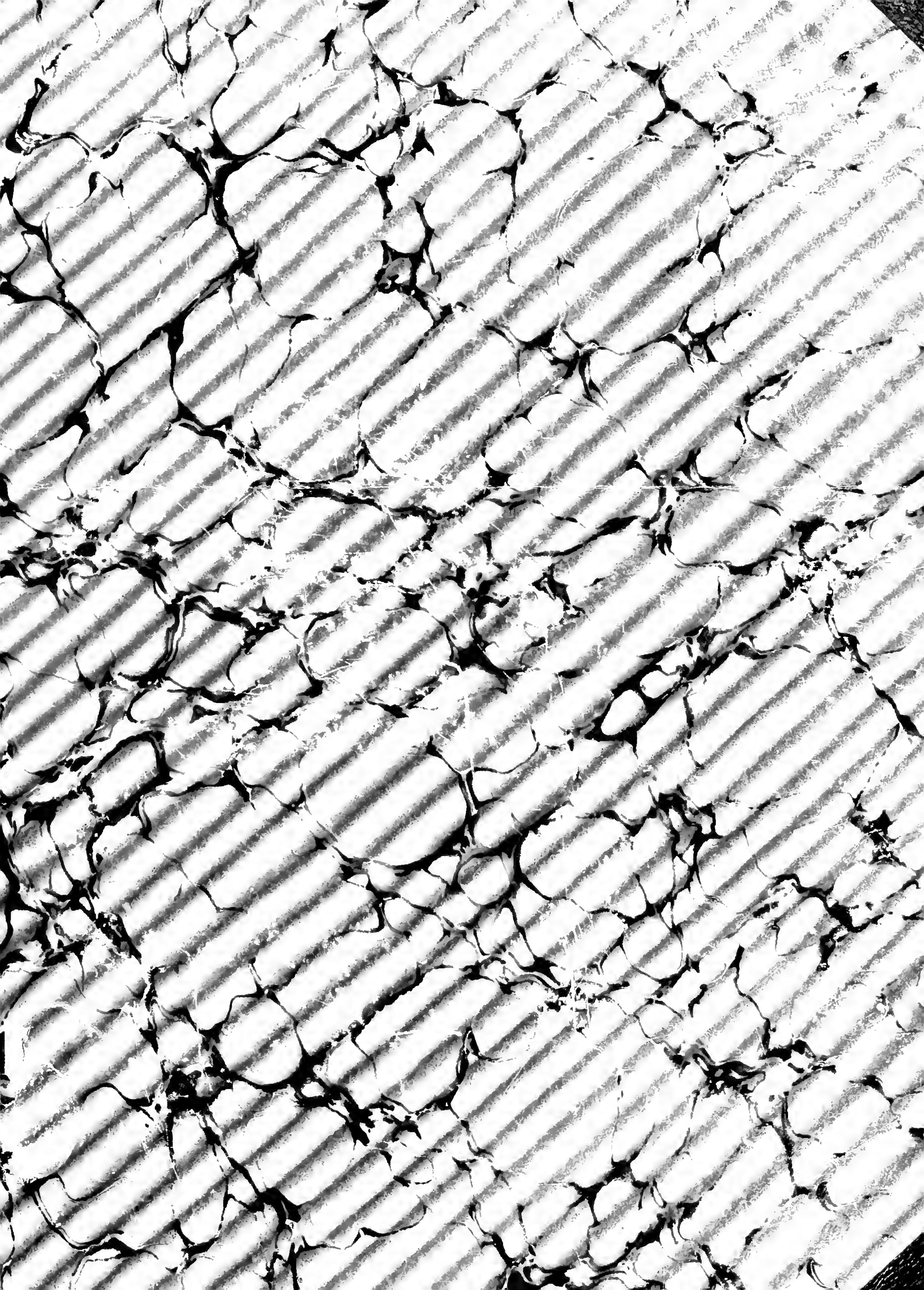

THE

TRANSACTIONS

OF THE

American Agricultural Association.

PART I.

NEW YORK:
1846.

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REPORT OF AN ADDRESS ON RAIN STORMS.

ERRATA, Etc.

Page 21, line 24—For *Armsrtong* read Armstrong
" 24, " 1—For calcar*i*ous read calcareous.
" " in the table—For Lupi*us* read Lupins.
" " place a comma after Lupins tor tallowing.—
" 29, omit *Beets* in the rotation for calcareous soils in the second year.
" 56, strike out "*a*" in the sixteenth line before the word "saturation."
" 57, strike out the word "*is*" in the last line.
" 59, read the last six lines of page fifty-nine and all of page sixty, between the third and fourth lines from the bottom of page fifty-six.
" 59. the two last lines should read "the soluble portions in such manner as to prevent the action of the decomposing agents; but the action of copperas and alum, they fix or change the soluble into permanently insoluble substances"

ocean. On the afternoon of the fourth, a most destructive tornado was experienced in the northern part of Ohio, being almost exactly in the centre of the general storm. On the second and third of February, the centre of the storm was nearly stationary. On the fourth and fifth it traveled North, sixty-two degrees East, at the rate of sixty-two miles per hour. The storm of February 16, traveled in a direction North, fifty-three degrees East, at the rate of twenty-three miles per hour. In both of those storms, the wind, after it became violent and there was a considerable fall of the barometer, manifested a tendency to revolve about a centre, with a motion spirally inward.

Professor Loomis remarked upon the importance of numerous and well concerted observations spread all over the United States; and upon the imperfection of the observations made at the Academies in the State of New-York. The Academies are not furnished with barometers, and the observations of the wind are very loose and unsatisfactory. He showed the inadequacy of such observations for the purpose of investigating the phenomena of storms, and hoped that the Association would use its influence to induce the Board of Regents to re-organise the system upon a scale more in accordance with the claims of science.

REPORT OF AN ADDRESS ON RAIN STORMS.

DELIVERED BEFORE THE ASSOCIATION, MAY, 1845, BY

ELIAS LOOMIS, A. M.

PROFESSOR OF MATHEMATICS AND PHYSICAL SCIENCE IN THE UNIVERSITY OF NEW-YORK.

HONORARY CONSULTING METEOROLOGIST OF THE ASSOCIATION.

PROFESSOR LOOMIS called the attention of the Association to the recent progress of Meteorology, and particularly to some remarkable phenomena of two storms which occurred in February, 1842. Both of these storms were of great extent. The first, which occurred about the fourth of the month, was remarkable for the amount of rain and an elevated temperature; the other, which occurred about the sixteenth, was remarkable for the strength of the wind and the fall of the barometer. On the morning of February 3, rain was falling over an area extending uninteruptedly from the Gulf of Mexico, on the South, to a great distance beyond the St. Lawrence, on the North; and from beyond the Mississippi, on the West, to an unknown distance in the Atlantic ocean. On the afternoon of the fourth, a most destructive tornado was experienced in the northern part of Ohio, being almost exactly in the centre of the general storm. On the second and third of February, the centre of the storm was nearly stationary. On the fourth and fifth it traveled North, sixty-two degrees East, at the rate of sixty-two miles per hour. The storm of February 16, traveled in a direction North, fifty-three degrees East, at the rate of twenty-three miles per hour. In both of those storms, the wind, after it became violent and there was a considerable fall of the barometer, manifested a tendency to revolve about a centre, with a motion spirally inward.

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At the Meeting of the Association in June, 1845,

On motion of Mr. Green, a Committee was appointed to call the attention of the Regents of the University of New-York to the plan proposed by Professor Loomis.

The Committee, consisting of Mr. Green, Professor Loomis and Mr. W. C. Redfield, subsequently presented the following Memorial for the consideration of the Board of Regents.

MEMORIAL

OF THE COMMITTEE ON METEOROLOGY,

TO THE BOARD OF REGENTS OF THE UNIVERSITY OF NEW-YORK, FOR THE PURPOSE OF SUGGESTING AN IMPROVEMENT IN THE

OBSERVATIONS MADE AT THE ACADEMIES OF THE STATE.

THE undersigned have been appointed, by the American Agricultural Association, a Committee to call your attention to some improvements in the present system of Meteorological Observations at the Academies of this State.

In order to exhibit this subject in its proper light, it is necessary to present an historical sketch of the progress of Meteorological Observations in the United States. Previous to the year 1819, no systematic effort had been made in this country for the promotion of Meteorology. Registers had been kept by various private individuals, but they were not numerous, nor was there any concerted action. In 1819, under the direction of the then Secretary of War, JOHN C. CALHOUN, a system of Meteorological Observations was commenced at the different Military Posts, which has continued to the present time. This was a very important movement, and was prompted by a most liberal spirit. It has furnished us with an approximate knowledge of the mean temperature of a considerable number of stations, many of them remote from the more populous parts of the United States. It should, however, be remembered that the instruments provided never exceeded a thermometer and a rain-guage.

In 1825, this system of observations was introduced into the State of New-York, almost without modification. Each of the Academies incorporated by the Board of Regents was furnished with a thermometer and a rain-guage; and was required to keep a register after a prescribed form, in order to be entitled to a dividend of the public fund. This system has now continued for twenty years, and the number of Academies reporting has increased from ten to forty. The plan was highly creditable to the public spirit and scientific taste of New-York. It was a movement in advance of public sentiment in the other States, and the observations were, perhaps, as extensive as it was expedient to undertake at that time. These observations have determined, with considerable accuracy, the mean temperature of the State. The Annual Reports of the Regents contain a vast amount of important Meteorological statistics, and they are often quoted with high commendation in Europe. The Empire State has thus reared to herself a monument, to which all her citizens may point with honest pride.

It is but recently that Meteorology has begun to claim the character of a science. The observations which have been made in this country and in Europe, have been analysed, and have led to important general conclusions. We can now distinctly see the foundations of a beautiful science; and it is one more intimately connected with the comfort and convenience of society at large, than almost any other. The discoveries already made indicate to us the kind of observation which is called for, to insure further progress. The system adopted at the Military Posts, and at the Academies of New-York is behind the present demands of science. Observations of the barometer are equally important with those of the thermometer, and a greater degree of minuteness and precision is called for in the observations generally.

More recently, the State of Pennsylvania has set a noble example to her sister States. In 1837, the Legislature of that State appropriated four thousand dollars for the advancement of Meteorology; and out of this sum, which was placed at the disposal of a Joint Committee of the American Philosophical Society and Franklin Institute, a barometer, two common thermometers, a self-registering thermometer and a rain-guage were purchased for each county in the State, to be placed in the hands of some skillful observer, who should volunteer to keep a journal of the weather, according to a common form prescribed by the Committee. The observations were commenced with little delay, and have been regularly continued. Here are made observations of the barometer and thermometer three times a day; of the self-registering thermometer, the winds estimated for sixteen points of the compass; depth of rain; and at some stations, observations of the dew point.

Within the past two years the observations at the Military Posts have been re-organised upon a system more in accordance with the claims of science. They now comprise observations of the barometer, attached thermometer, external thermometer, and wet bulb thermometer; direction and force of the wind; direction, velocity and amount of clouds, each at four hours of the day, viz—sunrise, 9 A. M., 3 P. M. and 9 P. M.; together with the amount of rain, and the times of its beginning and ending.

A similar system in the State of New-York would give a fresh impulse to the science of Meteorology. That branch of the science which is at present exciting the deepest interest, is the subject of *storms*. We have learned enough of their phenomena to see clearly the proper path to be pursued if we would discover their laws. Violent storms extend over a large area. Hence we need a very extensive and concerted system of observation. It is to be hoped that the examples of New-York and Pennsylvania may be imitated by other States ; but even if they should not, the labor expended here would not be lost. We have, first, the observations of the General Government at about sixty posts, stretching along the entire Atlantic coast, the Gulf of Mexico. the Indian Territory beyond the Mississippi, and the chain of the Northern Lakes. Next come the observations of the large States, New-York and Pennsylvania ; and then we have amateur observers, pretty numerous in New-England, scattered more sparingly over the South and West. We wish to see the whole United States covered with observers at distances from each other not exceeding fifty miles. Nor do we despair of such a result. The science is rapidly advancing, and every new discovery adds fresh stimulus to old observers, and encourages others to enter the field. If the Board of Regents would re-organize the system of observations in this State upon a scale corresponding to the present demands of science, we believe they would be sustained by an enlightened public sentiment. If the expense of the instruments should be deemed a serious objection, we would suggest that *complete* observations at half the present stations would be far more valuable than those we are now receiving. It is desirable that the stations be distributed over the State at equal distances geographically, rather than with reference to population. If the Board of Regents should think favorably of the object of this Memorial, we should be glad to make some further suggestions with regard to the details of the system.

A Second Memorial of the Committee on Meteorology.

The Board of Regents having invited a more detailed statement of the contemplated system of observations, the following paper was subsequently presented to the Board.

If it shall be decided to revise the present system of Meteorological Observations in this State, the following are some of the points which will call for consideration.

I. The number and position of the stations of observation.

II. The instruments employed.

III. The kind of observations.

IV. The hours of observations.

V. Specific instructions to observers.

I. The number and position of the Stations.

The first principle which it is desirable to carry out, as far as can be done consistently with other considerations, is to locate the stations at equal distances from each other. Two registers from the same place are not more valuable than one, if judiciously kept. Moreover, the importance of a Meteorological post is scarcely at all enhanced by its proximity to a great centre of population; yet large towns may have the advantage of furnishing a greater number of competent observers. Whatever system is adopted, it ought to be arranged with a view to permanence. The value of Meteorological observations is exceedingly impaired by frequent changes of instruments, of stations, or hours of observation. It ought to be calculated that the system which is now introduced should continue unchanged for at least twenty years. Hence it is important to select stations where no interruption of the observations need be anticipated for want of a competent observer. A large town, or a flourishing literary institution will furnish the best security against such a contingency; and Colleges can generally be depended upon more safely than Academies. We think it desirable that the distance of the stations from each other should not exceed fifty miles: and were we not deterred by the consideration of expense, we might recommend a less distance. The final selection of the stations will of course be influenced by many considerations unknown to this committee. We would venture, however, to propose the following list as indicating our opinion with regard to the number of stations and their geographical position.

COUNTY.	TOWN.	ACADEMY.	COUNTY.	TOWN.	ACADEMY.
Suffolk,	Easthampton,	Clinton.	Broome,	Binghampton,	Binghampton.
New-York,	New-York City,		Cortlandt,	Homer,	Cortlandt.
Orange,	Newburgh,	Newburgh.	Oswego,	Mexico,	Renssalaer.
Columbia,	Hudson,	Hudson.	Jefferson,	Watertown,	Black River.
Albany,	Albany, or at	Union College.	St. Lawrence,	Ogdensburg,	Ogdensburg.
Warren,	Glen's Falls,	Glen's Falls.	Ontario,	Geneva,	Geneva College.
Essex,	Moriah,	Moriah.	Alleghany,	Alfred,	Alfred.
Clinton,	Plattsburg,	Plattsburg.	Monroe,	Rochester,	Rochester.
Delhi,	Delhi,	Delaware.	Chautauque,	Fredonia,	Fredonia.
Oneida,	Utica, or at	Hamilton College.	Erie,	Buffalo,	Buffalo.
Franklin,	Malone,	Franklin.			

