A TREATISE

ON THE

POTATO:

WITH

AN ESSAY

TO SHOW

THE CAUSE OF THE DISEASE

AND TO SUGGEST

ITS REMEDY.

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TO THE

FARMERS OF THE UNITED STATES,

ENGAGED IN THE

MOST USEFUL,

MOST HONORABLE,

MOST INDEPENDENT AND HAPPY

OF ALL THE PURSUITS OF MAN,

These few Pages are Respectfully Inscribed,

IN THE HOPE THEY MAY PROVE TO THEIR BENEFIT

AND TO GENERAL ADVANTAGE,

BY THE AUTHOR.

TREATISE ON THE POTATO.

HISTORY OF THE USE AND CULTIVATION OF THE POTATO.

The potato is so associated in our minds, in this country, with the things that are agreeable to the palate and good for food, is so regular an accompaniment of all provision for the inner man, whether it be the most humble meal procured for the urgent cravings of hunger, or the most costly and sumptuous banquet designed to gratify extravagant gourmandism or splendid luxury; whether it be for fast or feast; that it is difficult for us to separate it, even in fancy, from the list of things necessary to subsistence, or to conceive of the time when it was not in use, or of the possibility that we can or must, ourselves, in future do without it. There is, at present, no vegetable candidate for our favor, and for general popularity, that appears qualified to succeed it at the board. How far the psoralia esculenta, or wild potato of the western prairie; or the helianthus tuberosus, or Jerusalem artichoke, may fill the important void to be made at the table if the potato should actually leave us, is not certain.

The potato has been in use among the civilized part of mankind from a date about coeval with the settlement of this country. It was a scion of uncivilized Peru in the days

of the Incas, and of barbarous Virginia before the time of Pocahontas. Sir Walter Raleigh, on a voyage to Virginia in 1586, became sensible of its merits and amiable qualities, and fancied it also to have some others, which it does not appear, on better acquaintance, to possess, and he exported it thence to England and Ireland. This is related on the authority of Sir Joseph Banks, and it is said that the plants imported by Raleigh were first cultivated at his farm in Youghal, in Ireland. Robert Southwell, President of the Agricultural Society, stated to that body, in 1693, that his father received them from Sir Walter Raleigh, and first introduced them into Ireland. This is probably a mistake, as they must have been in Ireland before his day. In a description of them by Thomas Heriot, they are called opanawk. "These roots," he says, "are round, some as large as a walnut, others much larger. They grow in damp soil, many hanging together, as if fixed on ropes. They are good food, either boiled or roasted." Mr. Heriot apparently refers to some of the product raised in England, not to the original stock brought from Virginia. They had probably increased somewhat in size in England, as the usual size of the potato growing in its natural state, in Virginia or Peru, is elsewhere described as less, being about the size of a nutmeg. The size of the potato, with us, in the first year from the seed, will not exceed that measure, unless the vine be transplanted. The size of the tuber as commonly sold in our markets, the produce of careful husbandry or gardening, is acquired by cultivation.

Gerarde describes the potato as the Virginia potato, and says that he received the roots from Virginia. This account is published by him in his Herbal, in 1597. He recommends them to be eaten as a delicacy, not as common food. The potato was known in Spain before it was in England, and was probably brought there by the dis-

coverers of America, or the early voyagers to it—it is said from Peru. The name in South America was papas.

It seems that the recommendation of Gerarde was followed, and that the potato was, for a long time, used only as a delicacy. It was only cultivated in gardens, and by a few persons, for almost a century. The year 1663 is mentioned as the date when it began to be more generally cultivated. But this was still in gardens. It did not become an article of field culture till the early part of the eighteenth century, about one century and a quarter before this present time. The year 1730 (or as other statements give it, 1739) was the date of the first field crop in Scotland, which appears to have preceded the culture at large in England. Probably it was not earlier in the American Colonies. It is rather a striking instance of the changes in the arts and mode of living, from age to age, that this plant which, for half a century or more, was only used as a delicacy, and was probably regarded as too choice to pass the lips of laborers, except those who might have raised it, and continued so to be used within two centuries, is now raised for the fattening of swine. It is produced in such quantities in the west as to be sold for fifteen cents the bushel; and in the eastern States has been marketed at twenty-five cents.

This very hardy plant, native to the lower latitudes of the temperate zone, is cultivated with success in Norway, in lat. 70 north.

The modes of cultivation of the potato have been almost as various as the cultivators; and indeed the soil may be varied somewhat to suit the different varieties. Some varieties succeed best on dry, mouldy, rich soil; others do well on moist grounds. Mr. Johnson, however recommends one soil as best for all kinds. The amount of the product, and the quality of the potato depend very

much on the character of the soil. Mr. Johnson says, "No inhabitant of the garden varies more in quality in different gardens than the potato: for a variety will have a strong, unpleasant flavor in one soil, that has a sweet, agreeable one in another. In a heavy, wet soil, or a rank, black loam, though the crop is often fine and abundant, it is scarcely ever palatable. Silicious soils, even approaching to gravel, though in these last the tubers are usually corroded or scabby, are always to be planted in preference to the above. A dry, mouldy, fresh and moderately rich soil is unquestionably the best for every variety of the potato. The black skinned and rough red thrive better than any in moist, cold soils." It becomes of course important in choosing seed potatoes, to consider the nature of the soil and climate. In England the modes of cultivation have been various: and are known by the distinguishing names of dibbling, drilling, furrow-planting, holeing-in, trenching-in, and bedding in. The last is used in wet soils. In this country the mode of cultivation is more uniform.

A marked difference has been found in the nutritive quality or rather nutritive quantity of potatoes, which was supposed to be depending on the variety, though it may be supposed quite as likely to be derived from the soil. Thus from a statement of an analysis made by Mr. George Sinclair, an English writer, it appears, as he says, that the yam is a very productive variety, attains to a large size, but is often hollow, and less nutritive than most others: 64 drachms afford of nutritive matter 190 grains. The ox-noble gave 194 grains to 64 drachms. The purple red, to the same quantity, afforded 200 grains: the hundred-eye, a very prolific variety, 218 grains: the rough-red 250 grains. I know not whether any of these varieties have been cultivated in this country. The dif-

ference is very great, amounting to nearly thirty-two per cent; or 200 bushels of the last would be equivalent in nourishment to 264 of the first.

The Potato has been universally cultivated, both in field and garden culture, by the tubers, or the eyes of the tuber. This is the only profitable mode of growing them; as, if raised from seed, transplantation is necessary, or otherwise, two or three successive crops, before the tuber attains a good size. This mode of cultivation being so convenient and profitable, has afforded temptation, when a good variety was obtained, to continue the cultivation of the variety by means of the tuber, too long and pertinaciously, till the decay of old age had manifestly affected them. Many varieties obtained from seed taken from old plants would much sooner feel the debility and decay of age. Occasionally, when new varieties have been obtained from seed, those which were not considered to be profitable, either for quality or productiveness, were of course not continued, but suffered speedily to become extinct. On the other hand, those which were considered valuable it became an object to continue in cultivation, as long as possible. Generally when resort has been had to seed, it was chosen from those varieties which had long been in public favor, and had the highest reputation. The degree of excellence is apt to be measured by the duration of popular favor;—and thus the seed has generally been selected from the oldest varieties. The cultivator could make no greater mistake than this. The seed should be obtained from the most vigorous plants; while universally and necessarily those varieties which have been in favor twelve or fifteen years have parted both with their vigor and their excellent qualities, and are entirely unsuitable to use for seed.

