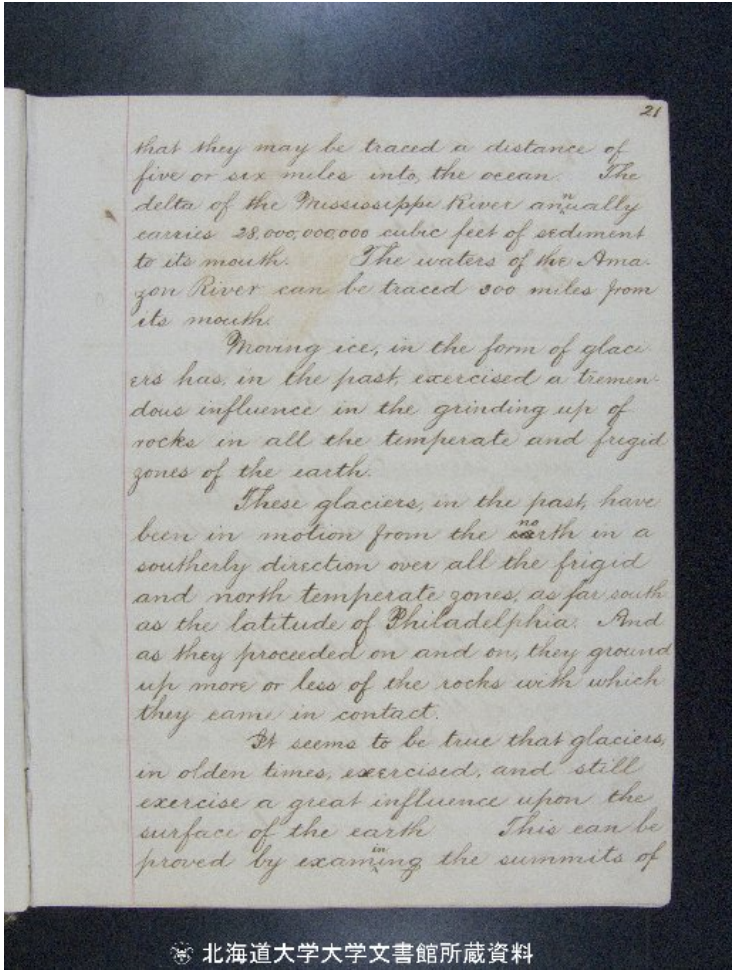


penetration of water into the cracks, which have been formed on the rocks in one of the ways of which we have been speaking, the rocks are generally burst asunder, owing to the immense power of the water's expansion when frozen.

——— Moving of Water ———
or Ice

Water in moving over any thing with which it comes in contact wears it away more or less rapidly according the degree of hardness of the substance. Thus, water, even when flowing over the solid rock, wears it away quite rapidly. The amount which is worn in one year or even in a hundred years, might seem quite small, yet in the countless ages which have elapsed since the creation of the world, running water has accomplished very great results.

Rivers, at the present time, are exerting a great influence in this direction. The waters of the Rhone are so muddy,

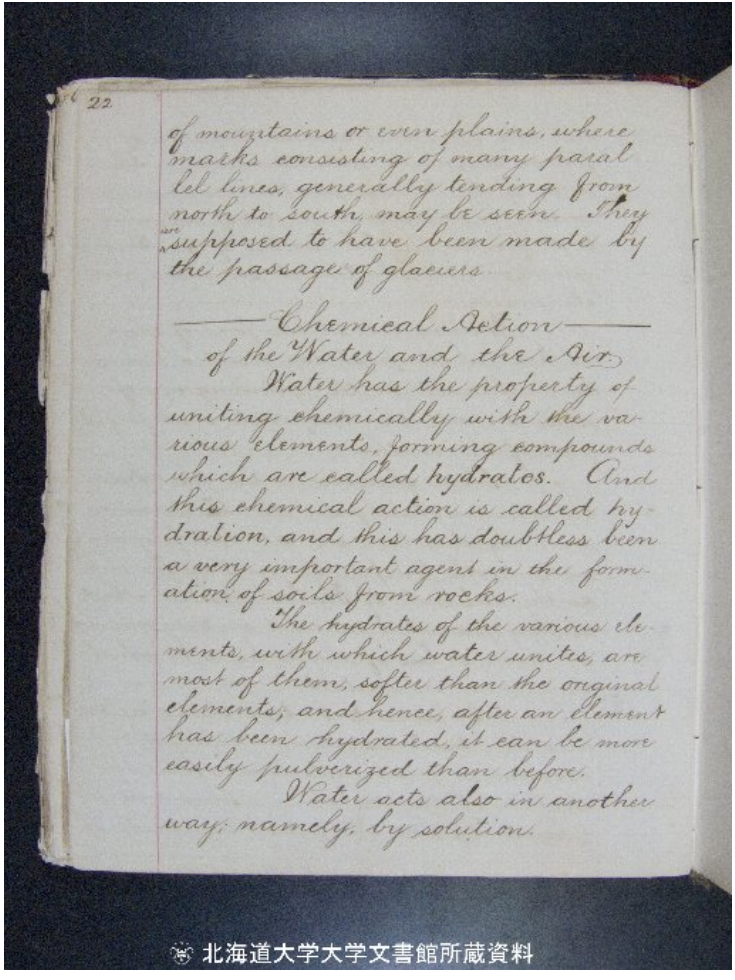


that they may be traced a distance of five or six miles into the ocean. The delta of the Mississippi River annually carries 28,000,000,000 cubic feet of sediment to its mouth. The waters of the Amazon River can be traced 300 miles from its mouth.

Moving ice, in the form of glaciers has, in the past, exercised a tremendous influence in the grinding up of rocks in all the temperate and frigid zones of the earth.

These glaciers, in the past, have been in motion from the north in a southerly direction over all the frigid and north temperate zones, as far south as the latitude of Philadelphia. And as they proceeded on and on, they ground up more or less of the rocks with which they came in contact.

It seems to be true that glaciers, in olden times, exercised, and still exercise a great influence upon the surface of the earth. This can be proved by examining the summits of



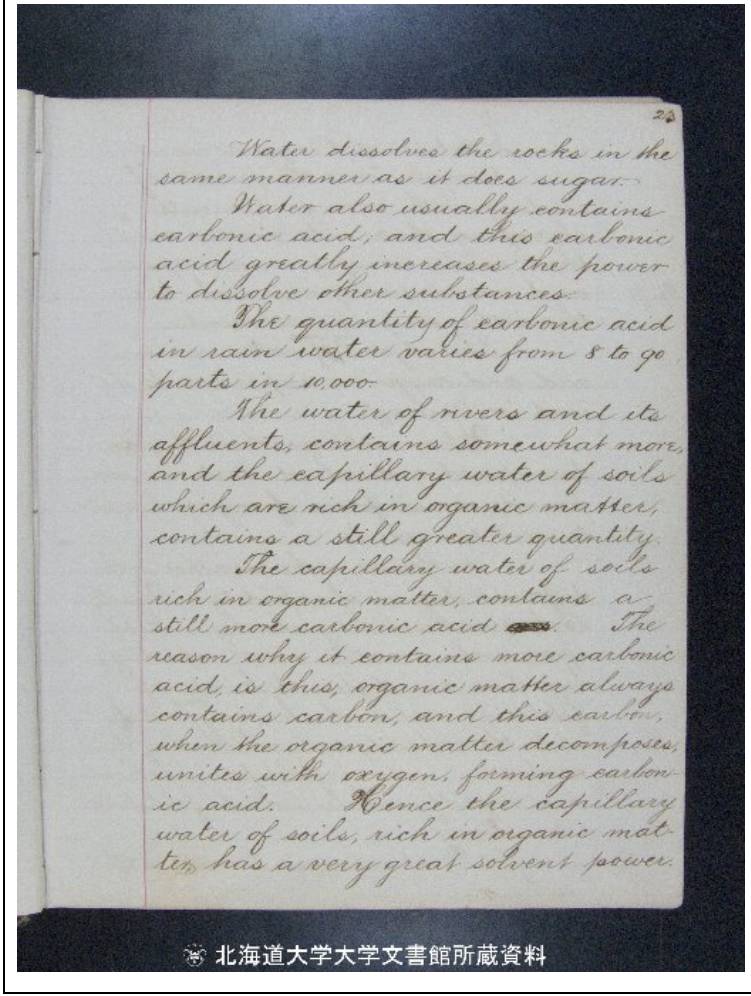
mountains or even plains, where marks consisting of many parallel lines, generally tending from north to south, may be seen. They are supposed to have been made by the passage of glaciers.

———— Chemical Action ————
of the Water and the Air

Water has the property of uniting chemically with the various elements, forming compounds which are called hydrates. And this chemical action is called hydration, and this has doubtless been a very important agent the formation of soils from rocks.

The hydrates of the various elements, with which water unites, are most of them, softer than the original elements, and hence, after an element has been hydrated, it can be more easily pulverized than before.

Water acts also in another way; namely, by solution.



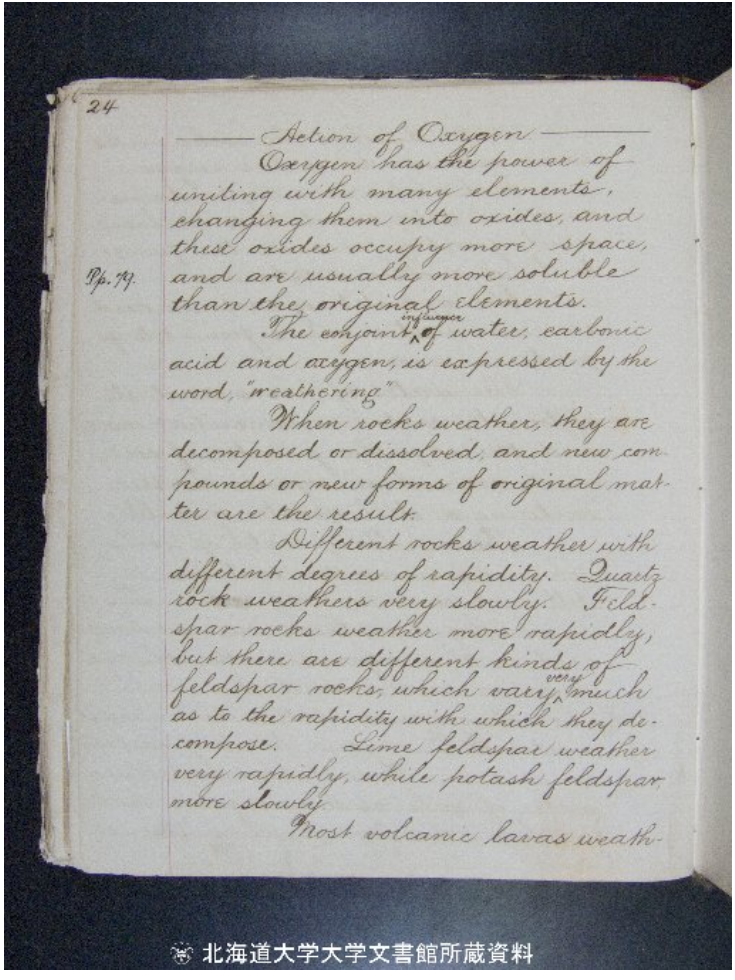
Water dissolves the rocks in the same manner as it does sugar.

Water also usually contains carbonic acid, and this carbonic acid greatly increases the power to dissolve other substances.

The quantity of carbonic acid in rain water varies from 8 to 90 parts in 10,000.

The water of rivers and its affluents, contains somewhat more, and the capillary water of soils which are rich in organic matter, contains a still greater quantity.

The capillary water of soils rich in organic matter, contains a still more carbonic acid. The reason why it contains more carbonic acid, is this, organic matter always contains carbon, and this carbon, when the organic matter decomposes, unites with oxygen, forming carbonic acid. Hence the capillary water of soils, rich in organic matter, has a very great solvent power.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——— Action of Oxygen ———

Oxygen has the power of uniting with many elements, changing them into oxides, and these oxides occupy more space, and are usually more soluble than the original elements.

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The conjoint influence of water, carbonic acid and oxygen, is expressed by the word, "weathering".

When rocks weather, they are decomposed or dissolved, and new compounds or new forms of original matter are the result.

Different rocks weather with different degrees of rapidity. Quartz rock weathers very slowly. Feldspar rocks weather more rapidly, but there are different kinds of feldspar rocks, which vary very much as to the rapidity with which they decompose. Lime feldspar weather very rapidly, while potash feldspar more slowly.

Most volcanic lavas weath-

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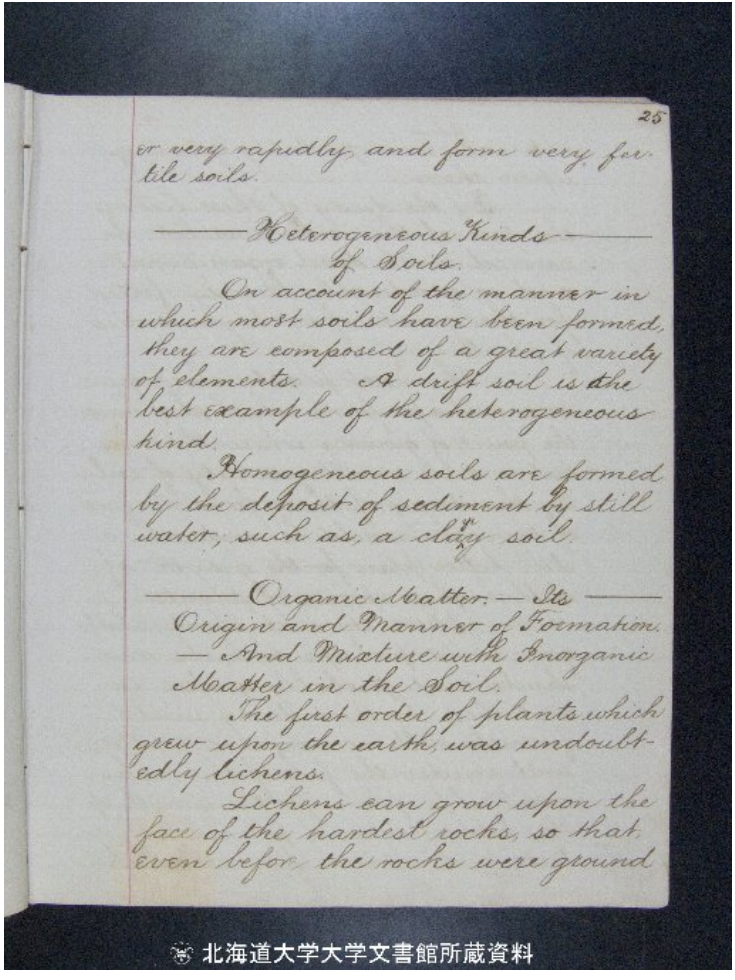


or very rapidly, and form very fertile soils.

——— Heterogeneous Kinds ———
of Soils.

On account of the manner in which most soils have been formed, they are composed of a great variety of elements. A drift soil is the best example of the heterogeneous kind.

Homogeneous soils are formed by the deposit of sediment by still water, such as, a clayey soil.