To complete the system, a few other stations are desirable where no Academies are located; for example, the middle of Long Island; the southern part of Hamilton County; the southern part of St. Lawrence County; and the western part of Tioga County. Perhaps at some of these places volunteer observers might be found, according to the system in Pennsylvania.

II. The Instruments to be employed.

1. A barometer at each station we consider indispensable to carry out the proposed system.
2. A standard thermometer.

3. A second thermometer to be used as a wet-bulb thermometer. A knowledge of the moisture of the air is well nigh as important as a knowledge of its temperature or weight. Various instruments have been used for this purpose, but the wet-bulb thermometer is recommended by considerations of economy and convenience.

4. A pair of self-registering thermometers.

It is very desirable to know the greatest heat and cold of every day, and we can never be sure of attaining this object without self-registering instruments. Such instruments would therefore furnish most important observations, although the remaining observations would still be valuable without them.

5. A Rain-gauge.

6. A Vane.

The vane is a most important Meteorological instrument; but it is generally so badly made that it may, perhaps, be best for the State to provide them all of uniform construction. The most useful form of an instrument not self-registering is probably the following. Let the vane be firmly attached to an upright revolving shaft, to whose lower extremity is secured a graduated circle. A fixed index will then point out exactly the direction of the wind at the time of observation. Such an instrument might be provided at very moderate expense. But whatever form be adopted, the cardinal points of the compass should be carefully determined by Astronomical observations; or by the magnetic needle, in which case allowance should be made for the variation.

The following is an estimate of the expense of a set of instruments for a single station.

A standard barometer made by Newman, of London, costs $100. A cheap barometer may be obtained for $10. A barometer which will furnish satisfactory results may be obtained for about $20.

Two thermometers of a good construction will cost $2 25 each. A pair of self-registering thermometers will cost $5 00. A rain-gauge, $2 50; making the price of one set of instruments, $32 00.

At this rate, the instruments for twenty-one stations would cost $672; but if the instruments now in use at the different Academies are considered sufficiently trustworthy, something might be saved from this estimate. The construction of the instruments should be superintended throughout by some competent gentleman of science, as without good instruments, the labor expended in observing them will be well nigh lost.

III. The kind of Observations.

The observations will of course extend to all the instruments furnished; besides which, certain valuable observations may be made without instruments. Among these may be mentioned the character of the clouds — the quarter from which they come — proportion of the entire heavens covered — also the force of the wind, etc.

IV. Hours of Observation.

A great variety of objects are to be accomplished by Meteorological observations, all of which can only be secured by observations made at every hour of the twenty-four. We should be glad to see such a labor undertaken at some of the Academies in this State; but of course could not think of recommending it for general adoption. For most purposes, observations in the night are quite as valuable as during the day; and particularly in tracing the effects of a storm, it is important that there should be no very long interval between two successive observations. For this reason, it is desirable that one observation should be made as early in the morning and another as late in the evening as is consistent with general convenience. Sunrise and 9 P. M. fulfill these conditions, and are besides recommended by other considerations. 9 A. M. is an important hour, because it furnishes very nearly the mean temperature of the day, and 3 P. M. is very near the hour of greatest heat. We accordingly recommend four hours of observation, viz. sunrise, 9 A. M., 3 and 9 P. M.

It is desirable that special observations should be made whenever any extraordinary phenomena occur. For example, if the barometer is unusually high or low, the time and amount of the maximum or minimum should be entered under "Remarks." So also in a great storm, the precise instant of the wind's changing should be recorded, etc.

V. Instructions to be issued to Observers.

In case this system should be introduced, it will of course become necessary to issue specific instructions with respect to the proper position of the instruments, and the mode of using them. We will not enter upon this subject at present, but we will suggest that before the instruments are distributed to the Academies, they should all be carefully compared with some acknowledged standard at Albany or New-York, and a record of the comparison be preserved in an official form for subsequent reference. Columbia College is in possession of one of Newman's Standards, and we are not aware of any other in the State.

It will probably be best to have printed forms distributed to all the observers. We forward a form as a sample, which, however, we do not recommend without some modification.

All which is respectfully submitted.

Signed, ANDREW H. GREEN, ELIAS LOOMIS, W. C. REDFIELD, } *Committee.*

THE CHEMICAL PRINCIPLES OF THE ROTATION OF CROPS.

PRONOUNCED BEFORE THE AMERICAN AGRICULTURAL ASSOCIATION, MARCH 4th, 1846, BY

D. P. GARDNER, M. D.,

HONORARY CONSULTING CHEMIST OF THE ASSOCIATION, MEMBER OF THE LYCEUM OF NATURAL HISTORY, ETC.

FORMERLY PROF. OF CHEMISTRY AND NATURAL PHILOSOPHY IN HAMPDEN SIDNEY COLLEGE, VA.

MR. PRESIDENT AND GENTLEMEN:

IT is necessary to premise this memoir by explaining that the Executive Committee had expected a communication from another gentleman and did not until a late hour throw the burden upon me, but my desire to gratify them has induced me to hazard the criticisms of the Association—tempered, as I know they will be—by the circumstances of the case. I have selected the subject of the rotation of crops partly because opportunities have fallen in my way to witness some facts which are commonly overlooked by writers on this topic, and because I regard it as a question of pure chemistry. I propose to search after general principles only, for if these can be determined, particular cases or the rotation suited to any district of country will be determined by a little consideration. This is moreover the only way whereby the subject can be discussed so as to be of utility to the whole country, the agriculture of which it is the object of your association to advance. A local rotation is hampered with considerations of expediency, with the price of land and of labor, the merchantable crops, the profit or loss of grazing, which offer obstructions to reaching any generalization; but whereas every crop and agricultural process is profitable in some part of our widely extended country, it is proper that such considerations should be dismissed, and introduced only in reaching particular cases. I know that in this day practical disquisitions are considered superior to all others, but if we make no effort to group facts scattered abundantly around us, the art can never advance. Your Association has the noble object in view of reaching principles in agriculture, and therefore I have no hesitation in presenting a theoretical memoir, the design of which is to attempt the deduction of the principles of rotation.

I. The Object and Necessity of Rotation.

That no doubt may arise of the object to be gained by systems of rotation I will advance a definition which may guide us in the following discussion. The object of a rotation is the production of the greatest profit in crops with the least exhaustion of the soil. The views entertained by practical men on the subject are however by no means fixed; in many parts of the country it is imagined that the only condition of a rotation is that the same plant be not cultivated annually, and that a succession of corn, wheat and oats is as much a system of rotation as any other plan—it is indeed a rotation, but not a system.

How far there is any practical necessity for rotations is also a point in much doubt. We are often assured by good farmers that given crops as corn, wheat, hemp, have been grown in certain districts from time immemorial. These are exceptions to a general rule and of no force whatever; they prove that there are spots on the earth's surface of extraordinary fertility, or, what is more frequently the case, that in such districts there is some cause of reparation, by freshets, irrigation, or the washings of adjacent hillsides. Wherever the fertility of new lands, which results from the growth of forests or accumulation of uncut grasses for centuries, is exhausted and the soil reduced to a state similar to the subsoil, it is necessary to adopt some means to increase its yield, either by manures or a system of rotation. That this condition is ultimately reached in uplands will be readily granted; the only point worthy of further consideration is how far a rotation will economize manure already in the soil in new lands, or manure added artificially. This is the immediate subject of the memoir.

Experience and analogy have led men to adopt rotations wherever agriculture has been practiced for a length of time. Experience has fully demonstrated that no plant will continue to luxuriate under ordinary circumstances for an indefinite period. To this rule trees are only an apparent exception, for they submit in time to new species when left in a natural state; they live indeed for centuries because by the great development of their roots they penetrate year after year into new strata of soil; but it is well known that in northern forests the birch and maple follow the pine, and in more temperate regions the pine succeeds the oak and allied genera.

Analogy is remotely a guide to rotations in the case of forests, but if we observe the phenomena of vegetation on new lands it becomes extremely instructive. The planter of the south-west makes haste to cultivate cotton on his new lands, because, for a few seasons he is not overwhelmed with grasses, but is called upon to combat annual weeds easily overshadowed by his crop. If a portion of new land be left waste we discover that a succession of plants invades its surface and not certain species, we find that however convenient the seeds may be, the plants of the first year give place in time to new genera. To this point I have paid particular attention in Virginia, and find that however the species may vary in different soils, there is a sequence of natural families sufficiently apparent. Where the land is remarkably rich, the plants first developed are species of the families Chenopodiaceæ, Solanaceæ, Polygonaceæ — these give place to Malvaceæ, Compositæ, and Umbelliferæ; and finally species of Leguminosæ, Rosaceæ, and Gramineæ succeed. It is not asserted that other families are absent, but these are so fully developed as to be characteristic of the vegetation. This natural succession differs with the latitude, soil, and degree of moisture; but whatever may be the families, it is sufficiently apparent that the plants of new soils, or rich weeds as they are called, give place sooner or later to those of the barrens. Nor is this the only evidence of a natural rotation. After a season when the roots of grasses have produced a mat of vegetable fibres, is it not well known that the meadow becomes infested with wild onions, buttercups, (*Ranunculus*,) thistles, and other weeds, which, if not exterminated, soon overwhelm the grasses? Hence the prudent husbandman adds ashes or lime, and scarifies his meadows; for by these means the roots are rapidly decomposed, and the soil brought back to a state of composition favorable to the development of grasses: or if he be conducting a rotation, he ploughs the meadow, and thus acquires by art a natural coat of manure, of great service to such cultivated crops as, like the Chenopodiaceæ, require a soil rich in organic matters.

II. Explanation of the foregoing natural rotation.

The difficulty of making certain plants grow after each other in the same soil, was said to arise from the mutual repulsion of plants, and explained by Von Humbolt, Plenk and De Candolle, by reference to the experiments of Brugman and Macaire. These naturalists discovered that the root of a plant growing in water, throws out a dark mucilaginous fluid which they called its excrement. Thus the excrementitious deposit of any plant is supposed to be inimical to the growth of its species, and also to some others; but may on the other hand be of service to an entirely different family. De Candolle saw in these reputed facts the explanation of rotations, which he therefore resolved into the art of discovering such a succession of crops, that each might flourish on the organic remains of its predecessors. Clean fallows were also commended as a means of hastening the decomposition of excrementitious matters.

But it is neither satisfactorily shown that excrementitious matters accumulate in the soil nor that they are inimical to the growth of the species. Macaire, Braconnot and others have failed to obtain positive evidence of such dejections, when a soil was employed instead of water, and Alfred Gyde states that plants are benefitted by watering with a solution of their excrementitious matters. Some, as BOUSSAINGAULT, go so far as to regard the dark mucilaginous matters said to be exuded by roots in water as the effect of a diseased action, denying the excretion, but this cannot be maintained, for amphibious plants as mints, cress, Myosotis palustris and other species, which are not placed in an abnormal situation when growing in water, yield this substance. The experiments of GYDE appear also explicit on this point. If we are to receive the theory of DUTROCHET, that the penetration of the soil fluid through the roots is a phenomenon of Endosmosis, there is a necessity of admitting the passage outwards of a portion of the elaborated sap, which GYDE states to be identical in composition with the excrementitious matters collected by himself. That none should be obtained from sand, or soil, under certain circumstances, is not surprising, for the exposure of the exuded matter, over a large surface and in contact with oxygen absorbed from the air, would rapidly change it into a new body capable of escaping the ordinary tests—in the same way that alcohol by mere exposure over an extended surface is rapidly converted into acetic acid by oxydation. Although it is premature to deny that a portion of elaborated sap does escape from the root of some plants, it is very evident that this does not create a deposit injurious to the future growth of the species and is not the principle on which rotations are to be devised.

The natural succession of plants is connected with the presence of organic matter in the soil. The richest weeds which first occupy the surface having the greatest necessity for it, and thus through successive groups to the grasses and forest trees which grow well without any portion in the soil. Other elements of fertility being present, the Chenopodiaceous and allied families thrive only in such localities as yield azotized matters, since they cannot grow without a supply from the soil. This surmise is sanctioned by the obvious presence of organic matters in the soils where they grow, and by the fact that some species exhale ammoniacal gases, but it is fully established by the experiments of BOUSSAINGAULT. This chemist grew clover, peas, wheat and oats in a soil completely destitute of organic matter and supplied them with distilled water only; the clover and peas were found to double their azotized matter during growth, whilst the oats and wheat gained none whatever. As there was but one source of azote present, the atmosphere, it is apparent that the former have the capacity of supplying themselves therefrom, whilst the grain plants are altogether dependent on the soil. Hence in a soil charged with organic matters, rich in azote, those plants which require a supply by their roots will grow freely, and so far exhaust it in time as to render it unfit for the species, which is succeeded by an intermediate class, and finally by the Graminæ, Leguminosæ, and others capable of subsisting on aerial azote, and so far from exhausting, adding it to the soil. From this function of plants, we see an explanation of the natural rotation, and what is of more moment, a means of adapting our succession of crops to the accumulation as well as removal of azotized matters.

III. The Rotation of One Principle.

Boussaingault, Payen and the majority of French agriculturists estimate the value of manures by the amount of azote they contain; and there is not, for general purposes, a more useful test. Therefore the great object of manuring is with them the application of azote to the soil, and the great — if not the sole — principle in rotations the economy of this body. As some crops gain azote from the air, as clovers and grasses, these serve an important purpose in such a plan by concurring with manure in supplying food for the cerealia and such crops as exhaust the soil. According to Boussaingault we should therefore, in a system of rotation, introduce crops in such order that after the manure a highly exhausting plant as wheat may come and this be succeeded by others of less affinity for nitrogen, and again by those which draw their supplies from the air and are the ameliorating crops of this class of agriculturists. The soil now recruited by clover, lucern, grass, etc., will bear another azotized crop and the system is at an end.

There is something charmingly simple and plausible in this rotation of one principle, and its author has done much to establish it by appeal to practice. It is, moreover, identical with the natural rotation observed in new lands, and thus appears to challenge opposition. But there is a capital difference between any artificial and the natural rotation, in this particular, that in the latter case the plants die on the spot and are not removed hence, and whatever exhaustion arises from removing the crop is arrested. Our corn, wheat and oats not only draw azote from the soil but other bodies, and these are entirely withdrawn from the spot, whilst only the azote is removed by the natural succession of plants. Of the inorganic or saline matters much more is often withdrawn, that of azote; hence, whilst the new land is exhausted of but one element of fertility, the cultivated field loses more.