It has been a very common practice in this country to

cut the tuber into very small pieces for planting. I cannot but attribute the preference for this practice to a want of habits of accurate observation, as some of the most judicious cultivators, especially Mr. Knight, who to very scientific knowledge united very close and accurate observation, recommended the planting of the tuber whole: and, moreover, for the reason that the young sprout, before it has acquired ability to nourish itself by its roots, depends for its nourishment on the fecula, or starch, of the tuber, which would be supplied more abundantly in the whole state, than if divided, and consequently would be likely to make more healthy plants.

The potato in the last century, in England, was visited with an epidemic which was called by the name of "curl." This is mentioned by several different writers on vegetable physiology and agriculture. Whether that was the same disease as one of the forms now known among us, under the name of rot, it may not be easy to determine. In one species of the disease called rot, the edge of the leaf becomes curled and black. Fall planting was named as a remedy for the curl, but with what success does not appear, so far as I am informed. The following description of that disease is found in Mr. Smee's book:

"Putsche and Vertuch state that the plants which are affected by this disease have an extremely meagre appearance. The stem is unbranched, brownish green, or mottled, and here and there sprinkled with rusty spots, which penetrate to the pith; so that it is not white, but rust-colored, or sometimes black. The upper surface of the leaves is not so smooth as usual, but rough, wrinkled, curled or crumpled. The leaves are far more sessile than usual, and not of an uniform brownish, or dark green, but spotted. The passages for circulation, imbibition, and respiration, are none of them in a healthy state. The pith

is often discolored or dried up, even in the young shoots. The starved plant often perishes early in autumn, when the tubers should be making their most rapid growth. These tubers are scanty and tasteless, juicy and almost unfit for food. Even the color of the outer coat of the tuber is changed. The same tuber is in parts brown, in parts of a dirty yellow, and sometimes the two tints run into each other. Some sorts of potato are more subject to the disease than others; it is more prevalent in flat countries than in more elevated districts."

"From these descriptions," adds Mr. Smee, "I am much disposed to believe that our present gangrene is only an exaggerated form of the old curl." He attributes the present disease to an insect.

I have not learned that the cause of the curl was ascertained, or any remedy found, though a reward was offered for the discovery.

About nine or ten years ago the potatoes began to be affected with disease, which appeared in two distinct forms. In one of these forms, the appearance is of a black spot in the tuber, which is probably a congeries of fungi, or small plants of the fungus tribe, not the cause of the disease, but collected there as all other plants grow spontaneously on soil suited to their peculiar habit, it being the habit of the fungi to draw their aliment from decaying vegetable matter, not, like plants of a higher order, from inorganic matter. The other form of the disease makes its appearance on the skin of the tuber, by a copper colored or ruddy brown spot, and soon after, the fleshy part of the tuber becomes soft, something like the rottenness in an apple, and spreads rapidly through the whole of the potato. In the mean time the leaf becomes curled on the edge, and marked with a dark color. The first named form of disease was for a time attributed to insects.

That idea has been found to be erroneous. The two forms of disease arise, as I conceive, from one cause, which was mentioned by me many years ago, and will be explained in these pages, in which I design to show some reasons for the opinion.

Mr. Smee, an English writer, speaks of two kinds of disease, which he calls gangrene, the dry and the moist gangrene. These are the same diseases which attack the fruit trees, and are usually called canker. The moist gangrene is the second species of rot named above. His other disease, which he calls dry gangrene, is that condition of the potato in which the tuber shrinks internally, and leaves a hollow in the centre, sometimes having the form nearly of an X. The potato has been frequently marked in this way among us, for at least twenty-five or thirty years, I think, but certainly for a long number of years before anything was said about the rot. Considering this as one form of disease then, there appear to be three. I refer them all, however, to the same cause.

Humboldt says the potato is not indigenous in Peru, and that it is nowhere to be found wild in the part of the Cordilleras situated under the tropics. It has been said also that it is not to be found in Virginia, or in any part of North America; but in its natural state is only to be found on the western side of South America. The statement, however, that it is not indigenous to Peru, as well as that it is not to be found in North America, appear to be erroneous, for Mr. Smee says there is at Chelsea Botanical Gardens, in England, a fine plant said to be of the wild potato, which he was informed was procured at Santa Fe. There are, however, some two or three places thus named, and it is not certain which is intended. It was probably in New Mexico. Santa Fe de Bogota is in

about 4° north; and the other is in 35° north latitude, exactly corresponding to its locality south of the equator.

M. Poiteau, editor of the Bon Jardinier, Paris for 1843, says that he formerly received from M. Sabine some tubers of the wild potato from Chili, which he supposes the type of all the cultivated varieties. The plant is remarkable by the very spreading roots and by the great number of its white flowers; but the tubers, small and brownish, are infinitely far from the quality of our good varieties.

As the question of the locality of this plant is acquiring interest, I copy from Mr. Smee's work an account of it as given therein. It may become necessary to resort to the wild stock again to replenish our fields and gardens, and in that view it becomes important to ascertain the localities, and that our consuls in the vicinity should be requested to furnish seed from thence. "Don J. Pavon, in a letter to Mr. Lambert, says that solanum tuberosum grows wild in the environs of Lima, and fourteen leagues from Lima on the coast; and I myself have found it in the kingdom of Chili;" and Mr. Lambert adds, "I have lately received from M. Pavon very fine wild specimens of solanum tuberosum, collected by himself in Peru. In Chili, it is generally found in steep rocky places, where it could never have been cultivated, and where its introduction must have been almost impossible. It is very common about Valparaiso, and Cruikshank has noticed it along the coast for fifteen leagues, to the northward of that port: how much farther it may extend north or south, he knows not."

A further account of some tubers brought from the same vicinity is related by Mr. Smee. He says, "Caldcleugh, who had been sometime resident at Rio Janeiro, holding the office of Secretary to the British Minister, brought with him two tubers of the wild potato, which

he sent to the Secretary of the Horticultural Society of London, with the following letter, which is to be found at p. 249 in the fifth volume of the Transactions of the Society.

"It is with no small degree of pleasure that I am enabled to send you some specimens of the solanum tuberosum, or native wild potato of South America. It is found growing in considerable quantities in ravines in the immediate neighborhood of Valparaiso, on the western side of South America, in latitude 34½ degrees south. The leaves and flowers of the plant are similar in every respect to those cultivated in England and elsewhere. It begins to flower in the month of October, the spring of that climate, and is not very prolific. The roots are small and of a bitterish taste, some with red, and others with yellowish skins. I am inclined to think that this plant grows on a large extent of the coast, for in the south of Chili it is found, and is called by the natives *maglia*, but I cannot discover that it is employed to any purpose. I am indebted for these specimens to an officer of His Majesty's ship Owen Glendower, who left the country some time after me."*

"The two tubers were exhibited to the Society, and a drawing made of them before they were planted, (plate 9, fig. 2, Hort. Trans. vol. 5). Had there been a third, I should have been tempted to satisfy myself as to the real flavor which Mr. Caldcleugh, as well as Molina, describes as bitter. They were planted separately, in small pots, and speedily vegetated. They grew rapidly, and were subsequently turned out into a border, at about two feet distance from each other, when they became very strong and luxuriant. The blossoms at first were but sparingly pro-

* The remainder of this statement is apparently from the gardener, though it is not so stated by Mr. Smee.

duced, but as the plants were earthed up, they increased in vigor, and then bore flowers abundantly; but these were not succeeded by fruit. A drawing of a branch was made by Miss Cotton, which has been engraved (plate XII., Hort. Trans. vol. 5). The flower was white, and differed in no respect from those varieties of the common potato which have white blossoms. The leaves were compared with specimens of several varieties of the cultivated potato, which generally were rather more of a rugose and uneven surface above, and with the veins stronger and more conspicuous below, but in other respects there was no difference between them. The pinnulæ which grew on the sides of the petiole, between the pinnæ of the leaves, were few, not near so numerous as in some varieties of the cultivated potato; but in specimens of other varieties that were examined, their leaves were destitute of pinnulæ, so that the existence of these appendages does not appear to be so essential a characteristic as has been supposed, and as is stated in the supplement to the "Encyclopedia."