——— Organic Matter — Its ———
Origin and Manner of Formation.
— And Mixture with Inorganic
Matter in the Soil.

The first order of plants which grew upon the earth, was undoubtedly lichens.

Lichens can grow upon the face of the hardest rocks, so that even befor the rocks were ground

very rapidly, and form very fertile soils.

——— Heterogeneous Kinds ———
of Soils

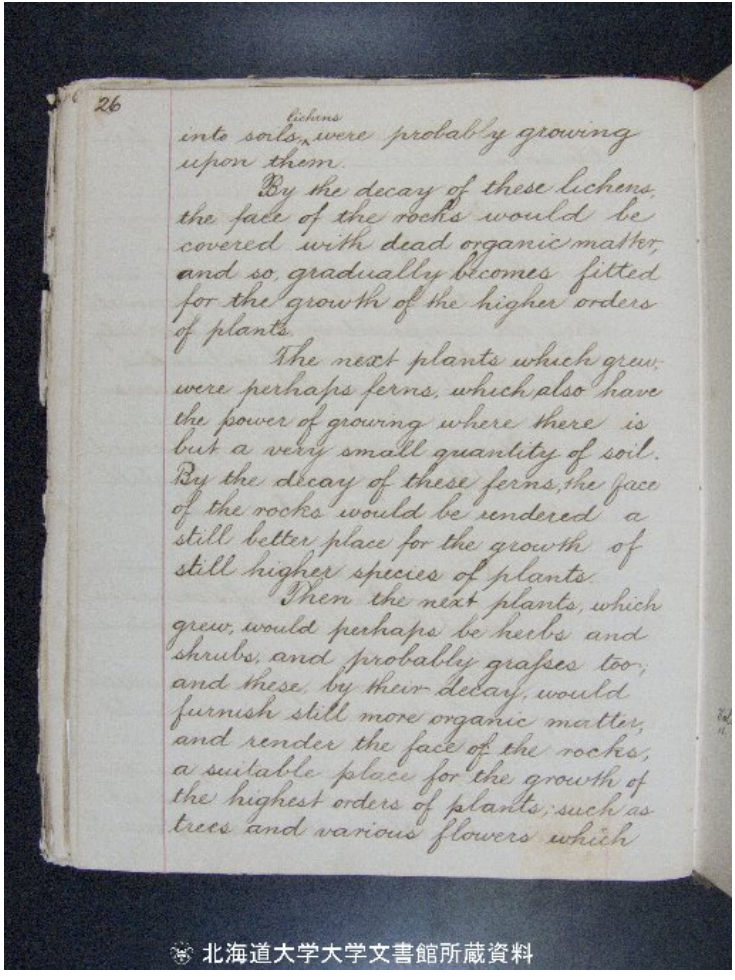
On account of the manner in which most soils have been formed, they are composed of a great variety of elements. A drift soil is the best example of the heterogeneous kind.

Homogeneous soils are formed by the deposit of sediment by still water, such as, a clayey soil.

——— Organic Matter — Its ———
Origin and Manner of Formation
— And Mixture with Inorganic
Matter in the Soil.

The first order of plants which grew upon the earth, was undoubtedly lichens.

Lichens can grow upon the face of the hardest rocks, so that even before the rocks were ground

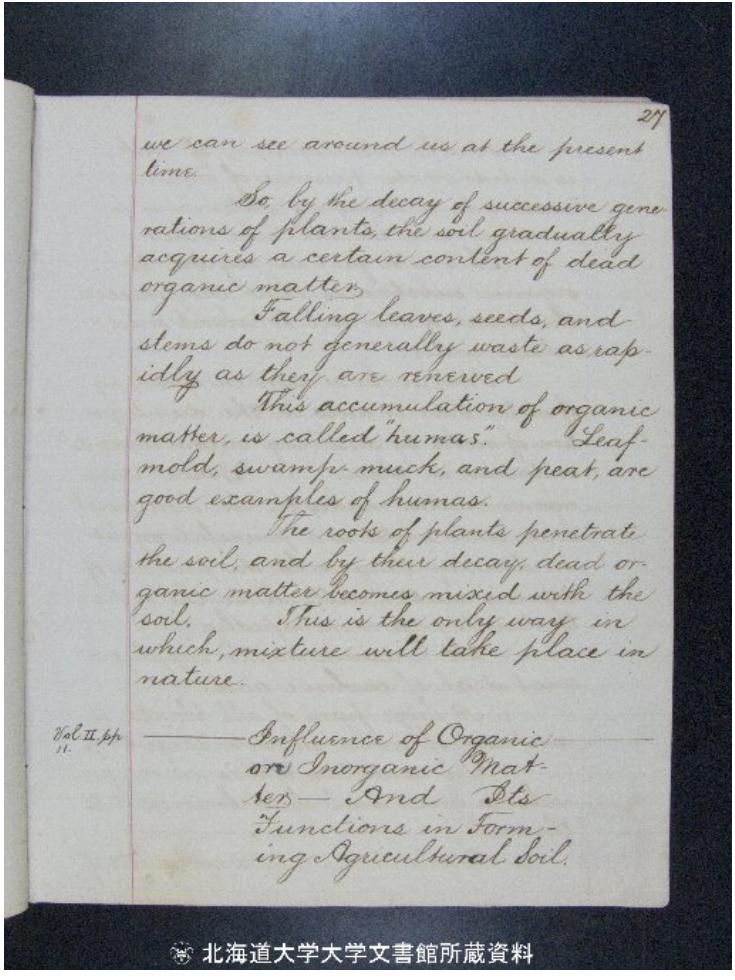


into soils lichens were probably growing upon them.

By the decay of these lichens, the face of the rocks would be covered with dead organic matter, and so, gradually becomes fitted for the growth of the higher orders of plants.

The next plants which grew, were perhaps ferns, which also have the power of growing where there is but a very small quantity of soil. By the decay of these ferns, the face of the rocks would be rendered a still better place for the growth of still higher species of plants.

Then the next plants, which grew, would perhaps be herbs and shrubs, and probably grasses too, and these, by their decay, would furnish still more organic matter, and render the face of the rocks, a suitable place for the growth of the highest orders of plants; such as trees and various flowers which



we can see around us at the present time.

So, by the decay of successive generations of plants, the soil gradually acquires a certain content of dead organic matter.

Falling leaves, seeds, and stems do not generally waste as rapidly as they are renewed.

The accumulation of organic matter, is called “humas”. Leaf-mold, swamp-muck, and peat, are good examples of humas.

The roots of plants penetrate the soil, and by their decay, dead organic matter becomes mixed with the soil. This is the only way in which, mixture will take place in nature.

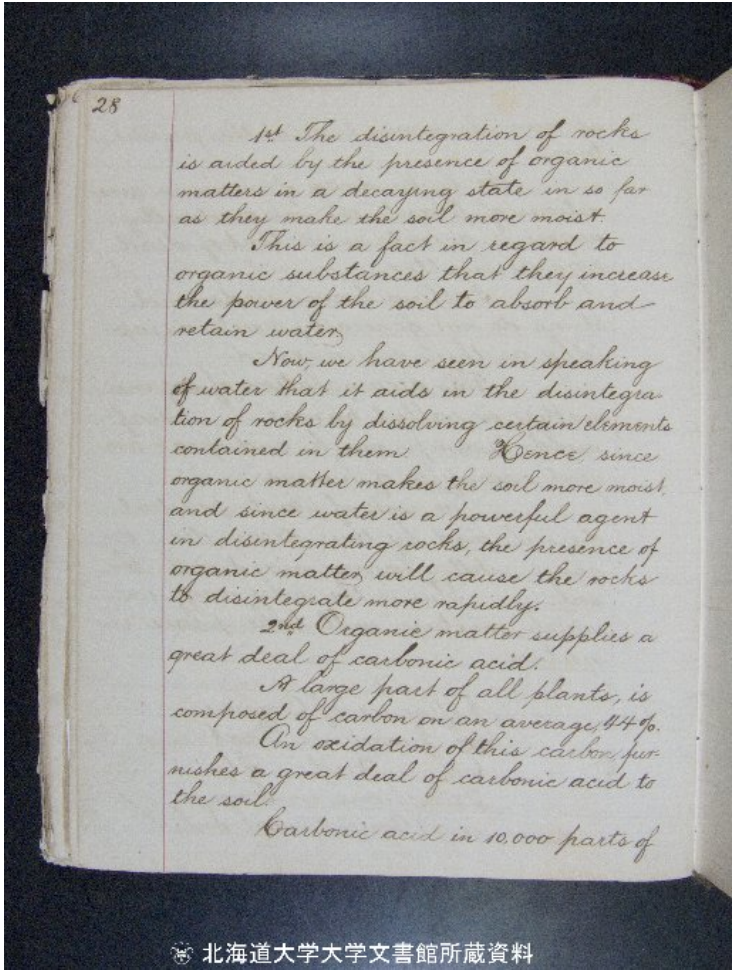
——— Influence of Organic ———

on Inorganic Mater

—— And Its

Functions in Forming

Agricultural Soil



1st The disintegration of rocks is aided by the presence of organic matters in a decaying state in so far as they make the soil more moist.

This is a fact in regard to organic substances that they increase the power of the soil to absorb and retain water.

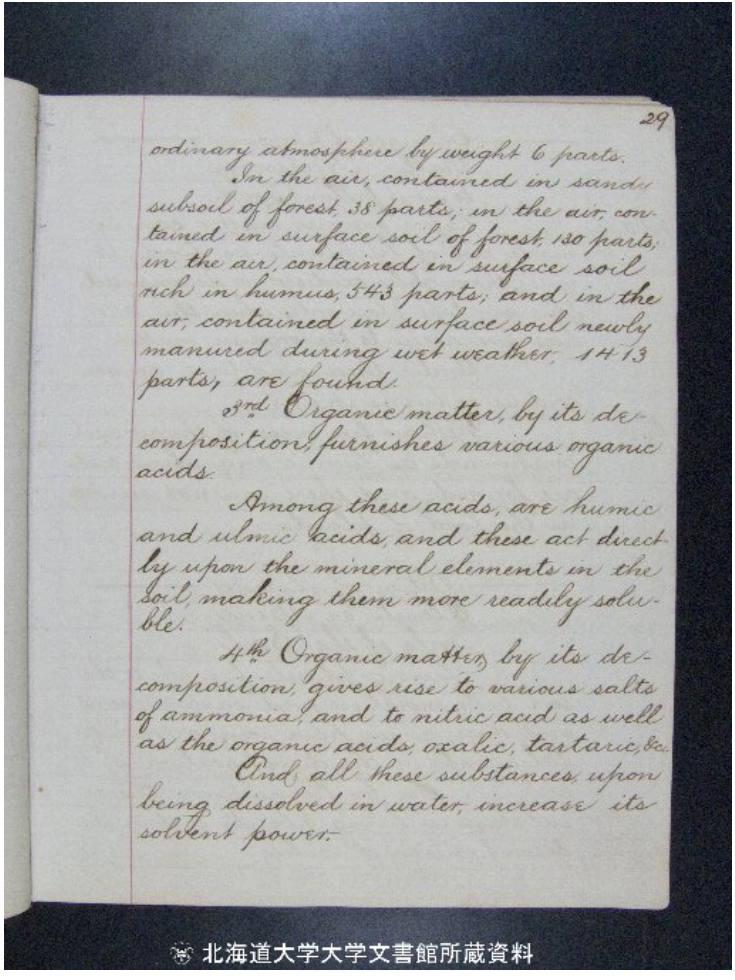
Now, we have seen in speaking of water that it aids in the disintegration of rocks by dissolving certain elements contained in them. Hence, since organic matter makes the soil more moist, and since water is a powerful agent in disintegrating rocks, the presence of organic matter will cause the rocks to disintegrate more rapidly.

2nd Organic matter supplies a great deal of carbonic acid.

A large part of all plants, is composed of carbon on an average, 44%.

An oxidation of this carbon furnishes a great deal of carbonic acid to the soil.

Carbonic acid in 10,000 parts of



ordinary atmosphere by weight 6 parts.

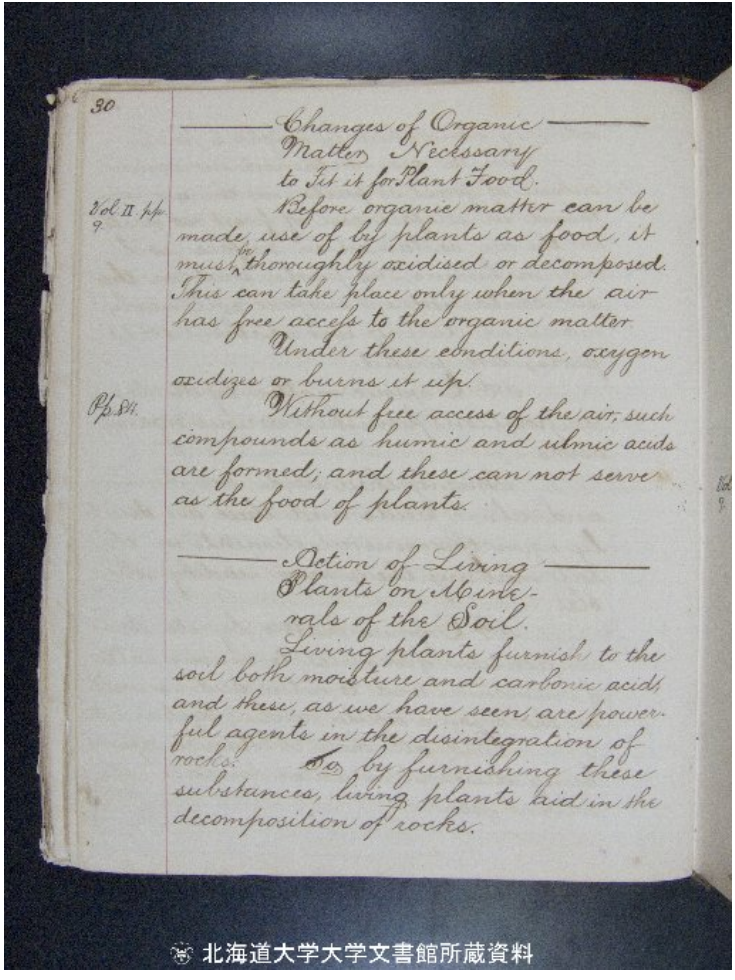
In the air, contained in sandy subsoil of forest, 38 parts; in the air, contained in surface soil of forest, 130 parts; in the air, contained in surface soil rich in humus, 543 parts; and in the air, contained in surface soil newly manured during wet weather, 1413 parts, are found.

3rd Organic matter, by its decomposition, furnishes various organic acids.

Among these acids, are humic and ulmic acids, and these act directly upon the mineral elements in the soil, making them more readily soluble.

4th Organic matter, by its decomposition, gives rise to various salts of ammonia, and to nitric acid as well as the organic acids, oxalic, tartaric, &c.

And all these substances, upon being dissolved in water, increase its solvent power.



Changes of Organic Matter Necessary to Fit it for Plant Food.