The greatest objection to this view of rotation is its opposition to experience, for it will be seen that a system, perfectly proper, according to this theory of one principle is inadmissible in ordinary practice. No one who is acquainted with the subject would expect much from the following succession: manure, corn, oats, beans, buckwheat, clover, wheat—yet it is a system in which the azotized matter of the manure would be well economized and the soil rather enriched in this respect. But the farmer knows that such a succession of seed crops would soon render his land valueless, whether organic matter were accumulated or otherwise. The one principle rotation is not, therefore, acceptable to the understanding of theoretical nor to the experience of practical agriculturists.

IV. The Precepts of Practical Writers.

The points advanced by practical writers as THAER, LOW, STEPHENS and RHAM, as the principles of rotations are of considerable moment, especially in the field, but are no more than surmises for the most part. They may be resolved into the three following assertions and precepts:

1. That each plant requires a particular food and should therefore be repeated at as long intervals as possible.

2. That seed crops being peculiarly exhausting are to be interchanged with green or forage crops and roots.

3. That plants which require hoe tillage, being cleaning crops, should follow those which are sown broadcast and encourage weeds.

In these positions we recognize the imperfect observations of farmers; each one is true within certain limits, and excepting the last, which is only a practical expedient, it is impossible through them to reach any general principle. That each plant requires a particular food is an assertion merely which, so far from carrying conviction, is altogether denied by some practical men and, whether true or false, is beyond the means of these writers to prove. The second assertion, that seed crops are exhausting, is sustained by experience; but in what way they are exhausting is not stated, and without this information the assertion is of little value. As we have remarked, the third position is a practical expedient only, because both seed and forage plants may be hoed crops, as corn, beans, cotton — tobacco, turnips, cabbages.

Hence the precepts of practical writers resolve themselves into the two points, that the same and allied species should be cultivated at as long intervals as expedient and that seed plants are to be as seldom introduced as possible. Both these positions are of practical value, but they do not merely labor under the defect of conveying no precise information, but may be used in forming schemes of rotation of no economy whatever. Thus the following plan is perfectly conformable with these precepts, but very objectionable.

Manure, corn, tobacco, oats with clover, wheat, beans.

or, as in the rotation for clay lands, by MR. RHAM,

Manure, roots, oats with clover, beans, wheat.

In the first a seed crop is followed by a foliage crop, but both of these are exhausting; in the second, beans are succeeded by wheat, both exhausting, but — and this is the imperfection of such arbitrary precepts — the exhaustion in every case is not of the same kind or degree. We are informed that certain crops are exhausting, but not of what; they impoverish the earth, yet we have no knowledge imparted of what substances. It is not enough to say of manure, for this is a compost of all the bodies necessary for plants. If we still further advance the speculations of practical men and assert that the exhaustion is of organic matter or humus, the position is denied by the second precept, for seed crops such as beans are exhausting whilst they require little humus — whilst on the other hand, many forage plants as cabbages, turnips, beets, are not seeds crops, but exhausting. We do not deny that excellent rotations devised by practical men do exist, but we do deny that every rotation based upon the foregoing indefinite precepts is necessarily good, and if they be no guide without the assistance of experience gained at great cost and by separate observations in the field, they are worse than useless. The defect of the precepts rests in this, that we are not informed in what respect the food of different plants varies, nor in what particular seed crops exhaust the soil. The apologists of the system may assert that these are remote facts not within the reach of the propounders, but this being the case the time has now arrived when a closer approximation to truth may be made and the former precepts abandoned or improved by modern investigation.

V. *Of the Exhausting Qualities of Crops.*

The soil may be exhausted to such a degree that it will cease to produce certain forage plants without the introduction of a single seed crop. If we enrich any field so that it produces tobacco and follow this crop by cabbages, turnips, flax, taking no seed from either, we speedily reach a period when none of these plants will yield a remunerating crop. This is one kind of exhaustion, but it is not complete exhaustion, for corn, wheat, oats, beans and clover seed may be obtained in good quantity from the same field. On the other hand, a few crops of hemp seed, linseed, corn, oil grains, wheat, will run down the land to barrenness; but this exhaustion is altogether different from the preceding; it is, in truth, the specific exhaustion produced by seed crops, and it matters not which are the seeds. Hence there are two distinct kinds of exhaustion well known to practical men and it behoves us, who desire the advancement of agriculture, to make the line of demarkation between them bold and distinct. There are other kinds of exhaustion to which we shall refer presently.

In a paper I had the honor of reading before the Association last year, I made a thorough examination into the nature of the exhaustion of lands by seed crops. The object of the communication was to prove the following points:

1. That all seeds contain an excess of phosphoric acid, amounting usually to thirty-five or forty per cent. of the entire ash, nearly the whole of the ash being in many cases phosphates; this was demonstrated in the case of corn, wheat, beans, hemp seed, flax, peas, cotton and other

plants. It was also shown that the straw and haulm seldom contain more than one to three per cent. of phosphoric acid, this substance being segregated in the seed. For the analytical evidence of these positions I beg to refer to the Farmer's Dictionary, in which the admitted analyses of all plants hitherto examined will be found.

2. That phosphoric acid is the least developed of all the mineral bodies of the soil, being seldom present to the extent of 0.5 per cent. and usually less than 0.1 per cent., in good soils.

3. That many soils containing from five to twelve per cent. of humus are known to be steril.

4. That the amount of phosphoric acid removed by given seed crops far exceeds that removed by the ordinary forage crops, being often five times as great.

The evidence of these positions was set forth at length in that communication and is therefore not worthy of repetition. The principle which I believe was fairly reached, and admitted, was that seed crops exhaust the soil of phosphoric acid — the deprivation of which is easily perceived, even in the best lands. It is not necessary for me to advance further evidence of this fact before your Association.

If it be admitted that phosphoric acid is segregated in the seeds, it is evident that the exhaustion effected by foliage plants, as tobacco, cabbages, flax, hemp, etc., not intended for seed and of the root crops, with perhaps the exception of turnips, is due to another cause. The experiments of Boussaingault and our own observations on natural rotations will now throw light on this other kind of exhaustion. Some plants draw all their azote from organized matters in the soil, others from the air; some families of plants appear only on rich soils and around dung-hills, whilst others inhabit the mineral earth destitute of organic matters. It is evident that phosphoric acid has nothing to do with this peculiarity, for none is removed from the soil, the dead plants restoring it; there is a diminution only in volatile matters or in the azotized products of the decaying organic matter. Let us cultivate a few crops of cabbages or tobacco on a rich spot of land, how soon will the organic matter disappear! Practical men may tell us that this is because the crops are hoed and the soil exposed to the sun, but this is not the cause; the hoeing improves the plant because by introducing air it hastens the decomposition of the organic matters of the soil or assists the fixation of atmospheric nitrogen. (*See Mulder. Journ. fur. Pract. Chem.* XXXII. p. 311). When putrescent manures are added to tobacco, potatoes and similar crops, the indication is to furnish azotized matters, and is altogether different from the object in view when it is added to wheat and certain grain crops. But if this point requires further evidence we may appeal to those plants which exhaust the soil differently under different circumstances. A flax crop raised for its fibre exhausts the soil of azote and may be followed by corn or beans, but if it be allowed to mature seeds it exhausts the soil doubly of azotized matter and phosphoric acid, and cannot be succeeded by corn except in the richest soils. Hemp raised for fibre may be cultivated many years in a soil containing much humus but the seed crops are rapidly exhausting.

Hence we have crops which exhaust the soil of azotized matters — crops which remove an excess of phosphoric acid — and grasses and clovers, cut before bearing seeds, which exhaust the soil of neither of these essential bodies but on the other hand enrich it in organic matters. Many cultivated plants, as corn, wheat, cotton, hemp, flax, cabbages, etc. raised for seed, exhaust in both respects and are therefore peculiarly expensive crops. With this amount of information, based on experience and several hundred analyses, we have the means of rendering intelligible the precepts of practical writers on the succession of crops.

Precept first resolves itself into the principle, that plants exhaust the soil unequally in respect to azotized matters and must therefore be so adjusted that the most exhausting should recur as seldom as possible.

Precept second. Seed crops, which exhaust the soil of phosphoric acid, are to be interchanged with herbage plants, which do not remove as much of this important substance.

These directions have now assumed a definite form and are an explicit guide to the well informed farmer ; he at once perceives that there are, over and above the precepts of expediency as to hoed or cleaning crops and deep rooted crops, classes of plants which differ remarkably from each other in their action on his fields. 1. Seed crops which exhaust the soil of azote. 2. Seed crops which do not exhaust the soil of azote. 3. Exhausting forage and root crops. 4. Crops which neither exhaust the soil of humus nor phosphates, but renovate the azote. With this amount of knowledge he can shape a fair system of rotation, whatever may be his crops — he can introduce indigo, cotton, tobacco, corn, bene, oil plants and many others which are not found in the arbitrary tables given by Low, Thaer, and Stephens or falsely placed by Buel and Armsrtong. But if we recur to our definition of the object of arotation — the production of the greatest profit in crops, with the least exhaustion of the soil or manure — we find that there is yet something wanting in the principles of rotation. In the fourth class above, we have plants which neither exhaust the soil of azote nor phosphoric acid ; it now becomes necessary to know in what respect they do exhaust it, so as to satisfy the economical condition of impoverishing the soil in the least degree.

VI. Plants Exercise a Natural Affinity for Specific Saline Matters.

It has been already shown that the seeds of cultivated plants cannot be matured without phosphoric acid, and we find upon examination that this is not the only instance in which a distinct partiality is evinced by vegetables for certain mineral bodies. Chemical analyses and the observations of naturalists assure us of this fact. It is notorious that the plants of salt marshes are distinct from those which are found near fresh waters. In Switzerland, the appearance of certain species of clover is known to indicate marl. The plants indigenous to clays, sands or calcarious soils are distinct, and if they be not instantly recognized it arises from the fact that most lands contain an admixture of all the mineral substances essential to fertility. From the analyses of chemists, now extended to several hundred, we find that there is also evidence of the affinity of plants for certain bases; thus it is sufficiently clear that Composite, Umbelliferous, Amentaceous, Gramineous and Chenopodiaceous plants prefer potash; Leguminious, Rosaceous, Solanaceous and Rubaceous plants affect lime; the families of Cruciferæ, Asphodeleæ and Liliaceæ select soda. Every person knows that oaks, maples and walnuts yield more potashes than pines. The study of this subject is not, however, completed: there are many points to be considered which tend to involve the inquiry in difficulty. It may be said that DAVY was the first who drew attention to this topic, in a chemical point of view, in the cases of gypsum and clover, oats and silica. Little had been done to this time until LIEBIG resuscitating the views of DUNDONALD and DAVY showed the affinity of several plants for certain bases. He enumerates grass, oats, wheat, barley, tobacco, peas, potatoes, clover, corn, turnips and the Jerusalem artichoke. This kind of classification has occupied much of my attention for several years, and has been dwelt upon in my lectures in the University, and for the reasons I have already advanced I beg to extend the number of plants to the families above enumerated, in which several are also placed in a situation different from that of LIEBIG: the subject is, however, far from decided and probably the exceptions to grouping in families may be greater than the advantages gained. Whatever grouping may be expedient, it is not to be forgotten that several circumstances are to be considered in making use of any analysis for the purpose of determining the place of a plant: these are—

1. That there exists an unquestionable isomorphism amongst many of the mineral bodies: thus — potash, soda, oxide of ammonium and hydrate of lime — lime and magnesia — sesqui-oxide of iron, sesqui-oxide of manganese and alumina — sulphuric and selenic acids — phosphoric and arsenic acids — are respectively isomorphous groups. Hence soda may replace potash; hydrate of lime may be present in place of either soda or potash. That this displacement or substitution does occur in nature is abundantly proved. Thus soda has been found to replace the potash of the oak in Long Island, on the sea coast. Marine plants, as the salsosas, transplanted to an inland situation are found to contain potash. Tobaccos from various sources, analyzed by BERTHIER, yielded potash as a base, whilst specimens examined by FRESENIUS and WILL yielded sixty per cent. of lime and magnesia salts.

2. The different parts of the same plant yield an excess of dissimilar salts: the potatoe tuber contains eighty-six per cent. of potash salts — the tops sixty-one per cent. of lime salts. In the same way, the roots, foliage and seeds of other plants give indications of an affinity for different minerals.

Hence it follows that analyses will differ with the nature of the soil on which the plant has been produced, and with the part examined, or if every portion be examined with the part used in excess. As it is usual to publish the mere analysis without designating the soil, or variety of the plant, it is necessary in arriving at trustworthy conclusions to look somewhat further than this. Therefore, in reaching my position, I have kept in view two points — the natural habitat of the plant and the circumstances under which its produce becomes of great excellence. Thus in the analysis of the onion by FOURCROY and VAUQUELIN, lime salts predominate; CADET found sixty-four per cent. of potash salts in the garlic; but I venture to place the family to which the onion belongs (*Asphodelæ*) amongst the soda plants, because it is well known that asparagus, many kinds of onion and other genera are indigenous to the sea coast and salt marshes, and because the Spanish onion which excels all others is cultivated in lands irrigated by salt water. Cruciferous plants are soda plants characterized by a remarkable affinity for sulphur, yet in the analyses of the ashes of turnips and cabbages they appear to be potash plants, that base acting as a substitute; I arrive at the conclusion that they prefer soda, from the fact that cabbages and many other cruciferous plants delight in situations near the sea shore. A gentleman well known to this Association has recently shown that the grapes cultivated near the low salt plains of New-Jersey contain soda instead of potash salts, and are in consequence of a very inferior flavor. Another interesting case of the influence of the bases on the flavor of plants exists in the case of tobacco. The French government agents, finding that the tobaccos from the United States had become decidedly inferior to the old samples, submitted specimens to the examination of M. PELOUZE, who ascertained that lime salts predominated in the inferior specimens in the place of the potash salts obtained by BERTHIER.