"The plants have been recently taken up, and all doubt respecting them is now removed; they are unquestionably the solanum tuberosum. The principal stems, when extended, measured more than seven feet in length. The produce was most abundant; above six hundred tubers were gathered from the two plants. They are of various sizes, a few as large, or larger than a pigeon's egg, others as small as the original ones, rather angular, but more globular than oblong; some are white, others marked with blotches of pale red or white. Two of these were selected to be drawn, and are represented (plate IX., fig. 3, Hort. Trans. vol. 5). The flavor of them when boiled was exactly that of a young potato.

"The compost used in moulding up the plants was very much saturated with manure, and to this circumstance I

attribute the excessive luxuriance of the growth of the stems. Had common garden mould been applied, they would not probably have grown so strong; and I suppose that whilst the plants were thus rapidly making stems and leaves, the formation of the tubers was delayed, for the production of these has been the work of the latter part of the season. They cannot be called fully ripe, nor have they attained the size which they probably might have done, if they had been formed earlier."

Mr. Smee adds, "I am informed by Mr. Thompson that this wild potato was lost from the Horticultural Gardens, many years ago."

The foregoing account, presenting the potato in its native locality and wild condition, and also an authentic relation of the process and mode of cultivation, and the success of the attempt, by which the change from the wild to the cultivated state is so well shown, was considered a matter of so much interest to cultivators, as well as to naturalists, that it has been inserted here entire.

From this account of the locality of the potato, it must be supposed that a mountain country is most congenial to its habit, and that the most suitable climate is to be found in lat. 35°. The mountains of Carolina would answer these conditions; and it is indeed probable that here originated those specimens which Raleigh first transplanted thence to England.

The potato takes a foremost rank among those matters fitted for nutriment, both of men and animals; The proportion of nutriment is very large. Beside its esculent use, it is employed in the arts for making starch and whiskey.

The varieties of the potato are very numerous. I have seen a list of one hundred and sixty kinds now or lately cultivated in the gardens of the Horticultural Society, in

England; which probably does not include all which are cultivated in that country. Whether they are as numerous in France, I do not know. I have seen about twenty named of the kinds raised there. In this country they are probably as numerous as in England. Mr. Cole, late editor of the New England Farmer, raised forty new varieties from seed. In Germany the varieties are but few.

From an account in the Quarterly Journal of Agriculture, it must be inferred, either that Gerarde's idea of the potato being held as a delicacy was not adopted very generally, or that the duration of this degree of favor to it was short, since that work would have it believed that some thirty or forty years later there was a strong prejudice against it. The statement there is, that prejudice for a long time retarded the general use of the potato. They were left, it is said, in the ground from year to year, a few being used in the autumn; the parent plants being covered with litter to save them from the winter's frost.* The progress of the cultivation was afterwards greatly retarded by the fact that "potatoes are not mentioned in the Bible," which was deemed a good reason for rejecting them. Ignorance of the proper mode of cooking them (an evil that has not yet been wholly remedied) also retarded their culture. A person who had been invited to partake of the first mess of potatoes in the county of Forfair, Scotland, about 1730, related that the roots had been merely heated, and that they adhered to the teeth like glue; while their flavor was far from agreeable. The food was about to be condemned, through the ignorance of the cook, when the accidental arrival of a gentleman who had tasted a potato in Lancashire, caused the rejected roots to be remanded to

* This care of the plant does not confirm the statement in regard to prejudice.

the hot ashes, and they became as dainty as they had been before nauseous. It is less than seventy years, by the same account, since any particular attention has been paid, in France, to the cultivation of the potato. They were long regarded as unwholesome, only fit for cattle, or the most wretched of human beings. The mode of cooking potatoes in France now is so diversified, that, it is said, a gentleman dined a party of friends entirely on them, and sumptuously too, they being prepared in thirty-two different modes.

PHYSIOLOGY OF VEGETABLES. THEIR STRUCTURE AND ECONOMY.

It may aid us somewhat in coming to a correct conclusion on the question of the origin and cause of the disease of the Potato, to bear in mind the general structure of vegtables and the functions performed by the several parts, and the purpose and result of these functions in their separate and united action, or what may be termed the economy of the plant.

The plant consists of root, stem, leaves and flowers; or, botanically speaking, of root, herbage, and fructification, each of which performs a different function, carries on its own process, and has a different part and office in producing the general result, or in the vegetable economy. The several parts seem not to differ so much in structure as in function; all of them being made up of cells, tubes, and vesicles, and the root, stem, and leaf being each provided with a framework of fibre, and each covered with a cuticle or skin. The function of the root is to draw up moisture from the ground, which is, through the medium of the trunk, and by some mysterious agency, converted

into sap and carried to every portion of the plant;—is further changed by the action of the leaves into a sap having different qualities from the ascending sap, and is then made to return again through the plant in its changed form; as the blood of man receives a change in its passage through the lungs, and is returned through his system in the form of arterial blood. This change performed on the sap by the leaves is so great that in some plants in which, later in the season, it becomes highly poisonous or narcotic, it is in the spring safe and wholesome to be drank.

The functions of the stem and branches are, to pass the ascending and descending sap to all parts of the plant. It is not easy in all cases to distinguish what is root and what is stem in a plant. Some parts are commonly regarded as roots which are in fact stems. The position only of being above or below the ground does not determine the question. The stem sometimes grows beneath the ground. The root has a downward tendency, and absorbing, sponge-like pores, by which the aliment is taken up for the plant. The stem commonly has leaf-buds.

The leaves perform the functions of respiration and perspiration; and the effect produced upon the sap by these two actions is, as above stated, to work a change in it, by which, in some plants the quality of the sap is materially altered. They are supposed also to perform the digestion of the plant, assimilating the aliment into the peculiar secretions; as well as absorption.

The internal organization, or anatomy of plants consists in a series of tubes, cells and vesicles regularly arranged, and through which that action is carried on which constitutes the vitality of the plant, or vegetable life.

The seeds of plants have four parts, each of which is easily discernible in the pea or bean. First, the point,

by which it is attached to the receptacle, or in the pea or bean to the pod, in the corn, to the ear. This is termed hilum or scar. Second, the thin husk or skin, which, when the seed is ripe, seems to be a part altogether useless, forms an envelope or bag very necessary to contain it in its earlier state, when it is a mere juice, or as it is called by the farmer, in the milk. Third, the cotyledon which is the main fleshy part of the seed, constituting its principal bulk, most frequently divided into two portions by a seam, as in the bean, which easily opens. Fourth, and the part which is all important in producing a new plant is the corcule, the most essential part in the germination of the plant, consisting of radicle, which descends and forms the root, and plume, which ascends and forms the stem. It lays near the scar or hilum, and when the bean swells and opens is distinctly seen in the shape of a fleshy filament which is the sprout or shooting of the new plant. The essential element in the constitution of the seed, which appears to be necessary to its fructification and the reproduction of new life by development of the embryo, is starch, which, by the application of due heat and moisture, effects the germinating process, in which the starch is converted into sugar.