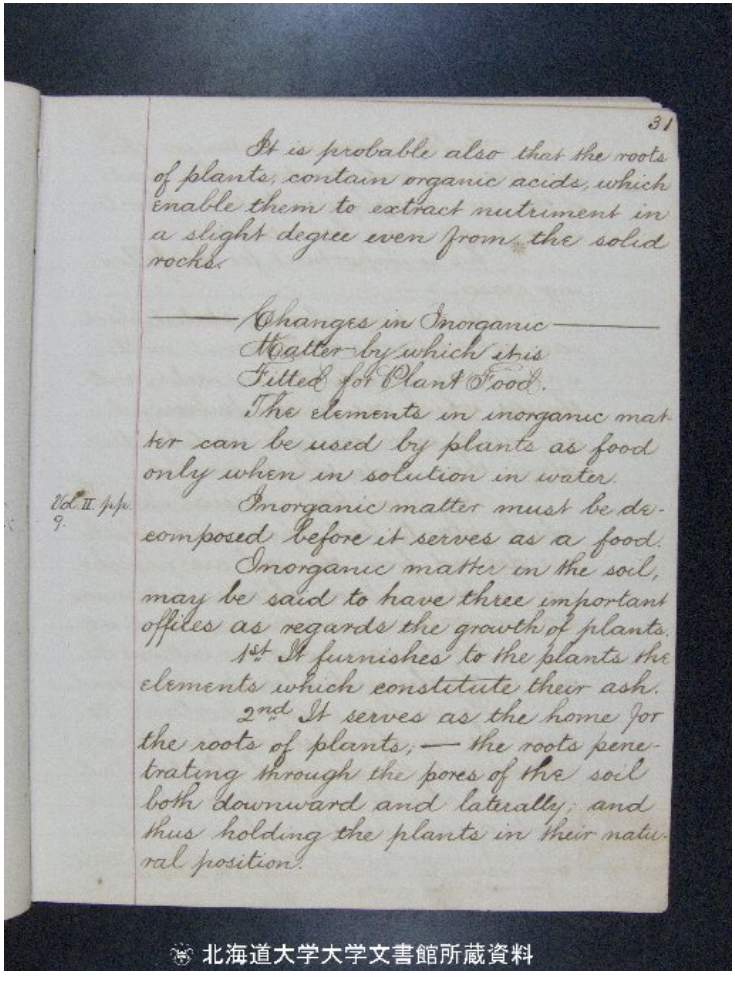
Before organic matter can be made use of by plants as food, it must be thoroughly oxidised or decomposed. This can take place only when the air has free access to the organic matter.

Under these conditions, oxygen oxidizes or burns it up.

Without free access of the air, such compounds as humic and ulmic acids are formed; and these can not serve as the food of plants.

Action of Living Plants on Minerals of the Soil

Living plants furnish to the soil both moisture and carbonic acid, and these, as we have seen, are powerful agents in the disintegration of rocks. So, by furnishing these substances, living plants aid in the decomposition of rocks.



It is probable also that the roots of plants, contain organic acids, which enable them to extract nutriment in a slight degree even from the solid rocks.

——— Changes in Inorganic ———
Matter by which it is
Fitted for Plant Food

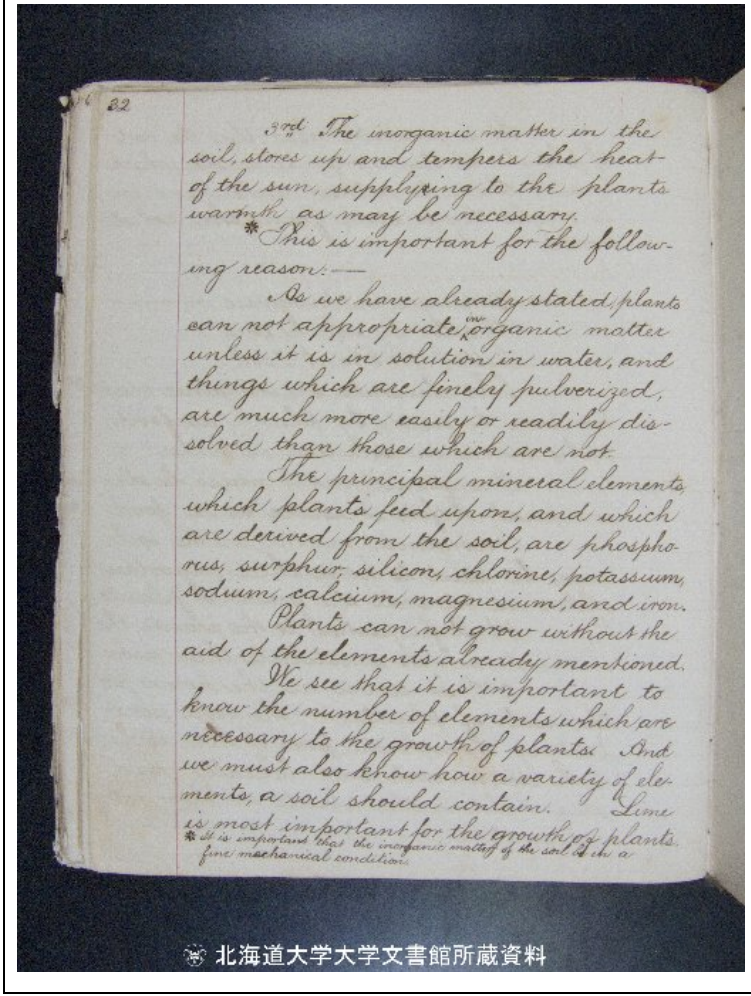
The elements in inorganic matter can be used by plants as food only when in solution in water.

Inorganic matter must be decomposed before it serves as a food.

Inorganic matter in the soil, may be said to have three important offices as regards the growth of plants.

1st It furnishes to the plants the elements which constitute their ash.

2nd It serves as the home for the roots of plants; —— the roots penetrating through the pores of the soil both downward and laterally; and thus holding the plants in their natural position.



3rd The inorganic matter in the soil, stores up and tempers the heat of the sun, supplying to the plants warmth as may be necessary.

*This is important for the following reason: ——

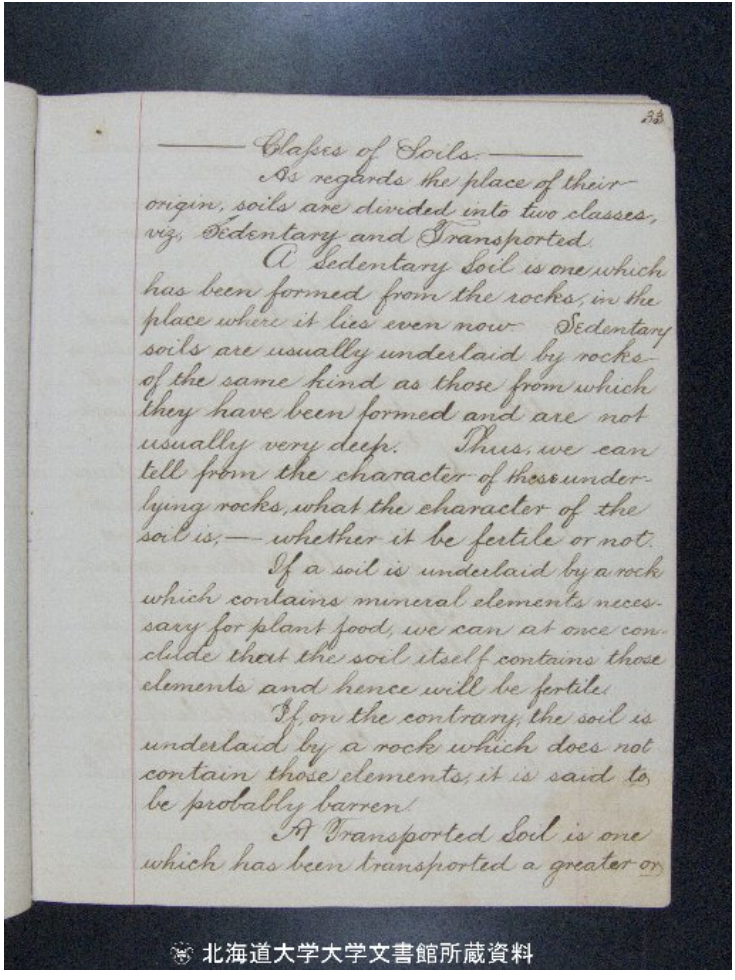
As we have already stated plants can not appropriate inorganic matter unless it is in solution in water, and things which are finely pulverized, are much more easily or readily dissolved than those which are not.

The principal mineral elements which plants feed upon, and which are derived from the soil, are phosphorus, surphur, silicon, chlorine, potassium, sodium, calcium, magnesium, and iron.

Plants can not grow without the aid of the elements already mentioned.

We see that it is important to know the number of elements which are necessary to the growth of plants. And we must also know how a variety of elements, a soil should contain. Lime is most important for the growth of plants.

*It is important that the inorganic matter of the soil be in a fine mechanical condition.



——— Classes of Soils ———

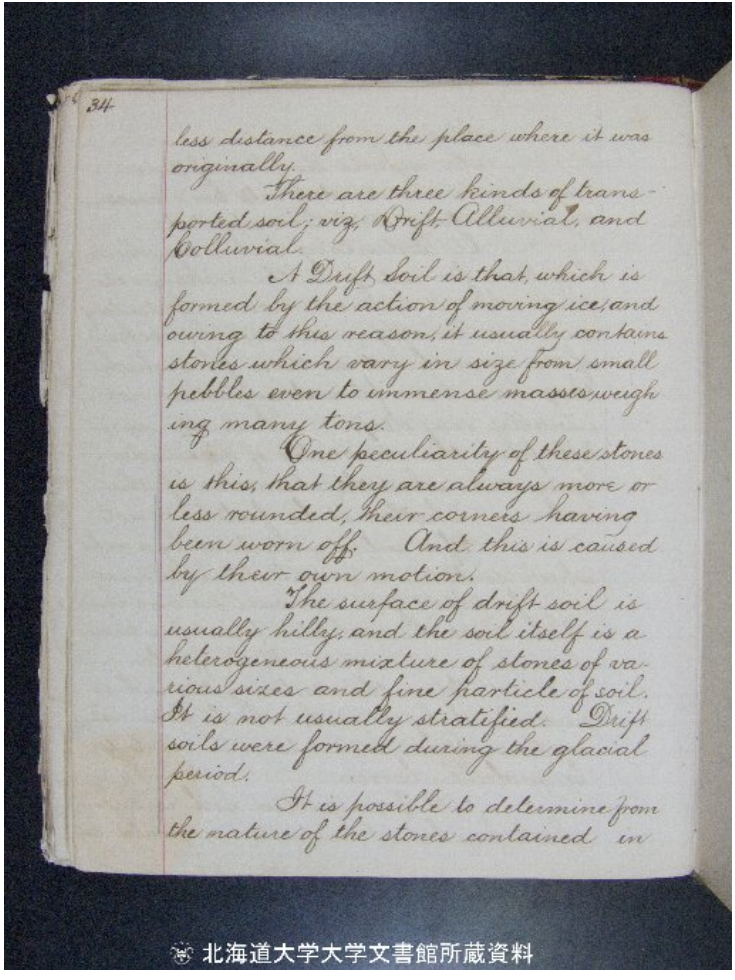
As regards the place of their origin, soils are divided into two classes, viz., Sedentary and Transported.

A Sedentary Soil is one which has been formed from the rocks, in the place where it lies even now. Sedentary soils are usually underlaid by rocks of the same kind as those from which they have been formed and are not usually very deep. Thus, we can tell from the character of those underlying rocks, what the character of the soil is, — whether it be fertile or not.

If a soil is underlaid by a rock which contains mineral elements necessary for plant food, we can at once conclude that the soil itself contains those elements and hence will be fertile.

If on the contrary, the soil is underlaid by a rock which does not contain those elements, it is said to be probably barren.

A Transported Soil is one which has been transported a greater or



less distance from the place where it was originally.

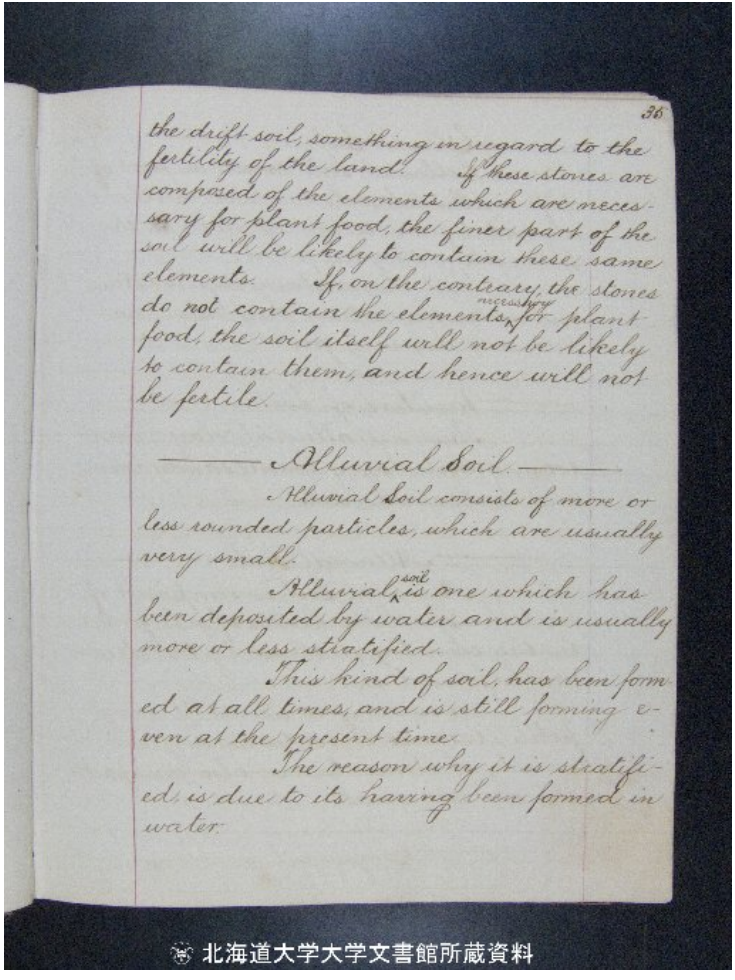
There are three kinds of transported soil; viz., Drift, Alluvial, and Colluvial.

A Drift Soil is that, which is formed by the action of moving ice, and owing to this reason, it usually contains stones which vary in size from small pebbles even to immense masses weighing many tons.

One peculiarity of these stones is this, that they are always more or less rounded, their corners having been worn off. And this is caused by their own motion.

The surface of drift soil is usually hilly, and the soil itself is a heterogeneous mixture of stones of various sizes and fine particle of soil. It is not usually stratified. Drift soils were formed during the glacial period.

It is possible to determine from the nature of the stones contained in



the drift soil, something in regard to the fertility of the land. If these stones are composed of the elements which are necessary for plant food, the finer part of the soil will be likely to contain these same elements. If, on the contrary, the stones do not contain the elements necessary for plant food, the soil itself will not be likely to contain them, and hence will not be fertile.