In determining the place of a plant in the saline groups, I have for the most part selected the ashes of leaves as the true guide, because, in the first place, the leaf is the important organ of vegetation in which the sap is elaborated and the future growth of the plant provided for; and secondly, because there is reason to suspect that some part of the saline matter of the roots may be, like that of the bark of trees, a refuse portion. It is true, that in the case of potatoes, the leaves are not removed and the saline matters of the tubers only are taken from the ground, and therefore economically considered this saline matter should be estimated, but the marked effects of lime in the culture of potatoes, on the tubers as well as the leaves, makes it evident that this base is the one that is essential, and that, although potash salts are given in the analysis of SPRENGEL, it appears to arise more from the mixed nature of the soil than the predilection of the plant, and the lime salts would be found in the tubers as well as in the leaves, on calcarious soils. If the view of Raspail be correct, that the presence of saline matters in tissues is the essential of their organization and the true source of their distinction from the mere proximate principles of which they are composed, it is a necessary consequence that the organizing portion of the plant — the leaf — should contain the essential saline matters, without which, or other isomorphous substitutes, it could not be developed nor carry on its functions; and if the leaf does not flourish the plant cannot attain perfection. In this view of the case, it is proper to determine the situation of plants in the saline groups according to the analysis of the leaf, if they be cultivated for foliage or roots only, unless the amount of mineral matter removed by the roots be very much the greatest.

The influence of cultivation is not to be overlooked in grouping plants. Under natural circumstances all the grain-bearing plants require little azotized matter, but from the development which many, such as wheat and barley, have acquired, they have become azotized plants, and are not to be maintained in their present state without a large supply of this food made to the roots. Many garden vegetables are also of this kind; the cabbage in nature consists of a few tough leaves and inhabits soils of ordinary fertility on the sea side; its present luxurious development, by which it attains a weight certainly a hundred times greater in several varieties, is the result of supplying food to the root in tillage, and if the supply be diminished the characters of the variety are soon lost and the vegetable degenerates.

The following table will show the position of most cultivated plants, so far as evidence exists at present. The conditions under which the classification has been made should be borne in mind.

Plants requiring much azote in the soil,	Seed bearing	Lime,	Hemp seed, Cotton, Hop, cultivated Peas.
		Potash,	Corn, Madia, Wheat, Rice, Oats, Barley.
		Soda with Sulphur,	Rape seed, Colza, Mustard seed, Linseed.
	Foliage or root crops,	Lime,	Tobacco, Potatoes, Hemp, Indigo, Madder.
		Potash,	Sugar cane, Carrots, Parsnips, Mangel-wurzel, Beets, Spinach.
		Soda with Sulphur,	Turnips, Kohlrabi, Ruta baga, Cabbages, Onions, Asparagus.
Plants requiring little or no azote in the soil,	Seed bearing	Lime,	Field Beans, Pindars, Vetches.
		Potash,	Rye, German and Polish Millet, Buckwheat.
	Foliage or root crops.	Lime,	Pomaceous fruits, Lupins for fallowing Clovers, Spurry, Lucern, Sainfoin; all cut before seed.
		Potash,	Meadow Grasses, Jerusalem Artichoke.

Thus the table presents ten groups of plants to be employed in a rotation, which are variously exhausting of saline matters and exhausting or ameliorating as respects azote.

VII. On the Chemical Principles of Rotation.

In purchasing a farm we do not merely aim to gain possession of a superficies on which plants may be set: the object is to obtain such a natural compost of mineral and organic matters as may afford nutriment to plants, in the most perfect manner and for the longest time. If, in a particular locality, there be but one or two remunerating crops our object is to secure a soil which will best feed these. The affinities of plants have been already set forth, whereby a judgment may be formed of the fitness of the farm. In converting the minerals of the earth into crops we must adopt such a system as not to exhaust it too rapidly in one respect, without drawing any resources from another part. If in a situation where every crop is marketable, we adopt a series which takes from the earth only phosphoric acid, we do ourselves injustice by turning to no advantage the purchase of azote, lime, potash and sulphur in the soil.

By a well digested succession of crops we economize each body of the soil, converting it into money without loss or improvidence. As we have paid for every kind of plant-food in the earth we incur a loss by allowing any part to remain unappropriated. Instead of cultivating one crop and going abroad for manure in a year or two, by cautious economy, we obtain that manure at home. The soil presents us with a magazine of saline matters or plant-food, for the most part in an insoluble condition. Annually, the dews of evening and showers act on the insoluble materials, and dissolve a portion: by tillage and judicious management more is rendered available. If the crops do not appropriate all the parts rendered soluble, some percolate into the soil and are wasted. The exposure of the earth, and most crops, rapidly deprive it of organic matter, and it becomes unfit for the growth of many, and diminished in fertility for all plants. By carelessness much waste is thus brought about, and this likewise occurs if manures be used. Farm-yard manure is but a condensed fertile soil, it merely wants the sand and clay which are for the most part mechanical components of lands, and contains the saline and azotized matters constituting the plant-food. Guano represents the soil also, but the fertilizing ingredients are here extremely condensed.

When a good farm, or stable manure, or guano is purchased, we obtain azotized matter, phosphoric acid, salts of lime, of potash, of soda and compound, of sulphur, all of which will be lost to the surface tillage, by volatilization, or percolation in solution, if neglected; or all of which may be reaped in harvests if judiciously managed. This end is to be accomplished only by a suitable rotation, which is therefore, as we have heretofore asserted, an economical expedient only.

As we are engaged in discussing general principles, it is no part of the subject to consider the case of particular soils and manures; but it may be remarked with regard to these, that if the soil be peculiar, as calcareous, green sand, etc., or the accessible manures, as gypsum, marl, refuse fish, be not perfect composts, the rotation must be adapted to the case and does not require the elaborate system necessary for more complex soils and manures. We must either give such land the complex character of the most fertile soils, an expensive process, or adapt the crops to meet its defects. But an opinion is not to be hastily formed of the nature of any soil; we may readily ascertain if clay or sand predominate, if it be rich in organic matter or lime, but before an accurate conclusion can be reached we must be certain that it does not contain alkaline silicates, phosphoric or sulphuric acid, and these are not readily detected even in the richest soils.

When the land or manure contains every kind of plant-food in legitimate proportion, with no great excess of any, as is the case in good soils, the problem to be solved is the system of rotation which shall economize all these ingredients. As to the question of market, it is local; nor do we consider whether grazing be adopted or the crops directly sold, as this in no way interferes with the principles in hand. If we sell oxen, sheep or wool, we deprive the soil of certain of its saline and organic matters, and the rotation must be filled up so as not to waste such as are not sold in this form. If we employ complex manures, true economy does not alter the rotation, each crop is enlarged, but the substances removed from the land or lost will be similar. It may be well to consider one point more fully. If a short rotation be adopted to improve the soil, a time will arrive when the improvement being effected, a new class of more exhausting plants may be introduced, but these are in all cases introduced according to the same principles. There is nothing gained after the soil has reached a certain tilth in continuing the improving system, the object is now to reap our reward; but to do this in such a way that at the end of the rotation the soil shall not have fallen below a certain standard, it is then to be refreshed either by manure, meadow grasses, lucern or other suitable means not now under consideration, but belonging to the topic of improving the soil, and not that of rotations.

The farm having reached its high point of tillage, by suitable means, is now to be cropped for profit, and reduced thereby to a certain practical standard—what are the general principles on which this cropping is to be conducted? Obviously by a system of rotation, during which every saline and azotized matter that becomes soluble is removed, and no part is wasted. This can be accomplished only by introducing such crops as have severally an affinity for the various kinds of plant nutriment, and adapting them to the proportion of food present in the soil. Phosphoric acid is the rare ingredient of soils and manures, excepting guano and bones, the former of which contains 12 and the latter 25 per cent. of this body. Next after this is the azotized matter which forms a small per centage of vegetable mould (0. 5 to 3. 0 per cent.) and is therefore to be removed cautiously. Sulphuric acid is present to some extent in all soils, abounding most in ancient marls and gypseous formations. The supplies of lime and alkalies are very much greater than any of the preceding bodies; the former attaining 10 and the latter 4 to 5 per cent. in rich alluvial lands. The extent to which we may remove these in a rotation is as their probable amount in the soil, which may be taken in general terms after the following rates per cent., in a perfect alluvial soil. Phosphoric acid 0. 20—azotized matter 0. 25--sulphuric acid 0. 10—alkalies 2. 00—lime and magnesia 5. 00. In estimating the consumption we must know the amount and kind of bodies removed with each crop. The difference of average crops in this respect is remarkably striking, and the subject has been fully detailed in my lectures in the University. It may be proper, here, to adduce by way of illustration, a few cases. A crop of wheat of 25 bushels with straw removes 123 lbs. of inorganic matters, consisting of about 12 lbs. of phosphoric acid, 90 lbs. of silica, 15 lbs. of alkaline salts. A crop of lucern of two tons removes 425 lbs. of mineral bodies, of which about 250 lbs. are lime, 20 lbs. sulphuric acid. Eight hundred bushels of beets remove about 360 lbs. of ashes, of which 316 lbs. are alkaline salts.

It would be tedious and out of place to read here the tables upon which these calculations are made; it may be enough to state that they have been made, and that they form one of the necessary items of knowledge in constructing a perfect rotation. In addition to this, every expedient used by practical men, as the introduction of cleaning crops, green fallows, depasturing fall crops, the employment of roots, etc., are to be attended to in carrying out the design of the rotation—the economy of the mineral and organic aliments of the soil. These expedients do not however, constitute principles to be incorporated in the system, but are only practical adjuncts to be used or otherwise according to local circumstances.

Recurring to the foregoing explanation of the two precepts deduced from practical writers, we find that they are sustained by the attraction of particular plants for certain aliments, and are therefore two principles for the government of rotations. To these we now add a further precept, that in the employment of foliage or root crops, to economize phosphoric acid, such as succeed each other, should differ in respect to their affinity for lime, alkalies and sulphur. Thus we have attained the following principles:

1. Seed crops exhaust the soil of phosphoric acid; and are to be introduced at intervals from each other as remote as may be expedient.

2. Certain plants require a large proportion of azotized matter from the soil; and are therefore to follow the application of the manure or to open the rotation in rich soils.

3. Certain crops recruit the soil, as respects azotized matter; and are to be employed after its partial exhaustion.

4. Foliage and root crops differ in their affinities for saline matters, and the amount which they remove from the soil ; and should be so introduced in a rotation as to economize those which are rendered soluble. These are also ameliorating or exhausting as respects azotized matters, and are to be selected in such a manner as to fulfill the indications of the second and third principle.

It may be proper to test the accuracy and practical value of these principles, by examining a rotation of undoubted value. For this purpose I have selected the Norfolk system, because it is well known to be the most successful ever devised ; it has raised entire counties in England from sterility to the highest prosperity, and has extended wherever the soil and market were available. It consists of the following succession : first year, manure, followed by turnips ; second year, barley sown with clover ; third year, clover, the first crop cut, then depastured and ploughed for wheat ; fourth year, wheat, succeeded by manure and turnips, as before. In this system the manure is followed by the plant requiring the most azotized matter, this is also a soda and sulphuric acid crop. Barley, the second crop, requires very much less azotized matter and exhausts the soil of only a limited amount of phosphoric acid and potash. This is succeeded by a lime plant, clover, which recruits the azotized matter and loosens the soil by its long roots. Wheat, which completes the rotation, is a potash and phosphoric acid crop, requiring a medium supply of organic matter. This rotation, when we consider the soil and the manures used, the former siliceous and the latter farm-yard compost and bone earth, is a perfect embodiment of the foregoing principles. Reached entirely by experimental means, it is strictly conformable with science : and is a striking illustration of the correctness of the doctrine, that rotations form a chemical study, which, originating with CHAPTAL, has been maintained to our day.

In conclusion, I beg to present a few instances of the application of these principles in the construction of rotations. The plants proposed for the several soils are indicated by the probable excess of mineral matters and phosphoric acid therein. The crops which may be substituted are placed vertically under the principal plant. There is in the rotation for clay soils, a mechanical impediment, arising from the difficulty of keeping them in tilth, which influences the plan ; and in sandy soils, also, it is necessary that too many hoed crops be not introduced, and that grazing be practised to render the soil compact. The rotations given are applicable north of Carolina.

I. A Rotation for Good Mixed Soils.

	First Year.	Second Year.		Third Year.	Fourth Year.	Fifth Year.	
Manure—or the soil in the highest condition.	Corn.	Oats,	Clovers,	Clovers,	Potatoes.	Wheat,	Carrots,
		Rye,	Grasses.	Grasses.		Oats,	Parsnips.
		Barley,				Barley,	

II. A Rotation for Rich Calcarious Soils.

	First Year.	Second Year.		Third Year.	Fourth Year.	Fifth Year.
Manures, etc.	Potatoes,	Wheat,	Clovers,	Clovers.	Corn,	Oats.
	Hemp,	Barley,			Beans.	Rye.
	Tobacco.	Beets,				

III. A Rotation for Rich Silicious Soils.

	First Year.	Second Year.		Third Year.	Fourth Year.	Fifth Year.
Manures, etc.	Turnips,	Rye,	Grasses,	Grasses fed off,	Corn,	Jerusalem Artichoke,
	Rutabaga,	Oats,	(Spurry.)	(Spurry, " ")	Wheat,	Rye.
	Beets, etc.	Barley.			Buckwheat.	

IV. A Rotation for Clay Soils.

	First Year.	Second Year.		Third Year.	Fourth Year.	Fifth Year.
Manures, etc.	Corn.	Oats,	Clover,	Clover,	Potatoes.	Wheat,
		Rye,	or Grasses.	Grasses.	Beets.	Barley,
						Oats,
						Beans.

HOP CULTURE.*

A PAPER READ BEFORE THE AMERICAN AGRICULTURAL ASSOCIATION, MAY, 1846, BY

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CORRESPONDING SECRETARY OF THE ASSOCIATION, ETC., ETC.

The treatise which has suggested this paper is entitled "An Exposition of the Culture of Hops, as the same is practised by Baron Maximilian Von Speck-Sternburg, on his estate at St. Veit, near Landshut, in Upper Bavaria, Leipsic, 1840;" it was received a short time since by the Association, accompanied with a very polite letter from its intelligent author, and referred by the Association to me for an opinion as to its value. As there is much in this work that is peculiarly adapted to the country for which it was written; it will, perhaps, be unnecessary to occupy the Association in hearing an entire translation of it. I shall, therefore, select only the portions valuable to our agriculturists and present with them in this communication such other useful information on the subject as I have been able to collect from reliable sources.

The Hop (*Humulus Lupulus*) is a slender climbing plant with fibrous perennial root and annual twining stem; it is diaecious, that is, some of the individuals are male and some female, each of which have respectively flowers of different construction; the male or staminiferous flowers, which grow on the stalk quite distinct from the female flower, prepare the pollen, or fertilizing dust, and afterwards wither away when the dust has escaped from the anthers and been committed to the air to be conveyed to the female flowers, which are in the form of strobili, or cones, consisting of scales, having at their base the germ of the future seed; the male plants are usually rejected in cultivation. There is but one species, having a number of varieties—the green bind, white bind and

* Darstellung des Hopfenbaues wie derselbe nach Anordnung des Freiherrn Max. von Speck-Sternburg Ordensritter, Mitgleid mehrer gelehrten Geselschaften und Rittergüterbesitzer, auf seinem Gute St. Veit bei Landshut in Oberbayern betrieben wird. Leipzig, 1840.

red bind. The aggregate fruits of the *Humulus Lupulus* are strobiles or calkins; in commerce termed hops. The lupuline glands or grains commonly termed yellow powder or lupulin are the most valuable part of the strobule.