The bark or outer covering of plants consists of an outer coat, called epidermis or cuticle, of a cellular integument, and of an inner coat or liber. The cellular integument of the bark, by extension forms the leaf, with a covering, on both sides, of the expanded cuticle. The cellular tissue in fact not only is extended into the leaf, but pervades the whole body of the plant, through the inner bark and the heart of the wood, and the pith. The wood, or heart, of a plant is formed by a number of layers, concentrically arranged, each years growth constituting one layer, with a cellular membrane intervening each, through

which the juices of the plant are circulated. The pith is in the centre of the stem, constituting usually, in herbaceous plants, a large part of the stem in bulk. In such plants it usually contains a large share of the juices. It sometimes forms an article of food, as the pith of a species of palm, called the sago palm, and also of a wax palm of South America. It is probable also that the pith of the sugar cane and of Indian corn might be very palatable and nutritious food. Between the bark and the proper wood is a layer of sap or alburnum, in perennial plants, which, however, is subsequently converted into proper wood.

Throughout these several parts of the plant, are disseminated the vascular and cellular openings or tubes which serve to convey the air, juices and alimentary matter from one part to another. These consist of the medullary appendices, proceeding from the pith and crossing the grains or layers of the trunk or stem, in a radiate direction, known by workmen as the silver grain, air vessels, called tracheæ, sap-vessels, and vessels which secrete the proper juices of the plant.

The roots absorb water, and substances contained in the water in solution, which is immediately converted into sap, and, in that form, passed upward to the branches, leaves and other parts. In the passage through the leaves it undergoes another change, which has been likened to the change which takes place in the blood of man, from venous to arterial, in passing through the lungs. Other vessels are appointed to carry on the proper secretions of the plant by which are produced tannin, fixed and volatile oils, turpentine, gum, rosin, starch, wax, tallow, camphor, sugar, opium, various coloring matters, and acids.

The buds are the embryo branches, which from time to time continue to be developed while the life of the plant

remains—constantly changing the form, and multiplying the limbs as well as enlarging the extension of the plant. In this, vegetable life differs from most of the animal world. Though in some of the lower orders of animals, as in the frog, something analogous exists, the animal not being evolved from the embryo in its perfect shape, but having new limbs developed after it has been in life some days. But with few exceptions the perfect animal is at once evolved from the embryo. It is different in the vegetable creation. The plant is continually putting forth buds, which if suffered to remain and vegetate on the parent stock, become new branches only, of the parent; but if removed from the stem and placed in the earth, in a condition for their growth become developed into a full and perfect plant, instead of a branch of the parent. In this case, however, it is merely the extension or multiplication of the form of the life already in being, and not a new life—not a new individual.

The principal matters absorbed by the roots of all plants are water and carbonic acid. These are essential to their growth. In the act of respiration they throw out oxygen, which is a principal constituent of both of those substances. And the consequence of setting free the oxygen of the water and carbonic acid is the production of gum, starch and sugar. Starch, which is very abundant in the potato and the cereal grains, is converted into sugar by the process of germination, as may be perceived by the sweet taste of malted barley.

The reproductive power of plants is in the seed only. It is only by the development of the embryo contained in the seed that a new life can be produced. This embryo of life is not fully developed at once, but continues gradually to be developed in the production of new parts, as above mentioned by means of the buds, which from

time to time put forth. Each of these buds, however, though it may produce new forms of vegetation, and propagate new plants, yet does not reproduce or generate new life; but it is merely an extension of the life generated from the single embryo of the seed. This is generally well understood by cultivators. Having thought proper however to state the principle here, and it being the basis on which my ideas of the disease rest, a few extracts are adduced from some of the writers on the subject whose opinions are universally acknowledged, in confirmation of it. The following is from Dr. James E. Smith, one of the most scientific writers on Physiological Botany.

"By buds, as we well know, plants are propagated, and in that sense each bud is a separate being, or a young plant in itself; *but such propagation is only the extension of an individual*, and *not a reproduction of the species*, as by seed. Accordingly all plants increased by buds, cuttings, layers or roots, retain precisely the peculiar qualities of the individual to which they owe their origin. If those qualities differ from what are common to the species, sufficiently to constitute what is called a variety, that variety is perpetuated through all the progeny thus obtained. This fact is exemplified in a thousand instances, none more notorious than the different kinds of apples, all which are varieties of the common crab, *Pyrus malus;* and I cannot but assent to Mr. Knight's opinion, that *each individual thus propagated has only a determinate existence, in some cases longer, in others shorter;* FROM WHICH CAUSE MANY VALUABLE VARIETIES OF APPLES AND PEARS, KNOWN IN FORMER TIMES, ARE NOW WORN OUT, AND OTHERS ARE DWINDLING AWAY BEFORE OUR EYES.

* * * * * * * * * * * * Gardeners know how many of the most hardy perennial herbs require to be frequently renewed from

seed, to exist in full vigor; and though others appear, to our confined experience, unlimited in that respect, we have many reasons to believe they are not so. Propagation by seeds, is therefore the only true REPRODUCTION of plants, by which each species remains distinct, and all variations are effaced; for though new varieties may arise among a great number of seedling plants, it does not appear that such varieties owe their peculiarities to any that may have existed in the parent plants. [Smith's Phys. and Sys. Botany, pp. 121, 122.]

Again this author says, [Chap. 19,] "Having examined the general structure and external form of plants, we now come to more important and even essential, though more transitory organs—the flower and fruit, or parts of fructification. *By these each species is perpetually renewed without limits*, so far at least as the observation of mankind has reached; while, as we have already mentioned, *all other modes of propagation are but the extension of an individual*, AND SOONER OR LATER TERMINATE IN ITS TOTAL EXTINCTION. [Ib. p. 194.]

Mr. Raspail says, "The substitution of a bud for the seed as the germ of a plant, is rather a transplantation than a reproduction. It is only a continuance of the same individual plant." [Raspail, p. 194, 196.]

Dr. Darwin, in his work entitled Phytologia, or the Philosophy of Agriculture, calls this propagation by buds, "lateral production," and "paternal offspring." Some of his own ideas upon buds and their faculty of propagation are very curious and instructive, while some are conjectural and imaginative. He had studied the whole physiology of the vegetable world with a zeal and intense ardor, and especially what relates to the function of reproduction and propagation. He says, in Sec. 7, 1, 3, p. 95, "Another curious occurrence in this lateral production of

vegetables by their buds has been lately published by Mr. Knight in the Ph. Trans. for the year 1795, who observes that those apple trees which have been continually propagated for above a century by ingrafting, are now become so diseased by canker or otherwise, that though the fruit continues of the same flavor, the trees are not worth propagating; as these grafts, though transplanted into other trees, he esteems to be still *an elongation of the original tree, and must feel the effect of age, like the tree they were taken from.* If this idea should prove true, on further examination, there is reason to suspect the same may occur in the too long propagation of plants from bulbs and wires, as potatoes and strawberries, which may have occasioned the curled tops of potatoes, and the black blight in the flowers of the hautbois strawberry, which some have ascribed to its only bearing male flowers; the cure of which must arise from our applying to other varieties more lately derived from a seminal offspring.

It is true that Dr. Darwin does not agree to the view therein suggested by Mr. Knight. He thinks the disease or degeneracy of plants raised from buds is not to be ascribed to the age of the original seedling stock, but to hereditary diseases derived from that stock, or some of the intervening line, which in the seminal progeny would be counteracted by intermixture. This might undoubtedly sometimes be the case. Though as a scientific question, there is some difference in the two theories, yet in agricultural practice, and as a question of cultivation, it becomes a difference almost without a distinction, and not important enough to be mentioned; the source of disease in each case being paternal, and requiring the same remedy.

NATURAL HISTORY OF THE POTATO.

The potato is a plant of the class pentandria, order monogynia, and included by Linnæus in the natural order luridæ, and by Jussieu in that of solaneæ. The genus, solanum, comprises a large number of species. Botanists have mentioned about an hundred. Some of these, beside the potato, are among the most valuable esculents. Of these are the solanum lycopersicum, familiarly known to us as the tomato, a corruption of the Spanish name estomatos; and the solanum melongena, or egg plant, a favorite vegetable in the States farther South. The potato plant has its botanical name from the edible tuber, solanum tuberosum. The common name potato seems to be a corruption of the name by which the sweet potato was known at the time the other was first seen by the English, which was batatas. The name of our potato was opanawk in Virginia, and in South America papas.