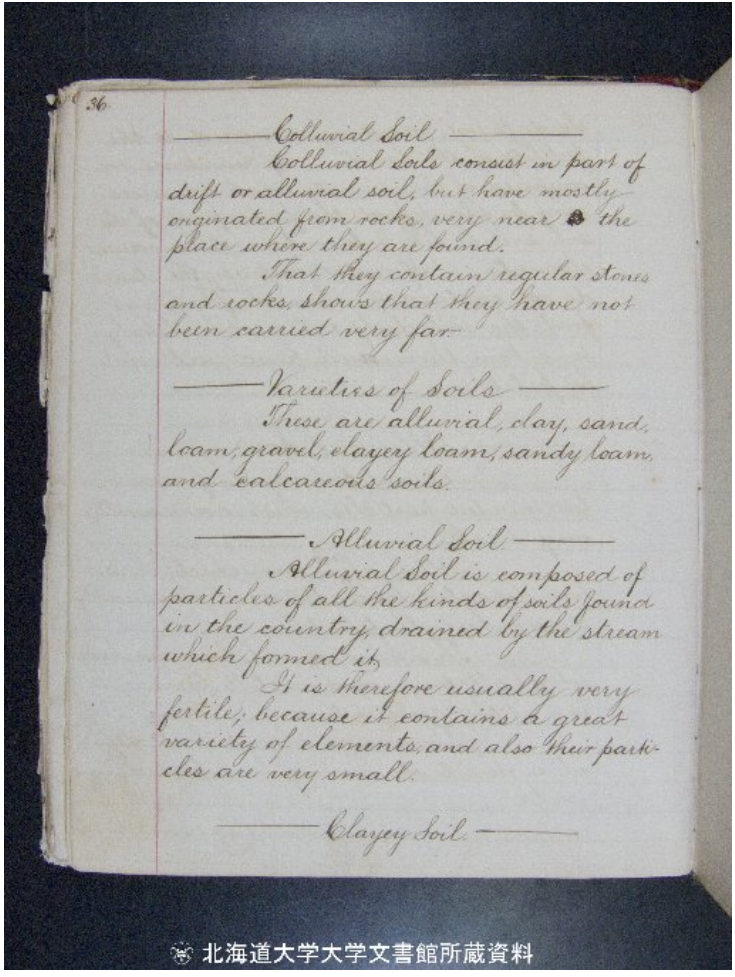
——— Alluvial Soil ———

Alluvial Soil consists of more or less rounded particles, which are usually very small.

Alluvial soil is one which has been deposited by water and is usually more or less stratified.

This kind of soil, has been formed at all times, and is still forming even at the present time.

The reason why it is stratified, is due to its having been formed in water.



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——Colluvial Soil——

Colluvial Soils consist in part of drift or alluvial soil, but have mostly originated from rocks, very near the place where they are found.

That they contain regular stones and rocks, shows that they have not been carried very far.

——Varieties of Soils——

These are alluvial, clay, sand, loam, gravel, clayey loam, sandy loam, and calcareous soils.

——Alluvial Soil——

Alluvial Soil is composed of particles of all the kinds of soils found in the country, drained by the stream which formed it.

It is therefore usually very fertile; because it contains a great variety of elements, and also their particles are very small.

——Clayey Soil——

——— Colluvial Soil ———

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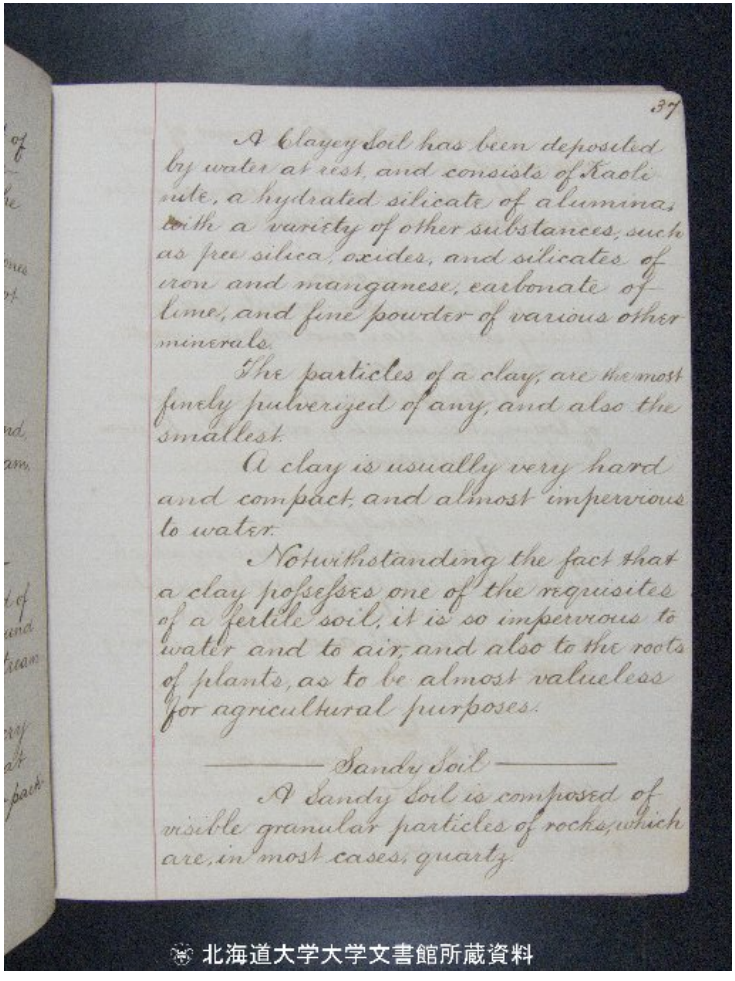
——— Clayey Soil ———



A Clayey Soil has been deposited by water at rest, and consists of Kaolinite, a hydrated silicate of alumina, with a variety of other substances, such as free silica, oxides, and silicates of iron and manganese, carbonate of lime, and fine power of various other minerals.

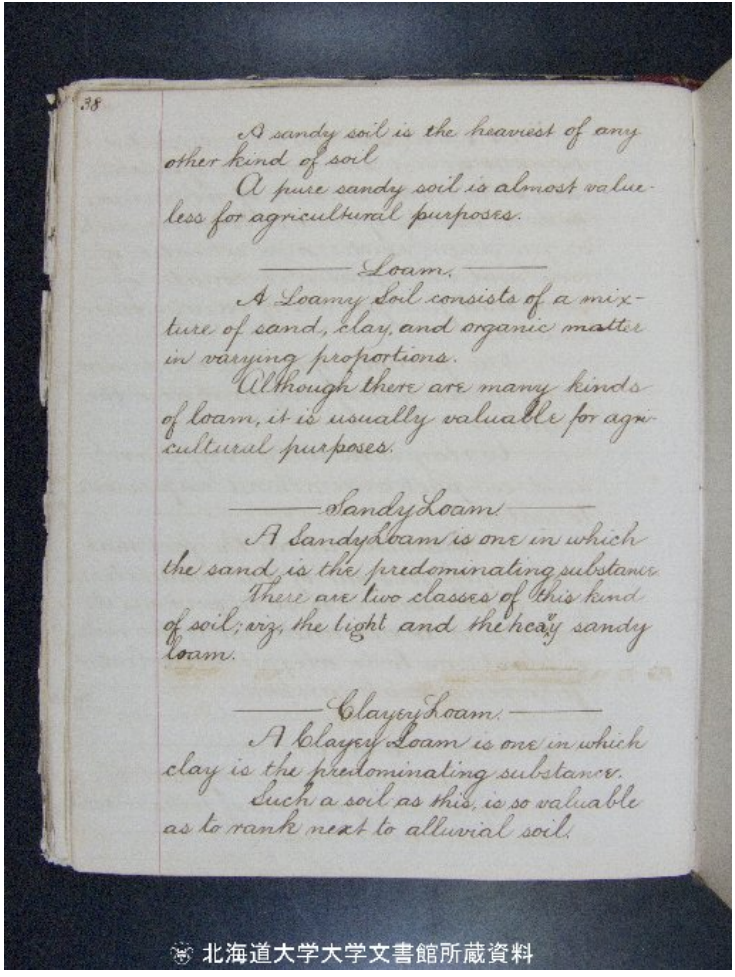
The particles of a clay, are the most finely pulverized of any, and also the smallest.

A clay is usually very hard and compact, and almost imperious to water.

Notwithstanding the fact that a clay possess one of the requisites of a fertile soil, it is so impervious to water and to air and also to the roots of plants, as to be almost valueless for agricultural purposes.

———— Sandy Soil ————

A Sandy Soil is composed of visible granular particles of rocks, which are, in most cases, quartz.



A sandy soil is the heaviest of any other kind of soil.

A pure sandy soil is almost valueless for agricultural purposes.

——— Loam ———

A Loamy Soil consists of a mixture of sand, clay, and organic matter in varying proportions.

Although there are many kinds of loam, it is usually valuable for agricultural purposes.

——— Sandy Loam ———

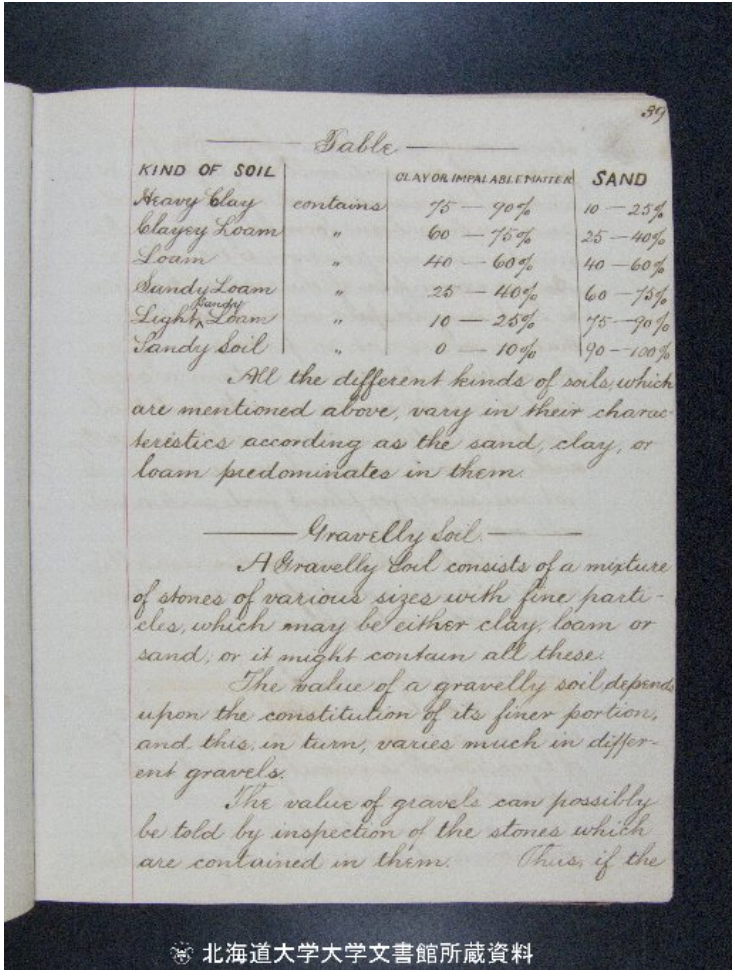
A Sandy Loam is one in which the sand is the predominating substance.

There are two classes of this kind of soil; viz., the light and the heavy sandy loam.

——— Clayey Loam ———

A Clayey Loam is one in which clay is the predominating substance.

Such a soil as this, is so valuable as to rank next to alluvial soil.



Table

KIND OF SOIL		CLAY OR IMPALABLE MATTER	SAND
Heavy Clay	contains	75 — 90%	10 — 25%
Clayey Loam	〃	60 — 75%	25 — 40%
Loam	〃	40 — 60%	40 — 60%
Sandy Loam	〃	25 — 40%	60 — 75%
Light Sandy Loam	〃	10 — 25%	75 — 90%
Sandy Soil	〃	0 — 10%	90 — 100%

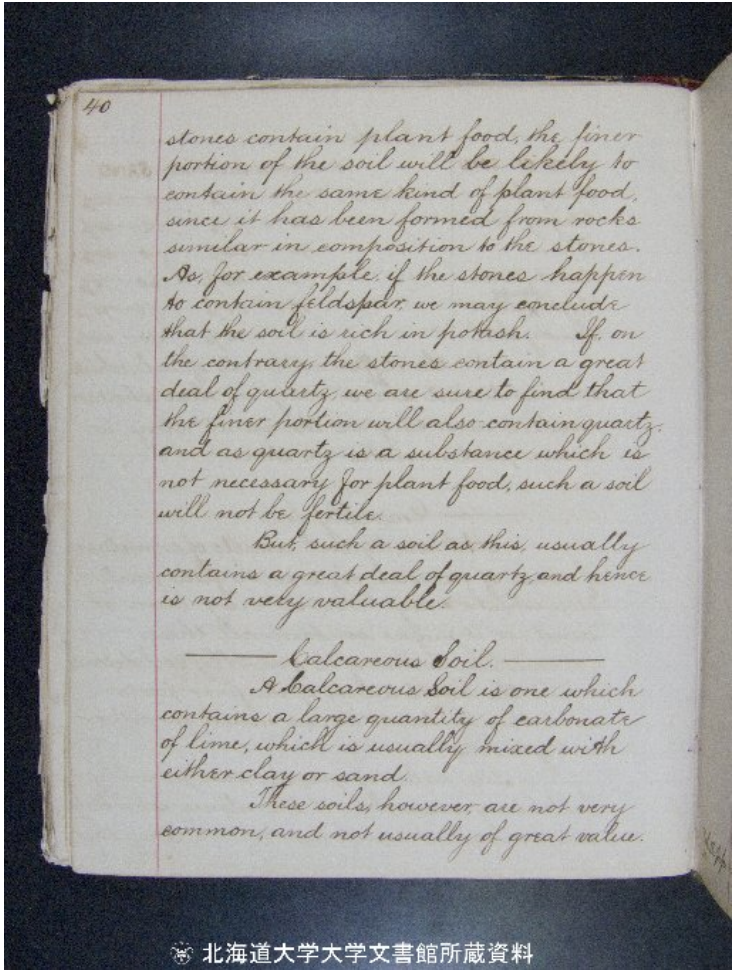
All the different kinds of soils which are mentioned above, vary in their characteristics according as the sand, clay, or loam predominates in them.

Gravelly Soil

A Gravelly Soil consists of a mixture of stones of various sizes with fine particles, which may be either clay, loam or sand; or it might contain all these.

The value of a gravelly soil depends upon the constitution of its finer portion, and this, in turn, varies much in different gravels.