It is a native of Britain and most parts of Europe.* It is no where cultivated in the East, and although it grows wild in Asia, its flowers are put to no useful purpose. The generic name, *humulus*, is formed from *humus*, "fresh earth," the hop growing only in rich soils, and the specific name, lupulus, is a contraction from *lupus salictarius*, a name by which it was formerly called, because it grew among the willows, to which, by twining around and choking up, it proved as destructive as the wolf to the flock. The current name *hop* seems to proceed from the Anglo-Saxon, *hoppen*, to climb.

There has been much legislation in England on this plant; its cultivation was forbidden by Henry VI. Brewers were forbidden to use them in beer by Henry VIII., and grounds were set apart for their cultivation by Edward VI. In the time of James I. an act was passed to prevent the importation of bad hops. A duty of £1 was laid on them in 1690; the concealment of them is now attended with a penalty of £20; and any person cutting off hop binds is, if convicted, guilty of felony without benefit of clergy. Without question the hop is indigenous to this country, being frequently found growing wild. The best soil for its production is a rich sandy, gravelly loam—some say containing much calcarious matter. Baron Von Speck says that his grounds are found by analysis to contain not the least particle of lime.† It should be rich to a considerable depth or made so artificially; the sub soil must be dry, and one of a porous rocky character is preferred. A southern exposure on a declivity or in a well sheltered valley is desirable. Old rich pastures make good hop gardens. The soil should be highly enriched and most thoroughly ploughed and harrowed. Baron Von Speck says, in Summer and Autumn, before planting, the land which was mostly in lucern' was twice plentifully and twice ordinarily manured, and ploughed in broad beds, with a four horse plough, very deep set, passed twice in each furrow.‡ In the Spring it was again repeatedly ploughed and divided into beds. A very large quantity of the richest fertilizing matter should be incorporated

* The following distich, from Baker's Chronicle, has led to the impression that it is not a native of Britain:—

"Hops, Reformation, bays and beer
Came into England all in one year."

† Die angewandten Reagenzien zeigten in beiden Bodenarten kaum eine Spur von Kalk.

‡ Schon im Sommer und Herbst vor der Anlage wurde das Land, welches meistens Luzernfeld war, zweimal stark, zweimal gewöhnlich gedungt, und dann zweimal 1 1-2 Fusz tief in breite Beete gepflugt welches letztere man durch zwei hintereinander in einer Furche fahrende vierspännige, Pflüge, die tief gestellt waren, bewerkstelligte.

with the soil; a succession of green crops, such as rye, cut green, or fed off with sheep, and early turnips are an excellent preparation for the land. It is far better to occupy two or three years in preparing the ground than to plant in an unprepared soil.

After the ground is in proper order, the rows are marked out about six feet apart each way, north and south, east and west, taking great care that they are straight, as this precaution saves much trouble and confusion in the after culture. Circular holes are then made eight inches deep and one and one-half to two feet in diameter. Four roots are then laid crosswise in the hole, or as the Baron says, "stick them in the soil leaning inward towards the pole;" if this is not done they spread too much, and it is difficult to confine the shoots within proper space for poling. About the time for corn-planting is the proper time for setting them. The roots for planting are obtained as soon as the Spring opens by ploughing within a foot of the hill on each side and laying the roots bare with a hoe and selecting only those of the last year's growth, cutting them about eighteen inches in length; these are called trimmings and are necessary to be carefully removed from the root, whether used or not; as they will not be wanted for several weeks after cutting, they may be kept in the cellar or by burying in the ground; the plants are sometimes raised in beds in the garden and may be raised from the seed. Care should be taken to have but one sort in a plantation, except where the grounds are very extensive, when it may be advantageous to have an earlier and later sort, that they may ripen in succession.

In about a week or ten days the hops will make their appearance, and the cultivation the first year will consist in subduing the weeds and keeping the ground well stirred. The vines produce some hops the first year, but they are not generally considered worth gathering. Early in the second year the hills are opened and the roots examined. If the ground is not sufficiently rich, as soon as Spring opens, the hop-field should receive a dressing of well rotted manure or compost, spread broadcast in the rows, or put in the hill, as is most advisable; this is done by opening the ground a few inches from the roots and mixing the soil with the dressing; after this the setting of the poles is immediately commenced, so as not to injure the vines, which will soon start from the roots and show themselves above the earth. The second year generally gives two-thirds of a crop and in the third year the plant is in good bearing, and will last six to eight years. It has, in some places, been the practice to root out the male plants, as worthless. That it is well to rear a number of male plants among the others to ensure the fertilization of all the seeds may be proved in various ways; but an appeal to the result of the opposite practice is most convincing. A bushel of hops collected from the plants of the fourth year raised from the seed weighed thirty-six pounds, there being male plants near, while a bushel grown in a garden where the male plants were all eradicated, weighed only twenty-two pounds; besides the greater quantity of hops thus obtained, the aroma and the strength of the bitter are much greater.

The poles are usually about thirty feet high and three inches in diameter, of hemlock or chestnut, cut in the winter one year before using, before the bark begins to peel, to give them an opportunity to dry, by which they are rendered much lighter and more easily handled; the bark is left on to enable the tendril to take hold: if the pole is smooth the hop often slips down. In setting, two poles should be placed in each hill, standing two feet apart; sometimes three are allowed, in which case they should be placed in such a way as to leave an opening toward the South for the free circulation of air. After the poles are set, the vines soon appear; those which spring up first are not saved for bearing, as they are apt to die very soon; they should be cut away, or, what is better, be buried in the earth; if cut, they often bleed, and are much injured. In Germany, six persons will make holes and set poles for one thousand hills in one day.

Two vines are allowed to one pole, making four in each hill. When about two feet long, they are turned around the pole, (with the course of the sun,) and fastened to it with woolen yarn. In Germany, half-withered rushes are used, as any strong material is apt to injure them; the yarn should not be tied, but merely twisted. If any are blown down, they should be carefully replaced; and when the vine is too high to be reached from the ground, a step-ladder is used. Baron Von Speck thinks it judicious to preserve two reserve tendrils, for fear of an accident to those selected. He says it is better to have two persons engaged in tying, as it is more convenient, and the work goes on more rapidly.

Immediately after tying the vines, the usual work of hoeing and ploughing commences, the weeds must be kept down, and the hop slightly hilled. The cultivator may be now very usefully employed; after which, the ground should be hoed, and left as level as possible. The picking is the next operation of the hop-grower. The proper time for gathering is, when the flower begins to turn yellow, and the seed brown, which, in New York, is about the 10th of September. The picking should never occupy more than twenty days. A light box, about ten to fifteen feet long, three feet high, and two feet wide at bottom, and three at the top, is carried into the field; the hop-vine is cut off about two feet from the ground, and the pole laid lengthwise across this box. Several women or children may be occupied, at one time, on one pole. After the vine is cut, the end that is left in the ground should be tied in a knot to prevent bleeding. In this country hops are picked without any regard to quality, but in England, where they are more particular, they are divided into three sorts: The green, which are not quite ripe, the light, yellow-brown, which are in perfection, and the very dark, which are past their prime. Some go even further, and make several qualities, according to color and fragrance. The dew should be entirely off before the picking commences, otherwise, the hop might become musty, or take so long in drying as to lose fragrance. No leaves, or long stems, should be left on the hop. The Baron's method is to strip the pole, and carry vine and all into a large, clear place for picking. The drying commences immediately after picking, as the hop sometimes spoils, if left forty-eight hours. It is usually dried in a kiln, which should be well fumigated with brimstone before using; of late, it is dried in rooms heated with stoves. Beech, birch, or maple charcoal, perfectly charred, ought to be used in drying. Pine is ruinous to the flavor of the hop.

When the leaves are brittle, and rub off easily, they are sufficiently dried, and after remaining eight or ten days, are ready for bagging. If bagged immediately after drying, the leaves break; by laying on the floor for a few days they are toughened. The hop is subject to the depredation of the grub-worm, which sometimes destroys whole fields. Lime is said to be an effectual preventive. The fly is also very destructive. The grounds are also much damaged by hail storms, after one of which it is necessary to go through the field to trim the vines and replace them on the poles. After picking, the poles are usually stacked in convenient places, for use in the following year.

This plant is used in a variety of ways, principally, however, in the manufacture of malt liquors, and is found to possess in itself elements of activity not contained in many other materials which have been employed in its stead. It combines the properties of astringency, bitterness, and aroma; besides its diuretic and narcotic principles, it imparts to the beverage a tonic quality, and an agreeable flavor, modifying the bitterness with a warm, stimulant property. The application of this vegetable in the manufacture of malt liquor, is to remove from the beer the active principle of its fermentation, for which purpose a certain quantity of hops are boiled with the wort before it is set to ferment, and no other material has been found to supply its place; as its essential oil conveys a pleasing flavor, and prevents the fluid from running into the acetous, or putrid fermentation. Experience has proved the salutary effect of bitter on the digestive organs; hence the use of hops in malt liquors—diminishing their noxious effects, invigorating the stomach, and promoting digestion.

Previous to the use of hops, ground ivy, quassia, gentian, wormwood, horehound and heath were used in making beer. In parts of Germany, broom-top is resorted to. A bitter wood was once imported into England from Jamaica, as a substitute for hops, but was discouraged and finally prevented, by the imposition of a duty of £80 per ton upon it. The amount of hops consumed in England as an ingredient in beer, in 1845, was 30,000,000 pounds.

The taste of beer-drinkers must have very materially changed since their first introduction; at that time the citizens of London petitioned Parliament that their use might be prohibited, as a nuisance, in common with Newcastle coals: one as spoiling the taste of the drink, and the other offending by a disagreeable smell.*

In 1845, the excise duty on hops raised in England was £285,526 3*s.* 7*d.*, or about one and a half million of dollars: in the same year 48,058 acres were cultivated in the United Kingdom.

Hop culture in our own country is principally confined to Maine, New Hampshire, Vermont Massachusetts and New York. Some of inferior quality are raised in Ohio and Indiana. The climate of New York is peculiarly favorable to their perfection, and the hops of this state are acknowledged by brewers of all countries to be very superior, and they command twenty per cent. more in the market than any other hops. The county of Otsego is celebrated for the excellence of its hops, and they are probably the best that are grown.

The following table will exhibit the exports of this plant from the city of New York, for several years past:

In the year	1837	there were exported	from this city	3,333	bales.
"	1838	"	"	3,250	"
"	1839	"	"	1,423	"
"	1840	"	"	426	"
"	1841	"	"	444	"
"	1842	"	"	5,296	"
"	1843	"	"	2,842	"
"	1844	"	"	3,098	"
"	1845	"	"	3,052	"

The average weight of a bale is about 200 pounds.

These were mostly shipped on foreign account to Germany and France, but very few go to England and those only in bond. The duty now imposed on American hops, in England, is £4 10*s.* or $21 60 per 112 pounds, and five per cent. added for inward charges—or, about twenty cents per pound.

* They began to be appreciated very early, however, as we learn from the praises bestowed by the poet:

"The hop for his profit I thus do exalt,
It strengtheneth drink and it breweth malt,
And being well brewed, well kept it will last,
And drawing abide, if you draw not too fast.

Trusse's 539 *Points of Good Husbandry*, 1557.

Last year, two bales of New York grown hops were sent to London as a sample; a committee of brewers was appointed to examine them, and they arrived at the conclusion that these hops were fifty per cent. stronger in aroma than those of England. The committee waited on Sir ROBERT PEEL, with this conclusion, and in the new tariff a decrease of the duty to just one half, or £2 5*s*. per 112 lbs. is proposed. A reduction of the duty has been advocated in England, for a long time, on the ground that a diminution in the cost of hops would induce the brewers to use nothing else in their malting; but the protective agricultural interests have, as yet, proved too strong for the manufacturers. It is believed that, with the proposed reduction of duty in England, this article will become one of the principal articles of export from this State; indeed, farmers in this State have, in anticipation of it, already laid out grounds enough to increase the export thirty-three per cent. within two years. The average product, per acre, in England, according to the London Mark Lane Express, is, for the last twenty years, less than 500 pounds per acre, while the average of the American harvest is 1400 pounds per acre.

The average value of hops in this market, for a series of years, is 16 cents per pound. They can now be reared at a cost of 8 cents per pound. The whole cost of raising 112 pounds would be $8 96, to which add, for the purposed duty, say $10 89, for freight $2 50, and all other charges $3, making, in all, at the utmost, $22 85 as the cost, landed in London. The average price of English hops is 44 cents per pound, making the cost of 112 pounds $48 25; equal to more than twice what it would cost us to land in London an article, which, according to the London brewers, is 50 per cent. superior in strength of aroma, leaving a margin of $25.40 per 112 pounds, for profit. If the English tariff is modified, as proposed, here is a great and most profitable market opened to our agriculturalists, and one which, from their well-known enterprize, they will be ready to occupy.

In 1845, 12,000 bales were reared in the United States, and from yards set out this year there will be an increase, to about 15,000 to 18,000 bales. The hops of New York, it has already been said, are the best. They are now worth 25 cts. per pound in market; those of New England stand next, and bring 20 cts. Those of the West are the poorest, being deficient in the lupulin, or flower, the most essential property of the plant. The dry, hot weather of New York is more favorable to the process of curing, upon which greatly depends the superiority of the crop.

The hop is a soporific, and pillows have been made of them to produce sleep. In Spring, the young shoots are eaten as asparagus; in Sweden, the vines are made into cloth, and a decoction of the roots are accounted a good sudorific. The Baron Von Speck says that sheep and horned cattle, when they become accustomed, will greedily eat the leaves, and during the hop-harvest they serve as a healthy, evening fodder for a flock of 1400 sheep; and he uses the tendrils as bands for grain and straw binding.

The governments of the several States have established inspections for their hops. Our own State has sustained a compulsory inspection until within a few years; that is, all hops sold in this State were compelled to pass the scrutiny of the State inspector. The Legislature has, within a few years, abolished the compulsory feature in all our inspections; leaving those only who desire to seek the benefit derived in a foreign country from the brand of a State officer. The operation of the inspection is, as I am informed by the present inspector, very prejudicial to the character of our hops abroad, as many inferior hops are sent here from other States, and are exported, after being branded by their owners as "New York first class." Foreign merchants are not long in discovering the deceit attempted to be practised upon them, and the result is very detrimental to the interests of hop-growers in this State, who have, with the consumers and shippers—certainly the only parties concerned—petitioned the Legislature to restore the compulsory feature. This is not the proper place to discuss the propriety of such restoration, and the opinion here expressed is that of another.