Others of this genus are acrid, noxious and poisonous. It comprehends a great number of species called nightshade, among them solanum dulcamara, woody nightshade, or bitter-sweet, and solanum nigrum, common nightshade. To the order solaneæ, belong also nicotiana, tobacco; datura, thorn apple; digitalis, foxglove; hyosciamus, henbane; atropa, deadly nightshade.

In some species of the genus solanum, the flowers are very handsome, and the fruit ornamental. The corolla is generally blue, purple, white or yellow. The fruit yellow or red. The herbage is fœtid and narcotic. Flowers without scent. Fruit often nauseous, and not eatable without dressing. The solanum lycopersicum is, however, as is well known, highly palatable and delicious as taken from the vine. Several species of the solanum are cultivated. Beside the potato, tomato, and egg plant, the

Ethiopian nightshade; the woody nightshade, or bitter sweet; the mullein-leaved nightshade; the shrubby; the oak-leaved; the dug-fruited; the Indian; Carolina; black-spined; Palestine.

The potato is an annual plant. Though originally found in but few places, it has become naturalized throughout this continent and Europe, and its habitation now extends from the equator to 70 degrees north. It was found native in Peru and Virginia. In its native state the tuber is quite small, being about the size of a nutmeg; and it has been brought to its present increased size by cultivation.

The varieties that have been produced by cultivation are almost endless. The principal varieties, however, are considered but two, the white and the red; the others are regarded as subvarieties.

The potato has sometimes been described as a tuberous rooted plant. This is, however, inaccurate. The tuber has not the structure and cannot perform the function of a root. The office of the root is to draw up aliment in the shape of water and earthy matters, to be conveyed to all parts of the plant, for its nourishment, and to this end it is furnished with pores, by which the absorption is effected. This is not the office of the tuber, and its structure is not adapted to this end. On the other hand the matter of the tuber is well elaborated in the economy of the plant before it is deposited, and its own nourishment is apparently the chief end and object of that economy. Not performing the function of a root, it is not then accurate to describe it as a root.

It is well known that the tuber of the potato plant consists in great part of starch. It is also known that the same ingredient enters largely into the process of fructification in all plants, and that there is a deposit of this

matter made in the receptacle or other part of the flower at the period of the formation of the fruit, to assist in the office of forming and bringing it to perfection. Now it would seem to be the case that the proper roots of the potato draw from the earth much more of the elements of this substance than can be used in the process of fructification; and the surplus is continued in the circulation of the plant, and returned with the returning juices, and at the bottom of the stem is concentrated and developed in the tuber, which makes the most important and valuable part of the plant. The proper root has performed its appropriate function of drawing up the necessary nourishment of the plant before the tuber has begun to form. The true root is composed of the small filaments which are connected with the stem; and the potato is, in fact, a fibrous-rooted plant, having roots similar to the grasses. The tubers are not attached to the roots, but to runners proceeding from the base of the stem, which are wholly distinct from the fibres which perform the function of roots.

The tuber is now generally considered as a part of the stem, an under ground stem, or root stalk. In proof that it is such, are mentioned the buds or eyes, which are similar to those on the stems and branches of plants, and of which it is said roots are deficient, and that these eyes or buds of the tuber, like the buds on the twigs of trees, are capable of propagating the plant. There seem to be again some reasons against regarding the tuber as a part of the stem. It differs in structure, elements and properties from the aerial stem, being more pulpy and juicy, containing more starch, and less fibre, and having more nutritive properties. This difference is supposed to be sufficiently explained by its underground growth. This condition would, no doubt, be the cause of some differences, but whether to

such an extent does not seem certain. Starch, the principal constituent of the tuber, as has been mentioned, is an essential element in the fructification of the plant. There being more of this substance, however, elaborated in the economy of the vegetable than is required in supplying the seeds, it may be supposed to be returned through the tissues of the plant, and deposited at the base of the stem. The tuber, then, might rather be regarded as a peculiar secretion of the plant, anomalous in its nature, than as a portion of the stem. And the period of its formation would also favor this idea. On the other hand the buds endowed with the faculty of propagation present an objection to this supposition, and favor that which considers it as a part of the stem.

In this light it is regarded by the author of an excellent volume entitled, "A Popular Treatise on Vegetable Physiology," published a few years since in Philadelphia. That writer says, "one of the most distorted forms of the stem is that which presents itself in the potato. This plant grows with an underground stem, sending up its flowering branches into the air, and sending its roots downwards into the earth; but on this stem it forms, at intervals, the tubers or knobs, which constitute such an important article of food to man. That these tubers are still parts of the stem, is shewn by their power of originating buds, from the points commonly known as the eyes of the potato. When, therefore, we divide the tuber into pieces, keeping an eye in each, from every one of which we expect a young plant to spring, we follow, in fact, the same plan as that adopted in planting sugar-canes, which are not propagated from seed, but by dividing the stem into its internodes, and laying each of these separately in the ground. The quantity of fleshy matter deposited in the potato serves for the nourishment of the growing buds

before their roots are formed; and thus it is that, if exposed to a warm and moist atmosphere, they are liable to sprout, without the contact of earth. It is remarkable that in their native climate, (the tropical part of South America,) the tubers of the potato are extremely small, and that they become so when plants are raised from British stocks in any countries equally hot."

This liability to sprout, however, when exposed to warmth and moisture, does not depend on the fact that the fleshy matter of the tuber serves for the nourishment of the plant, nor is peculiar to that plant. It is the case with other plants that the starch of the seed furnishes nutriment to the young shoot, and also, if exposed to the conditions of warmth and moisture they will sprout, though not in contact with earth. It is in the same way that barley is malted, and that seeds are rendered unproductive by too long keeping.

On the other hand, the tuber is considered by Dr. Smith, a most excellent authority on all matters of vegetable physiology, as a root, and the potato is mentioned by him (page 98) as an example of a tuberous rooted plant. The reasons already mentioned must be considered, however, sufficient to confute this idea, though countenanced by so distinguished a physiologist.

But whatever may be the relation of the tuber to the vegetable being, whether it be part of stem or root, or whether it be neither, it is sufficient for the present purpose to know that it is not the seed of the plant. It does not bear any analogy to the fruit, is not the pericarp, does not contain the seed; and whether it be a part of the root or an underground stem, by propagation by it of new plants, the production of a vine is not a reproduction of new life, but merely the production of a new form by extension of the old life, analogous to the production of new

forms by layering or grafting, by which a bud, instead of being the germ and sprout of a new branch, is made to take the form of a new, perfect plant, all parts, both root and stem proceeding from it. It is an extension of the same life, not a production of a new one.

Some varieties of the potato were found, on analysis, to contain as follows in 7000 grains or one pound

	Soluble matter.	Starch.	Fibre.	Water.
variety called the bread-fruit,	975	548	477	5000
" " Barbadoes,	980	667	616	4737
" " black-kidney,	970	695	622	4713

the soluble matters consisted of gum or mucilage, extractive, and saline matters. Other experiments show a large quantity of potash in the potato, which in this result may have been partly contained in the saline matters, and partly in the fibre.

The locality of the potato does not seem to be tropical, as stated by the author quoted on the preceding page. Humboldt expressly asserts that it is not to be found there. By the account given in the historical part of these pages, its habitation seems to be about lat. 35°. That is the latitude of Valparaiso, and also of Santa Fe (New Mexico); and the tract of country called Virginia, at the time of Raleigh's visit, or rather so named by him, covered the same latitude. It is probable that the plant may be found at this time wild in the mountains of North Carolina.