The value of gravels can possibly be told by inspection of the stones which are contained in them. This, if the



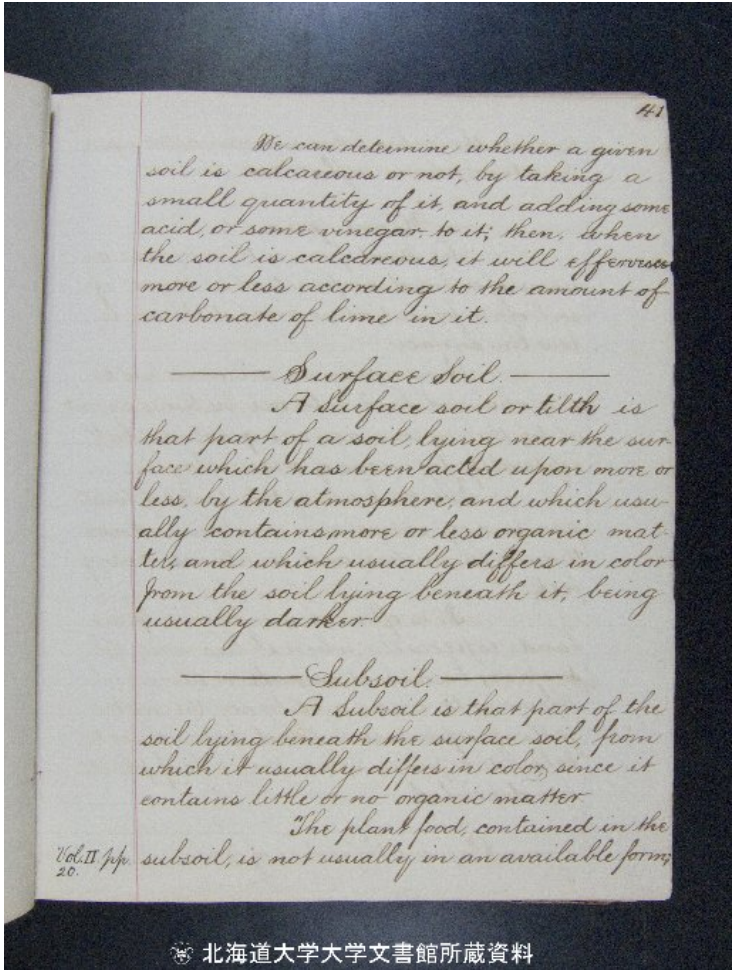
stones contain plant food, the finer portion of the soil will be likely to contain the same kind of plant food, since it has been formed from rocks similar in composition to the stones. As, for example, if the stones happen to contain feldspar we may conclude that the soil is rich in potash. If on the contrary, the stones contain a great deal of quartz, we are sure to find that the finer portion will also contain quartz, and as quartz is a substance which is not necessary for plant food, such a soil will not be fertile.

But, such a soil as this, usually contains a great deal of quartz, and hence is not very valuable.

——— Calcareous Soil ———

A Calcareous Soil is one which contains a large quantity of carbonate of line, which is usually mixed with either clay or sand.

These soils, however, are not very common, and not usually of great value.



He can determine whether a given soil is calcareous or not, by taking a small quantity of it, and adding some acid, or some vinegar, to it; then, when the soil is calcareous, it will effervesce more or less according to the amount of carbonate of lime in it.

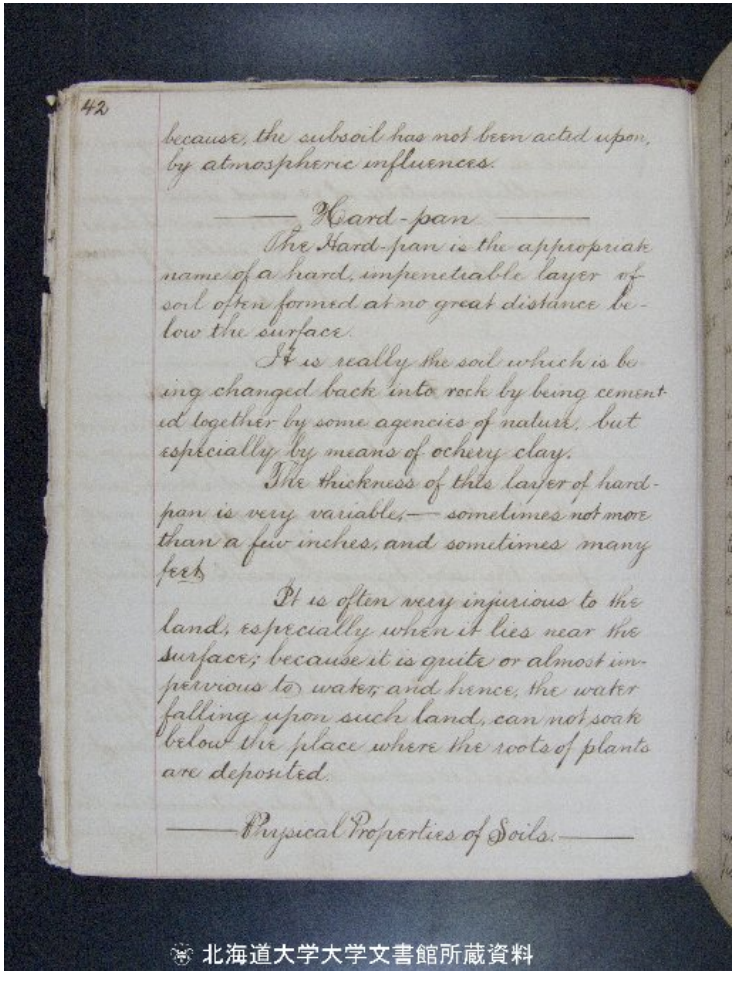
——— Surface Soil ———

A Surface soil or tilth is that part of a soil, lying near the surface which has been acted upon more or less, by the atmosphere, and which usually contains more or less organic matter, and which usually differs in color from the soil lying beneath it, being usually darker.

——— Subsoil ———

A Subsoil is that part of the soil lying beneath the surface soil, from which it usually differs in color since it contains little or no organic matter.

The plant food, contained in the subsoil, is not usually in an available form



because, the subsoil has not been acted upon, by atmospheric influences.

——— Hard-pan ———

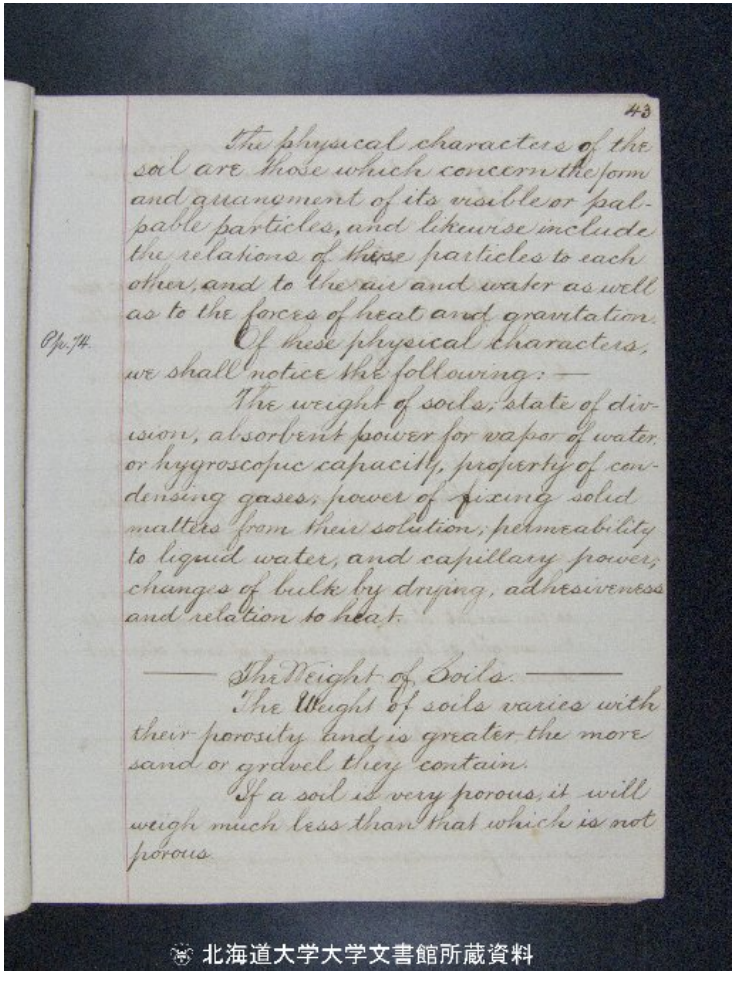
The Hard-pan is the appropriate name of a hard, impenetrable layer of soil often formed at no great distance below the surface.

It is really the soil which is being changed back into rock by being cemented together by some agencies of nature, but especially by means of ochery clay.

The thickness of this layer of hard-pan is very variable.—— sometimes not more than a few inches, and sometimes many feet.

It is often very injurious to the land, especially when it lies near the surface; because it is quite or almost impervious to water, and hence, the water falling upon such land, can not soak below the place where the roots of plants are deposited.

——— Physical Properties of Soils ———



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The physical characters of the soil are those which concern the form and arrangment of its visible or palpable particles, and likewise include the relations of these particles to each other, and to the air and water as well as to the forces of heat and gravitation.

Op. 74. Of these physical characters, we shall notice the following: —

The weight of soils; state of division; absorbent power for vapor of water, or hygroscopic capacity, property of condensing gases; power of fixing solid matters from their solution; permeability to liquid water, and capillary power; changes of bulk by drying, adhesiveness and relation to heat.

——— The Weight of Soils ———

The Weight of soils varies with their porosity and is greater the more sand or gravel they contain.

If a soil is very porous, it will weigh much less than that which is not porous.

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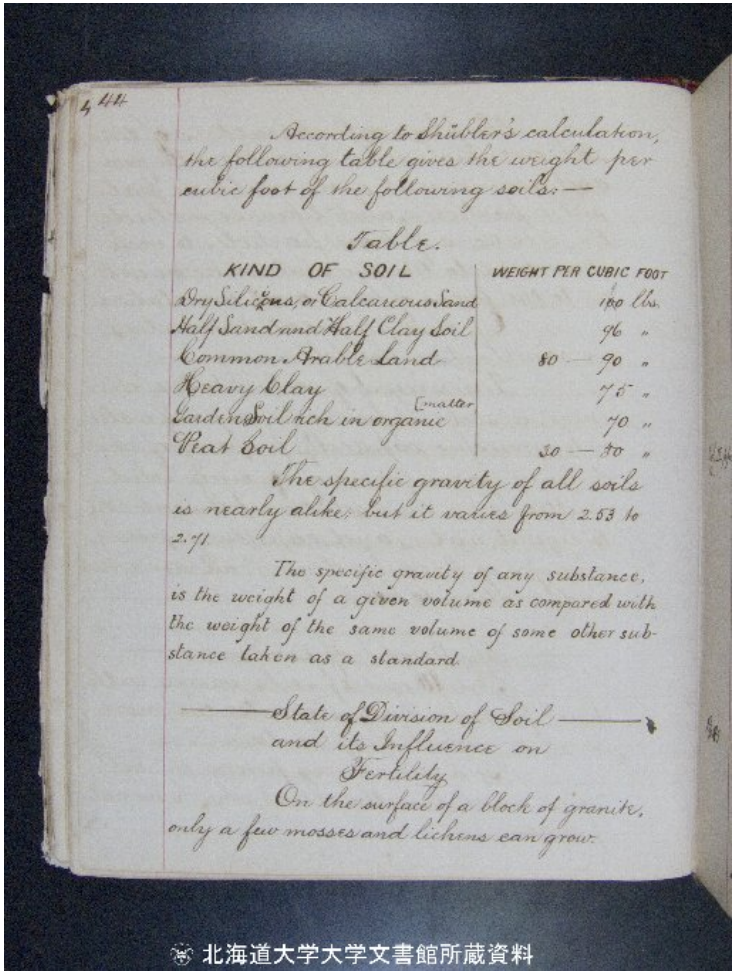


According to Shübler's calculation, the following table gives the weight per cubic foot of the following soils: ——

Table.

KIND OF SOIL	WEIGHT PER CUBIC FOOT
Dry Silicions, or Calcareous Sand	110 lbs.
Half Sand and Half Clay Soil	96 〃
Common Arable Land	80 — 90 〃
Heavy Clay	75 〃
Garden Soil rich in organic matter	70 〃
Veat Soil	30 — 50 〃

The specific gravity of all soils is nearly alike; but it varies from 2.53 to 2.71

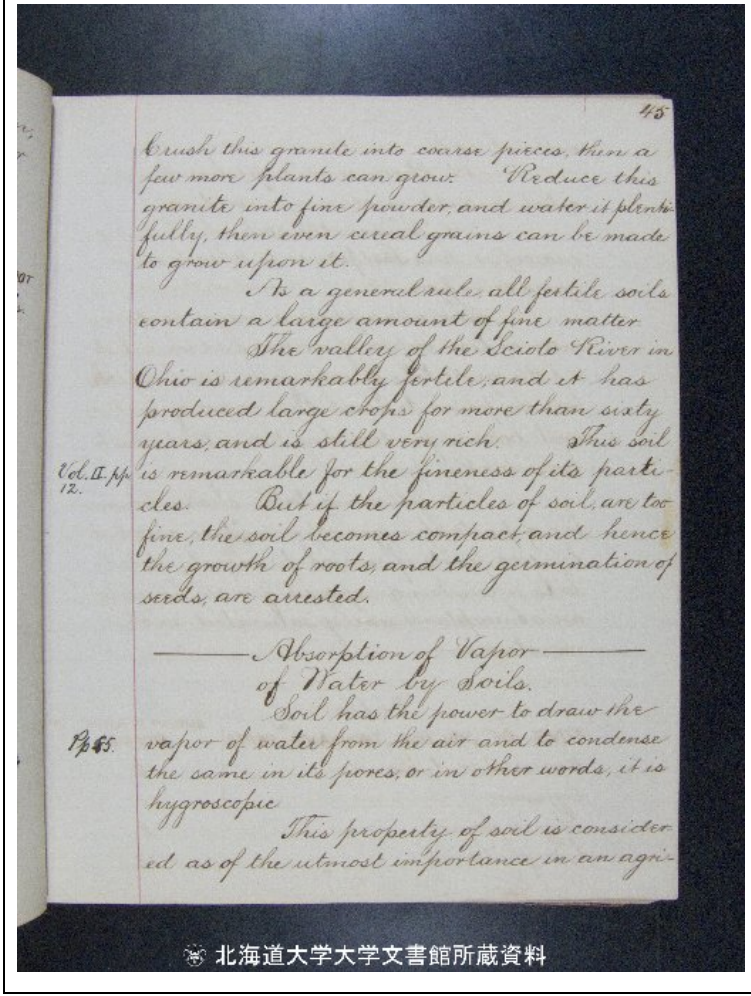
The specific gravity of any substance, is the weight of a given volume as compared with the weight of the same volume of some other substance taken as a standard.

———— State of Division of Soil ————

and its Influence on

Fertility

On the surface of a block of granite, only a few mosses and lichens can grow.



Crush this granite into coarse pieces, then a few more plants can grow. Reduce this granite into fine powder, and water it plentifully, then even cereal grains can be made to grow upon it.