In inspecting, hops are divided into first, second, and third classes, and refuse; which latter is only used by manufacturers in setting colors, &c. The second and third classes are usually of same quality of hops as the first class, but are injured by carelessness in curing and picking. Mr. G. W. Ryckman, who has had much experience in the use of the hop, in his former very extensive brewery at Albany, and to whom I am indebted for much information, recommends, in picking, that the hop be divided into three classes. The first class to consist of such as are picked in the first third number of the days of the whole picking; the second class to comprise those gathered in the second third number of the days; and the third class the remainder. The first class will be of a greener color, and better for export to Germany; the second class will be preferred in the manufacture of pale ale; and the third better for porter.

Notwithstanding the great superiority of American hops, they often do not command as high a price in foreign markets as English hops, owing to the extreme negligence of many growers in picking and curing. Many consumers judge of the quality by the appearance to the eye; and those not cleanly picked are condemned, though superior in strength and flavor. A letter from a distinguished merchant of the north of Europe says:—"You promise much, on the score of more vigilant inspection of hops. We prefer the American hops to any other raised, and if you would establish the reputation they so well deserve from their superior quality, they would command the market."

It is to be hoped that our farmers will soon find relief from the burdensome restrictions of the English tariff, which weighs heavily upon their interests. The population of that country want our agricultural products to supply their daily necessaries, and an abolition of the heavy duties now imposed will give an impetus, not only to hop culture, but to every other branch of agricultural industry.

ON THE USE OF VARIOUS MANURES.

A COMMUNICATION READ BEFORE THE ASSOCIATION, DECEMBER, 1845, BY

R. L. PELL, Esq.

Of Pelham, Ulster County, New York.

Mr. President and Gentlemen of the Association:

Having been requested by several of our members, to state to you my experience in the manufacture and use of manure and cultivation of wheat, I herewith comply. By analysis it has been discovered that all the cereal grains—all cruciferous and leguminous plants—all trees and shrubs, require in the soil certain chemical substances, in different quantities, according to the character of the plant. Those substances are eleven in number, viz.:—Potash, Soda, Lime, Magnesia, Alumina, Oxide of Iron, Oxide of Manganese, Silica, Sulphuric Acid, Phosphoric Acid and Chlorine. If one of these is entirely absent from a soil, it may not grow any of the cultivated plants; therefore the absolute necessity in the present age of analysis. You might add to your soil several chemicals and still not add the required one. Thus it is that so much valuable land in our State will not grow wheat, when, were the soil analyzed, the farmer might by an addition of perhaps potash, lime, or some other simple substance, make his land produce fine crops of that invaluable grain. The reason that rye and buckwheat will grow after wheat ceases, is that they require less lime and other chemical substances than wheat; at last you can raise no crop—the five finger vine takes possession of your soil and you consider it worn out and useless; when, by an expense perhaps of three dollars to the acre, it would produce you thirty bushels of wheat.

I had a piece of land that would not grow white beans, which, by the addition of fifty cents worth of two simple substances, yielded me at the rate of seventy-eight and three-quarter bushels of wheat, weighing sixty-four pounds to the bushel per acre, a small space being measured of the finest plants. I have grown wheat as an illustration of the applicability of straw as a manure, on a pane of glass by merely covering it with straw; the straw contained the principles of vegetable life—the substances already named—and the wheat contained the same; therefore, by applying the straw, as it decomposed, the requisites of growth were yielded to the grain, and it grew beautifully. Therefore it was I impressed on the minds of farmers that they might sell the grain but by no means the straw. I am now, and have been all Summer, buying straw of my neighbors, at one cent to two cents a bundle, which is thrown on my cow-yard, as an absorbent, and becomes in six months a rich and most valuable manure; that which is long and undecomposed is used for hoed crops, such as potatoes and corn; the decomposed and well-rotted as a dressing on the surface, mixed with guano, charcoal, ashes, etc. The same principle will apply to all. If you grow rye, return the straw to the field and plough it under; when rooted, it will grow rye even in ground too poor previously to grow any crop. When digging potatoes, cutting corn, etc., the haulm and tops should be returned to the soil; it will need no other manure, and will produce the following year the like crops if planted in the same ground. When trimming vines leave the tendrils and leaves at the roots of your vines, and they will require no other attention at your hands. If you would give to fruit trees a manure most suitable to them, burn the trimmed limbs and branches and return to the tree the ashes. The crop will be abundant. The reason why the manure of neat cattle is so nutritious to grass lands, is that the cattle are mainly fed on grass and, therefore, you return like to like; for the same reason horse manure is by far the most valuable on cereal grains, he being chiefly fed on farinaceous matter. In Weathersfield, the great onion district of Connecticut, they grow onions year after year on the same ground, and for that purpose leave the tops on the beds from whence they take the roots. If in Virginia the tops of the tobacco plant had been left on the soil and little more care been used, immense tracts in that State now deserted and barren, would have still yielded profuse crops of that plant and have enriched hundreds. It was never intended that the land should be stripped of all enriching matters, and thus those grasping *all* are punished.

For some years I have been engaged in endeavoring to grow crops superior to those grown in my vicinity and, for that purpose, have placed upon my soil composts composed of many substances, as until recently we have known little of chemistry as applied to agriculture, analyzing soils, etc. Frequently, my results were marvelous; but I knew not from what cause—whether they were produced by one of the manures used, or by all. Consequently I did not dare leave out a single substance, but rather added others. In one instance I applied my composition to a common squash vine, and produced a squash which was exhibited at the State Fair held in 1844, weighing the enormous weight of two hundred and one pounds, the heaviest on record by, I suppose, some fifty pounds. I applied it late in the season to a cabbage, which was also presented, weighing forty-four pounds, and to other roots, all of which received premiums. To wheat, and it weighed sixty-four and a half pounds to the bushel; to rye, and it weighed sixty; to oats, and they weighed forty-four and a half, thirty-two being the standard. When Sprengel's Analysis appeared showing that eleven substances were absolutely necessary to all good soils, I found my accidental composition contained them all, and twenty other enriching essentials. Previous to five years since, my orchards only bore fruit the intervening year. Since that time these, properly attended to, have borne every year and every year the fruit grew finer than the year previous and more abundant. The last was not my bearing year, nor was it the bearing year throughout the county; still my crop, for the number of trees experimented on, was most plentiful. The trees not attended to, though directly alongside of those which were bending to the earth with fruit, were entirely barren. The season, too, has been most unpropitious, as we have not had from April to October sufficient rain to moisten the earth to the depth of three inches; notwithstanding, the composition applied kept the roots constantly moist, and thus protected the crop from destruction. I prefer infinitely a manure composed of decomposed vegetable matter, such as grass, weeds, straw, leaves, hair, etc., to the manure of neat cattle, for the reason that the food eaten by stock goes to form all the animal economy; whereas if rotted, and the ammonia is preserved by means of charcoal dust, you have all the chemical substances unadulterated and pure, and, when added to the soil, it receives a ten-fold benefit. I once placed a dozen fowls that had been killed by a mink, at the roots of a peach tree. The growth was prodigious, and the leaves were still green when every other tree in the orchard had shed its leaves some time before. I would call the attention of the Society to what I consider a most valuable manure, and one that is within the reach of all to a limited extent. Having occasion, last Winter, to visit a bone establishment, I was told by the occupant that it had been declared a nuisance, and that he was on the point of removing to the East River on account of the smell arising from the liquid left after boiling bones, which liquid he was obliged to remove at once to the Hudson and if he was fortunate enough to reach that receptacle for all the filth of the city before it cooled, no disagreeable effusion arose. I informed this person that I could put him in the way of making one of the most valuable manures of this liquid—for when it cooled it formed a thick jelly, and contained of course all the most enriching substances boiled out of the bones. This is accomplished by the addition of pounded charcoal. I have used this compost to great advantage, and sown broad-cast on meadow lands. It is so devoid of obnoxious smell as to be carried willingly by sloops eighty miles up the Hudson. Charcoal is one of the most wonderful absorbents we have; as a manure I consider it very valuable. It absorbs from the atmosphere oxygen, hydrogen, nitrogen and ammonia, and while the weather is dry holds all these valuable stimulants; when rain comes it takes in eighty per cent. of water and releases the other gases which are carried down into the earth by the water. When it becomes dry the water is released, and the other gases imbibed. When used around trees, green-house plants, shrubs, grain or grass, it will invariably be found, on taking up the plant, closely adhering to the roots. I have had trees packed in it, and after a passage of eighty days they have been found perfectly green, and in most beautiful order, when others of the same species packed in matting, boxes, etc., have been perfectly dead. I first used it in 1840, and take pride in saying that I was among, if not the first, to make mention of its valuable qualities as a manure in this country. If spread over the compost heap, stable floors, barn yards, etc., it will absorb all the ammonia, prevent the waste of gases exhaling from it, and thus form itself into a very valuable compost. I saved apples packed in it last fall until this fall perfectly. Ashes, as a manure, I have found of great advantage on sandy soils. I have seen land so poor that it would not actually produce eight bushels of corn to the acre made to yield forty-five, merely by the application of ashes, properly applied. On some soils leached is as valuable as unleached. In fact there is scarcely a manure more valuable than ashes in a sandy soil, except perhaps marly clay. It makes a soil hold moisture, which is a great desideratum on a sandy soil. You may have noticed that it is much used on Long Island and in Jersey on light sandy soils, to very great advantage. It stimulates growth, like plaster when first used on land. If sown broad-cast on land, in grass a difference in growth will be almost immediately perceptible, and the yield in hay will pay the whole expense of ashing, say forty bushels to the acre, which will yield to the soil precisely what grass most requires, viz.: silicate of potash, for the formation of their stems—without which such formation is impossible. Ashes neutralize acids in soils, which is their chemical action. Their mechanical action is rendering soils less tenacious. Ashes may be used in most composts to great advantage, as the alkali excites decomposition.

Lime has been used on my farm to great advantage. I have sown seven to eight thousand bushels within the last six years and give decided preference to the oyster shell, for the reason that it contains no magnesia, which most of the stone limes do. I do not know whether it has been noticed, but I think it has a tendency to lessen the growth of the stem and leaves of plants and increase the fruit and seeds. Four years since I manured a fifteen acre lot with oyster shell lime, using three hundred bushels to the acre, on land that would not before grow anything more valuable than Johnswort. That year the wheat grown on it weighed sixty-four pounds to the bushel. I seeded it with one bushel of clover seed and half a bushel of timothy to the acre, and the first year after, cut two and a half tons and the second year three tons of hay to the acre. After mowing I usually top dress with a dry composition, and my afterwork is half as valuable as the first cutting, which is used for soiling stock. Lime is used on my farm to great advantage in potatoe culture. To it I attribute my success in that branch of agriculture. My potatoes never rot in the ground, when all the neighboring fields are entirely destroyed; they keep all Winter, and are generally very mealy and fine. This year they were very good, but not as large as usual, owing to the severe drought experienced throughout the Spring, Summer and Fall. I am clearly of opinion that the rot is caused by insects which the lime destroys. Bone manure I have likewise used to some extent, and can confidently recommend its use, particularly in soils long cultivated destitute of phosphate of lime. It is probably the most efficacious substance that can be used on a perfectly worn-out soil. It will be found of more advantage on a dry calcarious soil than on one containing much alumina I usually mix it with earth and allow it to ferment before spreading it on the land, and use from twelve to thirty bushels to the acre. I have found it of more advantage to the turnip crop than any other. In compost it is particularly valuable, yielding phosphates. As to its durability, personally, I can say nothing. Dr. Stanly, Bishop of Norwich, says:—"Lands in Cheshire bone dusted twenty years ago, show almost to a yard where this manure was applied." I hope the day is not far distant when the exportation of bones to foreign countries may cease.

Farm yard manure, if properly managed, is the most important to farmer. This varies much in value. Two farmers may keep a stock of twenty cows each, and still the manure made in the yard of one may be inferior to that made in the yard of the other; the one will feed his stock all Winter on straw and turnips, and consider himself much better off and wiser than the other who feeds on oil cake and hay. The manure of the latter will be one half more valuable than the former and a consequent difference will be perceived in the growth of crops upon which it is placed. Therefore it is that human ordure is more valuable than any other manure, as man lives on a variety of food, all containing in the greatest degree fertilizing ingredients. Why is it then that the citizens of New York permit such a valuable and enriching substance to be thrown off the docks? How could the surplus revenue of the city be better employed than by establishing a depot for its collection, where by the most simple process it could be converted into a portable and most valuable manure? Soap boilers' waste, coal ashes, ammoniacal liquor from the gas houses, butchers' offal, charcoal dealers' dust, and street dirt might all be preserved, and produce, instead of cost, after the first year, an enormous income to the city. The reason so little has been said on this subject is that absurd and ridiculous prejudices are entertained by many, who imagine a disagreeable taste is imparted to the vegetables grown under its influence. Recently France, Belgium, and other nations, have passed strict laws prohibiting, its waste under pain of imprisonment. Eastern nations have used it from time immemorial; the excrement from cattle being used by them as fuel, consequently this fertilizer became indispensable. In China it is dried and sold to the farmers at high prices throughout that immense empire, and has for ages been there considered as the most valuable of all manures. England and the United States may be considered the only two nations totally behind the age in that respect. In England all the filth of the large towns and cities is led off by the shortest possible route to the rivers, if there happen to be any passing through them. In London, particularly, sewers are constructed to lead it into the Thames. In all our cities and towns the example of the mother country is being followed. I have in several instances tried this manure, in comparison with others, and have invariably found that it increased the crop three-fold. Arthur Young placed six loads of night soil upon an acre of potatoes, and the yield was six hundred and fifty bushels; he manured another with one hundred and twenty cart loads of horse manure, and the yield was four hundred and eighty bushels. It behoves this Society, existing for the express purpose of improving agriculture, to move in this business, and use our strenuous exertions to persuade the authorities of our city to set apart a piece of unoccupied ground on the outskirts of the town, and direct that all refuse matter to be carried there, which, thoroughly incorporated with the substances before named, will produce a compost invaluable to the agriculturalist. I hope the Society will appoint a committee to investigate this matter.