The alimentary and nutritive properties of the potato are very great. Few plants contain a larger proportion. They are said to furnish all the elements necessary to the support of man, and they have sometimes constituted his sole food.

DISEASES OF PLANTS. THE POTATO DISEASE.

The vegetable world is subject to a variety of diseases. That which has life must experience decay and death. Unless endowed with immortality, there must be a dissolution of the physical organism; and of course there must be disease. Vegetable life, as well as animal, is subject to these conditions. The nopal, or Indian fig, *cactus cochinellifer*, a tree of South America, is very subject to gangrene, which disorder shows itself by a black spot in the leaf, and spreads till the leaf or branch drops off, or till the plant dies. The same plant is also subject to a sudden decay of the vital principle. It changes in an hour from a shining green to a dead yellow color, and becomes quite rotten. The honey-dew is a disease to which the hop and other plants are subject. The blight, mildew, mould, smut, ergot, &c., are, some of them, produced by fungi, which vegetating in the grain cause a drying of the sap, and a destruction even of the organic structure of the grain. This is the case with smut, as it is usually called with us; sometimes called blight, dust-bran, burntcorn, in England, and known by a variety of names. The disease attacks the gluten especially, and also prevents the formation of the starch. It is chiefly confined to the cereal plants. The disease is communicable from the parent seed, though the diseased seed, if well rubbed between the hands and washed clean, will produce healthy grain.

The mildew, commonly called rust by our farmers, a disease very different in its appearance from the smut, is yet caused in the same way, by a fungus, and one very nearly allied to the smut. It becomes attached to the stem, instead of the grain, and its roots penetrating into the plant, are nourished by the sap which should go to

the development of the grain. In consequence, the grain becomes shrivelled. This disease is mentioned in Deuteronomy, and by some of the prophets, and was known also to the Greeks and Romans, says Mr. Johnson, author of the Farmers' Encyclopedia, yet no cure has to this day been found for it; and though Theophrastus wrote upon it in his history of plants three centuries before Christ, the cause of it was not suspected till within a century of the present time. It was first mentioned by F. Fontana, an Italian, in 1767. All soils, all varieties of grain, and all situations are liable to this epidemic, though it has been said that high situations are not affected to the extent which grain in the low valleys suffer. The form of blight known as red-rust, and another called red-gum, are both caused by fungi, the first of which attacks the stem, like the rust or mildew, the other attacks the grain itself. The ergot commonly attacks rye, and other gramineous plants. The grain or berry becomes of a dark color, and elongated like a horn. This is also a parasitic fungus, like those above named.*

The canker, sometimes called dry gangrene, which attacks apple trees, is well known to most farmers. That disease is said on very good authority to attack generally two classes of subjects; the aged and those which have had an extraordinarily vigorous growth—which conditions would show the same cause of disease in both, that is, a waste of life, or dimunition of the vital principle.

The fungi, some of which to the common eye, have the appearance of mere earthy excrescenses or atmospheric concretions, are in reality endowed with vegetable life. Not only the mushrooms, but puff-balls, and some kinds

*The fungi are spoken of here as causing the disease. The peculiar appearance in these cases is from the presence of fungi; but from their habit it must be supposed that disease existed previous to their attack.

of mould, mildew, and blight are organized matter capable of reproduction and vegetation. Such are the ergot of some plants, and the smut of wheat. These differ from the vegetable orders next above them in the scale, principally in the aliment required for their support, and the conditions necessary to their existence. The others drawing their subsistence from water, or from the atmosphere, while the fungi are nourished by organized matter, animal or vegetable, in a state of decay, or in which decomposition or some change from a perfectly sound and healthy condition has taken place. The fine dust which issues from the puff-balls consists of the germs of new plants, which when borne through the air by the wind, and finding some substances suited to their subsistence, are thereto attached, and become developed in the ordinary course and manner of vegetation. The body of the silk-worm, when about to undergo its change to the chrysalis state, presents a condition favorable to the growth of these germs, and they frequently become attached to it, and the vegetation of the germ constitutes the disease known among the silk growers by the name of muscardine. And it is probable that the selection which is made by epidemic diseases among mankind may be owing to this cause; the miasma which is supposed to produce the disease, finding the requisite conditions for its growth only in subjects who are in somewhat impaired health or vigor. And this it is, probably, which gives rise to the disputes about the contagious nature of such epidemics; some persons living untouched in the midst of the disease, while others apparently receive it from the infected atmosphere, or contact with others.

The peculiar condition of timber called dry rot, is also occasioned by the growth of these fungi. The fungi may cause decay in vegetable bodies which had not previously exhibited any signs of disease or weakness; but they more

commonly only serve to hasten it where previous disease had existed, which is usually the condition of plants to which they become attached. These very minute vegetable bodies, like the smaller insects which are among the lowest in the scale of animal life, are extremely prolific. They are produced in such profusion that, borne upon the wind, they are ever ready to fix wherever the conditions are suitable to their nourishment.

It is very probable that the presence of some fungi of this sort in the potato may give rise to some of the distinctive characteristics appearing in the potato disease, called the rot. The writer does not profess certainty on this point. He has not made any examinations to determine if it may be so, or not. It has been stated on sufficiently good authority to be so. In his view it is not essential; for the theory which he intends to establish is, that if fungi are present in the diseased potato, they are there because the tubers are previously in a condition suited to afford them aliment—that is, they are already in an unhealthy, enfeebled condition. That condition is old age. All vegetable, as well as all animal life, has a limit to its existence. Whatever has life is subject to death, decay and disease. The potato has been propagated for the most part from sets or buds, for a long course of years. Occasionally a new variety is raised from the seed, but most of those at present in cultivation and use have been raised for many successive years from the buds or eyes of the tuber, which is only an extension of the same individual life, and not a production of new life. In addition to this, it is subject to a forced cultivation, in a climate to which it is not indigenous. These conditions would be likely to have much effect in shortening life. Though therefore the immediate disease may be either in part, or in whole the existence of fungi within, yet there is an ultimate cause to which the presence of these fungi

is owing, and that is the condition of old age. That is the disorder which is to be remedied.

The writer ventured to suggest this opinion in a paragraph of an agricultural paper in the winter of 1845—6. Since that time statements have been made in some of the papers going to show that some kinds of potatoes recently from seedlings had partaken of the disease. The fact is also stated by Mr. Smee. This at first sight might seem to invalidate the theory here advanced. But on the supposition that fungi are partly concerned in it, there are two considerations, which, if due weight is allowed to them, must exclude such a conclusion. The first of these considerations is, that though old age is peculiarly subject to the disease, nevertheless it may sometimes attack the young. The supposition that old age, in man, makes him peculiarly liable to disease and death, and to general debility, is not repelled by the occurrence of death or sickness in the case of a child. Old age *must* necessarily be subject to them. They *may* sometimes occur in childhood. The second consideration will be at once perceived to have force when the nature of the fungus is considered. For, supposing the presence of this plant; which having life is capable of reproduction, and that the reproduction is by immense numbers at a time: now in proportion to the proper subjects of the disease on which the fungi would naturally fix and find aliment, would they be increased, each new subject being a nursery for innumerable individuals constantly reproduced from their parent fungus. Each new reproduction constitutes a new stock of disease which when produced seeks a new subject on which to fix, and, wafted by the wind, finds for the most part a place of deposit in a diseased plant, or one in decomposition, particularly suited to it, *but sometimes fixes on healthy plants, which become diseased by its presence.* Thus the fungi nurtured in those potatoes which

were suitable to it, those debilitated by old age, have become indefinitely multiplied, and so numerous that, in some cases, they may fix and feed on healthy plants, as well as on the sickly. In this way the epidemic becomes generally prevalent.