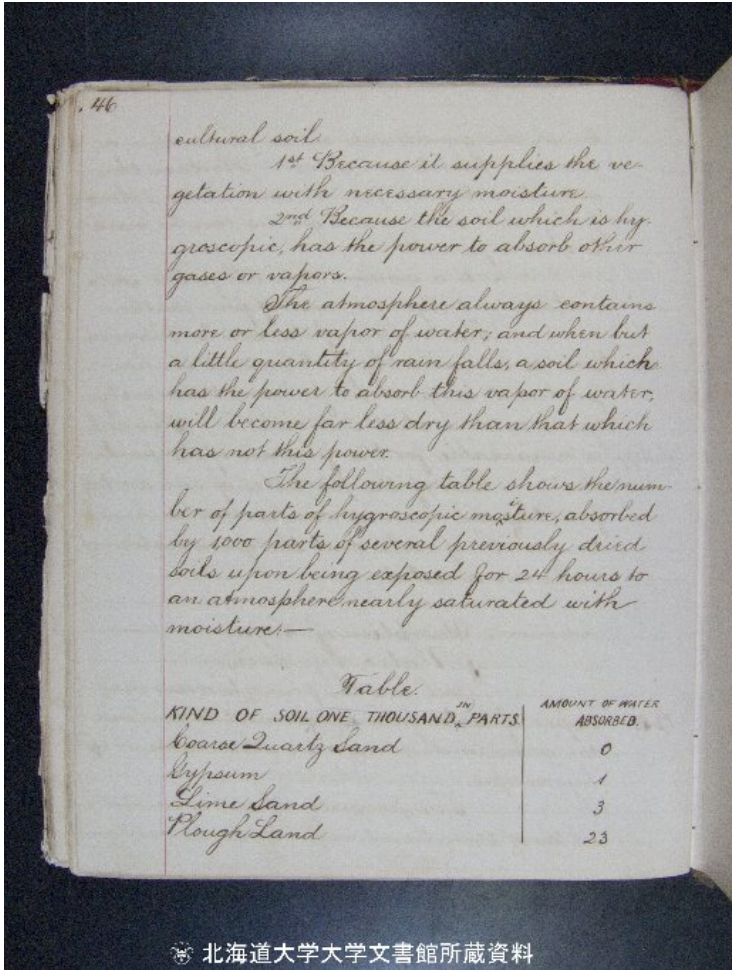
As a general rule, all fertile soils contain a large amount of fine matter.

The valley of the Scioto River in Ohio is remarkably fertile; and it has produced large crops for more than sixty years, and is still very rich. This soil is remarkable for the fineness of its particles. But if the particles of soil, are too fine, the soil becomes compact, and hence the growth of roots, and the germination of seeds, are arrested.

———— Absorption of Vapor ————
of Water by soils.

Soil has the power to draw the vapor of water from the air and to condense the same in its pores, or in other words, it is hygroscopic.

This property of soil is considered as of the utmost importance in an agricultural



soil.

1st Because it supplies the vegetation with necessary moisture.

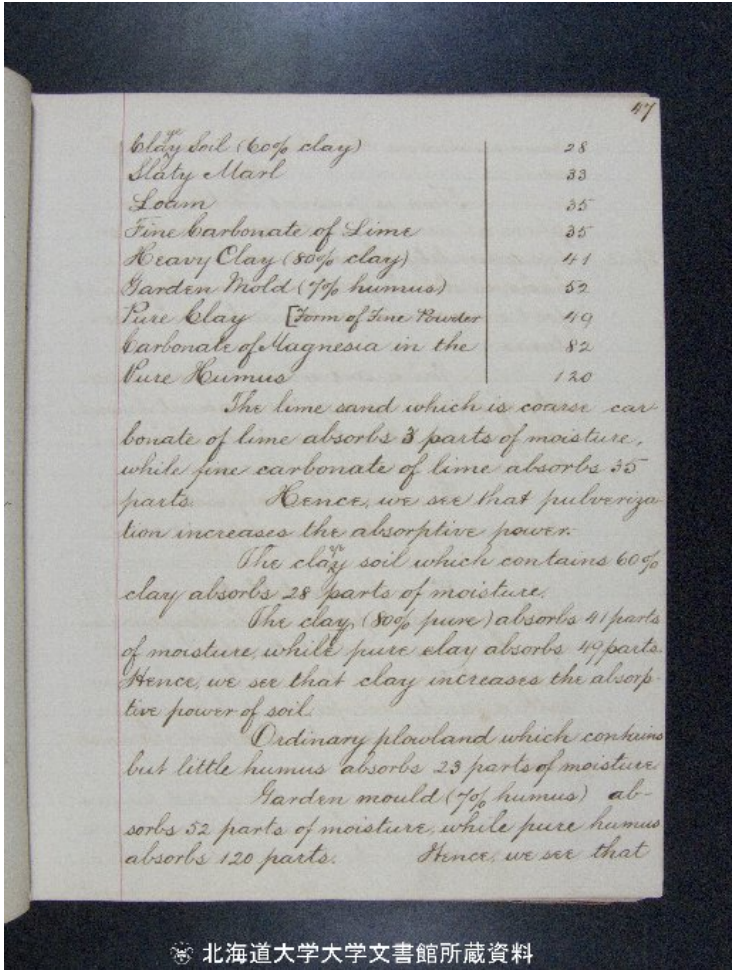
2nd Because the soil which is hygroscopic, has the power to absorb other gases or vapors.

The atmosphere always contains more or less vapor of water; and when but a little quantity of rain falls, a soil which has the power to absorb this vapor of water, will become for less dry than that which has not this power.

The following table shows the number of parts of hygroscopic moisture, absorbed by 1,000 parts of several previously dried soils upon being exposed for 24 hours to an atmosphere nearly saturated with moisture: ——

Table.

KIND OF SOIL ONE THOUSAND IN PARTS	AMOUNT OF WATER ABSORBED
Coarse Quartz Sand	0
Gypsum	1
Lime Sand	3
Plough Land	23



Clayey Soil (60% clay)	28
Slaty Marl	33
Loam	35
Fine Carbonate of Lime	35
Heavy Clay (80% clay)	41
Garden Mold (7% humus)	52
Pure Clay	49
Carbonate of Magnesia in the Form of Fine Powder	82
Pure Humus	120

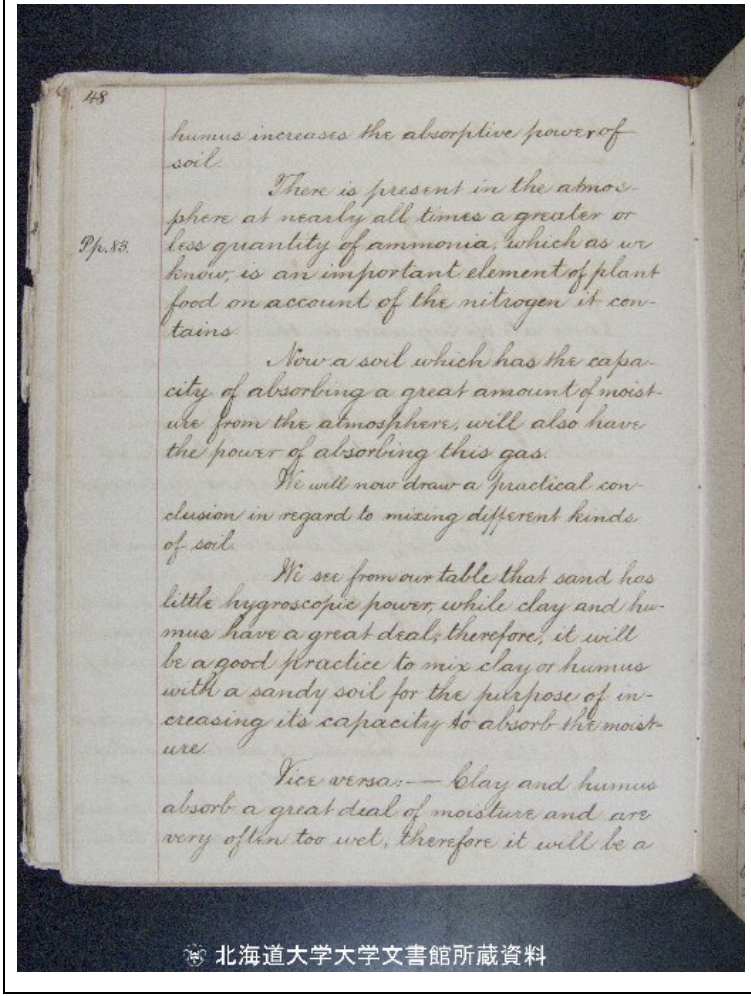
The lime sand which is coarse carbonate of lime absorbs 3 parts of moisture, while fine carbonate of lime absorbs 35 parts. Hence, we see that pulverization increases the absorptive power.

The clayey soil which contains 60% clay absorbs 28 parts of moisture.

The clay (80% pure) absorbs 41 parts of moisture, while pure clay absorbs 49 parts. Hence, we see that clay increases the absorptive power of soil.

Ordinary plowland which contains but little humus absorbs 23 parts of moisture.

Garden mould (7% humus) absorbs 52 parts of moisture, while pure humus absorbs 120 parts. Hence, we see



that humus increases the absorptive power of soil.

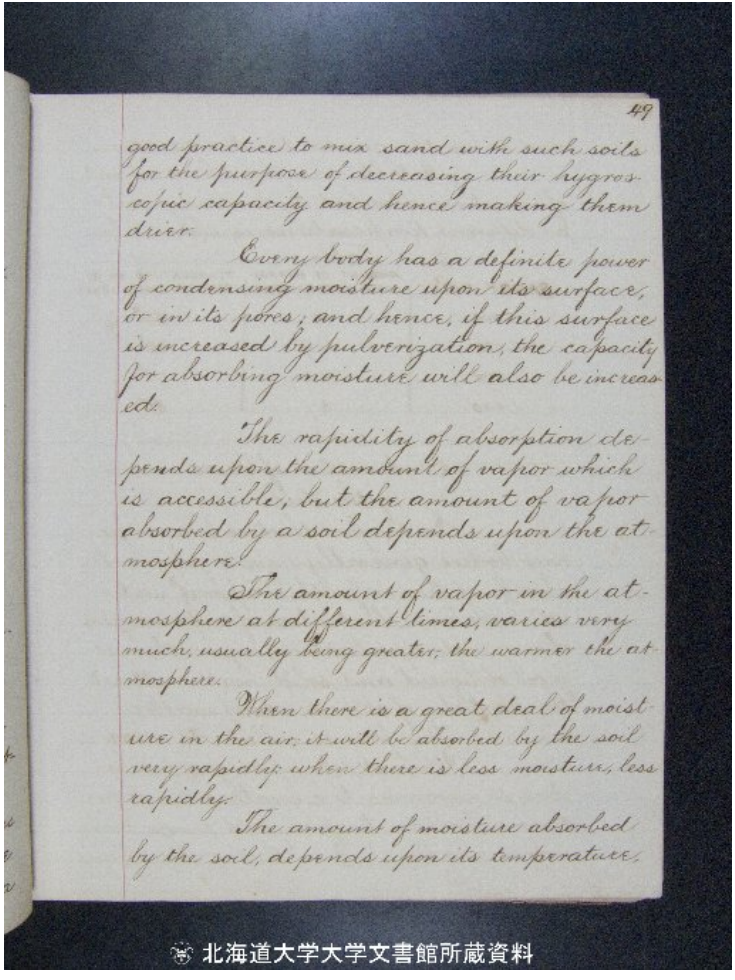
There is present in the atmosphere at nearly all times a greater or less quantity of ammonia, which as we know, is an important element of plant food on account of the nitrogen it contains.

Now a soil which has the capacity of absorbing a great amount of moisture from the atmosphere, will also have the power of absorbing this gas.

We will now draw a practical conclusion in regard to mixing different kinds of soil.

We see from our table that sand has little hygroscopic power, while clay and humus have a great deal, therefore, it will be a good practice to mix clay or humus with a sandy soil for the purpose of increasing its capacity to absorb the moisture.

Vice versa: —— Clay and humus absorb a great deal of moisture and are very often too wet, therefore it will be a



good practice to mix sand with such soils for the purpose of decreasing their hygroscopic capacity and hence making them drier.

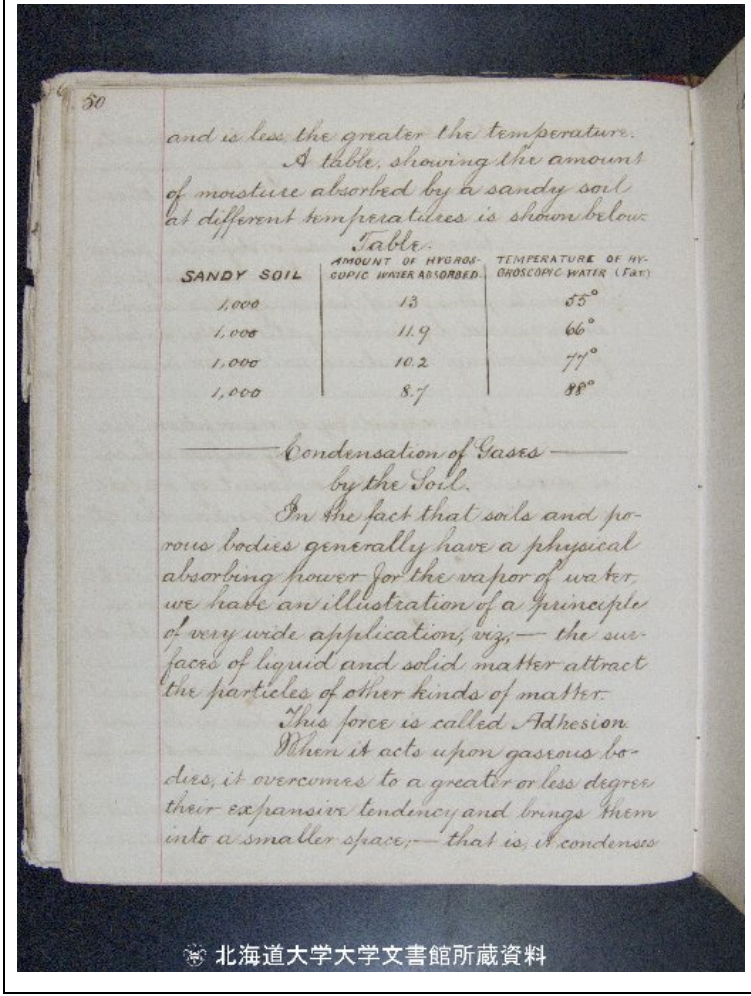
Every body has a definite power of condensing moisture upon its surface, or in its pores; and hence, if this surface is increased by pulverization, the capacity for absorbing moisture will also be increased.

The rapidity of absorption depends upon the amount of vapor which is accessible; but the amount of vapor absorbed by a soil depends upon the atmosphere.

The amount of vapor in the atmosphere at different times, varies very much, usually being greater, the warmer the atmosphere.

When there is a great deal of moisture in the air, it will be absorbed by the soil very vapidly: when there is less moisture, less rapidly.

The amount of moisture absorbed by the soil, depends upon its temperature,



and is less, the greater the temperature.

A table, showing the amount of moisture absorbed by a sandy soil at different temperatures is shown below.