All the weeds of a farmer should be carried to the barn yard. If too far removed, they may be collected in a corner of the field and converted into manure in forty hours, thus:—Form a bed of weeds twelve inches thick and cover them with a thin layer of quicklime one and a half inches in thickness—then weeds and lime in succession until all your weeds are disposed of—after which cover the whole with muck or charcoal dust; fermentation immediately takes place, great heat ensues, and if the heap is not well covered to keep out air, ignition is possible.

Farmers meet with serious loss by feeding their stock with the haulm of potatoes, cabbage, beet and turnip tops, for the reason that they contain at least seventy per cent. of water, consequently are poor feed for animals. On the other hand, if buried or ploughed under, their moisture causes rapid decomposition, and the manure, for reasons before stated, is more valuable than that of farm yard. In Italy the inhabitants are in the habit of sowing tares, buckwheat and other crops which, when in flower, are ploughed in for manure. They seemed particularly partial to lupins, which extract azotized matters from the atmosphere and yield them to the earth. The seeds of lupins are frequently boiled and sold as manure. It grows like the bean, bearing pods, but it is so bitter that animals will not eat it.

I know it is unpopular to say aught against guano, a manure so much favored in foreign countries, still, as I was one who received a parcel from this Society to experiment with, I am in duty bound, after having tried it to my heart's content, to state at least the result. In the first place my gardener planted three rows of onions across a bed sixty-seven feet long in drills, which were partially filled with guano, and alongside three drills the same length without any manure, the bed being rich. The result was those without grew the best and produced the largest bulbs; some of the other were killed. He planted three rows of beets sixty-seven feet long with and three without; many of those planted with it died outright. He planted three rows of salad with and three without; those with guano died in three days. Three rows of potatoes were planted with and three without, and no perceptible difference observed. Ten rows of corn, one hundred feet long, were planted with guano, and ten rows, one hundred feet long, with soot; those with guano died to a plant. Lima beans were killed by it, grass was killed, cabbages improved, cauliflowers injured, peas destroyed, strawberries injured, raspberries injured. It is useless to mention other articles, but safe to say every garden product I used it upon, and they were many say twenty-one different kinds of vegetables and plants, were either killed within one week or materially injured. In composts I found it very valuable; diluted with water and poured upon meadow land it produced a wonderful effect, making the grass grow astonishingly. It presented likewise a much greener appearance than the grass adjoining. Dissolved in water and used sparingly on green-house plants, it was found to increase their growth and give them a beautiful green appearance. Upon the whole I am sorry I ever had anything to do with it, and have now on hand nearly two tons, which will probably long occupy space in my laboratory—a memento of the gulls once inhabiting the shores of Peru.

WHEAT CULTURE IN WESTERN NEW YORK.

COMMUNICATED TO THE ASSOCIATION, APRIL, 1845, BY

GEN. R. HARMON, Jr.,

Of Wheatland, Monroe County, New York.

The soil that I have under cultivation is probably as well adapted to the production of fine wheat as any in the country. It is a gravelly loam, with limestone of small size or gravel up to lumps of several pounds weight. It is what has been called the hard oak opening. My system of cultivation is a three years shift. Clover is invariably sown on wheat in March or April, about eight pounds to the acre; and as soon as the ground is dry, in April, one bushel of plaster is added to the acre. The next year pasture or mow. The third year, in June, plough seven or eight inches deep. The clover should be mostly eaten off when ploughed. The turning under of a great growth of clover I believe to be injurious to the next crop of wheat. If fed off with sheep the manure they leave is worth more than if the clover had been turned under in its green state. In turning under green clover there is in the next crop frequently a coarseness in the leaf and straw that is not favorable to the production of a fine quality of grain. I go over the ground thus ploughed with a cultivator; harrow three or four times by the first of September; then cross-plough, and sow on the furrow from the tenth to the fifteenth of the month; then harrow it in with the cultivator harrow. It buries the wheat deeper than the common harrow, giving the plant a more vigorous appearance, rendering it less liable to injury by the thawing and freezing of the soil in March and April. Wheat for seed should be selected from that part of the field which is first ripe, and where it ripens evenly; all lodged or rusty straw should be rejected, for wheat from such straw does not fully mature. It will grow as soon as any other, but grain of superior quality is seldom obtained from such seed. All small or imperfect seed should be sifted out and nothing but the best sown. Twenty-four hours before the wheat is sown it should be washed in a concentrated brine. After draining a few minutes mix with each bushel two quarts of newly slacked lime, and then sow one and one fourth bushels of seed to the acre.

The above is my course of operation. My average crop for several years past has been over twenty bushels per acre of very superior quality, mostly sold for seed; the past season being over 1100 bushels. My price has uniformly been twenty-five cents over the millers. One great difficulty in the way of farmers improving their wheat crops is the sowing of poor grain mixed with other seeds. While at the State Fair at Poughkeepsie, in 1844, I saw several barrels of wheat of different varieties all mixed with so much cockle and chess that a Wheatland miller would not take such for flouring as first quality. The man that had it said it was sent to him from Western New York for seed, and he was trying to sell it as such. As long as such seed is sown we shall have those farmers that believe wheat will degenerate into chess.

In selecting the best Winter variety, I will name the ones that I believe will do best on the different soils where wheat is sown. There are some varieties that succeed better on some soils than others. If the soil is rich clay loam it is important to sow a small and early variety, as the Kentucky white, better known as Hutchinson wheat; the Mediterranean, or the Wheatland red. If the soil be a sandy or gravelly loam the improved white Flint, old Genessee red chaff, bold Saul's wheat, and Flint. In selecting the variety that will do best on all soils I am confident that the white Flint stands first for quantity, producing more flour of superior quality than any other of nearly forty different varieties that I have had under cultivation. I know of no Spring variety that will equal the Winter kinds where they succeed well. In some sections of the country none but Spring varieties will succeed. The Black Sea, red chaff and bearded, are the hardiest and most productive of any of the Spring varieties of good quality. The Tea wheat is a very beautiful Spring wheat, with white chaff and a bald white berry, but it is not as productive as the Black Sea; the quality is, however, much superior.

I will endeavor to arrange a case of wheat specimens this season for the Association. I have about forty different varieties of wheat now under cultivation, from which I can arrange one.

ON THE DISEASES, DECAY AND PRESERVATION OF TIMBER.

By EDWARD CLARK, A. M.

MR. PRESIDENT AND GENTLEMEN OF THE ASSOCIATION :

I propose, on this occasion, to make some remarks on timber and timber trees, some of the diseases to which in either form they are subject, and point out some of the preventives which may be economically applied.

The subject is broad and fertile, and merits a much more close and extended investigation than the circumstances under which we have convened will permit. My aim will, therefore, be merely to give a general outline, and leave deficiencies or details to be supplied by those who may be more directly interested in it. My object is practical utility. I shall, consequently, avoid technicalities, as far as my subject will permit, in order that I may be more generally understood.

The forest trees which in one way or another may be made to contribute to the conveniences and comforts of man, to say nothing of art and elegance, are exceedingly numerous; but a comparatively small portion of them, however, possess the character of durability when dressed into timber and applied to ordinary exposure. It is proper in this place to state that, by the term timber I mean to be understood, all varieties of trees suitable for building purposes, which have been felled by the axe or accidentally and roughly dressed or hewed.

The trees of our country, which claim to be more particularly noticed as applicable when reduced to timber for durable use, may be enumerated in the following order, viz.: The oak, pine, chestnut, cedar, cypress and locust. Others, it is true, may be added to the list; but the limits which I am forced to prescribe to myself in the discussion of the subject, will not allow me to treat of them except in a general manner. I shall therefore, confine my remarks chiefly to the oak, because from its more extensive application in subservience to the the wants of social beings, it holds the most important rank among them. I shall, nevertheless, refer to such other trees as may be pertinent to the occasion.

The family of oaks is very numerous, amounting to somewhere about one hundred and forty species. Few of them have, however, been found profitably available for building purposes, or generally in rural economy; the number, nevertheless, may be considerably increased, if needed, by the application of the means indicated by science, to which a more particular reference will be had in the sequel.

Of the white oak, (*Quercus alba,*) with which I shall commence, though a volume might be profitably written, little at this time need be said, because its character or properties are generally well understood. Deprived of its alburnum or sappy portion, well seasoned before use and kept in a dry atmosphere, it is for general purposes of building the most valuable of any other hitherto known.

This tree frequently grows in forests to the height of one hundred and twenty or thirty feet; but in openings it spreads into branches and seldom attains more than one half or two-thirds that elevation. The girth at the felling point varies according to soil, frequently exceeding twelve and even fifteen feet. It is of great value, particularly in ship building.

There is, however, a very material difference in the quality of oak timber—that for instance prepared from trees which grow in openings, or isolated measurably from all other trees, is more compact in its organic structure, stronger and more durable than that taken from dense forests. Again, those which grow in an atmosphere charged generally with sea water, or in a soil slightly impregnated with the chlorate of soda and which, consequently, contains salts of that material, are far less perishable than those produced under different circumstances, and which assimilate the salts of potash instead of those of soda. These qualities are again modified by the conditions of the producing soil; if dry, or somewhat elevated, the growth will be much slower than in low, moist lands, and, consequently, they will be more valuable or durable.

These remarks respecting the character or properties of the white oak apply also to the chestnut tree, (*Castanea Americana.*)—and are facts well known to our experienced ship-builders—and I have no doubt they will, with equal propriety to most other timber trees similarly circumstanced.

The live oak (*Quercus virens*) is to our country, of the oak family, next in importance to the white oak; it is indigenous to the southern portion of the United States, and is found in its greatest perfection in low, moist, loamy soils. This tree lives to a very great age, frequently exceeding eight or ten centuries, if the yearly annular accretions are to be depended on as authority. It generally grows to the height of forty or fifty feet; the trunk, large; branches, large and long; and from the strength and toughness of its fibres, and its great durability, the timber from it has obtained a preference for ship building to that of any other tree known.

This tree, not anywhere extensively to be found, is already becoming scarce in the neighborhood of navigable waters. Its great value in a national point of view, its limited development and its exceedingly slow growth, render its preservation and cultivation an object deserving the prompt and efficient attention of our government. In fact it is an obligation which the present owes to the prospective greatness of the future, and as human nature is constituted it should be elaborately cancelled.

There are several other oaks which may be used for timber, particularly if subjected to some mineralizing process, such, for instance, as the yellow oak, (*Q. acuminata*,) chestnut white oak, (*Q. prinos*.) black oak, (*Q. tinctoria*.) etc., but the woody fibres of them all want the strength and elasticity which so eminently characterize those of the white and live oaks.

In addition to these differences in the quality of wood others are presented of quite as much importance in the form of diseases, and require some notice, more particularly as the woodman, who is either paid by the day or labors at a certain rate for felling and dressing trees into timber, is wholly indifferent to quality, except so far as it may be the more easily worked, and thus present the fairest outward form.

Some builders are equally indifferent in regard to the quality of timber, and apply that which is diseased, or in a perishing state, with that which is sound to building purposes, without reference to consequences. Hence the frequent losses and disappointments which accrue and to which I shall again refer.

One of the most prevalent diseases to which trees are subject, is the solidification or closing up of the pores next to the pith, from which it extends outwardly towards the alburnum. In the first stages it is manifested by dottiness; afterwards the woody fibres which are affected, undergo the various changes of decomposition, and they become hollow to a greater or less extent in their trunks. This disease, by preventing the circulation, impairs the fibres and renders the timber obtained from such trees unfit for use, except for temporary purposes.

Another disease, if I may so term it, is prematurity; it is indicated by the death of the tops and topmost branches of trees. Whole forests sometimes present this appearance. It arises from a rock-bound or shallow soil, which does not furnish the necessary nutritive substances. Trees so affected do not grow large, nor are they rendered unfit for some uses in rural economy; the chief loss arises from the perishing portions, which can seldom be applied to advantage even for fuel.

This diagnosis was well understood by the early settlers of some districts of our country, as is manifested by the unreclaimed lands of this character which are frequently to be met with.

Trees from old age present the same aspect not unfrequently as those just described. In such cases the duramen or heart, as it is generally named, will have partially lost its strength, toughness and elasticity; they are only fit for the most common uses.

They are also sometimes affected by frosts and tempestuous winds, which render them cuppy near their centres, or, in other words, separate the woody fibres of a few years' accretion into annular and not unfrequently into broomy divisions. This disease does not generally affect the wood far up the trunk of trees, and is, therefore, remedial by lopping off.

There are other diseases to which trees are liable, such as maims, rind galls and excrescences, but I will pass over these to the decay, or to the more important ones to which timber is subject, and then notice some of the preventatives which chemical science has revealed.

If trees, when felled, be suffered to remain for a season on the ground, the temperature being favorable, a partial decomposition of the caseous and soluble portions of the woody fibres follows and sometimes very speedily, particularly in the alburnum; but as this should never be employed in building, except for the most temporary purposes, unless chemically prepared it would scarcely be necessary to refer to this exterior change, were it not in its progressive state a certain criterion by which to judge of the condition of the more perfect wood.

But the constituents of different genera and species differ in substances and proportions so materially as greatly to modify these changes, retarding or accelerating them according to the organism acted on.

Thus, some species of the pine may lay so exposed for a succession of years without sustaining any injury—except in their sappy coverings; while the oak and most other hard wood trees similarly exposed soon exhibit signs of deterioration and decay.

These changes, it is true, do not universally follow, for trees sometimes fall on soft peat or marl beds, gradually settle into, a d are preserved for indefinite periods of time by the saline antiseptics which are contained in them.

Sometimes, however, when so exposed, the vegetable tissues become slowly dissolved and are replaced by silico-aluminous depositions which exactly resemble them and which are in common language wrongly denominated petrifactions.

The decay before referred to is much more perceptible in trees that have bark on than when it has been removed; besides, when stripped they are seldom attacked by worms and borers, which, unless care be taken to prevent their action, prove energetic agents in the work of vegetable decomposition.

Timber so affected, though subsequently seasoned, is more liable to decay than that which has been seasoned properly and with care before use, especially if exposed to a confined, heated and moist atmosphere, such as is frequently presented in the holds of ships, particularly in low latitudes. Thus exposed, decomposition recommences, and the result is *one variety* of the *dry rot* or a total breaking up of the woody structure into powder.

Timber that is perfectly sound after long exposure is also subject to this disease, that of the live oak perhaps only excepted. It has been represented as the work of animalculæ, but if present, they result from and are not the cause of decay in timber any more than they are in dead animal substances, where they are known to abound in great numbers.

It has also been ascribed to fungi, which no doubt are the destructive agents of wood under some circumstances; but in such, as before referred to, it arises, beyond a doubt, from the entire decomposition of the adhesive substances which are assimilated during the growth of trees and firmly bind the fibres together. The destruction of these substances being complete the organism ceases and nothing remains but the residuary powders.