Again if a plant is raised from a seed which was produced by a diseased or very aged parent, it would be liable to disease almost as much as a bud taken from the old stock. From these considerations it is evident that the circumstance of seedling or new plants being attacked by the disease, does not in any degree invalidate the theorem here asserted, which is founded in an immutable law of nature, attached to all forms of life, and to all organized matter; and that law is dissolution.

In the Farmer's Encyclopedia, by C. W. Johnson, Emerson's Phil. Ed., 1844, art. Canker, it is said, "although young trees are liable to this disease, yet their old age is the period of existence most obnoxious to its attacks. It must be remembered that that is not a young tree which is lately grafted. If the tree from which the scion was taken is an old variety, it is only a multiplication of an aged individual. The scion may, for a few years, exhibit signs of increased vigor, owing to the extra stimulus of the more abundant supply of healthy sap supplied by the stock, but the vessels of the scion will, after the lapse of that period, gradually become as decrepid as the parent tree. The unanimous experience of naturalists agree in testifying that every organized creature has its limit of existence. In plants it varies from the scanty period of a few months, to the long expanse of as many centuries; but, of all, the days are numbered; and though the gardener's, like the physician's skill, may retard the onward pace of death, he will not be permanently delayed. In the last period of life they show every symptom that ac-

companies organization in its old age, not only a cessation of growth, but a decay of former developments, a languid circulation and diseased organs."

"The canker, as already observed, attends especially the old age of some fruit trees, and of these the apple is, most remarkably, a sufferer. 'I don't mean,' says Mr. Knight, 'to assert that there ever was a time when an apple tree did not canker in unfavorable soils, or that highly cultivated varieties were not more generally subject to the disease than others, where the soil did not suit them; but I assert, from my own experience and observation within the last twenty years, that this disease becomes progressively more fatal to each variety, as the age of that variety, beyond a certain period, increases; that all the varieties of the apple which I have found in the catalogues of the middle of the seventeenth century, are unproductive of fruit, and in a state of debility and decay.'

"Among the individuals particularly liable to be infected, are those which have been marked by an excessively vigorous growth in their early years." [Art. Canker.]

The disease now prevalent in the potato, as was briefly stated in the first chapter of this tract, appears in three forms. The first a shrinking internally, leaving a hollow in the centre. The walls of this cavity are usually of a darker hue than the body of the tuber, sometimes having a resemblance to the rust of iron. The adjacent part of the tuber is frequently hard, so that when the potato is fully cooked by boiling, and become soft and mealy, this part remains hard, approaching in this respect to the hardness of callous flesh, or horn. This is considered by Mr. Smee one form of gangrene, and of course, being unattended with moisture, the dry gangrene. Another form, which he also calls gangrene is that where the tuber becomes soft, pulpy and moist, something similar to the rot-

tenness in apples. This is the moist gangrene. This is the disease which has particularly caused so much loss to farmers, so much consternation to those who delight especially in ministering to their appetites, and in providing pleasant and nourishing food for the earthy and physical nature; and so serious a detriment to the state, in the damage to a staple which is food for both man and beast, and a source of much wealth.

There is still a third form of disease, which is distinguished by a collection of black, dry matter, in the body of the tuber, and which, by whatever name called, was pretty extensive in the potato in this country within a few years, and is referred to by many persons, who communicated their observations in relation to it to the public, through the agricultural journals. Whether this might be a distinct disease, and independent of the cause which is here assigned for the other forms of disease may be questioned. I refer all, however, as before said, to one cause.

The gangrene may commence, says Mr. Smee, in various parts of the plant. It may attack a part of a single leaflet, which may die, or any part of the stalk, causing the death of the part above. Frequently it is first found in the underground stem. The tubers themselves finally become diseased. When the tuber is affected, parts, here and there, become soft, discolored and rotten. Under certain circumstances this diseased matter becomes dry, passing into dry gangrene; in others, it remains soft, in the state of moist gangrene. Sometimes it commences internally, before it appears on the skin. The disease, says the above very close and scientific observer, who has made a business to watch and study the malady, cannot be said to reside in the blotch in the leaf, the dead part of the stem, or the rotten tuber. It is a far more hidden affair, having its

residence in the vital elements of the plant; and therefore we may infer that it is a disease connected with the sap and cellular tissue, and thereby influencing the vital actions which occur between these necessary constituents of the organic body.

The decay and infirmity of old age cannot always be exactly measured by a numerical standard. Some men have as much decrepitude at sixty as others at ninety. So it is undoubtedly in vegetable life. Old age may be accelerated by other causes than time. Temperature or moisture, too great heat from the fertilizers used, too much stimulus, surfeiting with too great a supply of aliment, too much watering, storing in moist cellars, and the like causes may operate so unfavorably on the potato as to shorten the term of existence, without any specific disease, and by mere decay of its substance.

Mr. Berkely considers fungi to be the cause of the disease. Mr. Smee combats this theory, and while he admits the presence of the fungi, yet justly says that they do not produce it, and his observation has shown him that they are not present till after the disease has taken place. As his remarks on this head are very interesting and the result of close observation, assisted by much science, I transfer them to these pages. He says:

"Doubtless the fungi exercise an important influence upon the progress of the disease, although they, most assuredly, have not the power of producing it. In fact they never make their appearance until the potato plant has been previously damaged, and until some portion of it is already dead. I have tried several experiments on the inoculation of sound potatoes with fungi, but the result has been a comparative failure; and sound potatoes would remain amongst others abounding in numerous fungi without being injured."

"When the plant is damaged, then these vegetable parasites appear, and the function which they are destined to perform is highly interesting, and, in fact, a wonderful example of natural economy; for whilst man is careless, and allows decomposing bodies to send forth their putrid exhalations, and even buries the dead in the midst of the houses of the living, and allows the existence of open drains, and untrapped sewers, nature, when not interfered with, amply provides against the occurrence of such unhealthy and offensive conditions by taking effective means to remove the dead material."

"The carrion crow, the vulture, and the jackall, may do much;—the maggot, the beetle, and the wasp may do much,—towards the removal of dead animal matter; yet to the vegetable parasite is left the duty of annihilating the exhalations of putrifying vegetables."

"No sooner does death occur than fungi grow. These eat up, as it were, the soft decaying parts as fast as they rot; and thus is inorganic matter converted into organic; thus is death converted into life."

Thus Mr. Smee, both by fact and argument, combats the idea that the fungi cause the disease. All this is in accordance with our previous knowledge. He considers the disease to be caused by an insect. In support of this idea, he adduces many forcible arguments, and some important facts; but he makes, after all, the following observation, which shows *conclusively* that the insect *is not* the cause; and affords some countenance to the idea suggested in these pages. He says: "*this creature cannot well live on a very vigorous plant, because it would be drowned by the water transpired at night. Hence it generally commences upon leaves which have in a great degree lost their vigor. On placing insects upon the new leaves of very vigorous*

plants, I have observed that the creature has always been obliged to leave them. It commences upon the larger and nearly exhausted leaves; from these it passes to others, and so on till the entire foliage is affected."

Again he says in another place, "we find that wild plants in general, and the assumed wild potato plant, *resist much more effectively the ravages of the disease than the more highly cultivated varieties.*"

THE REMEDY.