Table

SANDY SOIL	AMOUNT OF HYGROSCOPIC WATER ABSORBED	TEMPERATURE OF HYGROSCOPIC WATER (Far.)
1,000	13	55°
1,000	11.9	66°
1,000	10.2	77°
1,000	8.7	88°

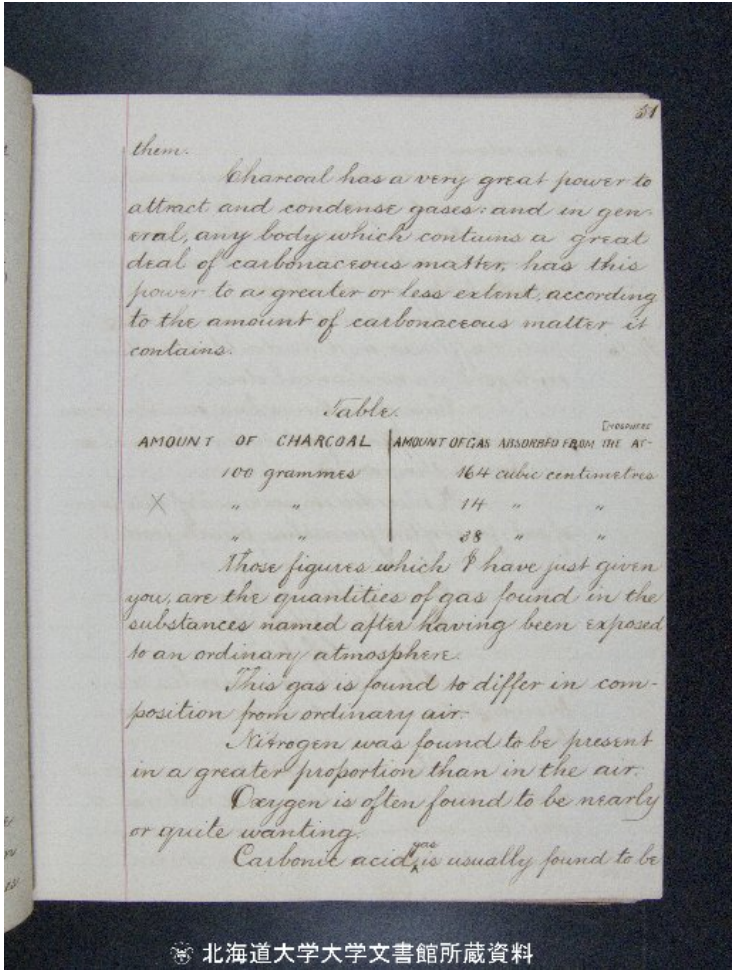
———— Condensation of Gases ————

by the Soil.

In the fact that soils and porous bodies generally have a physical absorbing power for the vapor of water, we have an illustration of a principle of very wide application, viz., —— the surfaces of liquid and solid matter attract the particles of other kinds of matter.

This force is called Adhesion.

When it acts upon gaseous bodies, it overcomes to a greater or less degree their expansive tendency and brings them into a smaller space, —— that is, it condenses



them.

Charcoal has a very great power to attract and condense gases: and in general, any body which contains a great deal of carbonaceous matter, has this power to a greater or less extent, according to the amount of carbonaceous matter it contains.

Table

AMOUNT OF CHARCOAL	AMOUNT OF GAS ABSORED FROM THE ATMOSPHERE
100 grammes	164 cubic centimetres
〃 〃	14 〃 〃
〃 〃	38 〃 〃

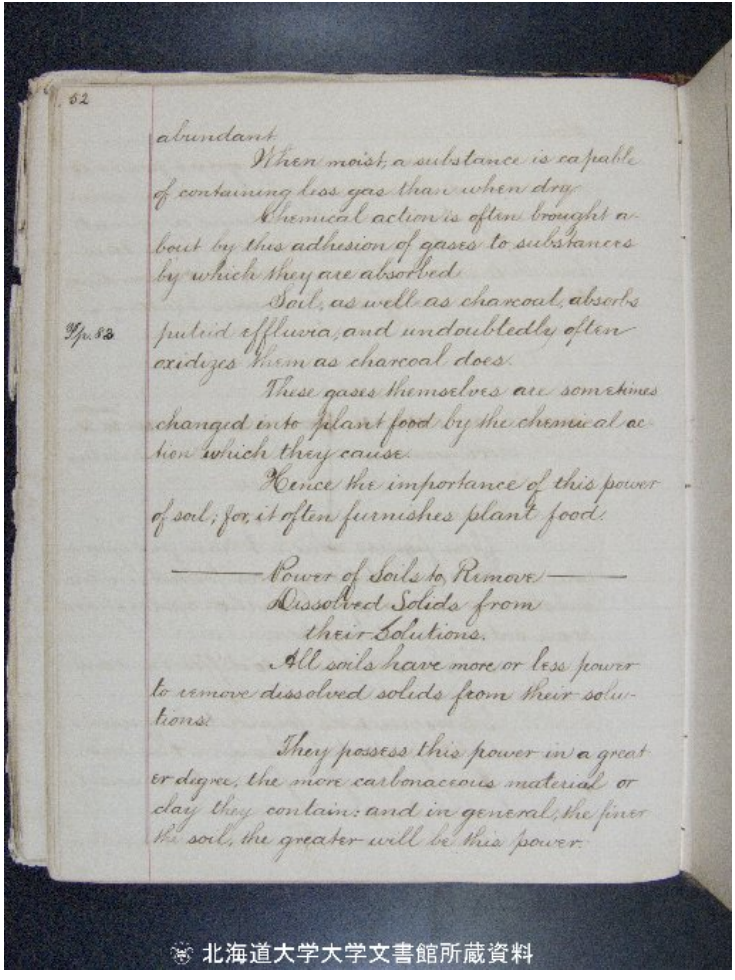
Those figures which I have just given you, are the quantities of gas found in the substances named after having been exposed to an ordinary atmosphere.

This gas is found to differ in composition from ordinary air.

Nitrogen was found to be present in a greater proportion than in the air.

Oxygen is often found to be nearly or quite wanting.

Carbonic acid gas is usually found to be



abundant.

When moist, a substance is capable of containing less gas than when dry.

Chemical action is often brought about by this adhesion of gases to substances by which they are absorbed.

Soil, as well as charcoal, absorbs putrid effluvia, and undoubtedly often oxidizes them as charcoal does.

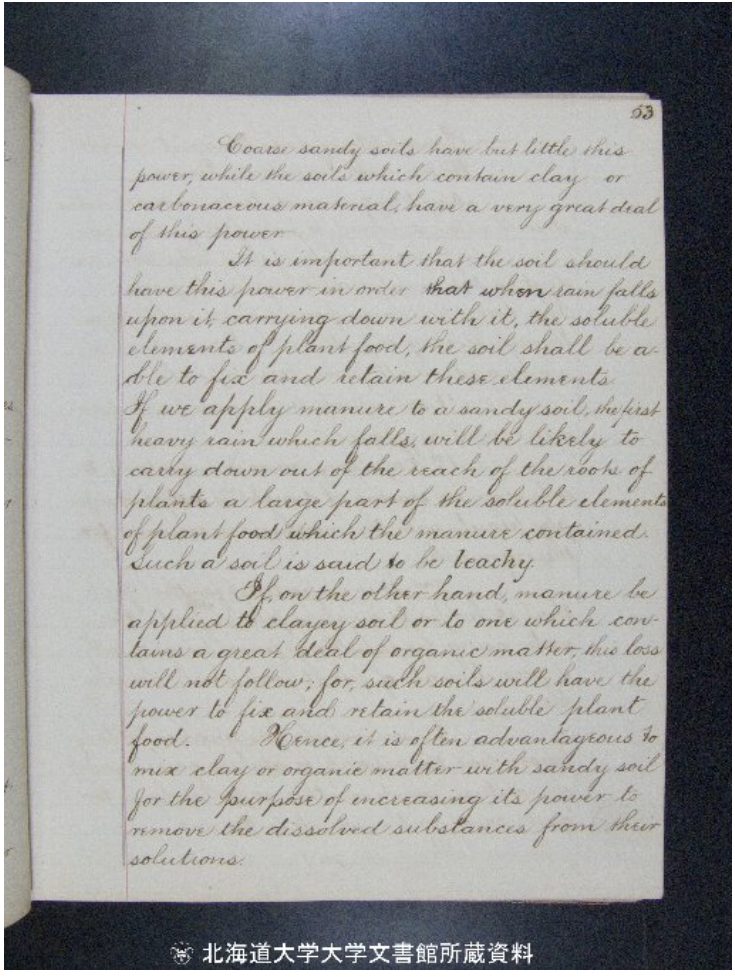
These gases themselves are sometimes changed into plant food by the chemical action which they cause.

Hence the importance of this power of soil; for, it often furnishes plant food.

——— Power of Soils to Remove ———
Dissolved Solids from
their Solutions.

All soils have more or less power to remove dissolved solids from their solutions.

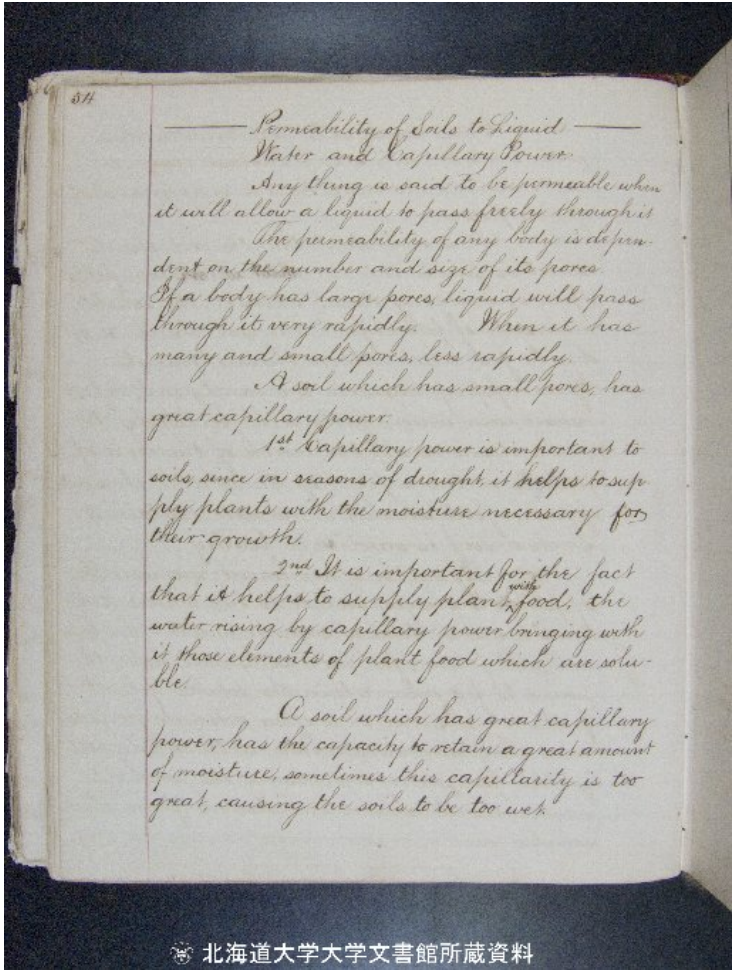
They possess this power in a greater degree, the move carbonaceous material or clay they contain: and in general, the finer the soil, the greater will be this power.



Coarse sandy soils have but little this power, while the soils which contain clay or carbonaceous material, have a very great deal of this power.

It is important that the soil should have this power in order that when rain falls upon it, carrying down with it, the soluble elements of plant food, the soil shall be able to fix and retain these elements. If we apply manure to a sandy soil, the first heavy rain which falls, will be likely to carry down out of the reach of the roots of plants a large part of the soluble elements of plant food which the manure contained. Such a soil is said to be leachy.

If on the other hand, manure be applied to clayey soil or to one which contains a great deal of organic matter, this loss will not follow; for, such soils will have the power to fix and retain the soluble plant food. Hence, it is often advantageous to mix clay or organic matter with sandy soil for the purpose of increasing its power to remove the dissolved substances from their solutions.



——— Permeability of Soils to Liquid ———

Water and Capillary Power

Any thing is said to be permeable when it will allow a liquid to pass freely through it.

The permeability of any body is dependent on the number and size of its pores. If a body has large pores, liquid will pass through it very rapidly. When it has many and small pores, less rapidly.

A soil which has small pores, has great capillary power.

1st Capillary power is important to soils, since in seasons of drought, it helps to supply plants with the moisture necessary for their growth.

2nd It is important for the fact that it helps to supply plan with food, the water rising by capillary power bringing with it those elements of plant food which are soluble.

A soil which has great capillary power, has the capacity to retain a great a mount of moisture, sometimes this capillarity is too great, causing the soils to be too wet.

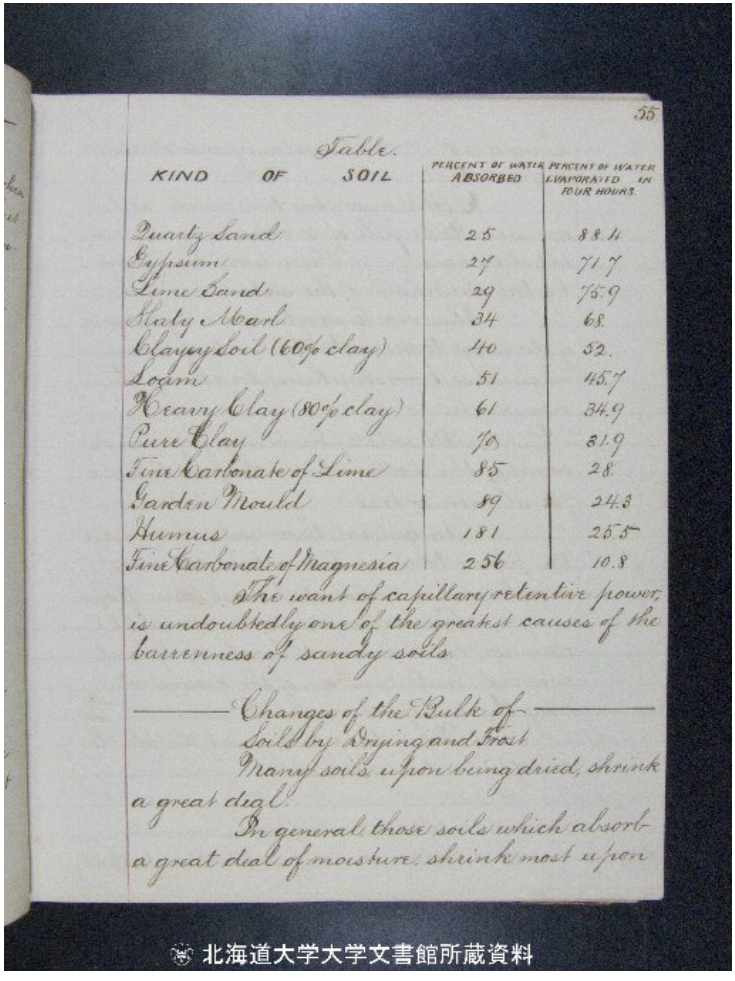

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Table.