Some of the timber brought to our market will, if examined, be found to have suffered from some of the diseases before described, but it generally commands as high a price as that which is perfectly sound, probably because the purchaser is ignorant that any difference in the quality exists; but the carpenter who uses such timber is inexcusable! particularly in the structure and repair of ships, and merits punishment for it as much as the house-breaker or incendiary.

This subject is of great moment, taken in connection with the wants and relations of civilized life, but one which, I regret to say, attracts very litle attention from those who are most immediately interested in the durability of timber.

In ship building the great mistake heretofore experienced has arisen from the commixture of more perishable or decayed timber with that which was sound and durable. This is exemplified by the condition of some of our old ships when broken up. In house building errors, though not so fatal to life and property, are often committed: witness, for instance, the warped and kimbo positions now presented by country dwellings that were once elegant and symmetrical.

The evil does not end here. Of the thousand houses now being erected in the city of New York and its suburbs, not one, I will venture to assert, has the beams on which the floors are being laid well seasoned; the consequence is, after the buildings are finished, they shrink from the base boards, and leave openings for the intrusion not only of currents of cold air, but for mice and various creeping things.

The use of unsound timber may, and no doubt does frequently, arise from the sheer ignorance of the workman; sometimes, however, it may be ascribed to design, in his selecting that which is more easily wrought in preference to durable quality.

Where the disposition exists, a slight attention to the condition of timber before use would in many cases prevent serious loss and evil. It is of the first importance both to our government and to many individuals concerned in its use, that disinterested inspectors should have the selection of all timber required in ship building, and the use of any other should be strictly prohibited. With the practice of such precautions a great improvement in ship and all other building could not fail to follow.

But to guard effectually against the decay of timber something more than a close inspection will be found necessary, and to this science points with unerring certainty.

It consists in filling the sap vessels of timber with some antiseptic substance or substances which shall fix the caseous and soluble portions permanently, or, by uniting with them, arrest their putrifactive tendency.

Substances of this character are numerous; but in their selection a strict regard should be had to economy. Mr. Kyan first introduced the practice of preserving timber by filling its pores with corrosive sublimate or oxymuriate of mercury; hence the term of kyanizing. This process has been abandoned and cheaper ones substituted for it. Among them may be included all the sulphates and sulphate-triple salts, which contain an excess of acid; dilute sulphurous and sulphuric acid, concentrated vegetable acids, some of the volatile oils, pitch, unrectified creosote, most of the metallic and some of the alkaline and earthy salts. In fact any substance that will act upon the caseous or albuminous portions of timber and change them into insoluble matter, will preserve it from decomposition for almost any length of time.

What is most remarkable in these changes, is that the sappy portions of timber are rendered by most processes quite as enduring as the duramen or more solid parts. Before describing any of the processes of preserving timber, I will make a remark or two on the season best adapted for cutting and seasoning of timber.

Various opinions are entertained in respect to the most appropriate season for felling trees for timber. If felled after the leaves have dropped, in Autumn, and before the sap commences to flow, say in February or March, (I speak of tropical climates,) the bark adheres firmly to the alburnum, and will if kept dry under cover, continue to do so several successive seasons. Fuel of this description is decidedly preferable to that which is cut at a time when the sap is in circulation and which invariably looses its bark in seasoning; and, by a parity of reasoning, timber cut, dressed, and kept dry in a similar manner should be preferred to that which was cut, etc., while the sap flowed.

There is another substantial reason why trees felled at the season of the recession of the sap should be preferred, which is, if the authority of those who have made vegetable physiology a study may be relied on, "that the sap vessels furnish no materials to trees for immediate assimilation after the middle or latter part of August, but transmit and deposit magazines of starch, etc., for the future growth of trees when the warm weather accedes and the sap vessels renew their accretory functions.

If such be the fact, as the circulation of the sap must measurably cease to flow in trees which have been felled during the prevalence of frosts, it follows as a necessary consequence that timber from trees which contain starch will be less liable to decomposition than that in which the starch has been converted to saccharine matter, because it is removed a stage farther from such change—provided they both be similarly treated.

But when trees have been felled, dressed into timber, and placed under cover for air-seasoning, or in water for water-seasoning, with proper expedition, there can be no very important difference in respect to the period of the year in which they have been subjected to the leveling action of the woodman, because the fluids in the sap vessels, in the first case, become so inspissated, or rather concentrated, as to possess antiseptic properties, which can only be disturbed by change of condition; and in the second case, they become so diluted, if exposed for a sufficient length of time, as to possess few if any of the elements of speedy and direct decay.

This leads to some remarks on the seasoning of timber. When trees have been felled they should at once be roughly hewed and placed under cover, some distance above the ground, in order to enable a free circulation of air and the slow evaporation of the water in the sap vessels, so as to prevent as far as practicable the checks or openings of the woody fibres, which, if left exposed to the influence of the solar action, are often so large and numerous as greatly to impair the value of timber.

Or, if to be water-seasoned, the timber should, if practicable, be immersed longitudinally or parallel to the course of running water. So circumstanced, the sap in the vascular organism is soon displaced by water, and this change of occupancy is continued till the timber is fully seasoned or deprived of its immediate putrifactive agents. This change will also take place in timber submersed in still water, but a greater length of time is necessary for its accomplishment. Sea water is sometimes employed for the same purpose; but it is too impure, imparting to timber which has been seasoned in it a disagreeable viscosity, particularly when placed in moist situations.

It is, when artificially prepared—that is, from salt deprived, by recrystalization, of its magnesia, lime and sulphuric acid, and is dissolved to a saturation in rain or river water—the cheapest, and one of the best preservatives of timber; next to this, copperas (sulphate of iron) and alum (super-sulphate of potash and alumina) may be ranked as cheap and valuable. All used singly, or the two latter, with some other saline preparation, which will reciprocally decompose each other, and deposit one or both of their bases in the sap vessels of the timber. When either of these substances are to be applied, singly, it will be necessary to prepare reservoirs of sufficient capacity to contain the timber required to be operated on.

These reservoirs may be formed by banking in portions of flat land from the floodings of tide water, or by excavating the earth and puddling to prevent leakage. They should be wholly isolated from surrounding water; but circumstanced so that a supply may at all times be at command to replace the ordinary consumption and losses occasioned by evaporation and otherwise.

When prepared and filled with saturated solutions either of common salt, (chlorate of soda,) or copperas, or alum, or any other material which may be preferred, the timber is to be placed in the reservoirs, there to remain until the sap vessels have become filled with the solution presented and until required for use.

But should this process fail, strong, air-tight wooden or iron vessels, filled first with timber, then with the requisite saline solution, and then exhausted by means of the common air pump, or expanded by heat so as to expel the air from the sap vessels, would be found every way competent to fill the sap cells of timber with preservative substances, and in no case at the expense of much power. Such an arrangement would, besides, be eminently adapted for the coloring and hardening of wood for cabinet work, pavements, railroads and for various other purposes. With this view I have made some experiments which promise well. I have also directed my attention to the protection of timber against the destructive action of the ship worm, (*Teredo navalis*,) on which subjects I intend, as soon as convenient to report the results to the association.

It may here be asked, what antiseptics are best adapted for reciprocal decomposition when presented to each other within the walls of the sap vessels? The answer, as I view the subject, is, that wood intended to be preserved by artificial means, if the saving of expense be an object, should, in the first place, be submerged in a solution of an alum composed of oil of vitriol, (sulphuric acid.) iron, clay (or alumina) and water, or in one of common copperas, (sulphate of iron.) until the sap cells have become filled, when it is to be removed and thoroughly air-dried under cover. It may next be immersed in any saline solution that will decompose that first applied, and when fully saturated be removed to a dry place under cover and there be suffered to season till required for use.

In lieu of the above named articles, blue vitriol (sulphate of copper) and common alum, (super-sulphate of potash and alumina,) may be used, and to those which do not contain an excess of sulphuric acid, a small quantity of this article may be beneficially added; in fact, if greatly diluted, it is of itself a powerful antiseptic. The solution in the second reservoir, for completing the process, may be composed either of the acetate of lime or the chlorate of lime, which on timber prepared as before described being placed in it, will penetrate its sap cells and occasion a reciprocal decomposition of the salts used.

If copperas be used in the first place and acetate of lime in the second, sulphate of lime and acetate of iron will result. The former in combination with the prot-oxide of iron is insoluble and alone sufficiently so to answer the purpose of its application, viz.: the closing of the sap vessels. The latter will remain in a fluid state till the aqueous portion evaporates, but in every state subject to be decomposed by oxygen as far as it may be present. Hence, it is one of the most valuable antiseptics that can be provided, because decomposition cannot take place unless this gas be present, and this salt (acetate of iron) will continue to absorb or combine with it till it is wholly decomposed or converted to a percetate. A change, protected as it would be by the woody fibres and by the partial closure of the sap cells, is not likely to take place in the course of many ages.

Many experiments have yet to be made before we arrive at a knowledge of the cheapest and best preparation for the preservation of timber.

The essential desiderata are—the expulsion of the sap from timber, the conversion of its soluble to insoluble portions, and the closing up, as far as practicable, of the sap vessels. The salts most economical and at present usually applied contain an excess of sulphuric acid. If it be not present to excess, it should be added, as before remarked, for it is to its coagulating property, exerted on caseous or albuminous portions of timber, that its efficacy chiefly depends. The metallic sulphates, if costs are to be taken into the estimate, are therefore preferable to any other with which experiments have hitherto been made.

Soaps from the metallic, earthy and alkaline salts have not, so far as my knowledge extends, been tried. I am now experimenting on some of them and believe they may be as useful for the preservation of timber as any other substance whatever, and they can certainly be applied at a much less expense than any other with which I am acquainted. But with these we must become further acquainted before we can determine their real value.

If the process of M. Boucherie be adopted and timber which has been previously charged with sulphate of iron be subjected to his water-tight sack apparatus, filled with an aqueous solution of quicklime, in such manner as to coerce its passage through its sap vessels, we shall have a compound of sulphate of lime and prot-oxide of iron formed at once in them, and perhaps at a cheaper rate than any other that can be devised.

It was my intention to have dwelled somewhat upon the best practical modes for coloring timber, but I have already much exceeded the limits which I had prescribed for the discussion of this and the other subjects proposed. I shall, therefore, be compelled to omit its consideration for some future occasion.

With this knowledge in respect to making a proper selection and preservation of timber before him, the ship and wharf builder, the carpenter and farmer, have it in their power to render their building and fencing materials very durable, almost imperishable, and that, too, if the importance of the measure be properly regarded, at a very inconsiderable expense.

This subject is particularly worthy the attention of our government, both in respect to the treatment of timber designed for the construction of ships and piers, and also for the preservation of vessels of war when laid up in ordinary.

In time of peace, it will be generally conceded that a national marine composed of small war vessels answers equally well numerically as the larger classes of ships for the naval service, while they are maintained at a much less relative expense. If this be correct, and the policy of retaining the smaller vessels in commission, or a portion of them during the continuance of peace while the larger ones are to be laid up, be adopted, then the question arises as to which will be the most economical measure for the government to pursue. Either to suffer our uncommissioned ships to decay at our wharves, and when wanted if worthy to repair or partially rebuild them; or, at a comparatively small expense, preserve them against decay so that at any time they may, with a small outlay on short notice, be re-commissioned for any public emergency? The answer cannot be mistaken, and the process is cheap, simple and certain.

It consists, in the first place, of divesting such vessels of their entire rigging and spars, closing them water-tight on all sides, filling them with a saturated solution, either of common salt, copperas, or such other antiseptic substance as may be preferred, and sinking them in fresh water, or in docks containing any solution similar to that with which they had been previously charged, even with or below their main decks, to suit the exigencies demanded by the occasion; but copperas will be decidedly better than the others mentioned, for the reasons before stated.

Piers may be constructed in some of our navigable fresh water streams, such for instance as the Potomac or James rivers, to protect them from ice, and they could be raised and fitted for service at the pleasure of the government in a very short time.

The material used in this manner for the preservation of ships would cost a mere trifle if compared with the ordinary expenses of repairs to which our marine as now managed is subject.

The solution so applied may when ships are wanted be transferred to earthy reservoirs on shore, and always be ready for repeated future use.

There could be no decay in the timber of ships so treated; the copper in or on their bottoms would remain entire, or undecomposed; or, if without copper sheating, they would be exempt from the depredations of insects; and, if copperas be the antiseptic used, such vessels would when brought into active service be strictly entitled to the name of *ironsides*: they would be very nearly incombustible as well as imperishable.

Timber that has been previously air-seasoned will be more speedily saturated than if recently dressed or water-seasoned.

It should be here remarked that common salt does not change the properties of the woody constituents; it merely combines or rather mixes with the fluids, and penetrates into the soluble portions in such manner as to prevent the action of copperas and alum; they fix or change the soluble permanently insoluble substances.

If I am correct, we have either of those two salts, that is, in the sulphate of iron and the super-sulphate of potash and alumina, applied separately, the desideratum essential to the preservation of wood; their application is not expensive, nor need there be any waste of material, nor diminution beyond what is absorbed by the timber conformably to the object proposed.

Of these two substances the salt of iron or copperas is to be preferred, because it costs less and will be found equally efficient. A triple acid—not known in commerce, but which can readily be prepared, and is as highly antiseptic as the super sulphate of potash and alumina—is an alum composed of water, sulphuric acid, iron and clay. It will be found when made on a large scale not much if any more expensive than copperas.

When desirable to subject timber to the action of two saline substances with a view to obtain the precipitation of their bases in the sap vessels, two reservoirs will be found necessary; that is, one to contain each of the salts in solution and into one of which the timber is to be first placed, and afterwards, when the sap vessels are full, it is to be removed to the other.

This process has been heretofore practiced, but was found not to answer the object contemplated, because after the vessels had become filled with a solution of one salt the precipitation which followed the introduction of another solution closed the orifices, and prevented the access of a further supply to the deeper cells of the wood. In consequence of this artificial means have been resorted to and the process is now found to be highly beneficial though attended with considerable expense.

But where time is no important consideration, as with governments, if proper attention be given to the process; such as sinking one end of the timber to a considerably greater depth in the reservoir than the other, and, when thoroughly charged, removing it from the solution and suffering it to become perfectly dry before it be placed in the other saline preparation. I believe the former process may be made to answer the purpose equally well, and may be effected much more economically.

This difference in the elevation of the ends of a piece of timber may be readily increased till it becomes perpendicular, and throughout every degree of the change the forces acting in the sap vessels, viz.: the pressure of the fluids in the reservoir against the air in them and capillary attraction are increased; certainly the former, and this force could be considerably augmented by depressing the timber in a vertical position to a greater depth, insomuch that no doubt remains in my mind as to the efficacy of the preservation of timber by the mode above described.