Possibly in the great extent to which the epidemic has spread, it may not be so easy to apply the remedy with as complete success as might have been done at an earlier stage of its progress, before it had infected healthy subjects. If it were yet in that stage when its ravages were confined to the old subjects, and those already in a state of debility and partial decomposition, it would be sufficient to resort to seed, and suspend altogether the practice of raising from the tuber. This would give a young and healthy race of potatoes in the place of the feeble and sickly old stocks. Such a practice will even now probably be of great benefit, and if very generally followed, would reduce the disease from an epidemic to a sporadic character. It may be, however, sufficient of itself to effect a cure. And this is the remedy which it was the writer's purpose to propose. Two auxiliaries will, however, be suggested, which it is thought, as they have been found advantageous in other diseases, may be in this also. The practice of planting the potato in the fall has been considered useful in England and in France. It was adopted in the beginning of this century in England, at the time when the disease known as the "curl" was very prevalent. It has

been lately recommended in France in a work published in Boulogne, in May, 1851, by M. Leroy Mabille, entitled, "Le Pomme de terre gueri par la plantation d' automne, et la cause de la malade expliquee par la guerison," as a cure for the epidemic under which the potato now suffers. The other auxiliary referred to is the application of salt. This has been used with effect as a preventive and cure of the mildew; and if the disease in the potato is in part owing to fungus, though it may be one of a species differing from the mildew, yet it may be reasonable to suppose that, if salt destroys the mildew, it may be fatal to other fungi of a species nearly allied. The mode in which salt has been used for this purpose was by sprinkling with a water-pot, or laying on with a plasterer's brush, a solution in water of one pound to a gallon. I have not the book of M. Mabille, and do not know to what cause he attributes the disease. It is not obvious that any particular cause or form of disease should be satisfactorily proved or explained by the remedy applied in the practice of fall planting. I have more faith in the selection of new land, and in the application of salt and wood ashes, as a dressing, avoiding the use of stable matters, and by all means preventing a contact of the seed and roots with such matters.

The application of copperas has been found very effective in France as a restorative in curing debilitated plants. This is applied in solution by watering, or by reducing it to powder and sowing it mixed with fine soil or earth. Its action has been very speedy and effectual, restoring the plant in a short time. It may be well as a remedy or restorative, in cases where healthy plants are attacked, to make use of salt or copperas. And the selection of new land, and fall planting may be recommended, the former especially, in connection with such remedies, or rather as

preservatives of young tubers, not long from the seed, against the attacks of the disease. But these or any other applications or modes of culture, cannot give immortality to the plant. There is a time when, in spite of all human means and efforts, it must decay. To many of the varieties that have been long in cultivation, that time has come.

If this be correct, the rot will continue to ravage the potato crop, notwithstanding all expedients that may be adopted, or whatever remedies may be applied, so long as those varieties are cultivated which have been a long time from the seed; and though other remedies may be partially successful, the only effectual one is to be found in raising from the seed, or in cultivating those varieties which are but few years from the seed. Though this is the remedy, and the only one, *yet it will not follow, however, that in every case of raising from seed, the plant will be free from disease.* The seed may be from diseased potatoes, or there may be causes of disease arising to young, no less than to old subjects. As before said, disease may sometimes attack the child as well as the old man. No period of life, either animal or vegetable, is absolutely exempt from disease. The conclusion, therefore, that the disease is not in consequence of old age, drawn merely from cases of sickness in young subjects, would be very illogical and erroneous.

It may be the case, however, that the long and tenacious adherence to the practice of raising from tubers has infected all the varieties in use with us to such an extent, either with actual disease, or with a morbid predisposition, that no healthy seed can be now obtained without resorting to the wild plant, in its original locality. Fourteen years has been assigned as the limit of duration for the varieties of the potato. Unless, therefore, we have some varieties derived from progenitors free from any taint or

any weakness predisposing them to disease, and the plant itself, the last in the line, from which the seed is to be furnished, is also in a healthy condition, very little may be gained by resorting to seed. The potato raised from new seed could then only be safe from the disease, when the seed was from a plant, itself not more than ten years from the seed, and each preceding renewal of the plant by seed, was, in like manner, the product of tubers from varieties not exceeding that age. It not being well authenticated that any seed of this kind can be obtained from any cultivated varieties now in use, it would consequently be impossible to speak confidently of the full success of reproduction by seed obtained here. If it be, as supposed, deteriorated by the cause named, then the only remedy is in having recourse to the seed of the wild potato, or, what would be equally good, to tubers from them.

Prof. Mapes has raised a new variety from seed in New Jersey, which, I am informed, has not been infected with disease. And I have heard of others which have been exempt.

The writer will repeat, and wishes it understood that he does not propose either the use of salt, or the adoption of fall planting, though partially they may be a preventive; nor copperas, though a restorative in certain cases, as distinct remedies for the prevailing epidemic. The remedy he proposes is reproduction:—raising new individuals from seed; not extending their life by the planting of buds. The other practices are recommended as likely to aid in producing favorable conditions of the plant; and preserving those not debilitated by age; but the reproduction by seed is alone relied on as giving to the potato an innate, fundamental health and vigor of constitution. There are other conditions also which it might be advantageous to attend to. The potato has become the subject

of rather too much forcing:—and fertilizers of the coarsest kind and the most stimulating and heating quality have been applied directly to the plant for a long succession of years. This practice is bad, not only as communicating an unpleasant savor to the potato; an effect to which vegetables of a succulent kind are very susceptible, but undoubtedly tending to shorten the duration of vitality, and produce weakness in the plant. I would therefore suggest a discontinuance of this practice: and that a new soil should be chosen for a potato crop, with a fertilizing only of salt and soot, or wood ashes; or, if a rich mould, with no foreign fertilizer;—and if a new soil cannot be had, that a first crop should intervene after the dressing has been put on the ground, or at least, if stable dressing is used, that it be as much as possible composted and mixed with the soil, and that all contact of it with the seed or root should be prevented.

I desire intelligent farmers to attend to these conditions, and inform me of the results.

The summary of the argument attempted in these pages, is:—

First. We are taught equally by physiology, the nature and constitution of the vegetable world, and by the observation of all men, that plants have life, and must, and do have a period to that life.

Second. That the only mode of reproduction of new life in plants is by seeds;—and the mode of multiplying by buds, is, like the growth of a branch, only a development of the bud; and not a new life:—it is merely a multiplication of the form of the old life.

Third. That the period for the duration of the potato in vigor, is about fourteen years, and that many of the

varieties now cultivated have been cultivated for that period; and must be supposed therefore to have arrived at the limit of their vigor, at least, if not of their life:—and the potato raised last year from the tuber dates its life back to the time of beginning its variety by seed.

Fourth. Analogy to the fruit trees, which are affected by canker;—which is the same disease now affecting the potato, so considered by the learned, called by Mr. C. W. Johnson, Knight, and Smee, the gangrene,—teaches that the condition of old age is that which causes the disease. Mr. Knight was satisfied of that point in regard to fruit trees; and his opinion was the result of long observation and investigation:—and I consider it conclusive in relation to the fruit trees.

Fifth. It has long been ascertained that the fungi fix themselves on and draw nourishment from decaying vegetable matter: and rarely, if ever, on perfectly healthy plants.

Sixth. It was ascertained by Mr. Smee that though the fungi were generally present on diseased potatoes, they did not appear till after the disease had commenced.

Seventh. Though Mr. Smee endeavors to prove that the aphis is the cause of the disease:—yet he confesses that when he placed these insects on sound plants, they would not remain on them, but left them:—from which it must be considered that they do not cause the disease, but merely like the fungi, feed on diseased plants.

Only two possible causes then remain. First; The disease must be an epidemic that indiscriminately attacks all plants, sound or weak, young or old:—or it must be, Second; Old age. I hope I have succeeded in showing it must be the last, and nothing else. To some minds,

it will appear, doubtless, that absolute certainty of the fact is not made out. It will be impossible, under any circumstances, to show a certainty, equal to that we have of the existence of the potato: but to my mind the reasoning here given is convincing.