KIND OF SOIL	PERCENT OF WATER ABSORBED	PERCENT OF WATER EVAPORATED IN FOUR HOURS.
Quartz Sand	25	88.4
Gypsum	27	71.7
Lime Sand	29	75.9
Italy Marl	34	68
Clayey Soil (60% clay)	40	52.
Loam	51	45.7
Heavy Clay (80% clay)	61	34.9
Pure Clay	70	31.9
Fine Carbonate of Lime	85	28
Garden Mould	89	24.3
Humus	181	25.5
Fine Carbonate of Magnesia	256	10.8

The want of capillary retentive power, is undoubtedly one of the greatest causes of the barrenness of sandy soils.

——— Changes of the Bulk of ———

Soils by Drying and Frost

Many soils upon being dried, shrink a great deal.

In general, those soils which absorb a great deal of moisture, shrink most upon

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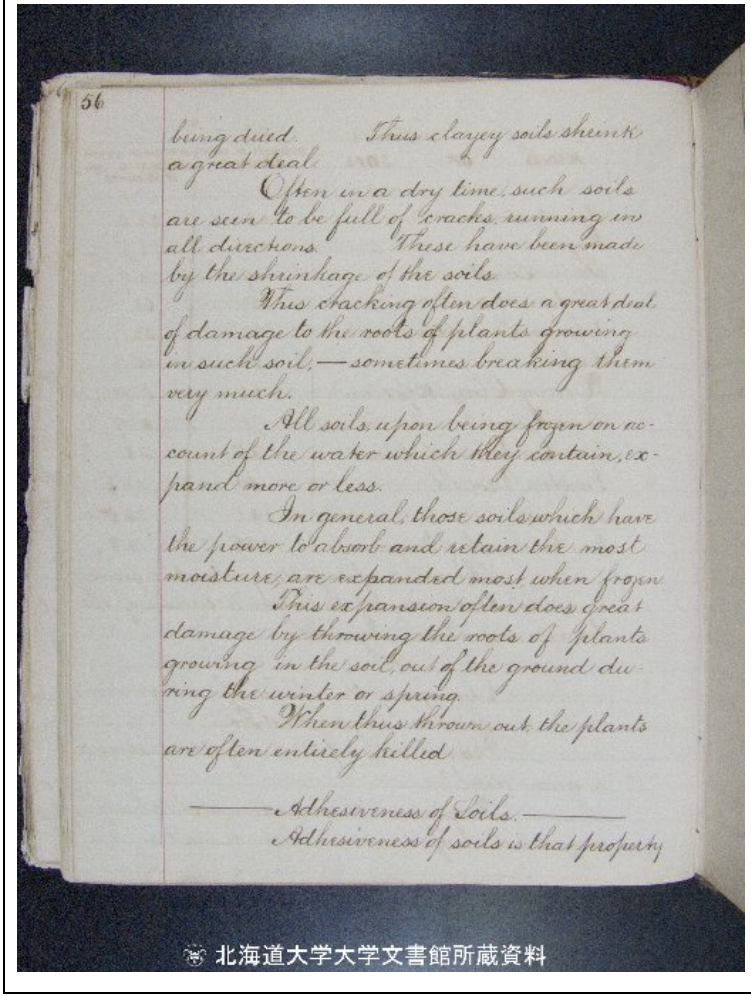


being dried. Thus clayey soils shrink a great deal.

Often in a dry time, such soils are seen to be full of cracks, running in all directions. These have been made by the shrinkage of the soils.

This cracking often does a great deal of damage to the roots of plants growing in such soil, —— sometimes breaking them very much.

All soils upon being frozen on account of the water which they contain, expand more or less.

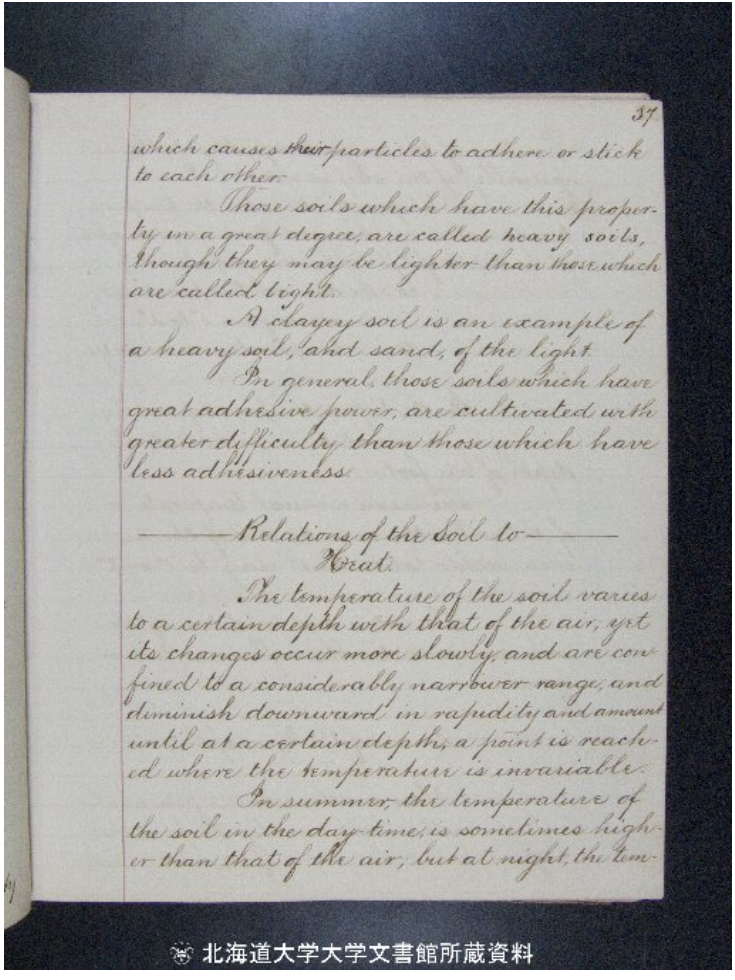
In general, those soils which have the power to absorb and retain the most moisture, are expanded most when frozen.

This expansion often does great damage by throwing the roots of plants growing in the soil, out of the ground during the winter or spring.

When thus thrown out, the plants are often entirely hilled.

———— Adhesiveness of Soils ————

Adhesiveness of soils is that property



which causes their particles to adhere or stick to each other.

Those soils which have this property in a great degree, are called heavy soils, though they may be lighter than those which are called light.

A clayey soil is an example of a heavy soil, and sand, of the light.

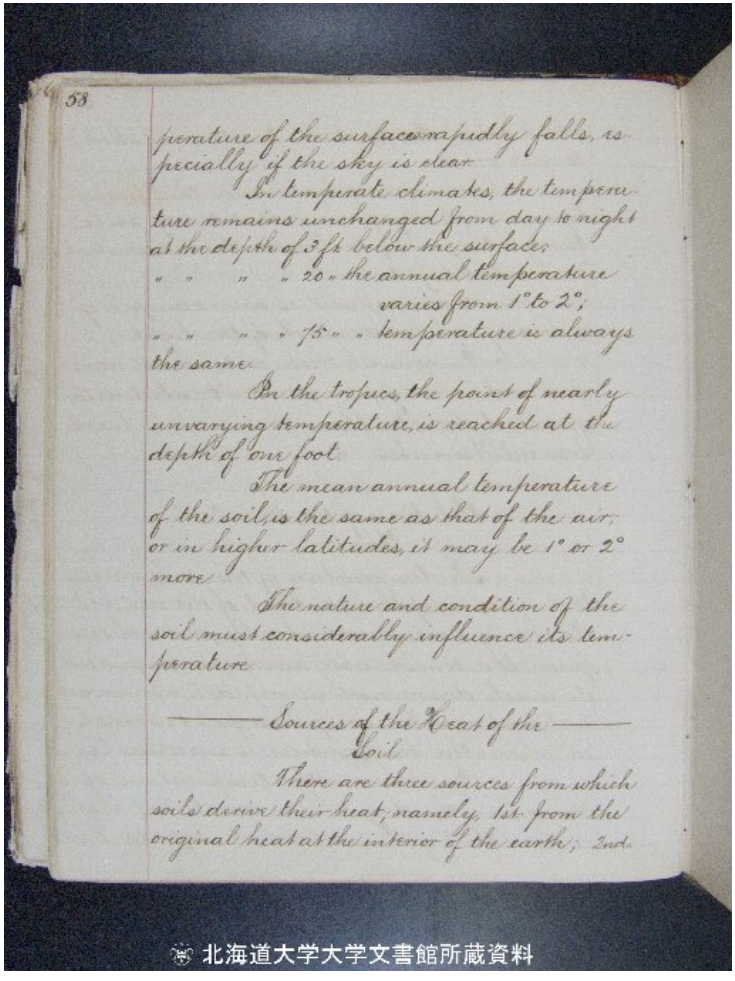
In general, those soils which have great adhesive power, are cultivated with greater difficulty than those which have less adhesiveness.

——— Relations of the Soil to ———

Heat.

The temperature of the soil varies to a certain depth with that of the air, yet its changes occur more slowly, and are confined to a considerably narrower range, and diminish downward in rapidity and amount until at a certain depth, a point is reached where the temperature is invariable.

In summer, the temperature of the soil in the day-time, is sometimes higher than that of the air, but at night, the temperature



of the surface rapidly falls, especially if the sky is clear.

In temperate climates, the temperature remains unchanged from day to night at the depth of 3 ft. below the surface;

〃 〃 〃 〃 20 〃 the annual temperature varies from 1°to 2°,

〃 〃 〃 〃 75 〃 〃 temperature is always the same.

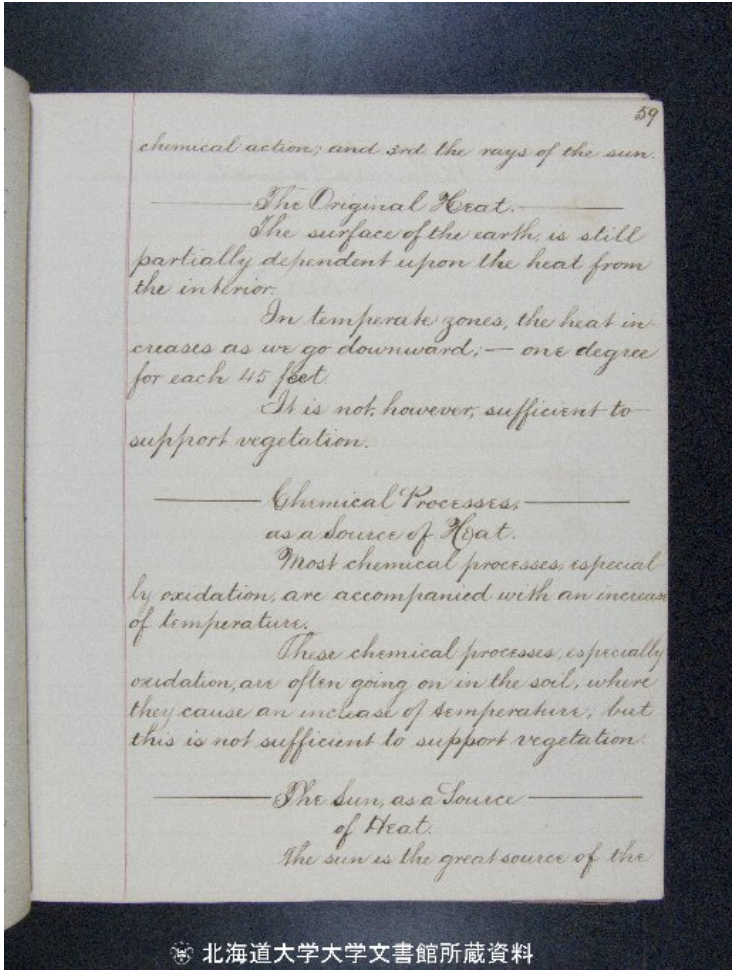
In the tropics, the point of nearly unvarying temperature, is reached at the depth of one foot.

The mean annual temperature of the soil, is the same as that of the air, or in higher latitudes, it may be 1°to 2° more.

The nature and condition of the soil must considerably influence its temperature.

——— Sources of the Heat of the ———
Soil

There are three sources from which soils derive their heat, namely, 1st from the original heat at the interior of the earth, 2nd



chemical action; and 3rd the rays of the sun.

——— The Original Heat ———

The surface of the earth, is still partially dependent upon the heat from the interior.

In temperate zones, the heat increases as we go downward; —— one degree for each 45 feet.

It is not, however, sufficient to— support vegetation.

——— Chemical Processes ———

as a Source of Heat.

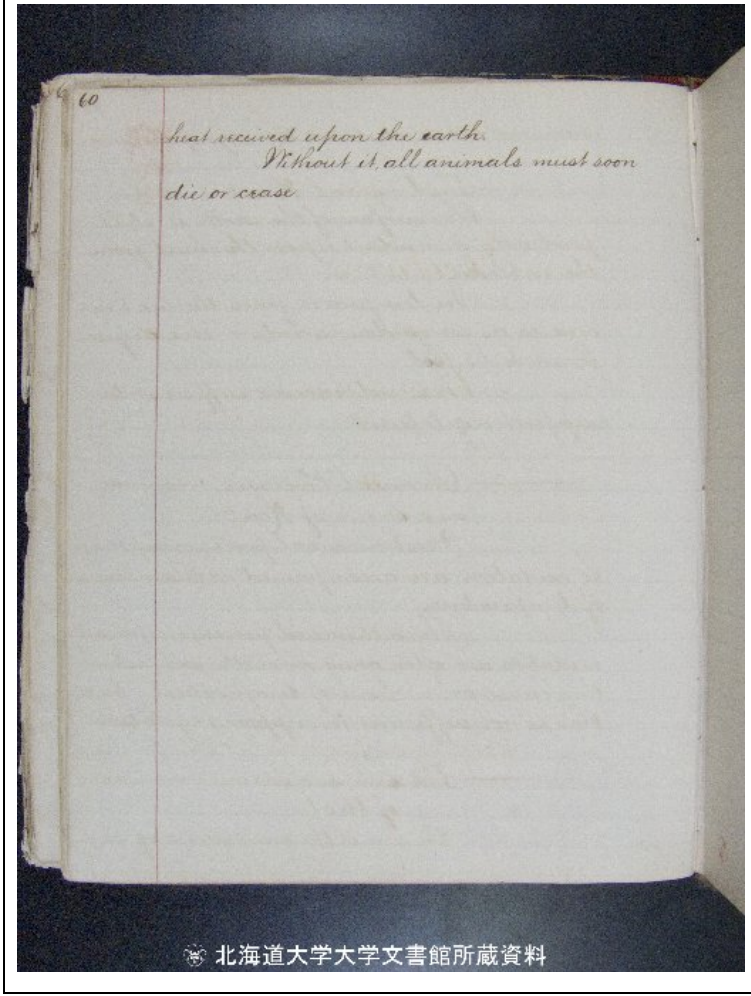
Most chemical processes, especially oxidation, are accompanied with an increase of temperature.

These chemical processes, especially oxidation, are often going on in the soil, where they cause an increase of temperature, but this is not sufficient to support vegetation.

——— The Sun, as a Source ———

of Heat.

The sun is the great source of the



heat received upon the earth.

Without it, all animals must soon die or cease.